Establishing, Culturing, and Harvesting Stooling Beds

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This is the second article of a two-part series. "New Stock Types and Species from Stooling Beds" was published in the Winter, 2007 issue of FNN, and discussed the advantages of stooling beds, the types of plant materials they can produce, and which plant species can be successfully stooled. In this article, we finish up with how to establish stooling beds, culture them, and harvest the cuttings.

Installing Stooling Beds.

Planning - Stooling beds may take 2 or more years to produce significant numbers of harvestable cuttings, depending on species, clone, management practices, and length of growing season. In Colorado, 2 acres of stooling beds of *Salix* (willow) and *Populus* (cottonwood) yield 100,000 to 200,000 cuttings each year (Grubb 2007). In Saskatchewan, one acre of hybric poplar stooling beds can produce anywhere from 154,000 to 348,000 cuttings per year. The beds remain productive for 4 to 8 years, after which vigor and productivity start to decline, and new mother plants should be established (Saskatchewan Forest Centre 2003). Other conservation nurseries have maintained stooling beds of *Salix* and *Populus* clones for **12** to **15** years without losses in vigor.

Factors that must be considered when selecting an area of the nursery for stooling beds include soil conditions, species characteristics, type of plant material, and whether the beds will be maintained manually or with tractor-drawn equipment. The literature states that "nursery soils must be fertile and well drained" but stooling beds are much less demanding than other nursery crops. Productive stooling beds of cottonwood and willow have been established on silt, clay, or rocky soils that are unsuitable for raising seedlings and, as long as irrigation is provided, stooling beds will also do well on sandy soils. A major consideration when planning stooling beds is access during the winter harvesting season. If the cuttings will be harvested mechanically then soils should be well drained to allow tractor access. This is less of a concern in northern climates, where soils remain frozen and can easily support machinery. Where stooling beds will be harvested by hand, row spacing can be much closer and beds can even be established on slopes.

Species growth characteristics must also be considered during the planning process. With dioecious plants including willow and cottowood, it is important to collect cuttings from both male and female plants in the field to ensure good sexual diversity in the stooling beds (Landis and others 2003).

The growth habits of some willow and cottonwood limit their use in stooling bed propagation. For instance, coyote willow *(S. exigua)* produces aggressive lateral suckers and so cannot be cultured in standard rows. The Colorado State Forest Service Nursery grows this species in two 0.5-acre fields in which plants grow freely. The plants grow for 2 years before the first harvest to all allow the cuttings to reach shippable size. Then the fields are harvested every other year.

Figure 1 - The design of stooling beds depends on several factors including the type of plant material desired, and whether machinery will be used for culturing and harvesting. For typical cuttings, single rows and wide aisles allow mechanical harvest from the sides (A). For larger poles, blocks consist of rows of plants in wider blocks (B). Photo A courtesy of Big Sioux Nursery.

Narrowleaf cottonwood *(Populus angustifolia)* is also not grown in typical stooling beds. Production blocks consist of rows of 3 to 6 inch (8 to14 cm) trees which are 10 to 16 ft (3 to 5 m) tall. The tree branches and terminal shoots are manually cut back to the stem each winter during dormancy to harvest hardwood cuttings; this type of culture is very similar to pollarding (Grubb 2007).

The type of cutting to be harvested will also affect the design of stooling bed blocks. For typical hardwood cuttings, plants are grown in single rows and spaced so that harvesting can be done from all sides (Figure 1A). Specialty products like poles of tree willows and cottonwoods require wider blocks of more closely-spaced rows (Figure 1B).

Before planting a stooling bed, soils are usually prepared well in advance. Soil for stooling beds should be ripped to break-up hardpan layers and then roto-tilled to break up clods. In some cases, it may be necessary to apply herbicides the year before establishment to kill stubborn weeds and lower the weed seed reservoir in the soil.

Row and Plant Spacing - For willows and cottonwoods, stooling beds are usually established with nonrooted hardwood cuttings but seedlings or rooted container cuttings would also work. The best season for planting stooling beds is early spring to minimize transplant shock, although with proper care, they could be established throughout the growing season. Approximately 1,000 hybrid poplar cuttings were needed per acre when planting stooling beds on a 3 **x** 12 ft (0.9 x 3.6 m) spacing (Saskatchewan Forest Centre 2003).

Table 1—Information for installing stooling beds of native woody plants of the Pacific Northwest

Plant Species		Spacing of Cuttings within Rows (ft)***	Growth Rate of Sprouts	Height and Width of Established Plants (ft)
Scientific name	**Common Name**			
Baccharis pilularis	Coyote brush	1 to 2	Moderate	6 by 4
Cornus sericea	Red-osier dogwood	2 to 4	Fast	16 by 10
Oemleria cerastiformis	Indian plum	2 to 4	Moderate	16 by 10
Physocarpus capitatus	Pacific ninebark	2 to 4	Moderate to Fast	14 by 8
Philadelphus lewisii	Lewis mock orange	2 to 3	Moderate	10 by 8
Populus trichocarpa	Black cottonwood	3 to 4	Very Fast	150 by 30
Rosa woodsii	Woods' rose	2 to 3	Moderate to Fast	8 by **
Salix amygdaloides	Peachleaf willow	3 to 4	Very Fast	50 by 20
Salix exigua	Coyote willow	3 to 4	Fast	26 by**
Salix lasiolepus	Arroyo willow	3 to 4	Very Fast	35 by 25
Salix scouleriana	Scouler's willow	3 to 4	Very Fast	25 by 16
Spirea douglasii	Douglas spirea	2 to 3	Fast	7 by**
Symphoricarpos albus	Snowberry	2 to 3	Fast	5 by**

*=modified from Crowder and Danis (1999)
**=species that spread laterally by underground shoots or rhizomes
***=lft = 30cm

Many nurseries use a single row system for stooling beds and the spacing of rows and plants within rows varies by species. The spacing between rows will depend on the size of established plants and whether tractor access is desired. If all culturing and harvesting will be done by hand, then rows can be much closer together. The widths and heights for a variety of plant species is provided in Table 1 along with suggested in-row spacings. Mark the beginning and end of each stooling bed with permanent markers and develop detailed maps as you go along. It's a good idea to separate stooling beds of similar appearing clones or ecotypes to avoid possible confusion during mid-winter harvesting (Morgenson 1992).

With some difficult-to-root species such as redstem dogwood *(Corn us sericea),* it may be beneficial to use a rooting hormone to assist in root establishment (Dirr and Heuser 1987). Most *Salix* and *Populus* species have pre-formed root initials present in the stem tissues and will root to high percentages (90% or greater) without hormones. In South Dakota, however, some ecotypes of *Populus deltoides* do not root well (Larson 2007).

Culturing Stooling Beds

Irrigation - Newly established stooling beds must be irrigated frequently to keep the newly transplanted plants or cuttings from drying, and to stimulate production on new roots. Use of a black plastic row covering will help maintain soil moisture and increase the speed of rooting. Established stooling beds of riparian species like willows and cottonwood require very frequent irrigation for optimal growth. Sprinkler irrigation will work but sprinkler heads will need extensions to keep above the height of the rapidly growing plants. For willow stooling beds in Ontario, 1 to 2 inches (25 to 50 mm) of sprinkler irrigation is required per week (Mathers 2003). Drip or flood irrigation is a more water efficient way to irrigate stooling beds.

Fertilization - Nitrogen (N) is the most important mineral nutrient for achieving rapid establishment and growth but should be applied in a balanced fertilizer to avoid excessive vegetative growth (Morgenson 1992). Where soil tests have shown that fertility is naturally high, no fertilizer is usually applied until the newly established plants have put on 4 to 6 inches (10 to 15 cm) of top growth (Mathers 2003). For established stooling beds, fertilization should be based on annual soil testing, and many nurseries apply a balanced fertilizer twice per season. In New Mexico, stooling beds are fertilized twice at a rate of 50 to 75 lb/acre (56 to 84 kg/ha) N and 25 to 50 lb/acre (28 to 56 kg/ha) **P** (Dreesen 2007). Recent research indicates that early spring N provides little benefit and should be delayed until late spring. Foliar applications of N as urea (3% spray) in September have shown to be beneficial and, unlike fall soil N applications, do not delay dormancy nor increase the risk of damage from an early frost (Saskatchewan Forest Centre 2003).

Pest Management - Monitoring for pests on a regular basis is especially important. Both willows and cottonwoods are very susceptible to the stem fungus *Cytospora chrysosperma.* The fungus infects the bark and causes blackstem disease, which can lead to severe losses of cuttings in stooling beds. If infected cuttings are harvested, then the disease can spread during storage. The severity of blackstem diseases increase with the age of the stooling blocks, so it is suggested that stooling blocks not be used for more than 4 to 5 years (University of Illinois 2007).

Populus species are susceptible to cottonwood leaf beetle which can be heavy defoliators. In Colorado, leaf beetles are treated with one application of an imidacloprid insecticide. The difficultly in controlling this insect is that the egg stage appears to be resistant to insecticide treatments. Adults and egg stages of beetle development may be present at the same time and on the same leaf. A new crop of adults will emerge 1 to 3 weeks after initial treatment (Grubb 2007). Both willows and cottonwood are susceptible to leaf rusts and must be treated with fungicides on a regular schedule. Weeds are managed with pre-emergent herbicides, by spot treating with contact herbicides, and regular manual cultivation.

Roguing and Pruning - Unhealthy or diseased plants should be rogued from stooling beds and, if necessary, replaced with vigorous plants. Stooling beds must be cut back every winter, including the first year of establishment, to approximately 4 inches (10 cm) above ground (Figure 2). With some species, pruning too low to the ground will generate shoots the following spring that are prostrate in habit and are difficult to harvest with mechanical equipment (Saskatchewan Forest Centre 2003). Following pruning, some nurseries cover the root crowns with soil or mulch to stimulate more shoots the following season.

Some plants spread laterally by underground stems or rhizomes which can become a management problem. With these species, it may be necessary to laterally prune the edges of the stooling beds with a coulter or vertical blade.

Figure 2 - Stooling beds are harvested by hand or with machinery during the winter dormant period. The Big Sioux Nursery bundles whips together before cutting (A) and then transports the bundles in wooden boxes (B). Lincoln-Oakes Nursery uses a side-mounted harvester that is powered by a tractor (C). Photos A&B by Big Sioux Nursery and C by Greg Morgenson.

Harvesting and Processing

Timing - Hardwood cuttings are harvested from stooling beds when they are fully dormant, which usually means December through early March. Harvesting cuttings early in the dormant period ensures that carbohydrate levels are at their highest, and also allows adequate time for buds to fulfill their chilling requirement. Harvesting early also reduces the chances for winter desiccation, which can seriously reduce rooting percentages (Vanstone and others 1986). Fall watering of woody plants, especially in arid environments, is recommended to alleviate winter desiccation, and should improve the performance of the harvested cuttings.

Harvest Methods - Harvesting is done with everything from simple hand tools to custom fabricated equipment. However they are harvested, special care must be taken to preserve the natural polarity of the cuttings. Some nurseries cut the bottoms of the whips at an angle which establishes the polarity whereas other nurseries mark the tops or bottoms with paint.

Manual harvesting is accomplished with hand pruners, pruning shears, pruning saws, lopping shears, or tractor-mounted sickle bar mowers. After pruning, the whips are placed on trailers and transported to the packing shed for processing. The Big Sioux Nursery in South Dakota has developed an innovative way to speed-up harvesting (Larson 2007). They trap the whips together into tight bunches (Figure 2A) which makes them easier to cut and transport (Figure 2B).

Lincoln-Oakes Nursery in North Dakota has developed a side-mounted mechanical harvester powered by the PTO on a tractor (Morgenson 1992). Whips are severed with a rotating blade and then transported by belts to a person who catches them and places them in large box (Figure 2C).

Once harvested, the whips transported back to an unheated processing area or packing shed. Processing depends on the type of product desired. For propagation cuttings and live stakes, side branches are pruned off the whips that are bunched together and cut to the desired length with a band saw. Care should be taken to select healthy, vigorous material with plenty of vegetative buds. For propagation cuttings, the top ends are usually cut flat (90 degree angle) while the basal end is cut at an angle (45 degrees or less) for easier sticking in the field or greenhouse. The terminal portions of the whips are discarded because they contain flower buds and root poorly. All cutting tools should be sterilized frequently to prevent the spread of diseases, and some nurseries spray or dip the bundles in a Benlate/Thiram solution to prevent storage molds (Morgenson 1992). Finally, the cuttings are collected into bundles and bound with twine, string or even large rubber bands. Be sure to label bundles of cutting with permanent tags that won't fade or be damaged by moisture.

The bundles of cuttings are stored in outdoor heeling-in beds or indoor cooler storage to maintain dormancy until they will be used at the nursery or shipped. Because they can become desiccated, cuttings should be soaked in water for 2 to 3 days to encourage the root initials in the stems to swell (Mathers 2003).

Summary

Stooling beds are an effective way to produce a large number of healthy, vigorous cuttings for use in the nursery or for sale to clients. Compared to field collection, stooling beds ensure that all cuttings will be collected at the proper time and will be of the proper species and genetic source. When properly established and cultured, stooling beds can remain productive for many years.

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