Forest Farming

Wisconsin Guidance Document 379

INTRODUCTION

Forest farming (formerly known as multi-story cropping) is an agroforestry practice that has several vertical layers of vegetation that include an overstory (canopy) and includes either or both of a midstory (shrub level) and understory. All of these layers can be productive either as a food forest with edible crops or for other uses such as medicinal herbs and mushroom production.

Other names that could create confusion are: two-dimensional farming, perennial polyculture, food forests, edible landscaping, woodland and forest gardening. Depending on how these are implemented, they could also fit the definition of Forest Farming.

WHERE USED:

Forest Farming is used on cropland, pasture, farmstead, or associated agriculture lands where improved economic or environmental conditions are desired over the existing farming practices. At this time WI NRCS is not manipulating existing forests to implement forest farming.

RESOURCE MANAGEMENT SYSTEM

The primary supporting practice for Forest Farming is Tree/Shrub Site Preparation (Code 490). It is crucial to have a well-prepared site prior to planting trees and shrubs. Site preparation is often the difference between planting success and failure.

Tree/Shrub Pruning (Code 660) may be needed as the forest farm begins to mature and light levels need to be managed to support understory shrubs and/or crops.

When Forest Farming is used for soil erosion control, trees or shrubs should be planted on the contour in conjunction with herbaceous vegetation. There may be situations where soil erosion in areas of concentrated flow will not be managed by tree planting and vegetation alone. Practices such as Grade Stabilization Structures (410, 638), Diversions (362), Terraces (600), Critical Area Plantings (342), and/or Lined and Grassed Waterways (412, 468) may need to be considered, designed, and implemented prior to tree and understory planting.

Supporting practices include:

- 490 Tree/Shrub Site Preparation

- 612 Tree/Shrub Establishment (in particular, this practice houses several guidance documents with useful information for tree and shrub plantings)
- 340 Cover Crops
- 660 Tree/Shrub Pruning
- 484 Mulching

WILDLIFE

Forest Farming provides opportunities to improve wildlife habitat for some species by creating travel lanes connecting important habitat areas, providing cover, and improving vertical structure. If possible, plan to include a variety of species that will result in different sizes and ages of vegetation. When wildlife habitat enhancement is a concurrent purpose, native species adapted to the site should be chosen. If the property is in an area important to grassland birds (areas of southwest and central Wisconsin), consider effects to grassland habitat. Site the project to minimize disrupting the connectivity of grasslands or consider other conservation practices like planting of prairie grasses (Wildlife Habitat Planting, Code 420).

PLANNING CONSIDERATIONS

Preplanning

Forest Farming involves adding new crops, products, and management tasks to an operation. Before implementing forest farming, careful planning around the following considerations is recommended.

Labor

- How will this new enterprise fit into existing labor across the season?
- Which new skills are needed? Do these skills exist within the current management team, or will help be required?

Machinery

- How will existing machinery be used? Will new machinery be required?
- Will new facilities be needed to house and service machinery?

Markets

- Is there an available market for forest farming products?
- Do these products fit into existing marketing streams for the farm?

Harvest and Storage

- How will new crops be harvested, processed, and stored? Does this fit within the existing processing on the farm, or will new infrastructure be required?

Challenges: There are many benefits to forest farming. There can also be challenges, most of which can be overcome by careful planning. Challenges include:

- Land use is constrained by tree layout for many years.

- Upfront costs of installation and maintenance of trees and other plants before economic return is realized.
- Increased labor and management complexity

Forest farming might not be a good fit if any of the following are true:

- Potentially tree-damaging herbicide drift cannot be eliminated from neighbors using such herbicides.
- Forest farm crops such as timber, medicinals, nuts, or fruit do not have an available local market.
- Land is rented annually, and a long-term lease is not possible.
- The goal with the trees or shrubs is nursery production where they will be removed from the ground and sold off site– this is not the intended purpose of this practice.

Site Selection

If different sites are under consideration, the preferred conditions of the species desired for planting will help in choosing a site. Conversely, if only one site is available the producer will need to select species that thrive in those site conditions. Factors to consider when evaluating a site include topography, indicator species growing nearby, soil, and site security (for high value crops). A more general factor is the hardiness zone of the area, although factors such as topography might create warmer or colder micro-climates that may not exactly match the general hardiness zone.

Topography and Site Size – Topography is the physical layout of the land. Slope and aspect are two important topographical considerations for forest farming. Slope is the steepness of a site. Flat sites with good drainage may be desirable for a food forest operation where vegetables, fruits, or mushrooms might be grown within the forest farm and require regular labor to maintain and harvest these products. Gentle to moderate slopes (~5 – 15% slope) are preferable for many medicinal herbs that thrive with good drainage and are harvested more intermittently. These slopes may also facilitate sap collection with tubing if tree sap is a desired product. Steep slopes are more limited in what might be able to be grown and regular access will be difficult.

Aspect is the direction that a slope faces. This is an important consideration for the amount and intensity of sunlight a site receives and the temperature of the site. South and west facing slopes tend to be drier and warmer, while north and east facing slopes tend to be cooler and moister. Many food crops and late-blooming fruit trees will appreciate the warmer and sunnier conditions on south and west facing slopes. Medicinal plants, mushrooms, early-blooming fruit trees (to delay blooming and avoid frost damage), and sap trees such as sugar maple generally prefer the cooler and moister conditions on north and east facing slopes.

In all cases, avoid low-lying areas where cold air pools. These are known as frost pockets and have shorter growing seasons than the rest of the landscape.

Topographic maps or digital resources that combine aerial imagery with topography are good tools for exploring the features described above.

Consider the size of the site and surrounding conditions as well. It may be difficult to create moist and cool shade conditions on sites that are small or long and linear. This is mostly a concern where the surrounding area is open and will allow abundant sunlight and drying winds into the site from the edges.

Additional design elements may be needed to block sunlight and wind around the edges of the site in these situations.

Indicator Species – It can be helpful to identify plants already growing on similar sites (similar slope, aspect, soils, and drainage in particular) on or nearby the property. For example, certain tree species can indicate good conditions for growing many medicinal plants, especially trees that thrive on rich soils or prefer calcium-rich sites. Tree species that thrive on those types of sites include sugar maple, basswood, shagbark hickory, black walnut, and hackberry. Wild plants (many spring ephemerals) also indicate these site conditions, including Virginia bluebells, hepatica, toothwort, Dutchman's breeches, spring beauty, jack-in-the-pulpit, cohosh, maidenhair fern, or wild specimens of the medicinal plant of interest. Knowing that these indicator tree and/or plant species are thriving on similar sites in the area can indicate that growing medicinal plants is a good choice for the site.

Soil – The attributes of the soil on the site are extremely important. Soil conditions can change rapidly within small areas and land use history may also change soil attributes. It is recommended that producers check the Web Soil Survey to learn the general attributes of their soil. However, recognize that the soil survey happened at fairly large scales and may not be suitable for interpretations at the scale of a few acres. Soil tests can help identify more specifically the attributes of the soil on the site. Follow sampling protocols of the agency or entity who will be analyzing the soil. In general, rich soils with good drainage will be capable of growing many different crops. Sandy soils will be more limited in nutrients and water retention, which will limit choices of trees and crops that can be planted. Clay soils will not drain as effectively and may provide operational challenges when wet. While soil can be fertilized or amended, recognize that many trees and other plants like medicinal plants do not respond favorably to fertilizer. Using mineral-based amendments that release nutrients slowly may be suitable to avoid this issue.

Security – Some forest farming products, such as medicinal plants, have enough value where theft is a potential issue. If this is a potential issue, consider how close the site is to a road or property boundary and if the site can be closely monitored, such as sites close to the producer's residence. Having the property well-posted can deter trespassing or assist in prosecution if a theft does occur.

<u>Tree Selection</u>

Tree Crops or Timber Trees - When choosing trees, it is important to decide whether the main purpose will be for timber or a regularly harvested crop (nut/fruit/sap). Historically, Native Americans would have managed similar systems for tree crops including serviceberries, plums, maple sugar, and acorns. Tree crops are often common components of present-day forest farming systems as well, but do require intensive annual management (pruning, nutrient management, pest control, and harvesting). Timber trees require relatively little management compared to fruit, nut, and sap crops. Primary management is periodic pruning and thinning to develop trees with straight trunks and few branches on the lower part of the trunk. However timber trees do not provide income for several decades. Tree species capable of producing valuable sawtimber include black walnut, northern red oak, white oak, sugar maple, red pine, and white pine. Note that markets and value of timber can change over time. An additional consideration is availability of professional services. While management of timber can usually be contracted out to professional foresters, the network of those knowledgeable about tree crop

management is much smaller. Consequently, opting for tree crops in forest farming requires a conscious decision about who will be managing/harvesting/marketing the tree crops, and what the financial arrangement with them will be.

Density and Configuration - The density, or how many trees there are per acre, has a major effect on how the forest farming system will function. It is important to consider the medium and longer-term goals of the system when planning for density. Note that a minimum density is required of 30 trees/acre that will reach at least 13' in height at maturity.

The design of each level of the canopy should account for the shade tolerance of each species over the maturation of the forest farm, especially desired species in the understory. Plan to transition to different understory crops as the trees grow and light levels change at ground level. Some berry-producing shrubs such as aronia, serviceberry, and elderberry are shade tolerant but yield more fruit in full sun. Likewise, pawpaw prefers partial shade, but fruit yield maximizes in full sun. Vegetable farming may be part of the system early in the life of a forest farm when there is still abundant sunlight on the ground (e.g., a food forest system). These plants may be most productive only in the first decade of establishment and taper off in production as the trees grow. Other understory crops such as medicinal plants or mushrooms thrive in shade and may be suitable to transition to as the trees provide more shade. Species selection and density of the overstory trees must be chosen with goals in mind for the mid-story and understory crops over time. Research the shade requirements for the understory crop(s) of interest and plan the tree canopy accordingly.

Different tree planting configurations may also create different possibilities for understory shrubs and food crops. Gaps may be left within the general matrix of trees where more light-demanding plants can be grown for a longer period. A more even planting of trees will help in making consistent shade conditions for many medicinal plants or mushrooms.

Within the growing season, light penetration to the understory forest crops is important. Along with tree planting density and configuration, the leaf characteristics of different species of trees may also affect light penetration. Trees that have thin canopies that allow more light through may be more favorable than trees that cast deep shade, depending on understory crop. Likewise, trees that leaf out late in the season and/or drop their leaves early in the fall also allow more light penetration early and late in the growing season. Trees such as black walnut have all these characteristics. For crops that prefer shade, species such as sugar maple have deep crowns that provide these conditions.

Other factors to consider when thinking about density and configuration include use of equipment, soil erosion potential, and purpose of the tree planting (timber or tree crops).

Often in these systems maintenance work and harvest of crops is by hand. However, if equipment is planned to be used, make sure trees are spaced to accommodate the width of the widest piece of equipment used. If the long-term plan is to use mechanical harvesting equipment, the width and height of the equipment will need to be factored in when designing the planting. Make sure to leave room around the perimeter of the forest farm for equipment access and turn around space, again based on the width of the widest piece of equipment used. If trees will be configured in widely spaced rows (or sets of rows) to allow alleys of crops to be grown in open areas in-between, use the Alley Cropping (Code 311) conservation practice standard instead of forest farming.

On sloped soils that are at risk of erosion, trees and understory crops are usually planted closer together as the slope increases to provide more cover and have more root mass to hold the soil. Planting closer together would also help mitigate potential soil erosion on sites that are prone to flooding.

Some tree crops (e.g. chestnuts or maple sap) require ample light hitting the sides of the canopy to maximize production, while timber trees grow straighter and taller when crowded closer together. The 'Agroforestry Species List' in the Wisconsin Field Office Technical Guide (WI FOTG Section 3>Conservation Planning Tools>Forestry) can give an idea of typical tree and shrub spacing by species. Also consider the efficiencies of grouping trees/shrubs producing crops by harvest season.

Spacing of trees and shrubs is determined mainly by the specific spacing standards of the tree species being used. Typically, tree spacing at maturity is recommended to mirror the mature tree spacing in a monoculture tree crop orchard or timber tree plantation. However, initial tree spacing is often much closer than the mature spacing. Many tree species, both tree crops and timber trees, are recommended to be initially planted at "double density". There can be several reasons for this:

1) Tree mortality over time will naturally reduce tree density towards the final mature density.

2) If genetically non-uniform tree seedlings are used, as is often the case in timber plantations, the unfavorable individuals can be culled over time.

3) For some tree crops, the revenue (harvest of crop) provided by the "extra" trees during the early years before thinning is required can more than pay for the costs of their establishment.

Tree Suitability - Select trees that are suitable for the local climate, landscape, and soil conditions.

Tree and shrub species native to each Wisconsin county can be found in the WI Native Tree and Shrub Guide by County, and those suitable for nut/fruit production can be found in the Agroforestry species list (WI FOTG Section 3>Conservation Planning Tools>Forestry). Trees in these lists have information either on appropriate soil drainage characteristics or other soil factors that will assist in matching potential trees to the site.

Because trees are long-lived, it may be worth considering how climate change will affect tree suitability. The Tree/Shrub Establishment (Code 612) Planting Guide guidance document has a section on tools that can be used to choose native species adapted to future climate conditions (WI FOTG Section 4>Conservation Practice Standards & Support Documents>Tree/Shrub Establishment).

Use caution when trying species that may be new to the area due to changes in hardiness zone or when factoring in predicted future climate. Hardiness zone maps are based on averages, and you may need to protect the young trees from killing frosts in spring and possibly fall until fully established. During a severe winter, species that are adapted to warmer conditions may top-kill. Often, they will re-sprout the following growing season, but this pattern may repeat itself several times before the plant is well-established.

Diversity is an important consideration when selecting species to plant. A more diverse planting will be resilient to insect and disease issues that affect one species or a limited number of species. Diverse plantings are also more likely to have several species that can adapt well to future climate conditions. Diversity has to be weighed against production goals but is valuable to incorporate if possible.

Black walnut is a tree with potential timber value and nut crop production (when grown on appropriate sites). However, it is important to note that black walnut produces a chemical called juglone that can affect some crops. Woody species that are sensitive to juglone include white oak, basswood, alder, chestnut, apple, pear, blackberry, blueberry, and grapes. Food crops susceptible to juglone include asparagus, cabbage, eggplant, pepper, potato, rhubarb, and tomato.

Some trees have the capacity to "fix" nitrogen from the atmosphere. However, avoid planting nitrogen-fixing trees or shrubs that are listed as invasive under Wisconsin state law, such as black locust (*Robinia pseudoacacia)* and black alder (*Alnus glutinosa*).

If wind relief is needed outside of the growing season, adding rows of conifer trees to block problem winds may be appropriate. See Windbreak Establishment and Renovation (Code 380) Wisconsin guidance document for more information on determining problem winds and windbreak design (WI FOTG Section 4>Conservation Practice Standards & Support Documents>Windbreak Establishment and Renovation).

Pests and Diseases - If growing fruit or nut trees, select varieties that are resistant to the common diseases in the area. Adding trees to a landscape usually attracts beneficial insects, but sometimes trees and shrubs can be alternate hosts for pests and diseases. For example, trees in the rose family (hawthorn, mountain ash, spirea, cotoneaster) can host fireblight that can infect apples and pears. Eastern red cedar (*Juniperus virginiana*) and other junipers act as a host for cedar apple rust, a major apple disease. Native plums and hawthorn can become a haven for apple maggot. Consult pest and disease manuals for the forest farm crops being planned. The University of Wisconsin-Division of Extension Learning Store often has information on common tree and shrub pests and diseases (https://learningstore.extension.wisc.edu/ or search for "UW Extension Learning Store" in a web browser).

Design - Many forest farms will be of relatively small-scale. Planning the configuration may need to be more detailed than larger planting projects. Creating a paper plan or using landscape design software at an appropriate scale (e.g., 1" = 8', 1" = 10', or 1" = 25') may be appropriate to account for crown widths of trees when they reach maturity. Careful measurement of the site, including all features that need to be considered (e.g., property boundary, cropland edge, woods, roads, buildings, waterbodies, power lines or other utilities, septic systems), is important to the design. Trees and shrubs can be represented by circles, scaled to the mature crown width. Ensure that mature trees will not encroach on or damage buildings, roads, or utilities. Consider potential effects of shade to adjacent land uses or properties. Creating a plan that shows mature tree crown widths will help ensure the planting does not result in future problems to infrastructure or adjacent properties. This plan can also help visualize canopy cover and how much light will be reaching understory shrubs and/or crops. Resources such as the Morton Arboretum website have data on mature crown width for trees grown in open settings.

Urban areas may have unique design challenges. Factors mentioned above like proximity to buildings, roads, or utilities are even more important in urban areas where infrastructure and adjacent properties are often closer together. In addition, there can be unique soil conditions like salinity or contamination that may need to be addressed prior to planting. There may also be additional regulations at city, municipal, or other entities that must be considered in the design.

ESTABLISHMENT

Tree establishment begins with good site preparation. Consult Tree/Shrub Site Preparation (Code 490) and Tree/Shrub Establishment (Code 612) Planting Guide for guidance. If starting with an agricultural field recently planted to annual crops, site prep may be minimal. Any amendments to adjust pH, such as lime, should be applied at this time. If starting with a fallow field or sod conditions, tree seedlings do not compete well with grass or weed competition. Tillage or herbicides will eliminate this competition from planting areas, however tillage may bring up weed seeds from the seedbank which can then establish and cause problems. Using herbicides will result in less ground disturbance and less likelihood of encouraging weed seeds to sprout. If planting into sites with sod and more established weeds, site preparation will likely take longer and be more intensive. If non-native invasive plant (NNIP) species are established on the site, use Brush Management (Code 314) or Herbaceous Weed Treatment (Code 315) to control these species prior to establishment. This will likely take several years depending on the level of NNIP density and size. Constant monitoring is required to detect new populations of NNIP that might start from the seedbank or seed transported by wildlife from adjacent properties.

Sites with compacted soil should be sub-soiled to allow tree roots to establish further into the soil. Otherwise, tree roots will spread shallowly when dealing with compacted soil, making the trees more vulnerable to being blown over by wind. When working on slopes that are 6% or steeper, do site preparation on the contour to minimize soil erosion.

Planning will also need to be done to determine the size of the tree stock available. Larger tree stock (potted or ball-n-burlap) will result in faster establishment of trees and shade, although is more expensive. Smaller stock (often bareroot) will take longer to provide shade, but is less expensive.

<u>Timeline</u>

Preparation for tree establishment should begin at least the year prior to planting to provide plenty of time for site preparation and ordering trees. If NNIP are present the timeline might include several years of control efforts prior to establishment. Timing for establishing forest farming systems typically revolve around a spring planting of the trees, as this is when most nursery stock is available. Often times nursery stock needs to be ordered in the fall prior to the spring planting to have access to the widest selection of seedlings. Fall is also an excellent time to plant trees, but nursery stock is often limited at this time.

The following is a rough preparation timeline leading up to a spring tree establishment:

Summer. In the summer before tree establishment, the main goal is to prepare a weed-free site. If the existing site is in row-crops then this is likely not an issue, and nothing needs to be done. However, if the existing site is in hay, pasture, or other perennial groundcover such as weeds or NNIP, then substantial preparation work will be required. There are a wide range of approaches available to kill perennial ground cover. See Tree-Shrub Site Preparation (Code 490) and Tree-Shrub Establishment (Code 612) for tree planting guidance documents.

Fall. Once the row-crops have been harvested or the perennial groundcover has been killed, the next step is to mark out where the trees and/or shrubs will be planted (call Diggers Hotline to mark underground utilities that might need to be avoided prior to marking tree locations). This can be done using a variety of techniques, from sophisticated GPS surveying equipment to a simple tape measure.

Planting spots should be marked with flags or other markings that will last until the spring. Research nurseries with stock adapted to the applicable hardiness zone and order trees and shrubs at this time.

Winter. The winter is the best time to schedule tree shipment from the nursery and order any other required supplies, such as tree tubes. In addition, the late winter is the best time to frost-seed some common groundcovers, such as Dutch white clover, if these will be used for temporary erosion control (when choosing groundcovers ensure they are compatible with desired forest farm plants).

Spring. The spring is focused on actual tree establishment. With spring weather often unpredictable, it is important to leave a large window for tree establishment so that ideal conditions can be taken advantage of when they appear. Planting as soon as ground conditions allow is ideal for tree establishment, when soil moisture is most abundant and temperatures are still cool.

MANAGEMENT

Weed Control and Herbicides

Post-planting weed control is very important, especially with grass competition. Tree and shrub seedling's roots do not compete well with grass roots until the trees are established and can find space below the grass rooting zone. Grass competition should be controlled for the first three to five years following planting in a minimum of a 3' circle (1.5' radius) or 3'x3' square around each tree (although a 6' diameter circle will allow even better tree growth). The Tree/Shrub Establishment (Code 612)-Planting Guide guidance document has more information on methods for competition control. If using tree tubes on the trees, the tubes are often made with no ventilation holes in the bottom 12-24" of the tube so that herbicide can easily be sprayed right up to the tree tube without any concern for accidentally spraying the tree seedling.

When using any herbicide, always follow the label and consider the potential effects on trees and crops. Herbicides often provide the most effective control of undesirable plants while the forest farm is becoming established. It is recommended to use the University of Wisconsin Extension Service weed control resources or WI DNR weed management resources for herbicide recommendations for specific weeds.

The following hierarchy of herbicide approaches is preferred:

1) Focus on pre-emergent herbicides. These are herbicides that act on weed seeds, not on the weeds themselves. Consequently, most of these herbicides have little impact on trees. However, ensure that they will not affect planting of covers or understory crops.

2) With grass weeds, use grass-specific herbicides. If grass weeds are the only issue, it is best to use a grass-specific herbicide instead of a broad-spectrum herbicide.

3) With broadleaf weeds, use extreme caution. Most herbicides that kill broadleaf weeds can also harm trees, shrubs, and other perennial plants, although the degree of harm varies widely. If herbicides for broadleaf weeds are required, then the goal is to prevent drift onto the trees or other desirable plants.

4) Be aware that carry-over residual effects of some herbicides can last several years, so reviewing past herbicide usage is recommended before planting trees and shrubs.

Mulching and/or establishing cover crops can also be effective in controlling weeds (assuming that site preparation has initially controlled weeds), and also help prevent soil erosion. Mulching trees increases growth, reduces competition from weeds, and can benefit soil quality as mulches break down. Common bio-based mulching materials include wood chips, bark, straw, and hay. Synthetic mulches like weed mats and landscape fabric are also available. Mulching large plantings will require a large volume of mulch, so careful planning around sourcing (including likelihood of weed seeds being present in the mulch), hauling, and applying mulch is necessary. Mulch should be applied in a ring 1.5-3' out from the tree (3-6' diameter) at a depth of 2-4". Avoid mulch "volcanoes", where the mulch is piled around the tree or shrub stem. This can cause rot or encourage rodents that damage the trees in winter by chewing bark. Mulch should be thickest on the outside of the ring and thin as it reaches the stem of the tree or shrub. The mulch should not make contact with the stem. Mulch may need to be reapplied every two to three years.

Mechanical cultivation in the forest farm will be difficult, especially as the trees get larger, so the area is often planted to a low-growing groundcover cover crop. The groundcover should be compatible with crops grown in the understory of the forest farm. An example of a common low-growing ground cover is Dutch white clover. It is easy to establish, spreads across the ground to cover up bare patches, does not compete with woody vegetation, and effectively keeps weeds out. Competitive species to avoid as groundcovers include alfalfa, reed canary grass, brome grass, tall fescue, Canada goldenrod, and perennial asters.

Branch Pruning

Most tree crops and timber trees require annual or periodic pruning. Tree crops require pruning to select branch ages and branch density that optimize productivity. Timber trees require pruning to minimize the knots caused by branches, which reduce timber value, particularly in the lower 12 – 16' of the tree bole. In addition, regular branch pruning of trees in forest farming can reduce tree canopy density and increase the amount of light that reaches the understory. It is important to space plantings to allow access during the pruning season. Consider tree diseases such as oak wilt when determining season of pruning. It will be important to assess after storms for damage and prune or replace trees as necessary. Some forest crop yields can be drastically reduced by untimely or mistargeted pruning. Learn how to prune each of the species in the forest farm properly.

Tree Shelters

Tree shelters are an important tool for protecting young trees. There are several types of shelters, but the most commonly used in forest farming are ventilated plastic tubes that are held in place with a single stake. The primary benefits of using tree shelters include:

- Protecting trees from rodents that can eat bark and girdle the trees. However, note that tree tubes can be attractive to rodents for winter nests if they are not seated properly in the ground.
- Protecting trees from deer and other animals that browse tree leaves and twigs.
- Protecting trees from weed control herbicide applications (most tree tubes do not have ventilation holes in the bottom 12-24" of the tube for this reason).
- Providing a clear delineation of tree locations when trees are small so that they are not accidentally damaged.

- Discouraging branch formation below the height of the tree tube, which minimizes pruning labor in the early years and prevents branches from forming at low heights which could interfere with other forest farm operations.

Tree shelters require annual maintenance. They should be checked at least once per year to ensure the stakes are sound, ties or other attachments are still holding, and the tube is in a vertical position. In fall (after leaves have dropped), clearing out vegetation from the bottom of the tube can help prevent rodents from nesting in the tubes over winter and damaging the trees within. Using pea gravel around the base of the tube can also help deter rodents, as well as help with anchoring the shelter. Bird netting is recommended for use over the top of the tube opening until the seedling grows to near the top of the tube. This is particularly important if bluebirds are present in the area. Bluebirds are prone to flying into the tube but are then unable to fly back out. Bird netting prevents them from entering the tube. Netting must be removed before the seedling emerges from the tube to prevent the growing tip of the tree from being deformed.

Irrigation

In most years, there is adequate rainfall for tree and shrub seedlings to survive without irrigation. While irrigation is optional when establishing trees, its use can greatly increase tree survival, growth, and productivity if a drought occurs. It can be helpful to think of an irrigation system as an insurance policy for the trees. The large cost of an irrigation system (and an adequately sized well if none is present) is the primary detriment to its adoption. If opting to include an irrigation system, it is critical that the system be installed in such a way that avoids hindering understory crops and tree management. For this reason, drip irrigation systems with belowground supply lines are a good choice.

If the irrigation system is to be blown out or drained for winter, it is often best to wait until late fall. Fall drought can cause tree mortality by damaging the roots and irrigation will help prevent this.

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