MULTIFUNCTIONAL PERENNIAL CROPPING SYSTEMS

Supplemental Design Information

Research funding provided by USDA
Multifunctional Perennial Cropping Systems
Supplemental Design Information

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Created by the Agroforestry for Food research group at the University of Illinois at Urbana-Champaign. Visit www.Agroforestry4Food.com for additional information and updates on multifunctional perennial cropping systems and related projects.

This book was originally created as part of a broader research study to help inform central Illinois landowners on the species, design, and planning of multifunctional perennial cropping systems (MPCs). Much of the information has been taken from outside sources to provide a single coherent book for use when considering MPCs. The “Financial Support” and “Marketing” sections as well as the “Appendix” are adapted directly or nearly directly from the sources cited and are not the work of the Agroforestry for Food research group. The remaining sections are either original work or integrate work from the cited sources. The book is not intended for sale and is freely available for sharing.

Images: The cover photo displays a mixed species alley cropping system at the University of Illinois at Urbana-Champaign - courtesy of Kevin Wolz. The back cover displays photos courtesy of Wendy Yang and Kevin Wolz.

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Mixed species row — Black Currant and Chinese Chestnut
Background

What are multifunctional perennial cropping systems (MPCs)?

MPCs are an agricultural system integrating various trees, shrubs, and perennial herbaceous plants to produce high-value food products and ecosystem services.

The term “multifunctional” refers to the landscape potential to provide ecological, cultural, and provisioning functions. The term “perennial” reflects the type of species used, primarily woody trees and shrubs. Lastly, “system” is used to highlight the integrated use of multiple species across the landscape. These systems are designed to target the marginal lands of farms where productivity is limited. MPCs include many traditional conservation practices such as windbreaks, hedgerows, alley cropping, riparian buffers, and bioenergy/biomass production.

Multi-story cropping—various species of different heights can be grown together in MPCs

Diagram adapted from original design by Amy Koester and courtesy of Kevin Wolz
What are the research goals for MPCs?

MPCs research is trying to advance the connection between producers, landowners, and researchers to move towards user-focused design and participation. A truly sustainable agricultural system must be suitable for each group involved. In this research, the goals are to understand the types of MPCs landowners prefer, the reasons for selecting those MPCs, and the barriers and motivators for adopting them.

Why focus on MPCs?

The agricultural landscape has been transformed to meet the needs of farmers, consumers, and global markets at the expense of social and environmental health. Conventional agriculture has degraded soil and water quality, wildlife habitat, rural health, and biodiversity. MPCs represent a potential system to help move towards solving the core issues of agriculture while meeting the benefits of conservation.

MPCs and conservation land

Currently, conservation programs pay landowners to take marginal land out of production to improve environmental outcomes. Doing so is costly to taxpayers and results in a loss of production. However, if ecosystem services can be generated from conservation land while additionally maintaining a level of profitability, then we may be able to bridge the gap between conservation and production. We hypothesize that MPCs can maintain a level of economic productivity while significantly improving the portfolio of ecosystem services produced on the land. The hope is that MPCs can be adapted to the unique needs and wants of landowners to become a useful type of conservation agriculture moving forward.

Inspired by the oak savanna

The central Illinois landscape was covered by oak savanna and prairie prior to settlement. These areas contained a wide diversity of species in a series of different canopy layers which have inspired the design and composition of MPCs. The native species of each layer are listed here.

**Canopy Trees:** Oak

**Medium Trees:** Crabapple, American Plum, Black Cherry

**Shrubs:** American Hazelnut, Elderberry, Gooseberry

**Brambles:** Blackberry, Raspberry

**Grasses/Forbs:** Prairie Grasses and Forbs

**Vines/Lianas:** Wild Grape

Multi-story cropping with trees and shrubs
What are the benefits of MPCs?

MPCs are designed for long-term productivity, environmental health, and cultural well-being. Using a mix of native and non-native perennial species in a systematic fashion can have numerous positive impacts. Below are a list of the possible benefits that may be provided by MPCs.

**Financial:** Planting perennial crops on land unsuitable for row crops provides income on acres that are otherwise unprofitable. The range of products produced differ from traditional grain crops and increase a farm operation’s diversity.

**Wildlife:** An array of perennial trees and shrubs provide habitat and food for a variety of mammals, birds, and insects throughout the year.

**Cultural:** Trees and shrubs incorporated into the landscape can be beautiful, and provide recreational opportunities for landowners. A diversity of edible food products that can be used in local communities and provide opportunities for work, education, and recreation.

**Soil and Water:** Perennial plants help prevent soil erosion and improve soil organic matter, structure, and water holding capacity. Also, deep rooted woody plants can reduce nutrient runoff by capturing nutrients from soil layers not accessible by annual crops, and maintain access to water during droughts.

**Biodiversity:** A mix of perennial crops may improve a farm’s resilience to harmful climatic events, disease, or other unpredicted future outcomes that may hurt a farm’s productivity.

**Climate:** Perennial plants sequester carbon in woody materials above and below ground reducing the net carbon released into the atmosphere. MPCs are also better adapted to climate extremes such as drought, heavy rainfall, and warmer temperatures.

What are the disadvantages of MPCs?

Planting multiple different perennial plants adds labor, complexity, and uncertainty to a farm enterprise no matter how small. Many species used in MPCs are uncommon and understudied. A lack of information means there is greater risk involved. The markets for non-traditional products may be more difficult to access than traditional crops, if they exist at all. Labor may be greater in the early years as plants need additional care to become established. The time till harvest of perennial crops is much longer than annual crops. Additionally, higher upfront costs means returns may not be realized until several years later. The variety of concerns that come along with MPCs must be weighed alongside their benefits to determine if they are suitable for a landowner.
Design

How should MPCs be designed?

Landowners must be the focus when considering how a complex, non-traditional agricultural system should be designed. Many alternative agriculture solutions are set-up using a standard solution to meet a specific goal often not considering the landowner. Without bearing in mind the unique characteristics of the land and how it is managed, a practice may not truly be accepted.

For MPCs, it is important to examine land at a farm scale, and thus build agricultural systems with the landowner included in the design process. The designs should be unique and personal like a farmer’s land. This allows researchers to understand what is wanted from MPCs, and how they may actually be used. Finally, practices used in MPCs should be informed by expert opinion in relevant fields such as forestry, agronomy, ecology, biology, etc.

Design elements of MPCs

1. **User preferences**: needs, goals, and values of the landowner, manager, and other stakeholders
2. **Landscape**: soil, climate, surroundings (buildings, forests, rivers, etc.)
3. **MPCs theory**: multifunctional species and combinations for food, ecosystem services, and human interaction
4. **Expert opinions**: input from professionals in the fields related to the practices used

The diagram shows the primary elements that go into the design of MPCs. The size of the circles roughly correlate to the importance of the variables in shaping the design.
MPCs scenarios

Building a framework

A general framework is needed when creating a design to put the numerous species, patterns, and objectives into a cohesive plan. Scenario planning can help select plausible situations for a certain landscape in the future by establishing how and why something is being done. Normative scenarios are one such method that works well in designing landscapes such as MPCs because of their unique ability to portray plausible, reasonable futures that may not yet exist.

Scenario development

Survey data interviews conducted with landowners in central Illinois helped identify general perceptions, needs, and wants regarding MPCs. Three goals stood out as to why a landowner would adopt MPCs. The goals were expanded upon by using opinions from experts in biology, forestry, and agronomy to develop the details of each scenario listed below.

- Production
- Conservation
- Culture

The three scenarios, which were formed from a study on landowner preferences of MPCs and conducted by the Multifunctional Landscape Analysis and Design Lab at UIUC, are described in detail on the following pages.

Normative scenarios

Normative design scenarios are plausible and reasonable situations that could and/or should exist in the future. They create the potential for engaging science and stakeholders to explore landscape policy and scientific questions in imagined alternative landscapes. Normative scenarios go beyond the “projected” future and examine the desired or preferred alternatives. The process allows landowners to inform science, and science to inform landowners in a collaborative process to achieve a novel agricultural system that may not have developed on its own.

<table>
<thead>
<tr>
<th>Annual</th>
<th>Perennial</th>
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<td>Herbaceous</td>
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<td>Monoculture</td>
<td>Polyculture</td>
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<td>Open System</td>
<td>Closed System</td>
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Conventional Agriculture  Multifunctional Solutions

Developing MPCs requires landowners to look beyond the current state of agriculture and consider a transformative landscape.
Scenario: production

The purpose of this scenario is to focus on high-production of food, ease of harvest, and economic viability.

How might this come about?

In this scenario, national interest in healthy, sustainable food continues to grow. This results in a rapid expansion of fruit and nut crops across the Midwest United States to produce locally productive and profitable perennial crops. Harvesting equipment becomes available through local cooperatives. Facilities are built to process nuts, fruits, and berries for value added and shelf-stable products. Demand for alternative fruits and nuts results in profitable, accessible markets (both wholesale and retail). Government support for alternative perennial crops remains similar to its current level.

Target benefits

- Profitability
- Income diversification relative to conventional agriculture
- Involvement in emerging specialty crop sector
- Low diversity for ease of management, harvest, and marketing
- High provisioning services
- Minimal complexity

Design patterns

- Plant spacing suitable for mechanical harvesting
- Use of waterways for bioenergy crops
- High-value timber species along borders
- Highly marketable species as primary crops
- Avoid removing cropland from production unless landowner states otherwise
- Grazing lands incorporated into cropping systems
- Similar to orchard cropping
- Focus on marginal land
- Low number of species
- No species mixing in-row to maintain ease of management

Species used

**Primary:** Chinese Chestnut, Northern Pecan, Black Walnut, Black Currant, Aronia

**Secondary:** Swamp White Oak, Red Oak, Elderberry, Cider Apple, Shrub Willow, Bioenergy (see herbaceous species)
Scenario: conservation

The purpose of this scenario is to promote native species for conservation and environmental benefits while maintaining a level of fruit and nut production for profit.

How might this come about?
Government interest in native perennial crops for their environmental benefits increases. The NRCS and FSA provide additional funds for establishment, management, and research into native perennials. Funding follows similar guidelines in place now where the primary purpose of these systems is to meet a minimum set of ecosystem benefits, but additionally the production benefits are acknowledged. Farmers can harvest selectively from conservation land for profit. Native fruit and nut species are subsidized and insured which makes planting them more viable. Ecosystem services and wildlife habitat production are quantified and eligible for tax-credits. CRP, EQIP, and other conservation programs become clear paths to establishing MPCs long-term. Marginal lands, even if not previously cropped, qualify for funding as well.

Target benefits
- Use of marginal land
- Plant and habitat diversity
- Native plants use
- Increased wildlife habitat
- Improved pollinator habitat
- Water quality improvements
- Eligible for conservation programs

Design patterns
- High diversity of species
- Primarily native species
- Species placed strategically to mediate environmental issues
- Increased cover and habitat for wildlife
- Mixed species rows to increase diversity within cropping fields
- Use of species and practices eligible for conservation programs (CRP, EQIP, etc.)

Species used

**Primary:** Northern Pecan, Prairie Crabapple, Juneberry, American Plum, American Hazelnut, American Persimmon, Elderberry, Aronia

**Secondary:** Swamp White Oak, Shellbark Hickory, Black Walnut, Norway Spruce, Highbush Cranberry, Eastern Red Cedar, and Prairie mixes (see herbaceous species)
Scenario: culture
The purpose of this scenario is to incorporate plants and patterns with high levels of visual quality, human experience, and education potential.

How might this come about?
Previous work examining the use of aesthetics as a driving force behind adoption leads to the careful consideration of how sustainable cropping systems can be selectively incorporated into the landscape. Landowners and governmental groups increasingly value aesthetic quality and underlying ecosystem services for various reasons such as improving interest in rural areas, diversifying homesteads and marginal grounds, and producing local foods. Public interaction with the land is considered ideal and profitable (agro-tourism). Research institutions show increased interest and funding for establishing on-farm trials and educational sites.

Target benefits
- Improved rural aesthetics
- Increasing cultivation of culturally significant materials
- Educational uses
- Recreation/community involvement
- Agro-tourism potential
- Research potential

Design patterns
- Planting patterns to improve aesthetic qualities and human experience
- Use of gradients in planting patterns
- Incorporation of research based field sites
- Mixed species rows with economic viability
- Incorporation of landowner preferences, needs, and goals
- Incorporation of recreational areas (U-pick, trails, etc.)
- Lower reliance on straight lines in planting patterns
- Use of a diversity of herbaceous grasses with flowering species on problematic areas

Species used
Primary: Chinese Chestnut, European Hazelnut, Black Currant, Northern Pecan, Aronia, Eastern Redbud, Diverse Polyculture Mix (see herbaceous species)
Secondary: Juneberry, Aronia, Persimmon, Raspberry
Where to place MPCs?

MPCs are placed on “opportunity lands” which can be classified as areas that are environmentally sensitive, not currently productive, or not used because of a farmer identified reason. “Opportunity lands” are identified using information from the NRCS Web Soil Survey, landowner interviews, and site visits.

Components of “opportunity lands”

• Marginal land
  » Unsuitable soil type
  » Sloped, erodible
  » Poor drainage
  » High flooding frequency

• Farmer identified
  » Field borders
  » Difficult to access
  » Not productive
  » Small irregularly shaped fields
  » Other

Marginal land

The NRCS Web Soil Survey identifies soil type, pH, and drainage ratings. Custom soil resource reports can be generated for each landowner’s property. Soils with more than 5% slope, poor drainage, and pH less than 6 or greater than 7.8 are considered marginal unless otherwise described by the landowner.

Farmer identified

The landowner must be consulted to identify opportunity land by outlining areas seen as problematic, unproductive, or difficult to farm.

Species selection

A list of species suitable for MPCs was formed out of consultations with experts in the fields of agroecology, forestry, and landscape design. The aim of species selection is to find timber, nuts, fruits, and berries that can be grown easily without excessive chemicals or labor and will provide environmental, economic, and cultural benefits. Though some of these species have yet to develop well-defined markets or management strategies, they are perceived as strong candidates for MPCs.

A complete list of species considered useful in MPCs can be found in the appendix section ‘Additional species information.’

Species mixing

The combination of multiple species of varying canopy heights into one row has two distinct advantageous: profit maximization and spatial efficiency. First, mixing allows a faster-growing understory to flourish and provide profit while a slower growing over-story matures. Secondly, combining species together in a single row saves space while minimizing competition with alley crops. Additionally, by using proper species and spacing, it is possible to reduce above- and below-ground competition for resources by selecting plants that occupy different rooting zones and canopy levels.
MPCs practices

MPCs practices are modeled after conservation practices used by the Natural Resources Conservation Service (NRCS) to address natural resource issues. The table to the right shows which MPCs practices are typically used and the similar NRCS practice.

**Note:** Two MPCs practices formed out of current MPCs research at The University of Illinois and are described below.

**Productive Conservation:** A diverse assemblage of native fruit and nut crops planted together in a single row. The goal of this practice is to qualify for CRP and provide a diversity of ecosystem and cultural benefits.

**Multifunctional Woody Polyculture:** Alley cropping with alternating mixed species rows of Chestnut-Black Currant and European Hazelnut-Black Currant.

To learn more about NRCS Conservation Practices, refer to the appendix or go to [www.nrcs.usda.gov](http://www.nrcs.usda.gov).

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<th>NRCS practices</th>
<th>MPCs practices</th>
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<tr>
<td>Alley Cropping</td>
<td>• Productive Conservation</td>
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<td></td>
<td>• Multifunctional Woody Polyculture</td>
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<tr>
<td>Biomass Planting</td>
<td>• Diverse Polyculture</td>
</tr>
<tr>
<td></td>
<td>• Shrub willow plantings</td>
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<tr>
<td></td>
<td>• Mixed Grass Biomass</td>
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<tr>
<td>Hedgerow Planting</td>
<td>• Productive Hedgerow</td>
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<td></td>
<td>• Fruit Border</td>
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<td></td>
<td>• Flowering Border</td>
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<td>• Native Production Border</td>
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<td>• Timber Border</td>
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<tr>
<td>Multi-Story Cropping</td>
<td>• Productive Conservation</td>
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<td></td>
<td>• Chestnut-Currant Production</td>
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<td></td>
<td>• Pecan-Aronia Production</td>
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<tr>
<td></td>
<td>• Multifunctional Woody Polyculture</td>
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<tr>
<td>Riparian Forest Buffer</td>
<td>• Pecan-Aronia Production</td>
</tr>
<tr>
<td></td>
<td>• Mixed plantings along waterways</td>
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<td>Tree/Shrub Establishment</td>
<td>All designs include trees and shrubs and fall under this category</td>
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<tr>
<td>Windbreak/Shelterbelt Establishment</td>
<td>• Windbreak</td>
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<tr>
<td></td>
<td>• Timber Border</td>
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<tr>
<td></td>
<td>• Productive Buffer</td>
</tr>
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Design workflow

The placement of species and combinations for a particular area is guided by landscape qualities (slope, drainage, context, etc.), participant preferences, and the design scenario/goals. The questions on the right are used to guide selection and placement of species. After the designs are formed, they are checked by the landowner and an expert from a related field to make sure they are plausible and reasonable. Any feedback is then incorporated into the designs to create the final versions. The various steps in the design process for MPCs are simplified below.

Guiding questions

1. What are the qualities and requirements of the landscape, scenario, and landowner?
2. Where are there opportunity lands to place species?
3. Which species are suitable for this scenario and the land available?
4. Which species combinations best meet the overall goals?
5. Are the species selected and placed in a plausible and reasonable manner?

This diagram shows a simplified version of the steps taken to create designs for a landowner.
Species Information

Selected MPCs species

Species in MPCs are chosen based on their unique attributes. The type of plant, its growth rate, products, and labor requirements have significant impacts on the management of a farm. Landowners should be aware of what each species entails before deciding to grow them. This section contains various tables outlining species characteristics to help inform decisions about planting, managing, and selling the products of various potential MPCs species.

Note: The tables in this section should only be used as an informational tool. The values given are not a guarantee. Location, weather, management, varietal, and other variables all contribute to the overall success.

Key

Suitable soil drainage classes (Drain): (1) poorly, (2) somewhat, (3) moderately-well, (4) well

Growth (rate): Slow, Medium, Fast

Zones: USDA Hardiness Zones

Products: Nuts, Fruits, Berries, Timber, Ornamentals, Wildlife food

<table>
<thead>
<tr>
<th>Common name</th>
<th>Latin name</th>
<th>Form</th>
<th>Height</th>
<th>Width</th>
<th>Drain</th>
<th>pH</th>
<th>Growth</th>
<th>Zones</th>
<th>Product</th>
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<tr>
<td>Apple (dwarf)</td>
<td>Malus domestica</td>
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<td>8-10’</td>
<td>6-10’</td>
<td>2-4</td>
<td>6.1-7</td>
<td>F</td>
<td>4-9</td>
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<td>25-35’</td>
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<td>F</td>
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<td>3-8’</td>
<td>2-6’</td>
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<td>5.5-8</td>
<td>S-F</td>
<td>3+</td>
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<td>Taxodium distichum</td>
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<td>25-35’</td>
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<td>75-100’</td>
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<td>6.1-8.5</td>
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<td>6-12’</td>
<td>6-12’</td>
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<td>3.5-6</td>
<td>S</td>
<td>4-8</td>
<td>B, W</td>
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<td>10-12’</td>
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<td>20-35’</td>
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<td>Gooseberry</td>
<td>Ribes uva-crispa</td>
<td>shrub</td>
<td>3-5'</td>
<td>3-5'</td>
<td>3-4</td>
<td>5.1-7</td>
<td>M</td>
<td>3+</td>
<td>B</td>
</tr>
<tr>
<td>Grape</td>
<td>Vitis vinifera</td>
<td>vine</td>
<td>12-20’</td>
<td>12-20’</td>
<td>3-4</td>
<td>6.1-7</td>
<td>F</td>
<td>6-9</td>
<td>B</td>
</tr>
<tr>
<td>Hazelnut, European</td>
<td>Corylus americana</td>
<td>shrub</td>
<td>12-25’</td>
<td>25’</td>
<td>2-4</td>
<td>5.5-8</td>
<td>M-F</td>
<td>4+</td>
<td>N</td>
</tr>
<tr>
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<td>Corylus avellana</td>
<td>shrub</td>
<td>6-12’</td>
<td>6-20’</td>
<td>2-4</td>
<td>6.5-7.5</td>
<td>M-F</td>
<td>3+</td>
<td>W, N</td>
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<tr>
<td>Hazelnut, Hybrid</td>
<td>Corylus x hybrids</td>
<td>shrub</td>
<td>12-20’</td>
<td>12-15’</td>
<td>2-4</td>
<td>5-7.5</td>
<td>M-F</td>
<td>3+</td>
<td>N, W</td>
</tr>
<tr>
<td>Hickory, Shagbark</td>
<td>Carya lacinosa</td>
<td>tree</td>
<td>70-85’</td>
<td>30-50’</td>
<td>2-4</td>
<td>6.1-7</td>
<td>S</td>
<td>4-7</td>
<td>N, T</td>
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<tr>
<td>Hickory, Shellbark</td>
<td>Carya ovata</td>
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<td>70-85’</td>
<td>30-50’</td>
<td>1-3</td>
<td>6.1-8.5</td>
<td>M</td>
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<td>N, T</td>
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<td>Honeyberry</td>
<td>Lonicera kamschatia</td>
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<td>5’</td>
<td>5’</td>
<td>3-4</td>
<td>6.1-8.5</td>
<td>F</td>
<td>4-8</td>
<td>B</td>
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<tr>
<td>Juneberry (Saskatoon)</td>
<td>Amelanchier alnifolia</td>
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<td>5-15’</td>
<td>5-15’</td>
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<td>5.5-7.5</td>
<td>M</td>
<td>2-5</td>
<td>B, W, W</td>
</tr>
<tr>
<td>Mulberry, Red</td>
<td>Morus rubra</td>
<td>tree</td>
<td>35-50’</td>
<td>35-50’</td>
<td>3-4</td>
<td>6.1-8.5</td>
<td>F</td>
<td>5-9</td>
<td>L, B</td>
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<tr>
<td>Oak, Overcup</td>
<td>Quercus lyrata</td>
<td>tree</td>
<td>40-90’</td>
<td>40-90’</td>
<td>1-4</td>
<td>4.5-6</td>
<td>M</td>
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<td>W, T</td>
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<td>Quercus rubra</td>
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<td>4.5-7</td>
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<td>5-8</td>
<td>T</td>
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<td>Oak, Swamp White</td>
<td>Quercus bicolor</td>
<td>tree</td>
<td>75-100’</td>
<td>50-75’</td>
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<td>6.1-7</td>
<td>M-F</td>
<td>4+</td>
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<td>Asimina triloba</td>
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<td>20-35’</td>
<td>20-35’</td>
<td>1-4</td>
<td>5.5-6.5</td>
<td>S-M</td>
<td>5-7</td>
<td>F</td>
</tr>
<tr>
<td>Peach (standard)</td>
<td>Prunus persica</td>
<td>tree</td>
<td>15-20’</td>
<td>20-25’</td>
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<td>6.1-7</td>
<td>M</td>
<td>4-9</td>
<td>F</td>
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<tr>
<td>Pear, Asian</td>
<td>Pyrus bretschneideris</td>
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<td>25-30’</td>
<td>25’</td>
<td>1-4</td>
<td>5.5-7.5</td>
<td>M</td>
<td>4-9</td>
<td>F</td>
</tr>
<tr>
<td>Pear (semi-dwarf)</td>
<td>Pyrus communis</td>
<td>tree</td>
<td>15-20’</td>
<td>15’</td>
<td>1-4</td>
<td>6.1-7</td>
<td>M</td>
<td>4-9</td>
<td>F</td>
</tr>
<tr>
<td>Pecan, Northern</td>
<td>Carya illinoinensis</td>
<td>tree</td>
<td>75-120’</td>
<td>75-120’</td>
<td>2-4</td>
<td>6.5-8</td>
<td>S</td>
<td>6-9</td>
<td>N, T</td>
</tr>
<tr>
<td>Persimmon, American</td>
<td>Diospyros virginiana</td>
<td>tree</td>
<td>50-75’</td>
<td>35-50’</td>
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<td>5.1-8.5</td>
<td>S-M</td>
<td>5-9</td>
<td>F</td>
</tr>
<tr>
<td>Plum, American</td>
<td>Prunus americana</td>
<td>tree</td>
<td>20-35’</td>
<td>20-35’</td>
<td>2-4</td>
<td>6.1-8.5</td>
<td>F</td>
<td>3-8</td>
<td>F, W</td>
</tr>
<tr>
<td>Plum (standard)</td>
<td>Prunus domestica</td>
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<td>10-15’</td>
<td>3-4</td>
<td>6.1-7</td>
<td>M</td>
<td>4-9</td>
<td>F</td>
</tr>
<tr>
<td>Prairie Crabapple</td>
<td>Malus ioensis</td>
<td>tree</td>
<td>10-25’</td>
<td>10-25’</td>
<td>2-4</td>
<td>5.1-8.5</td>
<td>M</td>
<td>4-8</td>
<td>W, F, O</td>
</tr>
<tr>
<td>Raspberry, Red</td>
<td>Rubus idaeus</td>
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<td>4-6’</td>
<td>3-4</td>
<td>6.1-7</td>
<td>F</td>
<td>3-9</td>
<td>B</td>
</tr>
<tr>
<td>Serviceberry</td>
<td>Amelanchier arborea</td>
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<td>5-15’</td>
<td>2-4</td>
<td>3.5-7</td>
<td>M</td>
<td>2-8</td>
<td>B, O, W</td>
</tr>
<tr>
<td>Spruce, Norway</td>
<td>Picea abies</td>
<td>tree</td>
<td>80-100’</td>
<td>25-40’</td>
<td>2-4</td>
<td>5-7</td>
<td>M-F</td>
<td>2-7</td>
<td>T</td>
</tr>
<tr>
<td>Spruce, White</td>
<td>Picea glauca</td>
<td>tree</td>
<td>40-60’</td>
<td>15-20’</td>
<td>2-4</td>
<td>6-7.9</td>
<td>S-M</td>
<td>2-6</td>
<td>W</td>
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<td>Salix spp.</td>
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<td>10-20’</td>
<td>1-4</td>
<td>5.5-8.5</td>
<td>F</td>
<td>3-9</td>
<td>O, W</td>
</tr>
</tbody>
</table>

**Key**

*Suitable soil drainage classes (Drain):* (1) poorly, (2) somewhat, (3) moderately-well, (4) well

*Growth (rate):* Slow, Medium, Fast

*Zones:* USDA Hardiness Zones

*Products:* Nuts, Fruits, Berries, Timber, Ornamentals, Wildlife food
Common plant spacing

Spacing depends on the manager’s goals, land, harvest method, and equipment available. The numbers provided in the table are for typical orchard style plantings and may be different than what is used in a mixed species system.

The first two columns provide plant spacing for machine harvest while the last two provide spacing for hand harvest. If the species does not have a value for machine harvest, it is either unknown or not commonly machine harvested.

<table>
<thead>
<tr>
<th>Species</th>
<th>In-row spacing: Machine (ft.)</th>
<th>Between-row spacing: Machine (ft.)</th>
<th>In-row spacing: Hand (ft.)</th>
<th>Between-row spacing: Hand (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple (dwarf)</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Apple (semi-dwarf)</td>
<td>-</td>
<td>-</td>
<td>14-18</td>
<td>20-25</td>
</tr>
<tr>
<td>Apple (standard)</td>
<td>-</td>
<td>-</td>
<td>18-25</td>
<td>20-25</td>
</tr>
<tr>
<td>Aronia</td>
<td>3-4</td>
<td>12-14</td>
<td>8</td>
<td>6-8</td>
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<tr>
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<td>-</td>
<td>-</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Blueberry, Highbush</td>
<td>5-6</td>
<td>12-14</td>
<td>5-7</td>
<td>8-10</td>
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<tr>
<td>Cherry, Sour</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Cherry, Sweet</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>25</td>
</tr>
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<td>Chestnut, Chinese</td>
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<td>30</td>
<td>30</td>
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<td>Cranberry, Highbush</td>
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<td>-</td>
<td>5-6</td>
<td>8-10</td>
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<td>3-5</td>
<td>12-15</td>
<td>3-5</td>
<td>8-10</td>
</tr>
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<td>Currant, Red</td>
<td>-</td>
<td>-</td>
<td>3-5</td>
<td>8-10</td>
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<tr>
<td>Elderberry</td>
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<td>-</td>
<td>4</td>
<td>12</td>
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<td>Gooseberry</td>
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<td>-</td>
<td>3-5</td>
<td>8-10</td>
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<tr>
<td>Grape</td>
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<td>10</td>
<td>6</td>
<td>10</td>
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<td>Hazelnut, European</td>
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<td>15-20</td>
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<td>16</td>
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<td>6-9</td>
<td>10-16</td>
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<td>Juneberry</td>
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<td>17-20</td>
<td>3-5</td>
<td>12-13</td>
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<td>-</td>
<td>-</td>
<td>25-30</td>
<td>25-30</td>
</tr>
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<td>Pawpaw</td>
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<td>-</td>
<td>8</td>
<td>12-18</td>
</tr>
<tr>
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<td>-</td>
<td>14</td>
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<td>Pear, Asian</td>
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<td>15</td>
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<td>Pear (semi-dwarf)</td>
<td>-</td>
<td>-</td>
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<td>Pecan, Northern</td>
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<td>30</td>
</tr>
<tr>
<td>Plum, American</td>
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<td>16</td>
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<td>Prairie Crabapple</td>
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<td>20</td>
</tr>
<tr>
<td>Raspberry, Red</td>
<td>-</td>
<td>-</td>
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<td>8</td>
</tr>
<tr>
<td>Serviceberry</td>
<td>-</td>
<td>-</td>
<td>20-25</td>
<td>20-25</td>
</tr>
</tbody>
</table>

Timber Spacing

Typical spacing for a timber planting is 8-12’ in-row and 10-15’ between-row. With these densities, periodic thinning is required every several years to provide space for growing trees.
Yield and harvest

Yield information varies widely by climate, management, soil type, and cultivar selection. Yields provided here are useful to compare different species with each other.

### Nuts, Fruits, and Berries

<table>
<thead>
<tr>
<th>Species</th>
<th>Yield lbs. (per tree)</th>
<th>Years to begin bearing:</th>
<th>Years to full production</th>
<th>Useful life (years)</th>
<th>Harvest dates (start)</th>
<th>Harvest dates (end)</th>
</tr>
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<tbody>
<tr>
<td>Apple (dwarf)</td>
<td>50-150</td>
<td>(2-4)</td>
<td>5</td>
<td>15</td>
<td>10-Jul</td>
<td>10-Nov</td>
</tr>
<tr>
<td>Apple (semi-dwarf)</td>
<td>180-300</td>
<td>(3-5)</td>
<td>10</td>
<td>20</td>
<td>10-Jul</td>
<td>10-Nov</td>
</tr>
<tr>
<td>Apple (standard)</td>
<td>300-400</td>
<td>(4-6)</td>
<td>10</td>
<td>50</td>
<td>10-Jul</td>
<td>10-Nov</td>
</tr>
<tr>
<td>Aronia</td>
<td>15-20</td>
<td>2</td>
<td>5</td>
<td>150</td>
<td>21-Aug</td>
<td>15-Sep</td>
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<tr>
<td>Black Walnut</td>
<td>~120</td>
<td>10-16 (3-6)</td>
<td>-</td>
<td>30-200</td>
<td>1-Sep</td>
<td>31-Oct</td>
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<tr>
<td>Blueberry, Highbush</td>
<td>7+</td>
<td>3-5</td>
<td>8</td>
<td>10-15</td>
<td>Varies</td>
<td>Varies</td>
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<td>50-60</td>
<td>(4-5)</td>
<td>10-20</td>
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<td>20-Jun</td>
<td>30-Jul</td>
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<tr>
<td>Cherry, Sweet</td>
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<td>50+</td>
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<td>20-Oct</td>
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<td>100+</td>
<td>1-Aug</td>
<td>30-Sep</td>
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<td>3-10</td>
<td>2.3</td>
<td>4-6</td>
<td>10-20</td>
<td>1-Jul</td>
<td>31-Jul</td>
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<td>1-Jun</td>
<td>15-Jul</td>
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<td>3-4</td>
<td>5+</td>
<td>20-Jul</td>
<td>10-Sep</td>
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<td>Gooseberry</td>
<td>4-8</td>
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<td>4-6</td>
<td>15-20</td>
<td>20-Jun</td>
<td>20-Jul</td>
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<tr>
<td>Grape</td>
<td>10-30</td>
<td>2-3</td>
<td>4-5</td>
<td>50+</td>
<td>1-Sep</td>
<td>20-Oct</td>
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<td>Hazelnut, European</td>
<td>10-15</td>
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<td>1-Oct</td>
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<td>1-Oct</td>
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<td>Hazelnut, Hybrid</td>
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<td>1-Sep</td>
<td>1-Oct</td>
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<td>31-Oct</td>
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<td>1-2</td>
<td>3-4</td>
<td>30+</td>
<td>10-Jun</td>
<td>31-Jul</td>
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<tr>
<td>Honeyberry</td>
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<td>4-5</td>
<td>8-15</td>
<td>30-50</td>
<td>1-Jun</td>
<td>31-Jul</td>
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<tr>
<td>Juneberry</td>
<td>5-10</td>
<td>4-5</td>
<td>8-15</td>
<td>30-50</td>
<td>1-Jun</td>
<td>31-Jul</td>
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<td>-</td>
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<td>1-Aug</td>
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<td>4-9</td>
<td>15-20</td>
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<td>1-Sep</td>
</tr>
<tr>
<td>Pear, Asian</td>
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<td>(3-7)</td>
<td>8-10</td>
<td>50+</td>
<td>1-Jul</td>
<td>1-Oct</td>
</tr>
<tr>
<td>Pear (semi-dwarf)</td>
<td>60-300</td>
<td>6-8 (2-3)</td>
<td>8-10</td>
<td>15+</td>
<td>1-Aug</td>
<td>1-Oct</td>
</tr>
<tr>
<td>Pecan, Northern</td>
<td>30-50</td>
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<td>20-25</td>
<td>300+</td>
<td>20-Sep</td>
<td>31-Oct</td>
</tr>
<tr>
<td>Persimmon, American</td>
<td>50-100</td>
<td>6-8 (2-3)</td>
<td>25-50</td>
<td>20-300</td>
<td>1-Sep</td>
<td>31-Oct</td>
</tr>
<tr>
<td>Species</td>
<td>Yield lbs. (per tree)</td>
<td>Years to begin bearing: seedling (grafted)</td>
<td>Years to full production</td>
<td>Useful life (years)</td>
<td>Harvest dates (start) (end)</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------</td>
<td>------------------------------------------</td>
<td>--------------------------</td>
<td>---------------------</td>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td>Plum, American</td>
<td>50-100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1-Sep 1-Nov</td>
<td></td>
</tr>
<tr>
<td>Plum (standard)</td>
<td>100-100</td>
<td>(3-4)</td>
<td>4-6</td>
<td>15</td>
<td>1-Aug 1-Oct</td>
<td></td>
</tr>
<tr>
<td>Prairie Crabapple</td>
<td>-</td>
<td>3-5</td>
<td>-</td>
<td>-</td>
<td>10-Jul 10-Nov</td>
<td></td>
</tr>
<tr>
<td>Raspberry, Red</td>
<td>5-8</td>
<td>1-2</td>
<td>3-4</td>
<td>6-10</td>
<td>Varies</td>
<td></td>
</tr>
<tr>
<td>Serviceberry</td>
<td>-</td>
<td>2-4</td>
<td>-</td>
<td>30-50</td>
<td>1-Jun 31-Jul</td>
<td></td>
</tr>
</tbody>
</table>

**Timber**

<table>
<thead>
<tr>
<th>Species</th>
<th>Financial maturity (years)</th>
<th>Optimum maturity (years)</th>
<th>Harvest DBH (inches)</th>
<th>Age at senescence (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Walnut</td>
<td>40-60</td>
<td>60-80</td>
<td>24-26</td>
<td>130</td>
</tr>
<tr>
<td>Hickories</td>
<td>60-80</td>
<td>80-120</td>
<td>18-22</td>
<td>130</td>
</tr>
<tr>
<td>Red Oak</td>
<td>40-60</td>
<td>60-80</td>
<td>20-26</td>
<td>100</td>
</tr>
<tr>
<td>White Oak</td>
<td>60-80</td>
<td>80-120</td>
<td>24-30</td>
<td>200</td>
</tr>
</tbody>
</table>

**Herbaceous species**

A multifunctional system is not limited to woody species. Perennial herbaceous plants can also provide numerous benefits key to sustainable farming. The following are some of the possible benefits:

- Biofuel production
- Pollinator habitat
- Increased diversity
- Reduced nutrient runoff
- Improved wildlife habitat
- Improved soil quality

Herbaceous plants used in MPCs are native, and combinations of these are widely used in conservation plantings across the Midwest United States. The table to the right displays many of the commonly used species.
Herbaceous mixes

**Native Bioenergy**
*Species:* Switchgrass, Big Bluestem, Indiangrass

*Purpose:* Species selected in this mix are known to have high potential as native bioenergy crops that can generate ecosystem benefits.

**Diverse Polyculture**
*Species:* Switchgrass, Big Bluestem, Little Bluestem, Prairie Cordgrass, Indiangrass, Compass plant, Lead plant, Illinois Bundleflower, Coneflowers

*Purpose:* The diverse polyculture mix is a selection of nine native species that have a high potential for biomass production, bioenergy, and environmental benefits. Many of the bioenergy crops under consideration, such as big bluestem and prairie cordgrass, are native grasses that are well suited to riparian and lowland buffer conditions.

**Prairie**
*Species:* Rose Milkweed, Prairie Blazing Star, Mountain Mint, Obedient Plant, Sweet Black-eyed Susan, Compass Plant, Prairie Dock, Big Bluestem, Purple Meadow Rue, Ohio Spiderwort, Golden Alexanders, Foxglove Beardtongue, White Wild Indigo plant, Yellow Coneflower, Purple Prairie Clover, Rattlesnake Master, and more.

*Purpose:* Prairies increase aesthetic quality, pollinator and wildlife habitat and food, improve soil quality, reduced erosion, and perennial cover for non-productive land. A vast diversity (50+ species) of early and late blooming, short and tall species are used to provide an abundant diversity.

**Why include bioenergy into MPCs?**

In the coming years, there will likely be a significant increase in the use of bio-based transportation fuels as the US and other countries set specific goals for replacing petroleum-based fuels with renewable sources. Greater demand for biofuels will place greater pressure on our land resources. To resolve this pressure, focusing on converting marginal land into perennial herbaceous crops suitable for bioenergy is a viable solution. Bioenergy crops can be very useful for MPCs in areas where woody crops may not be viable or productive.
Establishment

Site planning
The establishment of perennial crops typically takes between 3 to 4 years. During this time, additional care is needed to ensure the plants have sufficient water, little to no weed pressure, and are protected from predators. Good establishment techniques can reduce the time spent caring for a site in the future. A proper MPCs establishment includes:

- Good site preparation
- Proper planting techniques
- Adequate care for plants

Row orientation
The orientation of plant rows impacts how much light and air circulation is received. Rows planted in a north-south orientation will receive the most light. Rows planted east-west will receive better airflow and improve light availability for crops between the rows. On sloped land it is recommended to plant along contours to meet harvesting needs, reduce soil erosion, and provide proper air circulation.

Site preparation
Before planting, make sure a site is free of perennial weeds and has been adequately worked to receive transplants. It is difficult to control weeds once transplants are in the ground and growing.

Ground cover
It is highly recommended to establish a ground cover one to two years before planting trees and shrubs. Ground cover establishment is made easier by not having to work around trees, especially within a tree row. A ground cover should be dense enough to deter weeds. A mix of 2-4 species with clumping and running habits ensures proper coverage and diversity. Be sure to understand the advantages and disadvantages of selecting a certain ground cover. For example, fast-growing grasses will require more labor but can be hayed and sold. Low growing covers such as Dutch White Clover require less care and can provide pollinator habitat and fix nitrogen.

Planting time
Dormant plants, usually bareroot, should be planted in the spring as soon as the soil can be worked. Container plants may be planted anytime as long as adequate irrigation is provided. Avoid the use of fertilizer when planting to discourage irregular root growth.
Irrigation

It is important to provide adequate water during the establishment phase. Drip irrigation is recommended because it uses less water than other methods, reduces weed pressure between plant rows due to lack of moisture, and can be automated.

Trees per acre

It can be difficult to estimate the number of trees needed to plant a site. The chart below provides the estimated number of plants needed per acre given different in-and between-row spacings.

Plants per Acre by Row Spacing

<table>
<thead>
<tr>
<th>In-row Spacing (ft.)</th>
<th>Between-row Spacing (ft.)</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td>3630</td>
<td>2723</td>
<td>2178</td>
<td>1815</td>
<td>1452</td>
<td>1089</td>
<td>871</td>
<td>726</td>
<td>622</td>
<td>545</td>
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<tr>
<td>3</td>
<td></td>
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<td>1815</td>
<td>1452</td>
<td>1210</td>
<td>968</td>
<td>726</td>
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<td>5</td>
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<tr>
<td>6</td>
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<td>726</td>
<td>605</td>
<td>484</td>
<td>363</td>
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<td>8</td>
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<td>136</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>726</td>
<td>545</td>
<td>436</td>
<td>363</td>
<td>290</td>
<td>218</td>
<td>174</td>
<td>145</td>
<td>124</td>
<td>109</td>
</tr>
<tr>
<td>12</td>
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<td>182</td>
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<td>121</td>
<td>104</td>
<td>91</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>484</td>
<td>363</td>
<td>290</td>
<td>242</td>
<td>194</td>
<td>145</td>
<td>116</td>
<td>97</td>
<td>83</td>
<td>73</td>
</tr>
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<td></td>
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<td>182</td>
<td>145</td>
<td>121</td>
<td>97</td>
<td>73</td>
<td>58</td>
<td>48</td>
<td>41</td>
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<td>62</td>
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<td>41</td>
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<td>40</td>
<td></td>
<td>182</td>
<td>136</td>
<td>109</td>
<td>91</td>
<td>73</td>
<td>54</td>
<td>44</td>
<td>36</td>
<td>31</td>
<td>27</td>
</tr>
</tbody>
</table>

Planting

The method for planting trees and shrubs will vary by the size of the site. The traditional method of using a shovel to dig holes can be cheap but is the most time-consuming. It is typically used for small sites only. For small to medium sites, a mechanical auger (i.e., post hole digger) is used for digging holes. A team of two to three people is required to dig, plant, and water the transplant. For larger sites, a mechanical tree planter is used. Mechanical planters are pulled behind a tractor and work by cutting a slit into the soil to place the tree, which is then subsequently covered up by packing wheels. The machine requires at least two people, one to drive the tractor and one to plant the trees. The normal planting rate is between 400-1000 trees/hr.
Grafted trees

What is grafting?
Plants grown from seed have unpredictable qualities and can significantly differ from their parents. Grafting helps remove this uncertainty by taking one plant (scion) and joining it onto another plant (rootstock) of the same species to produce fruits, nuts, flowers, or stems identical to the original plant (scion). Grafting is commonplace in every fruit and nut orchard. Growers would not be able to produce the same cultivar of apple (e.g., Gala, Granny Smith, Red Delicious) without grafting.

What trees are grafted in MPCs?
Grafted trees include chestnuts, European hazelnuts, almonds, pecans, walnuts, apples, plums, pears, and peaches.

Should I buy grafted trees?
Seedling trees will almost always be cheaper, but we strongly recommend grafted trees if your goal is to maximize profit. Only purchase seedling trees if you have extensive grafting experience or are not concerned with productivity, uniform fruiting, or predictability in growth.

Pros and Cons of Grafting

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform ripening</td>
<td>Higher initial cost</td>
</tr>
<tr>
<td>Known quality</td>
<td>Lower genetic diversity</td>
</tr>
<tr>
<td>Consistent yields</td>
<td>Shorter lifespan</td>
</tr>
<tr>
<td>Lower cost</td>
<td>Can be less productive</td>
</tr>
<tr>
<td>Greater genetic diversity</td>
<td>Unpredictable ripening and quality</td>
</tr>
<tr>
<td>Longer lifespan</td>
<td>Possibly slower growth</td>
</tr>
</tbody>
</table>

Pros and Cons of Grafting

Grafting Chinese chestnut trees in early spring
Photo courtesy of Sylvain Cournet
Management

Pruning
Pruning fruit and nut trees, especially in the early years, is a must to ensure proper growth. Pruning in the winter helps vegetative growth during the upcoming growing season. Pruning in the late summer will remove nutrients from the root system and encourage less vegetative growth the next year. General objectives for pruning should be to:

• Maintain plants at an optimum size
• Shape the plants to be suitable for harvesting
• Remove suckering, advantageous growth, and dead/diseased material
• Improve air flow inside the plant canopy

Some plants require more pruning than others. Plants with high pruning requirements include apples, currants, raspberries, and Juneberries.

Pest control
Pests are pathogens, weeds, insects, or animals that are detrimental to an agricultural enterprise. Natural processes such as wind, temperature, rain, and native predators can control pests to an extent, but additional controls are usually necessary. A proper management plan utilizes a variety of methods to prevent, suppress, and eradicate pests while maintaining environmental and human health. The types of pest control methods include:

Cultural: The control of pests through proper planning and field management. This includes crop selection, crop rotation, irrigation, mowing, field sanitation (e.g., removal of rotting fruit), and more.

Physical or Mechanical: The use of physical methods to remove, exclude, or trap pests. This includes cultivation, nets, fences, tree shelters, etc.

Biological: The introduction of natural enemies into a field for pest control. This includes other insects, pathogens, and fungi. This is usually a short-term solution unless providing permanent habitat for beneficials.

Chemical: The use of manufactured pesticides to remove pests. This method should be used with caution to avoid negative impacts on human and environmental health. This is usually a short-term solution.
# MPCs management calendar

<table>
<thead>
<tr>
<th>Month</th>
<th>Nuts</th>
<th>Fruits</th>
<th>Berries</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>Prune lower limbs or narrow crotches.</td>
<td>Prune old, diseased, or narrow spaced branches/canes.</td>
<td>Check for deer and vole damage. Apply tree protection.</td>
<td></td>
</tr>
<tr>
<td>February</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>Prepare ground for planting. Plant ground cover.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>Plant bareroot trees. Graft trees if needed.</td>
<td>Plant cuttings or bare root plants.</td>
<td>Apply weed control.</td>
<td>Fertilize plants.</td>
</tr>
<tr>
<td>May</td>
<td>Plant trees.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>Tip prune trees if necessary.</td>
<td>Apply bird netting (if necessary). Begin harvest.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td></td>
<td>Harvest.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>Prepare ground cover for harvest. Harvest.</td>
<td>Harvest.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>Prepare ground cover for harvest. Harvest.</td>
<td>Harvest.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>Harvest. Remove unproductive and diseased trees.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>December</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adapted from W. Reid (2000), *Growing Pecans in Missouri*, University of Missouri Center for Agroforestry
Harvesting

Nuts
Chestnuts, pecans, and hazelnuts are the primary three nut producing trees in MPCs. Each species has specific harvesting requirements which should be considered before planting. **Note:** Machine harvesting nuts requires the ground to be free of tall grasses and debris, which can be broken down using a flail mower. Herbicides can be used in and between rows as well to reduce ground cover.

*Chestnut*
Chestnuts can be picked by hand, using Nut Wizards, or mechanically harvested. Hand picking is only used for small, non-commercial sites. Leather gloves should be worn to protect against sharp burrs that surround the nuts. Nut Wizards (www.nutwizard.com) are common for small to medium plantings (up to 10 acres). They are a broom-shaped tool with a cylindrical spring wire head on the end which is rolled over nuts lying on the ground. The head traps the nuts, which are then emptied into a bucket. For larger sites, mechanical chestnut harvesters exist (used widely in Europe) and one example is the FACMA (model C300T) pull behind harvester, which has been used at the Center for Agroforestry in Missouri. It can sweep, vacuum, and remove the burrs from chestnuts at a rate of more than 1,000 lb./hr. The machine costs around $30,000, but is difficult to purchase in the United States because of a lack of distributors.

*Hazelnut*
American and hybrid hazelnuts cannot be mechanically harvested because of difficulties from plant shape and nut drop. European hazelnuts can be harvested mechanically by using a sweeping and vacuuming method. The method works by waiting until the nuts have dropped from the tree after which they are swept into the alley where they are vacuumed up, separated from debris, and deposited into bins. Most machines are made and distributed in California and Oregon and can harvest about 15 acres per day.

*Pecan*
Pecans can be picked up by hand, using Nut Wizards, or mechanically harvested. Hand harvesting can be easy but requires a lot of time. Nut Wizards are popularly used for pecans (*see section on chestnuts for info on Nut Wizards*). Mechanical harvesting is possible using a hydraulic tree shaker to free the nuts from the tree, a sweeper to move the nuts into windrows, then a vacuum to collect nuts. Machinery for commercial plantings can be very expensive ($100,000+) and one should carefully consider cost-effectiveness before purchasing equipment.

*Fruits*
Mechanical harvesting of medium to large fruits is uncommon. Fruits used in MPCs such as apple, pear, persimmon, and plum all are all picked by hand. Labor requirements are higher for many fruits which should be considered carefully before being planted in larger systems.
Berries
Berries require time and skill to harvest efficiently. On small sites, no more than one or two acres, hand harvesting is feasible. As sites become larger it becomes more difficult to adequately harvest berries. Labor can be expensive, and most species require well over 100 hours per acre to harvest. On sites over one acre, mechanical harvesters are normally used. The purchasing of machinery can be a large investment, but over time can pay for itself.

The following berries can be machine harvested:
• Aronia
• Black currant
• Juneberry

Machine harvesting berries
The Joanna-4 is one of the more well-known machines capable of harvesting both black currant and aronia berries in the Midwest. The Joanna-4 is a half-row tow-behind side-harvester that is designed for plantings under 60 acres. It is capable of harvesting 1/3 acre per hour for younger, smaller shrubs, and 1/4 acre per hour for older, larger shrubs. The harvester is stated to have a very low berry loss rate, under 5%.

In addition to side row harvesters such as the Joanna-4, straddle harvesters are popular for Juneberry (especially in Canada, where it is widely produced), as well as black currants, aronias, and even raspberries.

More information and technical details on berry harvesters can be found at the following two sources:
www.aroniaharvest.com
www.oxbocorp.com/Products/Berries

Post-Harvest
No matter how much hard work one puts into producing a quality crop, improper post-harvest handling and processing can ruin a product. Knowing how and where to sell crops beforehand is essential for success. The goal of post-harvest practices should be to minimize damage, slow aging, and conduct the necessary processing for sale. Washing, refrigerating, drying, shelling, and juicing are all possible steps during post-harvest processing.
Tree protection

Young trees are susceptible to damage from deer, rodents, rabbits, and livestock. In mature orchards, fruits and nuts may be eaten before they are harvested. Evaluating the most effective and economical way to prevent damage takes careful planning. Evaluate your goals before making a final decision.

Animal damage

**Deer:** They can cause serious damage or death to trees during establishment. Leaves are browsed, young growing shoots are nibbled off, and bucks rub their antlers on smaller trees, damaging the bark. In areas with high deer pressure, trees can be killed or may never grow past deer browse height, remaining stunted for years if not protected. Protection from deer is highly recommended for all new fruit and nut plantings.

**Mice, voles, gophers, and rabbits:** They eat the bark and sometimes the roots of trees. They are more of a threat during the winter when food is scarce and tree bark is more tempting. Tall grass, cover crops, brush piles, and even tree tubes and mulches can provide hiding places for rodents.

Tree shelters

Tree shelters are installed around young trees and consist of a plastic cylinder or wire cage that is held down with stakes. They help prevent browsing by deer and bark damage from mice, voles, gophers, and rabbits. A good resource for comparing styles of tree shelters and support stakes is the NRCS Fact Sheet Tree Shelter Installation and Maintenance.

**Tubes:** Commercial tree shelters ("tree tubes") are made of UV stable polypropylene or polyethylene and protect trees from harsh winds, deer, rabbits and some livestock like sheep and chickens. To prevent deer browsing, the tube must be 5’ or taller. Tree tubes also help prevent damage from herbicides and string trimmers and are useful to see the tree’s location when mowing.

**Cages:** Tree cages are shelters made from welded fence wire and do not modify the microclimate around the tree, acting primarily as protection from herbivores. Wind can still move the tree, which allows for stronger trunk growth.
Wire fencing

**Woven wire:** Woven wire fence provides excellent control, but it is expensive ($4.00-$6.00 per foot) and labor intensive to install. It is usually 8’-10’ tall and will contain most types of livestock. It is low maintenance and will last many years. The high cost of woven wire is usually not justified unless deer pressure is extreme and the crop is very high value.

**High tensile electrified:** Electrified high tensile fence is moderate in cost ($2.00-$3.00 per foot). It provides good control of deer, although it is not impenetrable if deer are determined. It will require a fence energizer to be effective and weeds must be controlled under the fence in order to avoid shorting it out. It is suitable as a livestock perimeter fence.

**Offset/3D polywire fence:** This fence is inexpensive ($0.50-$0.70 per foot), easy to install, and moderately effective. It relies upon deer’s poor eyesight and reluctance to jump over a barrier if they don’t have enough space to land. It consists of two electrified wires with another single electrified wire offset 3 feet away. This is what provides the “3D” effect, as the deer do not have enough space to jump over or crawl under the first wire without hitting the other two.
Economics

The economics of MPCs can be difficult to predict and project because of their uncertainty and complexity. There are distinct economic pros and cons associated with planting these systems.

Pros
- Sharing of fixed costs because of multiple similar crops in one area (cooperatives or equipment sharing)
- Spreading of income over time where fruits and berries produce in the short-term and timber and nuts generate profit in the long-term
- Diversifying income sources reduces financial risk

Cons
- High initial cost of establishment and equipment
- Greater cost for processing and marketing
- Shortage of contractors and markets to sell products easily

Budgeting for MPCs

A two-step approach should be taken when budgeting for MPCs. Enterprise budgets should be combined with cash flow plans to examine long-term profitability of a farm. Enterprise budgets are a complete list of all costs and revenues expected for each enterprise on a farm. MPCs incorporate multiple enterprises such as timber, nuts, fruits, and berries. Cash flow plans integrate all farm enterprises together and examine their profitability over a certain amount of time into the future.

The following pages include:

1. Overview of the components of an enterprise budget
2. Two cash flow sheets: (1) single species systems and (2) mixed species systems used in MPCs
3. Examples of plant costs

This information aims to provide examples of the differences in cost, revenue, and budgeting between different species and system types.

It is recommended to only use these sheets as an informational tool. Economic budgeting is very specific to each farm and should always be done before adopting MPCs.

To see examples of enterprise budgets, cash flow sheets, and more information on the economics of MPCs, refer to The Center for Agroforestry’s article Economic Budgeting for Agroforestry Practices, which this information is based on:

www.extension.missouri.edu/explorepdf/agguides/agroforestry/af1006.pdf
### MPCs enterprise budget template

**Description**

The template below outlines a simple enterprise budget showing the various costs and revenues to consider for a single farm enterprise (e.g., growing chestnuts). MPCs typically contain numerous enterprises that all need to be accounted for. The template below is only a simple example, and additional revenues and costs may be appropriate.

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation payments</td>
<td></td>
</tr>
<tr>
<td>Nuts</td>
<td></td>
</tr>
<tr>
<td>Fruits</td>
<td></td>
</tr>
<tr>
<td>Berries</td>
<td></td>
</tr>
<tr>
<td>Agro-Tourism</td>
<td></td>
</tr>
<tr>
<td>Timber (sawlogs, veneer, etc.)</td>
<td></td>
</tr>
<tr>
<td>Property Tax</td>
<td></td>
</tr>
<tr>
<td>Insurance</td>
<td></td>
</tr>
<tr>
<td>Interest payments</td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td></td>
</tr>
<tr>
<td>Land</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site preparation</td>
<td></td>
</tr>
<tr>
<td>Fertilizer</td>
<td></td>
</tr>
<tr>
<td>Plant materials</td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td></td>
</tr>
<tr>
<td>Tree protection</td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td></td>
</tr>
<tr>
<td>Fertilization</td>
<td></td>
</tr>
<tr>
<td>Pesticides</td>
<td></td>
</tr>
<tr>
<td>Herbicide</td>
<td></td>
</tr>
<tr>
<td>Mowing</td>
<td></td>
</tr>
<tr>
<td>Thinning</td>
<td></td>
</tr>
<tr>
<td>Pruning</td>
<td></td>
</tr>
<tr>
<td>Nut</td>
<td></td>
</tr>
<tr>
<td>Fruit</td>
<td></td>
</tr>
<tr>
<td>Berry</td>
<td></td>
</tr>
<tr>
<td>Timber</td>
<td></td>
</tr>
<tr>
<td>Processing</td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td></td>
</tr>
<tr>
<td>Advertising</td>
<td></td>
</tr>
</tbody>
</table>

Adapted from L. Godsey (2010), *Economic Budgeting for Agroforestry Practices*, University of Missouri Center for Agroforestry
Potential yearly cash flow: single species

<table>
<thead>
<tr>
<th>Species</th>
<th>Year 5 Plant</th>
<th>Acre</th>
<th>Year 5 Acre</th>
<th>Year 10 Plant</th>
<th>Acre</th>
<th>Year 10 Acre</th>
<th>Year 15 Plant</th>
<th>Acre</th>
<th>Year 15 Acre</th>
<th>Year 20 Plant</th>
<th>Acre</th>
<th>Year 20 Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese Chestnut</td>
<td>-$2</td>
<td>-$110</td>
<td>$115</td>
<td>$5,639</td>
<td>$182</td>
<td>$7,477</td>
<td>$138</td>
<td>$5,668</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black Currant</td>
<td>$6</td>
<td>$7,113</td>
<td>$9</td>
<td>$10,212</td>
<td>$9</td>
<td>$10,212</td>
<td>$9</td>
<td>$10,212</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pecan</td>
<td>-$31</td>
<td>-$1,623</td>
<td>$33</td>
<td>$1,612</td>
<td>$33</td>
<td>$1,612</td>
<td>$33</td>
<td>$1,612</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aronia</td>
<td>$8</td>
<td>$7,247</td>
<td>$8</td>
<td>$7,247</td>
<td>$8</td>
<td>$7,247</td>
<td>$8</td>
<td>$7,247</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cider Apple</td>
<td>$6</td>
<td>$4,151</td>
<td>$6</td>
<td>$4,151</td>
<td>$6</td>
<td>$4,151</td>
<td>$6</td>
<td>$4,151</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juneberry</td>
<td>-$1</td>
<td>-$929</td>
<td>$4</td>
<td>$2,835</td>
<td>$4</td>
<td>$2,835</td>
<td>$4</td>
<td>$2,835</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elderberry</td>
<td>$4</td>
<td>$3,701</td>
<td>$6</td>
<td>$5,578</td>
<td>$6</td>
<td>$5,578</td>
<td>$5</td>
<td>$4,724</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>European Hazelnut</td>
<td>-$5</td>
<td>-$673</td>
<td>$18</td>
<td>$2,692</td>
<td>$18</td>
<td>$2,692</td>
<td>$18</td>
<td>$2,692</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Description

This table shows the potential yearly return for planting a single species of nut, fruit, or berry crop in an orchard setting. It does not account for the cost of irrigation, a truck, tractor, mower, labor, and fuel costs. These costs are removed because they vary significantly between landowners. This table should only be used to examine and compare different species cash flows. See the “economic planning” section of the appendix for more information.

Assumptions

- Spaced for machine harvest orchard
- Machine harvested
- Grafted trees only
- Annual costs (e.g., fertilization) are applied at plant specific rates
- The cost of a machine harvester will be paid annually over 15 years at 6% interest
- The depreciation cost of materials is accounted for over a 15 year period at 7% depreciation, spread over 8 acres
- Chestnut trees will be thinned 10% by year 10; pecans will be thinned 50% by year 20
- Crops are sold wholesale at the following prices per lb.: Chestnuts $3, Black Currant $1.50, Northern Pecan $1.50, Aronia $0.82, Cider Apple $337.50/bin, Juneberry $1.00, Elderberry $1.00, European Hazelnut $1.00
Potential yearly cash flow (per acre): mixed systems

(+) Ownership costs included
(–) Ownership costs not included

<table>
<thead>
<tr>
<th>System</th>
<th>Year 5</th>
<th>Year 10</th>
<th>Year 15</th>
<th>Year 20</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>Chestnut and Black Currant</td>
<td>–$2,579</td>
<td>$2216</td>
<td>$4,434</td>
<td>$9,229</td>
</tr>
<tr>
<td>Pecan and Aronia</td>
<td>–$3,167</td>
<td>$1,628</td>
<td>$1,382</td>
<td>$1,382</td>
</tr>
<tr>
<td>Chestnut-Black Currant and Hazelnut-Black Currant</td>
<td>–$222</td>
<td>$1,441</td>
<td>$5,114</td>
<td>$9,992</td>
</tr>
</tbody>
</table>

Note: Cash flow sheets will vary for each farm and may not match the values found above.

Description

This table shows the potential yearly cash flow of three mixed systems with or without select ownership costs. It displays how the return on a mixed enterprise can vary greatly based upon the costs incurred (which will vary by landowner). Not including ownership costs is useful for landowners who own farm equipment that is paid for. Including ownership costs is useful for landowners without equipment who need to account for the additional costs they will have to take on.

Assumptions

- All assumptions from the single species cash flow table on the previous page hold true
- $50 a year for water and $70 a year for fuel
- **Select Ownership Costs:** Landowner is purchasing new equipment (truck, tractor, and mower) and paying associated costs
- **Per-acre labor hours (costing $10/hr.):**
  2. Pecan - Aronia: 41 hrs.
  3. Chestnut - Black Currant and Hazelnut - Black Currant: 60 hrs.

**Chinese Chestnut and Black Currant:**
*Layout*: One species per row, alternating rows (15’ spacing) | *Plants per acre*: 49 chestnuts and 490 black currants

**Pecan and Aronia**: *Layout*: One species per row, alternating rows (15’ spacing) | *Plants per acre*: 49 pecans and 364 aronias

**Chinese Chestnut - Black Currant and European Hazelnut - Black Currant:**
*Layout*: Two species per row, two alternating rows (one with chestnut-black currant and one with hazelnut-black currant at 30’ spacing) | *Plants per acre*: 25 chestnuts, 49 European hazelnuts, and 421 black currants
<table>
<thead>
<tr>
<th>Species</th>
<th>Variety</th>
<th>Grafted</th>
<th>Price per plant according to quantity purchased</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Apple (semi-dwarf)</td>
<td>M-111 with ‘Liberty’ scion</td>
<td>Yes</td>
<td>$20</td>
</tr>
<tr>
<td>Apple (standard)</td>
<td>M-111 rootstock (75%)</td>
<td>No</td>
<td>$3</td>
</tr>
<tr>
<td>Aronia</td>
<td>Viking</td>
<td>-</td>
<td>$6</td>
</tr>
<tr>
<td>Blackberry, Thornless</td>
<td>‘Prime Ark Freedom’</td>
<td>-</td>
<td>$4</td>
</tr>
<tr>
<td>Chestnut, Chinese</td>
<td>Improved seedling</td>
<td>No</td>
<td>$3</td>
</tr>
<tr>
<td>Chestnut, Chinese</td>
<td>‘Qing’</td>
<td>Yes</td>
<td>$20</td>
</tr>
<tr>
<td>Cranberry, Highbush</td>
<td>Wild</td>
<td>-</td>
<td>$2</td>
</tr>
<tr>
<td>Currant, Black</td>
<td>‘Whistler’</td>
<td>-</td>
<td>$4</td>
</tr>
<tr>
<td>Currant, Red</td>
<td>‘Rovada’</td>
<td>-</td>
<td>$4</td>
</tr>
<tr>
<td>Currant, White</td>
<td>‘Blanka’</td>
<td>-</td>
<td>$4</td>
</tr>
<tr>
<td>Elderberry, American</td>
<td>Wild seedling</td>
<td>-</td>
<td>$2</td>
</tr>
<tr>
<td>Grape, White</td>
<td>‘Niagara’</td>
<td>-</td>
<td>$8</td>
</tr>
<tr>
<td>Hazelnut, American</td>
<td>Wild seedling</td>
<td>No</td>
<td>$3</td>
</tr>
<tr>
<td>Hazelnut, European</td>
<td>‘Yamhill’</td>
<td>Varies</td>
<td>$20</td>
</tr>
<tr>
<td>Hazelnut, Hybrid</td>
<td>Improved seedling</td>
<td>No</td>
<td>$5</td>
</tr>
<tr>
<td>Hickory, Shagbark</td>
<td>Wild seedling</td>
<td>No</td>
<td>$2</td>
</tr>
<tr>
<td>Juneberry</td>
<td>‘Regent’</td>
<td>-</td>
<td>$6</td>
</tr>
<tr>
<td>Mulberry, Red</td>
<td>Wild seedling</td>
<td>No</td>
<td>$3</td>
</tr>
<tr>
<td>Oak, Red</td>
<td>Wild seedling</td>
<td>No</td>
<td>$2</td>
</tr>
<tr>
<td>Oak, Swamp White</td>
<td>Wild seedling</td>
<td>No</td>
<td>$2</td>
</tr>
<tr>
<td>Pawpaw</td>
<td>Improved seedling</td>
<td>No</td>
<td>$2</td>
</tr>
<tr>
<td>Pear (semi-dwarf)</td>
<td>OHxF 333</td>
<td>No</td>
<td>$3</td>
</tr>
<tr>
<td>Pecan</td>
<td>Improved seedling</td>
<td>No</td>
<td>$3</td>
</tr>
<tr>
<td>Pecan</td>
<td>‘Osage’</td>
<td>Yes</td>
<td>$15</td>
</tr>
<tr>
<td>Persimmon, American</td>
<td>Wild seedling</td>
<td>No</td>
<td>$3</td>
</tr>
<tr>
<td>Persimmon, American</td>
<td>Improved seedling</td>
<td>No</td>
<td>$8</td>
</tr>
<tr>
<td>Plum</td>
<td>‘Burbank Elephant Heart’</td>
<td>Yes</td>
<td>$20</td>
</tr>
<tr>
<td>Plum, American</td>
<td>Wild seedling</td>
<td>No</td>
<td>$2</td>
</tr>
<tr>
<td>Raspberry, Red</td>
<td>‘Joan J’</td>
<td>-</td>
<td>$3</td>
</tr>
<tr>
<td>Raspberry, Yellow</td>
<td>‘Anne’</td>
<td>-</td>
<td>$3</td>
</tr>
<tr>
<td>Redbud, Eastern</td>
<td>Wild seedling</td>
<td>-</td>
<td>$2</td>
</tr>
<tr>
<td>Serviceberry</td>
<td>Wild seedling</td>
<td>No</td>
<td>$10</td>
</tr>
<tr>
<td>Sour Cherry (semi-dwarf)</td>
<td>‘Montmorency’</td>
<td>Yes</td>
<td>$20</td>
</tr>
<tr>
<td>Spruce, White</td>
<td>Wild seedling</td>
<td>-</td>
<td>$2</td>
</tr>
<tr>
<td>Walnut, Black</td>
<td>Wild seedling</td>
<td>No</td>
<td>$2</td>
</tr>
<tr>
<td>Willow, Shrub</td>
<td>Rainbow mix</td>
<td>-</td>
<td>$2</td>
</tr>
</tbody>
</table>

Plant costs are taken from the 2017 Savanna Institute Bulk Plant Program.
Financial Support

Funding MPCs through CRP: Saturn Farm, Ogden IL

One of the biggest questions with MPCs is, “How will I pay for them?” and the answer is often, “Apply for conservation programs.” It seems simple, but when applying for these programs, it becomes difficult to know how MPCs can be used. Thankfully, one pioneering farmer researcher is figuring out methods of enrolling MPCs into Conservation Reserve Programs (CRP) here in central Illinois.

On his farm in Ogden, Illinois, Kevin Wolz has enrolled 10 acres into the field windbreak (CP-5A) CRP program to pay for a portion of his MPCs planting. Rather than focusing on the typical species used, he constructed the windbreak with long-term profitability in mind. The windbreak consists of a high diversity of species that each have unique uses. He has also helped many other landowners establish similar CRP projects using productive fruit and nut species. This is a great example of how MPCs can be implemented for both conservation and economic benefits using government programs.

Windbreak planting plan
(Windbreak rows listed windward to leeward)

1. Shrub willow (ornamental cuttings)
2. Hazelnut (nut production)
3. Hybrid poplar (fast growing timber)
4. Hybrid poplar (fast growing timber)
5. Mixed Ribes species (berry production)
6. Juneberry and Elderberry (berry production)
7. Cherry (fruit production)
8. Mixed conifer species (timber)
9. Mixed conifer species (timber)
10. Mixed oak species (wildlife and timber)

A mixed species field windbreak enrolled in CRP
Photo courtesy of and copyright Midwest ARS LLC
### Conservation payments received

<table>
<thead>
<tr>
<th>Payment Type</th>
<th>Amount</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign-up incentive payment</td>
<td>$100/acre</td>
<td>Depends on the availability of sign-up incentives being offered at the time of enrollment.</td>
</tr>
<tr>
<td>Annual land rent</td>
<td>$340/acre</td>
<td>Based on his soil type (Drummer silty clay loam; 152A). This rate is 20% higher than the standard rate of $283/acre for this soil type due to a special USDA incentive that was available.</td>
</tr>
<tr>
<td>90% cost-share for plants and planting*</td>
<td>$0.16 per linear foot of row</td>
<td>Maximum payment amount is $0.16 per linear foot of windbreak rows.</td>
</tr>
<tr>
<td>90% cost-share for tree protection*</td>
<td>$2.50 per tree protector</td>
<td>Maximum payment amount is $2.50 per tree protector.</td>
</tr>
<tr>
<td>90% cost-share for ground cover establishment*</td>
<td>$66/acre</td>
<td>Maximum payment amount is $66/acre.</td>
</tr>
<tr>
<td>90% cost-share for weed control*</td>
<td>$27/acre</td>
<td>Maximum payment amount is $27/acre.</td>
</tr>
</tbody>
</table>

* Each of the 90% cost-share items above are typically cost-shared at only 50%, but during certain periods and with certain practices the USDA cost-shares an additional 40% via a Program Incentive Payment.

**Note:** When the sign-up incentive ($100/acre for this farm) is accounted for, it is possible to have an effective cost-share greater than 100%.
Conservation programs

Conservation programs are provided through the USDA and funded by the farm bill. With each farm bill, funding sources are liable to change. When available, certain programs allow landowners to receive payments for establishing MPCs. The qualifying programs are listed below.

- Environmental Quality Incentives Program (EQIP)
- Conservation Stewardship Program (CSP)
- Conservation Reserve Program (CRP)
- Continuous Conservation Reserve Program (CCRP)
- Sustainable Agriculture Research and Education Program (SARE)

What program do I qualify for?

Funding provided by conservation programs is situational, depending on your location, soil type, farm type, cropping history, and environmental sensitivity. Each program provides funding in different ways. The table below displays the type of support each program provides.

**Financial assistance** – Payments for transitioning to a certain practice of farmer’s choice

**Incentive payment** – Money to incentivize the use or research of conservation practices that improve soil, water, plant, animal, air, and related natural resources on agricultural land

**Rental payment** – Payment for the rental price of the land

**Stewardship payments** – Receiving money for conservation performance (the higher the operational performance, the higher the payment)

<table>
<thead>
<tr>
<th>Program</th>
<th>Assistance</th>
<th>Incentive</th>
<th>Rental</th>
<th>Stewardship</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQIP</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSP</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CRP</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CCRP</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>SARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adapted from *Inside Agroforestry: Finding Agroforestry in the 2014 Farm Bill, USDA-NAC*
Environmental Quality Incentives Program (EQIP)

What is EQIP?

The Environmental Quality Incentives Program (EQIP), administered by the NRCS, is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air and related natural resources on agricultural land and non-industrial private forestland. EQIP provides payments up to 75 percent of the incurred costs for implementing certain conservation practices and activities.

How does EQIP work?

Financial assistance payments through EQIP are made to eligible producers to implement approved conservation practices on qualified land or to help producers develop Conservation Activity Plans (CAP) to address specific land use issues. Payments are made on completed practices or activities identified in an EQIP contract that meet NRCS standards. Payment rates are set each fiscal year and are attached to the EQIP contract when it is approved.

Who is eligible?

- Applicants who control or own eligible land: cropland, rangeland, pastureland, non-industrial private forest land, or farm/ranch lots
- Those who comply with adjusted gross income limitation provisions
- Applicants that comply with the highly erodible land and wetland conservation requirements
- Those who develop a NRCS EQIP plan of operations that addresses at least one natural resource concern

How do MPCs fit in?

With EQIP, products may still be harvested given that the land maintains full environmental functionality, making MPCs an ideal fit. Many of the approved conservation practices employed by EQIP are the same as practices employed in MPCs such as agroforestry which includes field borders, alley cropping, and riparian forest buffers. Payments, which are one-time only, are made on newly implemented practices worked on with the NRCS, making the addition of MPCs to an already established farm possible.

When do I apply?

NRCS accepts and processes EQIP applications on a continuous basis. However, each state may establish deadlines for one or more application periods in which to consider eligible applications for funding.

To learn more

Contact your local NRCS field office or visit www.nrcs.usda.gov/wps/portal/nrcs.
Conservation Stewardship Program (CSP)

What is CSP?
CSP, administered by the NRCS, is a voluntary conservation program that encourages producers to address resource concerns in a comprehensive manner by undertaking additional conservation activities and improving, maintaining, and managing existing conservation activities.

How does CSP work?
CSP participants receive an annual land use payment for operation-level environmental benefits they produce. Participants are paid for conservation performance: the higher the operational performance, the higher their payment. The program impacts are focused on natural resources that are of specific concern for a state or geographic area. Applications are evaluated relative to other applications addressing similar priority resource concerns to facilitate a competitive ranking process. CSP offers participants two types of payments: (1) Annual payment for installing and adopting additional activities, and improving, maintaining, and managing existing activities; (2) Supplemental payment for the adoption of resource-conserving crop rotations.

Who is eligible?
Through CSP, NRCS provides financial and technical assistance to eligible producers to conserve and enhance soil, water, air, and related natural resources on their agricultural land. Producers must have effective control of the land for the term of the proposed contract. Contracts include all eligible land in the agricultural operation.

How do MPCs fit in?
- Farmers are paid for practices on their working land, allowing them to produce conservation benefits and make a profit which is ideal criteria for MPCs.
- CSP allows for easy transition out of CRP in a way that protects the accrued conservation value while beginning to harvest from it.
- Implementing edible woody buffers are one of many CSP enhancements commonly used MPCs practices.

When do I apply?
Applications are accepted year round.

To learn more
Contact your local NRCS field office or visit www.nrcs.usda.gov/wps/portal/nrcs.

All CSP information compiled from www.nrcs.usda.gov
Conservation Reserve Program (CRP)

What is CRP?

The Conservation Reserve Program (CRP), which includes the CRP general sign-up, Continuous Conservation Reserve Program (CCRP), and the Conservation Reserve Enhancement Program (CREP), is a land conservation program administered by the Farm Service Agency (FSA). In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Contracts for land enrolled are 10-15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.

How do these three programs work?

**CRP:** FSA enrolls CRP acres during periodic “general sign-ups,” through which land is bid into the program on a competitive basis and ranked using an Environmental Benefits Index (includes wildlife habitat benefits, water quality benefits, on-farm soil-retention benefits, etc.).

**CCRP:** Farmers and landowners may enroll land at any time rather than waiting for specific sign-up periods used for the CRP general sign-up. The program pays farmers to install partial field conservation practices, primarily conservation buffers or wildlife habitat. Unlike general sign-ups, land is enrolled automatically if it meets the eligibility criteria.

**CREP:** The state and USDA together pay farmers to address targeted conservation issues identified by local, state, or tribal governments or non-governmental organizations. These programs occur periodically and will differ by region and available funding.

When enrolled in one these programs, the FSA provides participants with annual rental payments, including certain incentive payments, and cost-share assistance as follows:

**Rental payments:** Rates paid out are based on the productivity of the soils within each county and the average dryland cash rent. The maximum rental rate for each offer is calculated in advance of enrollment in the program.

**Cost-share assistance:** This provides up to 50% cost-share to establish the appropriate cover on the land.

**Incentive payments:** Payments of up to 150% of the total cost of establishment, thinning, and other practices may be available. Additional bonuses for certain practices and areas may also include up to 20% on rental rates, upfront sign-up bonuses of $150 per acre, and 40% cost-share assistance for some eligible CCRP practices.

All CRP information compiled from www.fsa.usda.gov/programs-and-services/conservation-programs
Who is eligible?

To be eligible, land must fall into one of the following categories:

- Cropland (including field margins) that was planted or considered planted to an agricultural commodity in 4 of the 6 crop years from 2009 to 2013. The land must be physically and legally capable of being planted in a normal manner to an agricultural commodity; or,

- Marginal pastureland enrolled in the national Water Bank Program (a program that is no longer available);

- Marginal pastureland suitable for use as a riparian buffer or similar water quality purposes

How do MPCs fit in?

- CRP is an ideal choice for native species plantings because it allows landowners to receive payments for slow-growing fruit and nut trees through annual rental payments, cost-share assistance, and/or incentive payments.

- The CRP removes cropland from production and replaces it with a conservation practice such as field windbreaks, wildlife and pollinator habitat, shelterbelts, and riparian forest buffers, all of which are used in MPCs. These practices are already being employed by farmers in central Illinois who have enrolled their systems in CRP land.

- Marginal land is the target of both CRP and MPCs, thus making them a suitable combination.

When do I apply?

Farmers can apply (which is not necessarily available every year) when general sign-ups are posted or for CCRP and CREP at any time. Contact your local FSA office for current programs and incentives.

General vs. Continuous sign-up

- CCRP establishes conservation buffers and restores certain types of wetlands, rather than setting aside entire fields.

- One-time special incentive payments are offered for certain practices in CCRP, often resulting in a higher per-acre payment than for the CRP General Sign-up.

- The CCRP application process is non-competitive, meaning all eligible applications are accepted (as long as they meet the general criteria).

- The total acreage enrolled in CCRP is much less than the CRP general sign-up because many of CCRP practices are conservation buffers with narrow, linear footprints, in contrast to the larger whole-field parcels typical of the CRP General sign-up.

To learn more

- www.fsa.usda.gov/programs-and-services/conservation-programs

- www.sustainableagriculture.net/publications/grassrootsguide/conservation-environment/conservation-reserve-program/
North Central Sustainable Agriculture Research and Education (NCR-SARE)

What is NCR-SARE?
North Central Region SARE (NCR-SARE) is one of four regional offices that run the Sustainable Agriculture Research and Education (SARE) program, a nationwide grants and education program to advance sustainable innovation to American agriculture. NCR-SARE offers competitive grants and educational opportunities for producers, scientists, educators, institutions, organizations and others exploring sustainable agriculture in America’s Midwest. The 12 states of the North Central Region are Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

How does SARE work?
North Central Region SARE administers several grant programs, each with specific priorities, audiences and timelines. The focus for all of NCR-SARE grant programs is on research and education. Funding considerations are based on how well the applicant presents the problem being addressed, its relevance to sustainable agriculture in the 12-state North Central region, and how well it aligns with NCR-SARE’s goals.

How do MPCs fit in?
NCR-SARE offers competitive grants and educational opportunities for producers, scientists, educators, institutions, organizations and others exploring sustainable agriculture in America’s Midwest. The grants provided through NCR-SARE provide farmers to explore, test, and discover new sustainable agricultural practices relevant to their region. MPCs are an innovative and under-researched form of agriculture that has been awarded grants in the past.

Who is eligible?
Funding considerations are based on how well the applicant presents the problem being addressed, its relevance to sustainable agriculture in the 12-state North Central region, and how well it aligns with NCR-SARE’s goals. Applicants must fit into one of the SARE grant programs (listed above).

When do I apply?
Each grant application has a different timeline and should be checked online to plan accordingly. Visit www.northcentralsare.org/Grants/Timelines for more information.

To learn more:
www.northcentralsare.org

All NCSR-SARE information compiled from www.northcentralsare.org
High potential species

One of the most daunting obstacles for growers using MPCs is finding a place to sell the products. Markets for horticultural crops are continuously changing as are consumer preferences. However, certain trends and markets have been established for many of the crops used in MPCs. The following section covers how and where to sell some of the most promising perennial nut, fruit, and berry crops. High-potential species for the Midwest include:

- Chestnut
- Pecan
- Hazelnut
- Aronia
- Black Currant
- Cider Apple

For species not included above, the markets for sale remain relatively unknown or unestablished. Additional effort on the part of the landowner and researchers is required. Caution should be taken when choosing to grow crops without having a clear plan of where and how they will be sold.

Markets for MPCs crops

- On-farm
- Grocery store (local or national)
- Farmers market
- Distributor
- Restaurant
- Ethnic store
- Wholesaler
- Health store
- On-line
- Individual reseller

For additional information on available growers and buyers of specialty crops, visit one of the following sites:

www.MarketMaker.com
www.PerennialMap.org

Chestnuts being sold at the annual Missouri Chestnut Roast in New Franklin, MO
**Black Currants**

**How to sell them:** Fresh sale is possible with black currants with those who are familiar with it, but processing the crop into jams, jellies, fresh juice products, and wine may be the best way to utilize the berry. They are commonly used for their high concentrations of vitamin C and beneficial antioxidants. In Europe, fresh and processed markets exist and may be an indication of the undeveloped market potential in the United States.

**Where to sell them:** Decisions to commercially produce “minor” small fruit crops such as *Ribes* spp. should be driven by the availability of market outlets for the fruit. Fresh fruit sales are options for direct marketers, but most consumers are not familiar with the fruit. Growers near populations of people who are already familiar with the crop may have a ready market.

**Market trends:** Black currants are slowly gaining interest in the United States after their hiatus from production in the 20th century due to their ability to carry white pine rust, a disastrous disease in the northeast U.S.A. Due to their novelty in the Midwest, a market should be secured before plants are set in the ground. There is considerable potential given their success in Europe.

**Sources**

pubs.ext.vt.edu/438/438-107/438-107.html#L2

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**Aronia**

**How to sell them:** Because aronia berries have an off-putting taste when eaten fresh, berries are usually processed in some way or frozen to reduce the astringent taste and maintain quality. Many growers have developed value-added products such as jam, jelly, juice, sauce, ice cream and salsa that they sell in both local and non-local markets. Other vendors offer aronia berries, juices and food products for their nutraceutical properties.

**Where to sell them:** Aronias are useful in juice mixes and wine-making, particularly in dry red wines both for color and astringency. Beverage manufacturers including SoBe® and SunOpta® have included aronia juice in their products.

**Market trends:** Aronia berries are gaining popularity due largely to the rising interest in eating healthier foods. The berries are high in vitamins, minerals, and folic acids. They are one of the richest plant sources of phenolic substances, mainly anthocyanins, which are powerful antioxidants. Expanding markets is a goal of growers who comprise the Midwest Aronia Association (MAA). Find them at www.midwestaronia.org.

**Sources**

www.agmrc.org/commodities-products/fruits/aronia-berries/
www.greenlandsbluewaters.net/Aronia%20Case%20Study%20FINAL%20(1).pdf
Chestnuts

**How to sell them:** Chestnuts are typically sold in-shell but can also be frozen and sold, or dried for flour.

**Where to sell them:** The majority of growers in the Midwest sell their chestnuts locally. Research from the University of Missouri (Gold et al. 2005) revealed that the highest prices for chestnuts are paid by restaurants, followed by online customers, health and natural food stores, farmers markets, and on-farm sales. The lowest prices are offered by discount grocery stores, distributors, and wholesalers.

**Market trends:** The demand for chestnuts is expanding and is expected to continue to increase into the future. The U.S. produces nowhere near the number of chestnuts it consumes. “At the current rate of chestnut planting in North America, domestic chestnut growers will not meet the demand as it was in the year 2000 until sometime between 2080 and 2100” (Gold et al. 2005). Chestnut markets seem to be a promising sector for perennial crops moving forward.

**Sources**


www.agmrc.org/media/cms/SEnuts_08B2AC6D0625C.pdf

Cider Apple

**How to sell them:** Three types of apples are produced commercially: dessert, culinary, and cider. MPCs are focused on apples for cider production. This is because they require less pesticide application and have a rapidly growing market. Cider apples are either processed on-farm for cider production or sold to a processor.

**Where to sell them:** Cider markets will be largely dependent on available cideries to process apples. A good resource for more information on cider products, makers, equipment, supplies, supporters and events in the U.S. and worldwide is www.cydermarket.com.

**Market trends:** Cider is the fastest growing sector of the apple industry. The consumption of apple juice and cider has increased 1.5 lbs./person in 2011. Additionally, the consumption of hard cider has grown nine-fold from 2007 to 2014, and many major firms predict this trend to continue into the next decade.

**Sources**

www.agmrc.org/commodities-products/fruits/apples/commodity-apples/

www.hardcider.cals.cornell.edu/files/2016/06/Cider_Apple_Prod_Econ_Galinato_and_Peck-1e44sqk.pdf
**Hazelnuts**

**How to sell them:** Hazelnuts are sold as in-shell, shelled, diced, ground, or pressed for oil. The highest quality and priced nuts are sold unshelled. Hazelnuts have a high oil content. They are 50% to 60% oil by weight, and when pressed, produce a by-product of “hazelnut meal” which can be sold as well. The oil and meal have market potential as food for people and animals and use in cosmetics, flavorings, and more.

**Where to sell them:** No major commercial hazelnut processors exist in the Midwest but small-scale groups have begun to establish themselves (e.g., American Hazelnut Company). Additionally, some individual growers have purchased or developed small-scale equipment for sizing, cracking, separation, etc.

**Market trends:** The market potential of hazelnuts is currently undeveloped in the Midwest. The initial markets are likely to be in kernels, oil, meal, and other processed products until nut quality and size can meet standards favored by the in-shell market.

**Sources**

www.agmrc.org/commodities-products/nuts/hazelnuts/

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**Pecans**

**How to sell them:** Pecans are sold pecans in-shell or shelled. Buyers of pecans are mainly concerned about the shell out percentage, or percent of nut-meal in comparison to the shell. This is the marketable product, which varies drastically between pecan varieties. Farmers should be aware of the variety of nuts they are growing, and where they plan to sell them before entering the pecan market.

**Where to sell them:** Farmers sell directly to consumers through farmers’ markets and online at retail prices or to wholesalers/processors for wholesale prices. Farmers can shell their pecans themselves before sale, but should consider the cost of equipment when choosing this method of sale.

**Market trends:** The vast majority of pecans are grown in southern states and commercial production has yet to begin extensively in the Midwest. A warming climate makes their production in Illinois and surrounding states increasingly possible in the near future. However, due to their long time to maturity, pecan enterprises should be examined carefully to make sure they can be profitable or worth the farmers time.

**Sources**

www.agmrc.org/commodities-products/nuts/pecans/
www.aces.nmsu.edu/pubs/_z/Z307/
Resources

Growers groups

**Northern Nut Growers Association**
The Northern Nut Growers Association (NNGA) brings together people interested in growing nut trees. Members include experts in nut tree cultivation, farmers, amateur and commercial nut growers, experiment station workers, horticultural teachers and scientists, nut tree breeders, nursery people, foresters, and beginning nut growers.

[www.nutgrowing.org](http://www.nutgrowing.org)

**Midwest Aronia Association (MAA)**
MAA works to provide information on all things aronia berry. Their work helps improve the growing conditions of those engaged in aronia growing, improve marketability, network and cooperate with organizations, and connect those interested in aronia. They are based out of Iowa but have growers in states all across the Midwest.

[www.midwestaronia.org](http://www.midwestaronia.org)

**Upper Midwest Hazelnut Development Initiative (UMHDI)**
UMHDI is a collaboration of growers and researchers working to develop a sustainable hazelnut industry in the Upper Midwest. They are an excellent source to connected with hazelnut growers and learn more about the crop.

[www.midwesthazelnuts.org](http://www.midwesthazelnuts.org)

Research and education

**University of Illinois at Urbana-Champaign**
The Agroforestry for Food program at the University of Illinois at Urbana-Champaign evaluates the potential of multi-species alley cropping as a transformative agroforestry system to meet growing demand for healthy foods while advancing agricultural sustainability.

[www.agroforestry4food.com](http://www.agroforestry4food.com)

**University of Missouri**
The Center for Agroforestry at the University of Missouri, established in 1998, is one the world’s leading centers contributing to the science underlying agroforestry (the science and practice of intensive land-use management combining trees and/or shrubs with crops and/or livestock).

[www.centerforagroforestry.org](http://www.centerforagroforestry.org)

**University of Wisconsin at Madison**
The Center for Integrated Agricultural Systems at the University of Wisconsin-Madison is conducting pioneering research in silvopasture, the intentional and intensive integration of trees and livestock. UW is exploring innovative methods for converting degraded woodlands into productive silvopasture operations.

[www.cias.wisc.edu](http://www.cias.wisc.edu)
Land Institute
The Land Institute is a science-based research organization that promotes an alternative to current destructive agricultural practices. Their work is dedicated to advancing perennial grain crops and polyculture farming solutions. The Land Institute is committed to researching food production methods that sustain the land, a precious resource in an increasingly precarious state around the globe.

www.landinstitute.org

Savanna Institute
Savanna Institute is a science-based research and education organization that promotes agroforestry as an alternative to current destructive agricultural practices. Their work is dedicated to advancing woody crops and polyculture farming solutions. They are committed to developing a resilient agricultural system in the Midwest that is grounded in agroforestry and inspired by the savanna biome.

www.savannainstitute.org

Outreach and assistance

USDA National Agroforestry Center (NAC)
The USDA National Agroforestry Center accelerates the application of agroforestry through a national network of partners. Together, they conduct research, develop technologies and tools, coordinate demonstrations and training, and provide useful information to natural resource professionals.

www.nac.unl.edu

Green Lands Blue Waters (GLBW)
The mission of GLBW is to support the development of and transition to a new generation of multifunctional agricultural systems in the Mississippi River Basin and adjacent areas. They strive to incorporate more perennial plants and other continuous living cover into the agricultural landscape.

www.greenlandsbluewater.net

Farm Commons
Farm Commons is a nonprofit organization that aims to cultivate a community of support and resources for sustainable farmers. Farm Commons works by creating a wide range of legal resources and guides in many formats.

www.farmcommons.org

Association for Temperate Agroforestry (AFTA)
AFTA promotes the wider adoption of agroforestry by landowners in temperate regions of North America. AFTA’s educational programs are aimed at facilitating the exchange of scientific and practical information about temperate agroforestry, primarily in North America.

www.aftaweb.org

PerennialMap
PerennialMap is an online GIS map focused on locating and contacting individuals involved in the growing, selling, and buying of perennial agricultural products.

www.PerennialMap.org
Visiting MPCs in person

There are a handful of MPCs in central Illinois and on the campus of the University of Illinois at Urbana-Champaign. Some farms are focused on research while others are production oriented. To schedule a site visit, go to www.Agroforestry4Food.com.

Additionally, keep a look out for field days sponsored by the Savanna Institute (www.savannainstitute.org) and explore www.perennialmap.org to see which perennial crops are being grown near you.

Plant nurseries

Adams County Nursery (Aspers, PA)
www.acnursery.com
(717) 677-8105

Forest Keeling (Elsberry, MO)
www.fknursery.com
(573) 898-5571

Cold Stream Farm (Free Soil, MI)
www.coldstreamfarm.net
(231) 464-5809

Red Fern Farm (Wapello, IA)
www.redfernfarm.com
(319) 729-5905

Multifunctional Woody Polyculture research site at UIUC

Commodities and products. Agricultural Marketing Resource Center. (Available at www.agmrc.org/commodities-products/ as of May 18, 2017.)


University of Kentucky: horticultural intro sheets [e.g., Pawpaw, Juneberry, Gooseberries and Currant]. (Available at www.uky.edu/Ag/CCD/introsheets/ as of May 18, 2017.)


Numerous other publications provided by the University of Missouri Center for Agroforestry were used in creating this guide. They can be found at www.centerforagroforestry.org/pubs/.
Appendix

NRCS conservation practice descriptions ..................... 55
Additional economic planning resources ..................... 58
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Walnut-wheat alley cropping—Les Domaine de Restinclières, France
Mixed fruit species row—aronia, elderberry, and American plum
NRCS conservation practice standards

Information in this section is taken directly from NRCS conservation practice standards

Alley Cropping (CP 311)
Trees or shrubs are planted in sets of single or multiple rows with agronomic, horticultural crops or forages produced in the alleys between the sets of woody plants that produce additional products.

Purpose
- Enhance microclimatic conditions to improve crop or forage quality and quantity
- Reduce surface water runoff and erosion
- Improve soil health by increasing utilization and cycling of nutrients
- Alter subsurface water quantity or water table depths
- Enhance wildlife and beneficial insect habitat
- Increase crop diversity
- Decrease off-site movement of nutrients or chemicals
- Increase carbon storage in plant biomass and soils
- Develop renewable energy systems
- Improve air quality

Conditions where practice applies:
On all cropland and hayland where trees, shrubs, crops and/or forages can be grown in combination.

Biomass Planting (CP 512)
Establishing adapted and/or compatible species, varieties, or cultivars of herbaceous species suitable for pasture, hay, or biomass production.

Purpose
- Improve or maintain livestock nutrition and/or health
- Provide or increase forage supply during periods of low forage production
- Reduce soil erosion
- Improve soil and water quality
- Produce feedstock for biofuel or energy production

Conditions where practice applies:
This practice applies all lands suitable to the establishment of annual, biennial or perennial species for forage or biomass production. This practice does not apply to the establishment of annually planted and harvested food, fiber, or oilseed crops.

Hedgerow/Border Planting (CP 422)
Establishment of dense vegetation in a linear design to achieve a natural resource conservation purpose.

Purpose
- Habitat, including food, cover, and corridors for terrestrial wildlife
- To enhance pollen, nectar, and nesting habitat for pollinators
- Food, cover, and shade for aquatic organisms that live in adjacent streams
• To provide substrate for predaceous and beneficial invertebrates as a component of integrated pest management
• To intercept airborne particulate matter
• To reduce chemical drift and odor movement
• Screens and barriers to noise and dust
• To increase carbon storage in biomass and soils
• Living fences
• Boundary delineation and contour guidelines

Conditions where practice applies:
This practice applies wherever it will accomplish at least one of the purposes stated above.

Multi-Story Cropping (CP 379)
Existing or planted stands of trees or shrubs that are managed as an overstory with an understory of woody and/or non-woody plants that are grown for a variety of products.

Purpose
• Improve crop diversity by growing mixed but compatible crops having different heights in the same area
• Improve soil quality by increasing utilization and cycling of nutrients and maintaining or increasing soil organic matter
• Increase net carbon storage in plant biomass and soil

Conditions where practice applies:
This practice applies wherever it will accomplish at least one of the purposes stated above.

Riparian Forest Buffer (CP 391)
An area predominantly planted to trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies.

Purpose
• Create shade to lower or maintain water temperatures to improve habitat for aquatic organisms
• Create or improve riparian habitat and provide a source of detritus and large woody debris
• Reduce excess amounts of sediment, organic material, nutrients, and pesticides in surface runoff and shallow ground water flow
• Reduce pesticide drift entering the water body
• Restore riparian plant communities
• Increase carbon storage in plant biomass and soils

Conditions where practice applies:
Riparian forest buffers are applied on areas adjacent to permanent or intermittent streams, lakes, ponds, and wetlands. They are not applied to stabilize stream banks or shorelines.
Tree/Shrub Establishment (CP 612)

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

Purpose

- Maintain or improve desirable plant diversity, productivity, and health by establishing woody plants
- Create or improve habitat for desired wildlife species compatible with ecological characteristics of the site
- Control erosion
- Improve water quality
- Reduce excess nutrients and other pollutants in runoff and groundwater
- Sequester and store carbon
- Restore or maintain native plant communities
- Develop renewable energy systems
- Conserve energy
- Provide for beneficial organisms and pollinators

Conditions where practice applies:
Tree/shrub establishment can be applied on any site capable of growing woody plants.

Windbreak/Shelterbelt Establishment (CP 380)

Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

Purpose

- Reduce soil erosion from wind
- Protect plants from wind related damage
- Alter the microenvironment for enhancing plant growth
- Manage snow deposition
- Provide shelter for structures, animals, and people
- Enhance wildlife habitat
- Provide noise and visual screens
- Improve air quality by reducing and intercepting airborne particulate matter, chemicals and odors
- Delineate property and field boundaries
- Improve irrigation efficiency
- Increase carbon storage in biomass and soils
- Reduce energy use

Conditions where practice applies:
Apply this practice on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, and visual resources. Use other tree or shrub practices when wind, noise, and visual problems are not concerns.
Additional economic planning resources

Aronia
Ag decision maker: Aronia berries. Iowa State University Extension. (Available at www.extension.iastate.edu/agdm/decision-aidsall.html as of May 18, 2017.)


Black Walnut
Eastern Black Walnut decision support tool. University of Missouri Center for Agroforestry. (Available at www.centerforagroforestry.org/profit/ as of May 18, 2017.)

Chestnut
Chestnut decision support tool. University of Missouri Center for Agroforestry. (Available at www.centerforagroforestry.org/profit/ as of May 18, 2017.)

Chestnut market analysis: producers perspective. University of Missouri Center for Agroforestry. (Available at www.centerforagroforestry.org/profit/ as of May 18, 2017.)

Cider Apple
Assessing the economic feasibility of growing specialized apple cultivars for sale to commercial hard cider producers. (Available at www.pubs.ext.vt.edu/AREC/AREC-46/AREC-46.html as of May 18, 2017.)


Elderberry
Elderberry Financial Decision Support Tool. University of Missouri Center for Agroforestry. (Available at www.centerforagroforestry.org/profit/ as of May 18, 2017.)


Juneberry
Economics of Saskatoon berry production. (Available at www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/econ7053/$file/saskatoon.pdf as of May 18, 2017.)
Additional species information

This following section provides a general overview of the various species utilized in MPCs. The information for each species was taken directly from relevant sources such as NRCS Fact Sheets, University extension reports (most notably University of Missouri, University of Florida, and University of Kentucky), and commercial plant guides. The source of information is provided at the end of each page and can be helpful to look for more information. **Note:** The information is not exhaustive and should not be used as a planting guide/decision tool.

Apple ........................................60  Juneberry .................................78
Aronia .......................................61  Mulberry, Red ............................79
Bald Cypress .............................62  Norway Spruce ..........................80
Black Walnut ...........................63  Oak, Red ..................................81
Chestnut, Chinese .....................64  Oak, Swamp White ......................82
Currant, Black .........................65  Oak, Overcup ...........................83
Currant, Red .............................66  Pawpaw ...................................84
Eastern Redbud .........................67  Peach ......................................85
Eastern White Pine ....................68  Pear, European .........................86
Eastern Red Cedar ....................69  Pecan ......................................87
Elderberry ..............................70  Persimmon, American .................88
Hazelnut, American ..................71  Plum, American .......................89
Hazelnut, European ..................72  Plum, European .......................90
Hazelnut, Hybrid .......................73  Prairie Crabapple ......................91
Hickory, Shellbark .....................74  Raspberry ................................92
Highbush Cranberry ..................75  Serviceberry ...........................93
Honeyberry .............................76  White Spruce ............................94
Honey Locust, Thornless .............77  Willow, Shrub ..........................95
**DESCRIPTION** Apples are a medium-sized deciduous fruit tree. Varieties used for fruit production originated from central Asia but have since then spread across the world. The size of an apple tree varies by the cultivar but can be as small as 6–15 ft. tall on dwarf rootstocks and as large as 40 ft. tall on standard rootstocks.

**HABITAT** Apple trees grow well in a wide range of soil types but prefer well-drained, sandy loam to a sandy clay loam. Ideal soil pH for apple trees is near 6.5. Apples prefer full sun for quality fruit production. The early morning sun is particularly important since it dries the dew from the leaves, thereby reducing the incidence of diseases.

**MANAGEMENT** A pest control program is important when growing apples. Dessert apples require more care than cider apples. For cider apples, some pest issues can be tolerated at low levels. For example, external blemishes such as mildew, russet, or mild apple scab lesions are of little importance so long as internal fruit quality is good.

**HARVEST** When using apples for table eating, harvest while they are still on the tree in late summer and into the fall. When using apples for cider, wait till apples start to fall, collect ground-falls, then go around the tree once and pick fruits that look similar in ripeness (color) to the ground-falls. Shaking the tree slightly will cause ripe fruit to fall. Harvest all ripe fruit, then wait a week and harvest the next batch the same way.

**ECONOMIC USES** The apples can be pressed for juice or hard cider and can be eaten as well. Cider consumption is quickly gaining popularity and represents one of the fastest growing segments of the liquor industry.

**MPCS USES** In MPCs, apples are selected for cider use because they require less management than dessert apples. They can work well in mixed alley cropping systems, multi-story cropping, or orchard style plantings.

**NOTES** Special attention should be paid to rootstock selection (dwarf, semi-dwarf, standard) and apple variety chosen. Consult a fruit nursery or expert before investing in a cider production system.

**SOURCES**
- [www.cesonoma.ucanr.edu/files/209991.pdf](http://www.cesonoma.ucanr.edu/files/209991.pdf)
- [www.ohioline.osu.edu/factsheet/hyg-1401](http://www.ohioline.osu.edu/factsheet/hyg-1401)
**Aronia**  
(*Aronia melanocarpa*)

**DESCRIPTION** Aronia is a deciduous, cold-hardy shrub useful for berry production, aesthetic value, and wildlife food. It can grow to a height of 3–6 ft. and has fine-toothed, medium green leaves. In the spring, small white flower clusters 2–2.5 in. across bloom, making an appealing landscaping plant. Berries are blueberry-sized and have a purplish-black color.

**HABITAT** The berry grows best in full sunlight on low lying, moist but well-drained soils. New shoots form around the plant creating a hedgerow like structure. Aronias are commonly found in moist woods, drier thickets, or clearings on bluffs.

**MANAGEMENT**  
This is a relatively carefree shrub with little-known pest or disease issues. Mildew may be a problem when the plant does not receive adequate sunlight and air circulation. Thinning of older stems is recommended every few years to help maintain berry production.

**HARVEST**  
Fruit forms in mid- to late-summer and has a relatively long harvest window between August and September. Berries can be picked by hand or machine harvested and will require further processing since fresh berries do not have a well-established market.

**ECONOMIC USES** Berries are most often juiced and used for jelly or fruit drinks. The juice is prized for its extremely high levels of anthocyanins and flavonoids making it one of the healthiest berries in the world. The deep purplish-black juice is also useful as a dye or food coloring.

**ECOSYSTEM BENEFITS** White-tailed deer and rabbits browse the plant. The fruit is eaten by Ruffed Grouse, Sharp-tailed Grouse, and Prairie Chickens. The wide soil tolerance of this shrub makes it very useful for preventing soil erosion and improving soil quality in marginal areas.

**MPCS USES** This shrub is one of the most adaptable berry crops that can be used in MPCs and is machine harvestable. It grows quickly and produces well, making it suitable for nearly all MPCs practices, especially on poor soil. It is used in alley cropping, border rows, windbreaks, and riparian buffers.

**NOTES** The berry is rather astringent and can be improved in flavor when frozen or further processed.

**SOURCES**  
Bald Cypress
*(Taxodium distichum)*

**DESCRIPTION** The bald cypress is a large, slow-growing but long-lived deciduous conifer, which can reach up to 120 feet. Its trunk is massive, tapered and buttressed. The leaves are alternate, linear, and flat with blades generally spreading around the twig. The bark is thin and fibrous with an interwoven pattern of narrow flat ridges and furrows. It develops a taproot as well as horizontal roots that lie just below the surface and extend 20–50 ft. before bending down. It develops knees that grow above water providing additional support.

**HABITAT** Generally, this tree is restricted to very wet soils consisting of muck, clay, or fine sand where moisture is abundant and almost permanent. It is usually found in flat, swampy areas. Its thin bark makes the tree susceptible to fires.

**MANAGEMENT** Canopy thinning is the most important practice for regenerating this species. Thinning reduces competition and allows for light to penetrate the canopy. Nutria, a swamp rodent, feeds off the roots of newly planted seedlings and can be an issue.

**ECONOMIC USES** Its wood is valuable for building construction, fence posts, planking in boats, river pilings, doors, blinds, flooring, shingles, garden boxes, caskets, interior trim, and cabinetry.

**ECOSYSTEM BENEFITS** Riverine swamps of bald cypress reduce damage from floods and act as sediment and pollutant traps as they cause floodwaters to spread out, slow down, and infiltrate the soil. It also has the potential for rehabilitating margins of surface-mined lakes. Bald cypress domes can serve as tertiary sewage treatment facilities for improving water quality and recharging groundwater. The seeds are eaten by wild turkey, Wood Ducks, Evening Grosbeak, squirrels, waterfowl, and wading birds. Bald cypress domes provide unique watering places for a variety of birds and mammals and breeding sites for frogs, toads, salamanders, and other reptiles.

**MPCS USES** Bald cypress is one of the most flood tolerant timber species. It is suitable for wet and flood prone soils and used for timber borders or riparian buffers.

**SOURCES**
www.plants.usda.gov/factsheet/pdf/fs_tadi2.pdf
**Black Walnut**  
*Juglans nigra*

**DESCRIPTION** Black walnut, also called American walnut, is one of the most coveted native hardwoods. It is a medium to large tree ranging from 70–90 ft. tall. The branches spread widely and can form a massive crown when provided space. Black walnut is a popular dual-purpose tree for producing high-value timber and edible nuts.

**HABITAT** Black walnut is sensitive to soil conditions and develops best on deep, well-drained, nearly neutral soils that are generally moist and fertile. Walnut grows best on sandy-loam, loam, or silt loam textured soils but also grows well on silty clay loam soils.

**MANAGEMENT** Black walnut can be grown for a variety of reasons, including nut production and high-quality timber production. For timber, it must be planted in fairly dense stands to develop a tall and well formed, clear bole. This bole form results from the tree putting its resources into competing for sunlight and is ideal for wood fiber production.

**HARVEST** The fine, straight-grained wood is prized for woodworking and veneer. The distinctive tasting nuts are popular for baked goods and ice cream. The shells are ground for use in many products as well. Harvest of nuts occurs in the fall.

**ECONOMIC USES** Historically, black walnut has kept ahead of inflation and remains one of the most valued hardwood species. The nuts can be sold, but are not considered extremely profitable because of the difficulty in removing the shell from the nut.

**ECOSYSTEM BENEFITS** It is used by over 20 different species of wildlife for food and cover.

**MPCS USES** Black walnut offers a unique high value timber tree that also produces marketable edible nuts. It tolerates wet soil, giving it a broad range of areas to be used in. It is used in for field borders, timber plantings, and alley cropping.

**NOTES** Black walnut produces a toxin called juglone which inhibits the growth of certain plants around it, and is toxic to horses.

**SOURCES**
www.extension.umn.edu/garden/yard-garden/trees-shrubs/growing-black-walnut/#why-grow-walnut  
Chestnut, Chinese  
(*Castanea mollisima*)

**DESCRIPTION** Chinese chestnut is a non-native, deciduous nut-bearing tree resistant to chestnut blight which was responsible for the loss of the American chestnut (*C. dentate*). The tree is a spreading, medium-sized (40 ft. tall) tree with glossy dark leaves and bears a large crop of nutritious, starchy nuts. Along with the European chestnut (*C. sativa*) and Japanese chestnut (*C. crenata*), Chinese chestnut provides the basis for world chestnut production.

**HABITAT** The trees prefer well-drained, loamy to sandy soils with a pH from 5.5–6.5. Trees should not be planted in areas of poorly drained soil, or with a standing water table due to the prevalence of Phytophthora root rot. Chestnuts require full sunlight.

**MANAGEMENT** Known insects that may cause issues include the yellow neck caterpillar, potato leafhopper, and oriental chestnut gull wasp. Trees should be pruned beginning in their second year to promote proper structure and encourage vertical branching. Browsing by deer and small mammals is an issue for young trees, and therefore they should be protected using tree guards or fencing. Chestnuts may be successfully grown from seedlings and produce a reliable crop if they are improved varieties with known parents.

**HARVEST** Chestnut harvest occurs from September through October. Trees may drop nuts for 2 to 4 weeks. Nuts should be harvested promptly to preserve quality and prevent predation by wildlife. Leather gloves should be worn to avoid being pricked by the sharp, spiky chestnut burs. Nut Wizards are very popular in small to medium-sized orchards for harvesting. Mechanical harvesting is possible.

**ECONOMIC USES** Fresh chestnuts are prized for their sweet, savory flavor. Markets in the United States are growing slowly as consumer awareness increases. The nuts are usually sold in-shell but can also be dried as flour. Nuts are usually roasted, boiled, or steamed.

**ECOSYSTEM BENEFITS** As one of the most prolific nut producers for its size, the chestnut tree is prized by wildlife for a source of high-quality food.

**MPCS USES** Chinese chestnut is seen as one of the most promising food producing trees for MPCs. It offers landowners an extremely productive nut producing tree within a relatively short time span. The tree, when placed on well-drained soil, is ideal for alley cropping or orchard style plantings.

**SOURCES**

Currant, Black
(Ribes nigrum)

DESCRIPTION European black currant is a small, deciduous berry producing understory shrub native to northern Europe and central Asia. The shrub is upright, spreading in habit (3–6 ft.), and very cold hardy. It is traditionally grown for its berries that are popular in juices and wines for their tart, crisp flavor. It is closely related to European gooseberries (Ribes grossularia) and American currant (R. hirtellum).

HABITAT Black currants can tolerate partial shade and prefer a cool, moist, well-drained area with rich soils (high in organic matter). Avoid sites with poor circulation, light-textured, sandy soils, or waterlogged soils.

MANAGEMENT Pruning is a must with black currants and can be done during dormancy. Ribes spp. begin to produce fruit at the base of one-year-old wood, and production is highest on spurs of two- or three-year-old wood. Yearly pruning should aim to leave 4–5 of the best one-year-old canes, 3–4 of the best two-year-old canes, and 1–2 suitable three-year-old canes if healthy. Only 6-10 shoots should remain each year with varying age class. Canes older than 4 years old should be removed. This system ensures plants remain productive each year by avoiding non-productive older canes.

HARVEST By their third growing season, currants should produce a reliable crop that can be picked by hand or machine harvested in July. Wait for fruit color to turn dark before picking to avoid under-ripe, unpleasant berries.

ECONOMIC USES The berries are most often sold to be processed into high-value jams, juices, and wines. The berries are known to be quite valuable for their high vitamin C and polyphenol contents. Young leaves, harvested in the spring, are used for herbal teas.

ECOSYSTEM BENEFITS The berries are eaten by various wildlife for food and its low-lying shrub structure makes it a nesting habitat for many birds.

MPCS USES Black currants are one of the more productive and sought after berry crops due to their high-quality juice. They work well in tandem with tree crops because of their shade tolerance, making them suitable for alley cropping, orchard style plantings, or other mixed species systems.

SOURCES
www.ag.umass.edu/fruit/ne-small-fruit-management-guide/currants-gooseberries
www.www.uky.edu/Ag/CCD/introsheets/currants.pdf
**Currant, Red**  
*(Ribes rubrum)*

**DESCRIPTION** European red currant is a small deciduous, berry producing understory shrub native to northern Europe and central Asia. The shrub is upright, spreading in habit (3–6 ft.), and very cold hardy. It is traditionally grown for its crisp, sweet red berries that are popular in juices and wines. Red currant differs from black in that it is more often eaten fresh and is much easier to harvest. Fruits range in color from dark red to pink, yellow, white and beige, and they continue to sweeten on the bush even after they appear to be in full color. Plants are dependable, vigorous, late ripening, and very productive, bearing long-stemmed clusters of large red berries that are easy to pick. Other cultivated red currant species include *R. sativum* and *R. patraeum*.

**MANAGEMENT** Pruning is a must with red currants and can be done during dormancy. *Ribes spp.* begin to produce fruit at the base of one-year-old wood, and production is highest on spurs of two or three-year-old wood. Yearly pruning should aim to leave 4–5 of the best one-year-old shoots, 3–4 of the best two-year-old canes, and 1–2 suitable three-year-old canes if healthy. Only 6-10 shoots should remain each year with varying age class. Canes older than 4 years old should be removed. This system ensures plants remain productive each year by avoiding non-productive older canes.

**HARVEST** By their third growing season, currants should produce a reliable crop that can be picked by hand in June. Wait for fruit color to turn deep red before picking to avoid under-ripe, sour berries.

**ECONOMIC USES** The berries can be sold fresh or used to make high-value jams, jellies, and wines. The berries are more palatable than the related black currant and thus can be sold in fresh markets.

**ECOSYSTEM BENEFITS** The berries are eaten by various wildlife for food, and its low-lying shrub structure makes it a nesting habitat for many birds.

**MPCS USES** Red currants placed in the same row as tree crops may be difficult to harvest using machinery, but can be done easily by hand. They are used in alley cropping and multi-story cropping systems.

**SOURCES**  
www.fruit.cornell.edu/mfruit/gooseberries.html  
www.ag.umass.edu/fruit/ne-small-fruit-management-guide/currants-gooseberries
**Eastern Redbud**
*(Cercis canadensis)*

**DESCRIPTION** Eastern redbud is a small to medium-sized native deciduous tree known for its showy, pink to reddish purple flowers that grow in early spring prior to leaf break. The tree crown grows to resemble a vase shape as it matures. Commercially available varieties exist that produce improved flowers in the spring.

**HABITAT** The tree is a native understory tree in much of the Midwest and is found on moist, loam or sandy soils. It cannot grow on flooded, poorly aerated soils. The tree is fire tolerant.

**MANAGEMENT** Eastern redbud develops a deep taproot that grows quickly the first few years under conducive conditions. Pruning the tree helps develop a strong structure. Three main diseases affect eastern redbud: leaf anthracnose, Botryosphaeria canker, and verticillium wilt. Botryosphaeria canker produces stem and twig lesions and entire stands have been killed by the disease.

**ECONOMIC USES** Twigs and branches can be cut in the spring for florists, otherwise the tree is only used for aesthetic purposes.

**ECOSYSTEM BENEFITS** The flowers are used for nectar by honeybees and hummingbirds. White-tailed deer browse the foliage.

**MPCS USES** Eastern redbud is a versatile ornamental tree that works well in borders along roadsides, ditches, or other areas that may be seen by people. It is used strictly for ornamental purposes.

**NOTES** The flowers can be fried and eaten.

**SOURCES**
Eastern White Pine
(Pinus stobus)

DESCRIPTION White pine is the largest conifer of the eastern and upper Midwest forests, reaching 150 ft. in height. In dense stands, trees produce tall, cylindrical stems with pyramidal shaped crowns characterized by distinctive, plate-like branching. On young growth, the bark remains rather thin, smooth, and greenish-brown in color. On older trees, the bark becomes deeply fissured and dark grayish-brown in color.

HABITAT White pine grows on a variety of soils ranging from light, sandy to heavy textured soils.

MANAGEMENT White pine seedlings require weed control for the first few years after planting. Management of white pine should focus on thwarting the white pine weevil. Growing white pine where there will be partial shade on the developing saplings and pole-sized trees (especially on the terminal leader) seems to reduce infestation by the weevil. Therefore, growing white pine in mixed uneven aged stands is a good idea if possible.

HARVEST Straight boles are preferred when growing white pine for timber.

ECONOMIC USES The wood of white pine is light, durable, and easy to work. It is good lumber for toys, boxes, cabinet work, and similar items. White pine is used occasionally in Christmas tree plantations and as an ornamental in landscaping around homes and office buildings.

ECOSYSTEM BENEFITS It is often used for windbreaks and screens along roadways or borders. It has fair wildlife value. Gray and red squirrels, deer, mice, and 16 species of songbirds have been known to eat the seeds.

MPCS USES White pine is the largest native evergreen pine tree in the Midwest making it an ideal choice for windbreaks.

NOTES Caution should be taken when planting white pine near black currants (Ribes spp.) due to potential infestation of white pine blister rust.

SOURCES www.plants.usda.gov/factsheet/pdf/fs_pist.pdf
Eastern Red Cedar
(*Juniperus virginiana*)

**DESCRIPTION** Red cedar is a medium-sized evergreen, native to the Midwest. The tree is shaped like a pyramid or column, with reddish-brown to grayish colored bark that is fibrous and shedding. Branches are usually reddish-brown. The female cones ripen from September through October.

**HABITAT** The distribution of red cedar spans the U.S., East of the Rockies. It is especially well adapted to dry areas.

**MANAGEMENT** Red cedars are easy to control when small via burning, cutting, mowing, or other relatively inexpensive land management practices.

**HARVEST** Red cedar trees come to seed-bearing age in 10 years, and they bear cones every 2–3 years. Seed collection can be done by stripping or picking the berries by hand from the trees, or by shaking the tree.

**ECONOMIC USES** The wood of red cedar is very durable and easy to work with. It is used for fence posts, furniture, and small wooden specialty items. Red cedar leaves can be used for incense, teas, and other health purposes.

**ECOSYSTEM BENEFITS** Red cedar and other junipers are important to wildlife throughout the country. Their twigs and foliage are eaten extensively by hoofed browsers, but the main attraction to wildlife is the bluish-black fruit. Numerous birds and mammals, both large and small, make these fruits an important part of their diet. In addition to wildlife food value, cedars provide important protective and nesting cover. Chipping Sparrows, Robins, song sparrows, and mockingbirds use these trees as one of their favorite nesting sites. In winter, their dense and protective shelter is especially valuable. Additionally, the soil tolerance of this tree makes it particularly useful for improving soil quality in degraded areas.

**MPCS USES** Red cedar is an attractive medium-sized evergreen tree for windbreaks, hedges, or mixed timber plantings. It is a very tolerant species (especially of salt) making it useful in degraded soils.

**SOURCES**
- [www.extensionpublications.unl.edu/assets/pdf/ec186.pdf](http://www.extensionpublications.unl.edu/assets/pdf/ec186.pdf)
**Elderberry**  
* (Sambucus canadensis)  

**DESCRIPTION**  
Common American elderberry is a large, upright deciduous shrub or small tree with multiple spreading shoots. This shrub can reach up to 12 ft. tall. The flowers are small, white, and in flat-topped clusters that are up to 8 inches across. The fruit is a small, purple-black berry-like drupe, borne in flat-topped clusters. The European variety (*Sambucus nigra*) is used for commercial berry production in Europe.

**HABITAT**  
Elderberry can be found nearly anywhere from the central to the eastern United States along streams and rivers, woodland margins, and waste ground. Elderberry is adaptable to either wet or dry sites and prefers neutral to acidic soils. It grows best in full sun but can tolerate mild shade. They are extremely versatile shrubs.

**MANAGEMENT**  
Pruning is needed on a regular, if not yearly basis to keep the plants healthy and aesthetically pleasing. The plant tends to sucker. It can withstand extended flooding and high concentrations of nitrogen.

**HARVEST**  
Elderberries are harvested by hand in late summer and do best with several varieties planted closely together.

**ECONOMIC USES**  
The berry clusters are used to make jellies, jams, and juice. Only the blue and purple berries of an elderberry are edible. The flowers and berries are often used for medicinal purposes. The bark, leaves, and berries can be used to make dyes.

**ECOSYSTEM BENEFITS**  
Game birds, squirrels and other rodents, and several kinds of browsers feed on the fruit or foliage of elderberry. Deer browse on the stems and foliage. The elderberries are important sources of summer food for many kinds of songbirds. Additionally, when used in combinations with other trees elderberry provides a structural layer often used by songbirds for nesting.

**MPCS USES**  
Elderberries are tolerant of wet soil and can grow almost anywhere making it a versatile berry crop. Since it is not machine harvestable, it is less suitable for larger systems but still has a place in alley cropping systems, borders, riparian buffers, and conservation plantings.

**NOTES**  
CAUTION: The active alkaloids in elderberry plants can cause nausea when eaten in large quantities.

**SOURCES**  
Hazelnut, American
(*Corylus americana*)

**DESCRIPTION** The American hazelnut is a medium, thicket-forming shrub native to the Midwest. It can grow from 3–10 ft. tall. It has a straight trunk with spreading, ascending branches. Male flowers (catkins) are light brown, 1–3 in. long, and form in clusters of two or three. Female flowers are very small and appear as short, thin red threads in very early spring. The edible brown nuts are 1/2 in. in diameter and enclosed in a hairy, leaf-like husk with ragged edges. The nuts are sweet and may be eaten raw or ground and used as flour. Nuts are smaller than the commercial European hazelnuts but similar in flavor.

**HABITAT** It is found in the wild along streams, hedgerows, woodlands, roadsides, and marginal lands. It prefers well-drained, moist, loamy soil, but grows in many soil types given proper drainage. Do not plant hazelnuts where the soil is poorly drained, shallow, or too heavy or light.

**MANAGEMENT** American hazelnut is a competitive understory tree. It often competes with hardwoods and pines for light and moisture. It is a fairly shade tolerant shrub. However, do not expect good nut production under heavy shade. If hazelnut is used for production, animals must be managed to avoid a significant loss of nuts.

**HARVEST** Hazelnuts start to mature in late summer to early fall. Typically the nuts are harvested by hand. Mechanical production can be possible using tarps placed underneath the tree to capture fallen nuts when the shrub is shaken.

**ECONOMIC USES** The nuts are used as kernels or for oil, meal, and other processed products because the American hazelnut does not produce the large nuts favored by the in-shell market or for nut mixes. This means that value-added processing will be required to enter these markets.

**ECOSYSTEM BENEFITS** The multi-stemmed growing habit helps to reduced soil erosion, improve water quality, improve wildlife habitat, and reduce nutrient inputs. The dense low structure of the plant provides good nesting habitat. The leaves, twigs, and catkins of American hazelnut are browsed by deer and moose. The nuts are eaten by small mammals, small and large birds, and deer. The catkins are used as food by turkey.

**MPCS USES** American hazelnuts are used in windbreaks, borders, and alley cropping systems. Their sweet, small nuts are ideal for wildlife food or human consumption.

**SOURCES**
[www.plants.nrcs.usda.gov/cgi_bin/topics.cgi?earl=fact_sheet.cgi]
Hazelnut, European
*(Corylus avellana)*

**DESCRIPTION** European hazelnut is a large shrub, often pruned to a small tree (growing 10–20 ft. tall) that is responsible for nearly all global hazelnut production.

**HABITAT** European Hazelnuts prefer well-drained, moist, loamy soil, but grow in many soil types given proper drainage. Do not plant hazelnuts where the soil is poorly drained, shallow, or too heavy or light.

**MANAGEMENT** Eastern filbert blight (EFB) is the most prevalent disease, and devastating for European hazelnut. It causes little damage to the American species but can kill off European species within 5–10 years. EFB causes cankers on branches or main trunks which slowly spread along the plant. Pruning is required. Understory grasses will need to be mowed for machine harvesting of nuts. Commercial varieties will need an additional variety for pollination.

**HARVEST** In the Midwest, harvest usually occurs in late September into October. All commercially grown hazelnuts are harvested mechanically. Mechanical harvesting involves sweeping the nuts into a narrow windrow, collecting the nuts (usually by vacuum), separating twigs and leaves out, and then depositing the nuts in a trailer. Less sophisticated and less expensive equipment is used in smaller orchards.

**ECONOMIC USES** European Hazelnuts are sold unshelled as whole, diced, sliced or ground kernels, and as paste or as oil. The highest quality nuts, which command the highest prices, are sold unshelled. The most important market for these nuts is the snack food industry.

**ECOSYSTEM BENEFITS** Hazelnuts are an ideal crop for highly erodible land because they do not require annual tillage, and because they may be grown with perennial cover between rows. They can provide habitat and food for wildlife, pollinators, insects, and increase diversity on the landscape.

**MPCS USES** European hazelnuts have extremely high potential as a nut crop in the Midwest due to their tolerance of marginal soils and their nutritious, high-yielding nuts. They are best suited in alley cropping, orchards, borders, or multi-story cropping because of their compact structure.

**NOTES** Consult with a local horticulturist or hazelnut grower before planting European hazelnuts. EFB resistance and cold hardiness are major concerns.

**SOURCES**
- [www.ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/12300/em8987.pdf?sequence=3](http://www.ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/12300/em8987.pdf?sequence=3)
Hazelnut, Hybrid  
(*Corylus avellana x americana*)

**DESCRIPTION** Hybrid hazelnuts are a deciduous shrub created from crosses between the European hazelnut (*Corylus avellana*), which was bred for large commercial nut production, and the native species (*Corylus americana*), which brings winter hardiness and disease tolerance. Unlike the European hazelnuts, these hybrids are grown as multi-stemmed bushes, not as trees. Mature bushes may be up to 12 ft. tall and nearly as wide.

**HABITAT** Hazelnuts prefer well-drained, moist, loamy soil, but grow in many soil types given proper drainage. Do not plant hazelnuts where the soil is poorly drained, shallow, or too heavy or light.

**MANAGEMENT** Hybrud hazelnuts are wind pollinated and bloom very early in the spring prior to leaf-out. They are extremely cold hardy, but lose their hardiness in the spring when they start to expand to release their yellow pollen. After about twelve years, hazelnut bushes will often become overly large for easy harvest, with declining yields. They can be rejuvenated by coppicing them to the ground during the winter when they are dormant. They should regrow to full production in about three years.

**HARVEST** Hybrid hazelnut bushes will usually produce their first nuts in their fourth year, and reach full production in year eight or later. Hazelnuts start to mature in late summer to early fall. In general, if the clusters can be pulled from the bushes easily, they are ready to harvest. Currently, most hazelnuts in the Midwest are harvested by hand.

**ECONOMIC USES** The nuts are used as kernels or for oil, meal, and other processed products because hybrids do not produce the large nuts favored by the in-shell market or in nut mixes. This means that value-added processing will be required to enter these markets.

**ECOSYSTEM BENEFITS** The multi-stemmed growing habit helps to reduced soil erosion, improve water quality, improve wildlife habitat, and reduce nutrient inputs. The shrubs provide habitat for wildlife and pollinators. The nuts are eaten by a variety of animals.

**MPCS USES** Hybrid hazelnuts’ tolerance of less than ideal soil situations makes them useful for hedgerows, windbreaks, border rows, and even alley cropping. They produce a plentiful crop and perform a wide range of ecosystem benefits that are akin to MPCs.

**SOURCES**  
**Hickory, Shellbark**  
*(Carya laciniosa)*

**DESCRIPTION** Shellbark hickory is a very large native deciduous tree with an open, round to oblong crown. The bark is smooth and light gray with shallow interlacing ridges, later developing long, broad, loosely attached plates attached at the middle and curving away from the trunk, resulting in a coarsely shaggy appearance. The common name refers to the mature bark that peels away like a shell, albeit in strips. Has the largest nut of all hickories.

**HABITAT** Shellbark hickory usually occurs on deep bottomland soils of rivers and creeks but can occur on dry, sandy soils. It usually occurs in mixtures with various other bottomland species and is very shade tolerant.

**MANAGEMENT** Shellbark hickory sprouts readily when cut, and coppice management has been recommended for this and other hickories. It is a persistent sprouter following fire and/or grazing. The trees cast a very heavy shade and make the tree suitable for mixed woodland planting with shrubs underneath.

**HARVEST** The minimum tree age for seed production in shellbark hickory is about 40 years, with most seed produced between 75–200 years. Some seeds are borne every year, but mast crops are produced about every second year or more irregularly.

**ECONOMIC USES** The wood of shellbark hickory is hard, heavy, strong, and very flexible, making it a favored wood for tool handles. The hardness and beauty of the grain also make it desired for furniture, cabinets, and veneer. It also is prized as fuelwood and charcoal. All hickories, however, suffer from ring shake: a separation of wood along the annual rings and a serious problem for thin veneers. The nuts of shellbark hickory are sweet and edible and the largest of all hickories.

**ECOSYSTEM BENEFITS** The nuts are eaten by a wide range of wildlife species including ducks, quail, wild turkeys, squirrels, chipmunks, deer, foxes, raccoons, and white-footed mice. The tree is rarely planted as a shade tree; it is relatively slow growing and difficult to move because of its taproot.

**MPCS USES** Shellbark hickory is a dual-purpose nut and timber tree for areas with soil too wet or poorly drained for high-value crops.

**SOURCES**

**Highbush Cranberry**  
*Viburnum opulus var. americanum*

**DESCRIPTION** The native highbush cranberry (often referred to as American Cranberry bush) is a deciduous shrub prized for its ornamental value and small edible red fruits. It grows around 10–12 ft. tall with upright, spreading, arching branches. The fruit are berry-like (a drupe), bright red, and small. The common name alludes to the resemblance in fruit between the highbush cranberry and the cranberry of commerce (*Vaccinium macrocarpon)*.

**HABITAT** Highbush cranberry grows in wet woods, along streams, and on moist wooded hillsides, requiring moist but well-drained sites for best development. The plants are shade-tolerant, but flowering, fruiting, and foliage color are best on plants in full sun.

**MANAGEMENT** Highbush cranberry is adaptable to a variety of soils and acidies, but it does best in consistently moist but well-drained soil. A yearly application of compost or well-rotted manure will maintain growth and fruit yields. Plants may require occasional pruning to keep them from becoming leggy and to encourage the production of new shoots. Highbush cranberry can be propagated through hardwood and softwood cuttings.

**HARVEST** The fruit is commonly gathered from wild stands in late August or early September and best when picked slightly under-ripe.

**ECONOMIC USES** Highbush cranberry is used as an ornamental plant and valued for its edible fruits. The fruit is used in sauces, jellies, and juices. If picked after a heavy frost, the fruit is softer and more palatable, but they develop a musty, somewhat objectionable odor during cooking. The species has never developed into a commercial fruit crop.

**ECOSYSTEM BENEFITS** The bright red fruits often persist on the plants throughout the winter; good for ornamental value but suggesting that they may not be especially palatable for wildlife. They are known to be eaten by deer, moose, foxes, raccoons, chipmunks, squirrels, skunks, mice, rabbits, grouse, pheasants, Robins, Cedar Waxwings, and other songbirds. They are not normally eaten by birds until after they have frozen and thawed several times.

**MPCS USES** Highbush Cranberry is an option for those looking to add aesthetic value and edible fruits to a mixed windbreak or border planting, especially on wet soils.

**SOURCES**  
Honeyberry
*(Lonicera caerulea)*

**DESCRIPTION** Honeyberry is a multi-branched, deciduous shrub that is native to moist boreal forest areas in northern temperate climates of Asia, Europe, and North America. This shrub is unlike many of its honeysuckle relatives in that it produces an edible, tasty, blueberry-like fruit. It typically grows to 4–6 ft. tall and wide. Opposite, elliptic to ovate, glaucous green leaves (each 2–3 inches long) have slightly wavy leaf margins. Fruits are oval-teardrop-like in shape.

**HABITAT** It is best grown in organically rich and moist but well-drained soils in full sun to part shade. Shrubs will take full sun in the northern parts of the growing area but appreciate some afternoon shade in hotter southern parts of the growing area.

**MANAGEMENT** Consistent moisture is important in the early years of development. Shrubs will show some drought tolerance after root systems are well-established. Powdery mildew may be an issue but can be controlled. Improved varieties are available.

**HARVEST** Fruits ripen in early summer to a deep blue with reddish-purple insides.

**ECOSYSTEM BENEFITS** Many birds will eat the fruits and the shrub-like habit of the plant provides wildlife habitat.

**MPCS USES** Honeyberry has not been widely grown in the Midwest but shows promise as a productive berry crop.

**SOURCES**
- [www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?taxonid=278931&isprofile=0](http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?taxonid=278931&isprofile=0)
- [www.fruit.usask.ca/haskap.html](http://www.fruit.usask.ca/haskap.html)
Honey Locust, Thornless  
(*Gleditsia triacanthos*)

**DESCRIPTION** Honey locust is a woody, long-lived, native, deciduous legume, and is capable of growing to 100 ft. in height. The doubly compound leaves are alternate and dark green in color.

**HABITAT** Honey locust is a pioneering woody species commonly found in overgrown pastures, fields, fence lines, and woodlot edges. It has a very broad range of adaptation and is distributed nationwide, excluding Oregon and Washington. The greatest concentration of plants can be found in the central portions of the United States. It prefers moist, fertile, alluvial soils. It will withstand periods of drought and prolonged wetness and is commonly found in the upland areas along river drainages.

**MANAGEMENT** Once established, trees are generally maintenance free. Pruning of lower limbs will encourage tall, upright growth. This plant can become a nuisance and will dominate a site if left unchecked or mismanaged.

**ECONOMIC USES** This tree produces bean pods that can provide food for domestic animals thereby reducing feed costs. Wood from the honey locust is very dense, shock resistant and commonly used in the timber industry for purposes such as fence posts, railroad ties, and furniture.

**ECOSYSTEM BENEFITS** Honey locust is used extensively by wildlife. The bean pods are a favorite food of the white-tailed deer, squirrels, rabbits, hogs, opossums, and raccoons. Flowers of this species are incredibly attractive to pollinating insects. Honey locust is capable of forming dense thickets of thorny vegetation which provides excellent cover for a wide variety of game animals and birds.

**MPCS USES** This tree is used only for silvopasture designs. Domestic animals such as sheep, goats, and cattle will forage on the honey locust bean pods. Also, browsing and grazing animals (deer, cattle, and sheep) eat the tender shoots in spring and the bark of young trees in winter.

**NOTES** Only use the thornless variety when planting for MPCs. Honey locust may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Crushed/Ground seeds are toxic to some domestic animals and wildlife.

**SOURCES**

Juneberry
(*Amelanchier alnifolia*)

**DESCRIPTION** Often referred to as Saskatoon serviceberry, this deciduous shrub or small tree grows to be 15–20 ft. tall when unmanaged. This should not be confused with Downy Serviceberry (*Amelanchier arborea*). It is primarily used for commercial fruit crops in Canada and the northern United States. It grows in various growth forms such as thickets, mats, or small clumps and often has large root structures. Fruit are small, purple-black, and berry-like, with fleshy and sweet pulp.

**HABITAT** Juneberry grows in lower-elevation coniferous forests but grows sporadically up to timberline. In grasslands, it most often occurs in riparian zones or woodland interfaces. It prefers lightly shaded, disturbed sites.

**MANAGEMENT** There is considerable variation within the species and commercial cultivars, and this should be noted when purchasing plants. It is a short-lived species, normally surviving for about 20 years.

**HARVEST** Juneberry can be harvested mechanically using a pull-type or self-propelled harvester. They can also be picked by hand or picked using a hand-held shaker with understory carts to collect the fruit. Fruit will have to be cleaned of stems and unripe fruit after harvest. Multiple pickings may be required based on ripening evenness.

**ECONOMIC USES** The fruits can be eaten fresh or used for pies, jams, fruit leathers, and syrup. Juneberry wine is a specialty as well.

**ECOSYSTEM BENEFITS** It is an important species for reclamation, wildlife, watershed, and shelterbelt plantings.

**MPCS USES** Juneberry offers an early summer crop suitable for machine harvesting. It is well suited for a range of soil types and works well in alley cropping, multi-story cropping, windbreaks, borders, or planted for aesthetic purposes.

**SOURCES**
Mulberry, Red
(Morus rubra)

DESCRIPTION Red Mulberry is a medium-sized, fast growing deciduous tree with a short trunk and spreading branches. It is known for its dark purple fruits that are 2–3 inches long. Mulberry is a messy tree that drops fruits and flowers onto the ground and can be a nuisance in urban areas.

HABITAT It is a native tree found in moist soils of hardwood forests. There are two other species of mulberries (Black Mulberry and White Mulberry), but they are non-native and are often considered weedy or invasive.

MANAGEMENT Red mulberry has very few pest or disease issues and is relatively maintenance free when used for livestock systems.

HARVEST The berries come early in the year between April and June.

ECONOMIC USES Berries can be sold as a food crop or used as animal feed. They can be used similarly to blackberry–jams, jellies, plain, wines, etc. In the past, red mulberry was used to fatten hogs and as poultry food and is now being considered as a suitable silvopasture tree for animal feed. The wood is light, soft, weak, close-grained, and durable. It has been used for fence posts, farm implements, cooperage, furniture, interior finish, and caskets.

ECOSYSTEM BENEFITS Mulberry is a fast growing tree capable of sequestering carbon rapidly, especially in wet areas. It can be used in erodible areas to maintain soil, as well as providing wildlife habitat and food. It is a favorite wildlife food, especially songbirds like the Chestnut-sided Warbler, Grey-cheeked Thrush, Swainson’s Thrush, Tennessee Warbler, Scarlet Tanager, and Veery. The leaves and twigs provide browse for white-tailed deer and livestock. Also, the leaves provide larval food for two butterflies: mourning cloak and red admiral.

MPCS USES In silvopasture systems, red mulberries offer a great dual-purpose shade tree and food producer. They can play an integral part in reducing feed costs year round because of their nutritious fruits that produce for a longer period than most trees.

SOURCES
**Norway Spruce**

*Picea abies*

**DESCRIPTION** Native to the Midwest, Norway spruce is an evergreen tree that grows to 40–60 ft. tall with a large pyramidal crown of moderate density. Small-diameter branches sweep horizontally from the straight trunk which can grow to 4 ft. thick. Branchlets droop from the branches toward the ground in a graceful, weeping fashion forming a delicate pyramid. It is most commonly used as a windbreak or screen tree to provide a barrier.

**HABITAT** It grows well on wet, well-drained clay, loam, sand, and slightly acidic soils. It is overall a very tolerable tree of various soil types.

**MANAGEMENT** Norway spruce has few pests. The tree does not root sucker, stump sprout, or store seed to pop up later. It is also very easy to transplant.

**HARVEST** Norway spruce is very fast growing and can be harvested within ten years to be used as a Christmas tree.

**ECONOMIC USES** The wood is not as dense as hardwoods; however, it makes good construction lumber. Most of the studs one would buy are made from one of the spruce species.

**ECOSYSTEM BENEFITS** Norway spruce can be very useful in carbon sequestration. As an evergreen, it is able to photosynthesize any time the sun is shining and the temperature is above freezing. This causes it to grow tall and large in diameter in a relatively short time.

**MPCS USES** Norway spruce is used for windbreaks because of its fast growth and evergreen needles for year round cover.

**SOURCES**


Oak, Red  
(*Quercus rubra*)

**DESCRIPTION** Red Oak is a fast growing deciduous tree that is suitable for a variety of soils. It is a medium-sized deciduous tree with a rounded to broad spreading crown. It typically grows to 50–75 ft. Its leaves turn brown/red in the fall, and it produces an abundant crop of acorns. However, production may not occur until the tree reaches 40 years of age.

**HABITAT** It is native to the Midwest and grows primarily in moist, well-drained soil. It grows best in full sun and often occurs as the dominant tree in natural forests.

**MANAGEMENT** It will grow great on a variety of soils but will do best on deep, well-drained loam to silty, clay loam soils. Various species of red oak are susceptible to oak wilt, a fungal disease that causes leaves to die and fall from the tree. Once trees have been infected, little can be done to heal them. Additionally, it is susceptible to a number of defoliating insects and diseases, including Gypsy moth and oak wilt.

**ECONOMIC USES** Red oak is an important lumber species and is used in a variety of applications from firewood, flooring, etc.

**HARVEST** Red oaks grow faster than white oaks and reach a harvestable size earlier, as soon as 40–60 years.

**ECOSYSTEM BENEFITS** Heavy acorn production is important for many wildlife species including squirrels, turkeys, deer, and many birds. The long trees also provide nesting habitat for birds and act as carbon sinks due to their long lifespan.

**MPCS USES** It is one of the fastest growing oak lumber trees that is suitable for a variety of soils. Red Oaks work well in timber borders, windbreaks, or for producing wildlife food. Additionally, the leaves develop an attractive brick-red color in fall which has made this tree popular in urban settings.

**SOURCES**
Oak, Swamp White
(*Quercus bicolor*)

**DESCRIPTION** Swamp white oak is a long-lived species that can reach up to 70 ft. in height and 2–3 ft. in trunk diameter. Its botanical name is based on the two-toned appearance of the foliage, which is a glossy dark green above and nearly white beneath. Another distinctive feature of this species is that it bears acorns on very long (3–5 inch) stalks.

**HABITAT** It is often found on acidic soils that are very poorly drained. It does best in full sunlight and is commonly found along with bur oak, red maple, and pin oak. It is tolerant of poor soil conditions.

**MANAGEMENT** It is relatively tolerant of various soils and can be established under partial shade. If grown in a timber or forest planting it will grow a large, straight bole with a broad spreading crown. Lower branches will require pruning to improve stem quality. Attention should be paid to defoliating insects and diseases. Acorns can also be hurt by insect damage.

**HARVEST** Swamp white oak is similar to other oak species in terms of its growth and development. It will take 60–90 years to produce quality timber on good sites and 90–120 years on poor sites.

**ECONOMIC USES** The wood of swamp white oak is of high quality and is normally labeled as white oak. It is used for furniture, cabinets, high-quality veneer, and barrel staves. Poorer quality wood is used for fuelwood and fence posts.

**ECOSYSTEM BENEFITS** It is arguably the best nut producing tree for whitetail deer, turkeys, woodpeckers, sapsuckers, wood ducks, squirrels, and other small rodents. Also, it is an extremely long-lived tree that can provide carbon sequestration, soil quality improvements, and diversity to the landscape.

**MPCS USES** Swamp white oak is one of the best wildlife and timber dual-purpose species available to landowners. It can handle very poorly drained, wet soils and is used in riparian buffers, timber borders, or wildlife plantings.

**SOURCES**
Oak, Overcup
(*Quercus lyrata*)

**DESCRIPTION** Overcup Oak is a non-native, deciduous white oak that grows to 60–100 ft. tall, often with a short trunk and open, irregularly rounded crown. The bark is light gray becoming furrowed into scaly plates and ridges. It is named after its acorns, which are round, nearly globose with a warty gray cup almost enclosing nearly all of the acorn.

**HABITAT** The plant is native to the southern United States. It grows best on clay or silty-clay bottomlands of rivers and streams. It is also common on the edges of swamps and poorly drained areas. Tolerance to late spring floods results partly from its phenology (it leafs out a month or more later than most species). Many stands of overcup oak owe their development to tolerance of early season flooding that kills off earlier flushing species.

**MANAGEMENT** The overcup oak is a very slow growing oak which can cause it to be overtopped very easily. It is relatively intolerant of shade. Suppressed young trees respond strongly to release when the canopy is opened by disturbance. The tree is relatively pest free in the Midwest. Despite its natural habitat of wet, poorly drained soils, it does better with drainage and lighter soil textures.

**HARVEST** Overcup Oak takes longer to reach harvest maturity than red oak. Maturity may not be reached until 80–120 years.

**ECONOMIC USES** Wood of overcup oak is brownish, hard, heavy, and strong; it is marketed as white oak primarily for lumber and cooperage but is not consistently valued for quality products because of fire damage and defects from wood borers and heartwood decay following fire injuries. Checking during drying and seasoning often prevents general use even as ties and timbers. In some areas, this species has been avoided in cutting and has increased in dominance at cut-over sites.

**ECOSYSTEM BENEFITS** Overcup oak is planted to improve wildlife habitat and for bottomland restoration. Ducks, wild turkeys, hogs, white-tailed deer, squirrels, and smaller rodents eat the acorns.

**MPCS USES** The tree can withstand significant flooding and poorly drained soils, and is tolerant to drought and cold. It is used in borders and riparian buffers.

**SOURCES**
Pawpaw
(Asimina triloba)

DESCRIPTION Reaching a height of 15–25 ft., the pawpaw is a native, deciduous species of the United States. This slow-growing understory-tolerant species produces 12 in. leaves that are a dark green color and droop, giving the tree a “tropical themed” appearance. In autumn, the leaves turn mustard yellow and begin to fall in autumn. After the flowers have bloomed and been pollinated, the tree leafs out in late spring. The flowers are chocolate brown in color and have a velvety texture to them. The fruit itself is commonly referred to as the “banana” of the Midwest due to its ripe, creamy texture. The Cherokee and many other tribes used the pawpaw fruit for food, which is the largest edible fruit native to America.

HABITAT Pawpaw is primarily an understory tree in oak-hickory forests and exists in clumps due to the hardiness of their seeds and ability to sucker sprout. After the tree matures (around 5 years), it can handle full sun which will increase fruit production. The tree must be protected from strong winds, and should not be planted alone in the open. They are not suitable for very wet areas or poorly drained soils.

MANAGEMENT Irrigation and fertilization are critical during the growing season to maintain plant health. No pruning is required. At least two plants are needed for pollination.

HARVEST Fruit ripens between August and early October. When fully ripe, the light green fruit can weigh from five ounces to one pound and be 3–6 in. in length resembling a mango or papaya in shape. Harvesting is done by hand while the fruit is still on the tree. Fruit must be refrigerated or processed almost immediately.

ECONOMIC USES The fruit, when refrigerated, is edible for up to three weeks. Due to the short shelf-life, pawpaws are not of a commercial importance to the United States as an edible crop. The fruit makes a delicious jam, jelly, and ice cream.

MPCS USES Pawpaws are ideal for forest settings or established hedgerows where room allows. They can also be good for producing an intriguing alternative food crop.

NOTES The fruit spoils rapidly, within a few days once picked from the tree. The seeds, when crushed, can cause digestive problems in mammals (humans and wildlife) but when left intact, the seeds pass through the digestive system and cause no harm.

SOURCES
**Peach**  
*(Prunus persica)*

**DESCRIPTION** Peach is a small deciduous tree growing up to at most 30 ft. tall, and is known for its heavy fruiting capabilities. At maturity, these fruits are up to 3 in. long and 3 in. across, yellow to deep orange-red, globe-like in shape, and fuzzy from dense small hairs. The root system is woody, spreading, and relatively shallow. It is in the *Prunus* genus of stone fruits along with cherries, apricots, and plums.

**HABITAT** This tree prefers full sun, well-drained moist conditions, and a fertile loamy soil. While it can tolerate partial shade, drier conditions, and less fertile soil, fewer and smaller fruits will be produced. Peach is also intolerant of severe winter cold (temperatures below -10º F) and is vulnerable to late spring frosts.

**MANAGEMENT** Longevity of individual trees is typically 10–15 years. Peach is regarded as a relatively difficult tree to cultivate because it is vulnerable to various disease organisms and insects.

**HARVEST** Peaches are hand harvested in the early fall. They are ripe if they have a slight “give” when gently squeezed. Peaches can be picked under-ripe and can ripen in color, juiciness, and texture of the tree, but will lack flavor and sweetness.

**ECONOMIC USES** Peaches are sold fresh to wholesalers and grocers or at farmers markets and are very popular.

**ECOSYSTEM BENEFITS** Peach trees may be used as habitat by birds and other small animals.

**MPCS USES** Peach trees are not recommended as the first choice for fruit trees due to their sensitivity to early spring frosts. However, they can be excellent home garden or small orchard trees. They can also be excellent U-pick trees because of the high demand for peaches.

**NOTES** It is recommended to only plant the hardiest cultivars for much of the Midwest. Future projections for climates in this areas however, make growing peaches more viable.

**SOURCES**  
www.illinoiswildflowers.info/trees/plants/peach.html
**Pear, European**  
*(Prunus communis)*

**DESCRIPTION** The European Pear (or common pear) is a small to medium deciduous tree growing to 18–20 ft. tall and 12–13 ft. wide and produces a firm, bell-shaped fruit with apple-like flavor. It is native to central and eastern Europe but is now grown in the western half of the United States. This relative of the apple is propagated and managed in a very similar manner but is in some ways easier to grow than apples. Whereas apples can sometimes be pestered by a host of insects and diseases, pears are relatively trouble-free.

**HABITAT** Pear trees will do reasonably well in a wide range of soil types, although they will not tolerate poorly drained soils with a high water table. Pear trees require full sunlight.

**MANAGEMENT** Pears bloom several days earlier than apples. Late spring frost may damage developing buds, flowers, or fruit on frost prone sites. Pears need to be fertilized with caution as too much new growth can predispose the tree to fire blight. Young pear trees should be trained to the central-leader system used in training apple trees. Because of their more upright growth habit, young pear trees may appear too dense; however, once they begin to fruit, the branches will spread naturally. Pears need to be pruned less severely compared to other fruit trees.

**HARVEST** Pear fruits can be harvested in mid-August through late September (depending on variety) when mature and will continue to ripen in storage.

**ECONOMIC USES** Pears are sold fresh at farmers markets, grocers, or other retailers.

**ECOSYSTEM BENEFITS** Pear trees may provide habitat for birds and other small animals.

**MPCS USES** It is recommended to only plant the hardiest cultivars. However, future projections for climates in this area make growing pear more viable. They can be useful trees in U-pick or orchard style plantings.

**NOTES** Pears grown in Illinois and other areas in the Midwest are normally grafted onto quince rootstocks. Only select varieties that can grow in zone 5.

**SOURCES**
www.extension.unh.edu/resources/files/resource000587_rep609.pdf  
www.extension.umn.edu/garden/yard-garden/fruit/pears-in-home-garden/
**Pecan**  
*(Carya illinoinensis)*

**DESCRIPTION** Pecan is a native, medium to large sized deciduous tree ranging from 100–140 ft. The trunk is massive, often with a buttressed base. The nuts produced from the tree are thin shelled and oblong shaped with a reddish-brown color and pointed at both ends. The bark is grayish brown or light brown and is flat ridged and shallowly furrowed.

**HABITAT** Pecans are most often found in river basins, especially the Mississippi and its tributaries. It grows best in fertile, moist, well-drained soils not subjected to prolonged flooding.

**MANAGEMENT** Pecan is an easily managed tree. Very little pruning is needed since pecan trees form a natural, vase-shaped canopy. When grown in its native habitat and using local seed stock, pecan should not be prone to debilitating pests.

**HARVEST** Pecan nuts mature in the fall and are harvested using a variety of methods ranging from simple equipment to complex machinery. In small plantings on one to two acres or less, most people use nut rollers (Nut Wizards) to capture the nuts. Larger plantings will use a mechanical harvester. Harvesting should be done promptly at nut drop to avoid losses to wildlife or rot. *Caution:* Pecan trees are alternate bearing (AB), meaning the plant will produce a heavy crop one year and a light crop the next.

**ECONOMIC USES** Pecan trees produce edible nuts that have a high percentage of fat and are used extensively in candies and cookies. These nuts are sweet and delicious and are often added to bread, cake, and ice cream. The oil from the rejected nuts is used for cooking and cosmetics. The wood has been used for flooring, furniture, cabinetry, paneling, and other smaller projects.

**ECOSYSTEM BENEFITS** Many birds, opossums, raccoons, and squirrels eat pecan nuts, while deer browse on the branches. It provides habitat for a variety of birds and mammals as well.

**MPCS USES** Pecan trees offer landowners an extremely productive nut tree for soils not suitable for Chinese chestnut. The tree is ideal for alley cropping, timber borders, or orchard style plantings. It also has one of the more established markets for nuts in the Midwest.

**NOTES** Only plant northern hardy varieties in the upper Midwest.

**SOURCES**
Persimmon, American
(*Diospyros virginiana*)

**DESCRIPTION** Native to the United States, the American persimmon (often referred to as common persimmon) is a deciduous tree that can grow up to 50 ft. tall. The leaves are dark green and appear glossy. Mature bark is dark gray to black and breaks into blocks that are separated by deep furrows that are a dark red color at the bottom. Persimmon is dioecious, meaning there are male and female trees. The females will produce a flower that appears yellow to white in the early spring, and edible berry fruit can be harvested in the fall. The fruit is red to yellow in color and averages about 1 inch in diameter. The fruit is rich, sweet, and spicy when ripe but can be very astringent when unripe due to the lingering presence of tannins.

**HABITAT** Persimmons occur along streams, swamps, and upland forests. They can withstand short floods and droughts, and even persist as an understory tree for up to 10 years. The roots of American persimmon grow extremely deep and can damage underground structures.

**MANAGEMENT** Persimmons are best suited for full sunlight and well-drained soils. Their deep roots allow these trees to be planted nearby alley crops if desired.

**HARVEST** Fruits are picked by hand or cut down with pruners when near ripe from September through November. Fruits must set and be used once tannins have broken down and the fruit is soft. Persimmons will keep for over a month when refrigerated.

**ECONOMIC USES** The fruits are considered a delicacy in many communities. Its fruits can be used for fresh eating or in jams, cobbler, wines, or ciders. Additionally, the wood is valuable for its strength, color, and sturdiness.

**ECOSYSTEM BENEFITS** The deep rooting structures may provide improved soil nutrient retention, soil stability, and overall soil health. It is an excellent wildlife tree, as many animals will feed off the fruits.

**MPCS USES** It is an excellent riparian buffer or border tree for people or livestock. The deep roots make this an ideal crop along waterways, erodible soils, or windbreaks.

**NOTES** Asian persimmons can also be grown to produce sweeter fruits, but caution should be given to their hardiness. Most all Asian varieties will suffer from overly cold winters.

**SOURCES**
www.starkbros.com/growing-guide/how-to-grow/fruit-trees/persimmon-trees/harvesting
Plum, American
(Prunus americana)

DESCRIPTION American plum is a native shrub that can grow as small as 3 ft. in the form of a shrub to over 20 ft. when the plant is pruned as a tree. The twigs can appear spine-like when the leaves have been dropped and the new buds for the coming season are present. In the early spring, before the leaves appear, white flowers in groups of 2–5 are found at the end of the branches. The drupe, or plum, has a thin edible layer on the outside and the inside is made up of a yellow, edible fleshy core that surrounds a cluster of hard, round seeds.

HABITAT American plum can be found in dry to extremely wet areas. The species seems to do best in areas that receive adequate amounts of rain early in the year and has well-drained soil. The soil can be clay, silt, or sand. The species is well-adapted for many areas and temperatures.

MANAGEMENT Wild plums are tough trees that can survive with little attention from growers. These work great for landowners who expect to give little care to the plant.

HARVEST Care should be taken when handling or taking cuttings due to the spines on the limbs. Fruit is picked by hand and used in a variety of dessert, and can be dried or eaten fresh.

ECONOMIC USES Wild plums are best known for being able to eat the plum right off the tree. Many people enjoy jams, pies, and turnovers with fresh picked plums. Wines, dried plums, and potpourri can be crafted from the fruits. The tree can be grafted with European plum scion to produce improved fruit as well.

ECOSYSTEM BENEFITS American plum is highly important as wildlife cover and food. The thorny, suckering growth, when protected, forms a thicket valuable for bird nesting, roosting, and bedding. Twigs and foliage provide a highly preferred browse for whitetail deer.

MPCS USES American plum is a great addition to native plantings, riparian zones, and windbreaks.

NOTES Seeds are toxic to livestock when consumed in large quantities.

SOURCES
www.plants.usda.gov/factsheet/pdf/fs_pram.pdf
Plum, European  
(Prunus domestica)

DESCRIPTION European plum is an ancient domesticated species, known only in cultivation. It is the best known of cultivated plums, having been grown the longest and being the most widely distributed. It grows to a height of 15–20 ft. and is in the Prunus genus of stone fruits along with cherries, apricots, and peaches. European plums are suggested over Japanese Plums for their hardiness.

HABITAT European plum trees like a moisture-retentive soil and grow well in heavy clay soils if well-drained. Winter hardiness varies by subspecies with some hardy to zone 3.

MANAGEMENT The most serious problem on plums in the Midwest is black knot disease, which is difficult to control. European type plums will not cross-pollinate Japanese type plums. Plums, along with sour cherries, are one of the more reliable stone fruits.

HARVEST Fruits are picked by hand beginning in mid- to late July. They require little to no special equipment.

ECOnOMIC USES Fruits are often sold fresh but can also be processed into jams or jellies. Most of the prunes (dried plums) available for purchase are from a subspecies of European plum (often referred to as prune plums).

ECOSYSTEM BENEFITS Plum trees may provide habitat for birds and other small animals.

MPCS USES Plums offer a more reliable stone fruit for those looking to incorporate a U-pick or fresh market component to their MPCs design. Plums would be recommended in orchard style plantings or in easy to reach areas because they are hand harvested.

NOTES Winter hardiness varies by subspecies and fruit type. Be sure to consult with your plant nursery before purchasing.

SOURCES  
www.extension.umn.edu/garden/yard-garden/fruit/stone-fruit-for-minnesota-gardens/  
www.uncommonfruit.cias.wisc.edu/european-plum/
**Prairie Crabapple**  
*Malus ioensis*

**DESCRIPTION** Prairie Crabapple is a small deciduous tree about 10–25 ft. tall with a short trunk and a broad spreading crown. It is moderately dense with crooked branches, short lateral spurs, and twigs. The trunk bark is gray, scaly, and thin containing irregular furrows and fissures. The flowers of native crabapples are large, fragrant, and showy during the short period when they bloom during the spring.

**HABITAT** Populations are traditionally found in all counties of Illinois, but their range has shrunk due to habitat destruction. Crabapples prefer full or partial sun on moist to somewhat moist loam, clay-loam, or partially rocky soils. They are commonly found along open woodlands, savannas, borders, prairies, and clearings in wooded areas. They can be long-lived, exceeding 50 years of age if they do not succumb to any disease organisms or pests.

**MANAGEMENT** Prairie Crabapple is a relatively hardy plant that requires little to no management when disease issues are not present. However, like other apples and crab trees, this woody plant can be vulnerable to disease organisms and insect pests. Diseases to watch out for include apple scab, fire blight, leaf spot, and botryosphaeria canker. Pests include various mites, codling moth, leaf hopper, and Japanese beetles.

**HARVEST** The small fruits can be hand harvested in the fall.

**ECONOMIC USES** The fruit of Prairie Crabapple has been used to make apple jelly, cider, and vinegar.

**ECOSYSTEM BENEFITS** The plant provides an excellent source of food to a variety of animals. Ruffed grouse, purple finch, and white-throated sparrow peck at the buds while woodpeckers, starlings, and grackle peck at the fruit. The dense branching provides excellent nesting habitat for the Yellow-breasted Chat, Orchard Oriole, Song Sparrow, and other birds. Also, the nectar and pollen of the large flowers attract bees. Other visitors of the flowers include butterflies and skippers.

**MPCS USES** It is an aesthetically pleasing tree with attractive flowers and is suitable for wildlife and conservation plantings. Additionally, it can be grafted onto later in its life to begin producing dessert or cider apples.

**SOURCES**  
www.illinoiswildflowers.info/trees/plants/prairie_crab.html
**Raspberry**  
*Rubus idaeus*

**DESCRIPTION** Raspberries are a medium-sized woody bramble with a long-lived root system and short-lived canes. The canes are biennial in most types where in they produce leaves the first year, then fruit the next. Raspberries come in two basic types: red and black (*Rubus occidentalis*). Yellow raspberries are a mutation of red or black.

**HABITAT** Raspberries grow best in full sun with slightly acidic, well-drained soil. They can tolerate sand or clay as long as it is well-drained. They prefer sites with high organic matter content and with pH should be between 6.0–6.5.

**MANAGEMENT** Raspberries should be considered a “high stakes” crop. Initial investment in a planting is relatively high and substantial labor is required. Raspberry pruning will depend on the type of raspberry (summer-bearing vs. primocane-fruiting). However, pruning will be necessary on both raspberry types.

**HARVEST** The harvest of berries should occur when they are sweet and ripe. Eat them promptly or dry or freeze them. Berries do not keep ripening after harvesting. For best flavor and ease of picking, wait until they are fully ripe. Raspberries should fruit well for at least six years and may produce for more than twenty years.

**ECONOMIC USES** Berries can be sold fresh or processed in jams, jellies, juices, and other value added products. Raspberries have a short shelf life, but demand for raspberries is usually excellent.

**ECOSYSTEM BENEFITS** The berries are eaten by a variety of birds. The fast growing habit of raspberries may help to improve soil quality by producing abundant organic matter.

**MPCS USES** Raspberries are not often used in MPCs due to their high labor requirement and short productive lifespan. When used, they are placed near homes or in orchard style plantings for personal use or U-pick systems.

**NOTES** Red raspberry cultivars can be divided into two types: summer bearing, and fall- or everbearing (primocane-fruiting raspberries). Summer-bearing cultivars are the most common. Thornless varieties exist for raspberries as well ("Joan J" is one well-known variety).

**SOURCES**
- www.ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/18936/ec1306.pdf
- www.extension.psu.edu/business/ag-alternatives/horticulture/fruits/red-raspberry-production
Serviceberry (Amelanchier arborea)

DESCRIPTION Serviceberry (often referred to as Downy Serviceberry) is a native deciduous tree that can grow to 30 ft. tall with a narrow, rounded crown. This should not be confused with Juneberry (Amelanchier alnifolia) which is the species used for commercial fruit production. Its flowers form in elongated clusters and have five white petals. The fruits are small and blueberry-like in appearance and taste. The tree is commonly used for ornamental plantings for its aesthetic value but also provides edible berries in June through July. It is a short-lived species, normally surviving for about 20 years.

HABITAT It grows in a wide variety of habitats. Typically it is found in swamps, dry woods, rock areas, forest edges, and open woodlands across the northern regions of North America. It is commonly an understory species. It is one of the earliest flowering tree species.

MANAGEMENT Maintenance is low for this species other than root suckering, which should be handled accordingly. Pruning is recommended.

HARVEST Berries are harvested by hand and refrigerated. Berries can last for a few weeks when refrigerated.

ECONOMIC USES The berries can be eaten fresh or made into jams, jellies, and juices.

ECOSYSTEM BENEFITS A wide range of mammals eat the fruit or browse the twigs. Birds also nest in the crown. It is an important species for reclamation, wildlife, watershed, and shelterbelt plantings. It can be started from seed or vegetative cuttings.

MPCS USES Downy Serviceberry is a great multi-use tree for its edible berries, aesthetic qualities, and wildlife benefits. It can be placed in almost any MPCs design since it is tolerates most all soils. Riparian buffers are an ideal choice for this tree.

SOURCES
**White Spruce**  
*Picea glauca*

**DESCRIPTION** White spruce is a native evergreen tree with aromatic foliage that grows to 40–60 ft. tall spreading to be 10–20 ft. wide. The crown is broadly conic to spire-like and can sometimes be shrub-like near tree lines where the branches are slightly drooping. The common name is derived from the white waxy layer on the foliage. White spruce is highly variable over its habitat range, and several varieties (apart from the typical) have been recognized.

**HABITAT** It is tolerant of heavy soil, but good drainage is a must. Common habitats include river banks and mountain slopes. On good sites and with proper planting, trees can live from 100 to 250 years.

**MANAGEMENT** It does best in full sun. The shallow, spreading root system benefits from a 3-4 in. layer of organic mulch. It needs very little pruning.

**HARVEST** Straight boles are preferred when growing spruce for wood.

**ECONOMIC USES** The wood of white spruce is used primarily for pulpwood and lumber for various construction, prefab houses, mobile homes, furniture, boxes and crates, and pallets. It also is used for house logs, musical instruments, and paddles.

**ECOSYSTEM BENEFITS** The tree provides excellent nesting and shelter for a variety of animals but also provides food for wildlife. The cones of the white spruce are eaten by Red-breasted Nuthatches and Evening Grosbeaks. The foliage can be eaten by grouse, rabbits, and deer. Squirrels eat the seeds.

**MPCS USES** White spruce is used as a large evergreen tree in a windbreak or shade tree near a home.

**SOURCES**
Willow, Shrub
(Salix spp.)

**DESCRIPTION** Shrub willow is a fast-growing woody shrub used for bioenergy production, biomass, and ornamental uses. It can be as small as 2–3 ft. in height or more than 20 ft. based on management with varying widths. The term “shrub willow” encompasses a variety of *Salix* species commonly referring to those used for bioenergy or ornamental qualities (most common include *S. eriocephala*, *S. purpurea*, and *S. nigra*).

**HABITAT** Shrub willows grow on a wide range of soils but do particularly well on poorer and wetter soils. They can be found in riparian areas such as the banks of streams and ponds, low woods, roadsides, and gullies. They are a very tolerant species.

**MANAGEMENT** Willows are planted as unrooted, dormant hardwood cuttings and are difficult to propagate from seed. There are very few pest and disease issues for the plants and they are easily managed.

**HARVEST** When grown for biomass, above-ground growth is harvested during the dormant season on a 3–4 year rotation by a self-propelled forage harvester. During the spring following each harvest, the remaining portion of the willow plant responds by producing numerous new stems, initiating a new cycle of growth that can be harvested in another 3–4 years. This cycle can be repeated for six to eight harvests before the plant needs to be replaced.

**ECONOMIC USES** The woody material from shrub willows is increasingly being used for biofuel. Unfortunately, it has not yet been widely adopted in the United States because of their high cost of production relative to currently used fossil fuels. In addition to biofuels, willow cuttings can be sold to florist and at farmers markets for their showy characteristics (color, shape, buds).

**ECOSYSTEM BENEFITS** Their extensive root systems help prevent soil erosion, while the shrubs provide wildlife habitat and enhance the landscape. With their rapid growth and short rotations, they can take up excess nitrogen and phosphorus runoff from agricultural activities.

**MPCS USES** Shrub willows are used for their tolerance of marginal, wet soils and are great biomass producers. These aspects make them perfect for riparian buffers and borders on marginal soil.

**SOURCES**
www.extension.psu.edu/publications/ee0102
www.fao.org/docrep/008/a0026e/a0026e12.html