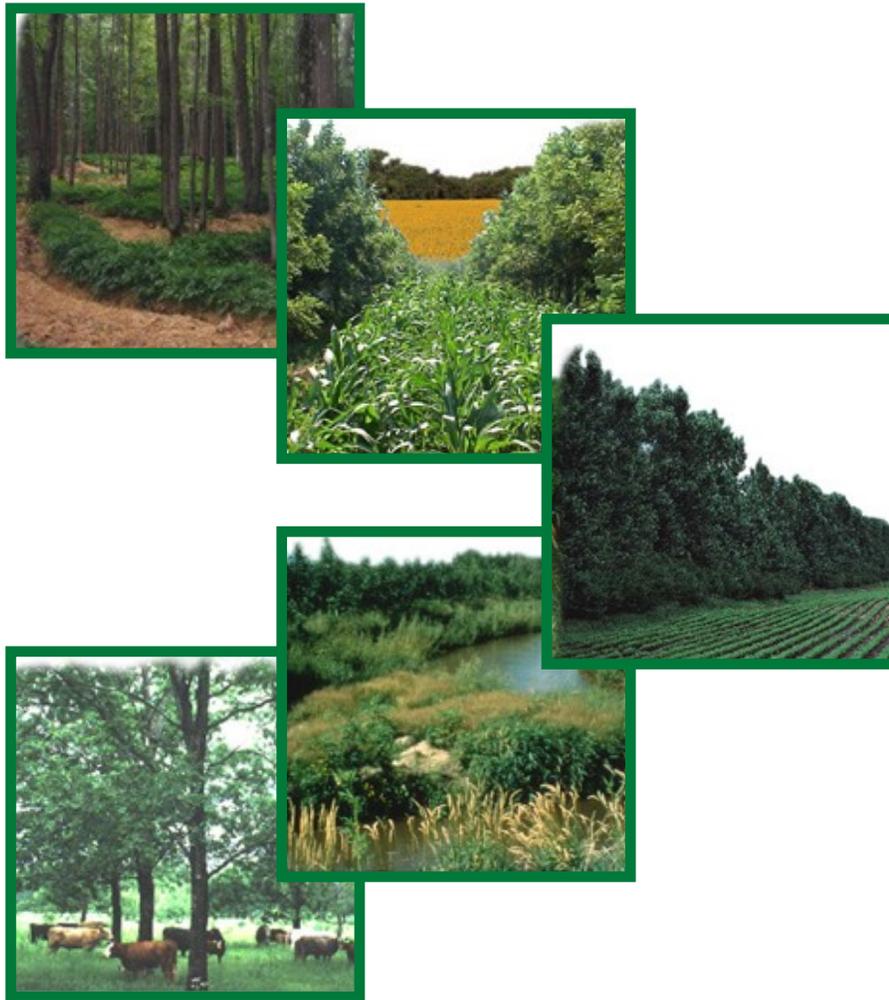


Training Manual

for Applied Agroforestry Practices

2018 Edition



The Center for Agroforestry
University of Missouri

A Global Center for Agroforestry, Entrepreneurship and the Environment





Training Manual for Applied Agroforestry Practices – 2018 Edition

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User's Guide to the Training Manual

Farmer's and other landowners drawing sustenance from the land strive continually to produce goods through methods that are economical, conservation-minded and socially acceptable.



Agroforestry practices are unique and through their proper application each objective of economy, conservation of resources and social acceptance can be met. Agroforestry practices are designed to fit specific niches within the farm to meet specific landowner objectives. When properly designed, agroforestry practices can achieve a balance between diverse, and often seemingly opposed, objectives.

This manual will help explain each of the agroforestry practices and their application. Additionally, the manual is designed to assist in the decision process so that, when established or managed, the agroforestry practice is most effective at achieving the desired objectives.

About this Manual

This training manual is designed to provide easy-to-use information about agroforestry. The intended audience includes forest and agricultural landowners, resource professionals and other educators; yet, anyone interested in establishing or managing trees for multiple functions on the landscape can use the agroforestry guidelines to assist in achieving success.

This updated edition of the training manual is not intended to function as the comprehensive source of information on agroforestry. Agroforestry is both an art and a science. Therefore, do not use this training manual as your only resource of information on agroforestry practices. Rather, it is designed to be used as a tool to assist in the decision-making process. There are countless ways for trees to meet conservation, economic and societal goals, and we are learning more and more each day about effective designs that better ensure agroforestry will meet one or more specific goals.

How this Manual is Organized

This manual is divided into specific chapters explaining agroforestry practices and management. Chapter 2 is intended to assist you in implementing your knowledge of agroforestry into your operation in a step-by-step process. The appendices contain information about the economics and taxation involved with agroforestry, as well as crop sheets for selecting the appropriate trees, shrubs, grasses, forbs and crops for your agroforestry practice. You may pull out chapters and appendices and use them independently as needed.

Let's Begin

From specific land management practices designed to conserve limited resources to the marketing of specialty, non-commodity products, the ideas in this manual can improve the likelihood of your success. We hope it is both a useful tool and a source of inspiration for additional management practices that utilize trees or shrubs on the farm for multiple benefits.

Land management practices that integrate trees and shrubs with agriculture can provide benefits to the farm and the surrounding landscape. We hope that the ideas and practices put forth in this manual inspire and assist in making decisions related to managing land resources that involve trees and shrubs. It is our desire to help farm managers and land owners achieve long-term satisfaction from working harmoniously with the soil, water, air, forests and wildlife resources of this Earth.



Gene Garrett, left, former director of the Center for Agroforestry, and Michael Gold, right, interim director, speak about the opportunities agroforestry provides at the First World Congress of Agroforestry, 2004, Orlando, Fla.

About the University of Missouri Center for Agroforestry (UMCA)

Agroforestry practices help landowners diversify products, markets and farm income; improve soil and water quality; and reduce erosion, non-point source pollution and flood damage. The integrated practices of agroforestry enhance land and aquatic habitats for fish and wildlife and improve biodiversity while sustaining land resources for generations to come.

UMCA is one of the world's leading centers contributing to the science underlying agroforestry. UMCA, established in 1998, has been supported by significant collaborative funding from the USDA-ARS. Interdisciplinary research conducted by faculty, re-search specialists, graduate and undergraduate students, provides sound science that uncovers new environmental and economic benefits from agroforestry practices and solves production challenges.

Linked to the Center's solid science and re-search programs are several key partnerships with landowners, natural resource professionals, federal and state agencies and non-profit organizations. Through these critical partner- ships, UMCA and its partners are producing an expanding list of positive outcomes for land- owners, the natural environment and society as a whole.

UMCA Philosophy:

"A farm can be regarded as a food factory and the criterion for its success is saleable products. Or, it can be regarded as a place to live, and the criterion for its success is harmonious balance between plants, animals and people; between the domestic and the wild; and between utility and beauty." – Aldo Leopold

UMCA Mission:

To initiate, coordinate and enhance agroforestry activities to meet the environmental, social and economic needs of land management within the state of Missouri, North America and the temperate zone world-wide.

To accomplish our mission, UMCA:

- Conducts, coordinates and promotes interactive research on agroforestry practices to improve the productive and protective functions of agricultural and forest lands.
- Conducts, coordinates and promotes interdisciplinary research on the social, economic and market dimensions of agroforestry.
- Conducts an active outreach program that increases the awareness and adoption of agroforestry practices.
- Conducts, coordinates and promotes interdisciplinary research on the policy dimensions of agroforestry.
- Provides opportunities for formal education via a series of online courses. Both a graduate certificate and/or master's degree in agroforestry are available through MizzouOnline at the University of Missouri.
- Develops and carries out a collaborative international agroforestry program in the areas of instruction, research and outreach.

Chapter 1: Defining Agroforestry

Agroforestry: Definition and Practices

What is agroforestry?

Agroforestry is new market opportunities. Sustainable “climate-smart” agriculture. Land stewardship. Habitat for wildlife. Improved air and water quality. Diversified farm income. Increased wealth for rural communities.

In simple terms, agroforestry is intensive land-use management combining trees and/or shrubs with crops and/or livestock.

Agroforestry practices are designed to fit specific niches within the farm to meet specific landowner objectives.

Agroforestry practices help landowners to diversify products, markets, and farm income; improve soil and water quality; and reduce erosion, non-point source pollution and damage due to flooding. The integrated practices of agroforestry enhance land and aquatic habitats for fish and wildlife and improve bio-diversity while sustaining land resources for generations to come. In a changing climate, agroforestry practices can be designed and strategically located to provide greater resiliency in agricultural landscapes so landowners can meet production objectives when faced with extreme weather (e.g., drought, floods). Tree-based practices sequester significant amounts of carbon that can help meet future potential greenhouse gas reduction goals.

Definition of Temperate Agroforestry (USA):

Intensive land-use management that optimizes the benefits (physical, biological, ecological, economic, social) from biophysical interactions created when trees and/or shrubs are deliberately combined with crops and/or livestock.

Agroforestry Key Criteria

Four key criteria characterize agroforestry Practices. Application of the 4 “I” criteria are key to determine what is, and what is not, an agroforestry practice.

Intentional

Combinations of trees, crops, and/or livestock are intentionally designed, established, and/or managed to work together and yield multiple products and benefits, rather than as individual elements which may occur together but are managed separately. Agroforestry is neither monoculture farming, nor is it a mixture of monocultures.

Intensive

Agroforestry practices are created and intensively managed to maintain their productive and protective functions, and often involve cultural operations such as cultivation, fertilization, irrigation, pruning and thinning.

Integrated

Components are structurally and functionally combined into a single, integrated management unit tailored to meet the objectives of the landowner. Integration may be horizontal or vertical, above- or below-ground, simultaneous or sequential.



Working with UMCA staff and natural resources professionals helps landowners plan and implement agroforestry practices.

Integration of multiple crops utilizes more of the productive capacity of the land and helps to balance economic production with resource conservation.

Interactive

Agroforestry actively manipulates and utilizes the interactions among components to yield multiple harvestable products, while concurrently providing numerous conservation and ecological benefits.



Specialty mushrooms can be grown on logs in a forest farming practice for additional income, as explained by Nicola MacPherson of Ozark Forest Mushrooms at this field day.

The five recognized agroforestry practices

- **Riparian and Upland Forest Buffers**
- **Windbreaks**
- **Alley Cropping**
- **Silvopasture**
- **Forest Farming**

1. Riparian and Upland Forest Buffers Riparian forest buffers are strips of permanent vegetation, consisting of trees, shrubs, and grasses, planted or managed between agricultural land (usually cropland or pastureland) and water bodies (rivers, streams, creeks, lakes, wetlands) to reduce runoff and non-point source pollution. Forest buffers are usually planted in three distinct zones near an agricultural stream for stabilizing streambanks, improving aquatic and terrestrial habitats, and providing harvestable products. Upland buffers with cool- or warm-season grass alone or combined with shrubs and/or trees are also used to reduce nonpoint-source pollution and prevent gully formation in agricultural watersheds.

2. Windbreaks

Windbreak practices (and variations, e.g., shelterbelts, timberbelts, hedgerows, and living snowfences) are planted and managed as part of a crop or livestock operation to enhance crop production, protect crops and livestock, manage snow distribution, and/or control soil erosion.

Field windbreaks are used to protect a variety of wind-sensitive row crops, forage, tree, and vine crops to control soil erosion, and to provide other benefits such as improved insect pollination of crops and enhanced wildlife habitat.

Livestock windbreaks help reduce animal stress and mortality, improve feed and water consumption, enhance weight gain and calving success rates, and control odor. Timberbelts are managed windbreaks also designed to increase the value of the forestry component.



Forest Farming

Silvopasture

Alley Cropping

Riparian Forest Buffers

Windbreaks

Definition and Practices

Is it agroforestry?

Application of the 4 I's

The four key criteria revisited *Application of the 4 "I" criteria are key to determine what is and what is not an AF practice:*

- *Intentional*
- *Intensive*
- *Integrated*
- *Interactive*

Characteristics of Agroforestry Practices

- ✓ *Land-use practices deliberately integrated into the whole farm*
- ✓ *Contain complex interactions among components suited to particular environments and human needs*
- ✓ *Competition and its management is critical*
- ✓ *Has two or more outputs*
- ✓ *The "cycle" of an agroforestry practice is always more than one year*
- ✓ *Even the simplest agroforestry practice is more complex, ecologically (in terms of structure and function) and economically than monocropping*
- ✓ *For the landowner, often judged successful or not by the bottom line "does it pay?"*

3. Alley Cropping

This practice combines trees planted in single or multiple rows with agricultural or horticultural crops cultivated in the wide alleys between the tree rows. High-value hardwoods such as oak, walnut, ash, and pecan are favored species in alley cropping practices, and can potentially provide high-value lumber or veneer logs in the long-term.

Crops or forages grown in the alleys, and nuts from walnut, pecan and chestnut trees, provide annual income from the land while the longer-term wood crop matures. Specialty crops (herbs, fruits, vegetables, nursery stock, flowers, etc.) can be grown in alleys, utilizing the microclimate created by trees, to boost economic production from each acre.

4. Silvopasture

This practice combines trees with forage (pasture or hay) and livestock production.

Silvopasture can be established by adding trees to existing pasture, or by thinning an existing forest stand and adding (or improving) a forage component. Trees are managed for high-value timber or sawlogs, and at the same time they provide shelter for livestock, reduce heat stress and improve food and water consumption. In the winter, the protection of trees reduces cold stress — therefore, animals do not lose as much energy keeping warm and are able to gain more weight.

Forage and livestock provide short-term income at the same time a crop of high-value sawlogs is being grown, providing a greater overall economic return from the land.

5. Forest Farming

In forest farming practices, high-value specialty crops are cultivated under the protection of a forest overstory that has been modified and managed for sustained timber production and to provide the appropriate microclimate conditions.

Shade-tolerant specialty crops like ginseng, shiitake mushrooms, and decorative ferns grown in the understory are sold for medicinal/botanical, decorative/handicraft, or food products. Overstory trees are managed to produce timber and veneer logs.

A key concern in developing agroforestry nomenclature for the U.S. is overlap and confusion with mainstream land use management

disciplines, e.g., forestry, agriculture, and livestock production. There is a fundamental need to develop a definition and criteria that would effectively distinguish practices that are agroforestry from those that are not. Application of the four criteria defining agroforestry (intentional, intensive, integrative, and interactive) provide the key to determine what is and is not an agroforestry practice.

Perspectives on U.S. agroforestry and landowner adoption

Although there is currently no national database or inventory, landowner adoption and application of agroforestry practices, while small, is beginning to accelerate. A significant expansion of agroforestry in the U.S. will require an increased focus on the four “P”s of adoption:

- *Peer-to-peer learning*
- *Professionals*
- *Partnerships*
- *Programs*

Specifically, it will require *more*:

Peer-to-peer learning:

- Identifying respected landowners / producers that have adopted and practice agroforestry.
- Getting them connected with other producers who are not currently practicing agroforestry.
- Knowledge of local customs/culture and employing methods/tools such as:
 - *Farmer meets farmer in the “back forty”*
 - *On-farm demonstration sites, workshops*
 - *Social media/networks*

Professionals:

- An increased number of professionals with agroforestry expertise are essential to provide the technical, educational, marketing assistance requested by landowners.

- Advancing agroforestry literacy through:
 - o Regional/state agroforestry academies (e.g., UMCA Annual Agroforestry Academy)
 - o Agroforestry majors/certificates offered by universities (e.g., online Master’s Degree and Graduate Certificate in Agroforestry offered by the University of Missouri).
 - o Certification of agroforestry professionals (e.g., joint national “certified agroforester” program sponsored by professional forestry/ natural resource/agricultural societies – under discussion).

Partnerships:

- Bringing people together to increase awareness and understanding of agroforestry, landowner objectives, community, and watershed goals.
- Multi-state/regional partnerships may be most effective. Examples include:
 - o 1890 Agroforestry Consortium.
<https://nifa.usda.gov/1890-agroforestry-consortium>
 - o Northeast and Mid-Atlantic Agroforestry (NEMA).
www.nemaagroforestry.org
 - o Mid-American Agroforestry Working Group (MAAWG). Midamericanagroforestry.net
- Lasting partnerships need a clear purpose and tangible project(s) to keep members engaged. For example, NEMA and MAAWG sponsor networking and educational activities to advance regional agroforestry interests. For example, MAAWG helped to establish Annual Agroforestry Academy.
- Establishing agroforestry communities of practices e.g., the eXtension Forest Farming community of practice created by a team led by Virginia Tech with USDA support.

Programs:

- USDA and other state/local programs provide vital resources that make it possible for professionals to provide the assistance that supports planning and establishment of agroforestry practices.

Programs cont'd:

- USDA assistance helps advance agroforestry adoption and practice application includes:
 - o The Natural Resource Conservation Service's (NRCS) Environmental Quality Incentives Program (EQIP) provides agricultural producers with financial resources and one-on-one help to plan and implement conservation practices;
 - o The Sustainable Agriculture Research and Education (SARE) offers grants to farmers, ranchers and agricultural professionals for on-farm research, education, and professional and community development;
 - o The National Institute of Food and Agriculture's Renewable Resources Extension Act and McIntire-Stennis Cooperative Forestry Research programs;
 - o The U.S. Forest Service's Forest Stewardship and Research & Development programs.
- The 2012 Census of Agriculture (USDA National Agricultural Statistics Service) includes the first-ever agroforestry practice question. Simply asking the right question might get a producer/landowner thinking about adopting agroforestry!

Additional Resources

In Print:

- Garrett, H.E., (ed.) 2009. North American Agroforestry: An Integrated Science and Practice. 2nd. ed. Madison, WI. American Society of Agronomy, Inc. (out of print)
- Gordon, A.M., S.M. Newman and B. Coleman (eds). 2018. Temperate Agroforestry Systems. CABI, 326 p.
- Jose, S., M.A. Gold and H.E. Garrett. 2018. Temperate Agroforestry in the United States: Current Trends and Future Directions. In: Gordon, A.M., S.M. Newman and B. Coleman (eds). Temperate Agroforestry Systems. CABI, 326 p.
- Schoeneberger, M.M., G. Bentrup, and T. Patel-Weyand (eds). 2018. Agroforestry: Enhancing resiliency in U.S. agricultural landscapes under changing conditions. Gen. Tech. Report WO-96. Washington, DC: U.S. Department of Agriculture, Forest Service. DOI: <https://doi.org/10.2737/WO-GTR-96>. 228 p.
- Wilson, M., S.T. Lovell, T. Carter. 2018. Perennial Pathways. Planting Tree Crops: Designing & Installing Farm-Scale Edible Agroforestry. K. Gruley and K. Keeley (eds). Savanna Institute. 108 p.

Online:

- Center for Agroforestry, University of Missouri. <http://www.centerforagroforestry.org>
- Association for Temperate Agroforestry. www.aftaweb.org/
- Cornell Agroforestry. <http://smallfarms.cornell.edu/projects/agroforestry/>
- eXtension Forest Farming Community of Practice. <http://www.extension.org/pages/62959/forest-farming-community>
- Green Lands/Blue Waters. <http://greenlandsbluewater.net/>
 - Mid-America Agroforestry Working Group (MAAWG) <http://midamericanagroforestry.net/>
 - Midwest Perennial Forage Working Group (MPFWG) http://greenlandsbluewater.net/Perennial_Forage/
 - Perennial Biomass Working Group
 - Perennial Grains Working Group
- Midwest Cover Crops Council: www.mccc.msu.edu/
- NEMA – Northeast/Mid-Atlantic Agroforestry. <http://www.nemaagroforestry.org/>
- Savanna Institute. www.Savannainstitute.org
- University of Minnesota. Center for Integrated Natural Resources and Agricultural Management: <http://www.cinram.umn.edu/>
- USDA National Agroforestry Center: <https://www.fs.usda.gov/nac/>
 - Working Trees - https://www.fs.usda.gov/nac/Working_Trees/index.shtml
 - Inside Agroforestry - <https://www.fs.usda.gov/nac/publications/insideagroforestry.shtml>
 - Agroforestry Notes - <https://www.fs.usda.gov/nac/publications/agroforestrynotes.shtml>
- U.S. Department of Agriculture, 2011. USDA Agroforestry Strategic Framework, FY 2011-2016. Washington, DC. 35 p. https://www.usda.gov/sites/default/files/documents/AFStratFrame_FINAL-lr_6-3-11.pdf
- USDA Agroforestry Fact Sheet. https://www.usda.gov/sites/default/files/documents/FactSheet_final_8-1-11.pdf
- Virginia Tech Agroforestry. <https://agroforestry.frec.vt.edu/>

Notes

Chapter 2: Introduction to Planning for Agroforestry

In this chapter

- **Developing a Plan for Agroforestry**
- **Identifying Land Uses, Resources, Goals and Market Opportunities**

Developing a plan may seem tedious at the beginning, but the long term benefits far outweigh the difficulties of plan creation. By having a plan, landowners can better envision how to successfully integrate an Agroforestry Practice to their farm. The planning process will also help develop a familiarity with the management that is required in order to reach the goals, objectives, benefits and economics that are desired. The best way to ensure success is by thoughtful and honest planning.

A Plan for Integrating Agroforestry on the Farm

Why plan? The development of a plan for integrating agroforestry practices to the farm system is as important as the actual establishment of the practice itself. Planning -- and the development of a timeline -- will help maximize the chances for the success of the agroforestry practice. Planning will not only assist in understanding how the practice and its placement on the landscape can accomplish specific on farm goals, but will provide assistance in identifying market opportunities for products that may be grown in the practice. **Remember: Diagnosis precedes treatment.**

The culmination of the planning process is the development of a 5-year management and activities schedule. This final, yet very important step, will help define the inputs

needed over time in order to keep the agroforestry practice a meaningful and productive component of the farm system for years to come.

Steps to Developing an Agroforestry Plan

Personal Assessment

- Step 1: Initial Objectives and Priorities
- Step 2: Evaluate Personal Resources

Biophysical Site Assessment

- Step 3: Identify Current Land Uses
- Step 4: Map Area(s) for Agroforestry Development
- Step 5: Climate Assessment
- Step 6: Soil Assessment
- Step 7: Physical Features (Terrain)
- Step 8: Timber and Non-Timber Forest Crop Inventory

Agroforestry Development Ideas

- Step 9: Agroforestry Ideas – Brainstorming
- Step 10: Listing ‘Best Bets’

Evaluating the ‘Best Bets’ in the Context of the Industry

- Step 11: SWOT Analysis
- Step 12: Porter Five Forces Model
- Step 13: Revising your ‘Best Bets’ **Marketing Strategy for ‘Best Bets’**

- Step 14: Select and Describe Target Market(s)
- Step 15: Adding Value to Products
- Step 16: Getting Products to the Buyer
- Step 17: Setting the Price
- Step 18: Promoting Your Products

Agroforestry Practice Design and Management

- Step 19: Revisit Your Objectives and Priorities
- Step 20: Detailed ‘Best Bets’ Crop Information
- Step 21: Designing Your Agroforestry Practices
- The Agroforestry Development Plan**
- Step 22: A Five-Year Management Projection
- Step 23: Yearly Activity Schedule

Coupled with the Workbook (See Appendix Section 5: Planning for Agroforestry Workbook), these steps are designed to help guide you through the various stages of creating a plan for your agroforestry development area(s), and will assist you in gathering information on:

- *Your objectives and priorities*
- *Personal resources (e.g., labor, equipment, buildings, animals, plants)*
- *Climate, soil conditions and physical features*
- *Current land use*
- *Land available to practice agroforestry*
- *A non-timber plant inventory (for woodland only)*
- *Market conditions for potential products*

Together with chapters' three to 10 of this manual and the tree/shrub/grass/forage information provided in the appendices, the steps provided in this workbook will allow you to identify what agroforestry products can grow on your land, which of these products you can sell profitably, and how to develop basic business and marketing strategies. The final steps are a five-year development plan and yearly activity schedule, outlining the work you plan to do to establish your agroforestry development(s). The time you put into researching, preparing and following your plan is an investment in your future agroforestry success.

The steps presented in the following pages—designed to guide you in creating an agroforestry plan—are often inter-related, and information gathered in one step will likely impact information gathered in other steps. For this reason, the creation of your plan will likely require you to revisit (and expand) each step as you learn more and develop new ideas.

Note: The succession of steps has been organized to help you develop your plan logically. You need not complete each step in the order they are presented. You may prefer to gather information in a way that best suits your circumstances.

In addition to identifying available resources, site conditions and marketable plants, filling in the Workbook forms will help you explore and articulate your values and attitudes. Every landowner will have different personal and production goals for an agroforestry development, and your plan for your land will be different from someone across the country, State, or even across the road. To accommodate these differences, this guide is not based on a single set of goals. Instead, it has been developed to provide a set of tools that you can use to make informed decisions in creating a profitable agroforestry business.

An agroforestry development plan is based on the capability of your land, your personal goals, your business goals, and your land stewardship objectives. These goals and objectives will be reassessed and changed as you obtain new information during the planning and initiation of an agroforestry development. Agroforestry practices are always changing, and understanding and working with change will help you best achieve your goals.

There are many sources of information and advice available to assist you with your agroforestry development. Since agroforestry practices often involve various fields (e.g., forestry, agronomy, animal husbandry, horticulture, soil science, marketing) you may have to augment your personal knowledge. Sources listed at the end of each chapter in the training manual are designed to guide you.

How to Proceed

You'll find a pull-out Workbook in Appendix 5. The Workbook forms can be photocopied as needed. The information, tools and links you need to complete the plan are found in chapters that follow (chapters 3 to 10).

It is recommended that you read through these steps before you begin to write down information in the corresponding chapters of the Workbook.

Note: Depending on the size of your property, you may have one or more areas on which you want to develop agroforestry practices. Planning will be easier if you prepare separate forms for each separate development area, especially if potential agroforestry development areas have different site conditions and current uses.

Step 1: Initial Objectives and Priorities

Landowners exploring multiple uses for their property face many preliminary decisions. Not least, if you have a number of different objectives for an area, some may seem to be in conflict. The choices each landowner makes reflect a set of individual values and attitudes. Your personal and business goals become the criteria for assessing the different possibilities for your land.

Your land management objectives and priorities will be specific to your circumstances and the area you want to develop for agroforestry. **However, among other possibilities, you may want to:**

- *Develop a new source of income from unproductive land (diversification)*
- *Reduce costs of an existing farm or forest operation*
- *Develop a source of long-term income*
- *Develop a source of short-term income while awaiting long-term income from timber*
- *Reduce property taxes*
- *Protect or improve environmental conditions*
- *Increase grazing opportunities*

Turn to the Planning for Agroforestry Workbook: Appendix 5 and complete the table of initial objectives and priorities. Remember that these initial objectives may change as you learn more about your land and your agroforestry business. After you finish this assessment, you will be able to weigh your objectives against what you can actually produce on each area of your land.

Step 2: Evaluate Personal Resources

In addition to your land base, your agroforestry development will require the input of other personal resources. An evaluation of the resources available to you will help determine which agroforestry options are best suited to your operation. An evaluation should include:

Management and labor availability – Periods during which you are not busy (between or after harvests) and the periods during which labor and management time will be committed to other activities.

Equipment and buildings – Buildings and equipment, including machines and hand tools, that can be used for this development.

Livestock – Your operation may already have cattle, sheep or other animals.

Plant material – Your own sources of seed, seedlings, cuttings and larger trees.

Other materials – Resources such as sawdust or shavings, manure and straw for mulch.

List these personal resources, as well as anything else that you consider of importance, in the table provided in the Workbook.

Step 3: Identify Current Land Uses

List the present uses of each area of your land and the products you harvest, and record them in your Workbook. These uses could include:

Residential
Recreational
Farming (which crops)
Grazing (type of livestock)
Timber production
Non-timber production
Environmental use

Step 4: Map Area(s) for Agroforestry Development

An agroforestry development may include all of your land or only specific areas, such as existing woodlands, open field, logged-over area or riparian zone. In either case, identifying objectives and making decisions will be much easier if you break your land into separate development areas with similar current uses and site conditions (such as soil, moisture and existing plants). Steps in the Workbook, including the sketch map, should be completed for each separate development area. Pages of the Workbook can be copied for this purpose.

For each agroforestry development area, you should:

- Draw a sketch map of the area you are targeting for agroforestry development. Using the leg- end provided in the Workbook, indicate boundary lines, main geographic features, houses, other buildings and roads.
- Identify and measure the area approximately, marking these measurements on the sketch. This will help determine planting requirements and potential crop production.

There is some overlap between Step 3 and Step 4, since you will indicate these uses on your sketch map. Step 3 gives an opportunity to provide information on land use in greater detail, and by thinking about land uses, you may decide to modify your sketch map.

Why Assess Your Land?

Assess climate, soil and physical features on each site on which you intend to develop an agroforestry practice. These assessments will allow you to determine:

- *Which plants you can successfully grow on each site*
- *Limitations to planting and growing these plants*
- *The most effective management practices*

Assessments can be as detailed as you want, or as required by the project. The introduction of long-term or special-needs crops such as black

walnut trees requires a different level of site assessment than the planting of a shallow-rooted annual crop. Even if you plan to begin small, with a few tree seedlings on a fence line and a small planting of medicinal herbs, you should still assess the limitations and potential of your land.

The information provided here, and the accompanying form in the Workbook, provides a basic site assessment. More detailed assessments require added time, equipment and expertise. They are only worth doing if it will help with a critical aspect of your agroforestry development. For most developments, they are not necessary.

Step 5: Climate Assessment

Climate on your site ultimately determines what you can grow on your land. Combining this data with the information provided in Appendices 2 and 3 will establish the range of possibilities for your agroforestry practice.

Hardiness Zone - The US Department of Agriculture Plant Hardiness Zone Map has mapped plant hardiness zones for the entire country. You can find the Plant Hardiness Zone Map for different regions of the USA at the USDA Agricultural Research Service website: <http://planthardiness.ars.usda.gov/PHZMWeb/>

Using the above website you can locate also locate a Plant Hardiness Zone Map specific to your State.

These zones rate the conditions affecting winter survival of plants. The primary factor is the minimum (coldest) winter temperature, with some consideration for the number of frost-free days, summer rainfall, maximum temperatures, snow cover and wind.

Most information sources, and suppliers of seeds and plants, list the minimum hardiness zone for particular plants. Plant breeding programs have resulted in cultivars or selections of many plants that differ in hardiness from their parent (check this carefully to prevent a costly error).

In some cases, the hardiness zone mapping is only an approximate guide for local conditions. Enter hardiness zone information in the table provided in the Workbook. Additional information you may find, such as frost-free days and date of soil thaw, should also be included in the table.

Soil Information Sources

Information about various versions of a soil survey can be obtained with the following means:

- *By checking the list of published surveys on the soils web site of the USDA*
- *By contacting the appropriate state office of the NRCS*
- *By contacting the appropriate local office of the NRCS*

Note: *Additional information about Missouri soils can be found at the Missouri Cooperative Soil Survey web site at (<http://soils.missouri.edu>).*

Step 6: Soil Assessment

Land Capability Classification - The Land Capability Classification shows, in a general way, the suitability of soils for most kinds of agricultural land use or field crops. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. There are two primary categories in this classification system, the Capability Class and Capability Subclass.

The Land Capability Classification identifies the potential of local areas for agricultural production. County Soil Surveys contain the Land Capability Classification for all soils in your county. The County Soil Surveys also provide useful climate information.

The classes are ranked from I (highest) to VIII (lowest), but the capability subclasses refer to soil groups within a class. Classes I - IV are considered capable of the sustained production of common field crops. Crop species become limiting as the land capability declines from Class I to Class IV. Class V lands are only capable of producing perennial forage crops or specially adapted crops. Class VI lands are capable of providing sustained pasture. Class VII land are incapable of either arable culture or grazing.

Capability Subclasses include: (e) runoff and erosion; (w) wetness; and (s) root zone or tillage problems - shallow, droughty or stony.

List the climatic, capability rating and limiting factors for your site, as well as any other information you believe might be useful, in your Workbook.

Soils are an extremely important feature of your land base because they are the material in which the plants of your agroforestry practice will grow. Soil survey publications represent a snapshot in time. They contain information that was current as of the indicated publication date. The text, tables and soil maps may have been updated since publication. The most up-to-date information is available on the NRCS Web Soil Survey <http://websoilsurvey.nrcs.usda.gov/app/>

Read about the soils (formation of soils), look at a soils map, then examine your soils. One way to gain an understanding of your soil is to dig several soil pits at least 18" deep, and examine your soils for several important features. However, soils are landform dependent, and samples taken should represent different landforms and positions on those landforms. It is recommended to dig one or two pits per acre, and more if the area/landform is not uniform. For more detail on soil assessment, see Additional Resources at the end of this chapter.

Important note: If you are planning to practice agroforestry on a woodland area, plan to do a plant inventory. Since this requires setting up survey plots in a grid system, you probably want to do your soil assessments at the same time as your plant inventory.

Soil Texture and Composition

Mineral soils are particles of rock or minerals produced from rock by weathering and other geological processes. Soil textures are grouped into the three particle sizes shown in the table below. Sands and gravel are the largest particles, while clay and silt soils contain the smallest particles. The finer textured soils hold more water and dry out more slowly. Organic soil layers or horizons are derived from decaying vegetation, usually in a thin layer above mineral soils. Where found in a sizable layer, they tend to retain both water and nutrients.

In your Workbook list the soil type(s) found in each of your agroforestry development areas, and map the locations if there is more than one type.

Soil Depth

Soil depth determines the rooting capability of the plants you may wish to grow. In particular, forest soils can be quite shallow, requiring extra care in management. You will notice distinct layers as you dig down and you may come across restricting layers such as: 1) stones and rock outcrops that can interfere with digging and cultivation, and can reduce the nutrient and water-holding capacity of the soil. Rock outcroppings are areas with very little soil; and 2) hardpan, a hardened layer below the surface of the soil that can prevent penetration of water and roots. Additional soil features that may be problematic include: fragipans, claypans, abrupt textural changes and general discontinuity. Deep-rooted plants such as alfalfa or black walnut will be severely impacted by hardpan. Neighbors and previous landowners may know if there is a hardpan, but you may have to dig several holes to determine the extent.

Note and record in your Workbook the approximate percentage of rock fragments in the soil (stoniness), and depth and type of any restricting layers. Show their extent on the sketch map.

Soil Moisture

Soil moisture, which is key to the establishment and growth of plants, is closely linked to soil texture. The spaces (pores) between soil particles hold water and air needed by plants for good growth. Generally, coarser soils are well-drained and are often dry for longer periods, while soils with finer textures hold more water and are likely to remain moist longer. Other factors, such as ground water level or the presence of an impermeable layer that restricts drainage, also determine soil moisture.

As you dig your pit, is the soil dusty and dry? Does water seep into the bottom of the hole? Often, the time of year and recent weather will influence soil moisture.

High Water Table, Standing Water or Flooding

Areas such as wetlands and parts of riparian zones which remain fully saturated for extended periods of time are of special concern. These areas are sensitive to access development and machine use, and are important for wildlife habitat and other environmental values. You will need to identify these areas of your land and plan to use especially careful management. Access may be limited for all or part of the year.

In your Workbook and on your sketch map, it is important to note any: wetland features, evidence of flooding, areas that experience overland flows or standing water during spring runoff, and areas with continual seepage or high water table.

Both very wet or dry conditions pose challenges for planting and management. However, some plants are particularly adapted to one or the other of these extremes (see Appendices 2 & 3 for a listing of suitable plants). Note the moisture conditions of various portions of your proposed development area on both your sketch map and

in your Workbook.

Nutrients

The availability of nutrients in the soil affects the quantity and quality of products produced. You can undertake a soil test to determine the soil pH (acid/alkaline balance), specific nutrient levels, and recommendations for various crops. Tissue analysis is also an effective way (preferred in forest soils) to determine nutritional status of existing trees and plants. Although there are soil sampling field kits, soil and tissue samples are usually sent to a laboratory for analysis and interpretation. In your Workbook note the status of soil nutrients that you have determined and attach any lab reports.

Step 7: Physical Features (Terrain)

The physical features outlined in Step 7 are closely related to – but also different from – the soil characteristics described in Step 6. For ease-of-use, physical features are described separately from soil characteristics. However, the information you generate through each step is entered into the same table in the Workbook. This allows you to easily see the relationships between physical features and soil characteristics. There are several physical features that can influence your capability to produce particular crops on a site.

Aspect refers to the direction toward which the site slopes (if any). South and southwest-facing slopes are usually warmer and drier than those facing north, and naturally support different plant communities. Terrain relief refers to whether the site is steep, flat, sloped, rolling, gullied or broken (steep slopes between benches). This will influence access and machine capability, water management, cold air drainage, and other microclimate factors. Frost pockets are one additional feature to consider. Cold air flows downhill and pools in low areas. The resulting localized frosts can damage delicate flowers and shoots that start to grow early in the spring. Even crop plants correctly chosen for your hardiness zone can be affected. Assess low areas on your land for potential frost pockets—the absence of native berry plants can be a good indicator. Avoid these areas for frost-sensitive

plants. Sloped or bench land that has good air drainage is a better choice.

Enter your observations of the physical features mentioned above in your Workbook and on your sketch map.

Step 8: Timber and Non-Timber Forest Crop Inventory

If you want to practice agroforestry in woodland areas, this chapter will help you inventory the variety of plants growing on your land—everything from trees to herbs on the forest floor. The inventory of trees described here is restricted to their potential production of non-timber products (e.g., medicinals, florals) and their interactions with other plants (e.g., shade, moisture, nutrients). A non-timber vegetation inventory can be used to help create a list of ‘best bets’— plants that can be successfully grown on your land, and will also help you decide how to manage your woodland efficiently and productively (i.e., managing competition for sun, water and nutrients). There is literature available elsewhere on timber inventory methods (see Additional Resources).

If you own more than a few acres of land, you should sample your land base, using inventory plots to obtain a ‘best approximation’ of the vegetation. Sampling is an excellent compromise between doing nothing (and having a very limited picture of your land) and trying to do the impossible: counting every tree, shrub and herb on your property.

A. Preparing Your Inventory

An inventory should give you a timely snapshot of your land; it should not take too long, nor should it be too difficult. Inventory plots are the sites where you record information about vegetation and other features on your land. They form a pre-determined portion (or percentage) of the larger area you’re interested in sampling. Multiplying your plot data by the number of plots that would fit in the larger area will give an estimate of what you would find if you actually measured everything. Size of inventory plots

depends on what you're trying to survey and the vegetation cover on the plot. In your forest vegetation survey, you will actually take two separate surveys from the same plot center. This is because you need to collect information about two very different types of vegetation: Trees; shrubs and other smaller plants.

Plot cruises can be used to estimate the number of plants in a forest by species, diameter, height, form class and grade. All fixed plot cruises have statistical sampling error which is important to know and understand before relying on the data. A plot cruise simply consists of counting and classifying all trees or plants species in a series of circular sample plots. Circular plots are usually 1/10-acre in size (37.2 feet radius). The plots are evenly spaced throughout the stand to provide an equal sampling of all forest types across all topographic changes

B. Doing Your Inventory

Locating your plots in the field. Following a compass line is a vital skill when conducting your vegetation inventory. It is beyond the scope of this training manual to review compass work in detail but there are a couple of points to remember:

- The right compass for the job. Ideally, you should have a 'ranger' type with a mirror in the lid, gunsight sighting, liquid dampened needle, and an adjustment for setting declination.
- Staying on track. With a little practice, staying on your traverse line is not difficult. Hold the compass level, line up the arrow in the mirror face, sight on the farthest object you can pick out through the gunsight (e.g., recognizable tree, rock, stump), and walk toward it. When you reach that landmark, sight again and find a new object to focus on.

Obtain a good guidebook to the plants of your area. Remember that quality can have a big impact on the prices you receive for non-timber forest products. That means you will have to make judgment calls when doing your inventory. Information on product specifications—including acceptable quality—can be found in Appendices 2 and 3. It is also important to

remember that you should contact buyers before you harvest, so that you can harvest to the correct specifications.

Tree Inventory

The tree inventory described here is only intended to determine the non-timber resources available (e.g., boughs, vines, bark, burls).

Number of trees and species. Record the number of trees of each species found at the plot. This will assist in determining what non-timber products can be obtained, and what plants can be grown under the canopy.

Tree age. This is optional, but can be useful to know. An increment borer is easy to use and will not harm the trees. Record the age of one or two average trees per plot.

Tree height. This is also optional, and only really useful for a timber inventory. Details on calculating height can be found in the guide "Conducting a Simple Timber Inventory," <https://extension.tennessee.edu/publications/Documents/PB1780.pdf>

Condition of trees. Helpful in determining whether marketable non-timber products can be harvested. Also helpful in assessing the possible function as a windbreak.

Crown closure. The degree of canopy closure will determine the conditions for raising or enhancing shade-loving species in the understory

Non-tree Inventory

Begin your inventory by identifying and listing all the harvestable non-tree species found in the plot on your plot sheet. Include plants that provide good browse if you intend to graze the area.

For each species, record the following: Total number of plants for each species. Where possible/feasible, count the number of individual plants of each species found in the plot. This will be easier on an open forest floor

than it will be on dense sites. You may choose to record sites like the latter simply as 'dense coverage.' This is one of those instances where judgment calls come in. Even an approximate number could be useful in developing a harvesting plan.

Estimate of the percentage cover for each species. How much of the plot do you think the species covers? Provide an estimate to the closest 10%.

Proportion of harvestable vs. non-harvestable individuals. The aim here is estimate the amount of harvestable individuals for each species (none, 20%, 50%). Your decisions will be based on factors such as size, color, and insect or other damage. If many of the plants are not harvestable in their current condition, cultural practices such as fertilization and pruning may be available that would improve product quantity and quality.

C. Using Your Inventory

First, make sure all areas inventoried are marked on your map(s). Next, you need to take the raw data from your inventory (plot sheets), compile it, and present it in a useful format. That means taking the information from your sample plots and organizing the information so it represents your entire development area.

Trees and/or Other Resources per acre Among your survey information, you have recorded the number of each plant species that appears in each inventory plot. Now you want to convert that number into the number of plants per acre. This is done using the plots per acre factor. The plot information is then extrapolated to one acre and then multiplied by the total acres. For example, if you counted ten individual witch hazel shrubs in your plot cruise

One plot on 1-acre:
Plot size 1/10-acre
Plot radius (feet) 37.2
Average trillium plants /plot 8
Factor to 1-acre, multiply times 10
Total estimated witch hazel per acre = 80

Once you know the approximate number of plants of a given species per are you have a fairly good idea of the plant resources you have on your land. Record the information in the tables provided in the Workbook.

Step 9: Agroforestry Development Ideas – Brainstorming

After reading the chapters 3 through 10 in this training manual, you will probably come up with some ideas for agroforestry developments on your property. Once you have done this, it is time to engage in some brainstorming. In addition, check out the appendices 2 (Trees and Shrubs for Agroforestry) and 3 (Grasses and Forages for Agroforestry) to develop additional ideas.

Brainstorming is the process of putting ideas down on paper as they come into your head. List them all and don't try to self-censor the ideas. You can reduce this list to 'best bets' later. Input from family and friends, as well as ideas from neighboring landowners, can help generate useful ideas. This is also a point at which expert advice may expand the list of possibilities. For additional assistance consult the Additional Resources that are listed at the end of every chapter.

For each development area, sort the list by practice and record this information in your Work- book. In general, more intensive agroforestry practices (e.g., forest farming) are suited for smaller units of land, while the more extensive practices (e.g., silvopasture) are suited to larger units of land.

Step 10: Listing 'Best Bets'

The intent of this short but important step is to create a list of potential crops that can be grown on your land. This list of 'best bets' will be based on the information you have gathered so far—including land and personal resources, site conditions and current land use—combined with the plant information provided in Appendices 2 and 3.

Perhaps the easiest way to approach this list is by first determining what plants can grow under the climatic, soil and physical conditions that occur in each of your agroforestry development areas. Plants you already cultivate on your land, plants revealed by your non-timber inventory, and crop ideas you have developed while gathering information, will all form part of this list.

You can add substantially to the list by looking at Appendices 2 and 3 to see what other plants can be successfully grown on your site, and what products can be made from them. You want this list to be as extensive as possible, so you can consider the widest possible range of options.

Your list can be refined by considering the resources at your disposal (e.g., labor, buildings, equipment) at different times of the year. These factors will limit the crops and crop combinations you can grow. Finally, you can further refine your list by revisiting the objectives you have for your land, such as income diversification, reduction of land taxes or environmental protection.

The list of 'best bets' you make in this part of your Workbook should include all the plants that can grow on your land, and the products that can be derived. Make sure you include timber products that can be made from trees you would plant as part of an agroforestry development. If you have done a timber inventory—in addition to the non-timber vegetation inventory list those possible timber products as well.

Along with Chapter 10 of the Training Manual, the following steps will help you develop a marketing strategy, or marketing plan. Each step contains directions needed to complete corresponding sections in your Workbook. You should note that every part of every step might not apply to your situation.

Step 11: SWOT Analysis

Having analyzed the current situation of your farm with respect to objectives and priorities, personal resources, site assessment and vegetation inventory and brainstormed ideas of agroforestry practices, you can use that information to identify Strengths and

Weaknesses, Opportunities and Threats or a SWOT analysis for the crops you think may produce. This can be helpful in defining and clarifying the issues you need to address in the rest of the planning process.

As detailed in Chapter 9, Marketing Principles, in identifying strengths and weaknesses, you will be focusing on factors that are internal to your business. Opportunities and threats refer to the external environment of your business. The plan you will develop will be shaped by both internal and external factors; it will build on your strengths and minimizing the impacts of your weaknesses while in the same time be responsive to the opportunities and threats your environment offers.

In the SWOT Analysis worksheet, summarize the internal strengths and weaknesses and the external opportunities and threats for your business as you identify them today. Consider all aspects: natural, physical and human resources, marketing, operations, and finances.

Step 12: Porter Five Forces Model

The Five Forces Model (developed by Dr. Michael Porter of Harvard University) serves as a good framework for assessing different industries you would like to get in. The Five Forces Model identifies coordination and control aspects of an industry and provides a guideline for understanding the resources and relationships needed to be successful in a market. The model is presented in more detail in Chapter 9 – Marketing Principles. Using the information and examples provided in Chapter 9, use the following ideas to evaluate the chosen crops in the context of the industry:

- ✓ Identify Barriers to Entry
- ✓ Identify suppliers/Bargaining power of suppliers
- ✓ Identifying Buyers/ Bargaining power of buyers
- ✓ Identify substitutes
- ✓ Identify competitors and their competitive advantages

Step 13: Revising Your ‘Best Bets’

In Step 11 you identified the plants that can grow on your land, and which you can produce with the resources you have available.

After a thorough analysis using the SWOT Analysis and Porter Five Forces Model, the list of ‘best bets’ can be refined to include those plants and products you think have the best market potential. When selecting a list of marketable ‘best bets,’ consider:

- *How difficult is to enter the market?*
- *Is the required supply available?*
- *Are there buyers nearby?*
- *What is the demand for the crop, relative to supply?*
- *How does harvesting and selling these crops fit in with the rest of your production system? For example, will the crop(s) require big inputs of labor during an already busy period?*
- *Is investment of resources (labor and capital) likely to provide an adequate return?*
- *How does that return compare to other possible crop/product options?*
- *Where possible, use your vegetation inventory information to list the approximate volumes of the crops you have for sale. For crops not yet planted, you should estimate how much you’ll be able to sell so you have an idea of how much to plant.*

Step 14: Select and Describe Target Market(s)

Refer to Chapter 9 – Marketing Principles to develop the following steps (14 to 18). In these steps you will be creating a marketing strategy.

Your marketing strategy is about defining your customer or target market and tailoring your product, pricing, distribution and promotion strategies to satisfy that target market.

Your first task in building a customer strategy is to identify your target market. Target markets are most commonly characterized as either individual households or businesses. Begin your target market research by developing a customer profile. Customer profiles can help you determine if a market segment is large enough to be profitable. Break your target market up into segments based on differences in their geographic location, demographic characteristics, social class, personality, buying behavior or benefits sought.

Example:

Product: Elderberry jelly

Customer segments:

1. Farmers markets customers

Geographic: Local area

Demographic: Mostly female, mid-age, moderate to high household income

Psychographic: Support for local agriculture, health conscious

Needs/Preferences: Prefer locally produced food, fresh food, convenience

2. Online customers

Geographic: Nation-wide (USA)

Demographic: Younger, moderate to high household income, high level of education

Psychographic: Price sensitive

Needs/Preferences: Like the comfort of shopping from home

3. Health food stores customers

Geographic: Regional area

Demographic: Older, higher household income, high level of education

Psychographic: Health conscious, less price sensitive

Needs/Preferences: Prefer healthy, high quality Products

Step 15: Adding Value to Products

As you think about the products your business will offer, try to describe them in terms of the value they will bring to your customers. List all value added opportunities and identify “pros” (how it will benefit the needs of each customer segment) and “cons” (e.g., costs, risks) for each

of them. Identify also unique characteristics that will differentiate your product from competitors. Define each product to address specific needs for each market segment.

Step 16: Getting Products to the Buyer

Now that you have a customer and product in mind, your next task is to identify how to move or distribute products from your farm to the customer's house or store shelves. Distribution strategies typically describe Location - Where will you sell your product?; Distribution - Which sales channels will your product follow?; and Transportation - How will your product reach the buyer?

Step 17: Setting the Price

In general, pricing strategies are based on two factors: prevailing market prices and your costs. In the long run, your price has to cover your full costs—including production, marketing and promotion—as well as a return for your time and investment. Try to identify prevailing market prices for similar products if they exist; learn about what customers are willing to pay and what prices your competitors charge. Also identify and document all your production, marketing and promotion costs. Decide how you want to price your product for each market segment. Do you want to undermine the competition by offering a lower price? Can you set a high price that reflects your quality image or market demand? Are you simply looking to cover costs? Do you have power to set a price? How sensitive is demand to price changes? Take all these aspects into consideration and try to establish a realistic price or price range for each product.

Step 18: Promoting Your Products

Promotion is very important to gain product recognition among customers. Promotional strategies often are built around a “message.” The message that you deliver about your product or business is just as important as the product itself. Equally important is how and when you deliver that message through the use of advertising tools

and media. Consider also the costs of each promotion method.

Step 19: Re-visit Your Objectives and Priorities

The first step in developing your agroforestry plan was to outline your initial objectives and priorities for your land-based business. Since then, you have gathered considerable amounts of information that will likely change at least some of those original goals. Record your revised objectives and priorities in the space provided in the Workbook.

Step 20: Detailed ‘Best Bets’ Crop Information

To develop the most functional and profitable agroforestry practices, you should know as much as possible about each plant you intend to grow. You will have gathered much of this information while filling out your Workbook, using your land assessment, plant inventory (where appropriate), market research, Appendices 2 and 3, and possibly your own additional research.

Important information includes the biological requirements of each plant, the agroforestry practices they can be grown in, what other plants (and animals) they are compatible with, labor requirements for harvesting, potential volumes, value-added opportunities, and useful market information.

The table provided in the Workbook may include categories of information you do not have. You can exclude these or take extra time to find the information. There is also extra space for additional information you consider important but not specifically listed here.

Step 21: Designing Your Agroforestry Practices

Now is the time to arrange your plants into agroforestry practices that best meet the management objectives you outlined in Step 19. The information on each plant crop, and the

management information provided earlier in this chapter, will allow you to design and manage agroforestry practices that best meet your objectives. Fill in a table in the Workbook for each agroforestry practice you intend to develop.

Note: Remember that price and marketability are not the only criteria for selection of the plants you will include in your agroforestry practices. Some plants may be chosen because they provide valuable ecological functions to your agroforestry practice, such as trees for shade and windbreaks, or legumes for nitrogen fixation.

Building an Agroforestry Development Plan

The purpose of building an agroforestry development plan is to create a schedule of the work that needs to be done in the years ahead in order to fully develop your agroforestry area(s). Your completed Agroforestry Development Workplan will include specific tasks, timelines, and labor projections for each agroforestry practice on a year-by-year basis. You will need a Development Plan for each agroforestry development area.

The Development Workplan is the final step in your Workbook, and will form the practical basis for your agroforestry development. You will no doubt change and adapt your work projections in the years ahead, but a good Development Plan will form a clear starting point and help focus your management efforts.

The Development Plan includes two distinct parts:

- *A five-year plan outlining specific tasks for each agroforestry practice*
- *A yearly activity plan, broken down into specific tasks for each month.*

Step 22: A Five-Year Management Projection

Your five-year management projection is a schedule of the work you plan to undertake in the next five years to develop your agroforestry

practices. The specific tasks and timelines you prepare will form the basis for your yearly activity schedule.

Don't worry too much about getting absolutely everything right on the first pass. Your plans will change over time and you can go back and adjust your projections accordingly. For now, you are mainly interested in conceptualizing the overall operation on paper.

The five-year management projection has four sections:

- Area: size of the area to be managed.
- Practice: agroforestry practice and its associated products.
- Year: year that you want the management activity to take place.
- Management Objective: specific objective you hope to accomplish.

Use the template provided in the Workbook to create your own five-year management projection.

Step 23: Yearly Activity Schedule

The yearly activity schedule describes specific tasks that need to be done, when and by whom. This is the document you will use to plan your work schedule on a month-by-month basis. A good yearly activity schedule will allow you to identify potential time and business conflicts, and ensure you avoid overlapping seasonal activities that could create shortages of labor and resources.

A yearly activity schedule—one for each agroforestry practice—has five sections:

- Crop Plant: the plants that you have decided you can grow and market.
- Management Objectives: a record of objectives, transferred from your five-year projection.
- Task and Time of Year: a list of specific tasks that must be accomplished to achieve each objective, including timelines associated with each task.
- Materials: estimates of seed, seedlings,

fertilizer, fencing, animals, feed and other items necessary for corresponding tasks.

- Labor and Equipment: a record of labor and equipment needs (if any) for each of the specific tasks.

Like the five-year management projection, your yearly activity schedule will likely change as you learn more. Remember to leave yourself plenty of time to complete all the work. As landowners well know, most tasks take longer than expected.

The yearly activity schedule will also be helpful in costing the materials, labor and equipment that are necessary for the cash flow projection of your business plan. For details on business planning, refer to *Building a Sustainable Business: A Guide to Developing a Business Plan for Farms and Rural Businesses*. The information in the Workbook will provide a good basis for a business plan that includes a comprehensive cash flow projection.

Additional Resources

Agroforestry Long-Term Lease Workbook. <http://www.savannainstitute.org/resources.html>

Building a Sustainable Business: A Guide to Developing a Business Plan for Farms and Rural Businesses. Minnesota Institute for Sustainable Agriculture. 2003.

<https://conservancy.umn.edu/bitstream/handle/11299/115840/>

[Building_a_Sustainable_Business_%20Guide_for_Farms_and_Rural_Business.pdf?sequence=1&isAllowed=y](https://conservancy.umn.edu/bitstream/handle/11299/115840/Building_a_Sustainable_Business_%20Guide_for_Farms_and_Rural_Business.pdf?sequence=1&isAllowed=y)

Conducting a Simple Timber Inventory, The University of Tennessee Institute of Agriculture.

http://trace.tennessee.edu/utk_agexfores/39/

Financial Decision Support Tools, MU Center for Agroforestry:

<http://www.centerforagroforestry.org/profit/elderberryfinance.php>

Handbook for Agroforestry Planning and Design. University of Missouri Center for Agroforestry. 2013.

<http://www.centerforagroforestry.org/pubs/training/HandbookP&D13.pdf>

Cover Crop Economics Tool, NRCS (scroll down page to Cover Crops Economics Header).

<https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/il/soils/health/?cid=stelprdb1269028>

Cropping Systems Calculator, Land Stewardship Project.

<https://landstewardshipproject.org/stewardshipfood/chippewa10croppingsystemscalculator>

Perennial Pathways: Planting Tree Crops – Designing & Installing Farm-Scale Edible Agroforestry. <http://www.savannainstitute.org/resources.html>

United States National Arboretum, USDA Plant Hardiness Zone Map:

<https://www.usna.usda.gov/science/plant-hardiness-zone-map/>

USDA NRCS Soil Survey:

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/> Soil Survey Manual, Soil Survey Division Staff

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p_2_054262

USDA Web Soil Survey: <https://websoilsurvey.nrcs.usda.gov/app/>

Notes

Chapter 3: Alley Cropping

In this chapter:

- **Defining Alley Cropping**
- **General Benefits and Limitations**
- **Alley Cropping Functions**
- **Design Considerations**
- **Tree Arrangement**
- **Tree and Shrub Selection**
- **Selection of Companion Crops**
- **Specialty and Biomass Crops**
- **Operation and Maintenance**
- **Economic Incentives for Alley Cropping**
- **Summary**
- **Success Stories**
- **Additional Resources**



In this alley cropping example, soybeans are planted in the alleyways between nut trees for short-term income, nuts for medium-term income and in the long-term a possible timber harvest.

Alley Cropping

Alley cropping is broadly defined as the planting of two or more sets of single or multiple rows of trees or shrubs at wide spacings, creating alleys within which agricultural, horticultural, or forage crops are cultivated. The trees or shrubs may include valuable hardwood species, such as nut trees, or trees desirable for wood products. Shrubs can provide nuts, fruit, or other products. This approach is sometimes called

intercropping and multi-cropping (or silvoarable in Europe). Currently most of the emphasis and research focuses on pecan, chestnut and eastern black walnut alley cropping applications. However, there are numerous other potential tree, shrub and crop combinations.

Role on the Farm

Alley cropping provides the opportunity to grow wood or other tree products such as nuts or fruit, while providing an annual income through the production of companion crops while at the same time realizing natural resource conservation.

Benefits of Alley Cropping

- *Diversify farm enterprise*
- *Reduce erosion*
- *Improve water quality*
- *Protect crops*
- *Enhance wildlife*
- *Improve aesthetics*

Diversifying farm products and supplementing income:

Alley cropping diversifies farm enterprises by providing short-term cash flow from annual crops while also providing medium- to long-term products from woody components. Timber and non-timber products may contribute to income generation from the farm. In addition to the potential for producing nuts, berries, and fruits, well-managed timber can provide a long-term investment.

Reducing soil erosion from wind and water:

Soils with a high erodibility index (>8) are highly susceptible to damage and are difficult to protect when used as crop land. The soil erodibility index provides a numerical expression of the potential for a soil to erode considering the physical and chemical properties of the soil and the climatic conditions where it is located. The higher the index, the

greater the investment needed to maintain the sustainability of the soil resource base if intensively cropped.

Alley cropping protects fragile soils through a network of roots produced by the trees and supplemental ground-cover resulting from fallen leaves and the companion crop. Rows of trees, shrubs, and/or grasses planted on the contour of a slope will also serve to reduce soil movement down the slope.

Reducing erosion on sloping cropland:

The interception of rainfall by the tree canopy and increased infiltration due to tree and herbaceous roots protects the soil; water quality is improved due to interception of sediment by herbaceous cover in tree rows and interception, sequestration, and decomposition of agricultural chemicals by tree and herbaceous root environment. Agricultural chemicals (e.g., nitrogen) leached beyond the root zone of the agronomic crops can be absorbed by the deeper root systems of the tree, hence minimizing the leaching of chemicals into the ground water resulting in improved water quality.

Microclimate impacts:

Trees and shrubs improve crop production by slowing wind speed and reducing wind erosion, modifying the crop microclimate with similar effects to that of windbreaks (see Chapter 6 on windbreaks). Alley cropping can reduce crop evapotranspiration by 15-30 percent and increase water content in the tillage layer by 5-15 percent. Deep tree roots transport soil nutrients to leaves. Leaves contribute organic matter to soil and release nutrients as they decompose.

Protecting crops:

Alley cropping reduces damage from insect pests by reducing crop visibility, diluting pest hosts due to plant diversity, interfering with pest movement, and creating habitat more favorable to beneficial insects.

Enhancing wildlife habitat and aesthetics:

Linear plantings of trees and/or shrubs in an agricultural landscape increases the habitat diversity for wildlife, both through increased amount of edge and/or as a result of the increased diversity (vertical and horizontal) of vegetation. Increased vertical complexity has been correlated with increased bird numbers. These areas can also serve as protective corridors for wildlife movement and provide a food source.

Limitations to Alley Cropping:

Alley cropping, as with other forms of multi-cropping, requires more intensive technical management skill and marketing knowledge. The following limitations should be considered:

- *Requires a more intensive management system including specialized equipment for the tree management and additional managerial skills and training to manage multiple crops on a given site*
- *Removes land from annual crop production and may not provide a financial return from the trees for several years*
- *Requires a marketing infrastructure for forest products that may not be presently established*
- *Trees may be an obstacle to crop cultivation if not carefully planned and managed*
- *Trees compete with companion crops for sun, moisture and nutrients*
- *Companion crops may compete with trees for moisture and nutrients*
- *Herbicide drift from crops may damage trees*

Alley Cropping Functions

There are numerous mechanisms in which alley cropping impacts the landscapes to which it is applied, including water management, nutrient cycling, soil quality, microclimate modification and pest management.

- Alley cropping impacts water management by altering the hydrologic cycle through increased water infiltration via disruption of overland flow by the tree/grass strip. Water cycled through the system is more thoroughly filtered and any excess is gradually released.

- Nutrient cycling and soil quality are impacted as deeply rooted trees exploit lower soil horizons and cycle the nutrients to the surface through litterfall. Additional nitrogen is added to the nutrient pool if a nitrogen-fixing tree or shrub is used. Reduced soil erosion by wind and water help maintain soil quality. Additional moisture is added to the site through interception of rainfall by the tree canopy.
- Microclimates are modified due to reductions in wind velocity which reduces air temperatures and evapotranspiration of intercropped plants and soil.
- Pest management can be strengthened through the structural diversity in the landscape developed by the intentional association of trees and crops. Alley cropping creates habitat to build up biodiversity and associated populations of natural enemies of insects, diseases, or weed pests and can interrupt pest cycles.
- Similar to the function of riparian forest buffers, alley cropping practices may help intercept, fix and biodegrade sediments, nutrients, pesticides, and other biological pollutants present on the site.
- Similar to the establishment of windbreaks, alley cropping may improve wildlife habitat by providing food, cover, nesting sites, and travel lanes for a variety of wildlife species.
- Incorporation of trees and shrubs add opportunity for additional products which are derived from the tree/shrub component (wood, nuts, fruit, foliage) as well as the option to plant sensitive crops which can be grown due to the protection from the trees.

Not all of these functions may exist with each application of alley cropping. The function is dependent upon the way the plant components are manipulated in the design process. There is also a lack of understanding of all the different interactions that can occur with the different combinations of tree/shrub/herbaceous (annual and perennial) plants. For a given design, we do not have enough information to evaluate all the different pest interactions to

definitively state that beneficial insects will be favored and negative pests will be reduced, although there are examples of this.

Designs Unique to Each Landowner

Each alley cropping practice can be uniquely designed to reflect landowner needs and site potential. However, there are physical interactions between the rows of woody species and the companion crop that should be understood and reflected in plans for the alley cropping practice design.

Physical growth traits of individual trees and how these influence the crop, are based on three factors:

- Light Competition*
- Root Competition for Water and Nutrients*
- Allelopathy*

A) Light Competition (aboveground)

A tree species should be selected that best accommodates the sunlight requirements of a specific crop. Some tree species have small leaves and feathery foliage casting a light shade and lend themselves well to alley cropping. When considering a tree species for an alley cropping practice, small leaves and light shade is preferable to heavy shade.

In what ways can light competition be reduced?

- *Spacing*
When the distance between rows of trees/shrubs is increased, the years an alleyway may be cropped with minimal competition from the trees is also increased.

- *Row Orientation*

An East-West orientation of tree rows will maximize the sunlight received by an alley crop, provided the topography permits this arrangement. Trees may have to be planted on the contour if erosion is a consideration. Trees may be planted in other orientations if prevailing winds have a negative influence on crop yields.

- *Maximizing available light*

Trees with small fine leaves will allow more

light through the canopy. These leaves decompose rapidly and allow nutrients to be recycled into the soil faster. As decomposed materials contribute organic matter to the soil, the soil moisture-holding capacity is increased. Increased organic matter enhances soil microbe and earthworm activity. This also improves soil tilth and health.

- *Understanding crown and foliage characteristics - phenology*

Utilize trees that leaf-out late in the spring and/or drop leaves early in the fall. If the agronomic crop component matures in the early spring, such as winter wheat (*Triticum aestivum* L.), a tree that breaks dormancy late is ideal; alternatively, a crop that is harvested late in the fall is appropriate with a tree that drops its leaves early. Black walnut (*Juglans nigra*) is a good example of a tree that satisfies both scenarios.

- *Timely Thinning and Pruning*

Properly thinning trees within rows can maintain semi-open crown conditions. Maintained through regular thinning, these openings can help continue the vigorous growth of shade intolerant companion crops. Pruning basal branches before they reach 1" in diameter improves future wood quality and thins the depth of the canopy permitting more sunlight to reach companion crops.

B) Root Competition (below ground)

Competition for water and nutrients between the tree and the intercropped species not only affects the yields of the companion crop but also the growth of the trees.

What ways can root competition be reduced?

- *Understanding rooting zones*

Vertical distribution of root systems varies among species. Deep-rooted species have a reduced volume of roots near the surface (good for minimizing competition with adjacent crops). Erosion can be addressed through ground cover establishment and management.

- *Which trees have deep roots?*

Tree species have different site requirements. For instance, as a rule, wetland species tend to be shallow rooted. While a potential species list has been included in the appendices, it is always useful to consult your local forester for assistance in determining species suitable to your planting site.

- *What can be done if the trees are more shallow rooted?*

Through the use of a Ripper, Coulter, or Chisel Plow, roots can be severed (the addition of sub-surface knives may also be used to sever more roots outside the rip).

Trenching trials strongly suggest that even during the early years of tree development, competition for water and/or nutrients is the major reason for reduced crop yields. With early (beginning with young trees) and repeated (annually or biennially) ripping lateral roots, the number of tree roots can be significantly decreased in the plow zone. The remaining roots will remain active deeper in the soil profile.

C) Allelopathy (Chemical Interactions)

Traditionally, the term allelopathy denotes the negative biochemical influence exerted by one plant on the growth of nearby plants. For example, pine needles may produce acids that inhibit growth of plants on the forest floor, while roots of black walnut trees produce a compound called juglone, which also inhibits the growth of other plants.

A broader definition would also include positive influences. For example, some plants (e.g., legumes, European black alder, black locust) fix nitrogen that can benefit nearby plants.

Chemical interactions can be controlled by choosing plant combinations that work together. Juglone, for instance, does not affect all plants. Conversely, nitrogen-fixing plants are only useful to neighboring plants that require extra nitrogen.

Tree arrangement

The tree and/or shrub row(s) are placed at intervals across the crop field, depending on the purpose, either on the contour or perhaps even perpendicular to prevailing troublesome winds. Several factors are used to determine the interval between the row(s) of trees or shrubs including slope length, field width, crop light requirements and equipment width.

As mentioned earlier, landowner objectives will determine the products to be harvested from the alley cropping practice. These objectives also determine the arrangement of trees/ shrubs and crops and the set of management practices needed to obtain those products. Alley cropping practices are highly diverse and range from simple to complex. Plantings can consist of a single tree species or a number of species. Similarly, single tree rows or multiple rows may be used.

There are several key factors to consider when planning and establishing the practice on a given site:

Layout: Tree Arrangement

- Single or mixed species
- Number of tree rows - single vs. multiple
- Alley width: Between row spacing
- Within row spacing

With a conservation perspective in mind, slope length relates to the spacing needed to reduce water erosion. The light requirement for the crop or forage to be grown in the alleyway must be considered prior to tree establishment. Finally, alley width must be set as multiples of the widest field equipment width.

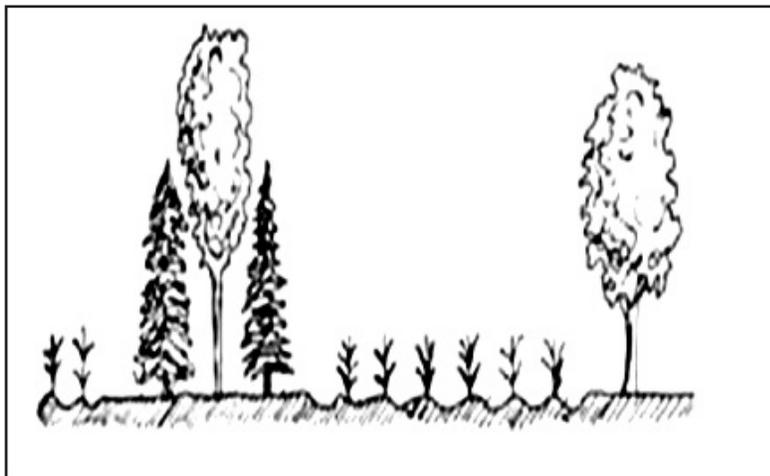


Single vs. Mixed Species - The row(s) of trees can have either a single species in the row or mixed species. A single species is the easiest to plant but a mixed species planting with similar growth rates and site requirements may provide greater economic and environmental diversity.

Factors to consider when deciding how many rows to establish and the arrangement of the trees within the rows may be based on a number of potential benefits including:

- *Annual crop being produced and area removed from production by tree/shrub rows*
- *Desired tree/shrub crops and management needed to enhance production (such as weed control and pruning)*
- *Erosion concerns that multiple rows and combinations of trees/shrubs/grasses can better address*
- *Wildlife habitat created through multiple rows of combined trees/shrubs/grasses*

Single vs. Multiple Row Sets of Trees - Single rows take up the least amount of space but the trees will probably require pruning to enhance the quality of the future wood product. Multiple rows, however, will result in self pruning of the interior row(s). Conifers are a good choice as the “trainer” trees in the outside rows since hardwood species will tend to bend toward the light in the alleyway thus reducing their wood value except as chips. Nitrogen-fixing “nurse trees” can also be used.



Top: Triple row of trees using conifers to train high-value hardwoods. A single-row tree strip is also shown. Bottom: aerial view of single, double and triple row configurations for alley cropping at the Horticulture and Agroforestry Research Center, New Franklin, Mo.

Advantages to single rows:

- *Environment maintained*
- *Less tree to tree competition*
- *Reduced competition between components*
- *Wildlife habitat enhanced*
- *Plant-insect relationships increased*
- *Economics improved*

Single rows create the proper environment for nut trees to develop full crowns. Trees in single rows which are spaced further apart develop wider, more branched crowns. Conversely, if high value tree form is important, then closely spaced trees may encourage self pruning and straight bole development. In single rows,

trees are open on at least two sides, and therefore have less competition between trees within each row, when compared to multiple row configurations. Single tree rows add diversity to a typical row crop field. Researchers think the greatest value to wildlife of woody herbaceous buffers are the benefits created through breaking up the traditional monoculture setting associated with agriculture. Vegetation change and structural diversity is an important tool in controlling agricultural pests. Products coming from the farm are diversified through the addition of trees and their products.

Advantages to double rows:

- *Environment maintained*
- *Reduced competition*
- *Wildlife habitat*
- *Economics*

When rows are offset, double rows of trees maintain similar advantages to that of single row plantings while improving the potential to realize environmental benefits, such as soil and water protection. Compared to rectangular grid patterns of tree planting, double rows allow maximum utilization of space for companion crops

Competition for light between trees can be reduced through offset row configurations.* Multiple rows of trees planted in offset configurations maintain exposure of a majority of each trees crown/canopy to sunlight. Double rows provide the same benefits as a single row alley crop setting, but allow structure (vertical and horizontal vegetative layering and density components) and diversity (variety of species planted) to be increased. This creates an environment for greater utilization of the tree row by increased numbers of wildlife species. Finally, products coming from the farm are further diversified.

It is also possible that thinned trees can provide early economic gain (prior to final crop tree maturation).

[*As mentioned, caution should be observed since deciduous hardwood trees will exhibit a tendency to grow towards light. If an environment of unequal lighting is created (more light to one side of a trees' crown), most hardwood species will grow towards sunlight, and away from competition. This can cause devaluing of the tree for wood products due to sweep (stem curvature).]

Advantages to multiple rows:

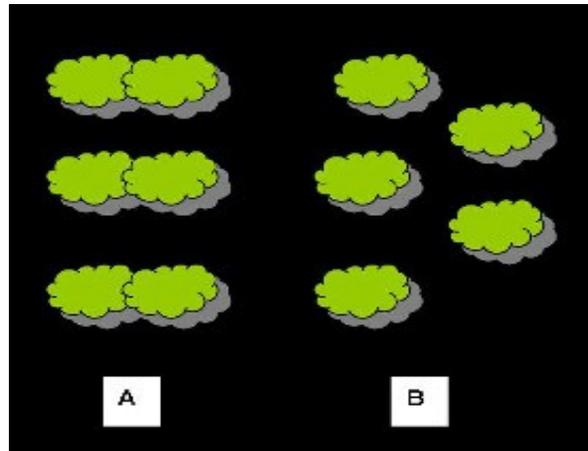
- *Benefit from competition between tree rows*
- *Wildlife habitat*
- *Plant-Insect relationships*
- *Economics*

Certain trees will benefit from some light competition. For high value wood, it is desirable to grow a single, straight stem. Trees and/or shrubs planted on either side of a high value tree species, can be used to train the stem of that tree. By using 'trainer' trees on either side of the high value tree, natural pruning and straight stem growth can be encouraged. Ultimately, this starts the process (may also require pruning) of producing a straight, clear (small or no knots) log of higher quality than might be grown in an open setting. However, choosing the correct 'trainer' species is important because you do not want the outside trees to outgrow your center tree. If they do, they will provide too much shade.

Wildlife habitat potential increases greatly with a wider row of trees. Increased numbers of animals will use this area for travel lanes and the interior creates protective cover opportunities for birds and small mammals.

Plant-insect benefits are the same for single and double row configurations, though some additional advantages may be realized by diversifying the species planted.

Economic benefits are similar to double row configurations. As with double rows, additional trees per acre in multiple row configurations may also qualify these plantings for cost-share assistance and create opportunities for medium-term tree crops to be removed for cash flow (e.g., trees grown for landscaping).

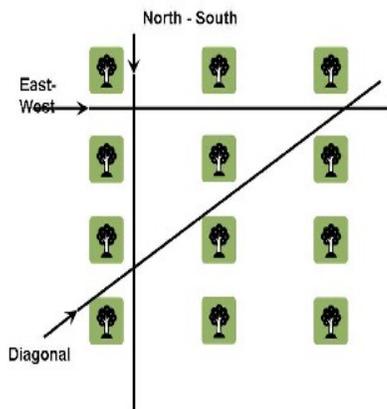


Crown competition between adjacent trees (A) as compared to the increased growing space available to individual trees when planting in an offset configuration (B). Double or triple rows of long-needled hard pines (e.g., cold tolerant loblolly or pitch x loblolly hybrids) can be grown either as (A) or (B). A byproduct of a double or triple planting is the potential for pine straw production within tree rows.

Tree and shrub arrangement

To enhance the growth of trees in multiple-row plantings, staggering the trees between adjacent rows will permit maximum crown development. Staggered spacing provides more room to grow.

Alley Width: between tree row/set spacing: If wood production is of primary importance, closer row spacing is desirable. Wider row spacing is preferred when nut production is desired.



Equipment Travel Lanes: The use of trees planted in rows can allow equipment passage in any number of directions.

The spacing should also be adjusted based on multiples of the widest farm equipment to be used in the alley way. Spacing to accommodate equipment is particularly important in nut production when early crown development is desirable. Plan alleys such that full, or multiple, passes of the equipment are utilized. For example, if using a 13-foot wide disk it may be desirable to have an alleyway 60 feet wide. This allows for 4 passes with the disk (52 feet) and a buffer (to ensure damage is not done to the base of the tree) of 4 feet adjacent to each tree row (8 feet; 4 feet on either side of the cropped alley).

The number of years that light-demanding crops are to be grown in the alleyways is another consideration:

- 60 feet spacing will generally allow crop production (e.g. corn, soybeans, cereals, etc.) for 5-10 years
- 80-120 foot spacing will allow production for up to 20 years or more
- As the shade increases over the life of the trees, it may be necessary to change the companion crop being grown in the alleyway (see plant material section).

Within Tree Row Spacing: The primary objective for the trees, and the cost of the planting stock, will help determine the with-

in row spacing. If erosion control is desired, a closer spacing would give better results. If the tree stock is of unknown origin and quality, a closer spacing would also be desirable to give more opportunities to select the best quality trees during succeeding thinnings. Closer spacing may also be required if minimum numbers of trees per acre are required to meet government cost share requirements. However, if expensive grafted tree stock is used for nut production, a wider spacing may be used to reduce cost.

For example, trees that are grown tightly spaced will have a tendency to grow up, towards the light. This growth trait is highly desirable when growing trees for quality wood production. Additionally, as these tightly spaced trees begin to shade one another, each of their branches in the shade will begin to die and eventually fall off. This is called self-pruning, and is again desirable when trying to grow high quality wood in timber production.

Tree and Shrub Selection: Desirable Characteristics

There are a number of desirable characteristics for trees or shrubs that will be grown in an alley cropping system. It is not necessary (probably not possible) that all of the following characteristics be exhibited by one tree species:

- Produces a commercially valuable product or multiple products (i.e., timber, nuts) that has an acceptable local market.
- Is relatively fast growing (medium growth rate on high value trees is acceptable) or highly valued for production or conservation benefits
- Produces appropriate shade for the companion crop
- Is adapted to a variety of sites and soils
- Is deep-rooted with minimal roots at the soil surface to minimize competition with crops in the alleyway.

- *Has foliage with minimal acid-generating potential if companion crops prefer a pH neutral soil. Conifers acidify soil, combine well with acid loving crops.*
- *Does not produce growth inhibitory chemicals (allelochemicals) that would prevent some crops from growing near them (e.g., black walnut)*
- *Has a growing season that complements the companion crop*
- *Produces wildlife benefits*

Selecting companion crops

Companion crops are planted in the alleys between the tree rows. The choice of companion crop will vary depending on the types of trees selected and the crop(s) desired by the grower. There are three major groups of crops which can be grown in an alley cropping practice: 1) Row/cereal and forage crops; 2) Fruits and other specialty crops; and 3) biomass producing crops.

Initially, the growing environment in the alley will be favorable to row crops requiring full sun (corn, soybeans, wheat) or forages. Potential companion crops include row/cereal crops, forages, fruits and other specialty crops, biomass producing crops.

As trees grow taller and develop larger crowns, they will exert greater influence on the growing environment in the alley with increased shade, water and nutrient competition and humidity levels, along with decreased temperatures and decreased wind movement.

While availability of sunlight is a primary factor that determines how well row crops or forages perform in the alley, water and nutrient competition is even more significant. The tree canopy density will be partially determined by the spacing of the trees within a row and the width between tree rows. This spacing will also influence below ground competition.

Plant Materials: Trees for Alley Cropping
Black walnut: Outstanding markets available for wood. Opportunities exist for the sale of wild nuts, cultivars provide a higher return. Produces light shade, has a short foliage period, and is deep rooted. The juglone allelochemical limits companion crop choices somewhat (esp. avoid nightshade plants).
Pecan: Markets available for both wood and nuts. Markets exist for nuts from native wild pecans and for cultivars. Nuts more valuable than the wood. More shade produced than with walnut but no allelochemicals.
Oaks: The wood has a high value and the acorns are good wildlife food. The oaks are relatively slow growing and produce fairly dense shade.
Chestnuts: Chinese chestnut produce valuable nuts at an early age, are blight resistant and adapted to the climate of the eastern U.S. Prices are high and markets are growing for domestic producers.
Nut or fruit bearing shrubs: Hazelnuts, pawpaws, blueberries, etc. could be used as stand-alone hedgerows or in combination with other taller tree species.

Tree/shrub selection for row crops

Corn, soybeans, wheat, milo, barley, oats, potatoes, pumpkins, lettuce, peas, etc. have demonstrated success in alley cropping. Most of these crops have high light demands. Using corn in the first few years speeds tree growth by creating a greenhouse effect for the tree rows. In an alleyway 60 feet wide, shade will limit their use after 5-10 years depending on the tree species.

Selection of forage crops – In an alley cropping practice, forage crops such as fescue, orchard grass, bluegrass, or alfalfa, are grown for hay production between rows of planted trees, but are not grazed. This distinguishes the alley cropping practice from a silvopasture practice.

Kentucky 31 tall fescue and orchard grass tolerate considerable shade and are very productive cool-season grasses. Other potential forages that show shade tolerance include Kentucky bluegrass, ryegrass, smooth brome, timothy and white clover. Winter annuals such as cereal grains, crimson clover, and hairy vetch must be reseeded every year and only provide one cutting of hay, but do not compete with the trees and provide good erosion control.



Bluegrass hay is harvested between rows of pecan trees in this alley cropping example, Shepherd Farm, Clifton Hill, Mo.

Cool vs. warm-season forages

It is also necessary to consider whether a cool or warm season crop and/or forage may be more appropriate for the site conditions and objectives. Studies conducted by the University of Missouri have found that many cool-season legumes and grasses produce greater biomass when grown under partial shade as compared to full sun. Some warm-season grasses showed similar responses, but most were southern temperate zone species.

- **Advantages and Disadvantages of Cool Season Forages**

Cool-season perennial species are most productive in the spring when temperatures are typically cool and moisture plentiful. They grow less or become dormant during the hot summer months when moisture is often limiting, then increase growth in the fall.

Cool-season forages can be highly competitive with tree crops for moisture and nutrients, especially in the spring as trees break dormancy. As young trees are becoming established, it is desirable that no vegetation grow within a 3-foot radius. To maximize the growth of older trees, vegetation should be controlled in a diameter approximately equal to the crown diameter size. However, this may or may not result in the greatest economic gain.

Warm-season forages

Warm-season perennial species grow most during the summer months. Though warm-season forages have a shorter growing season, they are still very productive.

Eastern gamagrass, bermuda grass, Switchgrass, Indiangrass, and big bluestem are examples of warm-season perennial grasses identified for use in Missouri. Southern climates may use bahiagrass or bermudagrass.

- **Advantages and Disadvantages of Warm-Season Forages**

The root systems associated with warm-season forages are typically deeper than cool-season grasses. This makes them an excellent choice for controlling erosion and protecting sub-surface water from leached pesticides and nutrients. These forages will likely be less competitive in the early spring when many trees are beginning their annual growth. Warm season “clump” grasses provide excellent habitat for quail in combination with woody shrubs.

Warm-season forages grow vigorously in the hot summer months. Therefore, a consideration is that this may put them in competition with trees and other woody vegetation at a time of the year when water is quite possibly the most limited resource. On the other hand, if a tree species puts on its growth in late spring, in certain instances a warm-season forage can make a good companion crop.

The point is that compatibility, even seasonal compatibility, must be considered when selecting trees, shrubs, grasses, and crops for an alley cropping practice.

Integrating Specialty Crops into an Alley Cropping Practice

Most often associated with the forest farming practice, specialty crops also have potential for integration into alley cropping practices. Landscaping plants, Christmas trees, small fruit trees or shrubs and berries can be grown either temporarily between the permanent in-row crop trees or in the alleyways. As the alleyways become more shaded, shade tolerant species such as redbud, dogwood and spruce could be grown for landscaping if there is a nearby market. Plants which can be marketed for their medicinal, ornamental, or food values (including St. John's Wort, wildflowers for seed, pumpkins, etc.) also provide unique opportunities for alley cropping. Species that are light demanding can be established in the alleyways while those requiring some shade can be planted within the tree rows as shade develops.

Specialty crops that can be produced in full sun include:

- Horticultural plants, such as tomatoes, pumpkins and blackberries
- Forages, grains and oilseeds
- Tree crops, such as nuts
- Seeds, such as wildflower or select grasses
- Christmas trees
- Shrubs and other landscaping plants
- Trees for lumber and wood fiber products

Biomass Crops

Both woody and herbaceous plants for biomass production could be an option for the alley-



Top: Lettuce intercropped until mid-June followed immediately by a pumpkin intercrop until October. Vineland, Ontario. **Bottom:** Grain is alley-cropped in a young pecan orchard, Georgia, U.S.

ways. “Soft” hardwood species such as cottonwood, hybrid poplars, willow, sycamore and silver maple could be grown for pulp, paper or oriented strand board if markets are available. Herbaceous biomass crops (e.g. switchgrass) are another alternative.

Operation and Maintenance

Pest management: Periodic inspection of the crops and trees is recommended to detect and identify possible pests. Insects and diseases can be significant factors in reducing the health and vigor of both the tree crop and the intercrop. The corrective actions should minimize the impacts on beneficial insects.

Fertilization and nutrient management: A normal fertility program should be applied for the intercrop in the alleyway. Generally, fertilization of the tree crop is not needed, but fertilizing the intercrop may also benefit the trees. Competition for nutrients can be minimized by root pruning or by adding more nutrients. Nutrients can be added in the form of chemical fertilizer, animal manure or a wide range of other materials. This may also include the use of living mulches or green manures.

Canopy management (Pruning): If there is too much shade under an existing stand of trees, the canopy can be pruned to allow more light to reach the understory plants. You may be able to accomplish this by clear-stem pruning for improved timber production. This involves the removal of branches low on the stem of a tree in order to raise the height at which the canopy begins. This allows more light to enter the understory from side angles while also creating adequate space for operating equipment. Remember, removing more than 40% of the trees foliage will significantly reduce the growth of the tree. It is best to always have 40-50% of a tree’s height in crown or foliage.



Alley cropping example: Paulownia and winter wheat in China. Through careful pruning, the proper shade canopy can be developed and light levels can be manipulated in an alley cropping practice. Often, the alley cropping practice will transition to more shade tolerant crops, or extensive tree removal by thinning will be needed in order to maintain light levels.

Periodic root “training” will improve crop yields: Based on research into tree and crop interactions it has been shown that even during the early years of tree development, competition for water and/or nutrients is the major reason for reduced crop yields. By early (beginning with young trees) and repeated (annual, biennial) deep ripping of lateral roots, the number of tree roots can be significantly decreased in the plow zone. Row crops will continue to produce commercial yields even as shade levels increase.

Weed Control: Weed control for an alley cropping includes both the rows of trees and the intercrop. For the tree row(s), weeds need to be minimized usually for the first three to five years in a band about three feet on each side of the trees. Weed removal can be done in a number of different ways, from herbicides and cutting to cultivation. An additional consideration for use in controlling weeds adjacent to trees may include mulch, fabric barriers or living mulches. Nothing will improve the growth of trees and shrubs like the control of competing grasses.

Maintenance tasks specific to trees:

- *Replanting: Replant all trees or shrubs that have failed for the first 3 years.*
- *Branch Pruning: Pruning of the trees may be necessary to improve wood quality, the microenvironment for the companion crop, allow equipment access, or correct storm damage.*
- *Root Pruning: Deep ripping of tree roots (up to 24 inches deep) projecting into the companion crop area will reduce competition. Unless down from the outset, do not rip both sides of the trees the same year. Allow a 2-year interval before ripping the other side. Deep ripping will need to be repeated on an annual or biennial interval.*
- *Thinning: The tree rows will normally need to be thinned to increase light in the alleyways and speed production of high value crop trees.*

To achieve the objective of maximum tree growth rates throughout the timber rotation, growers must be willing to periodically thin trees. Failure to do so dramatically and adversely impacts future tree growth rates and rotation length.

Economic Incentives for Alley Cropping

There are many agencies offering programs that can be used to establish and maintain agroforestry practices on private land. One of the most significant of these is the USDA Natural Resource Conservation Service (NRCS) Environmental Quality Incentive Program (EQIP) that may be used to support startup costs of establishing an alley cropping practice.

The EQIP program is designated to address environmental concerns associated with agricultural production. Landowners engaged in livestock or agricultural production can apply for 1 to 10-year contracts through a competitive application process based on environmental benefits. Eligible lands include cropland, rangeland, pasture, forestland, and other farm and ranch lands. Conservation practices are designed with the help of USDA/NRCS and other agencies to address the locally-identified priority resource concerns. EQIP contracts provide cost-share payments up to 50 percent of the establishment cost for conservation practices and various incentive payments. For alley cropping practices, EQIP

Federal Agency and Programs Offered	Programs Available for Alley Cropping	Key to Programs
USDA/NRCS		<ul style="list-style-type: none"> • CS = Cost Share (ranges from 50% to 90%, based on a predetermined expected cost structure) • LE = Land Easement (Rental payments based on an average rental rate per land use type; easements are typically 5, 10, 15, 30 years or permanent) • M = Annual maintenance payments (range from \$5 - \$10 per acre) • IP = Additional incentive payments (payments could include sign-up bonuses, additional cost-share, and/or increased land easement rates) • G = Grants
Environmental Quality Incentive Program (EQIP)	IP	
Conservation Security Program (CSP)	CS, LE	
USDA/FS		
Forest Land Enhancement Program (FLEP)	CS	
USDA SARE		
Producer Grants	G	

will pay \$50 per acre for first 3 years on land planted in trees and the grass strip adjacent to trees. No more than 50% of the cropland can be enrolled.

NRCS Standard 311 identifies the guidelines for establishing an alley cropping practice for EQIP. For more information, contact your local USDA/NRCS office.

Additional USDA programs to establish and maintain an alley cropping practice are offered through the Forest Service (FS) and the Sustainable Agriculture Research and Education (SARE) program. See chart below for a list of incentives offered by these federal agencies or consult the UMCA publication “Funding Incentives for Agroforestry in Missouri.”

Funding incentive for Alley Cropping through EQIP:

\$50 payment per acre for first 3 years on land in trees and grass strip adjacent to trees. No more than 50% of the cropland can be enrolled.

Cost Share Opportunities: Alley cropping is the tree or shrub component of an overall conservation management system for cropland or hayland. To be an effective conservation management system, several other conservation practices need to be considered for inclusion in the system depending on the objectives to be achieved. (Numbers in parentheses are NRCS Conservation Practice Codes.)

- Conservation Crop Rotation (328)
- Crop Residue Management (329, 344)
- Contour Farming (330)
- Contour Buffer Strips (332)
- Contour Orchard & Other Fruit Area (331)
- Filter Strip (393)
- Forage Harvest Management (511)
- Grassed Waterway (412)
- Stripcropping, Contour (585)
- Terrace (600)
- Pasture and Hayland Planting (512)

- Pest Management (595)
- Wildlife Upland Habitat Management (645)

Note: Cost share reimbursement rates vary by state and by year.

Summary

Alley Cropping needs to be part of an overall management system including crop rotation, crop residue management, combinations of buffer practices, pest management and nutrient management. Alley Cropping can help diversify farm enterprises, protect soil, improve air and water quality, enhance fish and wildlife habitat, conserve biodiversity, and beautify the landscape.

Success Story

Paul Smith

20-acre alley cropping practice, Northwest MO, near Claremont



“I guess I was a little hesitant at first to plant trees. I wondered at times what some of my farmer friends and neighbors would think of covering good bottomland with trees. My wife reminded me that her father had spent his lifetime clearing this off and now we’re planting it back in trees.

In 1999 we seeded this field to orchard grass, and alfalfa. The first cutting that year produced about 3 tons per acre, and I feel that we benefit from the alley cropping because we have a short-term benefit of the crops between the tree rows -- and eventually, my family or someone else will benefit from the tree crop.”

Success Story

Dan Shepherd

Shepherd Farms – Bluegrass hay and pecan alley cropping practice, buffalo ranch and agritourism business, Clifton Hill, Mo.



Dan Shepherd raises buffalo for processing into lean, high-quality meats and jerky, in addition to his pecan and bluegrass hay alley cropping practice. Shepherd Farms is also a nationwide leader in production, wholesale and retail distribution of Eastern Gamagrass seed.

“Alley cropping is ideal for achieving both our production and conservation benefits,” said Shepherd. “We earn an annual income off the ground, while the trees are being established. We also enjoy an abundance of wildlife in the habitat created by alley cropping. While the crops are growing we see deer, turkey and quail utilizing this ground and the trees.”



Early spring, winter wheat in a young Chinese chestnut orchard, Napton, Mo.



Winter wheat harvest in a young Chinese chestnut orchard, Napton, Mo.

Additional Resources

National Agroforestry Center:

<https://www.fs.usda.gov/nac/practices/alleycropping.shtml>

The Center for Agroforestry at the University of Missouri:

<http://www.centerforagroforestry.org>

Alley Cropping: <http://www.centerforagroforestry.org/practices/ac.php>

Savanna Institute: <http://www.savannainstitute.org/resources.html>

Alley Cropping video:

<http://www.youtube.com/watch?v=b8Kwb5yInPM>

In Print:

Garrett, H.E. (editor) 2009. North American Agroforestry: An Integrated Science and Practice (2nd Edition). American Society of Agronomy. pp. 133-162. (Chapter 7)

Wolz, K. and DeLucia, E. 2018. Alley cropping: Global patterns of species composition and function. *Agriculture, Ecosystems & Environment*: www.life.illinois.edu/delucia/publications/WolzAlleyCroppingReview.pdf Pages 61-68

From the United Kingdom:

<http://www.agforward.eu/index.php/en/silvoarable-agroforestry-in-the-uk.html>

Additional resources:

NRCS:

www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/landuse/forestry/sustain/guidance

AFTA:

Association for Temperate Agroforestry, Alley Cropping:

<http://www.aftaweb.org/about/what-is-agroforestry/alley-cropping.html>

EXERCISE: REVIEW OF ALLEY CROPPING

- 1. What factors affect the width between your rows?**

- 2. What are some of the advantages and disadvantages to alley cropping?**

- 3. What are advantages and drawbacks of utilizing narrow vs. wide alleyways?**

- 4. Identify two management practices that are critical to maintaining tree growth over time.**

- 5. Why is root pruning performed on tree/shrub species in alley cropping?**

- 6. Removing what percent or more of the tree's foliage can have a serious impact on the growth of the tree?**

- 7. How do you determine how far apart to plant trees in a tree line and how far apart to plant the tree rows? Is there such a thing as a wrong distance, such as too far apart or too close together?**

EXERCISE KEY

1. What factors affect the width between your rows? Landowner goals and objectives, desired crops, uses for trees, and width of existing crop production equipment all impact between and within row widths.

2. What are some of the advantages and disadvantages to alley cropping? Advantages: Short-term cash flow, trees benefit from crop fertilization, sun crops compete with weeds, reduce runoff, form of windbreaks, and provide increased economic diversity and long-term payoff. Disadvantages- Tree rows are obstacles for cultivation, provide competition for sunlight, moisture, and nutrients, and require more intensive management. Herbicide drift from crops may damage trees. Sun crops will need to be exchanged for more shade tolerant crops over time.

3. What are advantages and drawbacks of utilizing narrow vs. wide alleyways? Narrow alleys with more tree rows permit greater production of trees and shrubs per acre of land putting an emphasis on the value of the woody crop. Narrower alleys will also become shaded within just a few years forcing a shift from sun to shade loving crops. Wide alleys permit sun loving crops to be grown for many years and are often more compatible with farm equipment

4. Identify two management practices that are critical to maintaining tree growth over time. Ongoing weed control around the base of the trees, using herbicides, mulch, fabric barriers or living mulches is absolutely essential for rapid tree growth and establishment. As the trees age and grow, thinning out crowded trees within the row will enable the trees to maintain maximum growth rates over the long haul.

5. Why is root pruning performed on tree/shrub species in alley cropping? Tree roots can be pruned (severed) or “trained” to reduce competition for water and nutrients.

6. Removing what percent or more of the tree’s foliage can have a serious impact on the growth of the tree? Removing over 40% of the crown of the tree will reduce its growth.

7. How do you determine how far apart to plant trees in a tree line and how far apart to plant the tree rows? Is there such a thing as a wrong distance, such as too far apart or too close together? (See question #1) Depending on the emphasis of nut or wood production, and what kinds of crops are planned on, the width of the alleys must be adjusted to meet these plans. Wood production is compatible with narrow rows and multiple rows; nut production requires single rows and wide spacing between trees.

A “wrong” distance would be any planting configuration that does not meet the landowner’s short-, medium- and long-term objectives resulting in lower production from desired crops or reduced tree growth or poor tree form. Row-to-row distance also must match with existing equipment.

Notes

Chapter 4: Silvopasture

In this chapter:

- **Defining a Silvopasture**
- **General Benefits and Limitations**
- **Components of a Silvopasture: Livestock, Trees, Forages**
- **Summary**
- **Success Story**
- **Frequently Asked Questions**
- **Additional Resources**
- **Exercise and Key**
- **UMCA Research**



Cattle graze among Missouri pecan trees in this well-managed silvopasture practice.

Defining Silvopasture

Silvopastoral practices intentionally integrate the management of trees, forages, and grazing livestock for a production benefit. It is important to note that allowing livestock to graze in a natural woodland area without active livestock/forage grazing management is NOT considered agroforestry. Silvopasture can be created using two different approaches:

1. Establish trees into existing pasture.

The right choice of tree crop (often matched to soils) allows you to carry on a profitable livestock operation while creating a long-term investment in timber and/or forest products. Young trees allow plenty of light for forage production. Additionally, as the tree component develops, shade and wind protection will enhance livestock performance. Success and longevity of the practice hinges on two primary factors: control of the grass growth around young trees (necessary for early tree development) and proper management of tree densities (necessary for light management and forage long-term production).

2. Establish forages in the woods.

By establishing select forages in an intensively manipulated forest environment, the area can then be jointly managed for grazing and timber production. In most forests, the key to successful silvopasture will be forage production. Levels of forage production will hinge on two factors: having the light necessary for forage growth and response, and proper rotational grazing. Soil fertility should be adjusted to enhance forage development, and light adjusted by reducing tree density and managing tree spacing. It is important to recognize that long-term timber value and silvopasture viability hinges on keeping trees appropriate for the site and of high quality. Forages should be selected that match grazing objectives and light availability.

General Benefits of Silvopasture

- Diversify farm enterprise
- Improved growth of high quality trees
- Reduced stress and improved animal productivity
- Improved nutrient cycling
- Enhanced wildlife habitat

Properly applied on a landscape, the silvopasture practice can enhance and diversify farm income opportunities, provide environmental benefits and create wildlife habitat. Current research is focused on understanding the dynamics of the silvopastoral practice (i.e., interactions between trees, forages and livestock). The expected outcome is that silvopastoral practices will improve the productivity of the grazing animal, the quality and diversity of forage available to the grazing animal and wildlife, and effectively interpose timber stand improvement across a wide array of forested land.

General Limitations of Silvopasture

- Producer should already be practicing some type of rotational grazing
- Distance and access to water
- Challenges establishing young trees
- Challenges introducing forages to existing woodlands
- Maintaining proper light levels
- Fencing issues

Converting all of a pasture grazing system to silvopastures is unlikely on a wide scale. Many farm managers have a wide variety of existing resources. Choose pastures where tree growth could be ideal and mix with compatible forage(s).

Management Intensive Rotational Grazing (MiRG) helps to divide the farm into management units. Use the silvopastures strategically to compliment the grazing system. Creating small, fenced paddocks and rotating cattle builds in “recovery periods” for the forage and protects the soil and the trees. Grazing recovery periods can only be achieved when well-designed livestock water supplies and cross fences are used.

Components of Silvopasture

Silvopasture practices are different from other types of agroforestry because they require

landowners to manage livestock, as well as trees and forage plants. This three-way interaction means there are three factors to consider when designing your agroforestry practice: livestock, trees, and forages.

The five variables in a silvopastoral practice that can be subjected to management are livestock, livestock grazing practice, tree species, tree density, and forage species. The majority of research conducted has evaluated silvopastoral practices under conifers (mostly pine) with only limited evaluation of hardwood-based practices. Most hardwood research has been conducted with either oak species or nut-bearing species (e.g., black walnut, pecan). In certain instances under deciduous tree stands, forage production has been reported to be equal or even greater than in open exposure to sunlight. Fescue and orchardgrass production has been shown to be greater under a 35-year-old walnut canopy than in open pastures.

Managed grazing practices, similar to open pastures, should be developed and implemented to maximize forage production in a silvopastoral practice. The increased forage production under a canopy would result in increased stocking rate potential and greater productivity per unit of land.

A. Livestock

Cattle and sheep are primarily used in silvopastoral practices. Animal performance can be enhanced via use of silvopastoral practices. This occurs from reduction of heat stress and improved forage availability and nutritional quality. However, there may be instances where browsing livestock, such as species of goats, can be used to eliminate undesirable understory vegetation. In these instances, the livestock receive forage benefits from the woodland, and the woodland is enhanced when invasive or undesirable vegetation is eliminated. Selecting appropriate livestock will help landowners to achieve their objectives.

The greatest difference between silvopastoral and “open” management of cattle or sheep is the contrasting environmental conditions. In the open, such as a conventional pasture or range, radiant heat can be much more intense than in a shaded environment. Shade has been shown to improve animal performance, with primary emphasis placed upon heat stress amelioration. Research with cattle has shown that compared to unshaded or sparsely shaded pasture, uniformly distributed shade results in maximum grazing time.

Heat and cold stress can adversely affect cattle throughout much of the temperate zone in North America. Protection from cold can be important for livestock in northern climates. Properly positioned trees and shrubs can provide much needed protection for pastures, feedlots, and calving areas. Reducing wind speed lowers animal stress, improves animal health and increases feeding efficiency of livestock.

It takes careful management to ensure livestock do not damage young trees. Success will depend on your understanding of livestock behavior.

Grazing Considerations

- **Grazing - early stages:**

Protect trees from livestock in early stages of growth. Electric fencing works well. Once tree limbs are out of reach of stock, there is less to worry about.

- **Grazing - later stages:**

Tree growth likely to reduce annual forage production annually once a full canopy develops. Choosing a shade tolerant forage is important. More aggressive forages are less of a problem. Fit silvopasture practices into the overall grazing “system”.

Special Water Considerations for Silvopasture

- Consider using portable water tanks
- If installing permanent tanks, consider concrete tanks

- Consider using tank covers on permanent tanks
- Consider installing water within 600 feet travel distance

Animals acquire water through drinking and from the moisture in the forage they eat. As air temperature increases water requirements also increase. This becomes especially critical as air temperatures exceed 77° F. The need for available drinking water is compounded because forages become drier at higher temperatures. At 90° F, a 600 pound growing steer needs about 13 gallons of water per day. At 60° F, that need falls to eight gallons per day. One distinct advantage of a silvopasture system is that shade is distributed throughout the pasture and greatly reduces high temperature stress on livestock.

Water requirements vary for the kind, size, age, and breed of livestock. For example, *Bos taurus* breeds of cattle (European types) generally consume more water than *Bos indicus* breeds (such as Brahman-influenced breeds). Dairy breeds need significantly more water than beef breeds. The rule-of-thumb used by some livestock managers is one gallon of water per day per 100 pounds of body weight per animal. Water use also varies considerably depending upon the animal’s health, air temperature, water temperature, stage of lactation, and other environmental factors.

Water Distribution

Daily intake of water increases when travel distance is less than 600 feet. Water consumption may be 15 percent higher in small paddocks with water in every field (less than 600 feet of travel) than in similar systems with water available at a single source (where cattle may travel between 600 and 2,000 feet to water). When water is located close to the forage resource, the herd’s “social structure” is modified such that animals tend to water more frequently as individuals. This tends to keep the herd dispersed throughout the paddock and results in a greater portion of time spent grazing.

Of course, it is not always possible to install the “ideal” water system and many successful grazers utilize water in pastures larger than 32 acres with travel distances to water greater than 600 feet. Dedicated travel lanes have been successful to allow cattle to travel to central water locations. This approach, however, is best suited to level terrain and locations with only slight erosion hazards. To compensate for less than ideal situations special care must be taken to monitor grazing impacts on trees and forages. Adjusting the stocking levels and grazing rotation periods can help protect both the forage and the trees in a silvopasture practice with water distribution problems.

Water supply options for silvopasture include wells, creeks, ponds, springs and even municipal or rural water systems. Ponds can provide a good reliable source of drinking water for livestock and wildlife, as well as providing other benefits. Consider utilizing portable livestock tanks that can be removed during tree management or harvesting operations.

Browsing

Poorly managed livestock can cause two types of damage to trees: browsing and trampling. Livestock preferences are predictable; they will choose grass before they browse conifer trees. However, conifers are attractive to livestock when they are flushing in spring, so that is a good time to keep animals and trees apart. In hardwoods/deciduous trees, livestock browse can be a problem at any time. When available, livestock will seek out nutritional forage. The browsing of terminal shoots by domestic or wild animals will result in deformity and loss of tree growth. It is therefore desirable to have physical protection around hard- wood seedlings. Wire cages, or a single strand of high tensile electric wire along both sides of a seedling (usually 3 feet from seedlings), or seedling row, have been shown to be effective at reducing browse damage.

Fencing

Proper pasture rotation provides “recovery periods” for the grazed forage, minimizes

soil compaction, and protects trees in a silvopasture system. There are several key components in an effective and easily managed fencing system:



Fencing, placed approximately 3 feet from tree seedlings, is effective at reducing browsing damage from livestock.

- An energized fence is primarily a psychological barrier and can only be effective if the fence carries enough current to deliver a “deterrent” shock. Alternating current (AC) powered units are generally the best choice for energizing a fence if 220- or 110-volt power is available. For remote areas, battery powered systems with solar re-charge may be necessary. In a silvopasture practice, the potential for malfunction increases with the risk of falling branches or trees damaging the system.
- To assure effective operation, the energized fence should have a proper-sized energizer. Generally one-joule output per mile of fence is sufficient. Be properly grounded with a minimum of three feet of ground rod per joule output. Be protected from lightning by installing a surge protector at the power source, a lightning choke at the fence, and an additional ground rod every 3,000 feet of fence.
- High tensile wire is recommended when using energized fences for border areas and is also used for cross fencing. The number of strands depends upon the type of livestock being grazed. Generally, a minimum of four- to six- strands is recommended for border fencing and one to three strands for cross fencing cattle. Other types of livestock often require special considerations such

as distance above the ground of the bottom wire, and distance between wires for smaller livestock like goats and sheep.

- Polywire or polytape can be used for temporary or portable cross fencing to create smaller paddocks for intensive grazing or to allocate stockpiled pastures for winter grazing. This enhances the manager's ability to provide optimum, forage recovery periods.
- Fencing, placed approximately 3-feet from tree seedlings, is effective at reducing browsing damage from livestock.

Trampling damage

The damage livestock do by stepping on (or against) a seedling, as well as rubbing off the bark, is the number one cause of tree seedling death. Generally, trees are most susceptible when less than 16 inches tall, and during the period of rapid growth in early spring. Trampling damage causes deformation and weakening of the stem, and may also provide an entry point for pests and disease.

You can also use obstacle planting to create patterns that will help control livestock movement. When planting trees, it's important to visualize where animals could be encouraged to walk. With that in mind, you can use a tractor to position small logs or logging debris in rough lines to guide the livestock and keep them away from seedlings. Unlike a standard planting grid pattern, obstacle planting in a row creates a 'fence' that steers animals on pasture pathways between and around tree seedlings.

B. Trees

Typically, reforestation is designed to produce quality trees for wood production. Consequently, initial planting densities do not often coincide with producing good livestock forage. Even where good forage is available, supply decreases dramatically once the canopy closes past 50 percent. If trees are planted at 12-foot intervals, then, depending on site condition, that may happen after only 5 to 10 years.

Levels of management for livestock

- **Optimal:** Timing livestock access to the area to maximize positive interactions with the forages and minimize negative interactions with tree seedlings. Frequent rotation to optimize forage health.
- **Improved:** Moving livestock when forage supply is starting to decline and seedling trees have minimal damage.
- **Poor:** "Dumping" livestock on an area and leaving for extended periods of time, causing overgrazing of forages and damage to trees. Planting an obstacle row creates a 'fence' that steers animals on pasture pathways between and around tree seedlings.

However, with the selection of appropriate tree species and changes in planting design, it is possible to grow more than 300 trees per acre while maintaining good forage for a longer period. As an example, this can be accomplished by planting at 8-foot intervals between trees with 18 feet between rows.

Conventional planting is done on a grid pattern. However, by using different configurations, such as the planting scheme mentioned above, or by establishing tree clusters across a paddock, the time between required thinnings may be increased and the area available for forage growth may be maximized. Much wider spacing between tree rows is feasible and depends upon the landowner's objectives. In all but the most widely spaced initial plantings, such as 40 feet by 40 feet, thinnings will at some point be necessary in order to maintain light levels sufficient for forage production.



Tree arrangement on the land

The proper design plan of any silvopasture practice should consider the spacing between select trees and shrubs, both within a tree/

shrub row and between tree/shrub rows. Tree arrangement, either during tree establishment in pastures or as a result of thinning trees within managed forested stands, can vary greatly among trees in single, double or multiple rows; individual widely spaced trees; and/or clustered or grouped trees.

Advantages of single and multiple row plantings

Single Row

- Better crown space for nut production
- Maintenance is simplified (such as mowing)
- Some shade landscape is created
- Possible tree crop harvest capacity

Multiple Row

- Enhanced erosion control
- Better growth of trees for timber
- Improved wildlife value
- Greater diversification of farm products

Desirable characteristics of an agroforestry tree species

- **Marketable.** This includes both the wood itself and other products such as nuts or fruit, which would provide another source of income.
- **Compatible with the companion crops or forage you choose.** Some trees produce growth-inhibiting chemicals which may affect what you can grow.
- **High quality.**
- **Fast growing or of such a high value that a species of medium growth rate is acceptable.**
- **Deep-rooted** so the trees do not compete with the crops or forage for moisture.
- **Have rapidly decomposing foliage.**
- **Be properly matched to the site.** Site tolerant, suited to either a wet or dry site.
- **The leaves should produce a light, rather than a heavy shade.** This will be especially important as the trees mature and the canopy closes. The lighter the shade that is produced, the longer you can grow crops or forages.
- **Capable of producing the products you desire.**



An aerial view of the Horticulture and Agroforestry Research Center shows a silvopasture research area pattern. Double rows of tree plantings are shown on the left; triple rows are on the right. Multiple rows provide large volumes of wood without overly sacrificing forage production.

Differences exist between the results that can be expected from each tree arrangement. Landowner objectives will determine the best

arrangement of trees and the forages to be used, and it must be remembered that silvopasture management is intensive and dynamic over time.

There are several key factors to keep in mind when establishing the practice on a given site and determining the width of the alley between rows of trees. Key factors include equipment size, forage, changes through time and thinning and pruning.

Factor 1: Equipment Size

A silvopasture design that plans for occasional forage removal by mechanical means, must provide space between the trees so that equipment can move freely. The alley between tree rows should be wide enough to allow clear passage of the widest piece of equipment and should be organized so that full passes of the equipment are utilized. Ultimately, the design should recognize the branch and crown development which will occur over time for a given tree species and that may be associated with products desired from those trees. For example, when planting trees for nut production, where large crowns are desirable, wider space between tree rows should be planned.

Factor 2: Forage

Closer tree spacings may be designed for forages which are more shade tolerant, keeping in mind equipment requirements. However, most forages need a minimum of 50 percent light, so plan to manage tree densities to produce adequate light for forage growth.

Factor 3: Changes through time

Increased shading occurs as trees mature. As this happens, a change toward a more shade tolerant forage will be necessary to maintain suitable yields. These changes can also be offset by timely thinning of lower quality trees and through prunings that reduce branch density in a tree's crown.

Factor 4: Thinning and pruning

Timely thinning can be used to maintain semi-

open crown conditions. While used as a tool to manage the light available for forage production, thinning also serves to increase the resources (light, water, and nutrients) available to the remaining higher value trees and therefore, should enhance their growth rate. Another dual purpose management practice is pruning. Proper pruning of the lower branches, to develop a high-value butt log, can increase log value and increase the space available for operation of equipment. At the same time, this also increases sunlight available to the forage.

Finally, crown management through pruning may be beneficial if the desired tree product is nuts. An open crown not only allows more light to reach interior branch tips (necessary for flowering and fruiting), but also will allow increased light to filter through to the forage.



A single row of pine and fencing allows for managed paddock grazing based on forage response to grazing.

C. Forage

As feed for livestock, forage is a vital component of silvopasture practices. Choose forage(s) that will do well in the level of shade produced by the tree cover and meet the nutritional needs of the chosen livestock. Tree size, density, and pattern all influence understory forage production. Typically, combined canopy coverage must equal or exceed 35 percent before it significantly impacts forage production. However,

Special Considerations for tree spacing

Within a Row

- *Federal/State subsidy program requirements*
- *Production vs. conservation benefits*
- *Wood production vs. other tree products*
- *Grafted vs. seedling planted stock*
- *Markets for small-diameter material*

Between a Row

- *Production vs. conservation objectives*
- *Wood production vs. other tree products*
- *Light requirement of forage*
- *Duration of grazing regime*
- *Width of farm equipment*

many cool season grasses and legumes perform well in 50 percent shade. Recognize that shade produced by the canopy will increase over time as the trees mature.

Establishing pastures in the forest

1. Prepare your site for seeding as soon as possible after thinning (crop tree) or harvesting (selection cutting or improvement harvest) from the forest, so native vegetation doesn't have a chance to respond to canopy removal and invade the site.

2. Seed immediately after site preparation (light fire or disking, and necessary soil amendments like lime or fertilizer) to give domestic forage the jump on native competitors.

3. Lay out pastures and fencing for rotational grazing.

4. Install water supply to meet livestock requirements.

Forage growth and interaction

The forage component of a silvopastoral practice can be either competitive or complimentary with your trees. Your management decisions will influence which way the practice develops. As the selected forage begins to develop and fill an area, it may be beneficial for tree growth to eliminate the forage that would otherwise grow directly adjacent to the tree.



Annual rye and timothy grass grow well in shaded environments, as shown here under 8-year-old walnut grown between rows of pine.

It is desirable to use a weed mat, herbicide or some other form of control to eliminate grass growing within two to three feet of seedlings for up to five years. Tree growth will greatly benefit.

Cool season forages have their peak production in the spring when temperatures are cool. Later they are harvested or allowed to become dormant during the summer. These forages should be grazed no shorter than three inches and should be six inches in height at the end of the growing season.

Cool season plants tend to:

- Be competitive for spring soil moisture
- Be less competitive for water in the summer months when moisture may be limiting to tree growth
- Many perform reasonably well under partial shade

Warm season grasses should be grazed no shorter than 8 inches during the growing season and by the end of the growing season, the last grazing rotation should leave the forage with a height of 10 inches. These grasses achieve most of their growth in the summer months.

Warm season plants tend to:

- Be less competitive in the early spring when many trees are beginning their annual growth
- Be more competitive for water during the summer months when trees are putting on the majority of their diameter growth
- Most warm-season grasses native to Missouri do not perform well under partial shade

Can forage be grown in the shade?

Research at the UMCA has shown that many cool-season grasses and legumes, when planted under 50 percent shade, will perform equally to or better than open grown plants. Better performance means overall growth will improve (better yields) and often means that quality will improve, as well as digestibility.

Why?

Tree canopies modify the ground level climate. The combination of modified climate and change in light levels, causes many grasses and legumes to both, increase growth (due to modified climate and moisture), and have less lignin in their leaves (improved quality).

Summary

Always use managed grazing principles with the silvopasture practice. As a part of grazing

considerations, do not forget to supply adequate water for the livestock. As a rule, keep livestock within 600 feet of water.

As a part of a farms grazing system, the silvopasture practice can be a nice addition. It offers many opportunities to enhance livestock productivity through both the modified climate it provides and the improved forage it is capable of producing.

Advantages of a Silvopasture Practice:

- *Trees improve climate for grazing*
- *Complements ongoing pasture operations*
- *Shade enhances growth of some forages*
- *Livestock address short-term cash-flow*
- *Improved nutrient cycling*
- *Nitrogen-fixing forage crops also benefit trees*

Disadvantages of a Silvopasture Practice:

- *Fencing cost may be increased*
- *Management intensive grazing is required*
- *Equipment operation may be more difficult*
- *Possible additional tree maintenance labor*

Major factors influencing forage production

- Tree species
- Tree spacing
- Tree age
- Forage shade tolerance
- Forage selection

If you live where it's dry...

Forage can compete with trees for scarce moisture. Seed at lower rates and have livestock available to graze before the forage becomes competitive. By taking these precautions and matching tree and forage selections, your results should be:

- More palatable forage
- More efficient grazing
- More vegetation removal

Success Story

Jim Wilson

Pecan and walnut silvopasture practice near Nevada, Mo.



“Ever since we’ve been in nut production we’ve used cattle to control the height of the grass. We also benefit from the value of the beef that we sell in the fall, in addition to the nuts that we harvest.

We chose cattle to run in here because we fertilize these trees with nitrogen and it causes the grass to grow. By grazing, it gives us extra profit from the beef. And it also helps where we don’t have to mow as much.”

“Another thing that we like about the trees is that it’s cooler on a hot summer day. It’s at least ten degrees cooler down here, and the cattle are just scattered out everywhere grazing.”

2003 SARE Highlights

Good Bedfellows: Cattle, pecan trees in an environmentally sound mix, Haydon Farm, Okemah, Okla.

Oklahoma ranks second in the nation for native pecan production and third for its forage-based beef industry, so it’s no surprise that cattle and pecans co-exist on about 50,000 acres. They make good companions. Cattle gain weight

on grass that otherwise would require mowing, return nutrients through manure, and prune the lower limbs of pecan trees. In return, orchard shade encourages cattle to graze and gain weight in hot weather. There’s room for improvement in that symbiotic relationship, however, says Oklahoma State University (OSU) extension horticulturist Dean McCraw, who is using a SARE grant to refine the system. While most pecan/beef cattle operations use commercial fertilizer and follow a “typical” orchard spray program, “research has shown that profits and environmental impacts can be improved by replacing the purchased nitrogen with legume pastures and developing a customized pest management system based on scouting and weather monitoring,” he said. “We are looking at how all these components interact on real farms.”

Legume pastures planted in the orchards increased daily weight gain for the steers, improved soil health by reducing grazing compaction, reduced nitrogen runoff and increased habitat for beneficial insects. Over the three-year project, native pecan trees in plots with legume pastures averaged nearly 700 pounds of pecans per acre and over 250 pounds of beef gain per acre without any added nitrogen fertilizer. The result: a savings of nearly \$30 per acre in fertilizer cost while essentially eliminating fertilizer runoff potential. The benefit of legumes was most dramatic in flood-prone plots, where legumes prove tough enough to withstand excessive water and out-compete other vegetation.

While the orchard/beef combo proves useful in eastern Oklahoma, with its 100,000 acres of native pecan trees, another SARE project is helping ranchers find the system that best suits their own resources. Damona Doye, OSU extension economist, used case studies of cow/calf operations to identify management strengths and weaknesses in animal science, forages, financial management, and herd health. During the course of the multi-state project, more than 100 ranchers in three states

identified potential cost-saving measures of about \$3,000 annually each. Doye shared case study findings with other producers during information exchange forums and offered training to veterinarians and accountants so they can better assist their farm clients to improve resource management practices.



Hardwood silvopasture under white oak at the MU Wurdack Research Center.

Frequently Asked Questions:

Does the silvopasture practice have any long-term effects on soil compaction?

Soil compaction is a valid concern, both from the standpoint of optimizing tree growth, and from the potentially negative influence compaction can have on forage productivity. Any pasture may have problems from soil compaction. And, while it may be more challenging to see the effects of compaction on tree growth, it is visible in forage productivity. Therefore, one of the best ways to gauge whether or not the soil is being overly compacted is by the stand of forage being produced. If a forage stand is thin and does not grow back following removal of the livestock, then soil compaction may be a problem (this assumes that drought or lack of nutrients is not the factor limiting production). Always strive to not overuse pasture. Sound management, such as management intensive grazing, is the best method for limiting soil compaction, and will be evidenced by good forage development. Another way to say this is that if the forage in a silvopasture practice is maintaining growth and productivity, then compaction is not likely a problem.

Will rows of trees planted to a pasture develop an open growth form?

There is the potential that trees established in pastures will develop a more open-grown form. This form, wide crowns and increased branching, while not desirable if trees are grown for timber, is more desirable for trees grown to produce a nut crop. However, in either case pruning will likely be necessary to enhance productivity and often quality. Nut trees require pruning in order to ensure that light reaches flowers and results in nut development. Timber trees will likely require pruning for correction to their form and to enhance their quality. If trees are grown for timber, another option may include planting shrubs/trees adjacent to the timber tree in order to shade its trunk and encourage upright growth. Trainer trees will help reduce side branch development and cause the tree to grow up towards better light.

Is the silvopasture practice sustainable?

Sustainability refers to the long-term potential of a practice to continue through multiple harvests. And, yes the silvopasture practice “trees in the pasture” is sustainable. However, it becomes sustainable through proper planning and management. Planning should include an activities schedule that predicts when certain management will need to take place in the life of the practice. For instance, as newly established trees develop and produce increasing levels of shade, when will thinnings need to take place to maintain light levels adequate for forage production? Is it possible to predict this time? I would say yes, at least within a range. You can do this by looking at the forest site-index from the soil survey and judging the trees height development over time, and of course this will also be dependent on the initial planting density. This is just one example, but it illustrates the importance of planning and management (really the thought process of looking out to the future) on creating a reasonably sustainable practice.

Is “pasture in the forest” a proven silvopasture practice?

No. Experimental trials are underway and show promise. However, long-term impacts of cattle on existing trees in a forest stand, potential for cost-effective regeneration of trees and long-term maintenance of forage under forest canopies are under investigation. Finally, landowner willingness to use management-intensive grazing – essential for “pasture in the forest” – is critical.

Additional Resources

Forum/Blog

<http://silvopasture.ning.com>

Course

<http://www.silvopasture.org/>

Video

<http://www.youtube.com/watch?v=VJsKmBbtw7Q> and <http://centerforagroforestry.org/pubs/vid-eomain.php>

Silvopasture

Cornell University. Silvopasturing in the Northeast:

<http://www2.dnr.cornell.edu/ext/info/pubs/MapleAgrofor/Silvopasturing3-3-2011.pdf>

USDA National Agroforestry Center: <https://www.fs.usda.gov/nac/practices/silvopasture.shtml>

Fike, J. H., Buergler, A. L., Burger, J. A., and Kallenbach, R. L. 2004. Considerations for Establishing and Managing Silvopastures. Forage and Grazing Lands.

https://ext.vt.edu/content/dam/ext_vt_edu/topics/agriculture/silvopasture/files/silvopasturesconsiderations.pdf

University of Florida. Integrated Timber, Forage and Livestock Production:

<http://edis.ifas.ufl.edu/fr145> and <http://edis.ifas.ufl.edu/fr139>

Mississippi State Univ. Forage News:

<https://extension.msstate.edu/sites/default/files/publications/publications/p2847.pdf>

NRCS Conservation Practice Standard. Silvopasture Establishment:

<http://efotg.sc.egov.usda.gov/references/public/AL/tg381.pdf>

On Pasture. June 1, 2015. Creating Quality Silvopastures from Wooded Areas.

<http://onpasture.com/2015/06/01/creating-quality-silvopastures-from-wooded-areas/>

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Garrett, H.E. (editor) 2009. North American Agroforestry: An Integrated Science and Practice (2nd Edition). American Society of Agronomy. pp. 105-132. (Chapter 6)

Garrett, H.E., M.S. Kerley, K.P. Ladyman, W.D. Ladyman, L.D. Godsey, J.W. VanSambeek and D. K. Brauer. 2004. Hardwood silvopasture management in North America. *Agroforestry Systems* 61: 21-33.

Grazing Systems

University of Missouri Extension (Pumps and Watering Systems for Managed Beef

Grazing): <http://muextension.missouri.edu/explorepdf/envqual/eq0380.pdf>

National Sustainable Agriculture Information Service - ATTRA :

<https://attra.ncat.org/livestock-and-pasture/>

<https://attra.ncat.org/attra-pub/summaries/summary.php?pub=116>

<https://attra.ncat.org/attra-pub/summaries/summary.php?pub=245>

<https://attra.ncat.org/attra-pub/summaries/summary.php?pub=249>

<https://attra.ncat.org/attra-pub/summaries/summary.php?pub=244>

EXERCISE: REVIEW OF THE SILVOPASTURE PRACTICE

What considerations need to be taken into account in order to develop a successful silvopasture practice?

1. Identify the top three landowner objectives related to creating a silvopasture practice

- i.*
- ii.*
- iii.*

2. What are the three interactive components to consider in design of a successful silvopasture practice?

- i.*
- ii.*
- iii.*

3. What cost-share or incentive programs are available to assist with the silvopasture practice (don't forget to include assistance that might be available to establish managed grazing systems or watering systems)?

- i.*
- ii.*
- iii.*

4. Do you have any major concerns related to integrating the silvopasture practice with the current farm layout (such as access and movement of the livestock)?

5. Are there any conservation agencies or groups that could assist in designing integrated habitat that works with your current farming practices?

- i.*
- ii.*
- iii.*

EXERCISE: REVIEW OF THE SILVOPASTURE PRACTICE

6. What are the two primary ways that livestock can damage trees? And, is there a plan in place to minimize damage should it occur?

- i.*
- ii.*

7. What are the four factors that go into planning alley widths for the silvopasture practice?

- i.*
- ii.*
- iii.*
- iv.*

8. What other considerations are needed to reach the landowner objectives identified in question #1?

EXERCISE KEY

1. Identify the top three landowner objectives related to creating a silvopasture practice *Increase acreage available for grazing*, Better production from paddocks, Reduced stress on livestock for increased productivity

2. What are the three interactive components to consider in design of a successful silvopasture practice? Forage, Livestock, Trees

3. What cost-share or incentive programs are available to assist with the silvopasture practice (don't forget to include assistance that might be available to establish managed grazing systems or watering systems)? EQIP, SWCD Watering, USDA Rotational Grazing/Fence and Watering Systems

4. Do you have any major concerns related to integrating the silvopasture practice with the current farm layout (such as access and movement of the livestock)? Limiting access to streams and providing alternative watering systems. Protection of young, newly established trees.

5. Are there any conservation agencies or groups that could assist in designing integrated habitat that works with your current farming practices? USDA NRCS, MDC, MU Extension

6. What are the two primary ways that livestock can damage trees? And, is there a plan in place to minimize damage should it occur? Trampling, Browsing, Use single strand of electric fence spaced 3 feet from seedlings.

7. What are the four factors that go into planning alley widths for the silvopasture practice? Equipment size, Forage, Changes through time, Thinning and Pruning

8. What other considerations are needed in order to reach the landowner objectives identified in question # 1? Create a good activities schedule that outlines the process of implementing forest thinning, fencing, forage establishment, creating watering access, etc.

Notes

Chapter 5: Upland & Riparian Forest Buffers

In this Chapter:

- **Defining Upland and Riparian Forest Buffers**
- **Planning and Design**
- **Management and Maintenance**
- **Marketing Value-Added Products from Buffers**
- **Financial Considerations**
- **Success Stories**
- **Additional Resources**
- **Exercises**



Properly applied on a landscape, riparian and upland forest buffers can enhance and diversify farm income opportunities, improve the environment and create wildlife habitat. By developing an understanding of the interactions between a riparian buffer (trees, shrubs and grasses), the stream, and the adjacent upland area, its layout can effectively meet the goals for which it has been established. A similar understanding of the interactions of upland buffers with landscape position and annual crops is necessary to meet the design goals of these buffers. By understanding the requirements of each of the components of the buffer, it can be managed to maintain effectiveness over time, and also sustain its contributions to the farm as an integrated agroforestry practice.

What is a Riparian Forest Buffer?

Riparian forest buffers are designed combinations of trees, shrubs, grasses, forbs and bioengineered structures adjacent to, or within, a stream channel designed to mitigate the impact of land use on the stream. The term riparian applies to what is commonly called the flood-plain, and designed buffers often occupy only a portion of that landscape. At the landscape level, riparian forest buffers link land and aquatic ecosystems, and perform vital ecosystem services. By establishing, or managing, trees, shrubs and grasses in the zone adjacent to streams, water quality and aquatic ecosystem health can be sustained or enhanced. However, to be effective, buffer design and management strategies must include plants that are adapted to specific riparian environments (channel conditions, flood regimes, soils, water table depths, and upland topography), as well as provide management guidelines landowners are willing to follow to keep buffers healthy and effective.

What is an Upland Forest Buffer?

Upland forest buffers are areas of trees, shrubs, grasses and forbs planted on the contours of the upland areas of watersheds, within agricultural fields. They provide many of the same benefits as riparian forest buffers, but differ in location and are often narrower in width. They are not to be confused with the woody portion of an alley cropping system (see Chapter 3) or windbreaks (see Chapter 6) as they are primarily planted to reduce non-point source pollution and erosion, and prevent gully formation. However, depending on the site and land-owner objectives, upland forest buffers could provide some of the same benefits as these other two agroforestry practices.

Advantages of a Riparian Forest Buffer

- Reduce sediment, organic material, nutrients and pesticides in surface runoff and reduce nutrients and other chemicals in shallow groundwater flow
- Create wildlife habitat and provide wildlife corridors
- Create shade and lower water temperatures to improve habitat for aquatic organisms
- Provide a source of detritus and large woody debris for aquatic and terrestrial organisms
- Provide a harvestable crop of timber, fiber, forage, fruit or other crops consistent with other intended purposes
- Stabilize eroding stream banks and reduce scour erosion in the floodplain
- Increase carbon storage in plant biomass and soils

Disadvantages of a Riparian Forest Buffer

- Possible intensive management required, depending on design and harvestable products
- Loss of crop ground or pasture
- Flooding may damage harvestable products
- Challenges with artificial subsurface drainage (tile)

Advantages of an Upland Forest Buffer

- Stabilize crop field soils by providing a frictional perennial plant surface that slows surface runoff and traps sediment and associated nutrients
- Provides a zone of improved soil quality that allows high infiltration rates of water into the soil, allowing runoff to be filtered by the buffer before it reaches the shallow groundwater
- Provides a refuge for beneficial insects that may help control crop pests
- Provides wildlife habitat
- Slows wind that can increase evaporation from drying crop plants

Disadvantages of an Upland Forest Buffer

- Loss of crop ground or pasture
- May reduce available soil moisture for crops adjacent to the buffer

- Provides shade which may reduce growth of crops adjacent to the buffer
- Provides habitat for wildlife that may feed on adjacent crops

Riparian Forest Buffer Zones and Benefits

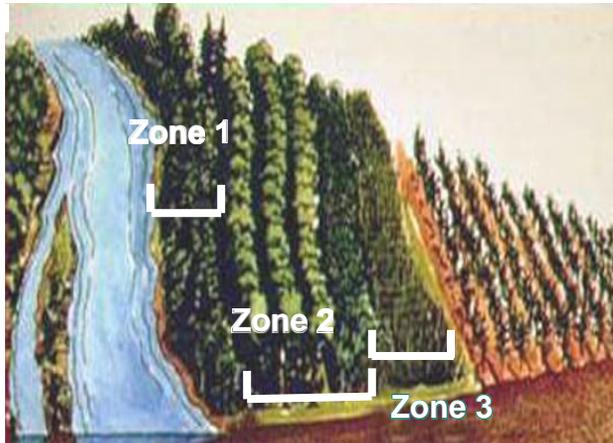
A riparian forest buffer is typically composed of three management zones, planted parallel to the stream:

Zone 1 – A zone closest to the stream bank that can include a mixture of fast growing native bottomland trees, shrubs, grasses and forbs that are designed to grow rapidly to stabilize stream banks. This vegetation should be able to tolerate periodic flooding and is not harvested to provide natural interactions with the stream channel, including shading of the stream and providing large woody debris to the channel following natural mortality or loss resulting from undercut stream banks.

Zone 2 – A much wider managed zone adjacent to Zone 1 consisting of trees, shrubs and grasses and forbs that can tolerate periodic flooding and high water tables. Upland trees and shrubs can be planted in riparian areas adjacent to deeply incised channels that have lowered water tables. Their primary water quality purpose is nutrient uptake and storage and flood mitigation. Woody stems, especially of multi-stemmed shrubs, slow floodwater and trap floating debris within the buffer keeping it out of the adjacent crop field or pasture. This zone can be managed for specific wildlife and additional income from nuts, berries, woody florals, or biomass products.

Zone 3 – An area adjacent to crop fields or pastures that provides high infiltration, sediment trapping, nutrient uptake and can help disperse concentrated runoff. Native grasses and forbs are normally preferred for their multiple benefits and adaptability, but dense, stiff-stemmed introduced grasses may also be effective. Grass and forb seeds can be harvested and sold for

other projects, or grasses may be harvested for hay or use as biomass.



The three distinct zones of a riparian buffer require individual management decisions to optimize their benefits. For example, in Zone 1, seek plants that help stabilize the bank and provide long-term support for aquatic habitat. For Zone 2, decorative woody florals, fruit-bearing shrubs and fast-growing trees are an excellent choice for additional income and to diversify wildlife habitat options. Zone 3 is well suited for native grasses and forbs.

Riparian Forest Buffers and Market Opportunities

Infiltration of nutrients, trapping sediment in surface runoff and debris from floodwaters, and stabilizing stream banks are the important water quality process functions of riparian forest buffers, but they can also provide a landowner with value-added market opportunities and enhanced wildlife habitat.

Edible berries and decorative woody florals, such as red osier dogwood and curly willow, may be planted in Zone 2 of the riparian buffer. These are valuable components of the floral and decorating industries. Nut- or fruit-bearing trees or fast-growing biomass trees planted in Zone 2 also contribute to income opportunities from buffers. Wildlife habitat for game and non-game species is significantly enhanced with the implementation of a diverse species riparian forest buffer, and lease hunting may be another economic opportunity gained through a riparian buffer system.

Planning and Design for Upland and Riparian Forest Buffers

Establishing a buffer for specific goals

When considering riparian or upland forest buffer design and implementation, it is important to understand landowner objectives and concerns; major functions of the buffer; present land-use of the proposed buffer site; soils and relief; stratigraphy and water table location; establishment methods to be used; short and long-term management methods; government programs; and market opportunities for potential products of the buffers.

The challenge to designing and maintaining a buffer system is to achieve your desired goals while also retaining the buffer's critical environmental benefits. For example, riparian buffers established for reducing stream bank erosion require designs which incorporate plant materials both on and adjacent to the eroding bank that have deep and fibrous roots that better stabilize soil. Buffers created for filtering sediment and associated chemicals and nutrients from agricultural runoff work best by slowing surface runoff, and improving soil quality that supports rapid infiltration, so water can move through plant root zones before it enters the adjacent water body. This can best be accomplished by establishing stiff stemmed grasses and forbs. Once in the soil, plant roots and soil organisms capture, transform and store non-point source pollutants that would otherwise end up in aquatic systems.

Considering your desired outcomes for a buffer is a necessary first step in creating a functional design. Landowners are strongly encouraged to work with a natural resource professional to make a sketch of the buffer on an aerial photo and identify major problem areas, such as severe bank erosion, grass waterways and gullies that exit into the existing perennial riparian plant community, drainage tiles, etc. Trees, shrubs, grasses and forbs should then be planted in their appropriate

zones to accommodate any unique problem areas. For example, trees, shrubs and deep-rooted native grasses and forbs should not be planted directly above field drainage tile lines. Shallower-rooted, native or non-native grasses are more appropriate for these sites. It is important to also be realistic about the time you have available for managing plants in buffer systems. In the case of many large scale row crop and/or livestock farms, the time required for buffer maintenance and harvesting of plants may not be available because these occur at the same time as intensive farming activities. In these cases, selecting lower-maintenance plants, or hiring a natural resource management professional to oversee the maintenance aspects of the buffer may be appropriate.

A list of the different plant species, their planting location and spacing are a critical part of the design sketch. The most effective riparian buffer, which can be as wide as 180 ft. (55 m) has three zones of vegetation, each planted parallel to the stream, as indicated in the section “Riparian Forest Buffer Zones and Benefits.” Upland buffers do not have specific zones as they are usually only 6-16 ft. (2-5 m) wide.

Many streams are deeply incised and are no longer in contact with their floodplain. Along these kinds of channels, upland as well as riparian tree and shrub species can be planted, depending on both functional and market objectives of the landowner.

A totally functional riparian buffer often requires additional riparian management practices. Examples of these kinds of practices include: 1) stream bank stabilizing bio-engineering techniques, 2) small wetlands or bio-filters to intercept field drainage tiles, 3) saturated buffers where tile lines are intercepted by lateral tiles that run parallel to the buffer causing their flow to move through the riparian soil profile to the stream, 4) stream channel stabilizing boulder weirs, and 5) controlled flash grazing practices.

Dick Schultz, professor, Department of Natural Resource Ecology and Management, Iowa State University, offers suggestions for preparing to establish a buffer:

“Before you select the kind of buffer to install along your stream, think of what you would like the stream and riparian zone to look like, and what you would like the site to accomplish. Once you have identified your objectives, walk the site with natural resource professionals and explain your objectives and desires. They may use the Natural Resources Conservation Service ‘Stream Visual Assessment Protocol’ or a similar tool to help you identify functional problems within the riparian zone. Once the site problems and objectives have been identified, select the buffer type that addresses your specific site’s needs.

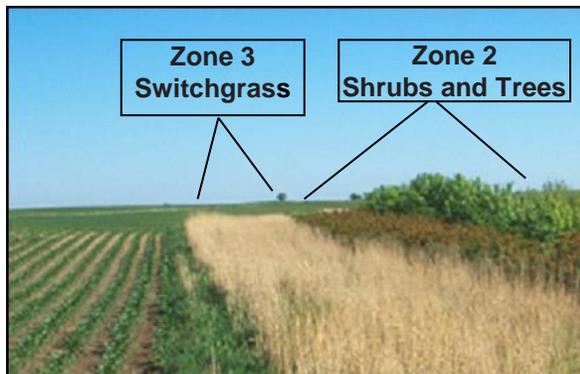
Keep in mind that riparian forest buffers and grass filter strips may not solve all of the identified problems along your stream corridor. They are primarily designed to reduce surface runoff of sediment and agricultural chemicals, bank erosion, subsurface movement of agricultural chemicals in the shallow groundwater, and degradation of aquatic or upland habitat. They are not designed to stop bank erosion along deep channels with vertical banks or stabilize the channel bed. They have no impact on groundwater moving directly through drainage tile networks, and they are not usually designed to accommodate livestock grazing. However, riparian buffers are but one tool among a number of riparian management practices.”

Key areas for consideration

Stream Channel – This involves an assessment of the shape and form of the stream channel, the material found in the stream bed and the shape and vegetative cover

of the stream banks. Channel lengths that have been straightened create problems both up- and downstream of the channelized section.

Straightening the channel increases the slope of the channel which increases the velocity and erosive potential of water moving through the channel. This can lead to increased down-cutting of the channel both up- and downstream of the channelized section. Once down-cutting has reached a resistant bed material and/or the strength of the bank soil reaches an unstable height, the banks will begin to collapse, widening the channel and encroaching on the riparian zone. Channels can be stabilized with practices such as boulder weirs and bioengineering techniques.



Adjacent to the Stream (Zones 1 and 2) – Plants growing on land in direct contact with the upper edge of the stream bank can both stabilize bank erosion and serve as a living filter. This area also functions to slow flood waters, filter flood debris, and provide both upland and aquatic wildlife habitat. Selection of the species to provide these functions will depend on their ability to withstand the frequency, magnitude and length of the flooding regime of the site and the depth to the water table during the growing season.

In Zone 1, deep rooted plant species can serve to provide bank stability along deeply incised channels. Longer lived woody roots can provide reinforcement of the bank soils and shade and organic matter inputs to the stream

channel. If the channel is incised, fast growing bottomland trees (such as silver maple, willow, cottonwood, green ash, and box elder) should occupy the first two rows adjacent to the channel to allow rapid stabilization of stream banks. These two rows of trees should be allowed to mature and die without removal to provide continuous shade and organic matter for the aquatic ecosystem, unless they are along streams with tile or other drainage roles. If drainage tile outlets are present, these rows of trees should be allowed to reach maturity but should be harvested to reduce the chance of contributing large woody debris to the channel thereby restricting drainage.

Where woody plant inputs to the channel are not desired, shrubs or deep-rooted grasses and forbs can be planted, although they do not provide the same strength to vertical banks because of their more rapid turnover. Where banks have a slope of 3 to 1 or less, these grasses and forbs can provide very effective stability.

The next two or three rows of trees or shrubs (Zone 2) can consist of bottomland or upland species along deeply incised channels where the water table during the growing season is an average of 4 or more feet (1.2 m) below the surface.

Where flooding is frequent and flood waters carry significant debris, several rows of multi-stemmed shrubs should be planted at the outer edge of the woody zone (Zone 2) to trap the debris and keep it from being deposited on the grass/forb outer zone or the adjacent crop field or pasture.

Select species adapted to the soil conditions on the site. Depending on landowner objectives, trees and shrubs that provide potential marketable timber or specialty crops can be used. Use a mix of tree and shrub species either by planting a different kind in each row or by block planting. A mixture prevents loss of benefits if one species fails and provides a more diverse wildlife habitat.

Understanding the Buffer Zone: Function and Management

Comprised of two or three zones, these zones become areas where specific plants and management are combined to create a forested riparian buffer that is highly effective at improving and maintaining water quality and aquatic habitat.

ZONE (Location, species choice)	FUNCTION	MANAGEMENT
Zone 1 (Beginning near the edge of the stream) (fast growing trees/shrub species)	<ul style="list-style-type: none"> • Shade the stream and moderate water temperature • Provide bank stabilization • Enhance aquatic habitat with organic matter • Final filter of material moving through the buffer • Reduce velocity of over-the-bank flood waters 	<ul style="list-style-type: none"> • Unmanaged zone, trees allowed to mature & fall into stream contributing important large woody debris • Large woody debris not allowed in streams with tile drainage or other specific drainage functions. • Use selective harvest, with replacement from planting or coppice resprouting • Logging equipment excluded • Grazing is excluded
Zone 2 (Beginning at the edge of Zone 1) (fast and slower growing trees and shrub species)	<ul style="list-style-type: none"> • Provide maximum infiltration • Uptake of Non-Point Source (NPS) nutrients and chemicals • Storage of NPS pollutants • Breakdown NPS pollutants • Provide forest-grown products • Enhanced wildlife habitat • Reduce velocity of over-the-bank flood waters • Trap debris moving in flood waters to keep it out of crop fields 	<ul style="list-style-type: none"> • Active management encouraged • Marketable products encouraged from trees and shrubs were feasible • Harvest should stimulate new growth • Avoid soil compacting activities • Grazing excluded • Wildlife activities such as bird watching or lease hunting
Zone 3 (Beginning at the edge of Zone 2) (grass and forb species)	<ul style="list-style-type: none"> • Slow surface runoff converting concentrated flow to sheet flow • Slowed runoff drops most sediment/debris at outside edge of zone • Remaining sediment is filtered from sheet flow • High infiltration of water delivering NPS nutrients & chemicals to soil filter • Uptake of nutrients and chemicals 	<ul style="list-style-type: none"> • Maintain vigorous vegetative growth • Remove biomass – mow and bail so as not to smother remaining plants. • Remove biomass – flash grazing possible with fencing of woody zones • Remove biomass – burn on 3-5 year cycle • Work accumulated sediments away from the buffer edge, back into the field

On non-recreational or non-incised streams, Zones 1 and 2 are often combined, and management becomes more closely aligned to that of Zone 2 alone. In each of the zones, it is important to recognize the role that buffer health plays in maintaining function. Healthy and actively growing vegetation provides the best capture and utilization of problem NPS nutrients and chemicals prior to their entering waterways.

In areas with frequent flooding, trees and shrubs should also be less densely planted so a ground cover of grasses and forbs can be established. Where the trees and/or shrubs completely shade the soil, surface erosion from

flood waters can be extensive and counter productive to the function of the buffer system. It is therefore important to maintain a woody plant spacing that allows enough sunlight to reach the soil to support a grass/forb cover.

This spacing depends on species and is usually wider than that recommended for planting timber trees but narrower than widths suggested for major nut growing plantations.

Outer Edge (Zone 3) – This zone provides the initial treatment of direct runoff from adjacent land uses. This runoff is usually in the form of concentrated flow associated with ephemeral gullies. Sheet flow or broad shallow flows are rare in cultivated field settings. As a result the intercepting plant community must present a dense and stiff barrier that can slow the concentrated flow, causing it to spread and drop its sediment load before entering the grass/forb zone and then move into the zone where high infiltration rates will allow the water to enter the soil filter.

Mixtures of grasses and forbs can be used effectively if the zone is wide enough. Width will depend on the length and slope of the adjacent crop field. If the grass zone has been established on previously cultivated riparian soil it will take at least 5-10 years to redevelop the maximum infiltration potential of the undisturbed soil. Where Zone 3 intercepts a grass waterway, a wider, triangular-shaped area should be developed to provide an apron for the water to spread over before entering Zone 3. Native warm- and cool-season grasses with associated forbs are best suited for this zone, as they remain upright under the flow of water and have deeper root systems than introduced cool-season grasses. These deep root systems, much of which are replaced annually, provide large amounts of organic matter to the soil. Organic matter improves soil quality by increasing amounts of large soil aggregates that create large macropores, which in turn favor high water infiltration rates and increased microbial activity for non-point source pollution processing.

Introduced cool-season grasses can be used but often require a zone that is twice as wide as that made up of native grasses, and may have less of an impact on improving soil quality.

The introduced grasses are easier to establish and can provide more fodder for livestock, but native grasses and forbs provide a more diverse habitat for upland game birds, such as pheasant and quail, and non-game species. As with the other zones, make sure to select those species that are adapted to the soil moisture and flooding regime of the site. It is important that the grass zone be well managed to maintain vigorous growth of the grasses and forbs (see section on Management and Maintenance of Forest Buffers). For native grass/forb filters burning or baling of the biomass on a 3-5 year rotation is required. For introduced grass strips mowing and baling or flash grazing can be used. If grazing is used, the woody zones (Zones 1 and 2) should be fenced.

It is imperative that the woody plant zone also have a grass/forb filter zone on the outside edge of the buffer. Most surface runoff from adjacent crop fields is in the form of concentrated flow. When that flow is intercepted by a woody zone that has minimal ground cover, gullies can easily form through the buffer. This is also true for grass waterways that are intercepted by woody zones without a grass/forb filter. Gullies that form in the riparian forest convey sediment to the stream and gullies can develop and move up into the crop field or the grass waterway. This is commonly the case for “remnant” forest buffers that landowners often believe act as effective buffers. If no grass filter is possible, then wider spacing of the trees and shrubs to allow a dense grass covered soil is necessary.

Additional Considerations

Width: Widths of Zones 1, 2, and 3 can vary depending on the physical characteristics of the site and the functional requirements needed to improve water quality and aquatic habitat. USDA Conservation Reserve Program (CRP) requirements will also dictate allowable widths of each of the zone. If CRP is not used to establish a forest buffer, then zone widths can be adjusted to meet management and functional objectives.

When determining the width of your buffer, it is a good rule of thumb that “wider is better.” If surface runoff is the only problem, a grass/forb filter 30-60 feet wide may be sufficient depending on the slope and width of the adjacent crop field. Concentrated flow in the form of ephemeral gullies or grass waterways may require a wider apron at the intersection of the two features. If bank stability is an issue, especially if the channel is deeply incised with vertical banks, a woody tree and/or shrub zone should be included. Buffer width may vary to address runoff hotspots as mentioned above or to adjust to field widths, especially along meandering channels. Widths of the various zones can be adjusted depending on the “needs” of the site. For example, if the crop field is relatively flat and the channel is deeply incised with vertical banks, the grass filter width could be reduced; if the crop field had significant slope and numerous areas of concentrated flow, the grass filter would remain at its designed width and the woody zones would be adjusted.

should be conducted to determine the fate of any concentrated flow entering the zone including that moving down a grass waterway.

If gullies exist from the edge of the field through the native plant community, a grass/forb filter zone should be added or widened. While buffers along the channel of an individual property can significantly reduce the sediment and nutrient load from the adjacent crop field, buffering only a small percentage of the entire length of a channel may not result in measurable improvements in water quality or aquatic habitat in the larger stream ecosystem.

Ideally streams should be buffered starting at their source and moving downstream. But any buffer along any portion of the channel is a positive contribution either directly in terms of improving water quality and aquatic habitat or by providing a role model that often stimulates other landowners along the stream to follow suit.

Impacts on wildlife habitat: Buffers can be designed to meet water quality functions, provide market options for the landowner and improve wildlife habitat. If upland birds like pheasants and/or quail are desired, a wide zone of native grass/forb filter with or without woody zones can be developed. If a diversity of non-game birds in addition to upland game birds is desired combinations of diverse woody and native grass/forb zones will provide the largest diversity. Continuous buffers along a channel will provide a connective corridor for wildlife movement.

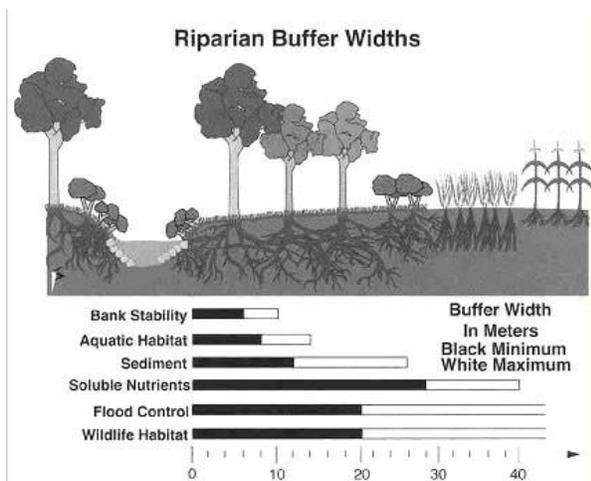


Figure 1. Riparian forest buffer widths by various sections. Source: Schultz et al. 2009.

Length: A zone of perennial vegetation should be included along the entire length of any stream channel. If a zone of woody or herbaceous species already exists, a survey

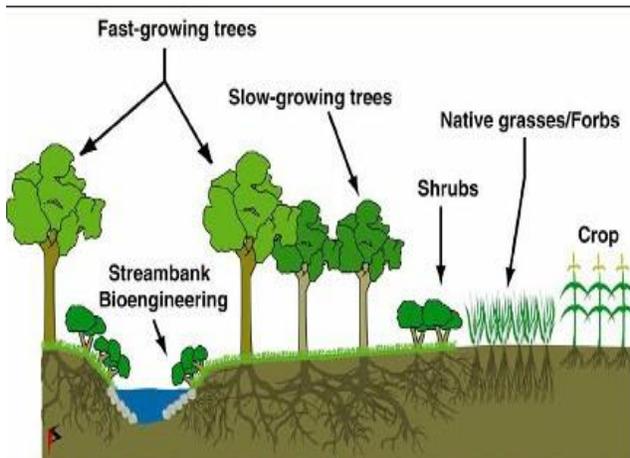


Figure 2. Selecting the appropriate species for a riparian buffer will help ensure its success and longevity. (Source: Schultz et al. 2009.)

Planting Tips and Species Selection

The selection of appropriate tree, shrub, grass and forb species is essential for the success of the buffer. When possible, select species of plants adapted to the site conditions. Often this is best accomplished by using native plants. Native plants - with proper management - will spread through underground rhizomes, bulbs or other vegetative means and are an excellent choice for the zones of a riparian forest buffer.

Compared with the roots of most non-native cool-season grasses, warm-season grasses and forbs have deep, extensive root systems that help improve soil quality and processing of non-point source pollutants. These native plants can withstand long periods of dry weather, and do not require watering unless the buffer is established in an urban setting and is less than one year old. The main considerations are: 1) selecting species that grow on potentially moist sites; 2) choosing species based on the severity of surface runoff from adjacent crop fields or grazed lands; and 3) making certain that seed of desired natives is both available and affordable. Most nursery information includes a description of sites suited for different species.

These seeds can be expensive. Most native seed nurseries have several mixtures that can be appropriate at varying levels of cost. Specific mixtures are also provided to meet specific CRP conservation practice standards.

Many forest nurseries carry one to two-year old seedlings of most tree and shrub species for planting in Zones 1 and 2 of the buffer. Use high quality stock with good root systems. Quality hardwood seedlings should have a minimum of four to five large lateral roots. Trees and shrubs should be planted in early spring, soak seedling root systems in water for up to 12 hours before planting and make sure the planting holes are completely closed so the roots do not dry out.

Consider as wide a variety of species as possible to develop diverse wildlife habitat and reduce potential diseases and insect infestations with associated loss of plants. If you plan to sell products from your buffer, identify markets prior to purchasing seeds or plants. Non-natives may also have good market value, but take care to avoid establishing invasive exotics.

To determine the most suitable species for your design, ask the following:

1. What are the functional needs of the site?
2. What are my objectives?
3. What are the problems?
4. Which species will do well on my site?
5. Which species are available from local nursery sources?
6. Will harvesting of products from these species occur at the same time as other land management activities (field cultivation, planting, harvesting, etc.)?

Species Combinations: *Here are species combination possibilities that could provide important riparian buffer functions.*

- Replace shrub rows with trees, or tree rows with shrubs, to increase timber product or floral and/or fruit product options or provide more diverse wildlife habitat. In either case, permanent woody roots are maintained with a mixture of species. Numerous different combinations of trees and shrubs and grasses and forbs can be used to more closely mimic the kind of riparian habitat that might have been native to an area. For example, where a shrub thicket of willow and shrubs might have been typical and the channel is not deeply incised, the trees can be completely removed from Zones 1 and 2 and a combined shrub zone created.
- Plant the entire buffer area to warm-season prairie grass. Some bank-stabilization may be needed (i.e., willow or red osier dogwood planted on the stream bank) to provide long-term stability. This system is best suited to riparian areas that are still in contact with the channel where banks are not high and are gently sloped.
- Where riparian grazing is desired and adjacent crop fields are more than several hundred feet from the stream, plant a native grass/forb mixture in a 15- to 20-ft (4.6-6 m) strip along the stream and completely fence that area. Fencing keeps livestock off the banks and can direct livestock to armored crossings and access to water for drinking. Ideally these would be minimal with watering sites provided away from the stream.
- Use direct seeding and broadcast or randomly plant a mixture of tree and shrub seeds or seedlings in both tree and shrub zones to naturalize the planting and avoid rows. (Source: Iowa State University Extension, "Stewards of our Streams" series,

Resource professionals at your local NRCS, state department of conservation or natural resources, or university extension office can assist you with species selection.

Planting an Upland or Riparian Forest Buffer

Woody species planting is best done with seedlings. Direct seeding can be done in some situations but the density of the ensuing stand of trees often is too dense to allow a complete herbaceous ground cover to develop. Preparing a site for tree planting depends on the existing cover of the site. If the buffer is to be planted into an existing crop field, seed the area to a mixture of perennial ryegrass and timothy. Seedlings can be planted directly into this minimally competitive grass mixture. After planting, spray a 4 foot wide strip centered over the trees with a grass killing herbicide.

Mow the grass strips between the tree rows for the first three to four years. Late season mowing will reduce winter habitat for rodents that can girdle seedlings. Distance between tree rows should be wide enough to support the mowing equipment that is available and to allow grass cover to remain throughout the life of the buffer. If the woody species are going to be planted into an existing grass or mixed grass- and forb-covered riparian zone, four foot wide strips should be sprayed with glyphosate prior to planting. Once seedlings are planted, keep this strip grass- and forb-free for the first 3-4 years and mow the strips between the rows of trees. Spacing of trees should range from feet (3-4.6 m) between rows and 8-10 feet (2.4-3 m) within the rows.

Site preparation for planting Zone 3 grasses and forbs in a filter strip can take numerous forms. If the site was previously in pasture, burning down the existing pasture vegetation with glyphosate in the fall and again in the spring, and then using a prairie seed drill can result in a good stand of plants. If the site was previously in row crops, light tilling of the surface to kill early weed species, followed by surface packing with a cultipacker and then using a seed drill will provide a good stand. Annual rye or oats can be mixed in with the native grasses and forbs if rapid cover is desired, especially in areas that are prone to flooding.

For woody plant establishment, site preparation

should begin in the fall, followed by spring planting.

Brad Riphagen is a Field Coordinator for *Trees Forever*, a non-profit organization founded in 1989 dedicated to planting and caring for trees and forests. He offers suggestions for planting trees, shrubs and grasses.

“When seeding grass and forbs, a firm seedbed is needed to ensure that the small seeds are in contact with the soil yet remain close to the surface. You can drill directly into soybean stubble and into sod that has been killed with glyphosate. When planting trees and shrubs into a crop field, it is a good idea to drill grasses, like timothy or perennial rye, which won’t out compete the trees and help to prevent erosion.

Order trees and shrubs early, up to four months before scheduled planting time to assure receiving the desired species. For direct seeding of most trees or shrubs, collect or purchase seed and plant in the fall. Direct seeding in the spring is possible if you can purchase seed from a dealer. Plant tree and shrub seedlings as early in the spring as site conditions allow. Grasses and forbs should also be planted in the spring.”

Management and Maintenance of Upland and Riparian Forest Buffers

Managing an Existing Streamside Forest for a Riparian Buffer System. Buffer function should be a primary consideration in management. Therefore, management of existing buffers should focus on either maintaining or enhancing buffer function. Although plant materials may be alive and growing, they may not be growing vigorously and be in the best of health. Plants with vigorous growth will have enhanced uptake and use of nutrients. This also equals greater storage of materials that would otherwise

travel into the water system. Management strategies need to look toward creating stronger plants, resulting in plants that are more likely to survive environmental stress, such as seasonal flood events. Natural life spans of plants should also be considered. Under proper management woody plants will grow vigorously until they have matured at which point their physiological processes will reach a plateau and begin to decline. When woody plants have reached this point they no longer add major stores of agricultural nutrients and chemicals and should be harvested and replaced with young seedlings or coppice stems from stumps or roots.

Densities of woody plants in existing stream side forests are often too great to support good perennial plant cover on the soil surface. Therefore one of the most important management tasks for maintaining buffer function is to thin the forest to allow light to reach the forest floor. If this is not done, gullies will form in the forest at points where concentrated flow, either from ephemeral gullies or from grass water- ways entering the existing forest. These gullies are sources of sediment in the stream and will ultimately work their way out of the forest buffer and into the adjacent crop field or pasture.

Management and Maintenance of Planted Forest Buffers. Function is maintained when the buffer zones are maximizing their potential for plant growth. For grasses and forbs, this may mean mowing or selectively applying flash or rotational grazing at appropriate times of the year (such as dry and not wet periods). This can assist in minimizing the accumulation of dead grass material and enhance overall grass and forb growth and vigor. However, it is crucial that access to adjacent woody zones or the stream or creek be limited. One method of limiting access is to only have fenced access available in small, planned areas (Figure 3). Additionally, grass zones adjacent to crop fields may occasionally need to have accumulated soils pulled back into the field. This can be accomplished by directionally disking such that soil is moved away from the grass edge.

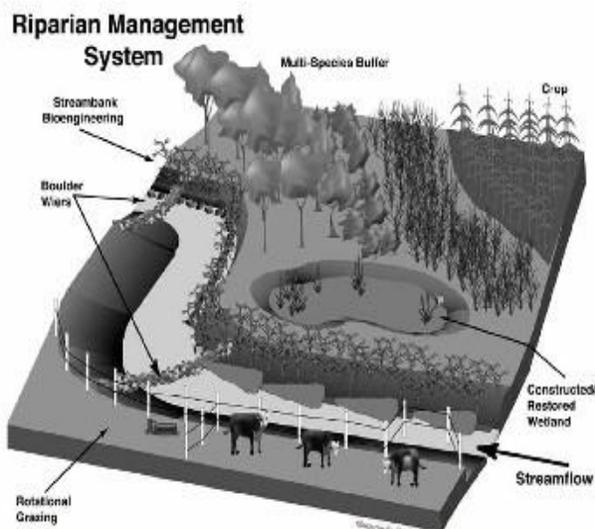


Figure 3. Riparian management system with livestock access restricted by fencing. Source: Schultz et al. 2009.

In the shrub zones, management may include such practices as cutting the shrubs back and control of invading grasses and weeds. In the timbered zone, thinning and selective harvest may be used to keep the remaining trees and herbaceous ground cover in a state of health and vigorous growth. Also, your management plan in the timbered zone should take into account the need for regeneration and the establishment of new seedlings. This can either be natural or artificial, such as when planting new seedlings. It is important to remember that as trees age, slower growth rates and death are natural. One management tool then, is to harvest mature trees prior to their death, degradation, or breakdown, when they may otherwise become debris in the waterway that inhibits proper flow or release stored nutrients back to the ecosystem.

Enhancement. From time to time, in spite of any maintenance that may be completed, it may also be necessary to enhance or enrich the buffer to maintain the desired functionality. This may be as simple as planting additions (over-seeding grass zones or planting trees or shrubs in openings created by harvest or loss

from flood damage). Remember, the goal is to have a healthy and vigorously growing buffer, and one without gaps that would allow water to channel through.

Maintenance begins at the time of buffer establishment and may include mulching, mowing, and herbicide application for weed control until trees and shrubs are large enough to compete on their own. A native grass and forb zone planting requires about 3 years to become well established. During the first 2-3 years it is important to mow the grass and forb zone as high as possible to reduce annual weeds, but without removing the young grasses and forbs.

You can increase the filtering capacity and potential economic returns by trimming, cutting back, mowing, or harvesting the shrub, grass and forb species. By keeping the plants in a state of vigorous growth, they will actively filter more soluble nutrients from the water.

Finally, inspect the buffer annually and after significant storm events to determine the need to remove excess sediment at the cropland edge of the buffer that can prevent shallow runoff from flowing evenly through the buffer, or to repair concentrated flow cuts through the buffer.

Replanting and reseeding. Replanting and reseeding are important maintenance practices during the first few years following establishment of a riparian buffer and can be done in the spring or fall. Replace significant losses of tree and shrub seedlings during the first three years to ensure the desired plant density of the mature buffer. If more than three or four consecutive seedlings have died they should be replaced. Spot planting can be done quickly with just a bucket full of water, seedlings and a shovel. Protecting young trees and shrubs from deer, rabbits and beaver can be expensive, but may be necessary in some cases.



Applying a chemical barrier helps seedlings get off to a good start.

Replanting in the native grass/forb zone may be a bit more involved, depending on the density and quality of the grasses and forbs. If there is poor establishment, a herbicide like glyphosate can be used, followed by re-drilling. If there is some establishment, but not as dense as desired, the site can be directly reseeded. If the areas needing reseeding are large a prairie seed drill can be used, if they are small, hand-spreading the seed and raking it into the ground is acceptable.

During the life of a forest buffer, trees will begin to compete with each other as they do in a natural forest, and without pruning and thinning they will not maintain an optimal growth rate. They will also provide such a dense shade that no living ground cover that completely covers the soil to reduce erosion from out-of-bank events will be able to exist. Depending on spacing, fast-growing trees such as cottonwoods and poplars will be competing with each other within 10 years of planting. After 8 to 9 years, every second or third tree may have to be harvested to increase water availability and growth space for remaining trees.

Prescribed burning. Fire is a good maintenance tool for native grass and forb plantings associated with upland and riparian forest buffers. To reduce weed competition and invigorate the grasses and forbs during the year, prescribed burns are usually performed early in the spring. During this time, many of the competing introduced cool-season grasses, weeds and woody plants begin growing while

the warm-season native prairie plants are still dormant. Always develop a prescribed burn plan prior to burning. Assistance for developing a prescribed burn plan may be available through your state department of natural resources or conservation.

While different burning frequencies may be used, an annual spring burn for the first three or four years is recommended. Following establishment of a good stand of desired grasses and forbs, a burning cycle of once every three to four years can be used. The burning cycle is usually defined by the accumulation of dead plant material on the ground, weed species invasion and general vigor of the plant community. Fall burns also can be used to stimulate forb growth more than the grass growth. However, they may be problematic if adjacent crops are not harvested, and will reduce winter habitat for wildlife.

Burning the native grass and forb component of an upland or riparian buffer can be tricky due to the close proximity of shrubs and trees. Such a burn requires numerous people, careful planning, attention to fuel sources and amounts, and attention to wind. Using a small, slow backfire (a fire that burns into the wind) helps to keep the fire more controlled while it is close to neighboring shrubs and trees. A fire break is often mowed or raked between the shrubs and/or trees and the native prairie component. The fire break can be wetted if the fuel is dry.

A good strategy is to burn when steady wind (10-15 mph) (16-24 kph) is blowing away from the woody zones. This way, a backfire can be started with a drip torch along a firebreak and allowed to burn into the prairie grass filter. The fire moves slowly because it is burning into a prevailing wind. Once the backfire has burned a strip of 10 - 15 feet ((3-4.6 m) in width, a head fire (burning with the wind) can be lit and allowed to burn rapidly with the wind. If there is heavy corn stover left along the crop edge, care must be taken to keep the fire out of the field. This can be done by raking or wetting

the stover or running a disk along the edge of the grass/forb zone just before the fire is lit. The crew, equipped with fire rakes, fire swatters, and backpack sprayers, should patrol the burn to keep it contained. Fires should be kept small and well controlled (start small to test the wind, moisture conditions, and to train your crew). A water tank in a pickup truck fitted with a small pump and garden hose can be very useful for wetting the fire break and corn stover. If you have not performed a controlled burn before, you should ask for assistance from a local natural resource professional who has experience dealing with controlled burns. Consideration should be given to the influence of burning on nesting birds and small mammals.

Ideally, you should burn in sections; burn only one side of the creek or break the grass/forb zone into three or four sections and burn one each year. Fall burns eliminate winter cover and late spring burns can destroy nests. However, fire helps to maintain native plant health. Most native prairie plants will grow more vigorously, produce more flowers and produce more seed after a fire. The active growing points of most prairie plants are below or just at the soil surface, and are therefore unaffected as the fire rapidly passes over. After the fire, these plants are stimulated by warmth of the blackened ground and the nutrients that were released from burned plant material. (End: Iowa State University Extension contribution)

Other Riparian Practices that May be Required

Specific Considerations for Stability: Stream Bank Structures

In some cases, erosion caused by runoff and/or sloughing of stream banks is too excessive to be stabilized by a Forested Riparian Buffer alone. Therefore, to quickly stop erosion, it may be necessary to use stream bank bioengineering. This is an expensive and intensive practice and is only appropriate for specific trouble spots.

Stream bank bioengineering can:

- Be used to change the steep angle on actively eroding banks to a more gradual slope on which plants may then become established,
- Slow water movement and reduce erosion by adding frictional material to stream banks,
- Reduce undercutting,
- Reduce stream sediment loads,
- Improve water quality,
- Improve aquatic habitat and wildlife habitat.

The following bioengineering practices and structures can be used singly, or in combination, to create a more stable stream channel and bank.

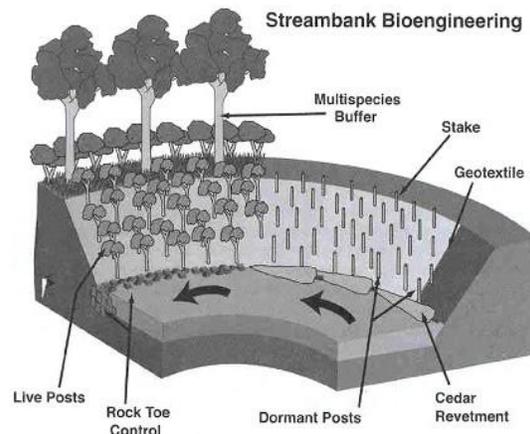


Figure 4. A combination of live and dead materials used in the stream bank bioengineering practice. Source: Schultz et al. 2009.

Rock rip-rap. Rocks anchored to the toe of the stream bank. This type of stabilization is useful in areas of severe undercutting. Size of the rock is directly related to stream size, and the volume and velocity of water flow. Larger streams with increased water volume and velocity will require larger rock. A mixture of rock sizes is often appropriate to provide a surface with minimal openings that allow water to move through turbulently. In no case should

large chunks of concrete be used for this purpose as they often allow large gaps that water is forced through at higher velocities and turbulence that can erode the soil behind the concrete slabs. In order to avoid undercutting of the anchored rock, the rip-rap should extend to stable material in the channel bottom. In some cases, it may be necessary to reshape the streambank prior to rock placement.

Tree revetments. In smaller streams, (1st-3rd order) cut trees can be anchored along the toe of the bank in place of rock rip-rap, with the butt of the tree facing upstream. Eastern red cedar is ideal for this purpose, as it can hold its leaves for more than a year following cutting; however, bundles of branches from other tree species can also be used. The dense branches provide significant friction that slows water and drops sediment, creating a stable bank toe on which other plants can become established. Logs and branches can also be hiding places for aquatic organisms. Planting willow cuttings and/or red osier dogwood seedlings above the cut trees or branch bundles can increase the stabilizing potential of this practice.

Geotextile fabrics. Fabrics of jute, coconut, or other fibers may be used in conjunction with any of the living structures. These fiber mats will hold soil in place while the live plant material becomes established. The fabric can be held in place with stakes and/or placed in the trench with fascines and covered with a shallow layer of soil.

Live post and stakes. By using dormant plant material, stream banks can be quickly stabilized. Dormant material (cuttings) of a few selected tree and shrub species (particularly willows) will quickly develop root structures below ground and produce live shoots above. Stakes of one-half inch diameter and larger are driven into an eroding bank. The longer the stake, the better stability that is provided because the more roots will sprout along the stem. Lengths may range from 2 to 3 feet for stakes, and up to 10

feet for posts. Installation should begin with the larger stakes being placed at the base, along the water line, and the smaller stakes planted into the upper stream bank.

Live fascines. Also known as wattles, these are bundles of live, dormant branches (whips) primarily of willow species. The material used is often the smaller diameter tops associated with the stakes that were installed as described above. Individual whips should be at least 4 feet (1.2 m) in length. These branches are then overlapped, with all butts and buds pointed in the same direction, to form bundles of up to 8 inches (20 cm) diameter and 10 to 20 feet (3 – 6 m) in length. As with live stakes, it is desirable to use species which will quickly root. Place the fascines in shallow trenches, leaving the upper live buds exposed. Soil should be tamped into place around the bundles and a dead stake used to anchor them in place. By placing fascines along the contour, small branch dams are formed against soil movement. This will create a terraced effect on stream banks. Bundles should be spaced from 3 to 6 feet (0.9 - 1.8 m) apart with narrower spacings used on steeper banks.

In-stream structures. Where channel incision is still actively occurring and stream banks are unstable, or where there is a lack of in-stream habitat, rock structures, such as boulder weirs can be constructed. These structures are constructed of properly sized rock and are no more than 1.5 to 2 ft. (0.5 – 0.6 m) high at their center. They are usually constructed with a slight V in the center to direct flow down the center of the channel. They have an upstream rock apron with a 4:1 slope and a down-stream apron with a 20:1 slope. These aprons reduce the turbulence of the water, while allowing enough to improve oxygenation of the water. These structures are usually used in series, allowing the pool of the downstream weir to back up to the apron of the upstream weir. This placement reduces channel bed erosion. Providing pools that are 1.5 to 2 ft. (0.5 – 0.6 m) deep reduces the critical bank height at low flow, thus reducing bank erosion. (See Figure 3, page 8).

Field Tile Structures. Artificial subsurface drainage (field tiles) passes directly through riparian forest buffers with no treatment of the water flowing in them. For any treatment of contaminants in the tile water to occur, the water in the tile must exit the tile and move through the living soil filter of the buffer. Two promising new techniques can achieve significant treatment of tile flow: biofilters and saturated riparian buffers.

Biofilters consist of passing the tile flow through a large volume of woodchips that have been buried in pits in the soil. The woodchips provide a habitat for microorganisms that can reduce nitrate and other contaminants. These pits can be developed as part of the grass/forb filter or can be placed directly upslope of Zone 3. Pits are usually about 4 feet (1.2 m) deep with an average size of 15 ft. by 100 ft. (4.6 – 30 m). A soil layer is placed over the buried chips and planted to grass. Equipment can travel over the pits although planting row crops directly over them is not recommended. The woodchips will need to be replaced periodically, perhaps every 10-20 years.

Saturated buffers consist of intercepting a field tile before it flows below the riparian buffer and splitting the flow into lateral tiles that run parallel to the buffer. The water in these lateral tiles then flows through the living soil filter of the riparian buffer. In an early test of this system at least 60% of the flow from the primary tile was diverted into the laterals and water moving through the buffer soil showed over 90% reduction of nitrate-nitrogen.

Considerations for Wildlife

One of the most notable benefits of using native plant species in a buffer is the creation of effective wildlife habitat. Native grasses and forbs provide different heights, densities, shapes of stems and leaves, different flowering times, and different flowers and fruits to attract different species of wildlife. The key is to plant as wide a mix of species as possible to achieve the maximum wildlife benefit.

Planting pure native warm-season grass strips with one or two species is more effective than just one species of introduced low-growing cool-season grass, but planting 5 or 6 species of native grass and 25 forbs provides much more habitat potential. Similarly, planting mixtures of trees and shrubs will provide more diverse structural habitat, but if a landowner is mainly concerned with upland bird habitat, trees provide perches for predator raptors that may prey on the prairie birds. In a recent study of bird use of riparian forest buffers over 40 species of birds were found in a three-zone riparian buffer where only 12 species were found in an area similar to the pre-buffer condition of the site.



Lease hunting is an opportunity for income from the wildlife habitat created by your riparian buffer. (MDC photo) Improved wildlife habitat for species such as ducks, pheasant and quail, are another benefit of riparian buffers.

Jim Wooley is the Field Operations Coordinator for Quail Forever, a non-profit organization dedicated to the protection and enhancement of pheasant and other upland wildlife populations through habitat improvement.

“Quail Forever and Pheasants Forever are interested in riparian buffers and other buffer systems because of the habitat that these types of practices provide for pheasants and other wildlife, including non-game wildlife. Beyond that, establishing a buffer offers an exceptionally good economic benefit for a landowner. He’s taking ground that in a lot of cases is productive, but may have some problems associated with it. In some cases, we’re looking at cash rentals and incentives that approach two hundred dollars per acre. That’s an excellent return on the ground, and the buffer is providing many benefits, not only to the landowners, but to society in general.”



Improved wildlife habitat, such as ducks and quail, are another benefit of riparian buffers.

Market Opportunities with Upland and Riparian Forest Buffers

Many products grown in the buffer have monetary value in addition to their functional conservation benefits. A trip to a local florist or craft store will give you an idea of the diverse

uses of plants and plant stems that could be harvested from an upland or riparian buffer with the proper species. It may also be helpful to ask if local stores are interested in purchasing locally and sustainably grown materials. At that time, inquire how they would like to receive the material (condition and packaging).



Willow and dogwood branches are bundled for sale to retail and wholesale florists, bringing as much as 50-75 cents per branch in some markets.



Markets for nut crops like black walnut (background) and pecan (inset) include farmers’ markets and retail/specialty grocers.

Decorative woody florals and craft products.

Decorative woody florals can be planted in Zone 2 of a riparian forest buffer for additional income. This category includes any woody plant species that has a colorful or unusually shaped stem, bud, flower, fruit or leaf. Common examples include pussy and curly willows and red- and yellow-stemmed dogwoods. These plants, and many others, are regularly used in the floral industry to add height and breadth, enhance line and form, and add a splash of

color. They retain their bright colors for a long time, extending an arrangement's usable life. Woody florals accent cut-floral arrangements and enhance consumer perceptions of size and value, and can make a statement even when used alone in a vase design. They can be sold to retail or wholesale florists by the stem or the bundle at competitive prices.

Learn more about decorative woody florals through research conducted by the University of Nebraska Extension Forestry Program.

Market Opportunities	
Examples of 'marketable' products	Timeframe to reach market potential
Floral and craft products	Beginning approximately 2 years after establishment, and if done correctly (i.e. plants re-sprout), continuing for many years
Berries and nuts	From 2 to 15 years, depending on the crop
Biomass	3 to 20 year rotation, market dependent
Timber trees	In most cases, 40+ years

Berries and nursery stock. Various species of edible berries, including elderberries, blackberries and raspberries, can be grown in the shrub zone of a riparian buffer for additional income. Markets for fresh berries can be found by contacting local farmers' markets, grocers and specialty health food stores.

Harvesting nut crops. Planting nut-bearing species including pecan, hazelnut, and black walnut in Zone 2 can provide income from nut

harvests. Nut crops are readily sold at farmers' markets, roadside stands or to retail and wholesale grocers. The University of Missouri Center for Agroforestry is conducting extensive research to identify outstanding cultivars of chestnut, pecan and black walnut. Informational guides and research updates are available at www.centerforagroforestry.org/profit.

Timber trees. Planting trees in Zone 2 of your riparian buffer for a future timber harvest requires a management plan and patience, but can be very profitable over the long-term. In Missouri, when the market is right, Silver Maple brings almost as much as oak species (price per board feet).

Integrating riparian buffers into your current land use practices can maintain the integrity of stream channels, reduce the impact of upland sources of pollution, generate income and optimize performance for environmental protection and economic production. With thoughtful consideration to site characteristics, landowner goals, species selection and environmental and wildlife benefits, riparian buffers provide an additional source of sustainable production with multiple conservation benefits.

Financial Resources

There are many agencies offering programs that can be used to establish and maintain agroforestry practices on private land. One of the most significant of these agencies is the USDA Farm Service Agency (FSA), through the various elements of the Conservation Reserve Program. Each of the programs are designed to take environmentally sensitive and highly erodible land out of production by offering a soil rental payment, a cost-share for the establishment of various conservation practices and other financial incentives to landowners who offer to set aside their land.

Riparian buffers have become a priority for most USDA agencies. Under the requirements of the FSA riparian forest buffer practice (CP22) or the NRCS 391 practice landowners must establish at least a two-zone buffer. The total width of the riparian forest buffer will vary depending on the size of the stream and landowner objectives. For first and second order streams, the buffer must be at least 50 feet (15 m) wide and cannot exceed 180 feet (55 m). Buffers along third order streams must be at least 100 feet (30.5 m) wide. Riparian forest buffers along the Missouri and Mississippi Rivers may be increased to 300 feet (91 m). Buffers may be extended beyond 180 feet or 300 feet (55-91 m) for the purpose of improving water quality benefits.

For more information, contact your local USDA FSA or NRCS office.

Additional USDA programs to establish and maintain riparian forest buffers are offered through the Forest Service (FS) and the Sustainable Agriculture Research and Education (SARE) program. The United States Fish and Wildlife Service (USFWS) also offers assistance; see chart below for a listing of incentives offered by these federal agencies or consult the UMCA publication "Funding Incentives for Agroforestry in Missouri."

Riparian Forest Buffer (CP22)	
♦	10- to 15-year contracts
♦	Conservation Reserve Program continuous sign-up
♦	Eligible for the following CRP financial incentives
-	120 percent Soil Rental Rate (SRR)
-	50 percent regular cost share
-	Student Intern Program (SIP)
-	Performance Improvement Plant (PIP)
-	\$7-\$10 maintenance
♦	Width requirements - (1st and 2nd order streams)
<i>Grass zone:</i>	<i>25 feet maximum</i>
<i>Minimum buffer width:</i>	<i>50 feet</i>
<i>Maximum buffer width:</i>	<i>180 feet</i>
♦	Width requirements (3rd order streams)
<i>Grass zone:</i>	<i>25 feet maximum</i>
<i>Minimum buffer width:</i>	<i>100 feet Maximum</i>

Summary

When incorporated on the farm landscape, forested upland and riparian buffers can effectively improve water quality and limit soil loss. A buffer can be established and become productive in a relatively short time period.

One of the keys to the successful buffer is the choice of materials and plant species that are suitable for the selected site. The next step is to understand the dynamics of the watershed and stream with respect to adjacent land-use issues so that the buffer design will adequately address the problem. Finally, be clear on the management needed in order to maintain the effective functioning of the buffer over time.

Success Stories

Lon Strum

Story County, Iowa



Lon Strum rotates corn and soybeans on his 1,000-acre operation in Story County, Iowa. Before installing a riparian buffer, his tractor would occasionally get stuck on the banks of Bear Creek. While he no longer produces corn or soybeans from the buffered land, he no longer loses his crops during wet years, doesn't have to worry about getting his tractor stuck, and enjoys the benefits of a healthy stream with a significant amount of habitat.

"When I was on the edges, I was constantly getting stuck as I was working close to the creek. It was just more hassle than what I wanted. Since putting in the riparian buffer, I don't notice any difference in the yields, but now I just go in straight rows."

"The buffer has also added to our wildlife habitat. This is the hunting paradise of Story County right here, especially for pheasant hunting. People have come from Alaska, Michigan, and all over Iowa. The demand is very large."

Ron Risdal

Story County, Iowa

Ron Risdal has experienced similar success with the riparian buffer he installed back in 1990. Risdal rotates corn, soybeans, and alfalfa on his farm.

"There's always something new. We can go fishing, or we can go out here and kick up a deer or pheasant or partridge."



"I don't think we've lost hardly any stream bank since 1993, but before we were moving fences almost every year. Yesterday morning when it was flooding, it stopped at the buffer strip instead of washing all over the bank. We don't have to haul rocks in the gullies like we used to do years ago."

Additional Resources

In Print

Schultz, R.C., T.M. Isenhardt, J.P. Colletti, W.W. Simpkins, R.P. Udawatta, and P.L. Schultz. 2009. Riparian and Upland Buffer Practices. Chapter 8 In: H.E. Garrett, (Ed.) North American Agroforestry: An Integrated Science and Practice, 2nd Ed. American Society of Agronomy, Madison, WI.

University Resources

Establishing and Managing Riparian Forest Buffers. UMCA. Agroforestry in Action Guide AF1009. <http://extension.missouri.edu/explorepdf/agguides/agroforestry/af1009.pdf>

Managing Iowa Habitat Series. Iowa State University Wildlife Extension and Outreach <https://www.nrem.iastate.edu/wildlife/extension-publications>

Stewards of our Streams: Maintenance of Riparian Buffers. Iowa State Extension and Partners. <https://store.extension.iastate.edu/product/Riparian-Buffer-Systems-Stewards-of-Our-Streams>

Research involving upland native grass buffers at Iowa State University.

Science-based Trials of Row crops Integrated with Prairies (STRIPS).

<https://www.nrem.iastate.edu/research/STRIPS/>

The University of Nebraska Forestry Extension (Resources about decorative woody florals and other specialty forest products) <http://ncdc.unl.edu/woodyfloral.shtml>

State-Based Resources

Missouri Department of Natural Resources (Perform a search for “buffers” to see current bulletins and information.) www.dnr.mo.gov/

Missouri Department of Conservation (Find the Resource Forester for your county through this online listing.) mdc.mo.gov/regions

Grow Native! (A native plant marketing and education program of the Missouri Prairie Foundation, established to increase the demand, use of native plants in the Lower Midwest) www.grownative.org

Federal Resources

USDA Agricultural Research Service (ARS) (Search for “buffers” to find research projects and publications) www.ars.usda.gov

Natural Resources Conservation Service (Use subject search to view nationwide guides and publications on riparian buffers.) www.nrcs.usda.gov/

The USDA National Agroforestry Center --

<https://www.fs.usda.gov/nac/practices/riparianforestbuffers.shtml>

ATTRA (NCAT) Riparian Buffer management guide attra.ncat.org/attra-pub/download.php?id=115

AFTA Riparian Buffers: <https://www.aftaweb.org/about/what-is-agroforestry/riparian-buffers.html>

Non-Profit Organizations

Trees Forever (An organization dedicated to natural resources stewardship and addressing the challenges facing communities and the environment, including water quality.)

www.treesforever.org/

STROUD Water Research Center. Watershed Restoration: <https://stroudcenter.org/restoration/>

Five Practices of Agroforestry DVD: Produced by the University of Missouri Center for Agroforestry

Includes the basics of establishing a riparian buffer practice.

<https://www.youtube.com/watch?v=8HDnyV1ViHw>

EXERCISE: REVIEW OF RIPARIAN FOREST BUFFERS

- 1. Why are warm season grasses viewed as an essential component of a well-designed riparian forest buffer?*
- 2. Due to the effectiveness of warm season grasses at slowing the movement of water headed towards streams and waterways, sediments accumulate at the up slope side of the buffer. Is this a problem in the long run and can it be managed?*
- 3. If I manage my grass/shrub/tree buffer for the first 3 to 5 years and it has become well established, can it be left alone to take care of itself from that point?*
- 4. As their name implies, warm season grasses do not begin active growth until late spring. However, fertilizers and other soil amendments are applied early in the spring. Also, while crops are being planted and getting established, the soil is relatively unprotected from rainfall and prone to serious erosion. Given this situation, how effective are warm season grasses as buffers?*
- 5. How wide should my buffer be?*
- 6. What cost share programs are available to help offset the costs of RFB establishment?*

EXERCISE KEY

1. Why are warm season grasses viewed as an essential component of a well-designed riparian forest buffer? Warm season grasses are typically stiff-stemmed clump grasses. Once established, warm season grasses roots penetrate deeply into the root zone. These two attributes contribute two essential functions to the buffer. First, the stiff stems hold up against water movement and forces water to slow down as it moves through the grasses. Second, coupled with the well-developed deep root profile and well aerated soil, flowing water will have adequate residence time to percolate into the soil. Sediments and phosphate fall out of solution, soluble nutrients enter the root zone, while atrazine can be detoxified by plant roots and microorganisms.

2. Due to the effectiveness of warm season grasses at slowing the movement of water headed towards streams and waterways, sediments accumulate at the up slope side of the buffer. Is this a problem in the long run and can it be managed? Yes, this can become a problem if the warm season grass buffer is not managed. Riparian forest buffers are living filters, and like all filters, they need to be “cleaned” periodically to function properly. In the case of a RFB, cleaning refers to periodic maintenance.

3. If I manage my grass/shrub/tree buffer for the first 3 to 5 years and it has become well established, can it be left alone to take care of itself from that point? RFBs must be managed continuously to maximize their buffer function. To maintain active growth and out-compete fescue and other invasive woody species, warm season grasses and forbs must be burned periodically. Trees must be thinned periodically to maintain active growth rates and not stagnate. Similarly, many shrubs selected for RFBs must be coppiced (cut back close to the ground) to maintain vigorous root and shoot growth.

4. As their name implies, warm season grasses do not begin active growth until late spring. However, fertilizers and other soil amendments are applied early in the spring. Also, while crops are being planted and getting established, the soil is relatively unprotected from rain-fall and prone to serious erosion. Given this situation, how effective are warm season grasses as buffers? For a buffer to be truly effective, warm season grasses are an essential component. The above stated problem is their biggest weakness. Therefore, warm season grasses need to be used in combination with both cool season grasses and woody perennials for a RFB to be effective on a year-round basis. Cool season grasses begin growth early in the spring, and even though they are relatively shallow rooted and lack stiff stems (so that water will knock them down and flow right over the top) they are active and a first line of defense against water, soil and nutrient movement early in the growing season. Combined with shrubs and trees, some of which also become active early in the growing season (e.g., willow species), RFBs are fully functional.

EXERCISE KEY, con't

5. How wide should my buffer be? The general rule of thumb is that wider is better. However, that is a very broad generalization. Buffer width depends on many factors including the purpose(s) for the buffer, the associated cropping pattern and related conservation practices being employed upslope, the specific soil and slope conditions, and whether or not government cost share programs are involved which require certain minimum widths. Buffers may be designed for bank stability, aquatic habitat protection and improvement, sediment control, removal of soluble nutrients from adjacent crop fields, flood control or wildlife habitat. To stabilize streambanks and protect aquatic habitat, effective buffers can vary from 30 to 90 feet wide. For sediment and flood control or to improve wildlife habitat, buffers must be wider, ranging from 60 feet to well beyond 150 ft.

6. What cost share programs are available to help offset the costs of RFB establishment?

USDA FSA offers a variety of cost share programs including the Conservation Reserve Program (CRP), and the Conservation Reserve Enhancement Program (CREP). Each of these programs contains approved practices that support RFB establishment. Further details on cost share programs are found in the UMCA Publication “Funding Incentives for Agroforestry in Missouri” (changes to these programs may occur frequently so check with your local FSA or NRCS office).

Notes

Chapter 6: Windbreaks

In this chapter:

- Defining a Windbreak
- How Windbreaks Function
- Windbreak Benefits to Soil, Crops and Livestock
- Windbreak Design
- Productive Windbreaks
- Site Preparation, Planting and Maintenance

Appendix:

- Non-Agroforestry Uses of Windbreaks:
 - o Windbreaks for Homes
 - o Windbreaks for Livestock Odor Reduction
 - o Living Snow Fences
 - o Windbreaks for Wildlife
- Success Stories
- Economic Incentives
- Additional Resources



This guide is intended to help you design and manage the interactive agroforestry practice of windbreaks. Properly applied on a landscape, a windbreak can enhance and diversify farm income opportunities, improve the environment and create wildlife habitat. By developing an understanding of the interactions between the

Agricultural practices benefitting from properly applied windbreaks include:

- Crop production
- Soil conservation
- Livestock and dairy cattle husbandry
- Livestock confinement facilities.
- Nut, fruit, and berry crops

Crops that can be produced from actively managed windbreaks include:

- Nuts, fruits, berries
- Timber, fencepost, firewood
- Christmas trees
- Boughs, cones, wreaths
- Landscape plants
- Shade-tolerant plants such as those grown in the forest farming practice
- Lease hunting opportunities when managed for wildlife benefits

windbreak (trees, shrubs and grasses) and the adjacent land area, its layout can be most effective at meeting the goals for which it is, or has been, established. By understanding the needs of each of the windbreak's component parts, the windbreak can be managed to best maintain its effectiveness over time, and also sustain its contributions to the farm or ranch.

Windbreaks Defined

A windbreak is any barrier (natural or artificial) that reduces troublesome winds by creating a wind shadow to the leeward (down-wind) side. Its major function is to reduce the velocity of the wind. A windbreak must be 2.5 feet or higher to have a significant effect. The kinds of materials that can be used for a wind-break include trees, shrubs, tall perennial or annual plants (e.g., switchgrass or sunflowers) that will attain a sufficient height to create the desired wind shadow.

The windbreak practice, also commonly referred to as shelterbelt, uses intensive management for growing trees, shrubs and/or grasses adjacent to other agricultural practices, and consists of one or more rows of closely spaced trees and/or shrubs planted at right angles to the prevailing winds. A windbreak becomes important to the agricultural system by enhancing production, or conservation, as it modifies air movement and wind speeds resulting in microclimatic changes. The terms windbreak and shelterbelt can be used interchangeably.



Seven Windbreak Structural Elements Determine Effectiveness

- Height
- Density
- Orientation
- Length
- Width
- Continuity/uniformity
- Cross-sectional shape

How Windbreaks Function

Windbreak Height. Height (referred to as 'H') is the most important factor determining the downwind area of protection. The windbreak 'H' is the height of the tallest row of trees in the windbreak. The windbreak will reduce wind speed for 2 to 5 times the height of the windbreak (2H to 5H) on the upwind side and up to

30H on the downwind side of the barrier. The area protected is a direct result of the height and density.

Windbreak Density. Density is the ratio of the solid portion of the barrier to the total area of the barrier. Wind flows through the open portions of a windbreak, thus the more solid the windbreak, the less wind passes through. By adjusting windbreak density, different wind flow patterns and areas of protection are established.

Density level is manipulated by choice of plant materials (e.g., deciduous vs. conifer); and plant arrangement. By combining low growing shrubs with medium and tall deciduous trees, dense plant material is provided at three levels (low, middle and upper) of the windbreak during the growing season. However, during the winter, the density would decrease due to the loss of foliage. Consequently, a conifer component would be desirable for year-round protection.

- **Dense (60-80%)** = Maximum wind reduction but short wind shadow
- **Moderately Dense (40-60%)** = Less wind reduction but longer wind shadow
- **Under 40%** = Effective for snow distribution across a field



The term windbreak porosity may also be used to characterize this structural element. The percentage of porosity is the amount of open spaces in the windbreak when viewed perpendic-

ularly to the windbreak. In other words, porosity is the inverse of density, i.e., a 60 percent dense windbreak would be 40 percent porous.

 Deciduous 25-35% Density Open Wind Speed 10 m sec⁻¹					
H distance from windbreak	5H	10H	15H	20H	30H
m sec ⁻¹	5	6.5	8	8.5	10
% of open wind speed	50%	65%	80%	85%	100%

 Conifer 40-60% Density Open Wind Speed 10 m sec⁻¹					
H distance from windbreak	5H	10H	15H	20H	30H
m sec ⁻¹	3	5	6	7.5	9.5
% of open wind speed	30%	50%	60%	75%	95%

 Multi-Row 60-80% Density Open Wind Speed 10 m sec⁻¹					
H distance from windbreak	5H	10H	15H	20H	30H
m sec ⁻¹	2.5	3.5	6.5	8.5	9.5
% of open wind speed	25%	35%	65%	85%	95%

 Solid Fence 100% Density Open Wind Speed 10 m sec⁻¹					
H distance from windbreak	5H	10H	15H	20H	30H
m sec ⁻¹	2.5	7	9	9.5	10
% of open wind speed	25%	70%	90%	95%	100%

Fig. 1. Wind speed reduction to the lee of windbreaks with different densities.

The degree of density will impact the extent of the area being protected and the magnitude of protection as shown in Figure 1. A solid fence (100% density) provides maximum wind reduction, but the area of wind reduction is shorter than with a dense tree windbreak. The dense windbreak (60-80%) provides a greater area of protection, and the magnitude of wind reduction is as good as the solid structural fence or wall. For the moderately dense windbreak (40-60%), the magnitude of wind reduction is somewhat less but the wind shadow is at its maximum. Once the density drops below 40%, the effectiveness of the windbreak begins

to decline. However, the 25-35% density level is very effective for even distribution of snow across a field for moisture management. This density level is not as good for stopping wind erosion.

Windbreak Orientation. Windbreaks are most effective when oriented at right angle to prevailing or troublesome winds, (Fig. 2, below). The best orientation for each windbreak depends on the objectives for the windbreak. A key point to remember is that although the troublesome wind may occur primarily from one direction, it rarely blows exclusively from that direction. As the wind changes direction and is no longer blowing directly against the windbreak, the protected area decreases.



Fig. 2. Windbreak Design Options.

Windbreak Length. Although the height of the windbreak determines the extent of the protected area downwind, the length of a windbreak determines the amount of total area receiving protection. For maximum efficiency, the uninterrupted length of a windbreak should exceed the height by at least 10:1 (i.e., a windbreak 30 feet tall needs to be at least 300 feet long). The ratio reduces the influence of end-turbulence on the total protected area.

Windbreak Width. The width primarily serves as a means to manipulate the desired density of the windbreak. The number of rows, the distance between trees, and species composition are factors controlling windbreak

density. Increasing the number of rows or decreasing the distance between trees increases density and provides a more solid barrier to the wind. A wider windbreak can also increase the value of the windbreak for wildlife and offers opportunities to produce products.

Windbreak Continuity. Continuity influences efficiency. Gaps in a windbreak become funnels that concentrate wind flow, creating areas on the downwind side of the gap in which wind speeds often exceed open field wind velocities. Gaps will decrease the windbreak's effectiveness. Access lanes through a windbreak should be avoided or minimized.

Windbreak Cross-Sectional Shape. Some windbreak guides call for a "hip-roof shape" to assist in "lifting" the wind. However, the cross-sectional shape of windbreaks with equal densities has minimal influence on wind velocities within 10H of the leeward side of a barrier. Beyond 10H, straight sides provide slightly more protection than slanted sides because more wind passes through the trees and extends the protected area farther to the leeward.

Windbreak Benefits

Windbreaks offer a variety of potential environmental and financial benefits to a farm or ranch enterprise through protection of crops and livestock. The rural community also benefits from improved air quality through wind speed reductions and the physical capture of airborne particulates including dust, smoke, pesticide droplets and odors. Windbreaks also provide aesthetic diversity by adding trees in an agricultural landscape and enhance wildlife habitats and corridors through the addition of tree, shrub and herbaceous cover.

Advantages of Windbreaks

- Enhance crop yield
- Protect soil from wind erosion
- Shelter livestock and crops
- Capture water runoff and nutrients
- Improve irrigation efficiency
- Filter and reduce dust
- Help control odors
- Screen unsightly areas
- Provide wildlife travel corridors and habitat
- Protect structures (homes, outbuildings, roads)
- Reduce noise
- Improve aesthetics

Disadvantages of Windbreaks

- Require more intensive management
- Need specialized equipment for tree/shrub management
- Remove land from annual crop production
- Financial returns increase gradually as a windbreak grows
- May harbor harmful crop pests, e.g., insects & weeds

Benefits for the Soil

Windbreaks have been widely recognized as a key tool to reduce wind erosion. When wind speed is reduced, the wind erosion process cannot start. Wind erosion can rob land of precious topsoil containing nutrients and organic matter. This loss can lead to reduced productivity and the need to add more nutrients. Wind erosion potential is the greatest when fields are very wide and the soil is bare and smooth. Windbreaks combined with other wind erosion control measures (e.g., reduced tillage, herbaceous wind barriers) create a conservation approach to tolerating wide weather extremes.

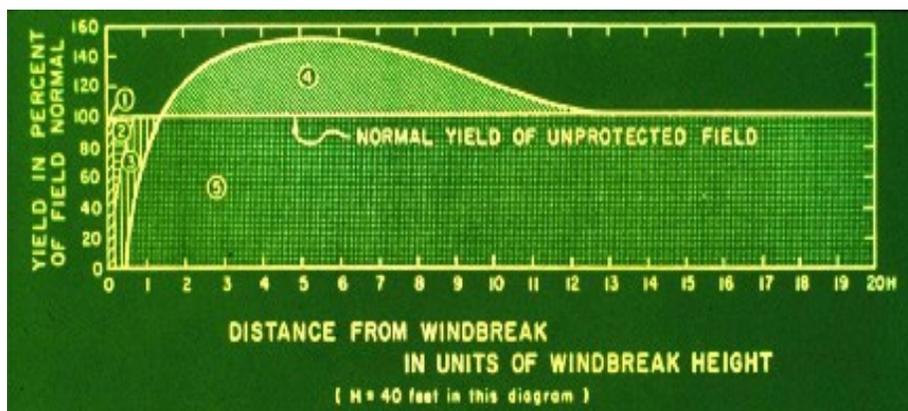


Fig. 3. Windbreak Benefits for Crops.

crops when protected by a windbreak. This yield increase generally occurs from $1.5/2H$ to $10-12H$ on the leeward side of the windbreak (Fig. 3). The amount of yield increase will vary from year to year due to different weather

Crop Windbreaks: Weighted Average Crop Yield Increase			
Corn	12%	Soybeans	13%
Barley	25%	Winter Wheat	23%
Hay	20%	Spring Wheat	8%

Benefits for Crops

Windbreaks improve crop production and quality by modifying the microclimate and reducing wind erosion. They protect crops from insect pests by reduced crop visibility, dilution of pest hosts due to plant diversity, interference with pest movement, creation of environments less favorable to pests and more favorable to beneficial insects. They can be designed to manage snow drifting to maximize use of the moisture for crops. Windbreaks improve irrigation efficiency by reducing evaporation losses; and improve water quality through interception of sediment and interception, sequestration and decomposition of agricultural chemicals in the tree, shrub and herbaceous rhizosphere.

When field windbreaks are suggested to landowners, they often have a mental image of crop reduction and/or loss adjacent to the windbreak and from the space occupied by the windbreak. What is often not recognized is the potential for increased crop quality and quantity on the leeward (downwind) side of the windbreak. Many years of field research have shown there is a yield advantage for many

conditions. There will also be some variation due to soils and the types of trees used in the windbreak (i.e., less competitive trees result in greater gains). The yield advantage is normally more than enough to offset the decrease in yield immediately adjacent to the windbreak and the land occupied by the windbreak. Some landowners will plant a deep rooted crop such as alfalfa adjacent to the windbreak in the area most impacted by competition and are able to gain good quality forage.



This field windbreak is designed to provide year-round protection by incorporating cedar and pine outer rows with an interior row of deciduous shrubs.

Benefits to Orchards and Vegetable Crops

In addition to the traditional commodity crops, windbreaks are also used to protect a variety

of horticultural crops including many fruit and vegetable crops. Some of the key benefits of protecting these types of crops include: improved crop quality from reduced bruising, better pollination from insects due to less wind, and early maturing of the crops resulting in possible marketing advantages. Windbreaks around orchards are also being examined for their use in preventing off-site drifting of pesticides. Many orchards and other farms are being engulfed by housing developments. Windbreaks can help buffer potential land-use conflicts.

Benefits to Livestock

Windbreaks provide valuable protection to livestock especially for young animals and in areas with cold northerly winds during winter and early spring. Reducing the wind impacts lowers animal stress and improves general health resulting better livestock production by increasing feed efficiency and weight gains, improving survival of newborns and increasing milk production. Windbreaks can also provide living screens to separate incompatible uses (i.e., livestock facilities from suburban residences).

Windbreak Design

Designing windbreaks requires the planner to be able to manipulate the different structural components of a windbreak in order to achieve the desired effect. Climatic and physical effects such as wind speed, apparent air temperature, snow deposition and evapotranspiration are modified as a result of the structural characteristics of the windbreak.

Ask Yourself: What needs to be protected?

- Crops/orchards
- Soil
- Livestock and/or Livestock Buildings

1) Determining the Windbreak Purpose As noted previously, a windbreak can have a variety of purposes ranging from crop protection to snow management. The design

of the windbreak is dependent upon the purpose(s) desired. To determine the purpose(s) requires understanding the desired objectives of the landowner and the physical site characteristics.

The first step in design is to interview the landowner to ascertain his/her objectives or purposes for the windbreak. A probing questioning strategy can be effective such as:

Crops

- *Have you had any wind erosion from your fields? If so,*
 - o *When did it occur?*
 - o *From which direction(s) does the wind cause the most problem(s)?*
 - o *Are you using other wind erosion control practices, e.g., reduced tillage?*
- *Have you had any crop damage or loss from the wind or blowing soil?*
 - o *When did it occur?*
 - o *From which direction(s) does the wind cause the most problem(s)?*
 - o *What crops are you growing that may be wind sensitive?*
- *Are you growing crops that need pollination?*

Livestock

- *When do your livestock need the most wind protection?*
- *What livestock pastures, lots or structures need wind protection?*
- *Do we need to be concerned with summer air movement in the livestock area?*
- *Which access roads need to be kept clear of snow?*
- *Is there a drainage issue associated with rain or snowmelt runoff?*

2) Site Evaluation

The next step is to evaluate the site conditions that may affect windbreak design and application. Use a conservation plan map or photo to identify fields in need of protection, existing windbreaks, soil problems, utilities, direction of prevailing erosive winds, property lines, roads and access lanes. (Fig. 4, next page.)

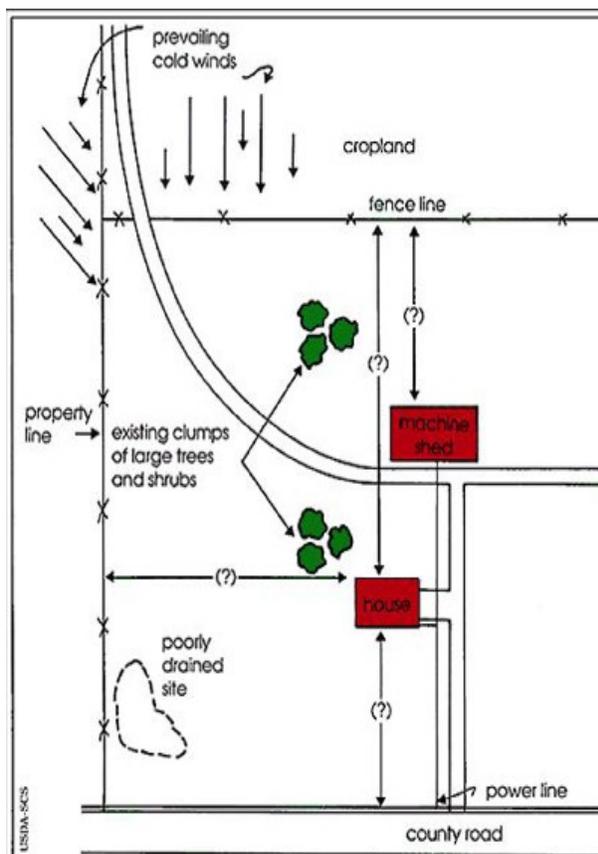


Fig. 4. Area sketch for site evaluation.

- Identify all areas needing protection based on the troublesome wind direction(s).
- Inventory the soils. Begin a starter list of species adapted to the soils.
- Observe the topography to determine any drainage concerns either into or away from the windbreak (especially snowmelt and feedlot runoff)
- Locate property lines, overhead and underground utilities (electric, telephone, gas, and/ or sewer), and existing trees or shrubs which may be within or adjacent to the proposed windbreak.
- Identify any access roads or lanes that could cause breaks in the windbreak.
- Locate the windbreak to avoid obstructing the winter sun, or oncoming traffic near driveways.

- Identify protection needs for the windbreak, such as fencing to keep out live-stock.
- Observe any existing plant species which may be alternate hosts for pathogens, e.g., cedar-apple rust.
- Inventory existing wildlife habitat and wildlife species in the area so the windbreak may complement.

3) Design Considerations for Different Windbreaks

Windbreak Design Tips for Crop Fields

- For crop protection/production and/or uniform snow distribution, windbreak-to-windbreak intervals should be 15 to 20H. For crops highly susceptible to damage from wind or small amounts of wind-blown soil during some portion of the growing season, a spacing interval of 6-10H provides a high degree of protection.
- For erosion control purposes, the Natural Resources Conservation Service uses a rule-of thumb of “no erosion out to 10H leeward” -- leading to a windbreak-to-windbreak interval of 10H plus the distance protected by the agronomic system (i.e., standing crop, crop residues, cropping pattern, ridging) being used.
- Different design densities and heights result in different snow drift patterns. For example, if the landowner wants to spread snow evenly across a field to improve soil moisture in a crop field, the windbreak design density should range from 25 to 35 percent. This would be roughly equivalent to a single row of deciduous trees without leaves at a wide spacing (15 to 20 feet). If soil erosion is a potential problem during the time the windbreak is at this density level, additional conservation measures will be needed.

- **Plan for 40-60 % density for crop and soil protection.**
- **Plan for 25 - 35% density for snow distribution.**

Windbreak Design Tips for Livestock

- Greatest wind protection occurs from 2H to 5H leeward of the tallest tree row.
- For wind and snow protection, the most windward row needs to be 100 to 200 feet from the windward edge of the primary protection area.
- Allow room for snow deposition outside of feeding area. Care must also be taken to accommodate the drainage both from the clean water runoff from the windbreak (i.e. snowmelt) and drainage from the livestock feeding area. Effluent from the feeding area can harm and sometimes kill trees and shrubs.
- Critical temperatures for beef cattle are determined in part by the condition of the coat. Below the critical temperature, livestock must expend more energy to keep warm.

Livestock Critical Temperatures

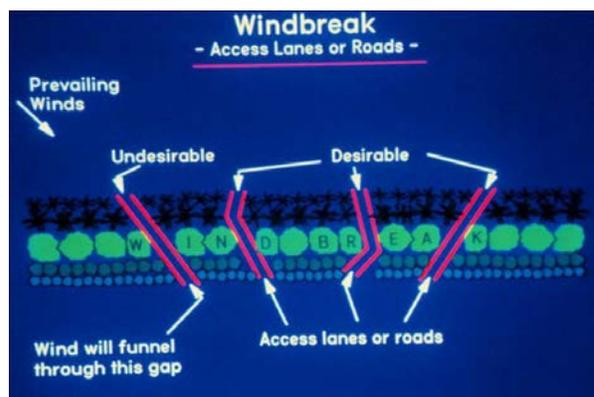
Coat Description	Critical Temperature
Summer coat or wet	59°F
Fall coat	45°F
Winter coat	32°F
Heavy winter coat	18°F

Adapted from D.R. Ames, Kansas State University



General Design Considerations

- Avoid creating gaps with access roads cut through a windbreak. Wind flow increases through gaps decreasing windbreak effectiveness. Where needed, design the opening at an angle to prevailing winds. Lanes or roads through single-row barriers should be avoided; where necessary, locate them 100 to 500 feet from the ends of the windbreak.



- Locate new rows of trees 50 feet from existing trees.
- Stay away from subsurface drain fields and overhead utilities.
- Avoid locating windbreaks within 200 feet of road intersections to prevent poor driver visibility.

Selecting Tree and Shrub Species

All species of trees and shrubs do not grow at the same rate nor do they grow to the same mature height. Likewise, adapted species vary in their growth on different soils within a geographical area. The amount of available soil moisture during the growing season and soil aeration are two important factors affecting tree and shrub growth. These factors are largely determined by soil texture, soil depth and climate.

Conservation tree and shrub suitability groups have been developed as a guide for selecting species best suited to different kinds of soils, and climate, predicting height growth at 20

years, and measuring effectiveness. These guides should be available in the NRCS Field Office Technical Guide. Information about different plants can also be obtained from PLANTS located on the internet at www.plants.usda.gov.

Windbreak Plant Materials

Select plants adapted to:

- Climate
- Soils

Select to meet objectives:

- Foliage density characteristics
- Height potential
- Wildlife needs

In addition to selecting plants adapted to the climate and soil, plants need to be selected that have the greatest potential for meeting land-owner objectives. The primary objective is to select plants that will provide the desired level of wind protection in a reasonable length of time (within 10 years). This means selecting species that will give the appropriate level of density and optimum height for the site. For example, conifers need to be considered if optimum year-round wind protection is desired. If wildlife is desired, select appropriate plants for the desired animals or birds.

Productive Windbreaks

For most of the other agroforestry practices, e.g., Alley Cropping and Silvopasture, a market-able product is typically produced from the woody component. Windbreaks have historically been a conservation practice providing benefits to the adjacent area by reducing wind impacts. The trees and shrubs in a windbreak have rarely been managed to sell a product. In older windbreaks planted in the 1930's and 1940's, plants were chosen that could provide fruit for home consumption and trees were cut for use as fence posts and rough lumber on the farm. The concept of producing usable products from windbreaks and other conservation practices has recently been revived and promoted in Productive Conservation: Growing Specialty Forest Products in Agroforestry Plantings.

For example, nut and fruit producing plants could be incorporated into a windbreak design with the intent of harvesting the fruits/nuts as a product. The harvesting would not impact the other benefits of the windbreak. Some commonly harvested fruits include chokecherry, highbush cranberry, sand cherry, currants, Corneliacherry dogwood, jostaberry, Nanking cherry, chokeberry, buffaloberry, pawpaw, persimmon, and many others. All are harvested for home consumption, but many are also gathered for commercial use as fresh fruit, jams, jellies, syrups, juices, concentrates, confections and wines.

A second possible enterprise could be decorative woody florals. Any woody plant species that has a colorful or unusually shaped stem, bud, flower, fruit or even leaf can become a decorative floral product. Some plant examples include stems from red and yellow-stemmed dogwoods; and curly, pussy, flame and basket willows. Even though the stems of these plants will be harvested, most of them will re-sprout from the roots restoring their value as part of the windbreak.

With any of these concepts, careful advanced planning is needed. Some unique challenges include understanding available markets, timing of harvest, perishability of the product, available labor, wildlife pressure, year-to-year production, etc. Once these issues have been resolved, thought is needed to decide how to incorporate the plants into the windbreak design. If the plants that will be harvested are primarily shrubs, the design can be fairly easy since shrubs typically are included in the outer or inner rows which will make access easier. Growing specialty forest products in windbreaks can provide supplemental income while at the same time improve the environment. Another advantage is that the windbreak will receive more management care and could result in a longer lasting planting. Success will only occur if the grower is a skilled manager and an effective marketer.

Windbreak Site Preparation, Planting and Maintenance

Site Preparation

Site preparation is an important first step to ensure successful survival of the trees and shrubs in the windbreak. The goal is to maximize the amount of moisture at the site and to minimize the potential for weed competition. The type of site preparation used depends on the soil and existing vegetation at the site. With sandy soils, care must be given to avoid wind erosion problems. On sloping sites, precautions must be taken to prevent water erosion. Site preparation can be accomplished either mechanically (e.g., tillage equipment including chisel plow, disc, rototiller, or scalper), chemically (pre and/or postemergent herbicides) or a combination of both.

Site preparation

- Maximize moisture
- Minimize competition
- Match the site
- Be timely
- Care for plants
- Plant at correct depth

Planting

Tree planting methods include using either a tree planting machine or hand planting tools. For both methods, some key techniques need to be followed:

- Do not plant on hot, windy days.
- Prevent roots from drying out.
- Do not plant when the temperature is freezing or below.
- Plant seedlings in a vertical position with root collar 1" below soil surface.
- Prepare a trench or hole deep and wide enough to permit roots to spread out naturally; avoid "J rooting" - prune roots as needed to prevent J roots.
- Pack soil firmly around roots to eliminate air pockets.

In arid areas where trees are difficult to grow shrubs or tall native grasses may be used to provide crop protection, to control wind erosion, and to capture snow for crop production.

Maintenance

The goal is to maintain the health and vigor of individual trees and shrubs while maintaining the overall structure of the windbreak as an effective wind barrier. With proper care, a windbreak will serve a long life of protection.

Windbreak maintenance

- Weed/grass control for the first 3 to 5 years with optional cover crop between rows
- Use supplemental water to ensure early survival and development
- Replant to fill gaps
- Protect from animals and pests
- Use corrective thinning and pruning
- Do not fertilize (cost prohibitive)

- Weed/grass control: Weeds need to be minimized usually for the first three to five years in a band about three to four feet on each side of the rows of trees or shrubs. The area between the rows can be planted to an annual cover crop (e.g., grain/forage sorghum, oats, corn, millet, wheat, rye, or sunflowers) which can help control weeds, provide wildlife cover, and protect young tree seedlings from soil or wind abrasion.
- Supplemental irrigation: Irrigation (e.g., hand, drip, sprinkler, furrow or flood) is not a substitute for good site preparation and weed/grass control. Irrigation should be used when soil moisture conditions are extremely dry at planting time or during a prolonged drought after planting.
- Replanting: Replant all trees and shrubs that have failed in order to fill in the gaps in the windbreak. Replant annually for at least three years after the initial planting and continue until a full stand of trees is attained.

- **Animal Protection:** Establish appropriate fencing to prevent livestock and large mammal damage. Controlling small mammals can include repellents, traps, special fencing, and seedling protectors (e.g. photodegradable plastic tubing or mesh netting). Consult with local and state game/wildlife specialists for control measures for your area.
- **Pest control:** Periodic inspection of the crops and trees is recommended to detect and identify possible pests. These inspections and in some cases the use of pheromone traps will help determine when corrective action is warranted.
- **Pruning:** Hail, wind or snow storms often cause breakage of limbs and sometimes the main trunk(s) of the trees and shrubs. Remove broken limbs and tops.
- **Fertilization:** Generally, fertilization of windbreaks is not recommended. It is not practical, economical, or feasible, in most cases. The only situation where fertilization may be justified would be a small, high-valued windbreak planted on soils that have obvious soil nutrient deficiencies. Apply fertilizer according to soil test results.

Summary

Windbreaks protect crops, soil, and livestock while also improving air and water quality, broadening biodiversity, and beautifying the landscape. One of the keys to the successful windbreak is recognizing what the landowner wants to accomplish through its application on the landscape. The next step is to then understand the properties of a successful windbreak. And finally, choose species to plant in the windbreak that will enable it to work as expected. With a little planning upfront, a windbreak can provide a variety of benefits from improving crop production to maintaining livestock health.

Non-Agroforestry Uses of Windbreaks

1) Windbreaks for Homes

Benefits

Windbreaks reduce energy consumption by reducing air infiltration into buildings resulting in less heat loss and by reducing the amount of snow removal from roads and around buildings.

Design Tips

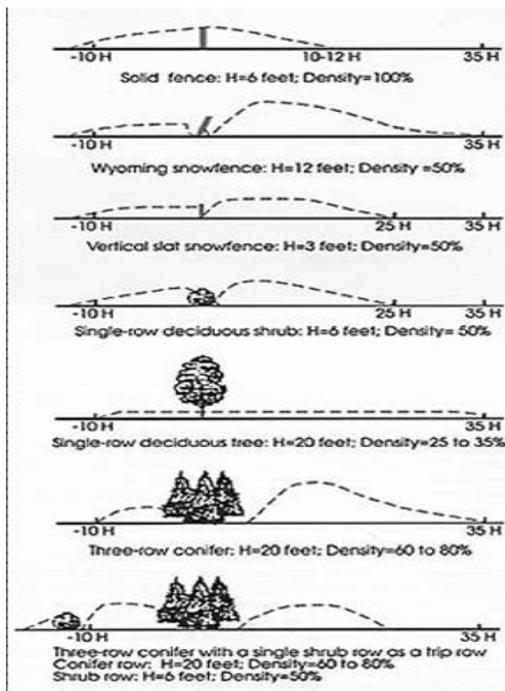
- For wind protection only, the tallest row needs to be 2-5H (H = planned height of the tallest row) from the primary area needing protection.
- However, for wind and snow protection, the most windward row needs to be 100 to 200 feet from the windward edge of the primary protection area. The distance between the area needing protection and the windward row varies with the amount of space needed for snow storage.
- Once this critical distance is met, check to see if the area needing protection is still in the 2-5H zone, i.e. a house. Areas and objects more than 10H from the windbreak will receive reduced wind protection.
- To protect structures, the windbreak should have a density ranging from 60 to 80 percent during the period requiring maximum protection. To achieve the minimum level of this density range, plant at least three rows of trees and shrubs with at least one row being a conifer.
- Extend the windbreak a minimum of 100 feet past structures needing protection to accommodate wind turbulence at the end of the windbreak and end-drifts of snow.
- Locate access roads from 100 to 500 feet from the ends of the windbreak. If a lane must cut a windbreak, it should cut through the windbreak at an angle to prevailing winds to prevent funneling of wind and snow drifting.

Two designs for protecting a structure from snow

- **Traditional multi-row windbreak:** A basic farmstead windbreak consists of three to eight rows of both conifers and deciduous trees and shrubs. Conifers or shrubs should be located on the windward side with tall deciduous species in the center. A row of shrubs on the interior or leeward side completes the design.
- **Modified twin-row, high density wind-break:** In areas with frequent heavy snows consider adding a row or two of shrubs 50 feet to the windward side to trip snow before it reaches the main windbreak. An auxiliary planting of shrubs on the leeward side of the windbreak can also add good emergency cover for wildlife. This can be supplemented with a food plot between the main windbreak and the auxiliary planting.

Go to Windbreaks for Rural Living for more information:

<https://www.nfs.unl.edu/documents/windbreakruralliving.pdf>



Windbreak designs for snow

Windbreak Design To Protect Homes and Outbuildings

Windbreaks for protecting structures such as the farmstead, roads and other buildings:

Position the windbreak as close to perpendicular to the most troublesome wind direction. "One-leg" windbreaks are sufficient if winds come from one direction only, but a "two-leg" or network of windbreak(s) provides greater protection for variable wind directions.

Plan for 60-80 % density for maximum protection. Locate windward row 100 - 200 feet from area needing protection. In areas with variable winds, multiple-leg windbreaks provide greater protection to the field or farmstead than single-leg windbreaks.

Community Windbreaks

Planned community windbreaks can provide extra protection for the entire development and be an economic gain for the developer and homeowner from increased property values. Windbreaks in the rural-urban interface can also reduce potential conflicts, such as blowing dust, privacy, odors or noise between land uses. High quality windbreaks between agriculture and communities can prevent windblown soil and snow. Sediment in the yard, dust in homes and pesticide drift can be great aggravation to both rural and urban homeowners. *For more information see Working Trees for Communities,*

<https://www.fs.usda.gov/nac/documents/workingtrees/brochures/wtc.pdf>



2) Living Snow Fences

Benefits

Blowing and drifting snow jeopardizes public safety and emergency services, interrupts businesses, increases road maintenance costs and causes wildlife mortality. Living snow fences are more cost-effective than structural barriers, can meet many additional objectives, and provide a wide array of benefits beyond snow control.

Design Tips

- To achieve maximum snow accumulation, the windbreak density should range from 60 to 80 percent.
- The most windward row should be a minimum of 100 feet from the area being protected to prevent inappropriate snow-drifts. This distance will vary (100 to 300 feet) depending on the location and severity of winters.
- A trip row of shrubs or dense conifer can be located 50 to 100 feet windward of the main windbreak to create a snow trap.
- For protecting roads, allow plenty of room for the leeward drift by locating the windward row of the windbreak 200 to 300 feet from the center of the road.

Below: Integrate windbreaks into an overall landscape design to achieve multiple objectives.



Refer to the windbreak design for snow figure for more guidance about snow behavior adjacent to different windbreak designs.

- Go to Working Trees: Living Snow Fences, <https://www.fs.usda.gov/nac/documents/workingtrees/brochures/livingsnowfenceforweb.pdf>, and Windbreaks for Snow Management, <https://nfs.unl.edu/documents/windbreaksnowmgmt.pdf>, for more information.

3) Windbreaks for Livestock Odor Reduction

Benefits

Windbreaks (or vegetative environmental buffers - VEBs) placed around livestock production facilities can help mitigate the movement of odors and dust generated by these operations. Urban expansion has placed many more people into closer contact with agricultural operations. Large scale livestock confinement production has led to increased concentrations of odor emissions travelling across highly modified landscapes relatively devoid of natural barriers. Windbreaks alone will not prevent these odor problems but can help reduce negative visual perceptions and the detection of smell by neighbors and surrounding communities.

Design Tips

- Windbreaks should consist of at least one to three rows of conifer and deciduous species.
- Two to three rows of trees can provide an ideal 60 percent windbreak density (or 40 percent porosity) for odor control.
- Shrubs are generally planted in the outside or inside rows, followed by conifers with deciduous hardwoods towards the middle or along the downwind side where they can grow more efficiently.

- Tree varieties and placement for the windbreak should be managed to maximize odor interception and dilution of air, and reduce odor leaving the source.
- Where site and facility conditions merit and allow, place plantings (not necessarily windbreaks) around the entire perimeter of the odor source.
- Even a site with a windbreak on one side that is strategically placed and designed can make a difference.
- For more information see Windbreaks: A “Fresh” Tool to Mitigate Odors from Livestock Production Facilities, https://lib.dr.iastate.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1163&context=nrem_pubs

4) Windbreaks for Wildlife Benefits

With careful design, windbreaks provide nesting habitat for a wide variety of birds (up to 57 species) and other wildlife. Windbreaks can also produce needed food as well as protective cover when the wildlife forage in adjacent areas. Shelter from predation and escape cover as well as emergency cover from severe weather e.g., blizzards can be provided.

Design Tips

- Windbreaks can be given a more natural look and still provide excellent wildlife habitat and wind protection.
- **Connecting Habitats** - Where appropriate, select the windbreak site that connects to a larger habitat block such as a river corridor, woodlot, wetland, woody draw, or similar area.
- **Herbaceous Cover** - Consider planting or leaving herbaceous vegetation such as a mixture of grasses and legumes, standing grain, or crop residues as a border (20 to 50 feet wide) along the edges of the windbreak. If grasses or legumes are used, they should be separated from the new tree planting to avoid competition. This strip

of cover can provide nesting, loafing, and foraging cover for a number of species.

- **Winter Cover** - Adding a shrub row 50 to 100 feet windward of the main windbreak as a snow trap results in greater wildlife protection on the leeward side of the main windbreak. Use species that will provide good thermal protection in the winter such as cedar and spruce.
- **Food** - Select species that may have high food value for a variety of wildlife. Planting food plots or fruit-bearing shrubs on the lee side of windbreaks provides food in an area protected from wind and possibly warmed by the sun, points that are particularly important in cold months.
- For more information see Windbreaks and Wildlife, <http://extensionpublications.unl.edu/assets/pdf/ec1771.pdf>



Quail find excellent habitat in field windbreaks.

Success Stories

Paul Huenfeld, Nebraska Producer Using Windbreaks with Organic Farming



“Organic farming and trees were just a natural fit, like a hand and a glove, as far as I was concerned. We needed buffers around the farm. We also really value the importance of habitat for the insects and the predators, and we see that along the trees where we can plant grass and legumes is an excellent source of habitat for the different species of wildlife.”

Claud Launius, Retired cotton producer, Malden Plain, Mo.



Claud Launius is a retired cotton farmer in the sandy soil area of “the Bootheel” of Missouri known as Malden Plain. “We were having a lot of trouble with blowing sand in the spring of the

year; it was blowing and hurting our cotton pretty bad--killing some of it.” Then, Natural Resources Conservation Service (NRCS) District Conservationist Phil Gurley told Launius about crosswind trap strips, and said he could get switchgrass seed through the Missouri Department of Conservation. Launius installed some on an 80-acre field in 1989. Although some cotton farmers have used wheat and rye to slow the wind, switchgrass grows to 6 or 8 feet and Launius says it keeps the wind up in the air. “In the spring, it’s windy when the cotton plants are babies, and that’s the worst time. If they get up to 6 or 8 inches tall they can defend themselves; but when they’re short, with just two leaves, wind and sand can just cut them off. It’s like a baby that gets sick--they don’t grow like they ought to until they get well again. That’s cotton, it’s like any plant.” When Launius retired he rented his land, and his tenant has kept up the wind strips.

Launius added four rows of switchgrass in strips with 24 rows of cotton. He figures he might have gone with 36 rows of cotton to 4 rows of switchgrass, “but I’d be afraid to tear any of it up.” Besides, he’s doing better with the 68 acres than he did with the original 80 acres. “Our yields have increased a half-bale per acre or more because the plants aren’t getting hurt. They just sit there and grow; the weather doesn’t bother them. We really like it.” Launius is surprised that others aren’t planting switchgrass wind traps, but thinks they just don’t want to give up those 4 rows of cotton ground. He notes that there are other benefits beyond protecting the cotton plants and boosting production. “It’s doing really well for quail and other animals, such as rabbits. By hiding in the switchgrass, the quail run the hunters crazy. The grass is really thick and it keeps getting thicker and thicker.” To maintain it, every other 4-row strip is burned every other year; that makes the switchgrass “stool out” more, and then it has millions of seeds on it –and that’s what quail and wildlife like.”

Economic Incentives

There are several agencies offering programs that can be used to establish and maintain windbreak practices on private land. The USDA Farm Service Agency (FSA) offers three programs that may be used for windbreaks and shelterbelts: the Conservation Reserve Program (CRP), the Continuous Conservation Reserve Program (CCRP), and the Conservation Reserve Enhancement Program (CREP). Each of these programs is designed to take environmentally sensitive and highly erodible land out of production by offering a soil rental payment, a cost-share for the establishment of various conservation practices and other financial incentives to landowners who offer to set aside their land.

Of these three programs, the CCRP program offers direct benefits to landowners establishing a windbreak/shelterbelt. CCRP is a voluntary program that focuses on funding conservation practices (CP) protecting environmentally sensitive land. Landowners with eligible land who wish to enroll that land in the CCRP may sign-up at any time during the year. NRCS Standard 380 identifies the guidelines for establishing a windbreak for the CCRP. For more information, contact your local USDA/FSA office.

The USDA/NRCS has four main programs that offer funds for tree planting and agroforestry. They are the Environmental Quality Incentives Program (EQIP), the Wildlife Habitat Incentive Program (WHIP), and the Conservation Stewardship Program (CSP). In conjunction with the funding programs noted, the USDA/NRCS also provides technical assistance to landowners who are interested in conservation planning and application.

The USDA National Institute of Food and Agriculture supports the Sustainable Agriculture Research and Education (SARE) program. Of the three funding types available through SARE, only one, the producer grant, is aimed at the landowner. Landowners who submit accepted proposals can receive up to \$15,000 to establish and maintain the sustainable practice that they propose.

See chart (next page) for a listing of incentives offered by these federal agencies or consult the UMCA publication “Funding Incentives for Agroforestry in Missouri.”

Federal Agency and Programs Offered	Programs Available for Alley Cropping	Key to Programs
USDA/NRCS		<ul style="list-style-type: none"> • CS = Cost Share (ranges from 50% to 90%, based on a predetermined expected cost structure) • PP = Practice payment derived for each particular practice • LE = Land Easement (Rental payments based on an average rental rate per land use type; easements are typically 5, 10, 15, 30 years or permanent) • M = Annual maintenance payments (range from \$5 - \$10 per acre) • IP = Additional incentive payments (payments could include sign-up bonuses, additional cost-share, and/or increased land easement rates) • G = Grants
Environmental Quality Incentive Program (EQIP)	PP	
Wildlife Habitat Incentive Program (WHIP)	PP	
Conservation Stewardship Program (CSP)	CS, LE	
USDA/FSA		
Continuous Conservation Reserve Program (CCRP)	CS, LE, IP, M	
USDA SARE		
Producer Grants	G	

Additional Resources

Windbreak Resources – USDA National Agroforestry Center

<https://www.fs.usda.gov/nac/practices/windbreaks.shtml> This page has many windbreak references; we suggest starting with the 11 publications listed under the Windbreak Series heading starting with How Windbreaks Work. The Agroforestry Notes also provide some specialized information.

NRCS Windbreak Information

NRCS State Windbreak/Shelterbelt Establishment Practice Standards and Specifications:

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/?cid=nrcs144p2_027140

Illinois

Illinois Windbreak Manual – Illinois Department of Conservation, Extension and NRCS:

http://web.extension.illinois.edu/forestry/iwm_complete.pdf

Essential Elements for Windbreak Design – University of Illinois Extension:

<https://web.extension.illinois.edu/cfiv/homeowners/081208.html>

Iowa

Planning Farmstead Windbreaks - Iowa State Extension

<https://store.extension.iastate.edu/product/Farmstead-Windbreaks-Planning>

Farmstead Windbreaks: Establishment, Care and Maintenance - Iowa State Extension

<https://store.extension.iastate.edu/product/Farmstead-Windbreaks-Establishment-Care-and-Maintenance>

Minnesota

University of Minnesota, Morris “Selecting Trees and Shrubs in Windbreaks”

<http://morrisonswcd.org/wp-content/uploads/2013/10/Windbreaks-Shelterbelts.pdf>

Missouri

Planning Tree Windbreaks in Missouri – University of Missouri Extension

extension.missouri.edu/explorepdf/agguides/forestry/g05900.pdf

Windbreaks: Agroforestry Practice – University of Missouri Center for Agroforestry:

<http://www.centerforagroforestry.org/practices/wb.php>

Using Windbreaks to Reduce Odors Associated with Livestock Production Facilities – USDA NRCS-MO – IS- MO380: www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_010805.pdf

Nebraska

Windbreak Design – University of Nebraska Extension NEBGuide G1304:

<http://nfs.unl.edu/documents/windbreakdesign.pdf>

Wisconsin

Windbreaks: Trees as Technology for Protecting Wisconsin’s Topsoil – University of Wisconsin:

www.cias.wisc.edu/crops-and-livestock/windbreaks-trees-as-technology-for-protecting-wisconsin-topsoil/

Wisconsin Dept of Natural Resources “Windbreaks that Work!”

<https://dnr.wi.gov/topic/ForestManagement/documents/pub/FR-070.pdf>

Additional Resources, cont'd

In Print:

Brandle, J.R., L. Hodges, J. Tyndall, and R.A. Sudmeyer. 2009. IN: North American Agroforestry: An Integrated Science and Practice (H.E. Garrett, Editor). 2nd Edition. Agronomy Society of America, Madison, WI. Pp. 75-105

Brandle, J.R., L. Hodges, and B. Wight. 2000. IN: North American Agroforestry: An Integrated Science and Practice (H.E. Garrett, W.J. Rietveld and R.F. Fisher, ed's.). Agronomy Society of America, Madison, WI. pp. 79-118.

Brandle, J.R., D.L. Hintz and J.W. Sturrock. 1988. Windbreak Technology. IN: Agriculture, Ecosystems and Environment, 22/23. Elsevier Science Publishers. Amsterdam, The Netherlands. 598 pp

EXERCISE: REVIEW OF WINDBREAKS

1. What are the advantages of windbreaks for:

- Cattle
- Soil
- Crops

2. How far from the windbreak will crops benefit with increased yields?

3. Compare and contrast the uses for single-row and multiple-row windbreaks.

4. When considering whether to use single or multiple row windbreaks, what factors should be considered?

5. When deciding between deciduous and coniferous species, what factors will also be used when writing out the management plan?

6. Putting in a windbreak will cause a farmer to take acres out of production. How can you persuade a farmer that putting a windbreak in will be beneficial in the long run?

7. What financial assistance programs are being funded through state or federal programs to help landowners with the cost of putting windbreaks up on their property?

8. A number of features must be analyzed prior to the placement of a windbreak. List four of these features.

For further thought:

Like any other aspect of agroforestry, windbreaks can provide advantages and disadvantages to the landowner. How do you work with the landowner to see past the disadvantages and not focus on the negative?

EXERCISE KEY

1. What are the advantages of windbreaks for cattle, soil and crops?

Properly designed windbreaks have been shown to increase crop yield for a wide variety of crops. Decreases in wind speed protect downwind crops, decreasing evapotranspiration and increasing water use efficiency. Decreasing wind speed enhanced soil stability and is the primary basis for the installation of windbreaks dating back to the Dust Bowl of the 1930's. During the winter, cattle use energy to keep warm, increasing their feed requirement. Windbreaks moderate winter temperature extremes, reducing cold stress. Windbreaks also improve calving success rates.

2. How far from the windbreak will crops benefit with increased yields?

The rule of thumb is that crop yields are improved out to 10-15H.

3. Compare and contrast the uses for single-row and multiple-row windbreaks.

Single-row deciduous windbreaks are designed to improve snow distribution across a crop field to improve moisture for early season crop growth. They are also used surrounding orchards to still the air and improve pollination and/or speed up crop maturation. They may also be used as a visual screen along roads. Other windbreak applications depend on multiple-rows of deciduous and coniferous trees and shrubs, combined and configured for specific purposes (i.e., crop production, animal protection, snow fences).

4. When considering whether to use single or multiple row windbreaks, what factors should be considered?

The purpose of the windbreak dictates the design.

5. When deciding between deciduous and coniferous species, what factors will also be used when writing out the management plan?

Both conifers and deciduous trees bring different attributes to the function of the windbreak. Deciduous trees are more porous to wind movement, and are less effective in slowing wind speeds. Conversely, deciduous windbreaks reduce wind velocity further downwind. Conifers provide much more wind blockage, critical to protect cattle from wind and snow and roads and buildings from snow buildup.

6. Putting in a windbreak will cause a farmer to take acres out of production. How can you persuade a farmer that putting a windbreak in will be beneficial in the long run?

A realistic assessment of the farmers' goals and objectives, coupled with a similar assessment of the entire farm and cropping system, will lead to the diagnosis that may include establishment of windbreaks. Evidence of windblown soil erosion and associated crop damage, need for cattle protection or protection of buildings and roads, may all lead to this diagnosis. Once the diagnosis includes windbreaks, the next step is to explore cost share programs that may help to offset establishment costs. Visits to other landowners that have functioning windbreaks, will be very effective in addressing farmer concerns.

EXERCISE KEY, con't

7. What cost share programs are being funded through state or federal programs to help landowners with the cost of putting windbreaks up on their property?

EQIP and CCRP both provide cost share for windbreak installation. (see “Funding Incentives for Agroforestry in Missouri” for a thorough discussion of available cost share programs).

8. A number of features must be analyzed prior to the placement of a windbreak. List four of these features.

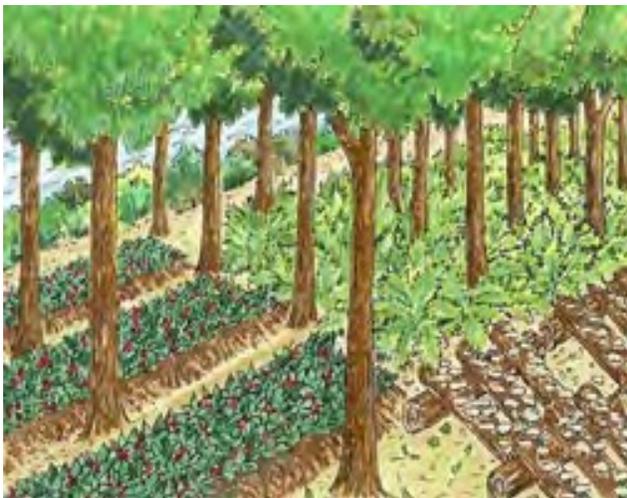
Height, density, orientation, length, width, uniformity, cross sectional shape.

Notes

Chapter 7: Forest Farming

In this chapter:

- Forest Farming Defined
- Non-Timber Forest Products
- Types of Non-Timber Forest Products
- Forest Farming Methods
- Designing a Forest Farming Operation
- Forest Management Considerations
- Summary
- Success Stories
- Additional Resources



Trees are planted with ginseng and other profitable medicinal plants in this illustration. Shiitake mushrooms grow on logs nearby, demonstrating another product that can be farmed in a forest.

What is Forest Farming?

Forest farming is the intentional and sustainable cultivation of marketable non-timber forest products (NTFPs) in woodlands with suitable shade and site conditions. This agroforestry practice diversifies forest management and enhances associated income opportunities. It also improves forest composition and structure and long-term health, quality, and economic value.

Forest farmers actively monitor and manage interactions between trees and understory crops with long-term forest health and productivity in mind. Both timber and non-timber crops can be managed on the same forested land, or non-timber crops can be grown in forests where timber harvesting is not possible or desired. Forest farming operations range from very small (< ½ acre) to very large (> 50 acres).

Advantages

- Enhance forest health
- Improve forest composition
- Diversify income opportunities
- Profit from the rising popularity of forest farmed products
- Range of operation sizes possible

Challenges

- Informal or immature markets
- Variable yield
- Limited information available on how to produce crops
- Volatile markets for some products
- Some crops attractive to poachers

What are Non-Timber Forest Products (NTFPs)?

Forest Farming is defined as the intentional and intensive management of forested lands to produce site-appropriate NTFPs. Forest farmers may intentionally manage shade levels in a forest and among understory plants to favor cultivation or enhanced growth of NTFPs with viable markets. NTFPs include a broad range of goods harvested from woodlands. Herbal plants such as ginseng and goldenseal, specialty mushrooms like shiitake and reishi, and wild foods such as fiddlehead ferns and miner's lettuce that grow in a forest are termed NTFPs.

Unlike other agroforestry practices such as alley cropping or windbreaks, where trees are introduced into an agricultural system, forest farming intentionally integrates agricultural techniques into existing or newly established forests to farm NTFPs. While some forest farmers grow NTFPs for personal consumption, many cultivate and harvest with revenue opportunities in mind.

The total value of the NTFP industry is challenging to estimate due to lack of data, and the fact that much of the economic activities associated with NTFPs are considered part of the informal economy, and thus are not reported. Never the less, evidence indicates that the industry contributes significantly to national, regional, and local economies. The value of NTFPs from Federal lands can be estimated using records of issuances of harvest permits, though these data underestimate overall values. From 2004 through 2013, the national forests and Bureau of Land Management generated nearly \$80 million from the issuance of harvest permits (Chamberlain et al. 2013). The total estimated wholesale value of NTFPs from Federal lands over this period exceeds \$9 billion. Since much of the forest land-base in the eastern US is privately held, these figures do not represent the entirety of NTFP economies.

Estimated values of individual products and market segments also indicate significant economic contributions. For example, Chamberlain et al. (2013) estimated the annual market value of wild-harvested American ginseng in 2007 ranged from \$18 million - \$36 million, depending on price. In 2016, retail sales of black cohosh roots were close to \$43 million according to the American Botanical Council. The annual value of maple syrup production exceeds \$100 million (Farrell and Chabot 2012). In 2007, the US exported pine nuts valued at about \$20 thousand, yet imported more than \$54 million of the nuts (Alexander et al. 2011). Each of these figures demonstrates a great capacity for growth of NTFP markets. An example of this growth can

be seen in the estimated sales of herbal supplements, which increased \$530 million between 2013 and 2016 (Smith et al. 2017). These and other data suggest that NTFPs provide significant economic opportunities for forest dwellers.

Types of NTFPs

Forest farmed NTFPs are generally divided into 4 categories:

- Medicinal
- Edible
- Floral
- Decorative and Craft

Medicinal NTFPs. People have collected medicinal plants in forests for as long as they have walked in them. Medicinal substances are used in nutraceutical, herbal health, cosmetic, and other products and derived from a variety of sources. This includes wood (e.g., aromatic oils from cedar), bark (e.g., smooth sumac, slippery elm), buds (e.g., cottonwood), leaves (e.g., catnip, ginseng, ginkgo), roots (e.g., black cohosh, goldenseal), fruit and flowers (e.g., Echinacea, partridgeberry, skullcap, St. John's Wort), and pollen (e.g., ash, maples, pines). Knowledge about medicinal NTFPs often is informal, but formal information regarding cultivation is increasing.

Edible NTFPs. There are a surprising number of forest-grown edible products. They include fiddlehead ferns, mushrooms, nuts, honey, maple syrup, and the fruit, leaves and/ or roots of many herbaceous plants. Demand for these products is consistent and in some cases increasing. Many types of nuts are farmed throughout Midwestern forests, including black walnuts, pecans, hickory nuts and butternuts. Forest farmed food such as shiitake mushrooms and ramps have been highlighted in gourmet magazines and cooking shows. Wild greens are particularly popular right now and include watercress, miner's lettuce, branch lettuce, dandelion, bean salad, and poke sallet. Wild populations of these plants are usually abundant and only need to be tended, not planted. Numerous types of berry species are cultivated and can be used in products ranging

from fresh fruit to jams, jellies, syrups, juices and wines.

Floral/Decorative NTFPs. Forest farmers can cultivate various decorative plant species to be used individually or in decorative arrangements. Galax is valued for its attractive and durable leaves. Holly is valued for its evergreen leaves (in some species) and bright red berries; and witch hazel, redbud, quince, mountain laurel, and rhododendron for their forced flowers. Pine cones, as well as other seed capsules and pods are used in a variety of craft, potpourri, and seasonal products. These products have consistent markets, command substantial prices, and are sold to floral shops and large retailers or wholesalers. Many plants are valued for landscaping; straw harvested in pine forests is frequently used as landscaping mulch.

Specialty Woods NTFPs. A number of species produce specialty woods and materials for use by local artisans in hand crafted products and art. For example, “diamond willow”, which is actually a diseased willow with cankered stems, can be carved and polished by crafts people to create beautiful walking sticks and other items. Smooth sumac, hickory, and aspen saplings are also converted to walking sticks and mass marketed. Burls are carved and turned into bowls. These value-added “art objects” often sell for up to \$100 or more.

Forest Farming Methods

Management requirements differ based on the NTFPs being farmed. For example, medicinal herb production often involves cultivating the forest floor and possible canopy management to create appropriate growing conditions. Small diameter hardwoods that are removed for timber stand improvement, for instance, may be used as logs for mushroom production. In general, forest farming methods range from minimal to intensive, which varies depending on what is being produced but often relates to tradeoffs between time and money.

There are three recognized methods of forest farming:

- woods grown,
- wild-simulated, and
- managed wild populations.

Woods grown is the most intensive and involves comprehensive site preparation and follow-up management. Start-up costs often are high, but the inputs can significantly increase yield. Wild-simulated is less intensive in terms of site preparation and may involve some canopy management and clearing of the forest floor, but once the plants or seeds are planted, little else is done management wise. Compared to woods grown, wild simulated typically renders less volume, but because the inputs are less, the risks are reduced and the returns may be similar. In the case of ginseng, the slower growth and more wild appearance of the roots often command price premiums, resulting in higher returns. Managing wild populations involves tending an existing population of a plant or fungi. It may involve canopy management, removal of competing understory plants, and thinning of plants to provide for better growing conditions. This method requires few inputs, comes with less risk, and usually does not provide high returns, but may be very desirable for products that have unpredictable markets. Lastly, although not a farming method, a landowner might choose to simply wild-harvest (or wildcraft) marketable NTFPs from their forest. If sustainable wild-harvesting methods are used, these plants and fungi should be available for harvest in future years.

Designing a Forest Farming Operation

It is recommended to start small when establishing a forest farming operation. It often takes multiple years to master NTFP cultivation. The first few years are typically filled with a mix of successes and failures in terms of growing and marketing. The next few years are a time to leverage lessons learned to refine production, increase efficiency, and build on developed markets. Starting small

Forest Farming Method	Management Intensity
Woods Grown	Woods grown, also known as forest gardening, is most intensive. In addition to potential thinning of the forest overstory, it often involves clearing undesirable vegetation in the understory and other practices that are more closely related to agronomy (e.g., tillage, fertilization, weeding, and control of disease, insects, and wildlife). Due to costs associated with input levels, forest gardening can be costly and time consuming but can render large NTFP yield.
Wild-Simulated	Wild-simulated is the cultivation of NTFPs in natural growing environments. A natural growing environment can deliver products similar in appearance and quality to plants naturally growing in the wild. Rather than administer intensive agronomic practices, wild simulated forest farmers use minimally invasive techniques to expose the soil, and plant seeds or plants. Fertilizers and pesticides are rarely used. Despite potential decreases in total yields, wild simulated products often have higher priced markets when compared to those that are more intensively cultivated.
Managed Wild Population	Managed wild populations involves working with plants or fungus that already exist. The forest canopy may be modified to favor growth of desirable NTFPs. Understory plants that are competing with the desired species may be removed. Annual harvests might not be possible. Inputs are very low and yields vary depending on the species and how often it is harvested.
Wild-Harvest or Wild-Craft	Wild-harvesting is the harvesting of NTFPs growing naturally in the forest. It is not generally considered forest farming because active management is not involved. There are no inputs and no risks. There are sustainable wild-harvest methods that can be followed to ensure future harvests.

Each forest farming method has advantages as well as potential drawbacks in terms of time and money, which also varies by crop. For example, woods grown ginseng may result in a greater yield when compared to wild-simulated but per weight value may be lower. Successful forest farmers have a good sense of available markets and NTFP prices and match method and product to maximize revenue.

allows a forest farmer to gain experience and suffer some setbacks without losing large amounts of money. Small areas can be used to test different crops, sites and management practices. Initial operations usually focus on two or three crops, but can include more if markets and labor are not a limiting factor.

Forest farming depends in large part on site conditions that are present and those required by the desired NTFPs. It is necessary to match and maintain appropriate sites to particular NTFPs. For example, if you want to produce floral greens that have a rich, dark green color,

optimum conditions may include less shade than what is required for ginseng cultivation. Over time, changes occur in a mature or a developing forest that may necessitate thinning, planting of additional trees, or providing artificial shade to maintain useful site conditions. Every forest farming operation should contribute to overall forest health and productivity.

Forest Management Considerations

A well-managed forest offers diverse financial opportunities. Managing the understory for NTFPs in addition to other activities such as timber harvesting and habitat improvement can increase revenue and benefit forest health and plant conservation. Success depends on realistic objectives in accordance with time, labor, and site conditions and amendments. Managing site-appropriate species with growth and value potential will help maximize revenue opportunities. While timber harvests are common sources of revenue for woodland owners, it is often several years between cuttings. Forest farming of marketable NTFPs can provide owners with intermediate income opportunities while timber and other salable products mature.

Timber Stand Improvement (TSI) is an intermediate practice that removes trees to improve species composition, stand structure, wildlife values, regeneration, and forest health. Crop tree management is one method for managing woodlands according to site conditions. With this technique, the best performing and most marketable trees are identified and their growth favored by thinning other trees to retain a suitable residual density. Both methods can provide woody material for use in NTFP production. For example, logs from thinning may be repurposed as mushroom substrate or used for terracing in hillside forest farms.

Management of the forest overstory trees will impact forest farming possibilities regardless of the NTFP crop. In each case, the level of light reaching the forest floor will be altered, the implications of which should be considered by forest farmers. To obtain additional details of forest management options, print or request a copy of the document “Forest Management Guidelines” from the Missouri Department of Conservation online at <https://mdc.mo.gov/sites/default/files/downloads/forestmanagement1.pdf>. (See additional resources at the end

of this chapter). For information on managing timber, contact forestry organizations listed under Additional Resources at the end of this chapter. Also see appendix section four, “The Basics of Selling Timber.”

In forest farming, shade levels can be adjusted by one of two methods:

If there is not enough shade for the understory, additional planting of trees may be necessary. Shade structures made of wood lath, boughs, or polypropylene shade cloth may be necessary to protect the plants until trees mature and natural shade becomes sufficient. If shade levels are too dense, thinning and/or pruning of trees may help create increase the light levels.



Ginseng grows well in this mix of alley cropping and forest farming. Walnut trees provide necessary shade.

Summary

Forest farming is one of five temperate agroforestry practices. Unlike practices that incorporate trees into agricultural systems (e.g., alley cropping and silvopasture), forest farming integrates cultivation into existing or newly established forests. Benefits include providing intermediate and periodic income from crops while timber matures or where timber harvesting is not possible or desirable. Forest farming practices help diversify forest management and provide important and useful products. Management should focus on site conditions and

tradeoffs between time and money in terms of method intensity. It also may be necessary to manage shade levels by thinning, pruning, and/ or adding trees.

Before beginning an enterprise, forest farmers should:

- 1) Identify and investigate existing or developing NTFP markets;
- 2) Select NTFPs of interest from the list of those with viable markets;
- 3) Obtain site requirements, production, and processing information for selected NTFPs;
- 4) Decide on a production method and operational investments; and
- 5) Thoroughly investigate technical resources and engage technical experts.

Markets for forest farmed products vary, but often are direct to consumer and via local stores, cooperatives, or farmers markets. However, in some cases, larger-scale markets are available. For example, shiitake, maitake, morel, and chanterelle mushrooms, as well as truffles, may be sold in small volumes at farmers markets or to gourmet restaurants, or in larger volumes to distributors for resale in regional markets. Markets for decorative products like grape vine wreaths often are in urban areas and may be very seasonal. Decorative products may be sold through cooperatives or to

local buyers. Non-local buyers may be reached through the internet. However, by marketing directly to consumers, a grower is more likely to retain a greater share of profits than when a middleman is involved.

A market analysis and business plan can help a beginning forest farmer chart out required inputs and is an essential starting point. This training manual offers a thorough framework for analyzing specialty crop markets and planning successful farming enterprises (see Chapter 9). Carrying out comprehensive and careful planning during and after startup will help minimize problems and increase chances for long term forest farming success.

Sources of expertise on growing and producing NTFPs can be obtained online from Cooperative Extension's Forest Farming Community of Practice (http://www.extension.org/forest_farming) and in County Extension offices, State Land Grant Universities, the Natural Resources Conservation Service, the USDA Forest Service, State Forestry and Conservation Agencies, and Internet sources (see Additional Resources section).



UMCA Forest Farming Research: Specialty and Gourmet Mushroom Production

Log grown shiitake and other specialty gourmet mushrooms have substantial markets. From gourmet chefs to general household consumers, the awareness and popularity of these edible NTFPs has grown significantly over the past 2 decades.

The University of Missouri Center for Agroforestry (UMCA) leads one of the nation's most comprehensive research programs for shiitake and other gourmet mushrooms in an effort to help develop mushrooms as a profit- able agroforestry crop in the Midwest.



Results indicate that shiitake is a premium, high-dollar mushroom that grows well in Missouri. Research is also being conducted to develop forest farming techniques for morel, truffle and other gourmet mushrooms. Numerous specialty mushroom workshops are hosted nationwide and often bring together researchers, niche-product experts, and landowners to advance specialty mushroom production and markets.

Examples of Forest Farming Products with Markets

Medicinal NTFPs: Ginseng, goldenseal, black cohosh, bloodroot, mayapple, solomon's seal, wild ginger, Oregon- grape, false unicorn (fairywand), ginkgo, skullcap, slippery elm, wild yam, Bethroot, Culver's root (black root), blue cohosh, boneset, lady's slipper, passionflower, partridge berry, hawthorne, pink- root, (indian pink), spikenard, stargrass (devil's bit), stoneroot, Virginia snakeroot, yellow indigo, and yellow root.

Floral/Decorative NTFPs: Grape vines for wreaths; burls for carving; bark, pine needles, wood splints, kudzu, various stems, and bark for baskets; , fall colored leaves and moss for decorations; cuttings from conifers for wreaths, roping, and garlands; salal, pussywillows, ferns, beargrass, and galax for floral greens for use in arrangements; and pine straw for landscaping mulch.

Edible NTFPs: Mushrooms including shiitake, oyster, reishi, morels, maitake, native truffles, and lion's mane; nuts including pecans, black walnuts; fruits and berries including gooseberries and blackberries, crab apples, elderberries, paw paws, and blueberries; vegetables including fiddle heads, ramps, bean salad (rosy twisted stalk), bear grass spiderwort, branch lettuce, burdock, dandelion, dock, miner's lettuce, nettles, poke sallet, sweet salad (Solomon's seal), upland cress (creasy greens), and watercress; syrups including sugar maple and birch; and honey.

Woodland Wildflower NTFPs: Spring ephemerals to be sold as potted plants including celandine poppy, wild geranium, bluebells, Jack-in-the Pulpit, mayapple, and trillium.

Specialty Woods NTFPs: Fine woods for making musical instruments and decorative bowls and plates including curly maple, black walnut, Appalachian red spruce, and eastern red cedar.

Biomass Plants: Willow and poplar grown as short rotation crops; and waste products from timber including sawdust, wood chips, bark, stumps, and branches.

Timber By-products: High quality sawlogs, low quality trees, firewood, and woody residues for energy production.



Left: High value medicinal herb markets have been increasing in recent years.

Right: Pine needles can be harvested into bales and sold for landscaping mulch



Success Stories

Ozark Forest Mushrooms, Timber, Mo.

One of the Midwest's most significant demonstrations of a successful forest farming practice is Ozark Forest Mushrooms near Timber, MO. Dan Hellmuth and Nicola MacPherson established the specialty mushroom operation in 1990 on what was then a timber operation, and together with a small staff, coordinate every step of the value-added process, from the inoculated logs to packaged, consumer-friendly, organic mushroom products.



Nicola MacPherson, right, talks to field day participants about year-round, sustainable shiitake mushroom production, used to extend mushroom production through the winter months.

A key to their success was developing an agroforestry practice that works within the natural setting of the land. Under the guidelines of the Stewardship Incentive Program, administered by the Missouri Department of Conservation (MDC), the couple harvests a renewable supply of oak logs for mushroom production while simultaneously maintaining their forested acres in a healthy ecological state. Consequently, what began with only 100 oak logs in production has grown to include 18,000 shiitake logs in production. Only five acres of the couple's 2,500 forested acres are utilized for the mushroom business.



A greenhouse with a wood furnace for burning spent/culled shiitake logs is used for mushroom cultivation during the cold season and sustainable usage of wood resources.

Ozark Forest Mushrooms gives particular emphasis to targeted marketing of their value-added boxed mixes and products. "The biggest marketing challenge for a rural area is that most of the mushrooms are a fairly high value specialty food, and the largest market is in some of the state's bigger cities," said Hellmuth. "We are marketing products to St. Louis and need to deliver them on a weekly basis."

"It's hard work that doesn't stop," MacPherson said, "but when I walk into a restaurant and see my mushrooms on the menu, or walk into a supermarket and see our products on the shelf, that gives me huge pleasure and makes all the work worthwhile."



Forest farming of log grown shiitake mushrooms, Ozark Forest Mushrooms, Timber, MO.

Additional Resources

Internet Sources: Understory Crops

- eXtension Forest Farming Community - http://www.extension.org/forest_farming
- Appalachian Beginning Forest Farmer Coalition - <https://www.appalachianforestfarmers.org/>
- NC State University Cooperative Extension: (numerous publications) <http://ncherb.org>
- National Agroforestry Center NTFP calculator - <https://www.fs.usda.gov/nac/tools/ntfp.shtml>
- National Agroforestry Center (additional forest farming resources): <https://www.fs.usda.gov/nac/practices/forestfarming.shtml>
- UM Center for Agroforestry: (publications on a variety of products and practices) - <http://www.centerforagroforestry.org/pubs/index.asp#pubs>
- Missouri Alternatives Center: (specialty crops listed) - <http://agebb.missouri.edu/mac/links/index.htm>
- National Sustainable Agriculture Information Service: (numerous publications) - <https://attra.ncat.org/horticultural.html#Agroforestry>
- Opportunities for Enhancing Nontimber Forest Products Management in the United States, *Journal of Forestry*: <https://academic.oup.com/jof/article/111/1/26/4599023>

UMCA DVD

Visit www.centerforagroforestry.org or the University of Missouri Extension web page at <http://extension.missouri.edu/explore/agguides/agroforestry/index.htm> to purchase.

Forest Farming video - <http://www.youtube.com/watch?v=ssFQXgGbwTE>

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EXERCISE: REVIEW OF FOREST FARMING

1. Identify the top three landowner objectives related to forest farming.

i. _____

ii. _____

iii. _____

2. What are the four general categories of Non-Timber Forest Products?

i. _____

ii. _____

iii. _____

iv. _____

3. What are the four methods of integrating forest farming with wooded environments? Which are the highest input and cost and which are the lowest?

i. _____

ii. _____

iii. _____

iv. _____

4. Identify three products to be produced from the managed land.

i. _____

ii. _____

iii. _____

5. Identify how the landowner can reach their objectives while producing the desired crops.

EXERCISE KEY

1. Identify the top three landowner objectives related to forest farming.

- i. Alternative income from forested land
- ii. Improved forest health
- iii. Improved timber value

2. What are the four general categories of Non-Timber Forest Products?

- i. Medicinal
- ii. Edible
- iii. Floral
- iv. Decoratives and Crafts

3. What are the four methods of integrating forest farming with wooded environments? Which are the highest input and cost and which are the lowest?

- i. Woods grown – highest input and costs
- ii. Wild-Simulated
- iii. Managed wild
- iv. Wild-harvested – lowest input and costs

4. Identify three products to be produced from the managed land.

- i. High quality timber
- ii. Shiitake Mushrooms
- iii. Ginseng

5. Identify how the landowner can reach their objectives while producing the desired crops.

First, identify certain wooded areas that may be more appropriate than others for growing the desired crop. Choose a northerly aspect and well drained site for ginseng production. There can be a bit more flexibility on the mushroom site (but, place it where access is good). Are there sites that are best for just producing timber (soils, aspect, slope position)? Select crop trees to create appropriate shade levels. Thin. Plant ginseng by planned method. Inoculate mushroom logs in an identified area.

Notes

Chapter 8: Agroforestry and Wildlife

In this chapter:

- **Wildlife benefits in your agroforestry operation**
- **What do I need to consider?**
- **What lives here and nearby now?**
- **Setting goals and objectives**
- **Agroforestry practices as habitat**
- **Economic opportunities presented by wildlife**
- **Resources for more information**



Wildlife benefits in your agroforestry operation

Regardless of what a landowner does on their land, including nothing, there are both positive and negative effects on wildlife. Many of our current agricultural practices, particularly those associated with larger farms and the associated increase in size of equipment, has drastically reduced the quality and quantity of available wildlife habitat. Agroforestry practices offer an opportunity to both provide benefits to wildlife as well as quality timber production. Many landowners view wildlife as an important by-product of their land management activities, particularly wood production. Agroforestry practices' diverse plantings result in structural and spatial diversity. It is this species and structural diversity that is beneficial to wildlife.

The sorts of benefits that landowners receive from wildlife are at least fourfold, including 1) aesthetic, 2) ecological, 3) economic, and 4) recreational benefits. Migratory birds, such as wood ducks and yellow warblers provide ample pleasure to the observer. Bees and flies are important pollinators in agroforestry systems, while foxes and weasels are important predators of seed-eating mice and others. Land-owners can benefit from agricultural tourism, including birders, bicyclists and families that are interested in visiting a farm to teach their children about food, or by providing lease hunting opportunities. Wildlife provide 1) endless opportunities for the amateur naturalist to learn about the interconnections among plants, animals, and their surroundings, 2) a plethora of photographic opportunities, and 3) entertainment at feeding stations.

Summary of benefits

Aesthetic – Wildlife provide auditory and visual beauty, and recreational interest.

Social – Wildlife help provide a sense of place that attracts families, photographers, birdwatchers, hikers, hunters and anglers.

Ecological – Wildlife diversity generally indicates high-quality habitat. Some animals provide soil aeration services, such as moles and ants; others disperse seeds and pollinate plants, such as birds and insects.

Economic - Wildlife can provide you with an economic return when you open your land to recreation (e.g. birdwatching, hunting, guiding or agritourism). Indirectly, pollinators provide billions of dollars of pollinating services, and bats provide billions of dollars in insect “pest” control.

What do I need to consider about wildlife and agroforestry?

For wildlife to be present, their basic needs must be met, including food, water, shelter and space. A shortage of any of these elements will severely limit the numbers of a given wildlife species that are able to be supported on a given property. In addition, many wildlife species have complex needs that include 1) the need for multiple habitats during their life cycle, 2) the need for different food items based on their age, 3) the difference in behaviors of the species between the breeding and non-breeding seasons, and 4) an annual migration of many birds, as well as some mammals and insects each year to warmer climates, where someone else is managing wildlife.

Types and amounts of wildlife that will benefit from agroforestry practices are dependent on the size of the agroforestry area, surrounding land uses, types of plantings, configurations of plantings, age of plantings, and the juxtaposition of different habitat types. Some wildlife species are known as area-sensitive, needing large, contiguous areas of habitat in which to live. Other wildlife species thrive where there is a lot of edge habitat, the area where two habitat types intersect. Some wildlife species are *specialists*, animals that are reliant on just one or two food sources, for example. Others are *generalists*, animals that can either feed on a large variety of foods, live in a variety of different habitat types, or both. These



characteristics of wildlife will, in part, determine the feasibility of management as part of your agroforestry operation.

Geographic scale, or size, of both agroforestry areas and surrounding land use is an important factor in wildlife habitat management. The scale of agroforestry practices, typically 4-8 ha, is small enough that managing for many wildlife species is impractical. This includes larger-bodied animals and area-sensitive species. If your agroforestry practice is embedded in a larger matrix of suitable habitat, it may be possible to benefit many large wildlife species. However, there are many smaller bodied animals that can be managed on smaller areas.

Agroforestry practices embedded in some habitats can lead to negative impacts on current wildlife populations. The linear and fragmented makeup of many riparian forest sites can lead to a decrease in the different types of small mammals inhabiting an area, as well as birds, reptiles and amphibians. In some cases, the increase in habitat and reproductive success for songbirds can be negated because of an increase in nest predation. Importantly, landscape context matters when managing for wildlife. The wildlife benefit derived from agroforestry is directly related to the surrounding *habitat matrix*.

Fragmentation, or the isolation of habitats, poses another issue for wildlife. Whenever possible, it is preferable to restore larger fragments or more connected fragments of habitat than to restore many small and isolated fragments. Cowbirds reflect an important example: cowbirds lay their eggs in other birds' nests. Many songbirds are naïve to this sort of "parasitic" behavior and will work to raise the larger and louder cowbird chick(s) at the expense of raising their own offspring. The rates at which cowbirds parasitize the nests of forest songbirds typically decline with distance from forest edges. Fragmentation also limits dispersal in amphibians and thereby decreases

their opportunities to colonize wetlands. For wildlife to thrive, it is important to maintain or recreate, habitat connectivity, within a larger geographic area. Agroforestry practices can be used to reduce the negative consequences of fragmentation by lessening habitat isolation through the use of plantings that are well thought out and well-connected with other habitats.

A final consideration pertaining to habitat fragmentation and isolation is *source and sink population dynamics*. When installing agroforestry practices, it may prove to be very inviting to wildlife species, and in fact, be heavily used by wildlife. However, when such practices are isolated from other suitable patches of habitat, they can serve to increase predator use of the area and thus lead to an overall reduction in the prey species. This is because as the prey species disappear from the site, it becomes open and inviting for others of its kind to recolonize, thereby increasing predator use of the area, and leading to another reduction or disappearance of the prey species from the area. This can be compounded when the site is irregularly shaped, which increases the amount of “edge” habitat which makes the prey species more vulnerable to predators.

In addition to the limits inherent in the wildlife species themselves and the land use of an area, wildlife benefits that can result from your agroforestry operation are also contingent upon your own goals and objectives for your property and the investment that you can and will make to integrate wildlife benefits with your timber production and agricultural production. To maximize benefits to wildlife, a landowner can slightly modify plantings and select plants that meet the needs of wildlife species with little impact to the production of forest products or field management. With careful selection of trees and shrubs, you can develop a new wildlife product and diversify your returns. However, it goes without saying that compromise is inherent when you are balancing tree production, crop income and



wildlife production. A strictly economic cost-benefit analysis is unlikely to result in favoring wildlife production. However, it’s the previously mentioned benefits of wildlife that help to balance the scales. In some instances, discussed later in this chapter, it is also possible to reap some economic return on an investment in production of wildlife habitat.

What lives here and nearby now?

The first step in constructing a wildlife management plan for your agroforestry area(s) is to conduct an inventory of what wildlife species are currently using or living on your land. It is advised that you conduct an inventory prior to goal and objective setting, because your goals and objectives should consider the wildlife that is currently on the property. Your interest and the amount of time and energy that you have available to invest, will determine the completeness of your inventory and the frequency with which you go out to observe wildlife. A good first step to take in conducting your inventory is to download an aerial map of your property or create your own map of your existing structures, crops, standing timber, and water features. This will be the foundation for your efforts to monitor wildlife. Spending time in the field to identify trees, shrubs and important understory plants will add detail to your map and provide information regarding current food, water and cover resources available to wildlife.

Standard methods are available to inventory mammals, birds, amphibians and reptiles on your property. Some insect groups, such as butterflies and moths, are more easily observed and identified than others. Some wildlife species are active when people normally are, during the day, and are thus more easily observed than species that are night-active. Some species are year round residents, such as nuthatches and cardinals, while others are only in the area for part of the year such as yellow-rumped warblers and kingbirds. To be able to document the greatest percentage of wildlife that are currently using your property, it is necessary to get out in different seasons and at various times during the day. Citizen science programs and trainings in your area can provide you with the skills, checklists and sometimes even the equipment you need to inventory wildlife on your property. These events will also provide you with opportunities to meet like-minded individuals and the instructors running the trainings, and perhaps garner some assistance in your inventory work.

Once you know what plants and wildlife already frequent your property, as well as the time and money you have and are willing to invest in a wildlife management plan, you're ready to define your goals and objectives.

Setting Goals and Objectives

You are more likely to meet with success in increasing wildlife on your property if you have clearly identified goals, and both short and long-term wildlife objectives. Your goals and objectives will guide you in your management activities and subsequent monitoring of wildlife populations on your land. If you do not clearly define what your goals and objectives are from the start, you may find that you divert time and financial resources with little return on your investment. The identified end goal of your wildlife management e.g. to harvest deer, will influence the sorts of agroforestry practices that you use to meet your goal.

In defining goals and objectives for wildlife, it's important to remember that as your agroforestry areas age and the structure and plant composition of these areas change, so too will the wildlife change. As your forests mature, those wildlife species that are dependent on young, or early successional forest habitat, will decline while species that are dependent on mature forests will appear and increase in number. For example, in very young stands, we can expect species such as quail and field sparrow to thrive, while in more developed stands, it is more likely that birds such as brown thrashers and northern cardinals with benefit. When the stand reaches maturity (30- 60 years), species that are dependent on mast will increase, such as white-tailed deer, white-footed mice and tree squirrels. The point is to recognize that wildlife species and benefits will change as your plantings mature. Realizing this from the beginning can lead to setting realistic goals and can reduce later disappointment.

Your wildlife objectives will guide you in your choice of trees to plant, distance between plants, cover crops and even the configuration of your fields. Some options may be more economically viable than others, while some options may give rise to more wildlife viewing opportunities. Another point regarding the setting of wildlife goals and objectives is to consider some of the potential downsides of managing for wildlife.

Wildlife can and may cause considerable changes perceived as damage. Eastern cottontail



rabbits and white-tailed deer routinely feed on tree and crop plantings, as well as ornamental plants and even weeds. While rabbit damage is easily identified by the clean 45° cut made, white-tailed deer damage can be identified by the ragged ends they leave behind. During the summer, rabbit and deer damage to woody vegetation is minimal because of the abundance of green, leafy vegetation available, but they can do considerable damage to seedlings and saplings during the fall and winter. In addition to feeding on woody stems, male deer will rub their antlers on seedlings and saplings, sometimes knocking stems completely out of the ground; in other cases, leading to misshapen boles and decreased wood value.

Rabbits can cause considerable damage in agroforestry. Dugger et al. (2003) found that damage to oaks planted in plots with natural vegetation was greater than in plots that had been planted to redbud grass (85% of the bareroot seedlings clipped and 31% of the bareroot seedlings clipped, respectively)

– *Millspaugh et al. 2009*

There are many methods available to reduce rabbit and deer herbivory in agroforestry plots. These range from fencing, which can be 100% effective but can also be quite costly, to protecting individual stems using plastic mesh tubes or shelter tubes (note that shelter tubes affect the microclimate within them which is warmer and more humid during the day). Fall mowing may be effective in reducing rabbit herbivory because of the elimination of winter cover. Keep in mind that even a relatively small patch (< 10m²) may contain rabbits.

Agroforestry practices as habitat

Managing for a diversity of habitat types will also tend to promote a diversity of wildlife. Agroforestry practices such as alley cropping, windbreaks, forested riparian buffers, silvopasture, and forest farming will provide

you with opportunities to manage for a diversity of habitats that may benefit wildlife. Trees and shrubs can enhance wildlife habitat as well as provide additional products on the farm.

Alley Cropping

Alley cropping systems are designed to grow an annual crop between rows of high value trees, like oak, pecan or walnut, until the trees are harvested or the alley crops are shaded out.

Alley cropping diversifies plant structure for wildlife habitat. Such structure is important for birds, and the matrix of trees and crops provide travel corridors for mammals and reptiles. You can optimize benefits to wildlife by carefully choosing the agricultural crop to be planted and its configuration. Once the trees have matured to the degree that they are shading out the crop, that habitat becomes important for amphibians, which must travel from one activity area to another without drying out.

Cover Crops

A native cover crop mixture that includes native warm season grasses will benefit wildlife. Previous research in such habitat has garnered observations of greater bird abundance, species richness, and reproductive success.

Riparian Forest Buffers

Riparian buffers consist of streamside plantings of a mixture of grasses, shrubs, forbs and saplings, which are attractive to wildlife. While these buffers can serve as travel corridors for wildlife, they are not necessarily a good place for birds to reproduce, unless other high quality habitat exists nearby. These buffer strips can also be valuable as habitat and travel corridors for amphibians, but need to be about 100 m wide to protect stream amphibians. The tree canopy of buffers reduces water temperature, while roots and fallen leaves provide food and hiding places for wildlife. A potential downfall of streamside buffers for wildlife is that they can lead to reduced nest success in some birds, particularly grassland birds. These areas are most used by generalist birds.

Windbreaks

Windbreaks, plantings of trees perpendicular to prevailing winds, can protect soil, crops, livestock, buildings and wildlife from harsh winds when properly designed and located. The microclimate that windbreaks create enables native insects to pollinate crops more efficiently. Size of the windbreak is often considered most important to bird diversity. However, it's important to note that birds that most benefit from windbreaks are forest-edge and generalist species. Windbreaks have been reported to have negative effects on grassland birds due to higher predation and cowbird parasitism rates. Some mammals, such as white-tailed deer and cottontail rabbits benefit from windbreaks because of the mix of food and cover available. Windbreaks are most beneficial to wildlife when they are large and provide a diversity of structure, including both deciduous and coniferous trees, shrubs and a diversity of understory grasses and forbs.

Forest Farming

High value specialty crops like ginseng and goldenseal can be cultivated under the protection of a forest canopy. This provides a harvestable product for the landowner which is incentive to keep the land in forest habitat. The diversity created with forest farming attracts a variety of wildlife species.

Silvopasture

Silvopastures combine trees, forage and livestock in an intensively managed system. Silvopastures are typically less diverse than a natural forest understory, but incorporating clumps of native grasses and forbs can provide quality habitat for wild turkey and other animals.

Restoration of Bottomland Forests

Bottomland forests can be incredibly beneficial to wildlife because of the availability of mast from oaks and nut-producing trees, fruit from soft mass trees and the variety of structure

provided by trees and shrubs. Bottomland forests are important for birds in every stage of development from grassland to mature forest.

Recently a number of federal programs have aimed to restore some of the millions of hectares of bottomland forest that were converted to agricultural use in the 19th and 20th centuries. Although trees can be difficult to establish, newer techniques, which includes the use of larger seedlings with well-developed root systems, can increase the likelihood of planting success. Once established, oak species provide mast for waterfowl and deer and are favored foraging areas for spring-migrating and breeding warblers. Faster-growing tree species can also benefit wildlife by providing needed structure to forest songbirds. During the early years of an oak planting, this habitat will be used by a number of grassland species. By planting oaks in combination with fast-growing tree species that promote quick stand development, you can more quickly benefit and attract forest songbirds. The downside to this approach is that the taller trees provide perches for cowbirds, which leads to increased rates of cowbird parasitism on forest songbirds. However, the rates of cowbird parasitism are not only varied at the local level, but are also sensitive to regional and landscape effects such as regional forest cover.

Special Applications

Many agroforestry practices have been adapted to help people and communities deal with



problems, such as wastewater and stormwater treatment, with fast growing willows and cottonwood trees. These trees provide wildlife habitat and may be a future energy source.

Elements of Wildlife Habitat and its Management Provided by Agroforestry Practices

Disturbance

Historically, fire, floods, wind, ice and wildlife browsing disturbed the land which in turn helped control invasive species and promote native plant growth. Today, vegetation can be managed by mowing, disking, thinning, prescribed burning and grazing. The extent and timing of disturbances helps create diversity and structure. Timing can also minimize impact to wildlife, such as mowing after nesting is complete.

Vertical and Horizontal Structure

Different layers of vegetation allow an assortment of wildlife to utilize the same area. Each tier creates a niche in the habitat area. Five or more layers are optimal and include the canopy, understory, shrub layer, herbaceous layer and the floor.

Connectivity

Many species of wildlife need a minimum amount of a particular habitat type; if it gets to be too small they won't use it. Vegetation can be used to connect several small isolated areas within a landscape, thus making it more viable and increasing the usable space for wildlife.

Economic Opportunities Presented by Wildlife

Agritourism and hunting leases are just two of the ways in which you can diversify your farm income with wildlife. Agritourism in its broadest sense involves any agriculturally-

based operation or activity that brings visitors to a farm or ranch. In the United States, it includes such activities as picking your own fruit, shopping at farmstands, horseback riding, honey or wine tasting, birdwatching or learning about cheesemaking. The Whiterock Conservancy, in Coon Rapids, Iowa, provides an example of a working farm enterprise that has also embraced agritourism in its mission. Its three-part mission includes: 1) Protect & Preserve the Natural Resources of the Middle Raccoon River Watershed, 2) Demonstrate Sustainable Multipurpose Land Management, and 3) Promote Low-impact Outdoor Recreation & Provide Environmental Education. Their approach to tourism is structured around stewardship which emphasizes the diverse landscape managed with diverse methods and used by diverse audiences. Their tourism focus is on education particular as it pertains to conservation and to manage visitor impacts to the property.

A hunting lease is an agreement between a landowner and a hunter or group of hunters, where the right to trespass and hunt is granted for a particular time and fee. Hunting leases are most popular in areas where little public land is available to hunt and access to private lands is at a premium. Before you delve into the world of hunting leases, it's important to consider what is reasonable to expect. The type and quantity of game animals depends upon not only your land, but that of the surrounding area. As your trees move through different phases of the growth cycle (i.e. seedling, sapling, mature tree), the type and extent of habitat available to game animals will change. The most profitable pay-to-hunt operations usually require the greatest investment in labor and management by the landowner.

Some general considerations when contemplating lease hunting include the following. To be effective and profitable, you need to have willing participants partake of the opportunity. It is therefore, suggested, that providing such opportunities near expanding urban and suburban areas will be

advantageous. Another consideration is the “quality” of the hunting experience provided to clients. This includes cost of the lease, distance from the clients’ homes, the abundance and variety of game animals, hunter safety, camping or lodging facilities and other amenities.

Finally, you’ll need to consider what sorts of leasing opportunities will be available throughout your timber rotation. Early on, it may be that mourning doves provide an opportunity, but once the stand has matured, opportunities for turkey and white-tailed deer hunting will be available which will require less intensive management on your part.

Types of hunting leases are variable. In the past, many landowners provided non-fee access with an informal verbal permission agreed to by a handshake. This may still be useful for managing nuisance populations, particularly if you don’t want to invest the time or energy or simply are not interested in fee hunting. However, agreements are becoming rare. They are most often still found in rural or rural-small town areas where hunters are more aware of farm-related issues and concerns. Another non-monetary hunting lease is an exchange of services, whereby a landowner allows hunting in exchange for a service such as the monitoring of land for trespassers or helping with farming operations. These arrangements can be either formal or informal.

There are four general categories of fee hunting:

- 1) daily lease;
- 2) short-term or season lease;
- 3) annual or multi-year lease; and
- 4) broker or outfitter lease.

A daily lease is often used when there is a relatively short hunting season and when a number of hunters can be accommodated on a small parcel of land. Most commonly, game species include pen-reared birds or mourning doves.

This sort of lease is intensive for a landowner to manage, requiring a greater intensity of interactions with hunters and more intensive wildlife habitat management to assure that game animals are available on the opening day of the season.

Short-term or season leases necessitate much less labor on the part of the landowner. This sort of lease works best for species such as turkey or white-tailed deer. Some considerations for short-term leases include the use of equipment, such as blinds. You need to be sure that hunters do not use any kind of screw-in type of tree stand or climbing steps, which may damage the eventual value of the trees that you’re growing.

In an annual or multi-year lease, a landowner enters into an agreement with a hunt club or a group of friends willing to share the cost of having long-term access to a hunting spot. An advantage to this sort of arrangement is that be the establishment of a long-term relationship with the land, the hunters may start to develop a sense of stewardship for the property and may ask to help conduct or participate in wildlife habitat management activities.

A broker or outfitter lease involves a middle man that rents all of the hunting rights from a landowner and then subleases to individual hunters by species or season. This alleviates a lot of the work by a landowner, who then only has to interact with one individual on all hunting related issues.

Regardless of the flavor of hunting arrangement that you enter into, one of the most important concerns for most landowners has to do with liability. Most landowners fear being sued or held liable for injuries sustained by hunters or others while on the land. The degree of landowner liability differs by the status of the visitor or use, with trespassers being afforded the least protection and invited visitors, the most. A qualified lawyer and an

insurance agent should be consulted before you enter into any hunting lease agreement or purchase liability insurance.

Resources for More Information

Cost share programs for wildlife exist on the federal, state and local levels. There are two federal agencies, both under jurisdiction by the United States Department of Agriculture (USDA) that provide the majority of support for conservation practices. In recent history, most of the support for conservation practices has been associated with federal farm programs. However, cost share programs that have not typically allowed for production of harvestable products can be used to develop and maintain habitat components in conjunction with farming practices.

The Farm Service Agency (FSA) administers the Conservation Reserve Program (CRP). The CRP includes many conservation practices, including windbreaks (Conservation Practice (CP) 5) and riparian buffers (CP22). The FSA also have several other programs that can be used to create or maintain wildlife habitat, including: Conservation Reserve Enhancement Program (CREP) and the Grassland Reserve Program. (<http://www.fsa.usda.gov>)

The Natural Resources Conservation Service (NRCS) often provides the technical support needed to design a CRP conservation practice. NRCS is also responsible for supporting and administering the following: the Conservation Security Program (CSP), Wildlife Habitat Incentive Program (WHIP), Wetlands Reserve program (WRP); and Environmental Quality Incentives Program (EQIP) (www.nrcs.usda.gov).

Private programs that provide support for wildlife habitat management activities on the national level include: Pheasants Forever (PF) (<http://www.pheasantsforever.org/>); National

Wild Turkey Federal NWTf (www.nwtf.org/)
Quail Forever (QF) (www.quailforever.org/);
and Ducks Unlimited (DU) (www.ducks.org).
In each case, the main thrust of the organization is to develop, maintain, and manage habitat for the wildlife species of interest. These groups are instrumental in putting private landowners in touch with professionals who will assist in designing habitat that is appropriate for the landowners' needs and desires. These private groups often have seed mixes available at reduced costs and equipment to rent for the development of local wildlife habitats.

Additional Resources

Agritourism and Lease Hunting

Successes and Challenges in Agritourism:

https://www.agmrc.org/media/cms/AgritourismSuccessesChallenges_F987C590149EE.pdf

An example: Whiterock Conservancy located near Coon Rapids, IA

www.whiterockconservancy.org

Wildlife Habitat Management

Iowa Natural Heritage Foundation: A Bird's Eye View: A Guide to Managing and Protecting Your Land for Neotropical Migratory Birds in the Upper Mississippi River Blufflands:

https://issuu.com/inhf/docs/a_bird_s_eye_view

Agricultural Research, December 2004: Agroforestry and Wildlife Management Go Together on Small Farms www.ars.usda.gov/is/ar/archive/dec04/farm1204.pdf

Purdue University Forestry and Natural Resources: Basics of Managing Wildlife on Agricultural Lands (IN) www.extension.purdue.edu/extmedia/FNR/FNR-193-W.pdf

Wildlife Management Institute: Best Management Practices for Woodcock and Associated Bird Species <http://dnr.wi.gov/topic/wildlifehabitat/documents/wcbmp.pdf>

Missouri Department of Conservation: General Management for Wildlife (MO)

<https://mdc.mo.gov/property/improve-my-property/wildlife-management>

Midwest Partners in Amphibian and Reptile Conservation: Habitat Management Guidelines for Amphibians and Reptiles of the Midwestern United States

<http://www.mwparc.org/products/habitat/>

Xerces Society (for information about providing habitat for pollinators)

<http://www.xerces.org/pollinator-conservation/>

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Notes

Chapter 9: Marketing Principles

In this chapter:

- **Marketing agroforestry products**
- **The “black box” of agroforestry enterprises**
- **Data collection**
- **Analyze current situation (SWOT Analysis)**
- **Industry assessment (Porter Five Forces Model)**
- **Researching and selecting target markets**
- **Developing product, price, distribution and promotion strategies**
- **Real world examples**

Marketing agroforestry products

Unlike other types of conservation practices where land is taken out of production, agroforestry is “productive conservation.” Agroforestry practices enable landowners to generate income from the production of a wide range of conventional and specialty products while simultaneously protecting and conserving soil, water and other natural resources. Products produced through agroforestry practices, including specialty or non-timber forest products, are produced from trees, within forests, or in myriad combinations with trees or shrubs, crops and/or animals. Many of these products have proven economic value but have been ignored by, or are unknown to, agricultural and forest landowners. In North America such products include: edibles (e.g., mushrooms, chestnuts, pecans, hickories, hazelnuts, persimmon, pawpaw, Asian pears, cornelian cherry, Kiwi fruit, aronia, elderberry, mayhaw, goji berry, other berries); herbal medicinals (e.g., ginseng, goldenseal, witch hazel, elderberry);

specialty wood products (e.g., diamond willow canes, redcedar closet liners, walnut gunstock blanks); floral and greenery products (e.g., curly and pussy willow), ferns, salal; fiber and mulch (e.g., cedar pet bedding, pine straw); and recreation (e.g., agritourism, fee hunting).

The “black box” of agroforestry enterprises, the need for market research

Agroforestry enterprises often produce niche products for markets about which little is known. All that may be known about a product’s market is that it is produced and eventually purchased and consumed. What happens to the product along the value chain between producer and consumer and why the consumer is buying the product is unknown, and it is commonly referred to as the “black box”. From a producer’s perspective, the list of unanswered questions is long. How do I get into the market? What are my costs and potential returns? Where can I buy what I need for my business and for what price? Is the supply readily available? Who are my customers? How many times does the product change hands before it reaches the final consumer? Who are my competitors, what are they doing? How is this market changing? What strategy should I use in order to be successful in this market? These and many other questions complicate the decision to produce and market niche products. Unlike commodity markets with readily available market information, the challenge for farms and small businesses that engage in agroforestry enterprises to overcome is the lack of information about niche specialty product markets. In order to successfully exploit niche product markets, agroforestry entrepreneurs must perform some market research to open the “black box” and overcome information asymmetry inherent in these niche markets.

Data collection

The first step in any market research process is data collection. It starts with investigating publicly available data (secondary information sources) and continues with information gathered specifically for the market(s) of interest (primary information sources).

Secondary information sources:

- Published reports and studies.
- Online information sources, such as websites, newsgroups, and electronic bulletin boards.
- Trade magazines and journals, newspapers, books and literature from competitors.
- Business directories.

Primary information sources:

- Personal interviews with consumers, producers, and other persons involved in the value chain.
- Observations (visiting farmer's markets, retail outlets, production facilities, as well as attending farmer field days, tradeshow, and marketing conferences).
- Online, mail or phone surveys.
- Focus groups.

This list is not complete but should give you an idea of some potential sources for market information that will help with analyzing the business environment and the industry for whatever product you may be interested in selling.

Analyze your current situation – SWOT analysis

Strengths, weaknesses, opportunities, threats (SWOT) analysis includes an examination of both internal factors (strengths and weaknesses) and external factors (opportunities and threats) that can have an influence on the success of your enterprise.

First, look inside the farm business and identify its strengths and weaknesses. What strengths does the farm/business have that helps you

accomplish your goals and makes you competitive? (e.g., the ability to provide quality products, consistent year-round supply, excellent customer service, competitive price, production or marketing skills, good location, reliable workforce, previous experience in the industry, strong financial position). Weaknesses are areas where the farm/business can be vulnerable to competitors. What can create problems in your business? What do your competitors do better than you? (e.g., lack of experience in the industry, insufficient finances, limited access to distribution channels, seasonal product, insufficient workforce). Identified weaknesses (e.g., lack of consistent supply because of the seasonality of the product) can be transformed into strengths (e.g., building indoor facilities to extend production time). In general, a farm must find ways to minimize the impact of its weaknesses on its business operations.

The second part of the SWOT analysis requires you to look outside your business at issues that you cannot control but can manage and identify opportunities or threats and find ways to influence their impact on your business. Is there anything in the marketing environment related to suppliers, intermediaries, customers, competitors, and public-at-large that can help (opportunity) or affect (threat) your business's ability to produce and sell products? Are there any trends favorable (opportunities) or disadvantageous (threats) for your business?

Examples of opportunities include a farmers market just developing in your area; a grower coop just taking shape close to you; buying property near a large population area that would allow you to direct market your product; increasing interest in locally produced products; increased interest in new, more sustainable agricultural practices; development of new varieties or cultivars.

Examples of threats include changes in federal and state regulations, increased competition from imports, inflation, shortage in raw materials, extreme climate events, fluctuations of markets, seasonal purchasing trends, and high levels of competition.

The process of identifying any strengths, weaknesses, opportunities or threats should help you identify areas where your strengths and opportunities align with a high probability of success as well as combinations of weaknesses and threats that need to be avoided or at least provide for methods to minimize their effects on the farm business. The SWOT analysis helps provide direction and serves as a basis for developing a business plan. It should be repeated at least once a year to review achievements, measure production efficiencies, and evaluate alternatives.

Industry assessment – Porter’s Five Forces Model

An approach proven successful in shedding light on the “black box” is the model developed by Dr. Michael Porter of Harvard University

(Porter, 1980) that describes the forces driving industry competition, known as Porter’s Five Forces Model (PFFM) (Fig. 1). Porter’s strategic forces help evaluate the ease of market entry and exit, buyer and seller power, power of substitute products and competitive rivalry and provide a general view of the industry. With respect to agroforestry, the method is especially useful for farm businesses that plan to enter new markets.

The forces and the questions they help answer:

Potential entrants (barriers to entry)

How difficult is it to enter the market and what resources are needed?

Barriers to entry are advantages that existing firms have relative to new entrants like high start-up costs, proprietary knowledge and learning curve, and cost advantages for existing firms.

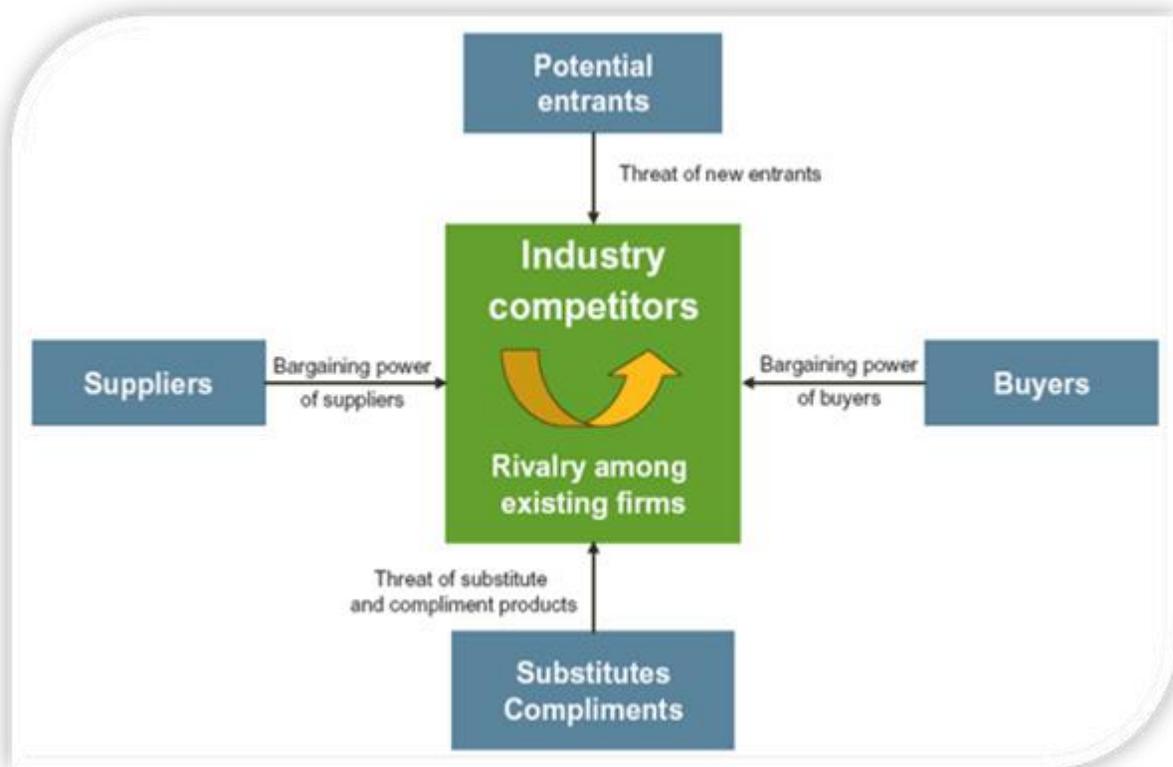


Fig. 1. Porter’s Five Forces Model

For example, if you want to produce mushrooms, large white button mushrooms firms definitely have advantages of scale and cost advantages associated with equity in facilities. Even if you have the necessary information, materials and equipment available, it's tough to break into the white button mushroom industry because of the large capital required to achieve a competitive scale. When supply is limited (like in the case of the elderberry industry), larger, existing firms have better access to the limited supply, leaving new entrants with the need of paying higher prices and/or limiting production. For all agroforestry specialty crops, information about production and marketing is lacking. In a few areas, universities, experienced growers and processors lower this barrier by providing the necessary information to get started. Attention should be given to researching laws and regulations which can facilitate or hinder entry into the industry. As a new firm (entrant), you would like to have easy access to the new industry, but once there, you would like to have some barriers to protect you from new entrants. It is important to know and understand these barriers for an easy entry and for creating protection in the future.

Bargaining power of suppliers

Who can provide the needed supply? Who has more control in the supply chain? Can you choose from a variety of suppliers thus getting competitive prices for the supply you need? If prices get too high can you use another input? If not, can you produce it yourself?

Suppliers are the individuals and businesses that provide the raw materials to be transformed into goods. Lack of available supply may increase the cost of production (e.g., limited sources of ginseng seed, import of elderberry concentrate from Europe) or delay the production start (e.g., need to propagate own elderberry plants or produce and graft own trees).

Bargaining power of buyers

Who is going to buy my product(s)? Would it be better to deliver directly to consumers or to

use intermediaries? Who are the intermediaries? How much control does the buyer exert? Who are the final customers and what are their needs? Are you competing against a respected brand name that creates a higher value for its products?

Buyers are the people/organizations who create demand in an industry. When the buyers exert power in an industry, they may impose specific requirements on the quantity and quality of products they buy. These may impose additional costs to sell the products. For small niche specialty products produced in agroforestry settings, there is a challenge to provide large enough quantities to enter distribution channels. Another challenge on the buyers' side is handling perishable products. For example, due to the newness of the industry, there is little knowledge among buyers on how to handle chestnuts. Due to high moisture content, chestnuts need to be kept refrigerated to minimize water loss and decay. Communication and information provided to retailers will ensure that chestnuts will be handled and stored properly and consumers will have a positive experience with the chestnuts they purchase.

Substitutes (substitute products)

Are my products in any way unique or can they be easily substituted by other products with a similar function? If buyers decide your products are too expensive, will they buy another product? It is very important to distinguish your products and to communicate their unique properties otherwise they will be easily substituted by lower price substitutes. For example, you need to distinguish native pecans from Georgia or Texas pecans if you want to sell them at a premium. Also, you need to communicate and educate the consumer of the various health benefits of elderberry if you want them to choose elderberry juice and not another cheaper or better known juice on the shelf.

Industry competitors (rivalry among existing firms)

Who are the competitors and what are their competitive advantages? What can I do better than them? Are you competing against a respected brand name that creates a higher value for its products?

Rivalry can take many forms, such as price discounting, new product introductions, advertising campaigns, and service improvements. Characteristic for new and small markets like the ones for niche specialty crops, the level of competition is low and existing businesses cooperate to grow the industry. However, to protect your place in the market, you need to start to differentiate from the others and create competitive advantages like quality, customer service and convenience.

Researching and selecting target markets

Customers differ in their values, needs, wants, beliefs and incentives to purchase. Product oriented businesses, who find a product they can produce and try to sell it without first looking at customers' needs, risk developing a product that won't sell. Instead, most successful businesses are customer oriented—they design marketing strategies around the needs of their customers.

The process of identifying customers' preferences and dividing the larger market into groups is called segmentation. Markets can be segmented in a variety of ways. The most common ways of segmentation are by demographic characteristics (e.g., age, sex, race, religion, education, income, household size), geographic location (e.g., counties, states, regions) and psychographic characteristics (e.g., lifestyle characteristics, behavioral patterns, beliefs, values and attitudes).

Creating a customer profile for each segment will help describe who are the customers, what they value, how much are they willing to buy and determine which segment can be the most profitable to target. By identifying and targeting only specific market segments you can develop more effective product, price, distribution and promotion strategies.

Developing product, price, distribution and promotion strategies tailored for each target market selected

A marketing strategy is a plan regarding what products to develop, how the products will get to the customers, for what price and how the product benefits will be communicated to customers.

Product strategy

What product will you offer to satisfy the needs of your target customers?

The most common marketing strategy for farmers producing agroforestry products is product differentiation to appeal to a focused group of consumers (the target market). Farmers have the opportunity to implement many creative marketing ideas to differentiate their products and services in response to the needs of their



Left: Terry Durham, producer and seller of elderberry juice (Hartsburg, Mo.)

Bottom: A variety of elderberry value added products offered by Wyldewood Cellars (Wichita, Kan.)



customers. Differentiation equates to adding value to the products. Adding value will allow you to obtain a better price for the same amount of raw material. For small landowners, adding value to agricultural and non-timber crops can make an enormous difference to the bottom line.

Ideas for Adding Value

Value can be added through processing, packaging and customer service. A few of the more common methods of adding value to your agroforestry products are described below.

- Many edibles you could produce in an agroforestry practice also have a market in a value added form. Fresh products are usually perishable and only available for short periods. Processing extends the period during which products can be made available, and allows processors to increase potential returns. Examples include: processed fruit products (jams, jellies, fruit leathers, sauces, chutneys, vinegars); frozen products (berries are the most obvious candidates, though mushrooms are sometimes frozen); and dried products (mushrooms, berries).
- Value-added decorative and craft products can provide immediate returns. The amount of skill required to produce these products varies. Some products (e.g., wreaths) are fairly easy to produce, while others (e.g., baskets and furniture) may require more time to develop proper skills.
- Herbal products offer a number of opportunities for adding value. Medicinal herbs are a good option for marketing at a local level but you must adhere to regulations that govern the sale of these products. Getting into the business of selling 'drugs' to the mass market should not be taken lightly. Herbal teas sold under food regulations may offer a much easier approach.

Is it Worth it? The 'Cons' of Adding Value

Adding value is not always the best option. Ask yourself some hard questions before you embark on the value-added route:

- Are financial and human resources / expertise available to develop value-added processing?
- If not, what will it take to acquire them (e.g., loans, training)?
- Do you have the long-term supply of resources to support a value-added strategy?
- What are the markets for potential value-added products?
- Can you meet the requirements of the marketplace?
- How easy will it be to break into those markets?
- How long will it take to recoup the costs of any processing equipment involved?
- Can you handle the risks sometimes involved in adding value? For example, are you better off taking less for your product but letting a middleman absorb the risk?

As with any business, you have to do the research, consider your resources and crunch the numbers to see if it's worthwhile. Usually, adding value is smart marketing.



Top: Curly willow can be a profitable crop when sold to local florists (Nebraska Woody Florals Cooperative).



Left: Chestnuts sold at the Missouri Chestnut Roast Festival

Distribution strategy: Getting products to buyers

There are three aspects to getting your products to buyers:

A. Distribution: The sales channel(s) your product will follow.

B. Location: Where you sell your product.

C. Transportation: How your product will reach the buyer.

A. Distribution: Sales Channels. Your product may be able to take a number of different routes—or sales channels—to the end user. Which sales channel(s) you end up using will depend on a number of factors, such as:

- Existence of a ‘dominant’ distribution system for your product
- Demand for your product from various levels in the marketing chain
- Time you have available and your marketing abilities.

Using these criteria, among others, you can choose one of the two basic marketing channels that most products follow: Direct marketing is the process of selling a product or service directly to the consumer. Direct marketing is the alternative most suited to agroforestry product producers. Selling direct provides the grower the opportunity to capture a larger share of the consumers’ spending and the opportunity to educate the consumer about the farm and its production methods (e.g., about the advantages to buy organic or locally grown products). Direct marketing is growing in popularity because consumers now demand safer and high quality products. Buyers place a value on coming face-to-face with the producer and their production location (farm, farmers market, on-farm retail store) and obtaining more information about the products produced.

Intermediary distribution provides other market outlets and include wholesalers, brokers, cooperatives and retailers. One of the challenges in the wholesale marketplace is the need to

provide a constant, dependable supply of large quantities of quality goods. Wholesalers may only accept a few weeks’ worth of product at any one time, forcing the producer to incur storage and multiple delivery costs. Another challenge is to maintain premium product integrity along the value chain (i.e., maintain freshness or maintain organic integrity at each stage of the product’s journey to the market). In general, the closer the producer is to the consumer, the greater the return as well as the workload. Your choice of sales channels may significantly impact your bottom line. You may be tempted to eliminate one or more middlemen in the chain. Remember that if you’re being paid outright by a broker/buyer/ wholesaler, that person is also accepting the risk of selling your product to the next level in the sales chain. Before you take over that role yourself, make sure that you are willing to accept the additional risk. Also, some products and markets may allow you to invite bids from different buyers and possibly obtain a better price. Knowing how your product is being distributed could, over time, help you establish ‘alternative marketing strategies’ to improve your returns. You may find opportunities to sell your products at a higher level and to cut out some of the middlemen. You may also discover potential channels that will provide other business opportunities.

B. Location. When selling directly to consumers, there is a range of choices as to where you will offer your product. Possible sites for marketing agroforestry products include:

- Your property (everything from timber to berry jam), if not too remote
- Roadside stands (your driveway, highway rest areas, park-and-ride locations)
- Farmers markets (in urban areas these can be especially lucrative)
- Craft markets
- Co-operative marketing with other firms (e.g., renting seasonal space at a plant nursery, Christmas tree lot, supermarket, bed and breakfast).

Many businesses take orders over the phone, by fax, email, or regular mail, and deliver the product (themselves or using a delivery service) directly to customers. For some products, particularly specialty foods and crafts, the Internet can provide easier access to a wider market than traditional mail-order techniques. All 'mail-order' type direct marketing systems require a product that is easily handled and access to reliable transportation for it.

C. Transportation Options. If you are pursuing a sales channel where your customers are not coming to you, it is necessary to consider how your product will get to them. Important factors to consider include: cost to ship to distant markets via various transportation modes, inclusion (or not) of transportation costs in the selling price (i.e., whether you or the buyer pays the freight costs), the reliability and timeliness of various modes of transportation (especially for perishable goods). Negotiating favorable freight terms may be critical

Right: Paw-paw samples and sales at the Farmers Market. **Below:** Chestnuts sold in a local natural products store



to the viability of your business, so do not simply accept the first quote you receive from a shipper. For air cargoes, some freight brokers may be able to offer much better rates than the airlines. Greater volumes may permit price breaks, so partnering with another businesses in assembling loads can be beneficial. Another way to reduce freight costs is to find trucking firms which are seeking 'back-haul' loads (i.e., freight for trucks from regional or provincial distribution centers that would otherwise be returning empty). It is important to compile a list of prospective transport options and their respective costs. In some cases it is simply not profitable to ship a specific product into a particular market.

Pricing Strategy: For how much can we sell our products?

Product pricing can be challenging since pricing for niche products produced through agroforestry practices is not regulated as in commodity markets. Producers who sell commodities are normally price takers, sellers that have no market control and must "take" or accept the going market price. For differentiated niche products, one or more pricing strategies can be considered, depending on the target market and product strategy. The basic functions of pricing are to cover costs, make a profit, and encourage customers to buy. You can either price to the market or price to your costs. (See <http://extension.missouri.edu/p/G648> - Break-even Pricing, Revenue and Units; <http://extension.missouri.edu/p/G649> - Selecting an Appropriate Pricing Strategy).

Pricing to the Market. When you're just starting out, pricing to the market is often the simplest approach. Pricing to the market involves finding out what others are charging for the same products, and then using that information to establish a similar price range. Buyers are also pricing to the market when they tell you what they're willing to pay for your products.

Pricing information on agricultural products can be obtained from a number of sources. If you plan to sell directly to the public, various retail market outlets

will provide you with information on the going rate for your product. Buyers will also provide pricing information, but keep in mind that these prices are usually negotiable. The Internet may be another source of pricing information, depending on the market you are seeking to access. Pricing information for agroforestry specialty crops and products can be difficult to obtain, but your best bet is talking to other producers and the buyers you've identified. The Internet also has limited pricing information for some products, especially for 'finished' or value-added products such as crafts, wreaths, berry jam and the like (these may also be obtained from catalogues from various companies).

Pricing to Your Costs. Pricing to your costs ensures that what you charge covers all your expenses – not necessarily the case when pricing to the market. Businesses sometimes start out by pricing to the market, and then shift to pricing according to costs once these become clearly identified. If you find that similar products are available for a much lower price than you could charge, you'll have to either adjust your profit margin or differentiate your product so that consumers feel it is worth the higher price. The timing of sales has a strong influence over the price which can be obtained, and the obvious objective is to sell when prices are highest (i.e., demand is high relative to supply). Non-perishable products allow greater flexibility in this choice, as do products processed to allow out-of-season sales. You may also wish to explore different management practices that will enable you to harvest early or late in the season when other supplies may be limited.

What goes into the cost equation?

Production costs, materials, fixed overhead, time/labor and profit. A simple formula for setting the price per unit is:

Price per unit = Total costs of production per unit + Desired profit per unit

Price setter or price taker?

Sometimes you will be able to set prices for your product, other times you won't. A number of factors will influence whether you are a price-setter or a price-taker:

- The scale of the market; Prices for internationally traded commodities (e.g., lumber, wheat) tend to be set far from the place of production. This is also true for many agricultural commodities and agroforestry products (e.g., mushrooms, some floral greens, medicinal herbs) that are traded in international or other extended markets.
- Product differentiation; If your product is unique (the opposite of a commodity) you are more likely able to influence the price you receive. 'Niche' market and value-added products usually have superior opportunities for cost-driven pricing.
- Your reputation within the industry; Sometimes experienced, dependable suppliers are able to get a higher price for their products (a 'premium') because buyers know they will reliably supply a high quality product.
- Your negotiating skills; If you have good negotiating skills, your ability to influence the prices you receive for a product will increase greatly.

In the end, the single most important influence on your pricing decisions will be your customer's ability and willingness to pay the price you are asking. However, keep in mind that you can also influence prices by promoting your products.

Communication (Promotion) Strategy: How and what will be communicated to buyers and consumers?

Promotion is essential to gain product recognition among customers. The promotion strategy should identify the message, the way of delivery, and costs.

Message: What do I want to communicate about my product? Consumers are often unfamiliar with niche agroforestry products, therefore the more

information provided about the products benefits, the more likely people are to try the product. Communicating “fresh-ness” and “local” or “small scale production methods” can be an important part of a promotion strategy.

Tools and delivery: How am I going to communicate this message? Local producers can advertise in newspapers, magazines, flyers and catalogs, radio, TV, billboards, within health food stores, and online. Publicity is more convenient than advertising because it uses non-paid media coverage of the firm and its products. Methods used to generate publicity include participation in festivals and fairs, collaboration with charities, sponsoring community events, and news releases. News releases to the media are a low cost method to get promotion. Offering free samples is a commonly used practice that helps establish local markets. Organizing workshops, giving talks, farm tours, attending farmers markets, collaborating with local Community Supported Agriculture (CSA) groups and word of mouth are ways to raise awareness, inform and educate consumers, and build trust and understanding. For products with health benefits not so known to consumers, fact sheets distributed at farmers markets and educational on farm displays are very useful.

Costs: How much will all of these cost? If paid advertising media are used, partnering with other farms can reduce individual advertising costs. Brands are created to identify a businesses’ product and distinguish it from the competition. While expensive, many niche producers concentrate promotional efforts on image advertising, i.e., promoting the concepts of “heart healthy”, “locally grown” or “green” products.

Real World Example

Ben’s Black Walnuts: Marketing the Eastern Black Walnut

Ben’s Black Walnuts, a small eastern black walnut nutmeat producer located in Iowa, provides an

excellent example of strategies for success in the eastern black walnut nutmeat market. Bill and Geri Hanson, owners of Ben’s Black Walnuts, successfully linked their unique abilities with an untapped market niche to provide quality black walnut nutmeat.

Eastern black walnut (*Juglans nigra* L.) markets are often categorized with other nut markets, such as pecan or English walnut. However, eastern black walnuts are unique for many reasons. They are native, locally grown nuts with a robust and rich flavor. Black walnuts are low in saturated fats, have no cholesterol and are high in polyunsaturated and monosaturated fats (the “good” fats) which can lower “bad” cholesterol levels (LDL) without damaging “good” cholesterol (HDL).

Historically there has been only one major processor of black walnut meat, Hammon’s Products Company. Hammon’s is located in southwest Missouri, but has contract buyers and hullers located in numerous locations throughout the Midwest. The going market price for black walnuts delivered to these contract buyers and hullers ranges from \$0.10 to \$0.14 per pound. Supply is collected 99% from the wild; there are no large producers using improved cultivated varieties. Producers who are growing improved cultivars have the option of selling directly to Hammon’s for a higher price; however, those improved cultivars must be delivered to the processing plant in Stockton, Mo. The market demand for eastern black walnut nutmeats is small compared to the demand for pecans or other popular nutmeats. Black walnut nutmeats are used in ice cream, baking, and candies. However, due to the strong flavor associated with the wild crop, the demand for black walnut nutmeats as a stand-alone “snack” is small. Currently, the black walnut market is not structured in a way that allows for segregation of improved cultivars. Hammon’s processing requires large quantities of nuts to meet their current demand in the ice cream and nutmeat markets. Due to the fact that there are very few plantations of improved cultivars and it may take up to 15 years for a plantation of improved cultivars to reach full production, Hammon’s has to rely on the wild nut crop.

The Hanson's strategies were to grow their own improved black walnut cultivars; process those nuts on the farm; and sell them directly to retail stores within a close radius of the farm. They started planting black walnut trees in 1984 on 10 acres. Since then they have expanded to nearly 18 acres of grafted black walnut trees. Instead of looking to the existing market for nuts which was controlled by Hammon's Products Company, the Hanson's began developing the machinery and equipment needed to process nutmeats. By modifying equipment designed for other uses, such as a huller/ washer that was designed for English walnut, the Hanson's developed a completely vertically integrated production system. Through direct marketing to local grocery stores and other retail outlets, nearly 2000 pounds of nutmeats are sold annually, grossing nearly \$12,000. By controlling the process from the tree to the store, they were able to maintain a higher quality product, create a niche market for quality black walnut nutmeats and capture a larger profit for themselves.

Labor, the constraining factor in the production system, is provided by Bill and Geri.

While the eastern black walnut market is still faced with a single large buyer, low commodity prices, and wild nuts of variable quality, Ben's Black Walnuts has carved out a niche. Focusing on quality, adding a personal marketing touch, vertical integration and capturing the full value chain, the Hanson's have recognized market forces and developed successful strategies.

Real World Example

Oak Leaf Wood and Supplies: "Your Trash is My Cash"

Paul and Kathy Easley have a "stump to store" niche market wood manufacturing business in central Illinois. At its outset 18 years ago, the Easley's' hardwood business cut exactly what the customer wanted, including fence boards, bridge decking and hog farrowing crates. At the same time, the Easley's began their own primary market research to study the

Ben's Black Walnuts are successful because of several reasons. First, the Hanson's control the supply and quality of the nut crop by owning their own grafted trees. Yield and quality from their black walnut plantation is predictable. The Hanson's continually work to improve the cultivars that they grow in order to extend the harvest season and improve cracking and nutmeat qualities.

Second, direct marketing to local retail outlets has helped link a person with a product (a face with a place). In other words, Ben's Black Walnuts are not just a product that comes from some distant processor; it is a product that comes from Bill and Geri Hanson. The Hanson's have developed a trust relationship with the retailer and consumer through their personal involvement with those market participants.

Finally, the scale of the operation is designed for the labor and inputs available. The Hanson's operation is designed to handle no more than 10,000 pounds of nuts per year.. They currently have enough trees planted to reach this capacity competition by touring numerous hardwood facilities in adjoining states. The entrepreneurs also studied everything these facilities weren't doing, learning they weren't involved in niche markets, such as the production of bowl, gun stock, pen or flute blanks. After making these market discoveries and focusing on these market opportunities, the Easley's moved their business in a new direction from its original markets.

Paul's experience with wood enabled him to recognize that highly figured wood products can be sawn from less than perfect logs. Today, he and Kathy saw up the lumber, then run the trees through their sawmill kiln and surfacing operation. They also have their own hardwood retail store (established 1990) in downtown Moweaqua, Ill.

The Easley's maintain a competitive advantage in several ways. First, they have a very low raw material (supply) cost. Tree services bring wood to the business instead of paying landfill dumping fees. Nearly 80% of his product consists of wood that would otherwise have been deposited into landfills, with the remaining 20% coming from their own farm.

Second, their knowledge and ability to turn "junk wood" into high value blanks helps maintain an edge on the competition. Crotch material, from logs often left behind in the woods after timber harvest, contains feathered (figured) grain. By proper slicing, Paul puts the feathered grain into the wood blanks and increases their value as much as 10 fold. He also adds value by using everything – for example, the pen blank is a byproduct that normally gets burned or thrown away as edging waste. Blanks are put back through the edger to create their shape ($\frac{3}{4}$ of an inch square, and 6 inches long), then put through a chop saw table 6 at a time. Pen blanks alone add up to \$10,000 per year.

Oak Leaf Wood and Supplies combines vision and experience with patience, taking the time to cut the wood to maximize its value. The business puts the needs of the customers, crafters and other high-end users at the center of activity. Recognizing that there are many different facets to woodworking and many market niches to be filled, the Easley's do not actually make any finished products in the retail business.

The products they manufacture and sell include cabinet grade stock, carving stock and ballpoint pen blanks. The retail business handles approximately one hundred species of wood.

Paul attributes part of the business success to his involvement in a variety of related activities. He is also a sawmill distributor, finding it easy to sell sawmills because people can see for themselves how they benefit his successful entrepreneurship efforts. Because demand for Oak Leaf Wood and Supplies products grew faster than the Easley's' ability to supply their

customers, Paul networks with 25 sawmills in a 50-mile radius of his facility, buying the product that his sawmill customers make and selling it in his retail outlet.



Using a band sawmill, Paul processes wood others might consider trash into value-added products on his farm.

The Easley's' market area includes the entire United States and seven foreign countries. They attribute this to tremendous high-quality, free publicity, and making a product that people wanted.

"Publicity is free, while advertising costs a lot of money," said Paul. "Good publicity is easy to do. If you are doing things that are unique and different than everybody else, if you're having a good time at what you do, tell people about it, and there will be magazines writing articles about you and your business."

The Easley's' business has been featured in close to one hundred magazines. Paul does not have a web site, nor does he want one. "We are so busy doing what we do that there is no room to do anything else.

"Keep it small, keep it simple, and don't buy any more equipment than it takes to get the job done," suggests Easley. "Then go to work, do the job with a smile on your face and be enthusiastic about your product. If you're willing to do that, and talk with your customer, you can succeed. We're living proof."

Credit: the "Forest Landowner's Guide to Evaluating and Choosing a Natural Resource-Based Enterprise," published by the Natural Resource, Agriculture, and Engineering Service (NRAES-151) Cooperative Extension program, based at Cornell University, Ithaca, New York.

MARKETING EXAMPLES FOR FORESTRY, AGROFORESTRY AND NATURAL RESOURCES

Enterprise	Retail or direct market	Wholesale market	Niche market
Firewood	Delivery to homeowner; roadside piles for campers	Broker, garden center, landscape contractors	Convenience store bundles; custom cut/split; select species
Fence posts and/or rails (Black Locust, Cedar or Osage Orange Hedge)	Homeowners	Landscape contractors, garden stores	Nature stores
Wood chips for cooking and smoking (hickory, apple, maple)	Homeowners and businesses	Convenience stores	Fairs and festivals
High-value sawtimber and veneer	-	Sawmills through traditional sale process	Sell harvested logs directly from log deck to buyers; sell to the export market
Custom sawmilling	Craft artisans, hobbyists	Other sawmills	Cut lumber at landowner's property
Drying lumber	Craft artisans, hobbyists, cabinetmakers	Local lumber store, chain stores, planning mill	Unique species or products such as crotch wood, matching panels
Value-added wood products (hardwood and grapevine baskets, bowls, kitchen utensils, and other value-added products)	Craft fair, tourist sites, Internet and catalog sales	Broker	Custom-shaped and custom-sized baskets; gift baskets
Christmas trees	Choose-and cut or parking lot trees	Garden stores; nonprofit organizations that sell trees for fundraising	Super large trees, tabletop trees, and select species; combine with sleigh ride and other activities or onsite sales
Holiday greenery (wreaths and roping from pine trees and grapevines)	Choose-and-cut parking lot sales	Broker; nonprofit organizations that sell greenery for fundraising	Decorated greenery at holiday crafts fair
Native vegetation collection for floral and food markets on a sustainable basis (moss, ferns, colored twigs, mushrooms, ramps, etc.)	Florist shops, craft artisans, fairs	Brokers for floral markets and edibles, stores, restaurants	-

**MARKETING EXAMPLES FOR FORESTRY, AGROFORESTRY AND
NATURAL RESOURCES (con't)**

Shiitake, oyster, and other mushrooms	Farmers market	Broker, specialty stores, restaurants	Dried mushrooms and other unique products
Ginseng / Goldenseal	-	Broker	Ginseng jams or other products at specialty stores
Walnut, pecan, hazelnut, or other nut production	Farmers market, Internet or catalog sales	Broker	Specialty stores
Recreational natural resource events (forestry, logging, heritage, wildlife, maple syrup festivals or field days; forestry skill competitions)	Individuals, organizations, and groups	-	Combine with value-added forestry products and many other unique offerings
Hunting lease	Hunting clubs and groups	Forester or other outlets to act as your broker	Combining hunting lease with cabin rentals
Vacation cabin	Individuals, families, hunt clubs	Broker	Combine with fee hunting, campground or other recreational access enterprises
Recreational trails (bird watching, hiking, cross-country skiing, horseback riding)	Individuals, nature and conservation groups, church and school groups	Broker	Special arrangements
Hayride/sleigh ride / bonfire combinations	Individuals, nature and conservation groups, church and school groups	Broker	Special holiday programs and promotions (e.g. Halloween, Thanksgiving, Christmas)
Nature-based bed and breakfast	Individuals, couples, small groups	Broker	Special program offerings
All-terrain-vehicle (ATV) and mountain-biking access	Individuals, groups	Broker	Special races, events, and promotions
Hay	Farmers, small-farm owners, horse owners	Auction	Special hay mixes for specific livestock
Vegetables	Farmers markets, roadside stands, pick-your-own, CSAs*	Broker, auction, cooperative, restaurants	Ethnic markets, organic

**MARKETING EXAMPLES FOR FORESTRY, AGROFORESTRY AND
NATURAL RESOURCES (con't)**

Field crops (corn, soybeans, small grains, etc.)	Livestock farmers	Elevator, cooperative	Popcorn, edible soybeans, fuel for heating stove, organic
Wine and table grapes	Farmers markets, CSAs*	Stores, wineries, restaurants	Organic, special and heirloom varieties for wineries
Bramble fruit crops (raspberries, blackberries, currants, gooseberries)	Farmers markets, roadside stands, pick-your-own, CSAs*	Stores	Organic, heirloom varieties
Fruit trees (apples, pears, peaches, etc.)	Farmers markets, roadside stands, pick-your-own, CSAs*	Broker, stores, restaurants	Unique and heirloom varieties and species, special sizes and quality
Honey	Individuals, roadside stands, farmers markets	Stores, restaurants, cooperative	Organic, honeycomb
Sheep and goats (milk, meat and fiber)	Farmers, 4-H groups, and other individuals and groups	Auction	Ethnic meat markets, organic markets
Exotic livestock (emu, fallow deer, ostrich, etc.)	Farmers, 4-H groups, and other individuals and groups	Auction	Ethnic meat markets, restaurants
Value-added food processing (slaughterhouse, bakery, canning, microdairy processing)	Farmers markets, roadside stands, fairs and festivals	Specialty stores, restaurants, broker	Organic, specialty products
Herbs (Echinacea, basil, etc.)	Farmers markets, roadside stands	Broker, stores, restaurants,	Organic, medicinal, special product combinations, heirloom varieties
Native plant nursery	Homeowners, local businesses	Landscape contractors doing residential and restoration work, garden centers	Specific in-demand species that are difficult to grow
Greenhouse	Homeowners, local businesses	Garden centers, brokers	Specialty plants for a specific market
Recreational agriculture (harvest festivals, corn mazes, petting zoos)	Individuals, organizations and groups	-	Combine with value-added, roadside stand, and many other unique offerings

* CSA indicates community-supported agriculture

Additional Resources

Online Marketing Resources:

- Growing Small Farms, North Carolina Cooperative Extension.
<http://growingsmallfarms.ces.ncsu.edu/growingsmallfarms-marketing/>
- Building a Sustainable Business. A Guide to Developing a Business Plan for Farms and Rural Businesses. Developed by the Minnesota Institute for Sustainable Agriculture.
<http://www.misa.umn.edu/Publications/BuildingaSustainableBusiness/>
- National Sustainable Agriculture Information Service Publication List
<https://attra.ncat.org/publication.html>
- University of Missouri Center for Agroforestry resources <http://www.centerforagroforestry.org/profit/>
- Marketing Specialty Forest Products University of Nebraska, Lincoln,
https://www.fs.usda.gov/nac/documents/morepublications/sfp1_MarketingSFP.pdf
- Productive Conservation: Growing Specialty Forest Products in Agroforestry Plantings. University of Nebraska, Lincoln,
https://www.fs.usda.gov/nac/documents/morepublications/sfp2_ProductiveConservation.pdf
- Agricultural Marketing Resource Center. Resources for Business Strategy and Analysis.
http://www.agmrc.org/business_development/strategy_and_analysis/
- Break-even Pricing, Revenue and Units. <http://extension.missouri.edu/p/G648>
- Selecting an Appropriate Pricing Strategy. <http://extension.missouri.edu/p/G649>
- Missouri Department of Agriculture. Food Safety, Farmers' Market Handbook:
<http://agriculture.mo.gov/connect/foodsafety.php>

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EXERCISE: REVIEW OF MARKETING

1. According to Michael Porter, there are five forces that influence how an industry is structured. What are they?

2. What are the main marketing strategies that you need to develop for each target market?

EXERCISE KEY

1. According to Michael Porter, there are five forces that influence how an industry or a business is structured. What are they?

The five forces defined by Michael Porter are:

- 1) Barriers to entry,
- 2) Bargaining power of suppliers,
- 3) Bargaining power of buyers,
- 4) Threat of substitute products, and
- 5) Rivalry among existing firms.

2. What are the main marketing strategies that you need to develop for each target market?

The main marketing strategies are:

Product – The right products to satisfy the needs of your target customers

Price – For what price can we sell our products?

Distribution – How are we getting the products in the hands of our customers?

Promotion – How are we letting people know what we have for sale?

Notes

Chapter 10: Economic Considerations

In this chapter:

- **Agroforestry Budgeting**
- **Agroforestry Costs**
- **Revenues**
- **Funding Incentives for Agroforestry**
- **Summary**
- **Additional Resources**

Agroforestry Economics Overview

This chapter is a brief overview of the resources and information found in the detailed Agroforestry in Action guides produced by the Center for Agroforestry. These guides are included in the Appendix of this Training Manual:

- *Economic Budgeting for Agroforestry Practices*
- *Tax Considerations for the Establishment of Agroforestry Practices*
- *Funding Incentives for Agroforestry in Missouri*

Agroforestry should not be thought of as a set of practices that take land out of production. Instead, agroforestry is a set of practices that responsibly weaves together production and stewardship. There are many economic benefits to incorporating agroforestry practices into agricultural landscapes. The five practices of agroforestry provide opportunities for generating income from a wide array of alternative products, ranging from edible nut and berry crops to diverse woody floral crops. Additionally, agroforestry practices provide valuable environmental services for landowners, such as soil and stream protection, wildlife habitat, and aesthetics at a low cost.

Monitoring the economic costs and benefits from an agroforestry practice is essential for analyzing its economic success or failure. Economic budgeting provides a method for systematically tracking costs and revenues that are incurred on any productive enterprise.

For most agroforestry practices, there are numerous incentive programs available that can help offset establishment costs. Federal income tax laws can also provide incentives in the form of increased deductions from taxable income and lower tax rates on certain types of income. This chapter will briefly discuss agroforestry from an economic perspective.

Budgeting, funding incentives, and tax incentives are three of the most important economic considerations when analyzing an agroforestry practice. Even if the goals of the landowner do not include managing the agroforestry practice for income, the landowner should be aware of ways to minimize the costs associated with establishing and maintaining that practice.

Economic Budgeting

Economic budgeting is a decision making tool used to:

- 1) report,
- 2) monitor,
- 3) analyze, and
- 4) forecast the financial performance of an economic enterprise.

Budgets can be highly detailed standardized forms or roughly delineated estimates on the back of an envelope. The quality of the economic analysis and thus the quality of the decisions made based on the analysis depend on the time and effort put into the budget.

There are several methods for budgeting, depending on the type of analysis being conducted. For agroforestry economic analysis, two main types of budgets are used:

enterprise budgets and **cash flow budgets**.

- **Enterprise budget:** This is a detailed list of all cost and revenues for a single enterprise, such as corn or livestock, typically for a single planning period.
- **Cash flow budget:** This is a detailed schedule of the amount and timing of costs and revenues. Cash flow budgets can identify possible risks, predict cash needs over a period of time, and provide a basis for comparison with other alternatives. A cash flow budget can combine several enterprise budgets to identify areas where losses from one enterprise can be offset by revenues from another enterprise.

Costs

Costs can be grouped into two categories: fixed and variable. Within these two categories, costs are separated even further into cash and non-cash costs. Cash costs are those costs that require out-of-pocket cash payments. Non-cash costs are often called economic costs or opportunity costs. Understanding each of these categories of costs will help organize data into economic information.

- **Fixed costs:**

Fixed costs are typically those costs that are attributed to resource ownership. In other words, fixed costs occur regardless of any productive activity being attempted. Fixed cash costs are out-of-pocket expenses that are not dependent on production level or commodity. Examples of fixed cash costs include property taxes and insurance. Fixed non-cash costs are accounting costs that do not require a cash outlay. Although these costs are incurred regardless of production, they are influenced by production activities. For example, depreciation is a non-cash fixed cost that accrues regardless of whether the capital is used for production or

not. A tractor will depreciate in value even if it is parked in a barn and never used. The amount and type of capital that depreciates will depend on the production activities. A crop enterprise may have depreciation from specialized equipment such as a combine and a planter, but a livestock enterprise will not have this type of depreciation.

- **Variable costs:**

Variable costs are those costs attributed to the productive use of resources. Variable cash costs include all input costs, such as seed, chemicals, fuel, hired labor, and maintenance. Variable cash costs for agroforestry practices can be broken down even farther into four main cost areas: establishment, maintenance, harvesting, and marketing. One of the most common mistakes that many landowners make is failing to account for their own personal time. Although many landowners enjoy the time they spend working with trees and nature in general, there is still an economic cost to the time that is spent establishing, managing, harvesting, and marketing products from agroforestry practices. Remember to count personal time spent as a variable cost.

Revenues

Typical revenues from conventional forestry can come from things such as nuts, timber, and seedlings. In agriculture, revenues are typically based on monocultured crops or livestock enterprises. However, by combining agriculture and forestry, more revenue opportunities can be realized from the same natural resource base. Revenues in agroforestry are limited only by the creative resources of the decision maker.

Many agroforestry practices require significant investment during establishment years, followed by a period of several years before the trees start to generate a return on that investment. This may be a strong disincentive to the adoption of these practices, even if long-run estimates indicate that the practice will be more profitable. Because of this characteristic of agroforestry, landowners should be

encouraged to seek out additional incentives for agroforestry.

Incentives for Agroforestry

Agroforestry incentives can come from many different sources. The fact that the practice improves the environmental quality of a landowner's property may be all the incentive needed to convince that landowner to adopt that practice. However, for some landowners to adopt requires a significant financial incentive. Programs designed to minimize or offset the initial establishment cost burden are the most common type of funding incentive available to landowners interested in agroforestry.

Funding incentives can come from at least three major sources:

- 1) Federal,
- 2) State, and
- 3) Private conservation programs.

Federal conservation programs are those initiated by major legislation, such as the Farm Bill. Examples of federally funded agroforestry incentives would include programs such as:

- Conservation Reserve Program (CRP)
- Environmental Quality Incentive Program (EQIP)
- Conservation Stewardship Program (CSP)
- Sustainable Agriculture Research and Education Program (SARE)
- Partners for Fish and Wildlife (PFW)

These programs offer cost share payments, land easement payments, and other incentive payments to landowners who adopt environmentally responsible land-use practices. One downside to many of these programs is the fact that the landowner often foregoes design flexibility and alternative product market income for the guaranteed program payments.

State funding programs are very similar to the federal programs. In 1990, the State of Missouri passed an innovative program called the Missouri Agroforestry Program which was part of the Missouri Economic Diversification and Afforestation Act. Although this program has had limited funding, the concept is unique in the fact that it encourages landowners to seek income opportunities from alternative products grown or harvested from land that is managed primarily for conservation benefits. The Missouri Department of Conservation was given the responsibility of overseeing this program along with a cost share program that promotes conservation practices. Other sources of funding in Missouri include the Missouri Department of Agriculture and the Missouri Department of Natural Resources.

Private funding sources with application for agroforestry often center on organizations that promote game animals or forestry. Private sources include groups such as Pheasants Forever, Ducks Unlimited, Quail Unlimited, and the National Wild Turkey Federation. These organizations offer cost-share programs and land easement payments to landowners who manage their land in a way that improves the habitat of the game animal they represent.

Tax Incentives

Another incentive for agroforestry adoption may be the income tax benefits that a landowner could receive.

There are three basic ways to substantially reduce your tax burden:

- 1) increased deductions,
- 2) reduced tax rate, and
- 3) tax credits.

The current Internal Revenue Code (IRC) offers at least four areas where a landowner can reduce their potential tax burden by establishing an agroforestry practice.

The IRC offers tax benefits for

- 1) reforestation,
 - 2) conservation,
 - 3) business investment, and
 - 4) capital gains.
- **Section 194** of the IRC describes the reforestation deduction and amortizable basis deduction. This deduction allows a landowner to deduct the first \$10,000 of reforestation expenses from taxable income and then amortize and deduct the remaining expense over an 84-month period.
 - **Section 175** describes the conservation deduction that allows a landowner to deduct certain conservation expenses up to 25% of the gross income earned from the farming business. These conservation expenses must be incurred in accordance with a plan approved by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), or a similar agency.
 - **Section 126** details how to exclude cost-share payments received from approved federal or state conservation programs from taxable income.
 - **Section 179** allows a landowner who is managing the agroforestry practice as an active business to deduct a large amount of expenses incurred for personal property used more than 50% in the business.

Summary

Agroforestry is a set of land-use practices that interlaces production and stewardship. From an economic standpoint, agroforestry can increase production diversity by integrating a wide range of commodity and alternative products. In order to monitor and analyze the economic parameters of an agroforestry practice, landowners may need to adopt some form of economic budgeting. Because of the impact of long establishment periods and long periods where no economic returns are generated, a combination of enterprise budgeting and cash flow budgeting is recommended in order to fully capture the short- and long-term revenue

potentials. Some agroforestry practices may have substantial cost during an establishment period and not generate revenue to offset those costs until several years later. Because of this, landowners may wish to seek funding incentives to help ease the establishment cost burden. Federal, state and private conservation programs offer land easements and cost-share payments for establishing agroforestry practices or related land use practices.

In addition to these programs, the IRC offers some substantial tax benefits for those who invest in reforestation, conservation, or some form of business that relies on the management of the natural resource base.

Additional Resources

Economic Budgeting Websites:

- Financial Management Resources
<http://www.pubs.ext.vt.edu/category/agricultural-financial-mgmt.html>
- University of Missouri Extension Agroforestry publications
<http://extension.missouri.edu/main/DisplayCategory.aspx?C=77>

Funding Decision Support Tools (excel based, free to download):

- University of Missouri Center for Agroforestry
<http://www.centerforagroforestry.org/profit/>
 - Chestnut Decision Support Tool
 - Elderberry Decision Support Tool
 - Black Walnut Decision Support Tool
- ***Land Stewardship Project Cropping Systems Calculator***
<https://landstewardshipproject.org/stewardshipfood/chippewa10croppingsystemscalculator>
- ***Wallace Center Grass Fed Beef Calculator***
<http://www.wallacecenter.org/resourcelibrary/-grassfed-beef-financial-calculators>

Funding Incentive Websites:

- USDA Farm Service Agency homepage. <http://www.fsa.usda.gov>
- USDA Natural Resource Conservation Service homepage. <http://www.nrcs.usda.gov>
- Sustainable Agriculture Research and Education (SARE) homepage. <http://www.sare.org>
- Building Better Rural Places, A publication of the U.S. Department of Agriculture agencies working together for sustainable rural development in collaboration with The Michael Fields Agricultural Institute and The National Center for Appropriate Technology (NCAT).
<http://www.ngfn.org/resources/ngfn-database/knowledge/resource.pdf>
- Forest Landowners Guide to Internet Resources: States of the Northeast, US Forest Service Northeastern Area and the Northeastern Area Association of State Foresters.
https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/15443/USFS_Forest_Landowners_Guide_to_the_Internet.pdf?1463067002
- Missouri Department of Agriculture. Financial Assistance: <http://agriculture.mo.gov/abd/financial/>

Tax Incentive Websites:

- National Timber Tax Website <http://www.timbertax.org/>
- Internal Revenue Service Website <http://www.irs.gov/>

EXERCISE: REVIEW OF ECONOMIC INCENTIVES

Variable cash costs can be grouped into four categories, what are they?

- 1.
- 2.
- 3.
- 4.

Two types of budgets are recommended for the economic analysis of agroforestry practices, what are they?

- 1.
- 2.

What are the four sections of the Internal Revenue Code (IRC) that can affect agroforestry adopters?

- 1.
- 2.
- 3.
- 4.

What is the difference between a variable cost and a fixed cost?

EXERCISE KEY

Variable cash costs can be grouped into four categories, what are they?

1. Establishment
2. Maintenance
3. Harvesting
4. Marketing

Two types of budgets are recommended for the economic analysis of agroforestry practices, what are they?

1. Enterprise budget
2. Cash flow budget

What are the four sections of the Internal Revenue Code (IRC) that can affect agroforestry adopters?

1. Section 194- Reforestation deduction and amortizable basis deduction
2. Section 175-Conservation deduction
3. Section 126-Cost-share exclusion
4. Section 179-Business investment deduction

What is the difference between a variable cost and a fixed cost?

A fixed cost is a cost that is associated with the ownership of resources. Fixed costs must be paid regardless of what activity is conducted on the property. Variable costs are costs associated with the productive use of resources. Variable costs are the costs that are used when comparing the economics of competing resource-use options.

Notes



Financial Decision Support Tools for Agroforestry

by *Zhen Cai, Ph.D.*, Assistant Research Professor, The Center for Agroforestry, University of Missouri School of Natural Resources

Excel-based financial decision support tools can help potential growers better understand the economics behind various management practices for some of the most common temperate agroforestry crops. The University of Missouri Center for Agroforestry has developed four model-based tools, including:

The Eastern Black Walnut Financial Decision Support Tool (timber production); the Black Walnut Financial Model (nut production); the Chestnut Decision Support Tool (nut production); and the Elderberry Financial Decision Support Tool (berry production). These tools are publicly available, free to use, and can be found at the www.CenterForAgroforestry.org.

The following Chestnut Decision Support Tool example illustrates how these models can be used. The tool asks users a series of questions designed for inputting data about the user's orchard, and outputs financial results based on those inputs. These instructions are designed to help you answer the user input questions after you've opened the spreadsheet to begin data entry. Please read these instructions before you begin using the Financial Model.

The Chestnut Decision Support Tool spreadsheet consists of six tabs:

1. Management Input
2. Cost Budgets
3. Financial Analysis
4. Input Tables
5. Chemical Costs
6. Growth Models

Users can select and enter their own information in the Management Input, Financial Analysis, Input Tables, and Chemical Costs tabs. The Cost Budgets and Growth Models tabs are for calculation purposes and cannot be edited by users.

Inputs

The Management Input tab consists of four sections: Establishment Decisions, Management Decisions, Harvesting and Marketing Decisions, and Financial Results. Blocks highlighted in yellow indicate areas where users should enter their own decision information. Once data is entered for each of the "Decisions" sections, financial results will automatically be calculated and will appear in "Financial Results". Establishment decisions include site prep, spacing, layout/design, site quality, planting stock, graft technique, fertilization, tree staking, and irrigation system. Each establishment decision offers a drop down option list to choose from (except for spacing). Choose one option for each decision that best reflects your establishment plan. For example, "site prep" has tree options: herbicide only, herbicide with discing, and user defined. For "user defined", you may enter your own cost per acre for site prep into cells B5 (cost per acre) and C5 (cost per tree). Estimated Cost per Acre = Estimated Cost per Tree * Initial Number of Trees per Acre, where the spacing indicated determines Trees per Acre.

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The same procedure should be followed when entering any user-defined decision.

The Management Decisions tab consists of options for thinning, fertilizing, pruning, weed control, pest control, disease control, and deer control. In order to provide the necessary input for "thinning", enter a number between 0 and 1 indicating percentage of trees removed at each thinning. For example, if the grower chooses to thin one-third of the trees at each thinning, enter .33 or 33% in the blank. Other questions in this tab should include both quantity and occurrence of the corresponding management decisions. For example, after selecting a fertilization method from the drop down menu, go to the Input Tables tab and enter the frequency of fertilization in cell G35, and the starting and ending years of application in cells G36 and J35. Costs will vary depending on frequency and duration of management activities.

	A	B	C	D	E	F	G
1	Site Prep	Estimated Cost/ac	Cost per Tree				Occurrence
2	Discing only	\$ 100.00	\$ 2.07	1			
3	Herbicide only (1 qt./ac.)	\$ 120.00	\$ 2.48	1			
4	Herbicide with Discing	\$ 150.00	\$ 3.10	1			
5	User Defined	\$ -	\$ -				
6							
7	Layout/Design	Estimated Cost/ac	Cost per Tree				Occurrence
8	Diamond						
9	Hexagonal				No Cost		
10	Rectangular/Square						
11							
12	Planting Stock	Estimated Cost/ac	Cost per Tree				Occurrence
13	Grafted Seedlings	\$ 968.00	\$ 20.00	1			
14	Seed	\$ 169.40	\$ 3.50	1			
15	Seedlings (bare root)	\$ 193.60	\$ 4.00	1			
16	Seedlings (RPM™)	\$ 847.00	\$ 17.50	1			
17	User Defined	\$ -	\$ -	1			
18							
19	Fertilization (initial)	Estimated Cost/ac	Cost per Tree				Occurrence
20	Good early growth (>8")	\$ 49.37	\$ 1.02	1			
21	Slow early growth (<8")	\$ -	\$ -	1			
22	User Defined	\$ -	\$ -	1			
23							
24	Thinning	Estimated Cost/ac	Cost per TC				Occurrence
25	33%	\$ -	\$ 0.04				As per model
26							
27	Tree Staking	Estimated Cost/ac	Cost per Tree				Occurrence
28	Re-Bar	\$ 67.28	\$ 1.39	1			
29	Steel conduit pipe	\$ 96.80	\$ 2.00	1			
30	T-posts	\$ 338.80	\$ 7.00	1			
31	User Defined	\$ -	\$ -	1			
32	Wooden stakes	\$ 19.36	\$ 0.40				
33							
34	Fertilization (maintenance)	Estimated Cost/ac	Cost per Tree				Occurrence
35	Bearing trees (33% N)	\$ 90.00	\$ 1.86		Fertilizer applied every	1	
36	Bearing trees (46% N)	\$ 90.00	\$ 1.86		First Year of Application	2	

Input Tables: enter values in each yellow cell

Further, if users want to specify the chemical application rate and calculate their own costs, use the detailed information in the Chemical Costs tab. Enter your own application rates (Low App Rate/ac in cell B2, or Hi App Rate/ac in cell C2). Be sure to select the correct unit from the options in cell E2.

Harvesting and Marketing Decisions includes four categories: harvest method, expected rate of return, expected price per lb for nuts, and number of acres.

Establishment Decisions:

Site Prep:

Spacing (Ft): x

Layout/Design:

Site Quality:

Planting Stock: Graft Technique

Fertilization:

Tree Staking:

Irrigation system:

Management Decisions:

Thinning: Enter a % of trees removed (i.e. 50%, 0.50)

Fertilization:

Pruning:

Weed Control:

Pest Control:

Disease Control:

Deer Control:

Select from a list of drop-down menu options for each management decision.

Enter a discount rate (expected rate of return on investment) in this section. For example, if a grower would like to earn 5% from their investment, they should enter .05 or 5% in the blank.

Outputs

- Financial Results:
 - The Chestnut Decision Support Tool outputs indicate the financial performance of the orchard over a 60-year period. Six financial indicators are provided to better understand the economics of growing black walnuts. These indicators include:
 - Present Value of Revenues (PV of Revenues)
 - Present Value of Costs (PV of Costs)
 - Net Present Value per acre (NPV)
 - Rate of Return / Modified Internal Rate of Return (MIRR)
 - Annual Equivalent Value (AEV), and
 - Years to Break Even

For information about the interpretation of and calculations used for these indicators, see *Economic Budgeting for Agroforestry Practices*.

The Chestnut Decision Support Tool, among other agroforestry models, also provides an enterprise budget. Go to the Cost Budgets tab for a printable budget with costs. A cash flow diagram is available on the Financial Analysis tab, which shows Total Revenues, Total Costs, and Net Revenues for each year.

Advanced Options

Most of the agroforestry Financial Decision Support Tool programs have been locked to prevent keystroke errors by users. However, different costs can be manually applied to the model by "unprotecting" the Input Tables. To unprotect the spreadsheet, click Review, then Unprotect Sheet.

Model Limitations

The Financial Decision Support Tools are simplified decision models, and thus have limitations. The models are based on the best information available at this time for each of the factors accounted for. For instance, nut production can be impacted by different management decisions (e.g. tree spacing, thinning); however, due to the limited field data on nut production over time, a simple linear regression model simulates nut production over 60 years in the Chestnut Decision Support Tool model. The predicted revenues and other financial values are estimates; thus these models are intended as a guide, not a crystal ball. The purpose of the models is to identify how varying establishment, management, harvesting, and marketing decisions affect the financial outcome of the system. While the models cannot provide a promised level of income, they are accurate in predicting whether or not a decision will increase or decrease returns.

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 **The Center for Agroforestry**
University of Missouri

A Global Center for Agroforestry, Entrepreneurship and the Environment



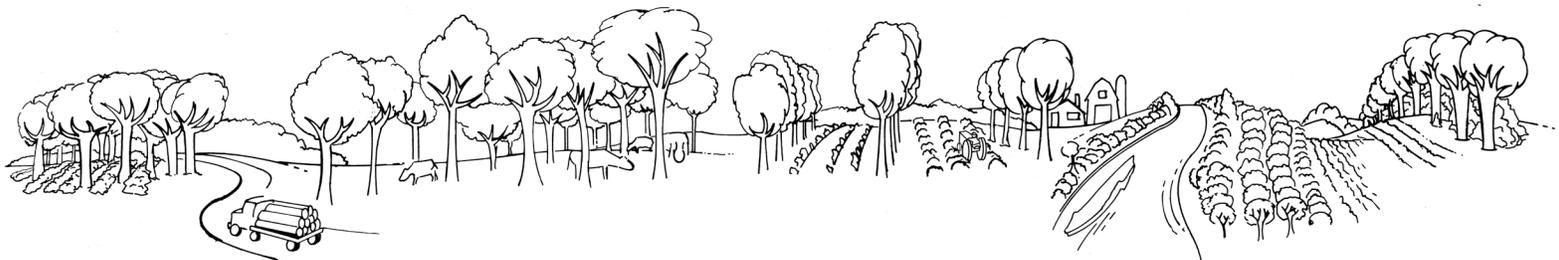
All Financial Decision Support Tools can be downloaded from the University of Missouri Center for Agroforestry website. Below are direct links for each agroforestry crop.

Black Walnut Financial Model: <http://centerforagroforestry.org/profit/walnutfinancialmodel.php>

Chestnut Decision Support Tool: www.centerforagroforestry.org/profit/ChestnutDecisionSupportTool.xlsm

Eastern Black Walnut Financial Decision Support Tool: <http://www.centerforagroforestry.org/profit/walnutfinancialmodel.asp>

Elderberry Financial Decision Support Tool: <http://centerforagroforestry.org/profit/elderberryfinance.php>



Appendix Section 2: Trees and Shrubs for Agroforestry

In this chapter:

- Identifying the Proper Trees and/or Shrubs
- Design and Management
- Tree and Shrub Recommendations
- Selection Table



The Center for Agroforestry is conducting research on Chinese chestnuts as a tree for profitable agroforestry plantings.

Agroforestry combines trees, shrubs, forages, grasses, livestock and crops in innovative, flexible combinations tailored to the landowner's needs. However, it is the trees and shrubs that are the foundation of any of the agroforestry practices. They occupy land for many years, taking longer to produce marketable crops than other agricultural crops and, thus, require careful thought before planting and long-term care. Yet, through deliberate integration with farm practices, long lasting production and conservation benefits can occur simultaneously.

What Makes a Tree Appropriate for Agroforestry?

The answer is not always the same for any given situation, and will likely vary according to each landowner's specific interest. That said, many trees and shrubs can be planted in configurations and/or densities that will enable them to meet several objectives.

The following pages may be used as a general reference and guide for the selection of appropriate trees and/or shrubs.

Identifying the proper trees and shrubs

When selecting a tree species, begin by matching the species with the site. The selected species should be capable of providing the products and services desired by the landowner. Depending on the practice selected, other considerations might include:

- *Suited to the soil and site conditions*
- *Species compatibility trees should be compatible with the companion crop*
- *High value*
- *Fast growing or of such high value that a slower growth rate is acceptable*
- *Deep-rooted so the trees do not compete with companion crops for moisture*
- *Drought-tolerant or capable of growing on a wet site*
- *Produce a light rather than a heavy shade.*
- *What species already exist on the site?*
- *Marketability - What products (nuts, wood, etc.) do you want to market? Do markets exist?*

Tree and Shrub Recommendations

Following is a table of tree and shrub species suitable for agroforestry practices in Missouri. Included in the table are recommended regions, agroforestry application, potential markets, typical site (upland or bottomland), soil moisture requirements, growth rate, height, light preference, and additional notes for each species. Trees and shrubs are listed in alphabetical order by common name.

This list is not exhaustive, but rather a starting point. All species listed for a given region may not be suited to all sites in that region. Species not generally recommended for a given region may have application on individual sites. For more specific information on trees and shrubs for a particular site, contact the area Missouri Department of Conservation Forester or Private Lands Specialist.



Mark Coggeshall, UMCA Tree Improvement Specialist, works to produce control pollinated seeds from eastern black walnut trees he is growing on a trellis system.

In addition to the table, a series of crop sheets have been developed that contain a short description of each species, its habitat, management and harvesting considerations, methods of propagation and economic uses.

Design and Management of Trees and Shrubs for Agroforestry

Planting design and management of an agroforestry practice depends on existing site conditions and the goals of the landowner (you may also refer to the section on each specific practice for more information on design considerations). Trees can be planted in single or multiple rows, on contours or in groups. Consider the products you wish to produce, any conservation or wildlife benefits desired, on-farm equipment and the needs of companion crops when planning the planting design.

As trees require some maintenance, management requirements may influence the planting design. Some important management considerations are:

- Weed control** - most important in a young trees life
- Fertilization** - depends on species selected and production objectives
- Pruning** - a must for timber production and recommended for nut production
- Thinning** - timely thinnings are critical to maintaining tree growth
- Grafting** - recommended for nut production, yet limit the number of trees requiring grafting in any given year.

- Weed control can reduce competition for moisture, nutrients and, in some cases, for light. Options for weed control include the use of herbicides, mulches (including living mulches such as many clovers, and fabric mulches) and cultivation. To gain the best growth from newly established trees, weed control should be maintained for a minimum of 3 years, and often for as many as 5 years.
- Timely fertilization may be necessary for high-yielding fruit and nut production. In fruit and nut production, having certain nutrients available to the tree at the appropriate time of year is often essential for flower and nut set. For timber production, the cost of fertilization is usually not recovered over the time it takes for a timber tree to reach maturity.
- Pruning allows room for equipment to pass below the branches and can be used to promote the production of desired products such as timber. Pruning is also a useful tool in management of fruit and nut trees. Through proper pruning, the shape of the crown and its density can be managed to facilitate and improve a trees productivity.
- Timely thinnings promote good tree growth by reducing competition for water, light and nutrients. As trees mature they grow to occupy more of the space where they are being managed. As crowns of adjacent trees begin to touch or overlap, this is also a general indicator that their root systems are overlapping. When trees touch or overlap, competition for light, moisture and nutrients between adjacent trees may become a factor limiting tree growth. At this point, thinning can be beneficial.
- Grafting primarily applies to fruit and nut production. By grafting scion wood to a tree you are assured that the fruit or nut produced has the potential to exhibit the exact same characteristics as the adult tree from which the scion came. However, this does not always occur, since moisture, nutrients and management also play a significant role in fruit and nut development. Yet, it is the best way to ensure success. Spread planting over several years to limit the number of trees that will require grafting in a single year.

Trees and Shrubs for Agroforestry Practices in Missouri

Common Name Scientific Name	Region	Agroforestry Application	Markets	Site	Soil Moisture	Growth Rate	Height	Light Preference	Notes
Trees									
American basswood <i>Tilia americana</i>	1 - 8	RB, FF	HV, LV, E	B-U	M	F	75-130'	● - ◐	Missouri native Sprouting habit
American holly <i>Ilex opaca</i>	1, 3 - 7	WB	NT, W	B	W-M, X	S	40-50'	◐	High tolerance to flooding Missouri native
American sycamore <i>Platanus occidentalis</i>	1 - 8	RB	LV, W	B	M-W	F	100'+	○ - ◐	Coppice regeneration Missouri native Disease prone
Austrian pine <i>Pinus nigra</i>	1 - 6, 8	WB	O, NT	B	M, X	F-I	70-120'	○	Diseases: foliar fungus/blight
Baldcypress <i>Taxodium distichum</i>	1 - 8	WB	O, W	B-U	W-M	S-I	100'+	○ - ◐	Missouri native
Black cherry <i>Prunus serotina</i>	2, 3, 5, 7, 8	RB	LV, HV		D-M	I	80-100'	○ - ◐	Missouri native
Black locust <i>Robinia pseudoacacia</i>	1 - 8	RB, AC, SP, WB	LV	U	M-D	F	40-60'	○	On MDC noxious plant list Missouri native Nitrogen fixing
Black oak <i>Quercus velutina</i>	1 - 8	AC, WB	LV, W	U	D-M	I	50-60'	◐	Missouri native
Black walnut <i>Juglans nigra</i>	1 - 8	RB, AC, SP, WB	HV, LV, F	B	M	I	70-90'+	○	Very site sensitive Missouri native Allelopathic (chemical growth inhibitor)
Black willow <i>Salix nigra</i>	1 - 8	RB	LV, E, W	B	M-W	V	30-60'	○	Missouri native
Blackgum <i>Nyssa sylvatica</i>	7, 8	RB	LV	B-U	W-D, X	I	50-100'	● - ◐	Missouri native
Blue spruce <i>Picea pungens</i>	1 - 6, 8	WB	O, W	U	M-W, D	I	70-100'	◐ - ○	Disease & insect problems
Bur oak <i>Quercus macrocarpa</i>	2 - 8	RB, AC, SP, WB	LV, HV, W	B-U	M-D, X	S	70-80'	○ - ●	Commonly used in CRP Missouri native
Cherrybark oak <i>Quercus pagoda</i>	6 - 8	AC, RB	HV, W, O	B	M, X	I-F	100'+	◐ - ○	Excellent market Missouri native
Chinkapin oak <i>Quercus muehlenbergii</i>	1 - 5, 7, 8	WB	LV, HV, W	U	D-M	S	60-80'	◐	Lumped with white oak for sale Missouri native
Common hackberry <i>Celtis occidentalis</i>	1 - 8	RB, WB	LV, NT	B-U	W-D	S-F	100'	◐ - ○	Can be hard to sell Missouri native
Eastern cottonwood <i>Populus deltoides</i>	1 - 8	RB, AC, SP, WB	W, LV	B	M-D	V	80-100'	○	Missouri native
Eastern redbud <i>Cercis canadensis</i>	1 - 8	WB	W, O, NT	U	M	I	<45'	● - ○	Easily transplanted Missouri native

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Common Name Scientific Name	Region	Agroforestry Application	Markets	Site	Soil Moisture	Growth Rate	Height	Light Preference	Notes
Eastern redcedar <i>Juniperus virginiana</i>	1 - 8	WB	W, LV, HV	U-B	D-M, X	S	<50'	○ - ◐	Some disease and insect problems Spreads/naturalizes easily Missouri native
Eastern white pine <i>Pinus strobus</i>	1 - 8	WB, AC	O, NT	U	D-W, X	I-F	<80'	◐	Disease and insect problems Preferred deer browse
Flowering dogwood <i>Cornus florida</i>	2 - 8	D	W, O	U	M, X	I-F	10-30'	◐ - ●	Problem with Armillaria root rot Invader or pest species Missouri native
Green ash <i>Fraxinus pennsylvanica</i>	1 - 8	RB, AC, SP, WB, FF	LV, NT	B-U	W-M, D	I	30-50'	○ - ◐	Commonly used in CRP Subject to borers and anthracnose Missouri native
Honeylocust (thornless) <i>Gleditsia triacanthos</i> var. <i>inermis</i>	1 - , 8	AC, SP, WB	LV	B-U	M-D	F	70-80'	○	Only thornless varieties recommended Pods can be used for cattle feed Missouri native
Ironwood (Hophornbeam) <i>Ostrya virginiana</i>	1, 3, 8	D	W, LV	U	M-D	S	<30'	● - ◐	Very hard wood Missouri native
Kentucky coffeetree <i>Gymnocladus dioica</i>	1 - 8	RB, AC, SP, WB	LV, HV, O	B	M	I-F	100'	○ - ◐	Ring shake can be a problem Missouri native
Loblolly pine <i>Pinus taeda</i>	3 - 8	SP, AC	NT, LV, O	B-U	W-D	F-V	90-110'	○	Does not produce seed this far north Susceptible to ice damage
Northern red oak <i>Quercus rubra</i>	1 - 8	AC, SP, WB, FF	HV, LV	U	M-D, X	I-S	60-80'	◐ - ○	Susceptible to oak wilt & chlorosis Missouri native
Northern white-cedar <i>Thuja occidentalis</i>	1, 4, 5, 7	WB	O	U	D-W	S-I	40-50'	◐	Wood is resistant to decay
Norway spruce <i>Picea abies</i>	1 - 8	WB	O	B-U	M	I-F	60-90'	○ - ◐	Good WB substitute for other conifers Disease & insect problems
Nuttall oak <i>Quercus texana</i>	8	RB	LV, HV, W	B	W-M	F	100'	◐ - ○	Self prunes better than pin oak High flood tolerance
Osage-orange <i>Maclura pomifera</i>	1 - 3	WB	LV, HV, W	B-U	W-D	I-F	10-40'	○ - ◐	Sometimes a pest tree
Overcup oak <i>Quercus lyrata</i>	8	RB	LV, W	B	W	S	100'	○	High flood tolerance Missouri native
Pawpaw <i>Asimina triloba</i>	3	FF	W, F	B	M	F-I	15-30'	◐ - ●	Site specific Missouri native
Pecan <i>Carya illinoensis</i>	1 - 8	AC, RB, SP	W, LV, HV, F	B	M, X	I-F	110-140'	◐ - ○	Use proper cultivars for nut production. Missouri native
Persimmon <i>Diospyros virginiana</i>	1 - 8	AC, SP, WB, FF	W, F, LV, HV	U-B	D-M, X	S	30-50'	● - ○	Missouri native
Pin oak <i>Quercus palustris</i>	1 - 8	AC, RB	LV, W, O	B-U	W-M	I-S	70-80'	○	Not tolerant of growing season floods Susceptible to oak wilt & chlorosis Missouri native

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Common Name Scientific Name	Region	Agroforestry Application	Markets	Site	Soil Moisture	Growth Rate	Height	Light Preference	Notes
Red (slippery) elm <i>Ulmus rubra</i>	3, 4	RB	LV, NT	B	M-D	I	40-70'	○	Missouri native
Red maple <i>Acer rubrum</i>	1 - 8	RB, AC, WB, FF	LV, O	B-U	W-D	F	50-70'	◐	Missouri native
Red mulberry <i>Morus rubrum</i>	3, 5	RB	F	B	M, X	I	40-50'	○-◐	Missouri native
Red pine <i>Pinus resinosa</i>	1 - 5, 8	WB	W, NT, O	U	M-D, X	S	<50'	◐-○	Short-lived
River birch <i>Betula nigra</i>	1, 3, 8	RB	LV, O, E	B	M	I	50'	○-◐	Missouri native
Sassafras <i>Sassafras albidum</i>	2 - 4, 8	D	W, NT	U	D-M, X	I	30-50'	○	Missouri native
Scarlet oak <i>Quercus coccinea</i>	3, 5, 7, 8	AC, SP, WB, FF	LV, HV	U	D-M	I-F	70-80'	○	Fastest growing oak Missouri native
Scotch (Scot's) pine <i>Pinus sylvestris</i>	7	WB, AC	O	B-U	M-D	S-I	35-60'	○-◐	Many disease and insect problems Short-lived
Shagbark hickory <i>Carya ovata</i>	1 - 8	RB, WB	W, LV, F	U-B	D-M	S	70-80'	◐-●	Missouri native
Shellbark hickory <i>Carya laciniosa</i>	1, 3, 8	RB	W, LV, F	B	W-M	S	80-100'	●-◐	Missouri native
Shingle oak <i>Quercus imbricaria</i>	1 - 8	WB	LV, HV, W	U-B	M-D	S	50-60'	○-◐	Susceptible to oak wilt & insects Missouri native
Shortleaf pine <i>Pinus echinata</i>	2 - 8	WB, SP, AC	HV, LV, W, NT	U	D-M, X	F-I	70-100'	○	Missouri native
Shumard oak <i>Quercus shumardii</i>	3, 7	AC, SP	LV, HV	B-U	M, X	I	100'	○	Susceptible to oak wilt & insects Missouri native
Silver maple <i>Acer saccharinum</i>	1 - 8	RB, WB	LV, O	B	W-M, D	F-V	60-80'	◐-○	Prone to ice and wind damage Missouri native
Sugar maple <i>Acer saccharum</i>	1, 3	FF	NT, LV	U	M, X	F	60-80'	●-○	Syrup ration - 80:1 Missouri native
Swamp chestnut oak <i>Quercus michauxii</i>	7, 8	AC, RB	LV, HV, O	B	M-W, X	S	60-80'	○	Best white oak for bottom areas Missouri native
Swamp white oak <i>Quercus bicolor</i>	1 - 6, 8	AC, RB	LV, HV, W, NT	B	W-M	S	60-70'	○-◐	Common in CRP Missouri native
Sweetgum <i>Liquidambar styraciflua</i>	1 - 8	RB, WB	LV, HV, O, NT	B-U	M, X	I	80-120'	○	Recommended for southern areas Missouri native
Tulip-poplar <i>Liriodendron tulipifera</i>	2 - 8	AC, WB	LV, HV, O	B	W-M	F	100'	○	Site-sensitive Suffers some wind damage Missouri native
Virginia pine <i>Pinus virginiana</i>	2 - 8	WB, SP	W, O	B-U	D-M, X	I	40'	○	Tolerant of a variety of soils Prefers clay, loam, or sandy loam Often used in land reclamation

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Common Name Scientific Name	Region	Agroforestry Application	Markets	Site	Soil Moisture	Growth Rate	Height	Light Preference	Notes
Washington hawthorn <i>Crataegus phaenopyrum</i>	1 - 8	D	W, O	U	M-D	I-S	15-25'	O	Susceptible to rust diseases Thorns
Water oak <i>Quercus nigra</i>	1, 4, 7	RB, WB	LV	B-U	M-W	I	60-70'	O - D	Poorer quality than other red oaks Missouri native
White ash <i>Fraxinus americana</i>	1, 3, 4 7	AC, RB, WB	LV	U-B	M, X	I	70-100'	D - O	Disease problems Missouri native
White oak <i>Quercus alba</i>	1 - 8	AC, SP, WB, FF	HV, W, LV	B-U	D-M	S	80-100'	D - O	Can be hard to regenerate/establish Missouri native
White spruce <i>Picea glauca</i>	1 - 5, 8	WB	O, W	B	M-W	S	50-80'	O - D	Not drought tolerant
Willow oak <i>Quercus phellos</i>	3, 7, 8	AC, SP, RB	O, LV, HV	B-U	M	S	80'	O - D	Missouri native
Common Name Scientific Name	Region	Agroforestry Application	Markets	Site	Soil Moisture	Growth Rate	Height	Light Preference	Notes
Shrubs									
American cranberrybush <i>Viburnum trilobum</i>	6, 8	D	W	B-U	M-W, X	F-I	8-12'	O - D	Minimum root depth 14"
American plum <i>Prunus americana</i>	1 - 8	RB, WB, FF	W, F	B	M	S-I	<15'	O	Thicket forming Missouri native
Arrowwood <i>Viburnum dentatum</i>	1 - 4, 6, 8	D	W	B-U	M-D, X	I-F	<8'	O - D	Adaptable to varying site conditions
Blackberry, raspberry <i>Rubus</i> spp.	1 - 3, 8	AC, RB, WB	W, F	B-U	D-M, X	F	6-10'	O - D	Thicket former Missouri native
Blackhaw <i>Viburnum prunifolium</i>	1 - 8	D	W	B-U	M-D	I	12'	O - ●	Missouri native
Buckthorn <i>Rhamnus cathartica</i>	5	RB, WB, D	W	B-U	W-D	F	10-20'	D - O	Alternate host for Oak Rust Can be invasive
Buttonbush <i>Cephalanthus occidentalis</i>	1 - 8	RB	W, E	B	W-D	F	6-10'	O	Wetland invasive problem Missouri native
Common chokecherry <i>Prunus virginiana</i>	1 - 8	RB, D	W, F, E	B	M	F	3-20'	O	Foliage toxic to livestock Natural wetland species Missouri native
Common elderberry <i>Sambucus canadensis</i>	2, 5	RB, D	W, F	B-U	M-D	F	<10'	O - D	Edible Good wildlife food source
Coralberry (Buckbrush) <i>Symphoricarpos orbiculatus</i>	1, 3, 5, 8	D	W	U	M-D	I	4-10'	O - D	Holds berries late in the season Missouri native
Cornelian cherry dogwood <i>Cornus mas</i>	1, 4, 8	D	W, O	U	M, X	I	10-20'	O - D	Few disease or insect problems
Deciduous holly <i>Ilex decidua</i>	1 - 8	D	W, O	B-U	M-W	S-I	<20'	● - D	Adaptable to varying site conditions
Fragrant sumac <i>Rhus aromatica</i>	1 - 8	D	W	U	D	F-I	<10'	D - ●	Missouri native

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Common Name Scientific Name	Region	Agroforestry Application	Markets	Site	Soil Moisture	Growth Rate	Height	Light Preference	Notes
Gray dogwood <i>Cornus racemosa</i>	1 - 8	D	W, O	B-U	W-M, X	I-F	10-15'	●	Thicket forming Can be invasive
Gooseberry <i>Ribes spp.</i>	1 - 3, 8	AC, RB, D	W, F	B-U	M	F	3'	○ - ●	Thicket forming Missouri native
Hazelnut <i>Corylus americana</i>	1 - 38	AC, FF, RB	W, F, O	B-U	M	F	7-15'	○ - ●	Difficult to establish from seed Missouri native
Nannyberry viburnum <i>Viburnum lentago</i>	1 - 6, 8	D	W	B-U	M	F	10-15'	●	Thicket forming
Ninebark <i>Physocarpus opulifolius</i>	1 - 8	RB	W, E	B-U	W-D	F	10'	○ - ●	Missouri native
Pussy willow <i>Salix discolor</i>	1, 3 - 7	RB, D	W, NT, E	B-U	W-D	I	<15'	○	May be propagated by cuttings
Redosier dogwood <i>Cornus stolonifera</i>	1, 3 - 6, 8	RB, WB	W, O, NT	B	M	I	6-10'	● - ○	Thicket forming
Rusty blackhaw <i>Viburnum rufidulum</i>	3, 7	D	W	B-U	M-D	S	<30'	● - ●	Missouri native
Serviceberry <i>Amelanchier spp.</i>	3, 7, 8	FF	W, O	U	M-D	I-F	<30'	●	Missouri native
Shrub lespedeza <i>Lespedeza bicolor</i>	3	RB, SP, WB	W, E		M-D	F	4-6'	○ - ●	Good cover and food for game birds and small mammals
Silky dogwood <i>Cornus amomum</i>	1 - 4, 6	WB, RB	W, NT, O, E	B-U	M	F-I	6-10'	●	Thicket forming Missouri native
Wahoo <i>Euonymus atropopureus</i>	1 - 8	D	W	B-U	M	I	<25'	○ - ●	Susceptible to foliar diseases Missouri native
Winged sumac <i>Rhus copallina</i>	5, 7, 8	D	W, O	U	D-M	F	5-10'	○	Missouri native
Witch-hazel <i>Hamamelis virginiana</i>	1, 3, 8	AC, FF, WB, D	W, NT	B-U	M-D	I	5-15'	●	Can be hard to establish Missouri native

Additional Resources

Online:

- USDA NRCS Plant Database: <http://www.plants.usda.gov/>
- Plant Resource Guide: Materials and Management: http://www.centerforagroforestry.org/pubs/training/app6_2015.pdf
- University of Connecticut Plant Database of Trees, Shrubs and Vines: <http://hort.uconn.edu/>
- Grow Native: <http://www.grownative.org/>
- Native Plant Information: <http://grownative.org/native-plant-info/>
- Silvics of North American Trees: https://www.srs.fs.usda.gov/pubs/misc/ag_654/table_of_contents.htm
- Missouri Flora Database: <http://www.missouriplants.com/>
- Arkansas Home and Garden Plant Database: <http://www.uaex.edu/yard-garden/resource-library/plant-database/>
- Native Prairie Plants of Iowa: <https://store.extension.iastate.edu/Product/sul18-pdf>
- Kansas Wildflowers and Grasses: <http://www.lib.ksu.edu/wildflower/>
- USDA Forest Service Plant Database: <http://www.fs.fed.us/database/feis/plants/>
- Nebraska Forest Service Tree Selection: <https://nfs.unl.edu/publications/selecting-trees>

Notes

Appendix Section 3: Grasses and Forages for Agroforestry

In this chapter:

- Identifying the Proper Grasses and Forages for Agroforestry
- Design and Management



Shade Trials: Learning about the shade tolerance of plant species is important to the Center for Agroforestry. Here mulches and forage crops are tested to identify their potential for planting under trees.

Agroforestry combines trees, shrubs, forages, grasses, livestock and crops in innovative, flexible combinations tailored to the landowner's needs. Through their integration with farm practices, production and conservation benefits can occur simultaneously. However, because the same resources are often used by all the plants in a given area, competition can pose some challenges to productivity.

What Makes a Forage/Grass Appropriate?

The answer will likely vary according to each landowner's specific interest and goals. That said, many trees and shrubs can be planted in configurations or densities that will also enhance the production of select forages and/or

grasses. In fact, the University of Missouri Center for Agroforestry has researched and identified many cool season grasses and legumes that produce better or the same under 50% shade as compared to full sun.

The following pages may be used as a general reference and guide for the selection of an appropriate forage/grass for your agroforestry practice.

As a component of a farm system, the properly designed and implemented agroforestry practice will help:

- Increase crop production
- Diversify products and farm income
- Improve soil quality and reduce erosion
- Improve water quality and reduce damage due to flooding
- Enhance wildlife habitat and improve biodiversity
- Reduce pest management inputs.

Design and Management

Planting design and management of an agroforestry practice depends on existing site conditions and the goals of the landowner. (You may also refer to the section on each specific practice for more information on design considerations) Many forages/grasses will do quite well under partially shaded conditions. The following table outlines some of the forages/grasses that the University of Missouri Center for Agroforestry has identified for use in partially shaded environments, and what can be expected from their productivity in shaded environments. In all cases, consider the products you wish to produce, any conservation or wildlife benefits desired, on-farm equipment and the needs of companion crops when planning the planting design.

When you decide on the appropriate forage/grass for your agroforestry practice, you should then seek out specific information on how to manage or establish that specific forage/grass species. Some considerations that will have a significant influence on the success of the forage/grass of choice include:

- Soil pH
- Time of seeding
- The use of companion or nurse crops
- Seeding method (broadcast vs. drilling)
- The use of herbicides to control undesirable/competing species
- Seeding rates
- The need for Inoculation
- Seed bed preparation
- Soil fertility

Each of the above mentioned establishment and management considerations can have a significant impact on both growth and productivity of a forage/grass stand. For more on establishing forages and seeding of a variety of forages common to Missouri, please reference:

Forage and Grass Recommendations for Agroforestry

Following is a table of forage and grass species suitable for agroforestry practices in Missouri. Included in the table are recommendations on practice applicability, potential uses and general site recommendations. Forages and grasses are listed in alphabetical order by common name. Consult with your regional agronomy specialist, or check with your University Extension personnel, to identify specifics on the appropriateness of a forage or grass to your region.

The following list is not exhaustive, but rather a starting point. All species listed may not be suited to all sites or regions within the State.

Identifying the proper forages and grasses

When selecting a forage/grass species, consider compatibility with the site. The selected species should be capable of providing the products and services desired by the landowner. Depending on the agroforestry practice selected, other forage/grass considerations may include:

- *Level of shade tolerance*
- *Season of production (example, warm vs. cool season grasses)*
- *Productivity capacity for a given site. For example: is it drought-tolerant, or capable of growing on a wet site that is known to flood periodically?*
- *Compatibility with end use (example: is the forage for livestock, or is the grass intended for erosion control and other conservation needs?)*
- *What species already exist on the site and can a natural forage/grass stand be enhanced?*

Common Grass and Legume Forages for Agroforestry Practices in Missouri

Common Name Scientific Name	Agroforestry Application	Valued for . . .	Growth Characteristics	Site Requirements	NOTES:
Alfalfa <i>Medicago sativa</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture 	<ul style="list-style-type: none"> • Hay 	<ul style="list-style-type: none"> • Perennial • Cool-season • Legume • Persists 5-8 years • Flood intolerant 	<ul style="list-style-type: none"> • Best on well drained soils • Does best in full sun • Soil pH above 6.0 	<ul style="list-style-type: none"> • Excellent hay • High maintenance • Low to moderate - tree competition
Alsike clover <i>Trifolium hybridum</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control 	<ul style="list-style-type: none"> • Perennial • Cool-season • Legume 	<ul style="list-style-type: none"> • Low, wet areas on a variety of soil types • Higher tolerance to soil acidity than Alfalfa 	<ul style="list-style-type: none"> • Sometimes utilized for forage and hay production in mixtures with red clover and grasses
Annual lespedeza <i>Kummerowia stipulacea</i> or <i>striata</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture 	<ul style="list-style-type: none"> • Wildlife benefits 	<ul style="list-style-type: none"> • Annual • Warm-season • Legume • Tolerates lower pH than other legumes • Tolerates high temperature 	<ul style="list-style-type: none"> • Productive on shallow, infertile soils • Best growth on well-drained soils 	<ul style="list-style-type: none"> • Allow to reseed in late summer • Best used in pastures and most effective when grown in grass sod
Annual ryegrass <i>Lolium multiflorum</i>	<ul style="list-style-type: none"> • Silvopasture 	<ul style="list-style-type: none"> • Forage 	<ul style="list-style-type: none"> • Annual • Cool-season 	<ul style="list-style-type: none"> • Best under high fertility 	<ul style="list-style-type: none"> • Winter Annual
Bermudagrass <i>Cynodon dactylon</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture 	<ul style="list-style-type: none"> • Erosion control 	<ul style="list-style-type: none"> • Perennial • Warm-season • Not shade tolerant 	<ul style="list-style-type: none"> • Prefers deep, sandy loam or medium textured soils • Will grow on poorer soils with management 	<ul style="list-style-type: none"> • Grazing tolerant • May winter kill particularly in Northern Missouri
Big bluestem <i>Andropogon gerardii</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Wildlife benefits • Erosion control • Hay 	<ul style="list-style-type: none"> • Perennial • Warm-season • Not shade tolerant 	<ul style="list-style-type: none"> • Prefers deep, well-drained soils • Intolerant of continuously wet soils 	<ul style="list-style-type: none"> • If burned, care must be taken to protect trees • Native
Birdsfoot trefoil <i>Lotus corniculatus</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control 	<ul style="list-style-type: none"> • Perennial • Cool-season • Legume 	<ul style="list-style-type: none"> • Tolerates poorly-drained, droughty, infertile and acidic soils better than Alfalfa 	<ul style="list-style-type: none"> • Allow stand to naturally reseed every 2-3 years
Buffalograss <i>Buchloe dactyloides</i>	<ul style="list-style-type: none"> • Silvopasture 	<ul style="list-style-type: none"> • Erosion control 	<ul style="list-style-type: none"> • Perennial • Warm-season • Drought resistant • Sod forming 	<ul style="list-style-type: none"> • Avoid sandy soils 	<ul style="list-style-type: none"> • Withstands heavy grazing

Common Name Scientific Name	Agroforestry Application	Valued for . . .	Growth Characteristics	Site Requirements	NOTES:
Canada wildrye <i>Elymus canadensis</i>	<ul style="list-style-type: none"> • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Wildlife benefits • Erosion control 	<ul style="list-style-type: none"> • Perennial • Cool-season 	<ul style="list-style-type: none"> • Grows in wet shaded areas 	<ul style="list-style-type: none"> • Native
Caucasian bluestem <i>Andropogon caucasia</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control 	<ul style="list-style-type: none"> • Perennial • Warm-season • Not shade tolerant • Long active growth period 	<ul style="list-style-type: none"> • Needs good drainage 	<ul style="list-style-type: none"> • Grazing tolerant • Don't need to burn
Creeping red fescue <i>Festuca rubra</i>	<ul style="list-style-type: none"> • Silvopasture • Riparian Buffer 	<ul style="list-style-type: none"> • Erosion control 	<ul style="list-style-type: none"> • Perennial • Cool-season 	<ul style="list-style-type: none"> • Grows best in well drained, infertile and droughty soils 	<ul style="list-style-type: none"> • Shade tolerant • Usually used for turf
Crownvetch <i>Coronilla varia</i>	<ul style="list-style-type: none"> • Alley cropping • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control 	<ul style="list-style-type: none"> • Perennial • Deep taproot • Spreads vegetatively • Legume 	<ul style="list-style-type: none"> • Best adapted to well-drained, fertile soils with pH 6.0 or greater 	<ul style="list-style-type: none"> • Does not tolerate grazing
Eastern gamagrass <i>Tripsacum dactyloides</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Wildlife benefits • Erosion control • Hay 	<ul style="list-style-type: none"> • Perennial • Warm-season • Slow to establish • Tolerates temporary flooding • Stiff upright stems • Forms large clumps or mounds • Not tolerant of shade 	<ul style="list-style-type: none"> • Deep soils in low areas 	<ul style="list-style-type: none"> • Excellent forage • Native
Hop clover <i>Trifolium agrarium</i>	<ul style="list-style-type: none"> • Silvopasture 		<ul style="list-style-type: none"> • Annual • Cool-season • Legume 	<ul style="list-style-type: none"> • Tolerates poorly-drained, droughty and infertile soils 	<ul style="list-style-type: none"> • Used mainly in Southern Missouri
Illinois bundleflower <i>Desmanthus illinoensis</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture 	<ul style="list-style-type: none"> • Wildlife benefits 	<ul style="list-style-type: none"> • Warm-season • Legume 	<ul style="list-style-type: none"> • Grows well on clay or limestone soils 	<ul style="list-style-type: none"> • Sometimes used in mix with warm-season grasses • Native
Indiangrass <i>Sorghastrum nutans</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Wildlife benefits • Erosion control 	<ul style="list-style-type: none"> • Perennial • Warm-season • Not shade tolerant • grows 4-6 feet tall • 2-3 years to establish 	<ul style="list-style-type: none"> • Deep, moist soils 	<ul style="list-style-type: none"> • Native • If burned care must be taken to protect trees

Common Name Scientific Name	Agroforestry Application	Valued for ...	Growth Characteristics	Site Requirements	NOTES:
Kentucky bluegrass <i>Poa pratensis</i>	<ul style="list-style-type: none"> • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control • Weed suppression 	<ul style="list-style-type: none"> • Perennial • Cool-season 	<ul style="list-style-type: none"> • Grows on a variety of soil types 	<ul style="list-style-type: none"> • Usually used in mixes for grazing
Little bluestem <i>Schizachyrium scoparium</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Wildlife benefits • Erosion control 	<ul style="list-style-type: none"> • Perennial • Warm-season 	<ul style="list-style-type: none"> • Droughty sites • Grows on a variety of soil types 	<ul style="list-style-type: none"> • Mix with warm-season grasses • Native
Orchardgrass <i>Dactylis glomerata</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control • Hay 	<ul style="list-style-type: none"> • Perennial • Cool-season • Shade tolerant • Short lived • Not tolerant of overuse • Bunch grass 	<ul style="list-style-type: none"> • Tolerates moderately poor drained soils, yet is intolerant to flooding 	<ul style="list-style-type: none"> • Mixes well with legumes (alfalfa, ladino clover) • Matures yearly • Moderate - tree competition • Disease problems under some conditions
Red clover <i>Trifolium pratense</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control • Hay 	<ul style="list-style-type: none"> • Perennial • Cool-season • Short lived • Legume • Easy to establish 	<ul style="list-style-type: none"> • Prefers fertile, well-drained medium to heavy textured soils 	<ul style="list-style-type: none"> • Requires reseeding • Best in grass/legume mixture • Common in pastures • Can crowd out grass in seeding year if planted too thick
Redtop <i>Agrostis gigantea</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control • Cover crop in orchards 	<ul style="list-style-type: none"> • Perennial • Cool-season • Long-lived • Sod forming 	<ul style="list-style-type: none"> • Will grow at lower pH and in wetter soils • Adapted to a wide range of soil conditions 	<ul style="list-style-type: none"> • Moderate - competition with trees • Use smooth brome grass, redtop, alsike clover and ladino clover in filter strips
Reed canarygrass <i>Phalaris arundinacea</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control • Hay 	<ul style="list-style-type: none"> • Perennial • Cool-season • Grows up to 6 feet tall and dense • Tolerant of wet and drought. • Mat forming - dense • Hard to establish 	<ul style="list-style-type: none"> • Grows well in wet or dry soil • Wet areas 	<ul style="list-style-type: none"> • Recommend low alkaloid variety • Too competitive with trees • Invasive in wet areas

Common Name Scientific Name	Agroforestry Application	Valued for . . .	Growth Characteristics	Site Requirements	NOTES:
Sideoats grama <i>Bouteloua curtipendula</i>	<ul style="list-style-type: none"> • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Wildlife benefits • Erosion control 	<ul style="list-style-type: none"> • Perennial • Warm-season 	<ul style="list-style-type: none"> • Droughty sites • Grows on a wide variety of well-drained soils 	<ul style="list-style-type: none"> • Mix with other native warm-season grasses • Native
Smooth brome grass <i>Bromus inermis</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control • Hay 	<ul style="list-style-type: none"> • Perennial • Cool-season • Sod former with good fertility • Winter hardy 	<ul style="list-style-type: none"> • Best growth on deep, fertile soils 	<ul style="list-style-type: none"> • Weeds or companion crops may retard establishment from spring sowing
Sorghum-sudangrass <i>Sorghum</i> hybrids	<ul style="list-style-type: none"> • Alley cropping • Silvopasture 	<ul style="list-style-type: none"> • Hay 	<ul style="list-style-type: none"> • Annual • Warm-season 	<ul style="list-style-type: none"> • Requires high fertility and moisture 	<ul style="list-style-type: none"> • Tall growing, competitive
Sudangrass <i>Sorghum bicolor</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture 	<ul style="list-style-type: none"> • Hay 	<ul style="list-style-type: none"> • Annual • Warm-season 	<ul style="list-style-type: none"> • Requires high fertility and moisture 	<ul style="list-style-type: none"> • Tall growing, competitive
Sweetclover <i>Melilotus</i> sp.	<ul style="list-style-type: none"> • Alley cropping • Silvopasture 	<ul style="list-style-type: none"> • Soil improvement 	<ul style="list-style-type: none"> • Annual/Biennial • Legume • Drought tolerant • Winter hardy • Deep taproot 	<ul style="list-style-type: none"> • Not tolerant of acid soils 	<ul style="list-style-type: none"> • Improperly cured hay can contain the poison Dicoumarol
Switchgrass <i>Panicum virgatum</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Wildlife benefits • Erosion control • Hay 	<ul style="list-style-type: none"> • Perennial • Warm-season • Long lived • Grows 4-6 feet tall • Flood and herbicide tolerant • Good deep root filtering • Slow to establish (2-3 years) 	<ul style="list-style-type: none"> • Performs well in wet areas • Will grow where many grasses will not • Prefers fertile, well-drained sites 	<ul style="list-style-type: none"> • Plant thick to avoid weed competition • If burned, care must be taken to protect trees • Native
Tall fescue <i>Festuca arundinacea</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control • Hay • Seed 	<ul style="list-style-type: none"> • Perennial • Cool-season • Drought tolerant • Hardy 	<ul style="list-style-type: none"> • Tolerates many soil conditions 	<ul style="list-style-type: none"> • May be too competitive with trees • Endophyte free/friendly endophyte varieties recommended • Grazing tolerant • Good fall pasture

Common Name Scientific Name	Agroforestry Application	Valued for . . .	Growth Characteristics	Site Requirements	NOTES:
Timothy <i>Phleum pratense</i>	<ul style="list-style-type: none"> • Alley cropping • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Erosion control • Hay 	<ul style="list-style-type: none"> • Perennial • Cool-season • Winter hardy • Short lived • Bunch grass 	<ul style="list-style-type: none"> • Prefers well-drained, moist soils • Not tolerant of droughty sites 	<ul style="list-style-type: none"> • Intolerant of overgrazing • Use in a mixture with other cool season grasses and legumes • Low - competition with tree
Virginia wildrye <i>Elymus virginicus</i>	<ul style="list-style-type: none"> • Riparian Buffer • Silvopasture 	<ul style="list-style-type: none"> • Wildlife benefits • Erosion control 	<ul style="list-style-type: none"> • Cool season • Perennial • Slow to get started 	<ul style="list-style-type: none"> • Grows in moist sandy soils • Prefers medium textured soils 	<ul style="list-style-type: none"> • Should be used in conjunction with other grasses
Western wheat grass <i>Pascopyrum smithii</i>	<ul style="list-style-type: none"> • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Wildlife benefits • Erosion control 	<ul style="list-style-type: none"> • Perennial • Cool-season 	<ul style="list-style-type: none"> • Grows well on low, heavy soils 	<ul style="list-style-type: none"> • Produces an open but uniform sod
White/Ladino clover <i>Trifolium repens</i>	<ul style="list-style-type: none"> • Silvopasture • Riparian buffer 	<ul style="list-style-type: none"> • Wildlife benefits • Erosion control 	<ul style="list-style-type: none"> • Perennial • Cool-season • Legume • Not drought tolerant 	<ul style="list-style-type: none"> • Does best in wet soils and seasons • Performs poorly on shallow, droughty soils 	<ul style="list-style-type: none"> • Use in combination with grasses
GENERAL NOTE:					
<ul style="list-style-type: none"> • *Warm season grasses may need prescribed fire for management which may not be compatible with agroforestry 					

Additional Resources

Online:

- For a number of publications on specific forages and grasses, visit:
 - <http://extension.missouri.edu/main/DisplayCategory.aspx?C=23>
 - Plant Resource Guide: Materials and Management:
 - http://www.centerforagroforestry.org/pubs/training/app6_2015.pdf
 - Establishing Forages: <http://extension.missouri.edu/p/G4650>
 - Seeding Rates, Dates and Depths for Common Missouri Forages:
 - <http://extension.missouri.edu/p/G4652>
 - USDA NRCS Plant Database: <http://www.plants.usda.gov/>
 - Plant Resource Guide: Materials and Management:
 - http://www.centerforagroforestry.org/pubs/training/app6_2015.pdf
 - University of Connecticut Plant Database of Trees, Shrubs and Vines: <http://hort.uconn.edu/>
 - Grow Native: <http://www.grownative.org/>
 - Native Plant Information: <http://grownative.org/native-plant-info/>
 - Silvics of North American Trees:
 - https://www.srs.fs.usda.gov/pubs/misc/ag_654/table_of_contents.htm
 - Missouri Flora Database: <http://www.missouriplants.com/>
 - Arkansas Home and Garden Plant Database:
 - <http://www.uaex.edu/yard-garden/resource-library/plant-database/>
 - Native Prairie Plants of Iowa: <https://store.extension.iastate.edu/Product/sul18-pdf>
 - Kansas Wildflowers and Grasses: <http://www.lib.ksu.edu/wildflower/>
 - USDA Forest Service Plant Database: <https://www.feis-crs.org/feis/>
 - Nebraska Forest Service Tree Selection: <https://nfs.unl.edu/publications/selecting-trees>

Notes

Appendix Section 4: The Basics of Selling Timber

Selling timber can be a rewarding experience for some forest land owners while a traumatic experience for others. Landowners who do a thorough job of planning and marketing are usually satisfied with a timber harvest; those who did not prepare for a timber sale are likely to be dissatisfied. Many people receive a fraction of their timber's true value because they do not know what they have or do not know how to sell it. This article presents guidelines to assist individuals in selling timber from their woodlands.

Define Your Objectives

A wise man once said, "Without a road map, you will probably never get to your destination." A successful timber harvest begins with identifying your objectives. This can best be done with a written Forest Management Plan that identifies your objectives, steps to achieving them, and times when they will be conducted.

The plan should also identify the type of harvest to be conducted and steps to be taken for reforestation after the harvest.

You need to tell the log buyer exactly what you expect from the timber sale. This is best done through provisions written into a timber sale contract. For example, if one of your objectives is maintaining water quality, a provision in the contract should state that Best Management Practices (BMPs) will be followed during road building, stream crossing, and harvesting. For a list of voluntary BMPs, contact a Missouri Department of Conservation (MDC) forester.

Why Sell Timber

Other than simply for financial gain, timber harvesting is a tool for accomplishing objectives that you may have identified in your forest

management plan. Such objectives may include:

- *Improving the overall health and vigor of the forest*
- *Promoting seedling regeneration*
- *Creating wildlife habitat*
- *Reducing the density of the forest (if overcrowded)*
- *Establishing planting areas*
- *Creating vistas and trails*
- *Developing certain types of recreational activities*
- *Salvaging damaged trees*

Steps in Selling Timber

When selling timber these steps should be followed:

- 1. Know what you have to sell**
- 2. Determine what your timber is worth**
- 3. Determine what method you will use to sell your timber**
- 4. Determine a method of payment**
- 5. Advertise your sale**
- 6. Develop a written contract with the buyer**
- 7. Supervise and inspect the harvest**
- 8. Practice good forestry**

Know What You Have to Sell

Before advertising a timber sale, you first need to determine what you have to sell. This involves selecting the trees to be harvested and determining what volumes and products are present in those trees. Make sure the trees are, in fact, on your property. Settle any boundary disputes with your neighbors *before* you sell any timber. Clearly mark the trees to be harvested so the logger can easily see them. Mark each tree with a spot of paint about chest high (bright blue or orange works best) on the same side of the tree so they are visible from a main trail or road. A second spot of paint should

be placed at the ground line. This paint spot will remain after logging to serve as a check to make certain that only marked trees were harvested.

After selecting the trees to be harvested, estimate the wood volume or the number of products that will be cut by species. Timber volumes are estimated by measuring individual trees. For more details read the University Extension guide “How to Measure Trees and Logs,” which is available from a MDC forester or the county Extension Service agent.

Some common products that may be produced from trees include sawlogs, stave bolts (to make barrels), veneer logs, firewood, pulpwood (to make paper), posts and poles. These products are determined by the species, size and quality of your timber and can vary greatly in price. There may not be a market for all these products within any given area. Local mills will determine the specifications for each product they purchase. For current market conditions, Timber Price Reports are available from a MDC forester.

Determine What Your Timber is Worth

The price paid for standing trees before they are harvested (called stumpage) has no set value.

Your timber is worth whatever you and the buyer agree to. Many factors influence the price of standing trees. These include:

- **Tree species.** Wood from some species is more valuable than wood from other species.
- **Tree size.** Large trees will have more volume and clear wood than smaller trees.
- **Tree quality.** Trees with fewer defects (e.g., branch scars, decay, imbedded wire) have higher quality, more valuable wood.
- **Volume of sale.** Large volume sales will bring a higher per unit price than small volume sales.

- **Distance to the mill.** The closer a woodlot is to the mill, the lower the hauling costs.
- **Site accessibility.** The ease with which the forest land can be reached affects costs.
- **Logging difficulty.** Steepness of terrain and soil moisture conditions affect the equipment that can be used and speed of harvesting.
- **Market conditions.** Poor markets mean lower timber prices. Buyers often pay more for logs when their inventories are low to ensure continued mill operation.
- **Your restrictions** on harvesting and skidding techniques. Restrictions set forth in your timber sale contract, such as seeding skid trails after harvest, will increase logging costs.

Different buyers may offer substantially different prices for the same timber, depending on their own particular costs and markets. The only way to actually determine what your timber is worth is to offer it for sale on the open market and contact as many potential buyers as possible.

Determine a Selling Method

Selecting the appropriate selling method for marketing your timber is the key to having a successful timber sale. The two methods commonly used in Missouri are sealed bid and negotiation.

The **sealed bid** sale is recommended most often for private woodland owners. This process informs potential buyers about the timber sale. These buyers are allowed a length of time (usually 4 to 6 weeks) to inspect the sale and submit bids. Each bidder is allowed to make only one bid and late bids are always rejected. Bids are then opened at a specified time and place, and the successful buyer is selected. If no bids meet your minimum requirements, you have the right to refuse all bids. No further price negotiations should take place after a buyer has been selected and unsuccessful bidders notified that the timber was sold. A blank Bid Solicitation is available from a MDC forester.

A **negotiated sale** involves face-to-face negotiations between the seller and a single buyer. This procedure often results in a price well below what the timber is worth because the buyer has no competition and the seller is often uninformed about the timber's value. For that reason, do not be too anxious to accept the first offer for your timber. A negotiated sale, however, may be the best method if:

- *You have a small amount of timber or poor quality timber to sell.*
- *Markets for the species and products for sale are so poor that few buyers would be interested.*
- *You want to work with a particular buyer that you know and trust.*
- *You are marketing certain specialty products.*

Method of Payment

There are two methods of payment available to woodland owners who sell timber.

In a **lump sum** sale you receive a single payment for the trees to be sold before the harvest begins. Splitting payments for each cutting area may be necessary for large sales. Payment is based on the amount of timber volume estimated and not the actual volume harvested. Lump sum sales, therefore, depend heavily on the accuracy of your estimate of the volume and quality of timber for sale.

An advantage of a lump sum sale is simplicity. The landowner is relieved of the burden of keeping track of the volume of timber being harvested and income is provided before harvesting begins. A disadvantage is that the seller receives bids that are based on an estimate of the volume to be harvested, which may be different from the amount actually harvested.

In a **yield sale** the landowner is paid a certain amount for each unit of product cut. This requires that someone (usually at the mill) scale the volume of products after harvest. An ad-

vantage of a yield sale is that the landowner is being paid for the timber that is actually being harvested. The disadvantage is that problems can arise in obtaining an accurate tally since tracking the logs is difficult once they leave your property.

Advertising Your Sale

There are several steps to follow in preparing a timber sale notice. You must have accurate, reliable information and you need to send it to as many prospective bidders as possible. An up-to-date Log Buyers List is available from a MDC forester. A timber sale notice should include the basic information that will later become part of the timber sale contract including:

- *Your name, address and telephone number.*
- *Location of the timber for sale. Include a map, legal description and directions.*
- *Description of the trees or logs to be sold. Include volume by species, number of trees, diameter classes and sawlog grades if appropriate. Describe how the trees and sale boundaries will be marked.*
- *Type of bid you are expecting: lump sum or yield sale.*
- *Times when potential buyers can visit and inspect the timber.*
- *Date, time and place written bids will be opened. Include how the successful bidder will be selected and notified.*
- *Whether or not a down payment is required to bind the offer when the contract is signed. An amount of 5 to 10 percent of the bid price is normally required.*
- *Any limitations or special ownership considerations on the sale. Such considerations include harvesting deadline, restrictions on access, conditions when loggers cannot operate (such as wet conditions), streamside management zones or buffers, etc.*
- *Requirements for a performance bond. A performance deposit is an amount of money above the sale price (usually 10 percent of sale price) posted by the buyer when the contract is signed and held in escrow by the seller. The bond's purpose is to ensure that*

the buyer abides by the terms set forth in the contract. The performance deposit should be refunded immediately after the sale is completed and contract requirements are met.

- *Statement whether the logger must carry insurance and liability. Insurance will avoid possible legal complications if a logger is injured on your property and liability insurance will cover any damage to your property or adjoining lands caused by the logger.*
- *Statement indicating your right to reject any or all bids.*

Timber Sale Contract

The purpose of a timber sale contract is to protect the interests of buyer and seller and must be signed by both parties. You should meet with the logger or buyer to discuss the items to be included in the contract; this will reduce the possibility of misunderstandings.

The written contract does not need to be a complex document, but it should reflect what you and the logger have agreed to with respect to the sale. Timber buyers will frequently provide their own standard contract. Such contracts may not adequately represent your interest as a seller. A blank Timber Sale Contract is available from a MDC forester. You may want to have a lawyer draft or review your contract. It is critical that you include the provisions that you feel are important regarding the harvest on your property.

Supervise the Timber Harvest

One of the most important things you can do during the harvest is to inspect it periodically. Before harvesting begins, review the timber sale contract with the logger and point out sale boundaries. If possible, walk the site to be harvested with the logger. This will accomplish two objectives; 1) it will give you an opportunity to get to know the logger, and 2) it will give you a chance to explain your objectives of harvesting timber. A logger that is familiar with you personally and aware of your objectives will likely do a better job on the site.

Once timber harvesting begins, visit the area frequently. When you visit the site make sure that logging meets the terms of the contract. Questions that arise should be discussed with the logger. Unless you discover a flagrant violation of the contract, a simple suggestion to the logger in charge of the operation will usually solve the problem. After the harvest is completed and all provisions of the contract have been fulfilled, write a letter releasing the buyer from the contract and return the performance deposit.

Practice Good Forestry

Improper logging practices can have adverse effects on water quality, wildlife and forest regeneration. To ensure that you are satisfied with the end result of the timber harvest, it is important that good forestry practices are applied during and after the logging operation. Following BMPs and having a reforestation plan are two important considerations for harvesting timber on your property.

Sources of Forestry Advice

Landowners who have little experience in forestry should contact a professional forester to assist in managing their woodlands. There are private and public foresters available to help you with your management plan.

Private Sources. A consultant is a professional forester whose services are available on a contract or fee basis, with the fee paid by the client. Consultants can perform a variety of work including forest inventories, timber sales and land appraisal. Consultants may also serve as the main contractor in carrying out a Forest Management Plan on your land. A list of consulting foresters is available from the Missouri Department of Conservation.

Public Sources. The Missouri Department of Conservation can help private landowners become good stewards of their forest land by providing technical forestry assistance. A forester can provide a variety of services to

help you meet your land management goals. These services are free-of-charge and will be as in-depth as you need, depending on your commitment to the long-term management of your forest lands. A forester can answer your questions over the telephone or may provide on-site assistance. A brochure entitled “Forest Management Assistance for Missouri Landowners” is available from a MDC forester and describes the services offered.

Contact: State Forester or a local forester at:
Missouri Department of Conservation
P.O. Box 180
Jefferson City, MO 65102-0180

Notes

Appendix A: Sample Solicitation of Bid for Timber

You are invited to bid on timber located as follows: in the NW 1/4, Section 23, Township 25 North, Range 14 West, Timber County, Missouri. The timber is located five miles south of Oak Grove on Route AB.

For additional information or for directions on how to see the timber, contact: Forrest Farmer, Oak Grove, Missouri; telephone 573/555-1234.

DESCRIPTION:

Approximately 160 acres of mixed oak timber. The trees to be cut are marked with a fresh orange paint spot at breast height and on the stump. About 1,600 trees are marked. Bids are to be made on a lump sum basis.

BID INSTRUCTIONS:

After the bid is completed, return it to:

*Forrest Farmer, Route 1
Oak Grove, MO 61234*

On or before -- Time: 1:00 P.M. Date:

Mark "TIMBER BID" on the envelope.

The owner reserves the right to reject any or all bids.

BIDDER: TELEPHONE:

ADDRESS: SIGNATURE:

AMOUNT OF BID:

Appendix B: Sample Timber Sale Contract

Joe Logger of Big Cedar, Missouri, herein after called the Purchaser, agrees to purchase from Forrest Farmer of Oak Grove, Missouri, herein after called the Seller, the designated timber specified below:

WITNESSETH:

ARTICLE I. *The Seller hereby agrees to sell to the Purchaser, subject to the terms listed below, all of the timber specified below, on a certain tract owned by the Seller, located in NW 1/4, Section 23, Township 25 North, Range 14 West, County of Timber, State of Missouri, located on 160 acres, more or less.*

ARTICLE II. *The Purchaser agrees:*

- 1. To cut only those trees marked with a fresh orange paint spot. Trees marked with an "X" may be cut if desired.*
- 2. Trees other than those specified above may be cut only for access on areas used for roads and landings.*
- 3. To pay the Seller a lump price of \$12,000.00 when the contract is signed to pay for the trees designated for cutting.*
- 4. To pay three times the stumpage value per tree, a penalty rate, for each tree that is cut which is not designated for cutting.*
- 5. To keep fields, fences, roads, and streams free from tree tops and other logging debris at all times. He also agrees to remove all oil and gasoline cans and other debris accumulated during cutting.*
- 6. And understands that the Seller is not responsible or liable in any manner for injury or damage resulting from the cutting and removing of these trees.*
- 7. That this contract cannot be transferred to another party without the written permission of the Seller.*

ARTICLE III. *The Purchaser further agrees to cut and remove said timber in strict accordance with the following conditions:*

- 1. To waive all claims to the above described trees unless they are cut and removed on or before December 31, 1999.*
- 2. To do all in his power to prevent and suppress forest fires on or threatening the sale area.*
- 3. To protect from unnecessary injury young growth and other trees not designated for cutting.*
- 4. To repair damage caused by logging to fences, bridges, roads, trails, or other improvements damaged beyond ordinary wear and tear.*
- 5. To allow the owner to cut and remove any portion of a tree left on the ground by the Purchaser after he has removed his products.*

Sample Timber Sale Contract (cont.)

ARTICLE IV. The Seller agrees to the following conditions:

1. To guarantee title to the forest products covered by this agreement and to defend it against all claims at his expense.
2. To grant or secure necessary entry and right-of-way to the Purchaser and his employees on and across the area covered by this agreement, and also other privileges usually extended to purchasers.

ARTICLE V. It is mutually understood and agreed by and between the parties hereto as follows:

1. All timber included in this agreement shall remain the property of the Seller, and shall not be removed until paid for in full.
2. In case of a dispute over the terms of this contract, we agree to accept the decision of an arbitration board of three selected persons as final. Each of the contracting parties will select one person and the third will be the State Forester or his chosen representative.

Signed in duplicate this _____ day of _____, 20____.

(Witness) (Purchaser)

(Witness) (Seller)

(Witness) (Seller)

ACKNOWLEDGMENT

STATE OF _____

COUNTY OF _____

On this _____ day of _____, 20____ before me personally appeared _____ to be known to be the person(s) described in and who executed the foregoing instrument and acknowledged that _____ executed same as _____ free act and deed.

In Testimony Whereof, I have hereunto set my hand and affixed my official seal, at my office in _____, the day and year first above written.

My Commission as Notary
Public Expires _____.

NOTARY PUBLIC [an error occurred while processing this directive]

Appendix Section 5: Planning for Agroforestry Workbook

Personal Assessment

Step 1: Initial Objectives and Priorities

Step 2: Evaluate Personal Resources

Biophysical Site Assessment

Step 3: Identify Current Land Uses

Step 4: Map Area(s) for Agroforestry Development

Step 5: Climate Assessment

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Step 10: Listing ‘Best Bets’

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Step 11: SWOT Analysis

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Step 13: Revising Your ‘Best Bets’

Marketing Strategy for ‘Best Bets’

Step 14: Select and Describe Target Market(s)

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Step 16: Getting Products to the Buyer

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Step 18: Promoting Your Products

Agroforestry Practice Design and Management

Step 19: Revisit Your Objectives and Priorities

Step 20: Detailed ‘Best Bets’ Crop Information

Step 21: Designing Your Agroforestry Practices

The Agroforestry Development Plan

Step 22: A Five-Year Management Projection

Step 23: Yearly Activity Schedule

Personal Assessment

Step 1: Initial Objectives and Priorities

Rank (X) the following management objectives according to your land-use priorities (low, medium, high). Remember these objectives are a starting point, and you can (and probably will) modify them later. If possible, numerically rank the top five objectives for your agroforestry project (1=highest to 5=lowest priority).

Objective	Low	Medium	High	Top 5
A new source of income from unproductive land				
Reduce costs of current farm or forest operations				
Develop new source of long-term income (i.e., timber)				
Increase short-term income while awaiting long-term timber income				
Tax advantages				
Increase grazing opportunities				
Increase wildlife opportunities				
Undertake environmental improvements				
Access to governmental programs and cost-share				
Other				

Personal Assessment

Step 2: Evaluate Personal Resources

What resources – in addition to your land base – do you have that could be put into your agroforestry development? The section below allows you to list and evaluate the resources of all the family members who will be involved and that you think will have an impact on your ability to develop this agroforestry area.

Resource	Landowner use and potential of resource
1. Management time – When will the new activity not be in conflict with existing activities?	
2. Labor – Times of year when labor is most available.	
3. Equipment and facilities – For animals, storage, value-added processing, time of year available.	
4. Specialized farm equipment – Identify special farm equipment, such as tractors, ATVs, spray equipment, etc.	
5. Irrigation – Water source available.	
6. Plant material – Your own sources of seed, seedlings, cuttings and larger trees, or will you need to purchase them?	
7. Livestock – Cattle, sheep or other animals. What are their needs, and when are those greatest (i.e. calving)?	
8. Materials – Sawdust or shavings, manure and straw, or pine straw, for mulch, etc.	
9. Other	

Exercise: Can I meet my labor and management needs?

	Total hours for year	Distribution of hours (for one year or for production period)			
		Jan-Mar	Apr-June	July-Sept	Oct-Dec
Suggested hours, full-time worker (~ 40 hours/week)	2,000	500	500	500	500
My estimate, cost of wages, full-time worker (\$7.25/hr. min. wage – in 2013)					
Labor and management hours available					
Principal Manager					
Team Member 1					
Team Member 2					
Team Member 3					
Hired Labor					
Total Hours Available					
Direct labor and management hours needed by enterprise					
Enterprise 1					
Enterprise 2					
Enterprise 3					
Total labor hours needed					
Total labor hours available (from above)					
Additional labor hours required (total hours needed minus total hours available)					
Excess labor hours available (total hours available minus total hours needed)					

Biophysical Site Assessment

Step 3: Identify Current Land Uses

List present uses of each part of your land and the products you harvest. Possibilities include: residential, recreation, farming (which crop), grazing (type of livestock), timber production, non-timber production, wildlife areas and green belts.

Land Use	Product/Resources Available
1. Residential	
2. Recreation	
3. Farming (list crops)	
4. Grazing Livestock (type)	
5. Timber Production	
6. Non-Timber Production	
7. Wildlife Areas	
8. Green Belts	
9. Other	

Exercise: Inventory your land and natural resources

Agricultural land resources: Cropland and pasture

Who can help? Your local extension agent or NRCS (Natural Resource Conservation Service) office can look at your property, indicate whether your present farm-management plan is sound, and recommend other options that could enhance your operation. Cost share programs or the sale of your agricultural development rights are other options that may be of value to you.

Number of acres of tillable land _____

Number of acres of pasture _____

Number of acres left idle _____

Number of acres you farm _____

Number of acres rented _____

Current crop(s)

Number of head of livestock _____

Total annual rental income from land rented to others who grow crops _____

Total annual rental income from land rented to others who raise livestock _____

Fertility of land, agricultural crops: Excellent Good Poor

Fertility of land, forests: Excellent Good Poor

Total annual income from pasture and livestock _____

How much of the annual pasture and livestock income is from land rented to others? _____

Rented from others? _____

Total annual income from cropland _____

How much of the annual cropland income is from land rented to others? _____

Rented from others? _____

Exercise: Inventory your land and natural resources, con't

Natural resources

Forest. Who can help? You may want to contact a state forester to assist you with the inventory and evaluation of your forest resources. He or she can advise you on the procedure for developing a forest stewardship plan. In some states, a state forester can help you prepare a forest stewardship plan. In all states, they can provide names of private consultant foresters to assist with a timber sale or assess the potential of your forest under different management options.

Total number of acres of forest _____

Three most common tree species (oak, poplar, pine, hickory, etc.) _____

Do you have a written forest management plan? _____

If yes, what year was it prepared? _____

Have your property taxes been reduced because you are enrolled in a land-use-tax assessment program for forestry? _____

What nontimber forest products, if any, are present on the property? (Include edible and medicinal plants, decorative or floral products, specialty wood products, and native wild plants.)

Have you or has a past owner sold timber to a commercial timber harvester?

If yes, when? _____ How many acres? _____

(Developing a forest stewardship plan will provide the information to answer the last two questions.)

Exercise: Inventory your land and natural resources, con't

How many acres of forest could a commercial operator potentially harvest during the next five years? _____

Within the next five years, what is the estimated income from a commercial timber harvest(s) that is compatible with your forest stewardship objectives?

Wildlife

Who can help? State wildlife biologists have limited time but may be able to visit and discuss options. Leasing the hunting rights is an option that could generate income to pay taxes or more. Investigate educational materials on hunting options and discuss them with your extension wildlife specialist. Also contact the U.S. Fish and Wildlife Service.

Are deer causing significant crop or forest damage?

Are other wildlife species causing crop damage? _____
If yes, what species?

Do you have large numbers of geese on your property? _____

Do you have quail or pheasant on your property? _____

Do you have wild turkeys on your property? _____

What other type of wildlife have you seen on the property?

Exercise: Inventory your land and natural resources, con't

What type of habitat improvements could be made to attract the wildlife you are interested in introducing to the property (timber harvesting, food plots, tree planting, etc.)?

Do you or other family members hunt on the property?

Do neighbors or other local residents now hunt on the property, with or without permission? _____

Do existing hunters pay you for the right to hunt on the property? _____

If yes, how much are you paid a year? _____

List any unique wildlife habitats or species on your property (e.g., forest ponds, wetlands, old forests, caves).

Aesthetic or intangible resources

List locations on your property that have aesthetic appeal and could be developed for recreational enterprises, such as vacation cabin or hunting camp. Unique locations include rivers, streams, scenic overlooks, rock cliffs and wetlands.

Exercise: Inventory your land and natural resources, con't

Water resources

If you have more than one pond, or spring, assess each.

Who can help? For assistance with evaluating your water resources, you may want to contact your local cooperative extension office. An extension agent should be able to direct you to a water-quality specialist in your area.

Ponds. Pond size (in acres) _____
Maximum pond depth (in feet) _____
Maximum summer water temperature at 2 feet _____
pH _____
Alkalinity (in parts per million) _____
What type of fish live in the pond? _____
Do livestock have full access to the pond? _____
Does livestock waste drain into the pond? _____

Streams/Rivers. Stream width _____
Stream depth _____
Does the stream run all year? _____
What type of fish live there? _____
Do livestock use the stream or does livestock waste run into the stream? _____
Is the stream bordered by forest of at least 25 feet in width along each side? _____

Springs. Number of springs on the property _____
Rate of flow of largest spring (gallons per hour) _____

Exercise: Inventory your physical and personal resources, con't

Buildings, houses, barns and other structures

List size, age, condition and the cost to convert or upgrade structures for use in the enterprise.

House

Barn 1

Barn 2

Other

List rental cost and location of any available public or private structures or facilities that you can use for your enterprise (e.g., kitchen, storage facility, or processing facility).

Machinery and equipment

For each piece of equipment (tractor, chainsaw, wagon, rototiller, backhoe, bulldozer, etc.), list make, horsepower, age, condition, attachments, or other relevant information.

1. _____
2. _____
3. _____
4. _____
5. _____

Exercise: Inventory your physical and personal resources, con't

Use of byproducts of farm/forest operation

Is animal manure produced from the farm operation? _____

Can it be used onsite? _____

List other byproducts, if any, from farm operations

Can they be used onsite? _____

How and where?

Are limbs and other wood from a recent timber harvest currently available for use? _____

What is the type and quantity of this material (e.g., cords of firewood that it would produce and number and species of vines)?

Labor and management resources

Time for management and labor involved in an enterprise must come from the team members or from outside sources. The opposite chart will help team members determine how much time they have available during each quarter of the year for management and labor activities. The time available can be on weekends or weekdays. Completing the chart will help you look at your time realistically and determine whether the enterprises you are investigating are compatible with the time you have available.

Exercise: Inventory your physical and personal resources, con't

Resource person	Hours by season and time of the week				
	Total hours avail/year	Jan-Mar Weekday/Weekend	Apr-June Weekday/Weekend	July-Sept Weekday/Weekend	Oct-Dec Weekday/Weekend
Management/labor					
Labor					
Potential labor sources outside team					

Exercise: Inventory your physical and personal resources, con't

Financial resources

How much startup money can you raise by using personal or family resources? _____

Where will the startup money come from (e.g. personal savings, family member, farm credit, bank, cooperative)?

Do you plan to borrow money from a bank for the enterprise?

Is there a grant program that could provide some startup money? _____

Exercise: Inventory your physical and personal resources, con't

Special skills that are commonly overlooked

If you or any of your team members have any of the following skills or experience, fill in the names. Also, add the names of relevant agencies or organizations with which you or your team members may have connections (such as cooperative extension, university agricultural experiment stations, the U.S. Department of Agriculture, state department of agriculture, and state forestry agencies).

Relevant experience	Name of person	Short description of skill/experience
Marketing skills		
Computer skills		
Production skills		
Sales ability		
Special skills, such as innovative thinking		
Other <i>(list skill)</i>		

Biophysical Site Assessment

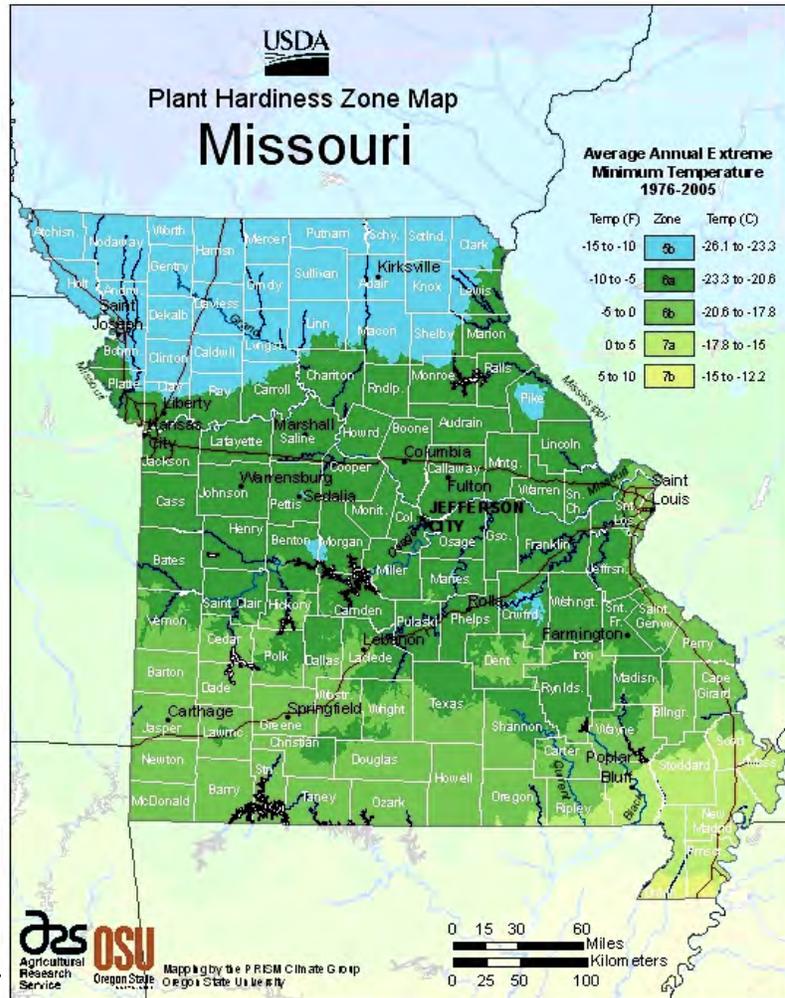
Step 5: Climate Assessment

Simply stated, the site assessment provides an overall measure of a land area's ability to support, or grow, a desired plant. Therefore, as a part of this assessment, the biological areas that will be considered include the climate, the soils and the land's physical features, sometimes called the topography or terrain.

Development Area	
Hardiness Zone: Include frost-free days, first and last frosts (see heat zone map on the next page).	
Indicator Plants	
Other Useful Climate Information: <ul style="list-style-type: none">- Mean annual rainfall- Mean annual snowfall- Average temperatures- Open ground: Average date of spring thaw and fall freeze	

Biophysical Site Assessment

Step 5: Climate Assessment, con't



USDA Hardiness Zones and Average Annual Minimum Temperature Range

Zone	Fahrenheit	Celsius	Example Cities
4a	-30 to -25 F	-31.7 to -34.4 C	Minneapolis/St. Paul, Minn.; Lewiston, Mont.
4b	-25 to -20 F	-28.9 to -31.6 C	Northwood, Iowa; Nebraska
5a	-20 to -15 F	-26.2 to -28.8 C	Des Moines, Iowa; Illinois
5b	-15 to -10 F	-23.4 to -26.1 C	Columbia, Mo.; Mansfield, Pa.
6a	-10 to -5 F	-20.6 to -23.3 C	St. Louis, Mo.; Lebanon, Pa.
6b	-5 to 0 F	-17.8 to -20.5 C	McMinnville, Tenn.; Branson, Mo.
7a	0 to 5 F	-15.0 to -17.7 C	Oklahoma City, Okla.; South Boston, Va.
7b	5 to 10 F	-12.3 to -14.9 C	Little Rock, Ark.; Griffin, Ga.

Biophysical Site Assessment

Step 5: Climate Assessment, con't

AHS Plant Heat-Zone Map

The 12 zones of the map indicate the average number of days each year that a given region experiences "heat days" – temperatures over 86 degrees (30 degrees Celsius). That is the point at which plants begin suffering physiological damage from heat. The zones range from Zone 1 (less than one heat day) to Zone 12 (more than 210 heat days).

Avg. No. Days

Annually Temp. is over 86 degrees F

ZONE 1: < 1

ZONE 2: 1-7

ZONE 3: 7-14

ZONE 4: 14-30

ZONE 5: 30-45

ZONE 6: 45-60

ZONE 7: 60-90

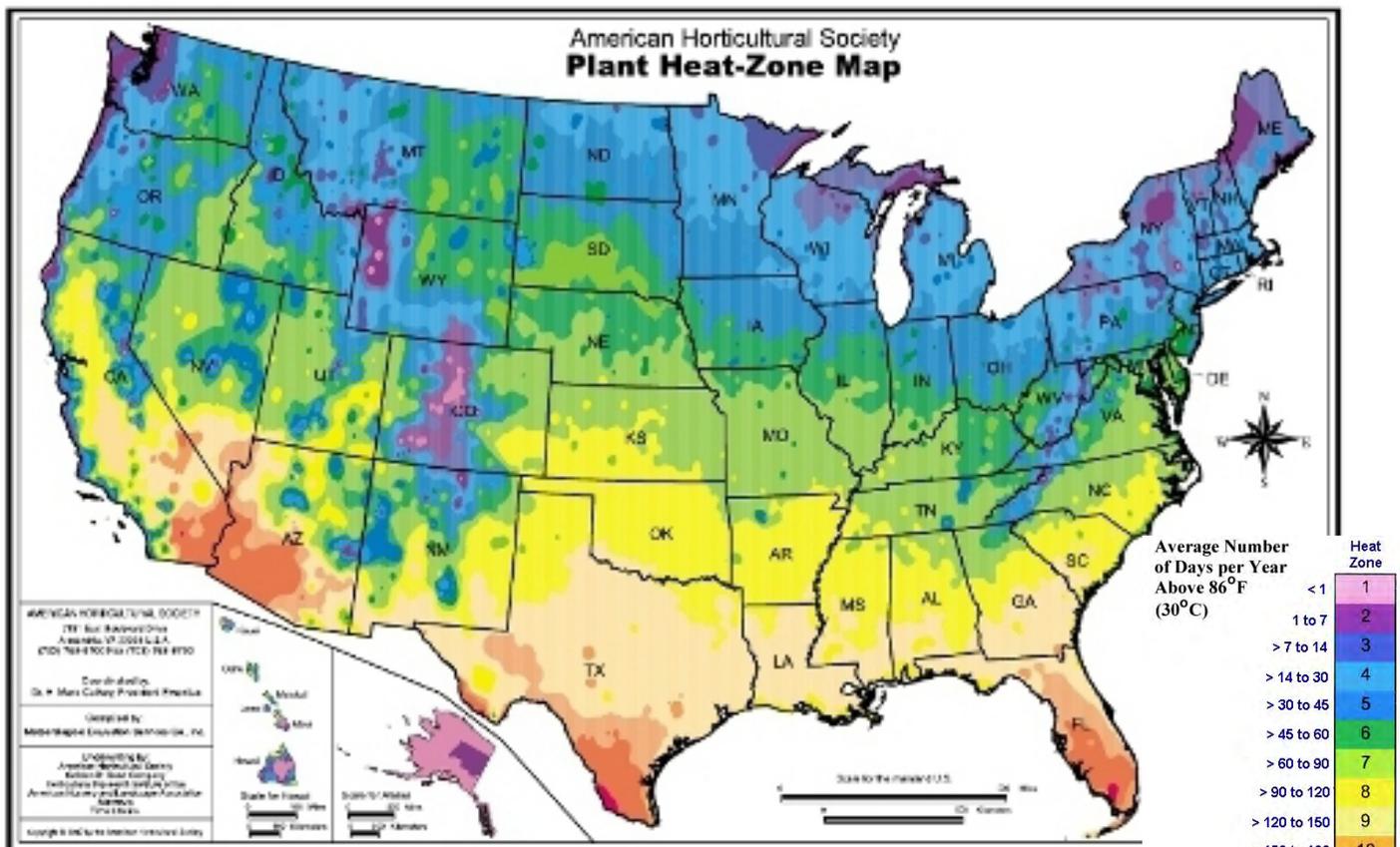
ZONE 8: 90-120

ZONE 9: 120-150

ZONE 10: 150-180

ZONE 11: 180-210

ZONE 12: 210+



Biophysical Site Assessment

Step 6: Soil Assessment

This area is for notes about the soil(s) present on specific areas of the sketch map. You should include information that is directly useful to your agroforestry development. Photocopy the table below if you are assessing more than one development area.

Development Area	Soil Type(s) if Known
1. Soil texture and composition: Sand and gravel, loam, silt and clay, organic layer (depth).	
2. Soil depth: Include rock outcroppings and hardpan (depth of soil cover), rockiness.	
3. Soil moisture: Particular note of wet areas and flooding (with time of year).	
4. Soil nutrients: pH, salinity, fertility (attach soil reports).	
5. Aspect: Especially south vs. north facing.	
6. Terrain relief: Slope, steepness, gullies.	
7. Soil stability: Presence of high risk indicators such as sheet, rill or gully erosion.	
8. Frost pockets.	
9. Roots, stumps and other debris in or on soil.	

Biophysical Site Assessment

Step 7: Physical Features (Terrain)

There are a number of physical features, or topography characteristics, that can influence the capability of your land to produce particular crops on a site. Because physical features are often closely related to soil characteristics, the information you obtain for each of your agroforestry development areas should be entered into the same table as the information from Step 6: Soil Assessment.

In combination, the terrain relief and aspect create a lay of the land that often will enhance the opportunities for a successful agroforestry practice. By listing unique land features you will be better able to place practices and plant species to the landscape to best ensure their survival and growth. For example, slope is very important in relation to the moisture available for plant growth. In general, north-facing slopes will have better moisture than south-facing slopes that are typically drier.

Agroforestry Development Ideas

Step 9: Agroforestry Ideas – Brainstorming

List your agroforestry ideas separately for each development area. An additional category (Associated Practices) is provided for systems that are not real agroforestry systems, such as hybrid poplar plantations.

Development Area	Agroforestry Ideas
1. Forest Farming	
2. Alley Cropping	
3. Silvopasture	
4. Riparian Forest Buffers	
5. Windbreaks	
6. Associated Practices (e.g., Poplar plantations)	
7. Wildlife Areas (e.g., increase quail habitat, lease hunting)	
8. Other ideas for integrating forest practices on the farm	

Exercise: Assessing my resources, goals and possible enterprises

1. Describe the long- and short-term goals that you and your team hope to achieve by starting this new enterprise.

(a) Long-term goals

- 1.*
- 2.*

(b) Short-term goals

- 1.*
- 2.*

2. List the family members or team members who want to be actively involved. Describe each person's responsibilities.

3. Specify how much time each week you and your teammates will have available to spend on your new enterprise.

4. How much money can each team member provide now to initiate the enterprise?

Exercise: Assessing my resources, goals and possible enterprises, con't

(Read and fill in number 5 only if you currently run a natural resources-based enterprise; otherwise, go to number 6).

5. Check the responses that best characterize your business goals during the next 3 to 5 years for your current enterprise. Answer any follow-up questions.

Maintain at about the same level as in the past

Expand. How?

Get out altogether. Why?

Other:

6. The following information will help you determine your financial goals for any current or new enterprise. List the yearly income (you and your family or teammates) expect from the sources listed below:

Current farm/forest enterprises

New enterprise (once it is established)

Non-natural-resource employment (current job)

Other

TOTAL

Exercise: What will it take to produce my product or service?

You will probably have to make some capital purchases, such as buying buildings, equipment or land and making major improvements, to start your new business. List the capital purchases and their costs.

What will be your major production tasks, such as planting, harvesting, building, advertising, sales and maintenance? Describe the tasks according to the month they should occur. Also indicate which months you expect to receive income.

Month	Task
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

Exercise: Relative merits of various enterprise ideas

Criteria	Enterprise ideas*				
Total					

*Rated on a scale of 1 to 10, with 1 being least compatible and 10 being most compatible

Example EXERCISE for Smiths: Relative merits of various enterprise ideas

Criteria	Enterprise ideas*				
	Shiitake	Grape-vine wreaths	Hunting lease	Ginseng	Aqua-culture
Compatible with residency status	10	10	7	10	10
Preferred by family	9	6	7	9	3
Meets financial goals	9	9	5	10	9
Uses underused physical resources	4	9	8	6	8
Uses management/labor resources	8	6	5	3	6
Potential market exists	10	5	9	10	6
Uses farm, forest byproducts	9	9	3	7	5
Family financial resources avail.	10	8	10	4	8
TOTAL	69	62	54	59	55

*Rated on a scale of 1 to 10, with 1 being least compatible and 10 being most compatible

Exercise: Identify barriers to entry

Development Area	Available Government Incentive Programs:
Crop/Product	Critical Resources Needed

Exercise: Identify suppliers and supply availability

Development Area	Available Government Incentive Programs:		
Crop/Product	Supply Needed	Supplier	Information about supply (quality, availability)

Exercise: Identify buyers and their needs

Development Area	Available Government Incentive Programs:	
Crop/Product	Buyer (and reasons)	Buyer needs

Exercise: Identify substitute products

Development Area	Available Government Incentive Programs:		
Crop/Product	Unique characteristics of product	Substitute product	Unique characteristics of substitute product

Exercise: Researching the competition

Development Area	Available Government Incentive Programs:	
Crop/Product	Competitor	Competitor Info

Evaluate the 'Best Bets' in the Context of the Industry

Step 13: Revising Your 'Best Bets'

List your revised 'best bets' in the table below, based on what you know about the marketing potential of the plants listed. This list will form the basis for your in-depth market research. Photocopy the table if you are assessing more than one development area.

Development Area	Available Government Incentive Programs:	
'Best Bet' Plants	Marketable Products	Volumes (indicate when available)

Marketing Strategy for 'Best Bets'

Step 14: Select and Describe Target Market(s)

Complete this worksheet for each major product you plan to produce. Develop a profile of the customer(s) you intend to target by market segment. (Refer to the Training Manual, Chapter 9 – Marketing Principles for this exercise)

Development Area	Available Government Incentive Programs:		
Product			
Customer Segment	1.	2.	3.
Geographic			
Demographic			
Psychographic			
Needs/ Preferences			

Marketing Strategy for 'Best Bets'

Step 16: Getting Products to the Buyer

Use the table below to outline how you will get each of your products to buyers. The three main factors to consider are:

- 1. Location:** Where will you sell your product?
- 2. Distribution:** Which sales channels will your product follow?
- 3. Transportation:** How will your product reach the buyer?

Photocopy the table below if you are assessing more than one development area.

Development Area	Available Government Incentive Programs:		
Product	Location	Distribution	Transportation

Marketing Strategy for 'Best Bets'

Step 18: Promoting Your Products

Complete this worksheet for each major product you plan to produce. Choose a promotion approach for each customer segment. (Refer to Chapter 9 – Marketing Principles for this exercise)

Development Area	Available Government Incentive Programs:		
Product			
Customer Segment	1.	2.	3.
Message			
Tools			
Frequency			
Cost			

Agroforestry Practice Design and Management

Step 19: Revisit Your Objectives and Priorities

List your top five land management goals (see original objectives listed in Step 1):

Top Five Land Management Goals:
1.
2.
3.
4.
5.

Agroforestry Practice Design and Management

Step 20: Detailed 'Best Bets' Crop Information

Use the table to summarize everything you know about each plant you plan to grow in one agroforestry development area. You can photocopy the table below so that you have one for each crop plant.

Crop Plant:	
Agroforestry practice (best produced in)	
Where produced (in development area)	
Shade (requirement or tolerance)	
Soil and water (requirement or tolerance)	
Particular plant needs (to produce needed quantity and quality)	
Labor required to grow and harvest (amount and time of year)	
Resource use fit (time, labor and other resources with other activities)	
Compatible crop plants (can be grown with or should not be grown with)	

Agroforestry Practice Design and Management

Step 20: Detailed 'Best Bets' Crop Information (con't)

Crop Plant:	
Compatible livestock (animal and useful interaction)	
Harvest requirements (e.g., by hand, machine, cut tops, dig)	
Post-harvest requirements (e.g., storage, drying)	
Packaging and shipping requirements	
Cost to grow and harvest	
Product(s) on market	
Current market price	
Profit potential	

Agroforestry Practice Design and Management

Step 20: Detailed 'Best Bets' Crop Information (con't)

Crop Plant:	
Volume (potential production)	
Grade standards in market	
Product influences and trends	
Value-added opportunities	
Other	

Agroforestry Practice Design and Management

Step 21: Designing Your Agroforestry Practice

Depending on the size of your operation, you may be able to put your entire development area on one table, or you may need several. Photocopy as required. You will want to create a separate table for each development area.

Development Area	Available Government Incentive Programs:	
Crop Plant(s)	Agroforestry Practice	Management Required (to grow marketable quality)

The Agroforestry Development Plan

Step 22: A Five-Year Management Projection

Using the information compiled in your Workplan, complete the following table. Depending on the size of your operation, you may wish to complete one table for each proposed system. Photocopy this table as required.

Development Area	Available Government Incentive Programs:		
Size of Area	Practice and Associated Crop	Year	Management Objectives

Notes

Appendix Section 6:

**Plant Resource Guide:
Materials and Management**

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Alfalfa (*Medicago sativa* L.)

Description

Alfalfa is an herbaceous perennial legume that can produce large amounts of nutritious forage material. It is a legume, with a tap-root, and can last up to 5 years if managed correctly. The energy and protein yield/acre rivals that of corn as used for silage purposes. It has the highest feed value of any commonly grown hay crop.

Habitat

Alfalfa is best suited to deep, fertile, well-drained soils with a pH of 6.0 to 6.5. However, with correct management it can be grown on differing soil types.

Management Considerations

Attacks by insects can be very problematic to alfalfa. The alfalfa weevil and potato leafhopper are the main insect problems in Missouri. By careful monitoring and management (chemical or harvest timing) can help control adverse insect problems.

High fertility is needed for establishment, along with proper levels of fertilizer and lime for successful competition of alfalfa and stand maintenance.

Harvesting Considerations

Alfalfa can be used as silage, hay, or pasture. Hay harvest can occur every 30 to 35 days during the growing season if weather permits normal rates of regrowth. Allowing livestock to graze for 3 days, then giving alfalfa 30 days for recovery, works well. Using this approach to graze alfalfa obviously involves partitioning the pasture area into smaller areas. Thus, fencing can be an added cost of using alfalfa in this manner. Intensive grazing is not much different than harvesting alfalfa for hay, where forage is cut, baled, and hauled away.

It is advisable to not cut or graze from September 15th to November 1st, allowing the plant to store over-wintering energy. However, following November 1st a final pre-winter harvest of the forage is permissible.

Propagation

Alfalfa exhibits autotoxicity, seed will not grow in existing stands of alfalfa. As old stands begin to decline, they must be plowed under before reseeding. Seeding of alfalfa can be done in the fall or late summer. If herbicides are not used for weed control, it is recommended to have a companion crop of oats (usually oats at 1/2 normal seeding rate) to help control the weeds and prevent erosion during the seedling establishment period. The oats should be harvested early to alleviate competition on the alfalfa. Depending on whether alfalfa is seeded alone, or with other legumes and grasses, approximately 10 to 15 lbs of seed per acre will

usually be needed. Seeding can be broadcast, no-tilled, or drilled into a prepared seedbed. With proper preparation, such as fertilizer and liming, the establishment of a stand in correct soil types should prove no problem.

Economic Uses

Hay, silage, and pasture are the most economic uses for the small landowner. Sprouts for human consumption are also a viable market, but the research for buyers must be thorough. Generally, local hay markets are readily available, and in bulk can often be sold to large corporations. Such marketing usually will require meeting with the buyer and addressing special considerations for product quality/appearance. Silage may be sold or used by the landowner as feed, just like hay. Pasture is mainly useful to the landowner, but cash-renting possibilities are available.

Notes

Uses in agroforestry for alfalfa include Alley Cropping and Silvopasture. Alley cropping can be implemented with rows of trees and strips of alfalfa for hay or silage lying in-between the tree rows. Silvopasturing can also be used, with grazed alfalfa providing benefits to both the trees and livestock. The same tree configuration, trees in rows, can be used in both alley cropping and silvopasture practices, or the trees can be managed in a grid pattern for the silvopasture practice. In either case, the only difference in forage removal is whether mechanical methods or animals are used. However, if livestock are used remember to protect the trees from browsing and/or rubbing.

Additional Resources

<http://muextension.missouri.edu/explore/agguides/crops/g04550.htm>

American Basswood (*Tilia americana* L.)

Description

American Basswood, also known as American Linden, is native to all of New England and the Midwestern United States. American Basswood is a favorite tree of bees as they extract nectar from its flowers, making a very high-quality honey in the process. Basswood is also a valuable timber tree. The stately appearance of American Basswood makes it a favorite shade tree for large areas, such as parks. Its leaves are the largest of any of the native basswoods. When found in the open, it may reach 80 feet tall by 40 feet wide, with its lower limbs pendulous but upswept at the tips. Basswood has alternate, ovate leaves that are about as wide as long, with a truncate (flattened) or heart-shaped base, finely serrated margins, and a short tip at the apex of the leaf.

Habitat

American Basswood prefers moist, well-drained, deep, rich soils and will grow on in a variety of pH levels. It thrives in full sun to partial sun.

Management Considerations

Basswood has a very fast growth rate. Consequently, it will also have a high site index associated with it, and may reach heights of up to 70 feet in 50 years in unmanaged forest stands. Management that reduces competition can provide improved growth rates. However, open grown conditions may result in sprouting. Basswood is less shade tolerant than most of its common associates, but vigorous sprouting and rapid sprout growth allows it to persist under competitive conditions.

In forested settings basswood is likely to develop a straight, clear bole. However, basswood may be easily damaged by fire. Caution should be used since this burn wounds will likely result in hollow or otherwise defective trees.

Harvesting Considerations

Many of the products gained from basswood include specialty wood products and markets for these should be sought out locally. These products can include soft wood for hand carving. Additionally, the bark has been used in weaving products like baskets. Little defect is noted in basswood when harvested before it reaches 120 years of age, but beyond this age decay and losses due to decay increase.

Propagation

Basswood will readily resprout from stumps of harvested trees. Futuristically, this can result in a clump of trees. Management of clumps as a result from cut trees should leave no more than 2 sprouts per stump. Ideally, management for a single stem is best for most species, but basswood is likely to be a prolific sprouter.

Seed and vegetative propagation can be used for establishing basswood. Basswood seeds show a pronounced dormancy and typically have poor germination rates. To enhance germination, and break dormancy, the seed coat must be penetrated. Use abrasion or acidic solutions to facilitate this process. Correctly treated seeds commonly average from 20 to 30 percent germination following stratification at 2° to 5° C (36° to 41° F) for 110 to 130 days. Seeds should be collected when it turns brown, but before they become dry and hard. It is desirable to have a moisture content of 20 to 40 percent (green weight).

Economic Uses

Basswood is a tree that has historically been used in a variety of ways. Its wood has been used for carving and in furniture. Its inner bark fiber has been used to weave rope and baskets. Its flower produces excellent honey. And, throughout the Eastern United States, basswood is frequently planted along city streets.

Uses

Its preference for moist, well drained soils, and its propensity to develop a spreading root system over time, makes it a good candidate for the agroforestry practice of riparian buffers. Additionally, it can provide farms with production potential as a timber tree, or a tree that produces top quality honey.

Additional Resources

USDA Silvics Manual on line at:

<https://www.fs.fed.us/database/feis/plants/tree/tilame/all.html>.

American Hazelnut (*Corylus americana*)

Description

Hazelnuts and filberts are produced by species of *Corylus*. Commercial filberts (*C. colurna* L. and *C. maxima* Mill.) are cultivated in various parts of the world, particularly Turkey, Italy, Spain, China, and the US. Nuts of the native American species (*C. americana* and *C. cornuta*) are smaller but similar to the cultivated ones in flavor, and *C. cornuta* also is commercially cultivated for nut production. Edible brown nuts 1/2 inch in diameter are enclosed in a hairy, leaf-like husk with ragged edges; initially green, ripening to a brown in late summer. The nuts are sweet and may be eaten raw or ground into flour for cake-like bread. The nuts were used by American Indians to flavor soups.

Habitat

American hazel occurs from Maine west to Saskatchewan, south to eastern Oklahoma, east to Georgia, and north through New England. American hazel grows along streams, hedgerows, meadows, woodlands, roadsides, and forest margins. It grows best on rich, moist, well-drained soils.

A large, deciduous, thicket forming shrub that can grow 3'-10' in height. Straight trunk, with spreading, ascending branches. Roots typically in upper 6" of soil. Some smaller roots run vertically toward the surface and branch profusely into very fine laterals. Broadly oval leaves with a heart-shaped or rounded base are dark green above and paler below, 2 1/2 to 5 inches long, with doubly serrated margins. Light brown male flowers are 1 to 3 inches in length in clusters of two or three, inconspicuous gray-brown female flowers, appearing as short, thin, red threads in early spring.

Management Considerations

American hazel is a competitive understory tree. It often competes with hardwoods and pines for light and moisture. Because of shading and aggressive growth, it has long been recognized as a major restriction to the successful regeneration of land conifers. American hazel is shade tolerant. It can grow under a light intensity of 15 percent or less and in some places even as low as 1 percent. However, do not expect good nut production under heavy shade.

If the light and nutrient needs of American hazel are met, this tree could be used in agroforestry practices like alley cropping and maybe forest farming. American hazel produces a sweet tasting nut that has been commercially sold, eaten raw or made into other delectable treats. If desired to grow hazelnut for its nuts it should not be used in conjunction with animals. The leaves, twigs, and catkins of American hazel are browsed by deer and moose. The nuts are eaten by small mammals, northern bobwhite, ruffed grouse and other large birds, and deer. Even though American hazel likes to grow along streams, it should be advised that

beaver like to eat the bark. American hazel could persist well in an alley cropping design. Additionally, quail could use the bare ground that develops on the ground beneath. This design could include large deciduous trees that will provide American hazel with ample shade for superior growth and moderate light for nut development.

Harvesting Considerations

The flowers of American hazel are formed in the summer and open the following spring before new leaves emerge. The hazelnuts form from the fertilized flowers by late summer or early fall. While plants of American hazelnut may begin producing seed after the first year and produce good seed crops every 2-3 years, commercial production levels will likely be later, with maximum production reached at about year 12. At harvest time, usually in October, the area underneath the trees should be trimmed and kept clean. Placing a tarp under the tree before mechanically removing the nuts can aid in nut collection. Once nuts are collected, they should be dried to about 10% moisture. If the seed is to be planted rather than eaten, then seed dormancy will need to be overcome by cold treatment.

Propagation

Hazelnut can be propagated by seeds or cuttings. Propagation by seed will provide more genetic variability between plants, and requires seed stratification. Production from cuttings will demonstrate the genetics of the specific clone (the parent).

Economic Uses

Hazelnuts are a highly profitable nut used in cooking and confectionary items. Many niche markets exist that use hazelnuts in their products. Hazelnuts are sold dried and in shell around winter holiday season.

Notes

Turkey produces about 65% of the hazelnuts on the world market. In North America, the main area of production is Oregon. Eastern Filbert Blight, a fungal disease, is a threat to all hazelnut trees and needs to be managed for if trees are infected.

Additional Resources

https://plants.usda.gov/plantguide/pdf/pg_coam3.pdf

Bald Cypress (*Taxodium distichum*)

Description

Bald Cypress is a long-lived and wind-firm tree that is native to the Southeastern United States. This deciduous conifer is very majestic in appearance and is rarely blown over, even in hurricane winds. Life expectancy is 200+ with 500 yr old specimens cut throughout the 1970's. The largest remaining stand of old-growth bald cypress trees in Missouri can be seen at the Allred Lake Natural Area where the trees range from 500 to 1000 years old. Usually 50-70 feet in height but can easily reach 130 ft with roughly a 30 foot spread. Creates a heavy straight trunk, sometimes up to 13 feet in diameter, and becomes flat topped in maturity. On wet sites, Cypress will likely forms "knees" with age. These are root protrusions from the soil and it is believed that these knees provided for gas exchange.

Habitat

A misconception with Bald cypress is it's assumed that it has to have "wet" soils. In actuality seed must be in a source of constant moisture for germination to occur and this is most commonly found in a swamp. It is very adaptable to wet or dry sites but is not tolerant to high pH soils.

Management Considerations

Because of its adaptability to both wet and dry sites, it can be planted in a variety of situations. However, due to its habit of developing a widespread root system, it can be difficult to place into integrated tree-crop systems where roots will compete for water and moisture. But this habit can be useful for reduced wind throw within windbreaks and riparian zones. And because of its adaptability, it can be a great addition to either system because of its tolerance to any areas soil characteristics. Its usefulness in riparian areas can be recognized through greater stream bank stabilization as a result of the widespread root system.

Harvesting Considerations

Because of its slow maturity and slow growth, it is not likely that marketable sawlogs will be produced within 40 yrs. This can be a plus in riparian settings where a long lived tree provides many year of soil stability. And, when a marketable size is reached, the wood of cypress is valuable. It produces a wood that is very decay resistant.

Propagation

Because of its need of water to germinate, the bald cypress may not propagate well in every area planted. However, seedlings are readily available.

Seedlings require light for good growth, thus control of competing vegetation is necessary. Bald cypress will also produce vigorous sprouts from the stumps of both young and old trees, following disturbance such as harvesting.

Economic uses

Bald Cypress wood is noted for its insect and decay resistance. It is used for heavy construction, including docks, fence posts, railroad ties, barrels, caskets, warehouses, boats; bridges as well as general millwork and interior trim.

Additional Resources

https://plants.usda.gov/plantguide/pdf/pg_tadi2.pdf

Big Bluestem (*Andropogon gerardii*)

Description

Big bluestem was one of the more important grasses of the tall-grass prairie that formerly covered much of the state. Big bluestem grows to a height of between 3 and 10 ft. Its roots can reach depths of 8 to 10 feet. It has tall, slender stems. The grass is green throughout much of the summer; the stem turns to a blue-purple as it matures. This is the reason for the name bluestem. The seed heads usually have three spike-like projections and resemble a bird's foot. This results in another common name for big bluestem -- "turkey foot."

Habitat

Big bluestem is adaptable to a wide range of soils; it thrives in light, porous soils as well as heavier, less well drained soils, even clays. It tolerates acidic or alkaline soils. It does well in dry or humid climates and tolerates cool as well as hot summers. The big bluestem grows in moist soils and lowlands and is not very plentiful in uplands. This native plant starts its growth in April and begins to flower in late summer with most growth occurring in August. Big bluestem can withstand short periods of waterlogged soils in summer, but not in winter. Of all the native grasses, Big Bluestem has one of the highest tolerances of acidity in the soil. It is useful for seeding of spoil areas and other poor sites where it has been known to thrive on areas with a pH as low as 4.5.

Management Considerations

Uses for Big Bluestem are many. Due to its rapid growth pattern, it is a top choice for erosion control on moderately to well drained soils. It is one of the most palatable warm season's grasses, thus making it popular for forage. Wildlife management agencies use Big Bluestem as a primary component in plantings for upland birds and mammals, which use it for nesting and escape cover throughout the year. In addition, insects are attracted in large numbers to Big Bluestem, which insures the usage by many species of songbirds.

Harvesting Considerations

Big bluestem, the "King of Grasses" produces better quality and greater amounts of forage than any other Native American prairie grass. Big bluestem is excellent forage. It can yield two to four tons of hay per acre.

Propagation

Planting can occur in April or early May, mainly by no-till practices. For stands that are being planted for wildlife purposes, it will require 6-8 lbs PLS (Pure Live Seed) of seed per acre. If planting an area for forage a higher rate (10-12 lbs PLS) of seeding will be needed. If using bulk seed, rates should be doubled. Dormant plantings can be done from December through February.

Economic Uses

Although commonly recognized for its forage value, big bluestem has broad application in conservation plantings. It is often used in mixes of warm-season grasses to control erosion and benefit wildlife. Often, the outer zone of the forested riparian buffer will incorporate big bluestem. Additionally, it can be applied adjacent to tree rows in an alley cropping setting, or as an outside set of rows in a windbreak, both will help with make an effective conservation practice and enhance wildlife benefits.

Notes

Wildlife biologists and upland game managers use warm-season grasses for game habitat, nesting and holding areas. The stubble of the grasses remains erect over the winter providing nesting cover and protected "trafficways." Little bluestem, lovegrass and sideoats grama are usually in these seeding mixtures in addition to big bluestem and indiagrass.

Additional Resources

<https://extension2.missouri.edu/g4673>

https://plants.usda.gov/factsheet/pdf/fs_ange.pdf

Bittersweet (*Celastrus scandens*)

Description

A woody vine, bittersweet can climb over most trees and fence posts. Reaching a full length of 60 feet, this vine produces alternate, ovate leaves that 5-8 inches long and 3-5 inches wide. The flowers are lighter green in comparison to the leaves and bloom from May to late June. Colors of the pedals range from pale-green to yellow. Bittersweet is dioecious, implying there are separate male and female plants. Nurseries recommend 1 male plant to every 6-9 female plants. From the flowers, distinctive red berries are produced and linger on the plant throughout the fall and into the following spring. The berries emerge from spherical orange-yellow fruit that “burst” open when the berries are mature.

Habitat

In light preference, bittersweet is a full sun species that is most often found in well drained areas such as glades, limestone bluffs, forests, and fence rows. This vine species does not need a structure to grow on, rather, it can grow horizontally on the ground and also curl upwards from around old tree stumps. A word of caution, bittersweet is an aggressively fast grower, do not plant this species near young trees or around seedlings because the vine will girdle the younger specimens as it grows.

For growing conditions, the bittersweet thrives in moist environments, but is not able to survive in water logged areas. In terms of temperature, bittersweet can survive the “bitter” cold months of the Midwest and also thrive in the hot, humid conditions of the southeast.

Management Considerations

Well suited for any habitat that is well drained, bittersweet is a great addition to windbreaks, alley cropping, and forest farming. This species does not need to grow vertical, but make sure the plant receives full to partial sunlight during the growing season and is not at risk of being damaged by equipment. Along with being part of an agroforestry practice, bittersweet can also be incorporated into gardens and other landscape use to enhance natural beauty.

Harvesting Conditions

To harvest, simply take a handsaw or pruning shears and cut the desired stem(s). After pruning, the stump may sucker sprout or the root will sucker sprout for a future cutting. Along with using the stems, harvesting the seeds before wildlife has a chance to consume the berries is also another consideration. The seeds can then be used in birdfeed for urban birdfeeders or as a seed source for local nurseries.

Propagation

Regenerations can occur through planting new seedlings, seeds, and also through root suckering. Root suckers are not able to survive the process of being transplanted from one sight to another due to the lack of root structure.

Transplanting a seedling on the other hand, is highly recommended and is a sure way to know the plant has a healthy root system to allow for maximal growth. Before planting, seeds should be kept in a cool, dark place at 3C for up to 3 months before planting.

Economic Uses

Bittersweet is harvested as a wood floral and can be an added touch to wreaths, floral arrangements, or indoor decoration. The berries attract many varieties of wildlife, especially during the winter months when food is scarce. Also during the winter, the deep red berries are a wonderful addition to the long, bleak winter months. The seeds within the berries can be harvested and used as a feed source to attract backyard wildlife or sold to nurseries as a seed source.

Notes

Other common names include American bittersweet, America's bittersweet, and climbing bittersweet. The leaves and stems have the potential to be poisonous to cattle. Use extreme caution and make sure livestock stay away from this species.

Additional Resources

Missouri Botanical Garden.

<http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=a151>

Black Locust (*Robina pseudoacacia*)

Description

Native to Missouri, black locust, also known as common locust, yellow and white locust. It is a medium sized deciduous tree with an average lifespan between 60 to 100 years. Fast growing with an average height of 30-50ft, spread of 20-35 ft. and diameter average of 1 to 2 ft. Since this species is a nitrogen-fixing legume, the leaves are very high in nitrogen and have been used in animal feeding trials with mixed success.

Flowers are 3/4in. long, white, and extremely fragrant, in a drooping arrangement maturing in late spring. Black locust blossoms provides a good source of forage for honey bees, and makes good honey.

Habitat

This species grows best in full sun, on moist, loamy soils of limestone origin, but establishes on a variety of disturbed sites; and competes well on large forest openings. It is found in cove forests and open, upland slopes, fence rows, disturbed ground, and limestone soils. In natural settings, Deer browse the foliage, birds and small mammals eat the seeds.

Optimum soil pH is between 4.6 and 8.2 and can grow on almost any soil type (sandy and sterile) with the exception of those that are permanently wet. Due to its shade intolerance, it is not found in dense woods except as the dominant tree. Habitat zones are between 3 and 9.

Management Considerations

During establishment, protection from weeds and deer are the main management priorities. Due to the rapid early growth, two years of protection are usually sufficient. Pre-plant site preparation to control weeds with tillage or herbicides is recommended, with continued weed control after planting. Where exceptional deer pressure exists, tubes or mesh sleeves may be required. Once established this species will not require active management unless straight trunks are desired for fence posts.

Harvesting Considerations

Although black locust is not an important timber tree in the United States, it is used for a wide variety of products and is planted for many specialized purposes. The wood of black locust is strong, hard, and extremely durable, it is extensively utilized for fencing, mine timbers, and landscaping ties. This tree also serves as a good erosion control plant on critical and highly disturbed areas, due to its ease of establishment, rapid early growth and spread, and soil building abilities. Pulp with satisfactory mechanical properties can be made and it has potential for use in fuel plantations.

Black locust is widely planted in the United States, Europe, and Asia for erosion control, reclamation of drastically disturbed sites, windbreaks, nurse crops, amelioration of sites, honey production, and ornamental use. Many early plantations on severely eroded old fields were failures, but establishment on spoil banks has been generally successful. Black locust is often broadcast or hydroseeded with a mixture of herbaceous seed. The most commonly used seeding rate is 2 to 3 lb/acre.

Because of its soil-improving properties, black locust is often planted in mixtures. Many species have been underplanted in black locust stands. Success of such planting has been variable and many factors have to be considered carefully. On mine spoil in Illinois, black locust was a valuable nurse crop for black walnut (*Juglans nigra*), silver maple (*Acer saccharinum*), and yellow-poplar (*Liriodendron tulipifera*), but not for cottonwood (*Populus deltoides*), sweetgum (*Liquidambar styraciflua*), or Osage-orange (*Maclura pomifera*). However, on surface-mined land in Kansas, survival, growth, and form of black walnut were impaired when planted with black locust (39).

Propagation

This species propagates easily by root suckers and stump sprouts and also transplants easily. Legumes or pods form and mature in mid September to October, dropping in late fall. It is a reliable seed producer beginning at age 6 with peak production at age 15 and production decline at age 40. As the leaves fall, decomposition is rapid releasing nitrogen, calcium and potassium into the soil. Due to the impermeable seed coat, the seeds should be scarified in sulfuric acid for 50 min, soaked in hot water or mechanically scarified. Germination rates are very high. If root cuttings are desired, use stock that is 1/4 to 1" diameter, 3 to 8 in. long.

Notes

There are 2 primary insects which inflicting damage on black locust: the locust leaf miner and black locust borer. The leaf miner attacks the tree in spring, turning the leaves brown by mid-summer or early fall. Overall tree growth is impacted, but not seriously. The larvae of the locust borer carve tunnels through the trunk of the tree, weakening it enough for wind breakage. Planting on good quality sites or in conjunction with other hardwood species and shading trunks will discourage infestation by locust borers. Heart rot is the only noteworthy disease effecting black locust.

Additional Resources

https://plants.usda.gov/factsheet/pdf/fs_rops.pdf

Black Walnut (*Juglans nigra*)

Description

Black walnut, also called eastern black walnut and American walnut, is one of the scarcest and most coveted native hardwoods. Small natural groves frequently found in mixed forests on moist alluvial soils have been heavily logged. The fine straight-grained wood made prize pieces of solid furniture and gunstocks. As the supply diminishes, the remaining quality black walnut is used primarily for veneer. The distinctive tasting nuts are in demand for baked goods and ice cream, but people must be quick to harvest them before the squirrels. The shells are ground for use in many products.

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. Soils with these textures hold a large amount of water that is available to the tree during dry periods of the growing season. Internal drainage and depth to gravel are especially important site characteristics for black walnut. As a general rule, black walnut will do best on soils that are at least 3 feet to impermeable layer. Throughout its range, walnut generally reaches its greatest size and value along streams and on the lower portion of north- or east-facing slopes.

Management Considerations

Black walnut can be grown for a variety of reasons, including nut production and high quality timber production. Due to its leaf configuration it is also well suited to being grown, or managed for, in most all the agroforestry practices. However, there are several key things to remember as you become successful in agroforestry while working with Black Walnut trees.

Black walnut is a very intolerant tree. Planted in fairly dense stands or under forest competition the tree develops 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. Logs 10 inches in diameter at breast height can be developed in 35 years under ideal growing conditions.

Weed control is essential in newly established plantings. In order for any tree to reach its growth potential, the tree must be placed on an appropriate site (soils, aspect, etc.) and have good control of competing grasses. This can be accomplished by a number of methods, including proper herbicides, weed barriers/mats, and the use of mulch.

Harvest Considerations

The best known use of black walnut is for its lumber and veneer, and for its nut production. The wood is used for fine furniture of all kinds, interior paneling, specialty products, and gunstocks. Usually markets in the Midwest for black walnut wood tend to be better from the late fall through early spring, after which prices tend to decline.

Black walnut grown for nut production may require the use of specialized equipment. There are companies that make tractor attachments for everything from shaking the tree (in order to cause nuts to drop in a timely fashion) to harvesters to collect the fallen nuts and hullers.

Propagation

The large edible nut ripens in September or October of the same year and drops shortly after the leaves fall. Good seed crops are produced irregularly, perhaps twice in 5 years. Stratification for 90 to 120 days is required for optimum seed germination but the necessity and duration of stratification may vary by seed source. Seeds should be planted in the fall in moist, well-drained, deep soil that is rich in organic matter. Black walnut prefers full sun.

Most seedling nurseries will also have black walnut seedlings available. Seedlings should be established early in the spring and be provided good weed control in order to maximize the sites growth potential.

Economics Uses

It is important for you as the landowner/Agroforester's to keep in mind what the desired results are to be. From the economic stand point Black Walnut has several desirable traits that can make it very profitable to you as long as proper management of these trees is taken. Historically, Black Walnut has kept ahead of inflation and remains one of the most valued hardwood species. Therefore with the proper care and management you can maximize your lands to bring you the most with little effort on your part.

By using grafted stock, in conjunction with proper management, nut harvesting can begin in 6 to 10 years.

Notes

Black walnut produces a toxin, known as "juglone", which inhibits the growth of other plants around it, thereby reducing competition. Juglone deprives sensitive plants of energy needed for photosynthate production. The symptoms of plants being affected by juglone include foliar yellowing, wilting, and eventually death. The largest sources of juglone on the tree are located in the buds, roots, and nut hulls.

Additional Resources

https://plants.usda.gov/plantguide/pdf/cs_juni.pdf

<http://www.centerforagroforestry.org/pubs/proppecbw.pdf>

Blackgum (*Nyssa sylvatica*)

Description

Known as one of the most beautiful native trees in the Ozarks and Boothill of Missouri, it is known for consistent fall color changing to fluorescent yellow to orange to scarlet purple. Blackgum, also known as black tupelo, pepperidge, tupelo, tupelo gum, is a medium sized tree with an intermediate growth rate, that when young has a pyramidal shape with with densely set branches but in old age the numerous spreading and open horizontal branches form an irregularly rounded or flat-topped crown. Large trees of this species are typically hollow due to various decay producing fungi and wood-boring insects.

Habitat

Having a wide range it can be seen along swamp borders and dry slopes in full to partial shade areas. Blackgum may be grown as an ornamental or used as a working tree in riparian forest buffers. Blackgum will tolerate brief spring flooding on alluvial sites and is common on the relatively dry upper and middle slopes in the Appalachian Mountains. On the drier uplands, it grows best on loam and clay loam. It is well adapted to fire. Its hardiness zone is 3-9. Optimum soil pH range is between 5.5 and 6.5.

Management Considerations

An easy tree to manage, it averages a growth rate between 12-15 feet over a 10 to 15 year period. This species does not tolerate high pH soils.

Insect and disease problems are common but have little significance to the health of the tree. Heart rot, leaf spots, rust, tupelo leaf miner scales and cankers are common ailments that can be seen but are not serious.

Since this species has been known to have a lifespan greater than 500 years in some areas, it typically hollows as it matures. If managing for wildlife is your main objective, it is known to provide several generations of wildlife species from insects to nesting birds, rabbits, squirrels, possums and hibernating bears due to the tree's usefulness for nesting and shelter.

As a working tree, this species can be used in the design of a riparian forest system since it can tolerate low oxygen sites, and may also be useful for its fall color in applications where aesthetic enhancement is desired.

Harvesting Considerations

In the past, the lumber was harvested for storage containers, pallet boxes, molding and furniture since the wood is tough. Presently, the lumber has low value and is commonly mixed with other low grade lumber at the market. It is difficult to dry and is probable to warping and twisting. It is also hard to split, has below average machining characteristics and is not durable to decay.

Propagation

The oval, soft black to purple fruit that ripens in September to early October is a favorite to deer and eaten by many birds and various mammals but not by humans. Seeds exhibit moderate embryo dormancy and require moist stratification for 60 to 90 days at 41F for optimum success.

Blackgum is usually found in a mix of other species including black cherry (*Prunus serotina*), dogwood (*Cornus florida*), hickory (*Carya* spp.), oak (*Quercus* spp.), eastern hophornbeam (*Ostrya virginiana*), and yaupon (*Ilex vomitoria*), it is shade tolerant and seldom grows as the dominant tree but it usually grows in the intermediate crown class on most sites.

Blackgum will sprout from the stump and from root suckers. Sprout numbers will typically decline as the tree gets large.

Economic Uses

These trees have moderate growth rate and longevity and are an excellent food source for wildlife, fine honey trees, and handsome ornamentals. Black bears, foxes, wood ducks, wild turkeys, robins, woodpeckers, mockingbirds, brown thrashers, thrushes, flickers, and starlings frequently eat the fruit, while white-tailed deer and beavers browse the twigs, foliage, and young sprouts.

Additionally, it provides cavity and nesting sites for a variety of birds and mammals. Black gum is an excellent ornamental plant for its straight bole, shapely crown and attractive autumn foliage.

Additional Resources

https://plants.usda.gov/factsheet/pdf/fs_nysy.pdf

Blackhaw (*Viburnum prunifolium*)

Description

Blackhaw is a deciduous shrub or tree from the honeysuckle family. It grows 10 to 20 feet tall with a short trunk that has a diameter of about 6 inches. It has an irregular crown with stiff, spreading branches. The bark is reddish-brown to dark brown or black and has a distinctive blocky appearance. The twigs are smooth, slender, gray or brown, and have orange-colored lenticel. The buds are a ½ inch in length, gray or reddish-gray and sometimes covered with purplish hair. The leaves are oval with short, pointed tips, rounded or tapering to the base, darker green on top, paler green on bottom, and 2-3 inches long. The flowers are white and in clusters. The fruits are shiny, bluish-black, ovoid, berries that occur on bright red stalks.

Habitat

The blackhaw occurs in dry woods and thickets and on rocky hillsides from Connecticut to Florida and west to Michigan and Texas, but is found in greatest abundance in the South.

Management/Harvest considerations

Blackhaw prefers moist, well-drained soils of rich or average composition of alkaline, neutral, or acidic pH. It can tolerate dry soils very well and thrives in full sun to full shade as a native understory or woodland edge shrubs. Blackhaw is a very hardy plant, tolerating temperatures down to about -40 degrees C.

It can be planted densely for a barrier thicket that branches and suckers from the ground-up

In agroforestry, blackhaw has a potential to be used in windbreaks and riparian buffers as a source of habitat and food for wildlife. The bark is collected for medicinal uses. The branch bark can be harvested in the summer and the trunk bark in the fall. Dry the bark in the shade before using.

Propagation

The seed is best sown in a cold frame as soon as it is ripe. Germination is usually slow, taking more than 18 months. Stored seed will require two months warm then three months cold stratification. When the seedlings are large enough to handle they should be put into individual pots in a coldframe or a greenhouse. Blackhaw can be propagated from cuttings of softwood, half-ripe wood, and mature wood. Cuttings of half-ripe wood are difficult to overwinter and should be kept in a greenhouse or coldframe until spring.

Economic uses

Blackhaw is used as an ornamental because it possesses year-round ornamental qualities similar to those of flowering dogwood. The blackhaw is most widely

used for its medicinal properties and as some economical importance. The bark of the root and stems is abortifacient, anodyne, antispasmodic, astringent, nervine and sedative. The root bark should only be harvested in the autumn. Tea is used internally in the treatment of painful or heavy menstruation, prolapse of the uterus, morning sickness, and colic.

Notes

To make a tea from blackhaw bark, use 1 ounce of herb per pint of freshly boiled distilled water. Steep for 15 minutes, and strain. Drink a cup 2-3 times a day.

Bloodtwig Dogwood (*Cornus sanguineum*)

Description

A deciduous shrub that has a rounded form, bloodtwig dogwood is an ornamental shrub that is very hardy. The shrub's name comes from the blood color twigs that are very obvious during the winter months when leaves are absent. During the spring, white flowers bloom and during the fall, a black berry will form. Like all dogwoods, bloodtwigs have a tendency to sucker sprout, causing new shoots to emerge. This species can reach a height of 6 to 8 feet and measure 4 to 6 feet in width.

Habitat

Preferring partial to full shade, this understory species can be found in moist areas that are well drained. When it comes to soil preference, bloodtwig dogwood prefers a loam textured acid soil that is fertile to allow for vigorous growth. In concern with weather, bloodtwig dogwood prefers warmer climates that receive a fair amount of moisture throughout the year and not just in the spring.

Management Considerations

Often referred to as an easy going tree, dogwoods are self reliant and will not require much labor from landowners. Once the shrub has been established, the land owner does not have to worry about providing water or nutrients for the plant. The only precaution is to root prune specimens that you do not want sucker sprouting or else your one dogwood could turn into a whole colony of little dogwoods. Unless this is in your management plan, watch for sucker sprouts and use mechanical means to make sure your dogwood population stays under control. In an agroforestry setting, using bloodtwig in alleycropping, riparian buffers, forest farming, and windbreaks is recommended. It can be used to enhance habitat for bobwhite quail.

Harvesting Considerations

Harvesting bloodtwig as a woody ornamental is as easy as a hot knife going through butter, literally. Most harvest practices involve taking a sickle mower out to the field and simply running the sickle down the rows. The best time to do this is when the shrub is dormant during the winter months.

Growing specimens and then selling them to nurseries, or landscapers, as ball-and-burlap transplants is also an option. Dogwoods are easily transplanted when they are still young.

Propagation

Propagation of bloodtwig dogwoods is very easy to accomplish, especially when transplanting an established plant from one location to a new location. Before digging up a plant to transport it, make sure to prune the roots a season. A direct seeding can be used to establish the species; however, site and environment

conditions must be suitable for germination to take place. The most productive form of propagation comes from the fact the species is a notorious sucker sprouter.

Economic Uses

Woody ornamental species, such as dogwoods, are being incorporated into various floral arrangements to give a touch of the outdoors to any bouquet. Along with using the stems for floral designs, harvesting the seed as a seed source is also an economical benefit. Along with these ideas, some craftsmen enjoy using dogwood as a wood source for furniture and wooden figurines. In European countries, the extract found in bloodtwig is used to make various types of soaps.

Notes

A very beautiful ornamental tree, bloodtwig dogwood can make any landscape breath taking, especially in winter when the red limbs are visible against the bleak background. The market for producing large quantities of bloodtwig and any other dogwood that will be used in landscape design is huge and profitable.

Additional Resources

<https://plants.usda.gov/core/profile?symbol=cosa81>

Bluebells (*Mertensia virginica*)

Description

A welcoming flower of spring, the bluebells ring their brilliant blue bells as a sure sign that spring is here. These showy plants that can't be missed on a spring walk grow up to 2ft. tall and are usually found in large clusters.

Native to Missouri, this perennial has loose clusters of trumpet-like blue flowers, up to 1in. long. The foliage, easy to identify before the flowers bloom, is smooth, oval and bluish green, averaging 4in. long. Foliage dies to the ground by mid-summer as the plant goes dormant.

Habitat

Found in moist, rich woods, along creek beds, gravel bars and river floodplains. They prefer southern slopes in partial to full shade. It's hardy in Zones 3 to 8.

Management Considerations

This is an easy species to manage since it is cultivated by fresh seed or divided in the spring. It is best left undisturbed. No threatening insect or disease problems are known to occur. As a spring ephemeral, it leafs out in early spring and can easily be identified for purposes of not harming the plant with mechanical equipment.

It prefers moist, cool soils, high in organic matter. If left undisturbed, this species will thrive and form large colonies.

Economic Uses

Pink and white-flowered forms are seen but rare in Missouri. Cultivation of this species could be handsomely rewarded toward sales of native ornamental gardeners. The blue flowers can be sold at local markets or simply be a beautification element on the farm. The seeds can be collected and sold with wildflower seed

Additional Resources

Missouri Botany Organization:

<http://www.mobot.org/gardeninghelp/plantfinder/Plant.asp?code=L200>

Missouri Plants:

http://www.missouriplants.com/Bluealt/Mertensia_virginica_page.html

Buffaloberry (*Shepherdia canadensis*)

Description

Native to North America, the buffaloberry is a shrub that can grow from 2” to 8” in height, depending on what pruning practices are implemented. Buffaloberry must have both male and female plants in order for fruit/seeds to be produced. Buffaloberry is known in different regions of the United States by various common names. Some of these common names include: russet buffaloberry, buffalo-berry, Canadian buffaloberry, russet red buffaloberry, soapberry, and soopolallie. Another species, *Shepherdia canadensis* var. *xanthocarpa* produces a yellow fruit in comparison to *Shepherdia canadensis*’ red fruit.

Deciduous in nature, the color of spring leaves ranges from a hunter green to a lime green. On the underside of the leaves, a silver lining can be seen and is a key feature in identifying buffaloberry. In the fall, the leaves will turn a neutral yellow and are not very showy. The flowers are very small and will appear shortly after the leaves have emerged. Similar in color to a dandelion, the flowers are not as showy as dogwoods and have no fragrance that can be detected by the human nose.

Habitat

Native to North America, the range for buffaloberry is from Nova Scotia to New Mexico. Understory tolerant, this species is commonly found growing under ponderosa pines, white spruce, balsam fir, and even cottonwoods or willows. Though understory tolerant, buffaloberry thrives in full sun and can grow to be a dominant tree in poor sites that have large amounts of sulfur. Buffaloberry is also a nitrogen fixer, similar to legumes such as beans or black locust.

In regards to soil types, buffaloberry can thrive in all three types: clay, sand, and loam. The site must be well drained since the species cannot tolerate being water logged for a long period. In contrast to nutrients that are available on the site, buffaloberry can thrive in areas that lack nutrients in the soil or have been cleared of all nutrients do to mining, aggressive agriculture practices, and over grazing of livestock.

Management Considerations

In the past, many government agencies have suggested this species to be planted in areas that had been stripped mined, over grazed, or a former dump site. This species is very aggressive once established and has been known to sucker sprout in areas where plenty of precipitation fell and where there was a lack of other competing vegetation.

In agroforestry practices, this species is ideal for areas that have been neglected or abused by being used as dump sites. In particular, this species can be used for windbreaks, silvopasture, forest farming, and alleycropping. A riparian buffer is another option, as long as the species are planted away from the water source. In a

silvopasture environment, cattle do not show any interest in buffaloberry twigs or their fruit, however, sheep and goats have been know to devour a whole thicket of this species. A word of caution, toxins in this species have been know to kill sheep, goats, and feral horses during years of severe drought when buffaloberry was the only vegetation available to consume. This toxin causes the plants to create a fowl taste and most animals (domesticated or wild) will not chew on the branches, but may browse the seeds.

Harvesting Considerations

Due to the size of buffaloberry, timber harvest is out of the question. However, this shrub can be used to make mulch or produce small pieces of wood that can be used by artisans interested in wood carving.

Propagation

The best propagation practices include direct seeding, transplanting young seedlings from one source to another, and using root cuttings. Through these propagations, the species is able to establish a healthy root system and not show any negative impacts of being moved from one site to another.

Economic Uses

The fruit of buffaloberry has been used in many Native American recipes from deserts to a form of fruit punch. Even today, many tribes across the Midwest hold annual pow-wows and will pay a large sum for the seeds to be used in drinks, foods, and decoration. A market can be found through Native American Tribes and also through organic markets that are looking for unique food ideas.

In the field of medicine, research has taken place to determine if an old remedy started by the Sioux Tribe can help calm irritated eyes. Today, many medicine men/women use the bark of buffaloberry to ease the pains of dry eye or cleanse eyes that are come in contact with dust, tree branches, or pollen. Modern medicine has taken an interested in this practice and research prototypes have been developed and are being tested in clinical trials.

Along with being an eye medicine, the Sioux also boiled the bark, leaves, and fruit to produce teas. These teas were used to help cure stomach problems, what we would consider stomach ulcers in today's society. The tea also is thought to have a healing effect on other parts of the stomach and intestines.

Additional Resources

https://plants.usda.gov/plantguide/pdf/cs_shca.pdf

Butternut (*Juglans cinerea*)

Description

A relative of the Black Walnut (*Juglans nigra*), this tree is small to medium sized but with a short straight trunk and broad open, somewhat irregular, flat or rounded-topped crown. Butternut is called "white walnut" because of its light-colored wood, which has a natural golden luster that becomes satin-like when polished. Butternut is more valued for its nuts than for lumber. It may mature at 60 feet tall by 50 feet wide when it is found in the open. Its leaves are pinnately compound with 11 to 17 leaflets that have a yellow to brown color in the fall. It has elongated corrugated nuts with flattened and shiny ridges. It has sweet-tasting nuts which gives the common name of Butternut. The Native Americans reportedly boiled the kernels to extract the oil, which was then used like butter. The kernels were also pickled in vinegar by the early settlers.

Habitat

Butternut grows best on streambank sites and on well-drained soils; it is seldom found on dry, compact, or infertile soils. However, it typically grows better than black walnut on dry, rocky soils, especially those of limestone origin. Butternut is found most frequently in coves, on stream benches and terraces, on slopes, in the talus of rock ledges, and on other sites with good drainage. It is generally considered to be more winter-hardy than black walnut.

Management Considerations

Naturally occurring Butternut trees are susceptible to butternut canker disease, but healthy trees found growing among diseased trees may be resistant to the disease. These trees could have potential value for propagation by grafting or breeding. Do not plant seedlings in areas with diseased trees for they will not likely survive.

Young trees may grow in considerable competition, but they are shade-intolerant and mature trees must reach the overstory. Fire easily top-kills butternut and older trees rarely sprout from the root crown or stump. Competing vegetation must be controlled when planting seeds or seedlings to maintain vigorous growth. Properly prune and maintain good tree care to maintain vigor of the trees for seed and nut production.

If trees have less than 70 percent live crown and more than 20 percent of the combined circumference of the stem and root flares are affected by cankers, remove and discard these trees. The wood may be salvaged.

In agroforestry plantings butternut will most likely find application in the riparian forest buffers and/or alley cropping practices. However, due to its susceptibility to butternut canker, plantings are not likely to be long lived unless a canker resistant variety is developed.

Harvesting Considerations

Nuts quickly become rancid and therefore need to be harvested quickly. Butternut is closely related to black walnut so many of the recommendations for seed collection and storage and for planting are similar for both species.

Propagation

Young trees may withstand competition from the side, but will not survive shade from above. The minimum size opening needed to establish and promote early development is about 2 to 3 times the height of the surrounding dominant trees. Seeds germinate in the spring after seedfall and a cold period (34-410 F) of 90 to 120 days to break dormancy.

Economic uses

Timber can be harvested for cabinet work, furniture, paneling, carving and novelties. Butternuts were often planted close to the house on farmsteads for their use as food. Kernels were used in baking and cultivars have been selected for nut size and for ease of cracking and extracting kernels.

Additional Resources

<https://www.arborday.org/trees/treeguide/TreeDetail.cfm?ItemID=803>

https://plants.usda.gov/plantguide/pdf/pg_juci.pdf

Canola (*Brassica napus*)

Description (Common names: rutabaga, Swedish turnip, canola, rape)

Annual or biennial, with a slender or stout, hard, long tuberous taproot; stems are erect, often many branched, and up to 1.5 m tall. Sometimes the stems are purple toward the base. The leaves are lobed, and the petioles are usually 10–30 cm long, with a few bristly hairs. The flowers are pale yellow, 1.2–1.5 cm long. Inflorescence can be many branched, and up to 1 m tall as an elongating raceme.

Canola is grown sparingly for young leaves used as potherb, but is more generally grown as forage for livestock feed, and as source of rapeseed oil. Rape oil is used in the food industry, as an illuminant and lubricant, and for soap manufacture. Residual rapeseed cake, though low in food value, can be used as livestock feed. Rapeseed oil has a potential market in detergent lubrication oils, emulsifying agents, polyamide fibers, and resins, and as a vegetable wax substitute. However, canola is probably gaining its greatest notoriety for use as a cooking oil because it has low levels of saturated fats.

Habitat

Canola requires fertile and well-drained soils. It responds favorably to nitrogen and phosphate fertilizers, but can be injured by direct contact with the fertilizer. Use only low rates of fertilizers in drills where both seed and fertilizer empty into same tubes. Sunny days and cool nights are favorable for growth; dry weather at harvest time is essential. Ranging from Boreal Moist to Rain through Tropical Dry to Moist Forest Life Zones, rape is reported to tolerate annual precipitation of 3 to 28 dm (mean = 8.3), annual temperature of 5 to 27°C (mean = 11.6), and pH of 4.2 to 8.2 (mean = 6.2).

Harvesting Considerations

Because fruit ripens evenly and shatters easily, to avoid shattering, it is recommended to harvest crop when yellow and windrow to ripen until seed inside is just changing from yellow to brown. Dry, mature seed may be harvested directly with combine. To combine standing crop, it is best to leave the crop until seeds are fully ripe, and with reel speed reduced to two-thirds normal speed for cereals, harvest crop during cloudy weather when plants are moist, thus reducing shattering. In some areas the crop is cut by hand and then flailed with sticks after drying in sun for a few days. In humid and temperate regions, artificial drying may be necessary.

Propagation

Seeds are sown in place. Plant canola 4-6 in (10.2-15.2 cm) apart in rows 30 in (76.2 cm) apart. Canola seed is either broadcast at 20 pounds (9 kg) per acre, or planted in rows 28 in (71 cm) apart at four pounds (1.8 kg) per acre.

References

General information:

http://www.hort.purdue.edu/newcrop/duke_energy/Brassica_napus.html

http://www.floridata.com/ref/B/bras_nap.cfm

Catnip (*Nepeta cataria*)

Description

Catnip is an erect perennial herb that grows to three feet in height. The stems are whitish, downy, square in shape, with opposite leaf arrangement. It has many small purple-spotted white, or pale lavender, tubular flowers which are tightly clustered at the end of the floral branches. The leaves are heart shaped with scalloped edges ranging from grey green to green color and are often crowded toward the top of the plant. The fruit on this herb is in the form of a nutlet.

Habitat

Catnip can be found along roadsides, near streams, hedgerows, borders of fields, dry banks, and waste ground, especially on calcareous and gravelly soils. It is native to dry regions of the Mediterranean, Europe, Asia, Eurasia and Africa, was introduced to America by the early settlers as a garden herb, and was later naturalized in North America (1).

Management/Harvest Considerations

Nepeta cataria grows well in well-drained soil with pH ranging from about 5 to 7.5. It grows best in full sun and with an annual temperature of 45-66 degrees F. Fields should be fertilized based on soil test recommendations for field crops, prior to planting. Catnip has very little insect or disease problems. Its major pest is weeds (competing vegetation), which should be controlled by cultivation because there are no herbicides labeled for use in catnip production. A stand of catnip will last for three years, after which time the weeds generally became a problem and a decrease in yield is expected. When growing conditions are good a yield of 4.4 to 6.7 tones/ha of dry weight can be harvested.

Catnip is harvested when it comes into full bloom, sometime in August. It is very critical that it is harvested at that time because after it blooms the aromatic properties of the volatile oils decrease. Plants are harvested by clipping the stems about 10 to 12cm above the crown. This allows regrowth from the adventitious buds. Plantings can generally be cut twice (mid-summer and fall) during the growing season. The thicker stems of the harvested plants can be removed to allow for a leafier, finer stemmed, and aromatic final product. The harvested plants are dried in the shade or with an artificial dryer. Depending on the buyer and its use further drying may be required.

Propagation

Catnip seeds are extremely small, germinate rapidly and produce healthy seedlings at temperature between 68-86 degrees F. The seeds are sown into warm seedbeds sixty to sixty-five days prior to transplanting, which should generally occur between March 1 and April 1. Daily management of the plantbeds is

necessary to produce strong, healthy seedlings. Seeds will typically remain viable for five years.

Economic uses

Catnip is marketed for cats in stuffed toys, catnip filled balls, and compressed pellets and in shaker bottles. The commercial catnip for toys is of lower grade, consisting of dried, ground up stalks, as well as leaves. Marketing possibilities include farmers markets, pet stores and higher-end retail stores. Growers should have an established market available before beginning production. Producers may be able to capture a niche of the pet supplies market, which comprises about 20 percent of the more than 30 billion dollars that the U.S. pet owners spend on their animals.

Catnip is also used in a number of pharmaceutical products and researchers have found a chemical that is highly effective as a natural mosquito repellent. Like other plants from the mint family, catnip has also been used to calm a number of digestive tract disorders.

Notes

Labor requirements per ¼ acre are approximately 75 hours for production, 64 hours for harvest and 8 hours for processing.

Additional Resources

<http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=e433>

http://ruralnetwork.royalroads.ca/sites/default/files/tools_resources/catnip.pdf

Kit L. Chin, Yadong Qi, Mila Berhane and James E. Simon, Biological Characteristics, Nutritional and Medicinal Value of Catnip, *Nepeta cataria*, No. 302

Chinquapin Oak (*Quercus muehlenbergii* Engelm.)

Description

Moderately tall, slow-growing deciduous tree reaches a mature height of 60 to 80 feet and often has wide-reaching lower branches when grown in the open. Bark is light grey or silvery-white and resembles the white oak (*Quercus alba*). Leaves are broad, flat, and simple (not lobed) with coarse teeth. The Chinquapin Oak is sometimes spelled *Chinkapin* Oak, and is also known as Yellow Oak or Yellow Chestnut Oak (among others). It is a member of the White Oak group and Beech family, and is therefore related to Oaks, Beeches and Chestnuts.

Habitat

(USDA Zones 5 – 8)

Native to most of the Midwest, Chinkapin oak is found in western Vermont and New York, west to southern Ontario, southern Michigan, southern Wisconsin, extreme southeastern Minnesota, and Iowa; south to southeastern Nebraska, eastern Kansas, western Oklahoma, and central Texas; east to northwest Florida; and north mostly in the mountains to Pennsylvania and southwestern Massachusetts. There are local populations in the mountains of southeastern New Mexico, Trans-Pecos Texas, and northeastern Mexico. Chinkapin oak is generally found on well-drained upland soils derived from limestone or where limestone outcrops occur. Occasionally it is found on well-drained limestone soils along streams. It appears that soil pH is strongly related to the presence of Chinquapin Oak, which is generally found on soils that are weakly acidic (pH about 6.5) to alkaline (above pH 7.0). It does well in most light conditions, and prefers upland sites.

Management Considerations

Chinquapin Oak prefers moist, well-drained, deep, rich, alkaline soils, but sometimes is often found near the summit of hills or uplands in dry soils that may be clay, sandy, or rocky. It can tolerate neutral to acidic soils. It thrives in partial to full sun. Moreover, it can withstand moderate shading when it is young but becomes more intolerant of shade with age. It is regarded as a species that performs best on dry, droughty soils, especially those of limestone origin. On more moist sites it performs moderately well. However, many oak-hickory stands on moist sites that contain chinquapin oak are succeeded by the beech, maple, and ash species (which are better suited to those sites). In an agroforestry application, chinquapin oak is especially suited for windbreaks, though it can also serve as an excellent wildlife food source for squirrels, mice, voles, chipmunks, deer, turkey, and other birds.

Because it is related to other Oaks, it is susceptible to vascular diseases such as Oak wilt and to insect pests such as the gypsy moth and acorn weevil. However, it is overall it has very few pest problems and does well even in urban settings.

Harvesting Considerations

Chinquapin Oak can reach 24 to 36 inches in girth at maturity, and is capable of producing a wide range of products in low-value to high-value wood markets. The wood of chinquapin oak is dark brown with a narrow, pale sapwood; it is hard, heavy, strong, and durable. These characteristics make it a valuable wood for many uses. It is commonly used as saw timber and is considered a member of the select white oak group. When properly dried and treated, oak wood glues well, machines very well, and accepts a variety of finishes. It is widely used for cabinets, furniture, pallets, and containers. Higher-value uses include staves used in making barrels. Oak wood was traditionally used for railroad ties and is commonly cut for firewood.

Despite the fact that the wood is of excellent quality, Chinquapin Oak is relatively uncommon over its natural range and moreover it is rarely found in cultivation because it is not a large tree. However, it would make a fine specimen for parks, estates and larger lawns. The sweet acorns are relished by wildlife and are even palatable to humans.

Propagation

Acorns will germinate without any pretreatment as soon as they are mature.

Additional Resources

<http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=a903>

Chokecherry (*Prunus virginiana*)

Description

Chokecherry is a native, deciduous, thicket-forming shrub/small tree. Numerous stems, slender and branching at the base, or with upright spreading branches, form the majority of the plant. Average heights may range from 3 feet to 20 feet, Great Basin heights have been recorded to 40 feet with 8 inch diameters. Extensive root systems are common among chokecherry, extending as much as 35 feet laterally and 6 feet of depth. Fruits are a fleshy drupe, containing a stone. Although edible, this stone is toxic to humans and must therefore first be cooked or otherwise treated prior to consumption. This shrub is also an important wildlife plant that provides cover and food to many birds and mammals.

Habitat

Chokecherry is widely found throughout much of the United States, it occurs from a line through Newfoundland to British Columbia south to North Carolina, Tennessee, Missouri, down to northern Mexico. It is found throughout many forest types, including forest edge, under full canopy, and with a variety of species in the overstory. It is shade tolerant, but persists in high percentages of sunlight. Fast growth rates are associated with chokecherry in good sites. Moist soil is required for optimum growth.

Management Considerations

Wildlife values are great with chokecherry, including food and cover. Additionally, chokecherry is widely considered in watershed protection and plantings requiring a diversity of species. The leaves may be used as browse and the fruits can be utilized by small mammals, humans, and other fruit-eating animals.

Very acidic to moderately alkaline soils can support chokecherry. High shade tolerance has been noted, but great densities will be noticed near forest edges. Both open and closed forest canopies can support a stand of chokecherry. Heavy grazing of stands of chokecherry will eventually reduce the number of stems and perhaps cause the species to decline in an area. Fire can be used to top-kill the individuals, with rapid resprouting from surviving root crowns and rhizomes.

Environmental benefits other than wildlife value are for establishing riparian buffers, soil stabilization, early cover, etc. Due to the fast growth and extensive rooting ability of chokecherry, it is useful in Riparian Buffer Strips, areas for increased diversity, and Windbreaks.

Harvesting Considerations

Berry production is a possibility for Agroforestry applications, with berries ripening between August 14 and 22 on average. Ripe berries tend to lose the astringent properties associated with chokecherry, and can be used in wines, syrups, jellies, jams, and in some cases are used for medicinal value (including treatment of cold sores, colds, and rheumatism).

Propagation

Regeneration can occur, with chokecherry, by rhizomes (vegetative) or by planting. Rhizomes can be planted from individuals that are aged enough, lab experiments show about 11 years, and good sprouting should occur. Seeding requires scarification of seeds by acid and/or mechanical means, due to the stony endocarp that surrounds the seed. If not removed, or seeds scarified, some resistance to germination may be noted.

Economic Uses

Berry production is the highest value of chokecherry, economically. The fruit is used for jams, jellies, wines, etc. Some of the wood may be of value, but the reduced size, comparatively is a downfall to high income from wood products. Some traditional archers use chokecherry stems for arrows, but unless a known market is relatively close they are not economically viable.

Notes

Cattle and domestic sheep eat chokecherry and due to its toxicity, poisoning sometimes occurs, though normally fatal quantities are not eaten unless other forage is scarce. A noticeable drop in toxin (cyanogenic glycoside prunasin) seems to occur after first frost. Chokecherry is susceptible to attack by the fungus *Plowrightia stansburiana*, which causes knotlike cankers to develop on stems. This condition eventually kills infected stems. Afflicted plants usually have a shortened life span.

Additional Resources

<https://plants.usda.gov/core/profile?symbol=prvi>

Dill (*Anethum graveolens*)

Description

Dill is an erect, freely branching annual herb with finely dissected, lacy, blue-green foliage. "Dill weed" refers to the foliage, and the seeds are usually just called "dill." The leaves are about 1 ft (0.3 m) long and divided pinnately three or four times into threadlike segments each about 1 in (2.5 cm) long. The dill plant grows about 3-5 ft (0.9-1.5 m) tall and sometimes gets top heavy and falls over. The flowers are yellow and borne in large, rounded, compound umbels (umbrella-like clusters in which all the flower stems originate from the same point) on stiff, hollow stems. The whole inflorescence can be 10 in (25 cm) across, and several of them on a feathery blue-green framework can be showy indeed. The fruit is a flattened pod about an eighth of 1 in (2.5 cm) long. All parts of the dill plant are strongly aromatic.

Habitat

Dill does best in full sun, as it becomes leggy and prone to topple over in partial shade. This crop does best in well drained soil with adequate moisture and it may bolt quickly to flower during a prolonged dry spell. Dill is an annual that can be grown all summer in USDA zones 3-7, in spring and fall in zone 8, and in the winter in zones 9-11 (see references for map of hardiness zones). In hot weather dill flowers and goes to seed quickly. Again, the plant requires long days and cool weather, and is sensitive to environmental stresses, such as low moisture, hail, high temperatures, strong winds, and hard rains during the flowering and seed maturation period. Again, the plant grows best in deep, fertile loam soils.

Management Considerations

An easily grown plant, Dill prefers a moderately rich, loose soil and full sun. This plant requires a well-drained soil and shelter from the wind. It can tolerate a pH in the range 5.3 to 7.8. Dill is a commonly cultivated herb, especially in warm temperate and tropical zones. It is grown mainly for its edible leaves and seeds, though it is also used medicinally. The plant quickly runs to seed in dry weather and it often self-sows when growing in a suitable position.

Dill is a good companion for corn and cabbages, also in moderation for cucumbers, lettuce and onions, but it inhibits the growth of carrots.

Harvesting Considerations

Grown best as an annual crop, timeliness of harvest is crucial to maximize seed yield, because seeds tend to ripen at different times and seed shattering is a potential problem. Generally, harvesting for dill weed or the essential oil of dill weed is done before the plant flowers. Harvesting for seed is initiated when the bulk of the seed crop is physiologically mature. Plants used for essential oil

production are steam distilled on the day of harvest to minimize volatilization losses.

Additional Information

Dill and other members of the carrot family are the sole food plants for the caterpillars of the beautiful black swallowtail butterfly (see reference below for pictures). Dill flowers attract beneficial insects too. Lacewings and syrphid fly adults eat the pollen of dill and other carrot family plants, and their larvae prey on plant sucking insects such as aphids.

Additional Resources

<https://www.cabi.org/isc/datasheet/3472>

General information (Florida State Extension)

<http://edis.ifas.ufl.edu/MV060>

Dogbane (*Apocynum cannabinum*)

Description

Perennial weed with extensive branched root system with vertical roots that can grow 8 feet or longer. Smooth stems can be 3-5 feet tall and have soft lance shaped opposite growing leaves that are bright green in the spring and summer and yellowish-orange to brown in the fall. Small bell-shaped flowers form from late June to August, which produce two seed pods each 3-4 in. Dogbane is frequently confused with common milkweed because both possess milky sap.

Habitat

Dogbane is native to North America. It occurs naturally along fence rows and roadsides. In Missouri it typically grows in the wild in dry rocky or open woods, glades and prairies. It grows more rapidly on moist sites than arid sites, but persists on both. Due to its capabilities of reproducing by seeds and vegetative buds in the crown region and on horizontal roots, dogbane has been establishing in crop fields and has become a problem. Wisconsin and Nebraska are two states that are under serious infestation.

Management Considerations

Dogbane should not be implemented in all of the 5 agroforestry practices due to its ability to rapid reproduction rate and invasive qualities. Riparian forest buffers could greatly benefit from dogbane because of its extensive root system. Nutrients from crop runoff like nitrogen and phosphorus could be efficiently trapped before reaching the waterway. Since agroforestry practices are intensively managed, the spreading of dogbane could be moderately controlled when practicing riparian forest buffers, but it is not guaranteed.

Dogbane is known to colonize crop fields in regions where no-till crops are grown due to extensive rooting systems that were already established in the soil. Major outbreaks were found in soybean and oat fields, and moderate outbreaks in corn and sorghum fields. Once colonized, the extensive root systems can take over and potentially reduce crop yields. The only known method for controlling outbreaks of dogbane is frequent moving. Since dogbane can reproduce via seeds and vegetative buds, intense tillage is not recommended when attempting eradication.

Dogbane outbreaks were least common where alfalfa and winter wheat were being cultivated. Alfalfa competes very well with dogbane due to frequent mowing which reduce root reserves, limit lateral root growth, prevent flowering, and avoid spreading root segments on tillage equipment. Winter wheat () establishes in the fall and grows rapidly in the spring before the soil is at an appropriate temperature for dogbane growth. Neither alfalfa nor winter wheat actually eradicates dogbane.

The milky sap of dogbane attracts butterflies. The milky juice contains a cardiac glycoside toxin but plants are unpleasant to livestock and cases of poisoning are unlikely.

Harvesting Considerations

Although dogbane is considered a weed, it is a very strong source of fiber. Native Americans called dogbane 'Indian Hemp' and used the roots to make ropes.

Propagation

Propagation of dogbane can be done by seed or by vegetative buds in the crown region and on horizontal roots. Germination is greater in light, but results can be poor if the seeds are not emerged ½ inch below the soil surface. Dogbane shoots will begin to emerge once soil temperatures reach 65 degrees F. After emergence, they grow and develop very rapidly. True seedlings are sensitive to soil disturbance so once seedlings have emerged, it is important to allow at least 10 inches of above ground growth before cultivation.

Economic Uses

Dogbane niches may be established all over. Dogbane can be used in craft projects such as necklace making. Dogbane roots can also be sold to rope makers. Presently, it is not as widely used as the Native Americans did.

Notes

Dogbane was a very important crop in Native American culture. Dogbane can be referred to as 'Indian hemp' or 'hemp dogbane'. The species *cannabinium* translates to hemp. Some humans considered this plant toxic, but the roots were still harvested in the 19th and 20th centuries for a variety of folk medicine and medicinal purposes.

Additional Resources

<https://plants.usda.gov/core/profile?symbol=apca>

Eastern Cottonwood (*Populus deltoides*)

Description

Fast growing and with a distinct triangular shaped leaf, eastern cottonwood is able to live over 100 years. Along with a long lifespan, this species is also able to achieve heights of 120 feet or more and a base diameter of 5 feet. The bark is a yellow-green color and smooth to the touch as a seedling and as it matures, the bark turns a dark gray and is deeply furrowed. The species is dioecious, meaning male and female trees exist and seed is dispersed through the wind in cotton bundles. In the fall, the leaves turn a pale yellow and are very attractive in the landscape.

Habitat

Found near streams and floodplains, eastern cottonwood is tolerant of both drought and rainy conditions. Eastern cottonwood spans from North Carolina all the way out to Montana and from Quebec down into Mexico and is found everywhere in between. In relation to soil types, this species can be found in sandy, low line areas to loamy conditions and even in clay soils. The only limiting factor in relation to soil that will cause problems with the growth and development of this species is bedrock or some other limiting factor that will interfere with root development. When the soil has no limiting factors, this species, along with others in the *Populus* genus has the ability to sucker sprout from the root and cause a new cluster of seedlings to occupy the base of the tree. Besides bedrock or another soil limiting factor, eastern cottonwood does not do well with fire and is very sensitive to the heat a fire can produce. Other species that are found in the same habitat are willow species, red mulberry, American sycamore, and hackberry.

Management Consideration

When it comes to management practices, this species will need little attention if planted on a good site that receives plenty of sunlight and water. Even though this is a drought or rainy resistant tree, young seedlings/saplings may be dramatically affected with severe drought or rainy conditions. If a drought should occur during the season you plant or a few seasons later, regular watering will need to be implemented for maximum root development. In the future, pruning lower or damaged branches will have to be done in order to keep the tree healthy and also maintain the value of potential timber that can be harvested. Along with eastern cottonwoods comes the cotton seed dispersal that can cause havoc on screens, air conditioning units, and allergies. If any of these factors are a concern to the landowner, seedless hybrids and varieties have been developed and can be used.

In agroforestry systems, eastern cottonwood can be grown in alleycropping to be harvested for timber, pulp, or other economical uses of the wood. Besides alleycropping, eastern cottonwood would be ideal for silvopasture since the species is fast growing and can inhabit various terrains. Windbreaks and riparian

buffers are the two big areas that this species is used in due to its ability to grow in wet areas and also be able to adapt to exist in different habitats across the mid and eastern sections of the United States. Forest farming can also be an option for a management plan consisting of eastern cottonwood because very few chemicals are leached out of the roots and into the soil that can cause damage to the understory crop(s).

Propagation

Mentioned before, eastern cottonwood has a tendency to have suckers, or new seedlings emerging from the roots of an already existing tree. These sucker sprouts can be a nuisance to keep under control. However, with proper equipment, sprouts can easily be detached from the main root and transplanted to another site. A word of caution, the new sucker sprouts are clones of the original plant and if the genetic makeup of the original plant is unable to ward off diseases, the suckers will have the exact same problem. Besides using sucker sprouts or a good seed source, taking recently pruned limbs and reducing them to a two foot stick and simply planting the stick in the ground is also a form of propagation. Also mentioned before, new technology has brought seedless varieties of this species that will not disperse the cotton in late spring/early summer.

Economic Uses

Since eastern cottonwood can grow very rapidly, it is used in the pulp and paper industry as a wood source for many mills across the eastern United States. Along with the pulp and paper industry, growing eastern cottonwood as a biomass source has become an interest to scientists and homeowners looking to produce cheap energy in contrast to the rising prices of fossil fuels. Several facilities across the country have started to use such biomass material as their energy source year round. New research projects are underway to determine if chipping the trees into fine particles and mixing these particles in with hay can be a source of cellulose for beef cattle.

The salicylic acid that is found in the wood is often used as a coupling ingredient in producing certain dyes for cloth. For carpenters, salicylic acid can be used as a currying agent for shell molding compounds. Along with these uses, this chemical can also be used in the production of latex paints, certain glues, and preservative for leather.

Additional Resources

Purdue University:

http://www.hort.purdue.edu/newcrop/duke_energy/Populus_deltoides.html

Eastern Gamagrass (*Tripsacum dactyloides*)

Description

Native to the eastern United States, eastern gamagrass is a warm season bunch grass. Since this grass is a perennial, with proper management it will come up year after year. A close relative of field corn, eastern gamagrass can have a vegetative width spread from 4-5 feet and reach a height of 5-10 feet. From June to September, the plant will produce orange-yellow flowers that will develop to produce seed.

Habitat

Gamagrass prefers light sands, medium loam, and heavy clay soils. This grass also prefers full to partial sun and will perform poorly in densely shaded areas. When considering where to plant this species, look for areas that receive large amounts of precipitation, riparian areas, or areas that retain good moisture, such as those areas close to woodlots.

Management Considerations

Weed control is very critical in the first year of establishment and can be accomplished using select chemicals or by manually removing weeds by such methods as cultivation. Burning areas with gamagrass is not uncommon and should be done every 5-8 years or so in order to stimulate vigorous new growth.

For riparian buffers, this grass is ideal and will flourish well in extremely moist areas.

Silvopasture and alley cropping are suggested only during the early stages of tree growth. Once the trees begin to shade and crowd out the grass, it may become necessary to establish another species that is more shade tolerant.

Inserting gamagrass in windbreaks may also be desirable, but make sure the shade produced by the dominate tree species in the windbreak does not interfere with the amount of sunlight the grass receives.

Harvesting Considerations

To harvest this species for hay or silage, wait for the second year of growth before going forwarding with harvesting. It is not uncommon to get 2 to 3 hay cuttings in a growing season. The ideal time for harvest is when the stems are 24 – 36 inches in height from the base to the tip of the tallest blade. Another harvest can take place 4-6 weeks following the first harvest of the year, as long at the same height criteria mentioned above is present. Leave about 6-8 inches of stubble to optimize regrowth for the plant.

Harvesting just the seeds can be a tedious job. Seed harvesting should be done around mid September when the seed heads are heavy and drupe from the plant.

Propagation

A down side to eastern gamagrass is the difficulty found in establishment. With new technological advances in the field of genetics, varieties that are much easier to establish in comparison to the original eastern gamagrass have come about with in the last 5-10 years and more are sure to come in the future. In any case, stratification of the seed is necessary. For improved success in establishment, place seeds in a wet environment at 35F for 10 weeks before planting. When planting the seeds, make sure soil temperature reaches around 65F. For planting the seeds a corn planter is the easiest method; however, new research has shown that drilling the seed can cause the seeds to germinate faster. Always control competing grasses.

Economic Uses

Seeds that are harvested can be sold as planting seeds for the next growing season. Along with selling seeds for production, the seeds are also edible for humans. The seeds are used in various backing recipes and in some cases, can take the place of corn in certain situations. The seed can also be popped and enjoyed as an alternative to popcorn. Other than the seed, the stems and seeds can be harvested in the fall and sold later on in the winter when pastures are low of forage for livestock.

Additional Resources

Other common names for gamagrass is “Sesame grass,” “fakahatchee grass,” “northern gamagrass” and “gama grass,”

Missouri Botanical Gardens:

<http://www.mobot.org/gardeninghelp/plantfinder/Plant.asp?code=R220>

Plants For A Future:

<https://pfaf.org/user/Plant.aspx?LatinName=Tripsacum+dactyloides>

University of Missouri Extension:

<http://muextension.missouri.edu/explore/agguides/crops/g04671.htm>

USDA:

<https://plants.usda.gov/core/profile?symbol=trda3>

Common Elderberry (*Sambucus nigra* ssp. *canadensis* (L.))

Description

Common elderberry is a large upright, deciduous shrub or small tree with multiple stems that are spreading or arching. This shrub/tree can reach up to 12 feet tall. The bark is smooth and brown becoming shallowly furrowed and rough with age. The twigs are stout, silvery-to yellow-gray with obvious, warty lenticels. The buds are very small, red-brown and pointed. The leaves are opposite, 6 to 11 leaflets, dark green above and much paler below. The flowers are small, white, and in flat-topped clusters that are up to 8 inches across. The fruit is a small, berry like drupe, purple-black, and very juicy, borne in flat-topped clusters.

Habitat

Elderberry can be found in Eastern United States-Nova Scotia to Florida, west to Manitoba and Texas. It can be found in rich moist soil along streams and rivers, woodland margins and waste ground. It is a nitrogen loving plant and thrives near places of organic waste disposal.

Management/Harvest Considerations

The common elderberry is adaptable to either wet or dry sites and prefers neutral to acidic soils. This shrub/tree can withstand extended flooding. It grows best in full sun but will tolerate moderate shade. Pruning is needed on a regular basis in order to keep it looking its best. Its tendency to sucker and the displacement of the stems, due to the weight of the fruit, is what makes it necessary to prune, if a formal appearance is desired. Its capabilities to spread out, tolerate competition, withstand extended flooding, and withstand high concentration of nitrogen makes it useful in riparian buffers.

The elderberries can be harvested by hand in late summer. They fruit more heavily when you plant two different varieties close together, such as Adams and York, as examples.

Elderberry makes a good shrub for wildlife plantings and may be planted in combinations with other trees in practices such as alley cropping or windbreaks. Game birds, squirrels and other rodents, and several kinds of browsers also feed on the fruit or foliage of elderberry. Bears love to eat the elderberry fruits while deer, elk, and moose 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.

Propagation

Elderberry produces a good seed crop almost every year. The seeds are dispersed by birds and other animals that eat the fruit. The seeds have a hard seed coat and embryo dormancy and may remain viable for up to 16 years in storage. Without pretreatment, seed germination may be delayed from 2 to 5 years after planting. Plants may flower and fruit after only 2-3 years and can reach full size in 3-4 years.

Although cuttings will have lower survival than otherwise planted, cuttings are an optional propagation method. Cuttings of half-ripe wood with a heel, or cuttings of mature wood of the current season's growth may both be used. Elderberry may also be propagated by division of suckers in the dormant season.

Economic Uses

Elderberry is most effective in shrub borders, roadside plantings, in wet or low areas, or as a screen. It is heavily used as a food source for all kinds of birds and other wildlife.

Its economic importance is in the production of the berries to make jellies and jams. Only the blue or purple berries of elderberry are edible. Edible berries and flower are used for medicine, dyes for basketry, arrow shafts, flute, whistles, clapper sticks, and folk medicine. It is well spoken of in ancient times for its medicinal values. The active alkaloids in elderberry plants are hydrocyanic acid and sambucine. Both alkaloids will cause nausea so care should be observed with this plant. Elderberries are high in Vitamin C. The red berries of other species are toxic and should not be gathered. The leaves and inner bark of young shoots are used as an insect repellent, the dried flowering shoots are said to repel insects and rodents. It has also been known to treat various fungal infections such as leaf rot and powdery mildew. Cattle tend to rub up against this shrub/tree to help repel insects. The bark, leaves and berries can all be used for making dyes.

Notes

To use elderberry as an insecticide follow the following steps; boil 3-4 handfuls of leaves in a liter of water, then strain and allow to cool before using.

Additional Resources

https://plants.usda.gov/plantguide/pdf/cs_san1c4.pdf

<http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=f470>

Faba Bean (*Vicia faba*)

Common names

Broad bean, horse bean, English bean, tick bean, field bean

Description

Broad beans get their name from the seeds which are large and flat. The seeds are variable in size and shape, but usually are nearly round and white, green, buff, brown, purple, or black. Pods are large and thick, but vary from 2-12 inches in length. The plant is an erect, stiff-stemmed, leafy legume reaching 2-5 feet when mature. They are quite different from common beans in appearance because the leaves look more like those of English peas than bean leaves. The flowers are 0.4 – 1.0 inches in length, with five petals.

Habitat

The faba bean requires a cool season for best development and is usually grown as a winter annual in warm temperate and subtropical areas. It can be grown anywhere it does not winterkill, or except where temperatures fluctuate rapidly. It is well-adapted to wetter portions of cereal-growing areas of western Canada. The faba bean tolerates nearly any soil type, but it grows best on rich loams.

Moderate moisture supply is necessary since this legume is not drought resistant. Moisture requirement is highest at approximately 9–12 weeks after establishment. The faba bean is more tolerant to acidic soil conditions than most legumes and thus can be grown in nearly all parts of the United States without liming. Hardier bean species can tolerate winter temperatures of 14.0 °F without serious injury. Winter types fare well when kept within an average temperature of 35 °F, without severe frost. Growing season should have little or no excessive heat.

Because they can over-winter well, they are often grown as a cover crop to prevent erosion. Additionally because they are a legume, they fix nitrogen in the soil and make a good “green manure”.

Management Considerations

Beans mature 90–220 days after planting. Harvest can be delayed a little longer for hand than for mechanical harvest. In either case, crop should not be cut until the lower pods are matured and the upper ones fully developed. If harvest is delayed until the upper pods are ripe, loss from shattering is great. An ordinary mowing machine can be used, but the drop-rake reaper is more satisfactory and reduces shattering. Crop should be cut on cloudy day and maybe cut at night and shocked early the next day. Large-seeded types are threshed with a common bean thresher with special adjustments to the cylinder. Small-seeded types can be thrashed without difficulty. After threshing, seeds are cleaned with ordinary fanning mills. For canning, beans are allowed to swell and then are picked by

hand before they become hard. As a dried vegetable, they are prepared the same way as other common beans.

Propagation

In areas that do not have hard frosts, planting may be done in the fall. In areas that have hard frosts, planting can be done in the early spring. Seed size will dictate method of planting, with larger seeded cultivars sown with a lima bean planter and smaller cultivars sown with a corn planter. Other regions of the world will often have plants in cultivated fields. In any event, seed should be planted to a depth of 2-4 inches. Row spacing may be varied from 24 inches apart, to wider, with about 6 inches between seed in a row.

When used as a green manure, seed may be broadcast. In all cases if proper Rhizobia are not present in the soil, then it is desirable to inoculate the seed prior to planting. Weed control may be accomplished in a fashion similar to other bean crops, whether by chemical or by cultivation is a personal preference.

Economic Uses

Pollination is critical to optimizing yields. Faba beans may be grown for personal consumption or as feed for livestock. Opportunities likely include local farmers markets.

Additional Resources

General information

<http://www.hort.purdue.edu/newcrop/cropfactsheets/fababean.html>

<http://edis.ifas.ufl.edu/MV017>

USDA

<https://plants.usda.gov/core/profile?symbol=VIFA>

<https://www.sciencedirect.com/science/article/pii/S0378429009002755>

Market information

<http://www.kitchengarden.co.za/favabeans.html>

Gray Dogwood (*Cornus racemosa* Lam)

Description

Gray dogwood has a wide range and may be found across most of the northeastern United States. It is highly adaptable to a wide range of soil and climatic conditions. It is a low growing shrub that seldom exceeds 8 feet in height. Individual plants may be 5 feet wide, yet root suckering may initiate further spreading of individual plants. As a shrub that tends to form thickets, it is widely used by wildlife for summer food and cover. Fruit will typically develop by September or October from loosely clustered flowers that were formed in June or July. Often these white fruit are highly visible and set off as they are born on red to reddish-brown colored twigs.

Habitat

Gray dogwood grows well in poor soil. It is also quite tolerant of wet soils and is hardy to zone 3. It has intermediate tolerance to shade.

Management Considerations

Gray dogwood may be viewed as invasive due to its thicket forming/spreading properties. As with all tree and shrub plantings, the single best management that can be applied is control of weed competition. Most often herbicide or cultivation is used.

Uses for gray dogwood can include riparian buffers and windbreaks. Essentially it may be used anytime a hardy shrub is needed. Its medium height can effectively augment taller plant materials in zones of a windbreak. And, in all cases the fruit and twigs have been know to be used by several wildlife species including: robins, cedar waxwings, rabbits, and deer.

Additional uses may include urban screens and highway beautification projects.

Harvesting Considerations

The fruit matures between August and September and is a favorite for birds and mammals that eat the berries. Additionally, harvest of fruit laden stalks may be added to floral arrangements. Cut stems must be kept moist and fresh prior to selling. Although local markets should be considered prior to planting as a commercial venture, the wildlife values and rooting ability make this an excellent shrub selection for use in riparian area.

Propagation

Gray dogwood has fibrous roots and seedlings planted early in the spring should have good survival. Once well established, branches can be pulled and staked horizontally and covered with soil in order to encourage filling of a site. This may be especially useful where erosion concerns dictate filling an area with plant materials.

Although cuttings have been used successfully, they are much less reliable. To use cuttings, collect dormant material that is 3/8-inch to 1/2-inch in diameter on the small end and about 9 to 12 inches in length. These cuttings must be kept in cold storage, or planted right away. They can then be driven into the ground (or placed in preset holes) with about 2 inches protruding above the soil. Soil must be in firm contact with the cutting.

Economic uses

Primarily used as a conservation shrub for erosion control or wildlife enhancements, the gray dogwood also has additional profit opportunities when grown as an ornamental to enhance or create a naturalized look around buildings. It may also have opportunities within floral markets due to the color contrast of autumn berries on reddish brown twigs.

Additional Resources

https://plants.usda.gov/factsheet/pdf/fs_cora6.pdf

<http://plantfacts.osu.edu/pdf/0247-320.pdf#search='gray%20dogwood%20pdf'>

Green Ash (*Fraxinus pennsylvanica*)

Description

Green Ash belongs to the Olive family (Oleaceae) and is a medium sized tree that produces an irregular to somewhat rounded crown, with heights of up to 70 feet. It is also known as red ash, swamp ash, and/or water ash. It is widely distributed across the Midwest and Eastern United States. Green ash and White ash have similar wood properties and are often marketed as the same. Ash are used by many wildlife species as browse and the seed is eaten by many birds and small mammals.

Habitat

The westerly range of green ash is dictated primarily by moisture limitations. Although a fairly successional tree that will grow on many sites, stands of green ash will most often be found in bottomland soils where good moisture is available. It is somewhat tolerant of flooding. The northern limits to its range are defined by frost free growing days. On average, green ash needs 120 to 280 frost free days per year.

Management Considerations

Green ash is relatively intolerant of shade and may be out-grown by other tree species associated with sites that have good soils and moisture. Therefore, without timely thinning of forest environments green ash typically begins to die out. Thin such that the crown of green ash has plenty of available light.

On the other hand, green ash has been planted with other hardwoods that have a higher value wood, such as eastern black walnut (*Juglans nigra*), and used as a trainer tree. In that case, as the trees develop the green ash assist in the upward growth and natural pruning of the lower limbs of the black walnut, and then begin to die back as the black walnut trees take over the site.

Green ash has been used in many windbreaks. It has a good crown, relatively quick growth, and is widely tolerant of many sites and soils. However, the greatest windbreak benefits will come by combining green ash with other species.

Propagation

As with most trees, the best growth and development of seedlings will occur when weed control is provided to eliminate competition from grass. Ash can be naturally propagated from seed of trees adjacent to a given site. Seed starts to fall from trees as soon as they ripen, and will continue into the fall and winter months. The seed is most often spread by the wind, but may also move with flood waters. Seed will naturally germinate in the spring. However, collected seed can be started through a process called stratification. Cold and moist conditions are

necessary in order to stratify and break the seeds dormancy, but they may then be started and grown in beds or containers.

Economic Uses

Primarily Green Ash is logged or used as a shade tree species. Therefore, most of the economical value for this species is tied up in lumber production. Such items as baseball bats, as well as tool handles, have in the past principally been made from Green Ash due to its strength, hardness and high resistance to shock. Another key fact is that Green Ash has excellent bending capabilities. However, when comparing Green Ash to White Ash in terms of durability as well as marketability White Ash is considered the better wood for such items that were just mentioned.

Interesting enough, Green Ash is now being used in the regeneration of spoiled banks that were created from strip mining. It is also often used as a species in riparian buffer plantings.

As previously mentioned Green ash is also very popular as a shade tree in residential, thus giving it potential as a nursery ball-and-burlap tree. Adding to its desirability is quick growth and the ability to adapt to its surroundings.

There are several diseases of green ash that limit its long-term use in most situations. However, its quick growth make it desirable from a marketing standpoint, as well as an environmental perspective where a site needs stabilization or protection that can be afforded by trees. For more on the diseases that might affect green ash please see the additional resources section.

Additional Resources

<https://plants.usda.gov/core/profile?symbol=FRPE>

Illinois Bundleflower (*Desmanthus illinoensis*)

Description

Illinois bundleflower is an upright, deep-rooted, warm season perennial, legume. It grows from two to four feet in height with twenty to thirty seedpods curving to form a bundle or cluster. The stems are light green and angular. The leaves are alternate, bipinnate, and yellowish green or medium green, and narrowly ovate in shape. The bundleflower has small, white to greenish white flowers. The fruit is sickle-shaped, flat, many in dense clusters, dark brown and about 1/6 of an inch long.

Habitat

The Illinois Bundleflower can be found on pastures, rocky prairies, waste areas, open wooded slopes, stream banks, ditches, and roadsides. It is most abundant in clay or sandy soils. It occurs primarily in northeastern Illinois, along the Illinois River valley, and along the Mississippi River valley in southwest Illinois. Populations can be found in Kansas, Oklahoma, Alabama, Texas and north as far as Minnesota.

Management/Harvest Considerations

Illinois Bundleflower is rated by some authorities as our most important native legume and is included in range revegetation programs. The plant is highly palatable to cattle and other herbivores and has a high protein content that compares to that of soybeans. The plant prefers full or partial sun, and moist to average conditions. Illinois Bundleflower is an excellent reclamation species, adapted to harsh dry conditions. Fire, broken sod, or patches of bare mineral soil are necessary to maintain self-sustaining population's. The crop is quite easy to establish but requires early weed control to reduce competition with other plants, such as little and big bluestem and indiagrass. Bundleflower fixes high amounts of nitrogen in the soil, and can rejuvenate worn-out-soil. Its nitrogen fixation potential could reduce nitrogen fertilizer needs in perennial agroecosystem. When bundleflower is established it should be used as part of a rotation system and not continuously grazed bundleflower is harvested for its hay to feed livestock. Research is being done on how often it can be cut for hay and how well it yields. It's a very heavy seed producer, producing about 800lbs/acre.

Propagation

Bundleflower is best-grown in areas receiving fifteen inches or more of annual rainfall. Bundleflower should be planted at a rate of thirteen pure live seed pounds per acre, at a depth of 1/4 inch to 1/2 inch in a firm seedbed. Once the seed is established it requires very little attention.

Economic use

Illinois bundleflower seed is being evaluated, by food scientist, for its potential nutritional and nutraceutical properties. The seed is being tested for both animal and human consumption. The research shows that it has high levels of anti-oxidants and a high protein content (30-38%). It could possibly be a multi-use species, grazed in some years and harvested as a grain crop in other year's. Its economic use is primarily as a hay/forage crop and has potential for use as a seed crop.

Notes

The common name "bundleflower" derives from the densely flowering, puffball-like heads. Livestock prefer it to any other plant, including alfalfa, often grazing it out of pasture (3).

Additional Resources

<https://plants.usda.gov/core/profile?symbol=deil>

https://www.wildflower.org/plants/result.php?id_plant=deil

Missouri Department of Natural Resources, Warm-Season Native Grasses on Reclaimed Minelands-Landowners management guide, 7/2003.

Indiangrass (*Sorghastrum nutans*)

Description

Indian grass is a tall, bunching sod-former, 3-8 ft. in height, with broad blue-green blades and a large, plume-like, soft, golden-brown seed head. It is an important associate in the tallgrass prairies and is relished by livestock. It appears to be favored by occasional flooding and repeated burning and sometimes forms nearly pure stands in the lowlands.

Habitat

Indian grass is rather adaptable and once established as it will tolerate wet, dry, or poor soil. Best growth occurs in a moist soil where the plant is exposed to full sun. Found on open prairies, bottomlands, and open woods, in deep, moist soils. This grass is fairly tolerant to drought conditions, leading it to invade disturbed areas.

Management Considerations

Although it is good forage for livestock, Indiangrass, like any warm season grass, cannot tolerate heavy grazing for extended periods of time. It is best to use rotational, or management intensive, grazing and thereby let the grass respond following grazing sessions with adequate new growth prior to again grazing the area. Indiangrass is can also be rejuvenated with fire, and after times of grazing, it is good to prescribe burn these acreages.

Harvesting Considerations

Warm season grasses can provide more tonnage per acre than many other types of forage. Cutting for haying purposes can be done in over the summer and in the fall prior to flowering. Indiangrass mixed with Big Bluestem provides some of the best quality prairie hay.

Propagation

Indiangrass propagates from both seed and rhizomes, it is also known to self-seed and this will lead to volunteer plants. Planting practices similar to big bluestem are adequate for this warm season grass since they are co dominants in many tallgrass prairie systems. Planting can occur in late April and early May with no-till being the main practice. Dormant seeding can be done in December through February.

Economic uses

When practicing rotational grazing, it is shown that cattle will gain more weight in less amount of time when using warm season grasses as the primary forage.

Kentucky bluegrass (*Poa pratensis*)

Description

Kentucky bluegrass (*Poa pratensis*) grows 18 to 24 inches tall and is readily identified by its boat-shaped leaf tip. It spreads by rhizomes and tillers and forms a dense sod. New shoots (rhizomes and tillers) are produced primarily in the spring and late summer. Most shoots produced in the spring remain vegetative. Shoots produced in late summer often terminate in an inflorescence the following spring. The lifetime of a Kentucky bluegrass shoot that terminates in an inflorescence ends soon after the seeds mature. During late spring and summer, the shoots of Kentucky bluegrass grow in an erect, or upright, position; whereas, in early spring and fall they become more decumbent. This pattern of growth is a response to day length rather than temperature. During long days shoots grow upright; during short days they become decumbent. Day length also influences the number of shoots that develop. Significantly more shoots are produced during the short days of early spring than during long summer days. It is a cool-season grass.

Habitat

Kentucky bluegrass is found most abundantly on sites that are cool and humid. It has become naturalized across North America and often occurs as a dominant species in the herbaceous layer. Kentucky bluegrass grows best on well-drained loams or clay loams rich in humus and on soils with limestone parent material. It needs large amounts of nitrogen during active growth stages. The optimal soil pH is between 5.8 and 8.2. Root growth is greatest in fall and spring and slows dramatically in summer. Root growth of Kentucky bluegrass peaks at soil temperatures of 60°F and declines sharply as temperatures rise above 70°F. Root growth practically ceases at temperatures above 80°F.

Management Considerations

Begin mowing young grass when it grows above a 2-inch cutting height. Either rotary or reel type mowers may be used but blades must be sharp and reels properly adjusted to prevent pulling up young seedlings. The initial cutting should be at a 2-inch height. Subsequent mowing should be frequent enough so that no more than one-third of the leaf is removed at each mowing. At a 2-inch mowing height the grass needs mowing before it reaches 3 inches. Weekly mowing is usually satisfactory at the 2-inch mowing height. At lower mowing heights more frequent mowing is required.

Propagation

Where bluegrass is established from seed, plant 2 to 3 pounds per 1,000 sq. ft. of lawn. When seed is broadcast over the soil surface, they may take a longer time to develop. However, when seed is drilled into the top inch of soil, the seedlings will most likely develop faster. Kentucky bluegrass can be seeded year round, but best results are obtained in the spring and fall. New seedlings require light and

frequent watering (2 to 3 times per day for the first 2 weeks). After seedling emergence, watering frequency can be reduced.

Economic Uses

Kentucky bluegrass is suited for a variety of applications, though silvopasture and riparian buffers may be ideal. However, the market for bluegrass seed may also provide opportunities in the alley cropping practice where bluegrass seed becomes the product harvested.

Additional Resources

Turfgrass Specialist (Texas Cooperative Extension)

<http://aggiehorticulture.tamu.edu/plantanswers/turf/publications/bluegrass.html>

USDA

<https://plants.usda.gov/core/profile?symbol=POPR>

Kentucky Coffeetree (*Gymnocladus dioicus*)

Description

Kentucky coffeetree may also be known as American coffee berry, Kentucky mahogany, nicker tree, or stump tree. It is a medium to large deciduous (max 100ft) tree with stout branches forming a narrow round-topped crown. It is intermediate shade tolerance, preferring full sun. Leaves are alternate and bipinnately compound (feather-like arrangement), 12 to 32 inches long; leaflets 2 ½ inches long by 1 inch wide. Leaf out early in the spring, turn yellow and drop early in autumn. Bark is gray to brown and shallow grooved with scaly ridges that curl away on the edges. Large uninspiring greenish-white flowers May to June. Fruit occurs in October persisting through the winter in pods 4 to 7 inches long and 2 inches wide. Pods contain 3 to 5 seeds inside; seeds ¾ inch blackish and hard-shelled. Pods drop unopened in late winter.

Habitat

Most often Kentucky coffeetree will be found in bottomland forests along streams, in moist woods at the base of bluffs, in mixed woods. Kentucky coffee tree is never common and has no common associates, but it does have similar site preferences as black walnut.

Management Considerations

In agroforestry applications, Kentucky coffee tree can be used in riparian buffers, alley cropping, silvopasture, and windbreaks. Prolific root sprouter. Very little wildlife uses this tree for food. However, it is used by nesting birds. The raw leaves and raw seeds are potentially toxic to mammals, but squirrels and deer have been reported to eat pods and seeds. Kentucky coffee tree grows best in rich, moist soils in full sunlight, but is very adaptable to heat, drought, basic soils, soil compaction, and wet sites.

Due to the structure and sparseness of the crown, Kentucky coffee tree may not need to be pruned much for alley cropping and silvopasture, but should be pruned to 17 feet or more if quality lumber is an objective. As with all legumes the tree bears root nodules containing nitrogen-fixing bacteria.

Harvesting Considerations

Kentucky coffee tree is considered an intermediate to fast growing tree and should reach a harvestable size of at least 16 inches in approximately 50 years. Growth is always site dependant. If thinning a stand the stumps of Kentucky coffee tree may need to be sprayed to reduce the likelihood of stump sprouting.

Ring shake (defect in quality; rings separate) in Kentucky coffee tree is a common problem.

Propagation

Root cuttings 4cm long and 1cm thick in a greenhouse in December. Plant the roots horizontally in pots.

Propagated primarily by seed. Seed is best sown in a greenhouse as soon as it is ripe. The seed can also be sown in early spring in a greenhouse. Scarification and pre-soaking the seed for 24 hours in warm water, especially if it has been stored, will improve germination. As soon as they are large enough to handle, prick the seedlings out into fairly deep individual pots and grow them on in the greenhouse for at least their first winter. Plant them out into their permanent positions in late spring or early summer, after the last expected frosts. Consider giving them some protection against the cold for their first couple of winters outdoors.

Economics Uses

Economic uses are limited in number as Kentucky coffee tree is not a common tree and has few regular markets other than propagation for use as an ornamental. The wood is used for cabinet work, furniture, construction, fencing etc... Not a primary lumber species, but can be sawn for high and low value lumber. Check with potential buyers (loggers and mills) before planting a monoculture of Kentucky coffee tree to produce lumber.

Notes

Although poisonous when raw, roasted seeds were once used as a substitute for coffee by native Americans and then European settlers, hence the common name.

First introduced into cultivation in 1748. 'Expresso', 'J.C. McDaniel' (Prairie Titan®) and 'Stately Manor' - At the current time, these cultivars are rarely offered in the trade. They are all male (fruitless) selections selected for their upright branching habit which is elm-like and much taller than wide

<http://www.hort.uconn.edu>

Additional Resources

<http://edis.ifas.ufl.edu/pdf/ST/ST28700.pdf#search='gymnocladus%20dioicus%20pdf'>

<http://plantfacts.osu.edu/pdf/0246-487.pdf>

Lespedeza

Common (*Kummerowia striata*)
Korean (*Kummerowia stipulacea*)

Description

Annual lespedeza is an acid tolerant, drought resistant, summer annual legume useful for pasture, hay and soil improvement. There are two main types of lespedeza grown in Missouri, Common Lespedeza and Korean Lespedeza. They have broad to long, heart shaped leaflets that are distinctly veined and have small hairs on the stems.

Habitat

Korean is better adapted than common lespedeza in the North because of its shorter life cycle. Both types grow in a pH range of 4.5-7.0, but do best at 6.0-6.5. Seed early in the spring, and as with all legumes, the correct species rhizobial bacteria inoculant should be used. Germination occurs in early spring but grows very little until early summer. Dry conditions may reduce growth but recovery following rain is very quick.

Management Considerations

With proper management, annual lespedezas are easy to establish, and will reseed themselves, but should be mechanically reseeded at some point in order to maintain an adequate stand.

Used with grasses, lespedeza will produce nutritious feed for most classes of livestock. The forage from lespedeza is fine-stemmed, with a high percentage of leaves, and does not cause bloat. Proper management, plus some summer rain, will allow lespedeza to produce quality pasture during midsummer when companion cool-season grasses are of low quality and not very productive. Lespedeza pasture can be used by all types of livestock but is especially valuable for sheep and cattle operations. Lespedeza can be grown with all of the adapted cool season grasses but performs best with orchardgrass. It also has an added value where quail production is important because annual lespedeza seed is an excellent quail food.

Harvesting Considerations

Missouri farmers can produce 1-2 tons of lespedeza per acre depending on variations in weather and management. Some studies have been shown to have gains in steers grazing on lespedeza to have 1.8 lbs gain per day. Early Missouri grazing trials also reported more pounds of beef produced from lespedeza and orchardgrass mixes than from lespedeza-fescue.

Propagation

For pure lespedeza stands, seed 20 pounds of seed per acre. In mixed stands, seed 15 pounds per acre of either type as a dormant seeding into established cool-season grasses. When drilling as a companion legume with cool season grass, seed 10 lbs per acre with the proper amount of grass seed per acre. One pound of lespedeza contains about 236,000 seeds. Mow or lightly graze the lespedeza in summer to ensure that the seedling grass plants survive. Do not plant lespedeza in the fall. It may then be killed by freezing if it germinates too late.

Economic uses

The use of lespedeza may reduce production costs. Lespedeza will produce less forage per acre than properly managed alfalfa or clover but can be maintained with lower production costs. Feeding trials report that lespedeza hay is only slightly less valuable than alfalfa for wintering calves and dairy heifers. However, lespedeza hay is inferior to alfalfa when fed to lactating dairy cows. It makes excellent hay for sheep and all types of beef cattle.

Additional Resources

<http://extension.missouri.edu/publications/DisplayPrinterFriendlyPub.aspx?P=M181-24>

<https://plants.usda.gov/core/profile?symbol=KUST2>

Loblolly pine (*Pinus taeda*)

Description

Loblolly pine is a large, evergreen tree that can reach heights of 90-110 feet. It has a long, clear trunk (bole) that is sometimes buttressed and a round spreading crown. Self-pruning is common among this species, which helps to develop a clean, branch free, bole. Young trees retain low branches longer than slash and longleaf pine. The needles are 4 to 9 inches long, in fascicles (groups) of three, stiff, and a bluish-green color. Fruits are produced in large quantity, and consist of dark brown, oblong to cylindrical cones, from 3 to 6 inches long, and they persist on the trees for more than one year. The main problems associated with loblolly pine include fusiform rust, bark beetles, pine engraver beetles, and prolonged flooding.

Habitat

The native range of loblolly pine includes most of the southeastern United States, although it can be grown in Missouri, it does not produce seed due to cool winter temperatures. Acidic soils are preferred as well as full sunlight. Many different sites are adaptable, including fertile, upland fields, moist forests, mixed hardwoods, and in association with shortleaf pine (*Pinus echinata*). The main factor limiting northward expansion of loblolly pine is the low winter temperature that damages flowering, and the damage that may develop in association with ice, snow and sleet as it accumulates on the long needles (may result in trees or branches being broken).

Management Considerations

Full sunlight is required for best growth, and a moist site is desired, though drier soils are adaptable. Main cause of mortality in seedlings is drought, especially during the growing season. Silvopasture, Forest Farming, and Alley Cropping are all good agroforestry applications for loblolly pine. The main products produced by loblolly pine include lumber, utility poles and pine straw. Young trees are somewhat tolerant of shade, but increasing age reduces the shade tolerance. Understory invasion of pine stands, by more tolerant species, can allow for succession of more hardwoods, which can then share dominance with loblolly pine, but the numbers and basal area of the pine will decline over time.

The majority of the root system of loblolly pine is within the top 18 inches of soil, so consideration at the base of the individual trees must be taken, as the competition between the tree and any other crop at this root zone will be quite high.

Harvesting Considerations

If lumber is desired, maturation is considered 150 years with diameters between 36 and 48 inches and height of 90 to 110 feet. Mean annual board-foot growth culminates at about age 50. Growth during a shorter time period, such as 25 year

rotation, may allow for greatest economic benefits even with the reduced size. Trees with 9.6 inch and larger diameter at breast height at age 20, can range from 2,100 fbm/acre to 40,000fbm/acre(most likely plantation style growth). Some other applications, such as pulpwood growth, can lead to even shorter rotations, but the implementation in agroforestry must be carefully scrutinized. Control of competing vegetation and fertilization will allow for best growth and maximum results.

Other intermediate products, such as pine straw (used as a mulch), can be harvested as timber crops mature. Pine straw develops as needles are dropped/cast as a natural process of tree growth and development. Over time these needles accumulate beneath rows of loblolly trees, and the accumulated needles can then be raked into rows and baled into small square bales. These square bales, weighing approximately 30 lbs in order to facilitate transport and use by urban homeowners, can then be used in flower beds and other settings where pine straw is desirable as a mulch material. The soil acidity created when needles begin to break down is often desirable for flowering plants that do better with acidic soils.

Propagation

Seeds can be used for propagations, but a stage of dormancy after seedfall is normal. This dormancy lasts the longest of any southern pine. To break dormancy cold, moist stratification of the seed for 30 to 90 days is recommended. Vegetative reproduction can be accomplished with cuttings from seedling up to 3 years of age. Sprouting occurs from buds in the primary needle axils when the tops are clipped off, the rooting is related to a trees age so attention to this factor is extremely important. Seedbed scarification or burning, to open up direct mineral soil contact, greatly increases chances of seedling survival.

It is often most feasible to order seedlings from a nursery. Best growth is presented from genetically enhanced seedlings, available from most nurseries, although the increased cost may be prohibitive. Seedlings from specific regions react differently to certain conditions, such as east Texas loblolly pines are more drought resistant, northerly sources of pine result in more cold-hardiness, etc. A nursery in the local area should have plenty of options for different sources of seedlings.

Economic Uses

Loblolly pine can be implemented for a number of products, including lumber, non-timber forest products, low-value wood products, and sometimes Christmas/ornamental trees. Non-timber products could include pine straw, in conjunction with forest farming operations.

Additional Resources

<https://plants.usda.gov/core/profile?symbol=PITA>

<http://www.centerforagroforestry.org/profit/pine/pine.asp>

Ninebark (*Physocarpus opulifolius*)

Description

Ninebark is a shrub that can grow from 3 to 10 feet tall with a widely spreading crown. Its bark is yellow, orange, or red-brown and appears shredded and exfoliating in long strips, especially on older stems. The twig is slender and red-brown. The young twigs have tight bark but on older twigs the bark splits and exfoliates in long strips. The leaves are alternate, deciduous, maple-like, and almost circular in outline, 1 ½ to 3 ½ inches in diameter, dark green above and paler below. The fruit is a ¼ inch pointed follicle that is in dense, upright hemispherical clusters and are red, turning into a bright reddish brown when mature.

Habit

Ninebark occurs on gravel bars, rocky banks and bluffs along streams and moist thickets, often overhanging the water. It is adaptable to a very wide range of soil and site conditions, from moist to dry, acid to alkaline, and gravelly to heavy clay. It will grow in partial shade to full sun. Its range is from Quebec west to Minnesota, South Dakota and Colorado, south to Oklahoma, east to Georgia and north to New York.

Management / Harvest Considerations

Ninebark is a shrub that is very adaptable to dry sites and is pollution tolerant. Because of these characteristics it is relatively a problem-free plant. It needs to be pruned right after flowering to remove crossed branches or dead wood. Thin out overcrowded stems by cutting stems back to ground level. In Missouri, fruits ripen from August to early October and are small, dry pods hanging in drooping, papery clusters that resemble bellows (1). Each pod contains 2 to 5 yellowish, shiny seeds. The seeds should be collected in late September. To allow them to further ripen and dry, they need to be placed in elevated wooden boxes with standard house screen on the bottom.

Ninebark's ability to tolerate pollutants makes it a valuable species in the development of riparian buffers. It is also selected for its rapid growth and its ability to reproduce vegetatively by stump or root sprouts.

Propagation

The seed should be sown as soon as it is ripe, if possible, in a cold frame. If sown in the spring it is likely to require a period of cold stratification. When they are large enough to handle, prick the seedlings out into individual pots and grow them in the cold frame for at least their first winter. Plant them out into their permanent positions in late spring or early summer, after the last expected frosts.

Economic Uses

Ninebark can form dense thickets, which provide good shelter and cover for a variety of wildlife species from small birds to large mammals. Ninebark's economic importance is in the production of seeds for sale. The importance of this shrub is for borders, massing, and bank covering. This shrub has no value for medicinal or timber production.

Additional Resources

<https://plants.usda.gov/core/profile?symbol=PHOP>

Northern Red Oak (*Quercus rubra*)

Description

Northern red oak is a moderate to fast growing tree that can be found on a variety of soils and site conditions. It is easily transplanted and is one of the more important lumber species of red oak.

Habitat

Because of the wide range of the northern red oak, its growing season varies from on average of 100 days in the north to 220 days in the south. Its native range extends from Nova Scotia to Arkansas, and it can be found growing primarily on moist, well drained soils throughout Missouri

Management Considerations

While northern red oak grows on a variety of soil types and site conditions it will always grow best on deep, well-drained loam to silty, clay loam soils. Northern red oak requires less growing space than those of other oak species with the same diameter, which makes it a good candidate for use in agroforestry plantings.

Northern red oak should be considered as one of the fastest growing native oak species in Missouri. Other fast growing species that have more limited ranges in the state include shumard oak, nuttall oak, and cherrybark oak.

Major risks to managing northern red oak include its susceptibility to a number of defoliating insects and diseases, including Gypsy moth and oak wilt. In addition, the red oak stem borer can become a serious problem in older northern red oak stands in southern Missouri. The loss of northern red oak acorns due to insect and disease predation, especially in poor seed years, is an ongoing problem in the state.

Propagation

Northern red oak is easily planted and transplanted. It is also a very prolific sprouter. These new sprouts will generally grow faster than younger trees of seedling origin due to the presence of a previously formed, well-developed root system.

Northern red oak acorns can quickly lose viability if allowed to dry out. Timely collection of sound acorns that are fall free from their caps is of paramount importance. Newly collected seeds should be soaked in water overnight to insure their soundness. Defective acorns will float and can be discarded. Floated seeds can be stored in plastic bags in the refrigerator and sown in the very early spring, or can be directly sown following collection. If sown outside seeds should be protected from mice, squirrels, and other rodents. The seedling tree produces a fairly fibrous root system, which allow for improved transplanting success rates.

If started in a nursery bed they should not be left there for more than two growing seasons.

Economic Uses

Red oak is an important lumber species and is used in a variety of applications from lumber, firewood, flooring, etc. Heavy acorn production is also important for many wildlife species including squirrels, turkeys, blue jays, deer and other mammals and birds.

Osage-Orange (*Maclura pomifera*)

Description

Osage-orange can be either a shrub or a tree, depending on its surroundings. It grows between 10 and 40 feet tall, but can reach up to 60 feet. Standing alone in full sun it will become a multi-stemmed shrub; with neighboring competition it can become a single-stemmed tree. The bark, up to ¾ inches thick, is light gray-brown with slight orange. On large trees it separates into shaggy strips. The leaves of the osage-orange are thick, shiny, and simple, alternating along twigs, dark green on top and light green underneath. Branches growing in full sunlight have sharp, stout thorns. Twigs in the shaded portions of the crown of mature trees are thornless. The leaves of the osage-orange turn bright yellow in autumn. The trees are either male or female, and only the females produce a large fruit from their small flowers. Flowers are produced from May to June. The fruit, commonly known as a hedge apple, is a large, green-yellow wrinkled ball up to 6 inches in diameter. As it ripens in the fall (September to October), the fruit often hangs in the tree after all the leaves have fallen off. It does not have recognized associates, but can sometimes be found near eastern red cedar, hickories, black walnut, and elms.

Habitat

Osage-orange is native to a relatively small area in eastern Oklahoma and portions of Missouri, Texas, and Arkansas. Preferring open sunny areas, the tree can grow in a variety of soils and with a variety of species.

Management Considerations

Osage-orange can be used in windbreaks and provides valuable cover and nesting sites for quail, pheasant, other birds, and animals. The bitter-tasting fruit is hardly eaten by wildlife. It is a medium sized tree and will not reach the heights of other windbreak trees, but it can be planted very densely to increase wind filtering. Pole-sized and larger osage-orange trees are practically immune to deer browsing, but seedlings and tender sprouts are highly susceptible. Livestock should initially be kept out of the windbreak with fence, although osage-orange can become a fence itself with time and minimal maintenance. It does best on moist well-drained soils, but tolerates extreme drought. The tree is cold hardy to northern Iowa and Nebraska.

Harvesting Considerations

When harvesting from a windbreak, be sure not to create a wind tunnel where it is not wanted. Do not make corridors parallel to prevailing winds. Create corridors at angles or with crooks to curb and slow the wind.

Propagation

The best way to propagate osage-orange is through stem or root cuttings, although the seeds will grow and you can reproduce trees from root sprouts. To

successfully collect seeds and grow seedlings you must locate fruiting females with several neighboring males. Fruits can be collected from the ground anytime after they fall until just before spring. Natural regeneration requires exposed mineral soil and full sunlight.

In pioneer days, people used to crush a number of osage-orange fruits and make them into slurry that was then poured into a plowed shallow furrow and covered with about 1/2 inch of soil. This method was used to start hedgerows.

Economic Uses

Osage-orange produces no sawtimber, pulpwood, or utility poles. The heartwood, bark, and roots contain many extractives of actual and potential value in food processing, pesticide manufacturing, and dye making. Osage-orange heartwood is the most decay-resistant of all North American timbers and is immune to termites. Some places grow osage-orange specifically to produce fence posts. After the post material is harvested, the plants resprout and in five to 10 years produce more fence posts. Several male thornless varieties (*Maclura pomifera* var. *inermis*) of osage-orange are now on the market, used in home landscapes, along city streets, and in institutional settings. Osage-orange staves are used in bow making. The wood is valuable for firewood, rating almost as high as coal in producing heat.

Notes

Known also as hedge, hedge apple, bodark (from the French bois d'arc, meaning wood of the bow), and bowwood, the osage-orange's name comes from the Osage Indian tribe, which lived near the tree's home range, and from the orange-like aroma of the ripened fruit.

Passion-flower (*Passiflora incarnata*)

Description

Passiflora incarnata is a fast growing perennial woody vine that employs tendrils to grab hold of adjacent shrubs, structures and other supports to lift itself to heights of eight to twelve feet. This flower is also known as Maypop. It has large serrated leaves that grow five to six inches wide by six to eight inches long. The flowers are single, arising on stalks from the axils of leaves. The individuals are up to three inches across, with several petals and a purple fringe. The fruit is oval, smooth, yellow when ripe, up to two inches long, and contains many seeds with gelatinous coverings.

Habitat

Passionflower is native to southeastern United States and is often seen growing on the edges of fields, along side ditches and other sunny, moist and fertile places.

Management and Harvest Considerations

Passion-flowers are drought tolerant and can be grown in different soils. It prefers a light, rich soil, and does well in dry areas. The plant requires a position in the landscape that receives full sun for best flowering. This plant is noted for not having any serious insect or disease problems. The roots of this flower spread invasively. Root rot is one of the most common problems associated with the passion-flower. Root rot can occur in wet poorly drained soils, particularly in winter.

The leaves, stems and flowers may be harvested at any time. This is a good way to keep the plant from crowding itself. Each year before the frost kills it, the entire vine may be cut back to the ground, yielding great quantities of herb. It may be dried in the sun or at a low heat.

Propagation

Maypop is the hardiest of all the passion-flowers. If the roots are protected it will survive as far north as the Pennsylvania border. Maypop grows readily from the seed, but takes several weeks to sprout. It is best sown on the surface of light soil or peat moss with bottom heat. After six months the young plants may be planted in the open. It may be propagated easily by cutting off half-ripened growth. These should be about 6 inches long; they will root easily in sand and do not require bottom heat. The vines may eventually overgrow and tangle themselves. Thin them out by cutting branches back to their beginnings. Passion-flower dies back at the first frost.

Economic Uses

The primary economic value of the Maypop is its medical use. It is used to treat nervous restlessness and gastrointestinal spasms. It is also used as a sedative and

painkiller. The use of this plant for medical purposes did not begin until the late nineteenth century in the United States.

The passion fruit is edible but seedy. It can be used to make jelly, but its best usage is for being a food source for several species of butterfly and their larvae.

Notes

It derives its common name, Maypop, from the way it just seems to pop out of the ground in May.

Additional Resources

The Garden Helper, <http://www.thegardenhelper.com/passion.html>

Paulownia (*Paulownia tomentosa*)

Description

Native to China, paulownia (aka Princess tree) is a small to medium sized tree that may reach 30 to 60 feet in height, and up to two feet in diameter. The bark is rough, gray-brown, with olive-brown to dark brown stems that are hairy and flattened at the nodes. Leaves are large, oval to heart-shaped, and hairy on the lower leaf surface, arrangement is in pairs along the stem. Flowers are upright clusters of pale violet color with noticeable fragrance. Fruits consist of a dry brown capsule with four compartments that may contain several thousand winged seeds. The capsules mature in autumn and open to release the tiny, wind-borne seeds, though the capsule remains attached to the tree all winter, which is handy for identification.

Habitat

Paulownia can be found in 25 of the United States, from Maine to Texas, along roadsides, stream banks, and forested edges. It is a very adaptable species, tolerating infertile and acidic soils and drought conditions. It can be found in disturbed habitats, including previously burned areas, forests defoliated by pests, landslides, rocky cliffs, and riparian zones. It has an ability to sprout prolifically from adventitious buds on stems and roots, which help it to survive fire, cutting, and bulldozing.

Management Considerations

Quick to establish, paulownia can be used to establish a canopy in a considerably short time period, the ability of the species to sprout from stem and root buds, gives it an advantage in areas of increased disturbance. These factors can prove to be a problem with native competition, so care should be taken to consider all alternatives. Naturally seeded or planted paulownia survives and grows best on moist, well-drained soils of steep slopes or open valleys, but it will germinate and grow on almost any moist, bare soil. A highly adaptable Paulownia is found in many site, soil, and forest type conditions. Princess tree needs bare soil, sufficient moisture, and direct sunlight for good seedling establishment. Seedlings are very intolerant of shade.

Harvesting Considerations

On good sites royal paulownia grows rapidly. Plantation spacings of 4 by 4 or 6 by 6 ft have been recommended; saw logs can be expected in 15 years. Heights at maturity range from 30 to 70 ft. Heights of 43 feet in 11 years have been reported in Russia. On poor sites, such as surface mine spoils, growth is considerably slower. The ability of paulownia to survive, grow, and reproduce on such harsh, exposed sites, however, has made it a favorite for re-vegetating surface mine areas. The tree thrives on dry southern aspects, even though it generally has a shallow root system. The species is valued as an ornamental and for wood carving.

Propagation

When severely coppiced, paulownia can re-grow to a mature tree within a single season, and millions of small fluffy seeds can be produced. Difficulty in propagation has been noted, though the species can be found naturally occurring in degraded, exhausted soils.

Economic Uses

In China, paulownia leaves and bark are used to promote hair growth, reduce swelling in feet, and various other medicinal applications. Other uses include sawlog production, low-value wood production, and perhaps seed production, to be sold to nurseries. The quick growth of this species on good sites allows for fast production of biomass, and with the coppicing ability of the species, re-propagation may not be necessary. Future stands could be grown from the roots of established trees once they are harvested for pulpwood, etc.

Agroforestry Uses

Possible agroforestry uses for paulownia include windbreaks, alley cropping, and riparian forest buffers. The adaptability of the species makes it a valuable asset in situations requiring adaptive growth and sites that are unusable to many species. Care must be taken to keep spread of paulownia in check, it has become considered a highly invasive species in many states and without management to keep it contained, rare/endangered plant species may lose habitat to it.

Additional Sources

<https://plants.usda.gov/core/profile?symbol=pato2>

Paw paw (*Asimina triloba*)

Description

Reaching a height of 15 – 23 feet, the paw paw is a native, deciduous species of the United States. This slow growing understory tolerant species produces 12 inch 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 mid to late October. After the flowers have bloomed and been pollinated, the tree leafs out in late spring.

The flowers are protogynous, meaning that the tree has both male and female reproductive organs, however the female organ will mature sooner than the male. This allows the tree not to pollinate itself. However, since many natural stands of paw paws are sucker shoots, self fertilization is possible. The flowers are chocolate brown in color and have a velvety texture to them. Fruit begins to form after pollination has occurred and becomes ripe between mid-August to early October. When fully ripe, the light green fruit can weigh from five ounces to one pound and be three to six inches in length.

Habitat

Primarily an understory tree, paw paws usually exist in clumps or thickets due to their ability to sucker sprout and the hardiness of the seeds to survive through animal digestive tracts. During the early years of life, paw paws must be placed in shaded areas. After five years or once they begin to produce fruit, they are capable of being in full sun and will actually produce more fruit in comparison to being in half to full shade. Even though it can survive in full sun, some form of a windbreak must be present because of the large leaves that are susceptible to being shredded from winds and severe forms of weather.

Surviving in temperatures of -15F, the paw paw requires hot, humid summers and 32 inches of moisture falling in spring and summer to survive. Even with the large amount of precipitation that is needed, paw paws are unable to live in waterlogged areas. In reference to soil types, paw paws thrive in all forms of soil, especially silty soils that are acidic.

Management Consideration

Irrigation is critical during the growing season. Fertigation, mixing a form of fertilize into the irrigation water when watering, is highly recommended and is very beneficial during seasons of drought. Irrigation can be enforced through drip irrigation or sprinklers.

Pruning is not required for paw paws, unless you wish to remove dead or damaged limbs. Due to the size of the species, pruning is not a factor and this can be beneficial to landowners who will not have time to do pruning on a seasonal bases.

In agroforestry settings, paw paws are ideal for forest farming, windbreaks, and alley cropping. Besides being part of agroforestry, paw paws are also a good addition to any garden or landscape.

Harvesting Considerations

In the timber industry, paw paw is not a prized specimen. The tree does not reach a tall height and the circumference around the trunk is too small to produce lumber. To harvest the fruit, picking the fruit while it is still on the trees is recommended. Fruit that has already fallen can be cleaned on the spot and the seeds removed for future propagation or to sell to a local nursery as seed stock.

Propagation

Paw paw can be grown from seed and seedling plantings. Seeds should be removed from the fruit, washed with a 20% Clorox Bleach mixture, rinsed several times with distilled water, and be stored at 2-4°C for 60-100 days. For the first three years of growth, the seeds and seedlings should be placed in a shaded area that receives around 20% direct sunlight during the summer. Paw paws are primarily an understory tolerant tree and extended periods of direct sunlight may cause the young seedlings to die. Taking trees from the wild and transplanting them into a new setting is not recommended. Most paw paws that are found in the wild are often sucker sprouts and do not have adequate root development to survive after they have been transplanted. The ideal time to plant seeds or seedlings is when the tree is dormant, such as early spring and late fall.

Economic Uses

With a low timber value, paw paw is redeemed for its fruit that has been referred to as having a blended cantaloupe and banana taste. The fruit, when refrigerated, is edible for up to three weeks. Due to the short shelf-life, paw paws are not a commercial importance to the United States as an edible crop. Many housewives and bakers use the paw paw as a substitute for bananas in many recipes and have found that the fruit makes a wonderful jam/jelly. Along with being an edible fruit, the plant naturally manufactures a natural chemical (annonaceous acetogenins) that acts as a pesticide to keep insects from colonizing or eating the tree. Not only does this chemical act as a natural insecticide, researchers have found that this chemical has a positive effect on reducing various forms of cancer in the human body.

Notes

Other common names for the paw paw include: Poor Man's Banana, Indiana's Banana, the Hosier Banana, and the Poor Farmer's Banana. The seeds, when crushed, can cause digestive problems in mammals (humans and wildlife) but when left in tact, the seeds pass through the digestive system and cause no harm.

Additional Resources

California Rare Fruit Growers, INC.

<https://crfg.org/wiki/fruit/pawpaw/>

Purdue University:

<https://www.purdue.edu/hla/sites/yardandgarden/pawpaw-the-midwest-banana/>

Peppermint (*Mentha piperita* L.)

Description

The leaves of this kind of mint are shortly but distinctly stalked, 2 inches or more in length, and 3/4 to 1 1/2 inches broad, their margins finely toothed, their surfaces smooth, both above and beneath, or only very slightly, hardly visibly, hairy on the principal veins and mid-rib on the underside. The stems, 2 to 4 feet high, are quadrangular, often purplish. The whorled clusters of little reddish-violet flowers are in the axils of the upper leaves, forming loose, interrupted spikes, and rarely bear seeds. The entire plant has a very characteristic odor, due to the volatile oil present in all its parts, which when applied to the tongue has a hot, aromatic taste at first, and afterwards produces a sensation of cold in the mouth caused by the menthol it contains. Peppermint blooms from July through August, sprouting tiny purple flowers in whorls and terminal spikes. Peppermint is native to Europe and Asia, is naturalized to North America, and grows wild in moist, temperate areas.

Habitat

Peppermint thrives best in a fairly warm, preferably moist climates and in deep soils rich in humus and retentive of moisture, but fairly open in texture and well drained, either naturally or artificially. These conditions are frequently combined in effectively drained swamp lands, but the plants may also be commercially cultivated in well-prepared upland soils, such as would produce good corn, oil or potatoes. Though a moist situation is preferable, peppermint will succeed in most soils when started into growth and carefully cultivated. It flourishes well in what are known in America as muck land, that is, those broad level areas, often several thousand acres in extent, of deep fertile soil, the beds of ancient lakes and swamps where the remains of ages of growth of aquatic vegetation have accumulated.

Management Considerations

The area selected for peppermint growing should be cropped for one or two years with some plant that requires a frequent tillage. The tillage is also continued as long as possible during the growth of the mint, for successful mint-growing implies clean culture at all stages of progress. A rich and friable soil, retentive of moisture is selected, and the ground is well tilled 8 to 10 inches deep. The usual method of mint cultivation on farms in America is to dig runners in the early spring and lay them in shallow trenches, 3 feet apart in well-prepared soil.

Harvesting Considerations

The herb is cut just before flowering according to local conditions. With new plantations the harvest is generally early in September. Harvesting should be carried out on a dry, sunny day, in the late morning, when all traces of dew have disappeared. The first year's crop is always cut with the sickle to prevent injury to the stolons. The herb of the second and third years is cut with scythes and then raked into loose heaps ready for carting to the stills.

The growing crop is kept well cultivated and absolutely free from weeds and in the summer when the plant is in full bloom, the mint is cut by hand and distilled in straw. A part of the exhausted herb is dried and used for cattle food, for which it possesses considerable value. The rest is cut and composted and eventually ploughed into the ground as fertilizer.

Propagation

The plants are propagated in the spring, usually in April and May. When the young shoots from the crop of the previous year have attained a height of about 4 inches, they are pulled up and transplanted into new soil, in shallow furrows about 2 feet apart, lightly covered with about 2 inches of soil. They grow vigorously the first year and will generate numerous stolons and runners on the surface of the ground. After the crop has been removed, these are allowed to harden or become woody, and then farmyard manure is scattered over the field and ploughed in. In this way the stolons are divided into numerous pieces and covered with soil before the frost sets in, otherwise if the autumn is wet, they are liable to become sodden and rot, and the next crop fails.

Economic Uses

The main marketable use of peppermint is for distilled oils used in flavorings and fragrances. Peppermint also contains a form of menthol that is added to many medications for both its smell and for its effectiveness as a carminative.

Additional Sources

International information (England and France)

<http://botanical.com/botanical/mgmh/m/mints-39.html>

Common Persimmon (*Diospyros virginiana*)

Description

Native to the United States and spanning in distribution from Connecticut to Kansas, Common Persimmon is a deciduous tree that will never grow above 50' in height and 18" in diameter at breast height when fully matured. 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 separate 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 from the tree in October or November the following fall. The fruit is red to yellow in color and averages about 1" in diameter.

Habitat

Persimmon can occur naturally along streams, in bottomland swamps, and upland forests. In consideration, it can withstand short periods of drought and flooding along with being in the understory of a forest during its germination, but after ten years, it will start to lose its understory tolerance. The ideal niche for persimmon is areas that will receive full sun and have adequate drainage properties. The roots of this species can grow very deep and may cause problems with underground pipes and wires.

Management Considerations

As stated above, the best site for this species is an area that will receive full sunlight and soils that are well drained. The first two to five years will be the most crucial for the seedlings and may require the owner to irrigate and do proper weed control.

From an agroforestry standpoint, persimmon can do exceptionally well in alley cropping, riparian buffer systems, and windbreaks. In alley cropping, the deep roots should not compete with shallow rooted grasses or forages. Harvest of the berries will take place after the crops in the alleyways have been collected as long as an alley crop such as summer wheat, alfalfa, or corn is chosen. With a deep root system, persimmon is a good addition to any riparian buffered area and will help control the amount of sediment movement from a field into a water source. Not only will the species aid in preventing soil erosion but will also be a great wildlife tree providing food for wildlife. The same is true in regards to windbreaks, the tree has deep root system that will allow for soil stability and the fruit that is produced will also provide wildlife food.

Harvesting Considerations

The fruit of persimmon is a delicacy in Asian communities that are established here in the United States. Outside of these communities, many rural areas have harvested this fruit for use in jams, cobbles, and homemade wines. Along with

using the berry, the seed is often dried and used as a substitute for coffee grains. Many Native American tribes brewed a form of persimmon coffee centuries before European settlers came to North America.

Along with the fruit, the wood can be just as valuable due to its strength, color, and sturdiness. At the turn of the 20th century, persimmon wood was used in manufacturing golf club heads and shuttles. Today, a market can be found for persimmon golf clubs, for enthusiasts who are more into traditional golfing. Along with golf clubs, persimmon wood was once used in the production of planes and in particular propellers and rudders.

Propagation

Seedlings can be obtained through seed source, grafting techniques, and also can be propagated through root cuttings. Cultivars of Persimmon are used in regards to characteristics that are desired in wood patterns and stability. Some cultivars have come about due to particular flavors in the fruit and also good fruit bearing traits. In regards to the deep root system, this species is not a good candidate for transplanting or hydraulic spading to new sites.

Economic Uses

As stated before, the wood and fruit are highly valuable in the right niche markets. Besides these uses, pharmaceutical companies use unripe fruit and inner bark as an ingredient for drugs that ease headaches, diarrhea, and stomach ulcers. The flowers that are produced by the tree are also useful in honey production.

Additional Resources

<https://plants.usda.gov/core/profile?symbol=divi5>

Uncommon Fruits Worthy of Attention by Lee Reich

Plains Coreopsis (Calliopsis) (*Coreopsis tinctoria* Nutt.)

Description

Calliopsis belongs to the Asteraceae family and is an annual forb which usually germinates in late summer or fall (after the first frost happens). In spring, the height of calliopsis can reach up to 4 feet. The leaves are opposite and are deeply divided, with the top portion being narrower than the rest. The flowers of this species are numerous and are usually 1-2 inches in diameter, and generally are yellow with rays that have a base which are red-brown in color.

Habitat

Plains Calliopsis can be readily seeded and grows rather quickly. Germination generally speaking takes between 10-15 days after seeding. Best time to seed is between August and September. Calliopsis likes moist soils and therefore is ideal for hard to drain areas including roadside ditches. Plant this species in full sunlight; however, plain calliopsis can withstand partial shade once it's established.

Management Considerations

Stands will reseed prolifically for several years on their own. However, there will be a gradual decline in floral production if the area does not undergo any form of soil disturbance. Therefore, about every two or three years the site/area should be disked or mowed to help control the perennial weeds from becoming established and to help promote calliopsis germination.

Economic Uses

As for the economic importance of this species it comes in the form of aesthetical value rather than dollars and cents. Due to its abilities to grow in areas that are hard to drain and its fibrous roots it also has the ability to aid in the prevention of soil erosion. Also plain calliopsis is an important Mid-Summer nectar source for many different butterflies as well as other nectarvores. A tea made from the root was used by Native Americans to treat diarrhea.

Notes

If your goal is to have a more serene and beautiful landscape then implementing these floral's into your system will work terrifically. If you were considering such an investment proper planting as well as management of these plants is highly recommended and should be monitored to maximize you benefits.

Additional Resources

Missouri Department of Conservation www.mdc.mo.gov

Red Clover (*Trifolium pratense* L.)

Description

Red clover (*Trifolium pratense* L) is a short-lived perennial and is the most widely grown of all the true clovers. The classification of red clover is sometimes confusing, but the red clovers grown in the United States may be grouped into two divisions -- early flowering and late flowering. This plant is native to the north Atlantic and central Europe, the Mediterranean region, Balkans, Asia Minor, Iran, India, Himalayas, Russia from Arctic south to east Siberia, Caucasus, and the Far East. It spread to England around 1650 and was carried to America by British colonists where it is currently widely distributed and cultivated.

Habitat

Red clover is native to wet and to dry meadows, open forests, forest margins, field borders, and paths. It grows best on well-drained loam soil, but also adapted to wetter soils. Most soils that produce good crops of corn, tobacco or small grains will also produce a good crop of red clover. Loams, silt loams, and even fairly heavy soils are better than light sandy or gravelly soils. Some of these soils may need lime or fertilizer, or both. Red clover is most productive on soil that is within a pH range of 6.6 to 7.6. It also needs P and K to produce good yields; the amount needed can be determined by soil tests. Red clover is reported to tolerate annual precipitation of 3.1 to 19.2 dm (mean = 8.6 dm), annual mean temperature of 4.9 to 20.3°C (mean = 10.6°C), and pH of 4.5 to 8.2 (mean = 6.3). Maximum yields are obtained at pH >6 with adequate calcium.

Management Considerations

For seed production, most growing areas require pollination with bees, using 5 to 8 strong colonies of bees per hectare. Best seed yields occur when there is an abundance of bees, and soil fertility and moisture are adequate to promote good growth, and when the weather is warm and clear during the flowering period.

Harvesting Considerations

Harvest the seed crop when the greatest numbers of seed heads are brown, usually 25–30 days after full bloom. Cut seed crop with mower. Let it cure in the swath or in small windrows. During rainy weather, the mowed crop cures better in swaths than in windrows.

Economic Uses

Red clover is extensively grown for pasturage, hay and green manure, and is considered excellent forage for livestock and poultry. Compared with alfalfa, red clover has about two-thirds as much digestible protein, slightly more total digestible nutrients, and slightly higher net energy value. Red-clover flowers are reported to possess antispasmodic, estrogenic, and expectorant properties.

Additional Resources

UMC Extension

<http://muextension.missouri.edu/explore/agguides/crops/g04638.htm>

General to applied information

http://www.hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html#Description

Red Maple (*Acer rubrum*)

Description

Red maple is also known as scarlet maple, swamp maple, soft maple, Carolina red maple, Drummond red maple, and water maple. Many foresters consider the tree inferior and undesirable because it is often poorly formed and defective, especially on poor sites. On good sites, however, it may grow fast with good form and quality for saw logs. Red maple is a subclimax species that can occupy overstory space but is usually replaced by other species. It is classed as shade tolerant and as a prolific sprouter. It has great ecological amplitude from sea level to about 900 m (3,000 ft) and grows over a wide range of microhabitat sites. It ranks high as a shade tree for landscapes. The flowers are small, with slender stalks, red or rarely yellowish, with petals; they appear from March to May depending upon elevation and latitude. Trees can flower and bear seed at an early age; 4-year-old trees have produced seed. Flowering occurs on all branches in the well-lit upper portion of the crown. Characteristically, the non-flowering branches are slow growing and lack vigor. The fruit, a double samara, ripens from April to June before leaf development is complete. After ripening, seeds are dispersed for a 1- to 2-week period during April through July.

Habitat

Red maple is one of the most abundant and widespread trees in eastern North America. It grows from southern Newfoundland, Nova Scotia, and southern Quebec to southern and southwestern Ontario, extreme southeastern Manitoba, and northern Minnesota; south to Wisconsin, Illinois, Missouri, eastern Oklahoma, and eastern Texas; and east to Florida. Red maple can probably thrive on a wider range of soil types, textures, moisture, pH, and elevation than any other forest species in North America. It develops best on moderately well-drained, moist sites at low to intermediate elevations.

Management Considerations

Red maple browse is toxic to cattle and horses, particularly during the summer and late fall. Red maple is relatively tolerant of landfill-contaminated gases, but ambient air pollution can damage the foliage. Red maple is often poorly regarded as a timber species due to its susceptibility to defects and disease, and poor form of individuals of sprout-clump origin. Red maple usually grows rapidly after heavy cutting or high-grading, and crop tree release may be a low-cost management option. Mechanical thinning of clumps can produce good-quality sawlogs on good sites.

Harvesting Considerations

Large enough quantities of low-value wood products, such as pulp wood, and biomass can be gained in a short amount of time. Sawlogs from soft maple are valuable enough to allow extended rotation periods for these products. Other harvest considerations include nursery stock, which would have a short rotation

time, about 3-5 years. The markets for nursery stock should be thoroughly checked before attempting to start growing.

Propagation

It is possible to stimulate red maple seed production through fertilization. The stimulation often lasts 2 years and may yield up to 10 times more seeds than an unfertilized stand. The seed does not require pre-germination treatment and can germinate immediately after ripening. Red maple has few germination requirements. The seed can germinate with very little light, given proper temperature and some moisture. Most seeds generally germinate in the early summer soon after dispersal. Shading by a dense overstory canopy can depress first-year germination; then second-year germination is common. Red maple stumps sprout vigorously. Inhibited, dormant buds are always present at the base of red maple stems. Within 2 to 6 weeks after the stem is cut, these inhibited buds begin to extend. Regeneration by seedling sprout may be especially successful. Generally, the species' great sprouting capacity makes it suitable for coppicing and accounts for its tendency to be found in sprout clumps. Red maple is difficult to propagate from cuttings and success varies considerably.

Economic Uses

Red maple is known in the lumber industry as soft maple. The wood is close grained and resembles sugar maple but is softer in texture, not as heavy, lacks the figure, and has somewhat poorer machining qualities. Red maple in the better grades is substituted for hard maple, particularly for furniture. Red maple lumber shrinkage from green to oven-dry moisture content is slightly more than shrinkage for hard maple. Red maple is widely used as a landscape tree. Low-value timber products and ornamental applications are the major products from Red Maple.

Agroforestry Uses

Red maple can be useful for riparian forest buffers, because of the adaptation of the species to moist sites. It is also useful in alley cropping, windbreaks, and forest farming. The adaptive capabilities of the species must be taken into account when planning an agroforestry application and used to the full benefit.

Additional Resources

<https://plants.usda.gov/core/profile?symbol=acru>

Redtop (*Agrostis alba*)

Description

Redtop is a long lived perennial grass that grows to a height of 3 feet. It produces 1/4" leaf blades of 4 to 24 inches in length. Redtop has a shallow root system and forms a loose, coarse turf. It grows both by seed and by a creeping habit that can grow as much as 3 feet in diameter. Redtop grows from Canada to the Gulf Coast and from the East to West coasts of the USA.

Habitat

It does best in moderately well-drained loamy soils; tolerant to high water table and periodic irrigation. It will grow on acidic soils, and is moderately salt tolerant. Open disturbed areas, such as roadsides, old fields, and pastures; wet meadows; riparian habitats; open woodlands.

Management Considerations

Redtop is the most widely adapted commercial grass species used. Redtop is an excellent wet-soil grass and can even remain alive for short period of time within flooded areas. It also is adaptable to dry soil conditions on both acid and alkaline soils. Used for pasture mixtures, mixed-hay production and for erosion control as a nurse crop in low input turf areas. It also is occasionally used for over-seeding as a winter lawn grass in the South East.

Harvesting Considerations

Redtop provides fair to good forage for big game in the spring and summer. The dense cover can provide cover for small mammals, waterfowl, and other birds. It is an important commercial forage species, providing good to very good forage for horses and cattle, fair to good for sheep. The species is often cultivated as hay because of its tolerance to mowing and grazing, good cold resistance, and heat tolerance. Grazing usually favors this species.

Propagation

Redtop grows from both seed and by creeping and one plant can cover as much as 3 feet in diameter.

Economic uses

Because it provides good forage for cattle and horses, farmers can look to this as an alternate to fescue. This species also provides needed cover for wildlife and will also have some palatability for deer and other big game. Redtop forms a dense sod which provides good surface erosion control, but because the roots are shallow, redtop provides limited protection to streambanks.

River birch (*Betula nigra*)

Description

River birch is a deciduous medium to large-sized native tree. The leaves are alternate, double serrated, wedge-shaped, and sharp pointed. The flowers are unisexual, borne in separate male and female catkins on the same tree. The bark is light brown to buff, paper-like; exfoliating on young trees, turning to scaly bark on older trees.

Habitat

River birches are generally seen along side stream banks, wet floodplains, and in forests. River birch requires an acid soil pH 6.7 or less. Since it can tolerate wet conditions as well as full sunlight it can grow rather quick eventually reaching heights ranging between 40 to 70 feet tall with large canopies. River birch can successfully be grown from New York to the southern U.S to the Midwestern states.

Management Considerations

River birch can survive on drier soils, although it is best adapted to moist soils that are periodically flooded. Maximum development is reached in fertile areas with a pH of 6.5 to 4.0. It is intolerant of shade and requires full sunlight. Fertilize young trees in late winter before new growth begins to ensure faster growth. Don't prune this birch and other birches until summer because they are "bleeders" and should not be cut when the sap is flowing. River birch is quite disease resistant but has severe problems in early spring with aphids and is favored by gypsy moth larvae.

The principal leaf disease of river birch is anthracnose leaf blight caused by *Gloeosporium betularum*. Minor problems may exist with leaf miner and iron chlorosis which commonly occurs when grown on calcareous soils and other high pH soils. River birch has no serious insect pests and is considered borer resistant. The tree is not very vulnerable to deer browsing

Propagation

Seed ripens and sheds in the spring and should be directly sown. A seeding density of 25 to 44 per square foot is desirable, lightly covered or without covering if seedbed is kept moist. Stratification of birch seed is usually counter-productive. Seedlings have moderate growth rate and are usually outplanted as 2 year old bareroot stock. Given effective grass and weed control, river birch is easy to establish

Economic Uses

River birch sap can be fermented to make birch beer or vinegar. The wood is used to manufacture inexpensive furniture, woodenware, wooden shoes, basket materials, toys, staves, and fuel. The leaves were chewed, or used as an infusion

in the treatment of dysentery. An infusion of the bark was used to treat stomach problems and other medical uses.

Agroforestry Uses

River birch is a very attractive ornamental tree. It is a desirable specimen for estates, golf courses, parks, and public grounds. Many species of birds eat the seeds including wild turkey and grouse. The leaves are browsed by white-tailed deer. River birch is used for strip mine reclamation and erosion control. It is used in forested riparian buffers to help reduce stream bank erosion, protect water quality, and enhance aquatic environments.

Additional Resources

Virginia cooperative extension program

https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/HORT/HORT-23/HORT-23_pdf.pdf

USDA silvics manual volume 2

https://www.srs.fs.usda.gov/pubs/misc/ag_654/volume_2/betula/nigra.htm

United State Department of Agriculture Natural Resources Conservation Service Plants Database

<https://plants.usda.gov/core/profile?symbol=BENI>

Sassafras (*Sassafras albidum*)

Description

Small to medium sized deciduous tree, but can grow to be 6 feet in diameter and 100 feet tall. Saplings have smooth orange-brown bark, while mature trees become deeply furrowed and reddish-brown in color. Leaves are polymorphic with three different forms of leaves: (1) Somewhat elliptical and unlobed (typical of older trees), (2) Right or left handed mitten shaped, & (3) symmetrically three lobed (Rarely 4-5 lobed). When leaves are crushed they have a distinct smell of fruit loops cereal. Small fragrant yellow-green flowers born on separate plants (dioecious) open in early spring before leaved emerge. Fruits are blue drupes on a thick reddish pedicel. In autumn the leaves turn vibrant shades of orange, red, and yellow. All parts of the tree are spicy and aromatic.

Habitat

Sassafras native range in the United States extends from southwest Maine to Iowa and southeast Kansas, southward to Texas and central Florida. Sassafras can be found on virtually all soil types like clay loams, poor gravelly soils, and pure shifting sand, but grows best in open woods on moist well-drained, sandy loam soils. It is a pioneer species on abandoned fields, along fence rows, and on dry ridges and upper slopes. Sassafras is commonly associated with tree species such as sweetgum, flowering dogwood, elms, eastern red cedar, hickories, and American beech. In fields with deeper soils it grows with elms, ashes, sugar maple, yellow poplar, and oaks. Minor noteworthy trees associated with sassafras are American and eastern hophornbeam, and pawpaw. In the Appalachian Mountains, it is associated with black locust, red maple, sourwood, and several oak species. On the northern edge of its range, it makes up part of the understory of aspen and northern pin oak.

Management Considerations

Sassafras is classified as intolerant of shade at all ages. In forest stands, it usually appears as individual trees or in small groups and in best site conditions is in the dominant overstory. In the understory it may live along the edges of heavy stands, but generally does not reach merchantable size. In mixed stands if it becomes overtopped, it is one of the first species to die. Sassafras is also very susceptible to foliage diseases and fire damage. On a plus side the growing plant repels mosquitoes and other insects, so it is a beneficial companion plant in the garden.

Harvesting Considerations

Sassafras should be harvested for the roots. The soil may be cleared away from a portion of the roots and the root-bark peeled away. The inner bark should not be damaged, so that the roots can grow new bark. Another method is to harvest the entire root, as the pith of the root, although weaker, has the same properties as the bark. With any method the tree should be given time to recover and grow new roots before harvesting again.

Propagation

Propagation is fairly simple from seed. If you can obtain it, fresh seed will give the best results and this should be sown immediately in a cold frame. It should germinate in the spring. If you can only obtain stored seed then this will need four months cold stratification at 4°C. Soaking the seed for 24 hours in warm water and then mixing it with some damp compost and placing it in the salad compartment of the fridge for 3 - 4 months should suffice. As soon as they are large enough to handle, prick out the seedlings into individual pots and grow them on in the greenhouse for at least their first winter before planting them out. Give the young trees some protection for at least their first winter outdoors.

Economic Uses

The whole plant is saturated with an aromatic essential oil and it is still commonly used as a food flavoring with considerable health benefits. The dried root bark can be boiled with sugar and water until it forms a thick paste used as a condiment. The root and the berries can also be used as flavorings. A tea is made from the root bark, and is considered to be a tonic. Teas are made from various other parts of the tree. In spring the leaves and roots are used together and in early summer the flowers are used. Sassafras oil used to be used as the basis of root beer, now synthetic flavoring is used.

Notes

Native Americans within range of *Sassafras albidum* used it extensively for many purposes. Infusions were used to kill parasitic worms, to treat syphilis, colds and measles, to reduce fever, control diarrhea, and relieve constipation. The Cherokee, Choctaw and Chippewa made tea from the bark and roots and used the dried leaves as a spice to flavor foods. Early European settlers quickly adopted sassafras tea. Research in the 1960's showed that safrole, a principle constituent of oil of sassafras, caused abortion in pregnant women and liver cancer in mice.

Additional Resources

Plants for a Future, Plant Portrait – *Sassafrass albidum*
<https://pfaf.org/user/plant.aspx?LatinName=Sassafras+albidum>

Floridata Marketplace, http://www.floridata.com/ref/s/sass_alb.cfm

Scarlet Curls Willow (*Salix matsudana* 'Scarcuzam' or 'Scarlet Curls')

Description

Reaching 25 to 30 feet height, this willow species will also measure 15 feet or more across from one side of its crown to the opposite side. Similar to a weeping willow, the golden branches will begin to droop but they also have a cork screw effect. The new twigs are a bright red and after the first frost of the season, fall or spring, the red twigs turn into a dark scarlet red that is very flashy and stands out from the rest of the tree. Scarlet curls is a fast growing species that is well suited to wet or moist areas.

Habitat

Similar to other members of the willow family, scarlet curls prefers environments that are moist and receive full sun. The ideal area for this species is in riparian areas or close to some source of water such as a backyard pond. This species is native to China and is not able to handle extreme cold temperatures or winter conditions such as ice storms or heavy, wet snow.

Management Considerations

A word of caution, never plant scarlet curls near any buried pipes or wires. The roots have a tendency to choke underlying obstacles, including other floral species. Keep a close eye on the conditions of the other plants that are close to the scarlet curls and perform regular root pruning. In an agroforestry setting, the best place to establish scarlet curls is in a riparian buffer area since the species is adaptive to wet growing conditions. Planting scarlet curls in windbreak and alleycropping management systems is also a wise management decision. In terms of soil conditions, scarlet curls can adapt to any soil texture but has problems with alkaline soils and extensive periods of drought. The branches are very susceptible to ice and extremely cold temperatures.

Harvesting Considerations

Primarily used as a decorative woody floral, the best way to harvest this product is by using a sickle saw or going in by hand and cutting each limb/twig individually. Scarlet curls are a very sensitive specimen and if a severe amount of damage occurs around the base the tree, the plant will die. When harvesting, make sure that all parties involved do not trample or compact the soil near the base of the tree because this may cause the roots to not be able to function correctly and cause stress on the tree.

Propagation

Never rely on a seed source as a form of propagation. Instead, use rooted cuttings that already have an established taproot. This species is also easily transplanted from site to site and can easily be grown to be used as a transplant tree that can be sold to landscapers and nurseries.

Economic Uses

The most popular economic use for scarlet curls is as a woody floral that can be added to any bouquet of flowers. Since the leaves are not present when the stems are harvested, to many people, the stem simply looks like a decorated piece of wire that has been added to the arrangement to add color.

Notes

This species is not native to North America so it is not resistant to some native cankers and insect interactions. If you do decide to use this in your agroforestry management plan, keep a close eye on the specimens during the first 3 years they are planted.

Additional Resources

Stadler Nursery and Garden Center.

<http://www.stadlergardencenters.com/trees/trees.php?tid=1051>

University of Nebraska-Lincoln Extension Forestry.

<https://nfs.unl.edu/documents/SpecialtyForest/growersguideweb2007.pdf>

Scarlet Oak (*Quercus coccinea*)

Description

A member of the Beech family, scarlet oak is a deciduous tree growing 50 to 80 feet tall and 1 to 3 feet in diameter. It has deeply lobed, glossy bright green leaves with bristly tips. The 5 to 6 inch long leaves are alternate and simple and turn a brilliant scarlet color in the autumn. The fruit is an acorn that measures up to 1 inch in diameter which takes two years to mature. This species can be readily distinguished from other oak species by the presence of a distinctive set of 2-3 concentric rings at the base of the acorn. The thin bark is moderately ridged and shallowly furrowed, with a dark gray to black color. The upper canopy is spreading and opens at maturity.

Habitat

Scarlet oak has an extensive native range, stretching from southwestern Maine to southeastern Oklahoma. It can also be found in most counties in southeastern Missouri. Scarlet oak inhabits drier, upland ridge soils that are normally acidic. Because of its superior drought tolerance and hardiness it can be found on a variety of soils, especially dry ridges, bluffs, and hills.

Management Considerations

Scarlet oak is commonly planted in Europe and the United States as a shade tree. It thrives in full sun to partial sun and is shade tolerant when young. It grows well on poor, dry, sandy, or gravelly soils. It also likes moist, well-drained soils, but does not tolerate alkaline soils and does not do well in neutral soils. Chlorosis and stunted growth are consequences of being planted on soils that are neutral or alkaline.

The tap root system of the scarlet oak is quite coarse, which makes it very difficult to transplant successfully. Major risks to growing scarlet oak include its susceptibility to a number of defoliating insects and diseases, including Gypsy moth. The loss of scarlet oak acorns due to insect and disease predation, especially in poor seed years, is an ongoing problem in Missouri.

Harvesting Considerations

Scarlet oak wood is of inferior grade and commonly labeled with other red oaks as red oak lumber used for products such as pallets and flooring materials. Acorns are an important food source for numerous wildlife species, such as squirrels, chipmunks, mice, wild turkeys, white-tailed deer, blue jays, and woodpeckers. These trees are good for cavity-nesting species and are recommended for such use over hickories and white oak because of its high number of cavities.

Propagation

Scarlet oak acorns can quickly lose viability if allowed to dry out. Timely collection of sound acorns that are free from their caps is of paramount importance. Newly collected seeds should be soaked in water overnight to insure their soundness. Defective acorns will float and can be discarded. Floated seeds can be stored in plastic bags in the refrigerator and sown in the very early spring, or can be directly sown following collection. If sown outside seeds should be protected from mice, squirrels, and other rodents. The seedling tree produces a deep taproot and needs to be planted out into their permanent positions as soon as possible. If started in a nursery bed they should not be left there for more than two growing seasons.

Economic Uses

Edible uses- the seed can be cooked or dried, and ground into a powder and used as a thickening in soups and stews. The powder can also be put into the ingredients for making bread. The seeds contain bitter tannins, which can be leached out by washing the seed in running water. Washing whole seeds can take several days and an easier way would be to leach the powder instead.

Other uses-the mulch of the leaves repels slugs, grubs and many other bugs that are harmful to garden plants. The wood is used in construction and in the making of some furniture.

Serviceberry (*Amelanchier arborea*)

Description

Shadblow serviceberry belongs to the family Rosaceae. Serviceberry is a native shrub or small tree that grows to 10 meters tall, with a narrow, rounded crown. The twigs are often red-brown to purplish, becoming gray. The bark is smooth, grayish, "striped" with vertical fissures and very ornamental. Leaves of the serviceberry are deciduous, alternate, simple, oval to oblong, 5-13 cm long, glabrous above, pubescent and paler beneath. The white flowers are 3-15 in elongate clusters at the branch tips, before the leaves appear. The fruit is 6-12 mm wide, on long stalks, red-purple at maturity; seed 5-10 per fruit.

Habitat

Serviceberry is typically found in the upper regions of North America where it is found throughout areas that are considered as temperate forests and has higher elevations that are associated with them. Serviceberry grows in a variety of habitats – swampy lowlands, dry woods, sandy bluffs, rocky ridges, forest edges, and open woodlands and fields. It is a late successional to climax species in mixed-hardwood forests of the central U.S., commonly as an understory species. In the southern Appalachians, downy serviceberry grows in red spruce-Fraser fir forests at elevations of 1500-2000 meters with yellow birch, mountain ash, elderberry, and hobblebush. Flowering (March-)April-May, among the first of the early spring trees and shrubs to bloom; fruiting June-August.

Management Considerations

Maintenance for this species is rather low; however, one of the most significant problems that is associated with this species is the fact that the roots produce suckers which left unchecked can cause you more problems than benefits. Therefore, it is recommended that proper pruning and or wiring of these trees/shrubs takes place to prevent future problems. Fire top-kills downy serviceberry, but it can sprout from root crowns and stumps following fire. Gypsy moth larvae (*Lymantria dispar*) feed selectively on downy serviceberry.

Propagation

Propagation from seed is highly desirable and can be done successfully if you follow the directions that are given. Principal consideration for planting and establishing is to plant this species in full sun or, if desired, it can be planted in areas that are partially shaded. The overall height of the tree should also be kept in mind. This tree/shrubs species can reach as tall as 15 to 20 feet. Typically speaking these trees will bloom in between April-May time frame producing a white flower.

Economic Uses

Trees of downy serviceberry are generally not large enough for sawtimber but they have been used for pulpwood. The wood is extremely heavy and hard and is occasionally made into tool handles. Cree Indians prized it for making arrows.

At least 40 bird species (for example, mockingbirds, cardinals, cedar waxwings, towhees, Baltimore orioles) eat the fruit of *Amelanchier* species. Mammals that either eat the fruit or browse the twigs and leaves of downy serviceberry include squirrels, rabbits, chipmunks, mice, voles, foxes, black bears, deer, and elk. The fruits taste similar to blueberry – they are eaten fresh or cooked in pastries or puddings.

Additional Resources

United State Department of Agriculture Natural Resources Conservation Service Plants Database, <https://plants.usda.gov/core/profile?symbol=amar3>

Shellbark Hickory (*Carya laciniosa*)

Description

The shellbark hickory is a slow growing long-lived tree that is sometimes hard to transplant because of its long taproot. It produces sweet, edible nut that is the largest of all the hickories. However, heavy crops are usually not seen until trees are around 40 years old and best crops are between 75-200 years. Good crops are usually every other year and can produce 2-3 bu of nuts per tree in a year.

Habitat

Shellbark hickory is widely distributed but not common. It grows best on deep, fertile, moist soils and generally on neutral or slightly alkaline soils. Mean length of growing season within its range is from 150-210 days. Precipitation varies between 30-59 inches per year including 3-35 inches of snowfall. Land that is subject to shallow flooding for a few weeks early in the growing season is favorable for shellbark.

Management Considerations

Shellbark hickory grows best on deep, fertile, moist soils, most typical of alfisols; but also grows well on heavy loams or silt loams. It is essentially a bottomland species and land that is apt to flood in early spring is favorable for growing shellbark. Good bottomland farm ground that is suitable for beans and corn is perfect for shellbark. Because of its deep taproot, it can be favorable in many agroforestry practices. Alley cropping and Silvopasture can implement the planting of shellbark because its deep root system does not interfere or compete with the companion crop or forage. Additionally, nut production can be enhanced by grafting, which should then cause trees to bear nuts sooner.

Shellbark hickory grows slowly in diameter, as do all hickories. When open grown, it can have a problem with epicormic branching but can produce a clear bole with careful pruning.

Harvesting Considerations

Because of its slow growth, saw logs would not be produced for about 40 years. But at this point, a harvestable nut crop could be obtained. On good sites, saw logs may be produced earlier and nut crop production can be improved.

Propagation

Shellbark hickory is most generally propagated from seed, but it readily sprouts with cut and coppice management has been recommended for this practice of regeneration. Otherwise, many nurseries produce shellbark hickory seedlings that may be purchased and out planted in the spring. However, good weed control is essential for enhanced early growth and survival, and do not plant if you suspect that flooding is likely to yet occur on a site.

Economic Uses

Most economic opportunities center on the wood or nut production. Because its wood is hard, heavy, strong and flexible, hickories are a favored wood for making tool handles. The nuts of the shellbark are the largest of all the hickories and are sweet and edible. Wildlife and people harvest most of the nuts.

Notes

Shellbark has the fastest height growth of all the hickories. This may cause some problems with alley cropping and what can be grown as a companion crop. But this could also be an opportunity to switch to a silvopasture practice and create a microclimate favorable for some forage production.

Additional Resources

https://plants.usda.gov/core/profile?symbol=CALA21&photoID=hila7_001_avd.tif

<http://dendro.cnre.vt.edu/dendrology/USDAFSSilvics/450.pdf>

Skullcap (*Scutellaria lateriflora*)

Description

Skullcap is a member of the mint family. It is an herbaceous perennial with a four angled, smooth stem with many branches, attaining a height of between 30-cm to 160-cm when mature. Skullcap has small hairless leaves that are about two to five centimeters long by one to one and a half centimeters wide, ovate, with a rounded base, an acute tip, and the leaf margin acutely serrated. The flowers are on only one side. They are pale blue, blossoming in summer, comprised of a fused upper and lower sepal. The upper sepal has a raised appendage that looks like a helmet or hood. The flower has four small nutlets.

Habitat

Skullcap can be found from July to August on shores, stream banks, springs, meadows, swampy places, and moist woods. It is very common in the eastern and central United States. It can be found from Newfoundland to British Columbia, south to Florida and Ontario.

Management and Harvest Considerations

To grow to its full potential, skullcap requires areas of constant moisture, such as moist thickets or marshlands. It prefers a fertile soil, is hardy to zone four, and grows well in full sun or partial shade. When growing in a hot, dry area, shade and moisture must be provided. Once harvesting begins, fertilize with a high nitrogen compost. Once flowering begins the plant is cut with shears or a mower. A light cutting the first year is possible, followed by two cuttings each consecutive year. When harvesting skullcap, keep the freshly cut herb in the shade until harvesting is complete or take immediately to the drying area. Do not allow the plant material to heat up. Skullcap will grow in very select areas throughout eastern and central North America. There are natural areas in these regions that are suitable for cultivating high-quality skullcap. This crop may be a viable alternative for some growers who have land less suited for other crops.

Propagation

Skullcap can be grown through direct seeding, transplanting, or dividing the roots. The preferred method is to start seeds indoors. Skullcap seed requires a cold stratification period and light to germinate. Sow seeds shallowly in flats with a prepared soil mix. The seeds should be moistened and refrigerated at about 40 to 50 degrees F. for one week or they can also be placed outside where the seeds will be exposed to nighttime cold temperatures. After the stratification period, put flats in the greenhouse for germination. Seeds should be started six to eight weeks before setting out in the field. In late spring, transplant outside in well-prepared soil. Space plants eight to twelve inches apart in rows one and one-half to three feet apart or in three-foot wide beds. The plants will spread quickly when established. It is very important that the planted area should be kept weeded.

Economic uses

Skullcap is a very important medicinal plant. Buyers can be found worldwide for this botanical. Both wild harvested and cultivated material is sold for the medicinal trade. Small producers use established brokers to bring buyers and sellers together. Some customers will deal directly with growers and harvesters, but most have specific harvest protocols. Many buyers require that the material be harvested at a certain time of the year or during a particular stage of bloom.

Notes

The Cherokee Indians used skullcap as part of a concoction given to women to promote menstruation. It was also used for diarrhea and breast pain. In the early 18th century in America, Skullcap was used in the treatment of rabies and was given the nickname “Mad Dog”, though it is unclear as to its success for treating rabies.

Additional Resources

Alternative Nature Online Herbal, medicinal herbs descriptions, uses and pictures, <http://altnature.com/gallery/skullcap.htm>

Smooth Sumac (*Rhus glabra*)

Description

The smooth sumac is more frequently found as a shrub 2 to 12 feet high, with smooth, brownish-gray trunk and branches. Its leaves are very long from 1 to 3 feet, and consist of from 11 to 31 leaflets, each leaflet being about 2 to 4 inches in length and about half as wide, lance-shaped, pointed, sharply toothed and whitened beneath. From June to August the plant bears greenish yellow flowers in dense clusters at the ends of the branches. These are followed by roundish, flattened fruits or berries, covered with short, crimson hairs.

Habitat

Smooth sumac occurs in dry soil thickets and waste grounds from Nova Scotia to British Columbia and south to Florida, Mississippi, and Arizona. Smooth sumac is moderately drought tolerant. Available water determines mature plant height.

Management Considerations

Smooth sumac is often used in naturalizing urban areas and for providing fast cover for bank stabilization. It lends a tropical effect in landscape because of its reddish fall color. It is also good for windbreaks and riparian plantings and is excellent for wildlife cover.

Harvesting Considerations

Smooth Sumac can have uses other than stabilization. Its leaves and roots are used in dyeing and tanning leather. The drupes are eaten fresh or processed into a lemonade drink. Its extracts are used as a tonic, astringent, and antiseptic. The drupes are also used as refrigerant and diuretic, and root bark as a tea to stop hemorrhaging.

Propagation

When planted, smooth sumac takes root quickly and develops a suckering habit. This helps with total use of the area to this unique plant. But it does shade out anything that is to grow beneath it.

Economic Uses

Because of its unique properties as an herbal medicine, possible markets may be found in areas that are to use them as such. It also is a cheap cover plant for erosion control and bank stabilization for riparian areas.

St. John's Wort (*Hypericum perforatum*)

Description

St. John's wort is a perennial non-native herbaceous plant 1-5 ft tall. Leaves are oppositely arranged no more than 1 inch long and elliptically shaped. Tiny characteristic glands are present on the leaves. Branches are rust colored and woody at the base. Flowers are bright yellow with five petals.

Habitat

St. John's wort likes well-drained sandy or gravelly soils and open areas, like rangelands, with plenty of sun exposure.

Management Considerations

This plant has the tendency to kick native plants out of their natural range, a typical characteristic of non native species.

St. John's wort can be implemented as a specialty crop in a forest farming system, silvopasture, or in an alley cropping configuration. St. John's Wort is unappetizing to wildlife and livestock because it has a traumatic effect on their immune system. Wildlife and livestock may suffer severe blistering and itching on light colored areas, and may lose weight or even die of dehydration. St. John's wort crops have a good chance of high yields if the animals desired forage is present.

Harvesting Considerations

St. John's wort can be harvested for leaves and flowers. Flowers of St. John's wort can be harvested when in full bloom. Leaves can be harvested when needed.

Propagation

St. John's wort can be propagated by seed and cuttings. Plants can develop seed with or without pollination. Seed and capsules disperse with wind and water and adhere to machines, tires, shoes, clothing, animal feathers and fur. Seeds have thick coats, and if consumed by animals they remain undamaged and usable. Germination occurs fall through spring. Brief contact with fire can increase germination. In soil, some seed can remain viable for up to 10 years. Seeds soaked in water can remain usable for at least 5 years.

Economic Uses

St. John's wort has not been proven yet as an anti-depressive plant. Homeopathic medicine and tinctures are made from the flowers and leaves. St. John's wort is highly consumed in Europe and is coming into fashion here in the United States. Future studies of St. John's wort may progress the plant to a higher economic status.

Notes

St. John's wort is also known as common goatweed or klamath weed. The native range for St. John's Wort was in Asia, Europe, and North Africa. It was introduced to North America in 1696 for its medicinal and ornamental properties. In 1893 it was recorded on grazing land in the west and is now growing in most of the greater 48 United States. In Montana alone, St. John's wort covers less than half a million acres.

Sugar Maple (*Acer saccharum* Marshall.)

Description

Sugar maple grows 75 to 100 feet tall and 2 to 4 feet in diameter. Trees grown in crowded woods have a long, branchless trunk with narrow crowns. Trees grown in the open have trunks that branch near the ground, forming crowns that spread 60 to 80 feet. The bark on young trees is dark gray, but as the tree ages the bark develops rough vertical grooves and ridges and may appear dark brown. The leaves are opposite of each other and are 3 to 6 inches long with 5 rounded lobes. The clusters of small flowers are light yellow-green, hanging from a long, slender (1-3 inches) stem appearing with the leaves in the fall. The sugar maples seldom flower until they are at least 22 years old. The fruit is horseshoe shaped and matures in the fall. The sugar maple is the largest and most abundant American maple.

Habitat

Sugar maple in North America extends from Nova Scotia and Quebec at its northern edge, west to Ontario, southeastern Manitoba, and western Minnesota, south to southern Missouri, and east to Tennessee, and northern Georgia. It grows best in areas with cool, moist climates. Sugar maple can survive in a wide variety of soil types. It grows on sands, sandy loams, loam's, and silt loam. It grows on soils ranging from strongly acidic to slightly alkaline. Sugar maple is often associated with beaked hazel, redberry elder, American elder, red raspberry, blackberries, spring beauty, and jack-in-the pulpit.

Management Considerations

Sugar maple is rated as very tolerant of shade, exceeded among hardwoods only by a few smaller species. Even-age and uneven-age silvicultural systems are available for managing stands in which sugar maple is a principal component and desired species.

A sugar maple stand managed for the production of maple sap requires a different type of stand than that desired for timber production. For the production of maple sap the following characteristics should be considered; leaves exposed to direct sunlight, large stem diameters, and wide, deepcrowns. Therefore, in a closed stand heavy thinning is recommended.

A good sawtimber stand of sugar maple has trees with tall, straight stems and no branching below the growing crown. In dense stands of sugar maple the inferior trees need to be removed with out promoting open grown characteristics in the remaining trees.

Harvesting

The sugar maple is an economical importance both in the production of maple syrup and as a timber species. Natural regeneration through seed establishment and prolific sprouting is generally successful in replenishing the amount of growing stock in a stand even after heavy cutting. The harvesting season for the syrup can last anywhere from four to six weeks. Maple trees should be approximately 12 inches in diameter before they can be tapped. The sugar content of the sap is higher in late winter than late fall, so it is recommended to be harvested in February and early March. It is harvested in late winter because of the rising temperatures that creates pressure within the trees, which causes the sap to run.

Propagation

Sugar maple is propagated from seeds. The seeds have an extremely high germination rate, with averages of 95% or more. For germination to occur the temperature must be slightly above the freezing point and not any warmer than 50 degrees. The seed develops a very strong radicle that has the strength and length to penetrate heavy leaf litter. The seeds can be harvested green and sown immediately. When large enough to handle they need to be planted into individual pots and then transplanted into their permanent positions when reaching 20cm or more tall.

Economic Uses

Sugar maple is used in the production of maple syrup and timber. The wood is one of the hardest of the maples and is highly valued for the making of furniture and flooring. Bowling alleys and bowling pins are commonly manufactured from sugar maple. The sugar maple is a favorite street and garden tree, because it is easy to propagate and transplant.

Notes

The sap is mostly water (97% on average) and contains a small amount of natural sugar. The sap is collected and boiled to evaporate much of the water, concentrate the sugar content, and to produce the characteristic maple flavor and color.

Swamp White Oak (*Quercus bicolor*)

Description

A member of the Beech family, swamp white oak is a long-lived, fast growing species that can reach up to 70 feet in height and 2 to 3 feet in diameter. Its native range extends from Quebec into eastern Kansas, and can be found growing throughout most of the northern half of Missouri. 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

Swamp white oak can be commonly found growing with other species such as red maple and pin oak on more acidic soils that are very poorly drained. It is known to be tolerant of flooding even when young. It will also grow well on many soil types once established including upland sites and can be found in association with bur oak on such sites. Swamp white oak can be transplanted rather easily, and is relatively fast-growing especially when young. Maximum growth rate will be achieved when it is planted in full sunlight.

Management Considerations

Swamp white oak is intermediate in tolerance and seedlings can become established under moderate shade. As the tree matures, it will develop a high quality, straight bole with a narrow crown if grown in a forested condition. In contrast, open grown trees will normally produce a short bole with a broad, spreading crown. Lower branches tend to be persistent and will require pruning to improve stem quality.

Major risks to managing swamp white oak include its susceptibility to a number of defoliating insects and diseases, including Gypsy moth, oak anthracnose, and occasionally oak wilt. The loss of swamp white oak acorns due to insect and disease predation, especially in poor seed years, is an ongoing problem in the Missouri.

Swamp white oak can also be used in landscape plantings, especially in urban areas where it can be tolerant of both poor soil conditions as well as air pollution. It produces a large crop of acorns every 3-5 years, and this seed production is normally initiated at a fairly young age in comparison to other native oaks in Missouri. Therefore, this species is an excellent food base for whitetail deer, wild turkeys, woodpeckers, sapsuckers, wood ducks, squirrels and other small rodents.

Harvesting Considerations

Swamp white oak is similar to other oak species in terms of its growth and development. In general, white oaks reach economic maturity when they are about 16 to 22 inches in diameter at breast height depending on the quality of the

site. It will take 60 to 90 years to produce such trees on good sites and 90 to 120 years on poor sites.

Propagation

Swamp white oak is easily planted and transplanted. It is normally propagated by seed. Like other oaks, swamp white oak acorns can quickly lose viability if allowed to dry out. Timely collection of sound acorns that are free from their caps is of paramount importance. Newly collected seeds should be soaked in water overnight to insure their soundness. Defective acorns will float and can be discarded. Floated seeds can be stored in plastic bags in the refrigerator and sown in the very early spring, or can be directly sown following collection. If sown outside seeds should be protected from mice, squirrels, and other rodents. The seedling tree produces a fairly fibrous root system, which allows for improved transplanting success rates. If started in a nursery bed they should not be left there for more than two growing seasons.

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 products would include fuel wood and fence posts.

White Oak (*Quercus alba*)

Description

Tall deciduous tree can grow 80 to 120 ft tall with a straight trunk and rounded crown. Its native range extends from southern Maine to east Texas. Some individual trees may exhibit fine fall colors of yellow, red, or purplish brown. Acorns ripen in autumn (September to October) of the first year and occur solitary or in pairs and do not require cold treatment before germination in late autumn.

Habitat

White oak occurs throughout Missouri over an array of sites from dry ridges to ravine bottoms. While it is found on many types of soils, white oak exhibits its best growth is on higher bottomlands where soils are deep and moist, with good internal drainage. It will commonly be found with hickories, other oaks, basswood, white ash, and black cherry. It is also known for forming even-aged stands after clear-cutting.

Management Considerations

In agroforestry applications, white oak can be used in alley cropping, silvopasture, windbreaks, and forest farming. With white oak's broad spreading crown, pruning or thinning of the stand will be necessary to sustain the light requirements of the ground vegetation in alley cropping, silvopasture, and forest farming applications. Growers need to be aware of its tendency to sprout from the trunk when it is opened up to light after a pruning or thinning. Sprouts are a defect in the timber quality. White oak has an intermediate shade-tolerance becoming less tolerant with age, having best growth in full sun. Blue jay, woodpeckers, wood duck, wild turkey, ruffed grouse, bobwhite quail, mice, squirrels, raccoons, and white-tailed deer eat the acorns.

Major risks to managing white oak include its susceptibility to a number of defoliating insects and diseases, including Gypsy moth, to which it is especially susceptible. Other pest problems include oak anthracnose, and rarely, oak wilt. The loss of white oak acorns due to insect and disease predation, especially in poor seed years, is an ongoing problem in the Missouri.

White oak is a relatively slow growing in comparison to other Missouri white oak species such as bur oak and swamp white oak. Good site selection will expedite the time to harvest of this long-lived tree. The terminal buds may need to be protected from livestock a year or two longer than faster growing species. Wind damage is rarely a concern, as white oak is known for strength from its deep roots to its strong limbs.

Harvesting Considerations

White oaks reach economic maturity when they are about 16 to 22 inches in diameter at breast height depending on the quality of the site. It will take 60 to 90

years to produce such trees on good sites and 90 to 120 years on poor sites. Allowing white oak to reach 19 inches or greater can create a sizable jump in price due to the ability of the mill to saw it differently or veneer the wood.

If white oak is desired to replace harvested or dead oaks in forest farms or windbreaks then large enough openings (greater than ¼ acre) must be created with adequate light to fulfill the relatively shade-intolerant white oak seedlings/sprouts. White oak, unless very old, will sprout from the stump after harvest. Replacement may be as simple as choosing which stump sprout to leave. Seeds in the forest seedbed should not be relied upon to regenerate oak, due to shading and moisture limitations that can dramatically impact seed regeneration success rates of this species.

Propagation

White oak trees are normally propagated by seed. Like other oaks, white oak acorns can quickly lose viability if allowed to dry out, especially since the acorns will readily germinate immediately after seed fall. Therefore, timely collection of sound acorns that can easily be removed from their caps is of paramount importance. Newly collected seeds should be soaked in water overnight to insure their soundness. Defective acorns will float and can be discarded. Floated seeds can be temporarily stored in plastic bags in the refrigerator prior to sowing. While root elongation rates will be somewhat retarded if the seeds are placed in the refrigerator, this root development cannot be arrested until spring. As a result, the acorns must be sown immediately and protected from mice, squirrels, and other rodents. Most seedling trees will produce a moderately fibrous root system, which allows for improved transplanting success rates. If started in a nursery bed they should be grown as a two year old seedling prior to outplanting.

Economic Uses

White oak is a very valuable timber species. Its wood is second only to black walnut in value. It is used for interior furnishings, veneer, cabinets, flooring, general construction, pallets, fence posts, railroad ties, fuel, and tight cooperage. Numerous overseas markets have a high demand for white oak. Some of the most important white oak exports from the Midwestern U.S. are used for high quality veneer and staves for wine barrel manufacturing.

Wild Plum/American Plum (*Prunus americana*)

Description

Grown as a shrub, wild plum has alternate leaves that are 2 – 4” in length. The full height can vary from 3 feet in the form of a shrub to over 20 feet 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, fascicles of white flowers in groups of 2-5 are found at the end of spine like branches.

In the fall, red drupes form at the end of the spines. the size of the drupes can range from .5 cm to 2 cm in length and have a circumference of .5 to 1 cm. 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

Wildly distributed across America, the natural range of wild plum stretches from Maine all the way out to Arizona and has a wide range of habitats from dry sites to marsh areas. Even though this species can live in a range of habitats, it seems to do the best in areas that receive adequate amounts of rain during the early to late spring and possess soils that are well drained. With these well drained soils, wild plum can thrive in all three soil types (clay, silt, and sand).

In respect to what aspect the species should be planted on, the wild plum can thrive on all four aspects and can thrive on any part of a slope ranging from the shoulder all the way to the foot of a hill. Temperature wise, the wild plum can handle severe summer droughts and mid-winter blizzards. Even though the species can take a beating from Mother Nature, it will not handle repeated years of such abuse.

Management Considerations

Wild plums are the “mustangs” of the Prunus family. they are able to care for themselves and do not require constant attention from the landowners. With this said, wild plum would make a great addition to areas that are isolated from the rest of the homestead or are remote and hard to access via roads or trails. This species is also ideal for landowners who do not have enough time to devote to watering, weeding, or pruning the trees on their land.

In agroforestry settings, wild plum can be used in windbreaks, alleycropping, and riparian buffers. In a silvopasture setting, wild plum may be used, but be warned that the seeds can be toxic to livestock when consumed in large numbers. Also in consideration with silvopasture, the wild plum use to be used as a hedge between property boundaries due to the thick spines that are found on the branches.

For hunters, wild plums can act as shelterwood for many species of game during all four seasons. Along with providing shelter, the fleshy fruit and seeds can act as a food plot that would attract game to an area, especially during hunting seasons.

Harvesting Consideration

Due to the lack of height obtained at full growth, wild plum is not a timber tree. With this said, the small amount of wood that is produced from a grown tree can be sold in the niche market of wood carvers and other individuals who enjoy carving trinkets out of wood. However, with the beautiful flowers that are produced in early spring, these limbs may be harvested and sold to a local florist and be used in arrangements of flowers. The only drawback would be the spines and the danger of someone hurting themselves while harvesting the limbs or moving the floral arrangement around.

Propagation

A very aggressive sucker sprouter, wild plum is also a good species that propagates rather easily through grafting. Along with grafting, transplanting seedlings and saplings is very common and will cause no harm to the root system after the transplant has been complete.

Economic Uses

Wild plums are best known for being edible and besides eating the plum right off the tree, many people enjoy jams, pies, and turnovers with fresh picked plums. Along with these traditional ideas, wines, dried plums, and potpourri can be crafted from the fruits. Native Americans would boil the bark to produce a mild tea that was used to ward off colds, help fight diarrhea, and ease kidney or bladder ailments.

For medical purposes, medical research has been conducted using wild plum twigs as an ingredient to help people with asthma and other breathing problems. Many scientists believe the chemical cyanide or prussic acid that is found in the tree has the potential to help fight against lung diseases, influenza, and digestive problems that occur within humans and possible animals as well.

Additional Resources

Oklahoma University. <http://www.biosurvey.ou.edu/shrub/prun-ame.htm>

Plants For a Future. <https://www.pfaf.org/user/Plant.aspx?LatinName=Prunus+americana>

Witch-Hazel (*Hamamelis virginiana*)

Description

Witch-hazel is an intermediate growing, coarse-textured, broadly rounded shrub with a short trunk and numerous crooked branches. It can grow into a 5 to 15 feet tree with a trunk diameter of up to 10 inches and a large, open crown. The smooth thin bark is light brown, developing rough patches and becoming scaly as the tree ages. The slender brown zigzag twigs arise from forked flexible branches. The alternate leaves emerge from scaleless, stalked hairy buds. The leaves are oval to nearly circular in shape, and irregularly round-toothed along their wavy edges. The leaves are 2-6 inches long, nearly as broad, and have 5-7 prominent veins. The upper surfaces are usually smooth, but both sides of the leaf may be hairy and the veins typically are. The leaves are a medium green above and paler below during the growing season, then turn a clear yellow in the fall. The fruits are hairy brown, half-inch oval capsules. After ripening the following summer, they split open explosively and shoot small shiny black seeds up to 30 ft in all directions. There are two botanical varieties of witch-hazel: the widespread *H. virginiana* variety *virginiana*, and the "prairie peninsula" form, *H. virginiana* variety *parvifolia*. There is also a horticultural cultivar called 'Rubescens' which has reddish flowers.

Habitat

(USDA Zones 3 – 9).

Witch-hazel is currently found in the Eastern half of the United States and Canada (and is a Missouri native). It occurs in a wide variety of wet to dry woodlands, growing on bluffs, steep ravine slopes, floodplains, and along boggy or rocky streams. It is commonly found along forest edges, often between the dry uplands and the wet slope forests. It sometimes forms a near continuous under story beneath the canopy on rich old growth sites. Vernal witch-hazel (*Hamamelis vernalis*), which is found in the wild only along rocky streams in the Ozarks, blooms in late winter to early spring.

Management Considerations

Although the most beautiful specimens are found on deep rich soil, witch-hazel is generally content with an ordinary sandy loam with moderate fertility. This species prefers a neutral to slightly acid soil pH, but will tolerate somewhat calcareous soil if it is kept moist. This is a mid- to late-successional species with a moderate growth rate. It is low in fire resistance due to its thin bark, shallow roots, and low branching habit. Witch-hazel prefers sun, but tolerates shade. Plants grown in heavy shade will have a more open form and less intense fall color. This shrub is shallow rooted and does not tolerate drought well, and thus can be hard to establish.

Witch-hazel can be used in a variety of agroforestry applications including alley cropping, forest farming, windbreaks (and to increase diversity of the forest).

Propagation

In the wild, reproduction is primarily from seed. The mature capsules burst open explosively discharging the seeds up to 30-40 feet from the parent plant. Some seeds are dispersed by birds. Witch-hazel seeds should be harvested as soon as the fruits mature in late summer to early fall and sown promptly. Fresh seeds may take up to 18 months to germinate. Seeds allowed to dry on the plant or stored after maturity will require two months of warm stratification, then one month of cold, followed by another two weeks warm and another four months cold - then a long wait for germination. Scarification may improve germination speed and percentage. When the seedlings finally appear, pick them out of the ground and place them into pots in a greenhouse for over wintering. They can be planted out late the following spring and will reach flowering size in about six years. Witch-hazel suckers freely and also can be propagated by layering in early spring or fall. Layering works well, but the process will take a year. Softwood cuttings can be rooted under mist in the summer. Volunteer seedlings can also be potted up and transplanted. It is also possible to purchase seedlings from nurseries.

Economic Uses

Beyond use as a shrub for wildlife, witch hazel has long been recognized as a healing herb. Its primary uses were for skin disorders, having astringent and anti-inflammatory properties. Both leaves and bark have been used. Use of herbal products may also cause adverse reactions in different people. So, find a good book explaining benefits and cautions that should be exercised prior to use of witch hazel. It can however, be stored as an alcohol extract for sale.

Additional Resources

http://www.floridata.com/ref/h/hama_vir.cfm

<http://abc.herbalgram.org/>