

# Training Manual

## for Applied Agroforestry Practices

*2013 Edition*



The Center for Agroforestry  
University of Missouri

*A Global Center for Agroforestry, Entrepreneurship and the Environment*





## **Training Manual for Applied Agroforestry Practices – 2013 Edition**

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Funding for this work is via the United States Department of Agriculture North Central SARE with Agreement Number H003044602 and NCR-SARE Project Number ENC12-129.

Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the USDA.



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# Acknowledgements

This publication is the result of the collaborative efforts of several individuals and organizations.

The University of Missouri Center for Agroforestry acknowledges the USDA National Agroforestry Center and the Mid-America Agroforestry Working Group, for contributions to the text of this manual.

Portions of this material are also credited to the “Forest Landowner’s Guide to Evaluating and Choosing a Natural Resource-Based Enterprise,” published by the Natural Resource, Agriculture, and Engineering Service (NRAES) Cooperative Extension program, Ithaca, New York. NRAES is an interdisciplinary, issue-oriented program sponsored by cooperative extension of fourteen member land grant universities and is housed at Cornell University. For more information, visit [www.nraes.org](http://www.nraes.org).

View this manual online at: [www.centerforagroforestry.org](http://www.centerforagroforestry.org)

Printed: July 2013

Michael Gold, Mihaela Cernusca & Michelle Hall, Eds.



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# Training Manual for Applied Agroforestry Practices: Table of Contents

## User's Guide to the Training Manual

### **Chapter 1:** Defining Agroforestry

*Mike Gold & Andy Mason*

### **Chapter 2:** Planning for Agroforestry

*Mike Gold & Mihaela Cernusca*

### **Chapter 3:** Alley Cropping

*Dusty Walter, Shibu Jose & Diomy Zamora*

### **Chapter 4:** Silvopasture

*Dusty Walter*

### **Chapter 5:** Riparian & Upland Forest Buffers

*Dick Schultz, Tom Isenhardt & Leigh Ann Long*

### **Chapter 6:** Windbreaks

*Bruce Wight & Richard Straight*

### **Chapter 7:** Forest Farming

*John Munsell, Jeanine Davis & Jim Chamberlain*

### **Chapter 8:** Agroforestry and Wildlife

*Rebecca Christoffel*

### **Chapter 9:** Marketing Principles

*Mihaela Cernusca, Mike Gold & Larry Godsey*

### **Chapter 10:** Economic Considerations for Agroforestry

*Larry Godsey*

## Appendices:

### **Section 1:**

- Economic Budgeting Guide
- Funding Incentives for Agroforestry
- Tax Incentives for Agroforestry

### **Section 2:**

Trees and Shrubs

### **Section 3:**

Grasses and Forages

### **Section 4:**

The Basics of Selling Timber

### **Section 5:**

Planning for Agroforestry Workbook

### **Section 6:**

Plant Resource Guide



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# User's Guide to the Training Manual

Farmers 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

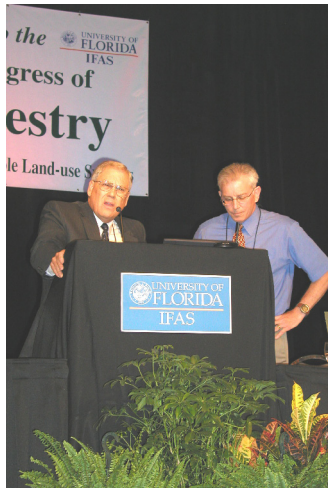
This manual is divided into specific chapters explaining agroforestry practices and management. Chapter 2 is intended to assist you in implementing your knowledge of agroforestry into your operation in a step-by-step process. The appendices contain information about the economics and taxation involved 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.

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## 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, associate director, speak about the opportunities agroforestry provides at the First World Congress of Agroforestry, Orlando, Fla.

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# 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. Since 1998, UMCA, established in 1998, has been supported by significant collaborative funding from the USDA-ARS. Interdisciplinary research conducted by faculty, research 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 research programs are several key partnerships with landowners, natural resource professionals, federal and state agencies and non-profit organizations. Through these critical partnerships, UMCA and its partners are producing an expanding list of positive outcomes for landowners, 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 worldwide.

## **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 biodiversity 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, simultane-



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



ous or sequential. 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 (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 designed to increase the value of the forestry component.



*Forest Farming*

*Silvopasture*

*Alley Cropping*

*Riparian Forest Buffers*

*Windbreaks*



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## 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

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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 is believed to be very low. 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
  - 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).

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 the 1890 Agroforestry Consortium (1890 AFC), Chesapeake Bay Agroforestry Team (CBAT), and the Mid-American Agroforestry Working Group (MAAWG)
- Lasting partnerships need a clear purpose and tangible project(s) to keep members engaged. For example, The 1890 AFC brings together the 20 1890 land-grant universities and USDA agency partners to advance agroforestry research, teaching and extension. CBAT is focusing on implementing the actions in Section 4 - Agroforestry of the Chesapeake Bay Forest Restoration Strategy. The MAAWG sponsors networking and educational activities to advance regional agroforestry interests. As a tangible project, The MAAWG is helping to facilitate the weeklong Agroforestry Academy.
- Establishing agroforestry communities of practices such as the Forest Farming community that has been established by a team led by Virginia Tech with USDA support.

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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.
- USDA assistance that helps advance agroforestry adoption and practice application includes: the Natural Resource Conservation Service's Environmental Quality Incentives and Conservation Stewardship programs; the National Institute of Food and Agriculture's Renewable Resources Extension Act and McIntire-Stennis Cooperative Forestry Research programs; and 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!

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## Additional Resources

### ***In Print:***

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- Brant, G. 2011. +H: The Human Considerations in the Adoption of Agroforestry. Agroforestry Note 43. USDA National Agroforestry Center, Lincoln, NE. <http://nac.unl.edu/documents/agroforestrynotes/an43g13.pdf>
- Chesapeake Bay Forest Restoration Strategy, including Section 4 – Agroforestry: <http://executiveorder.chesapeakebay.net/chesapeakeforestrestorationstrategy.pdf>
- 1890 Agroforestry Consortium: [http://www.csrees.usda.gov/nea/nre/in\\_focus/forests\\_if\\_1890agro.html](http://www.csrees.usda.gov/nea/nre/in_focus/forests_if_1890agro.html)
- eXtension Forest Farming Community of Practice: <http://www.extension.org/pages/62959/forest-farming-community>
- Green Lands/Blue Waters: <http://www.leopold.iastate.edu/green-lands-blue-waters>
- Center for Integrated Natural Resources and Agricultural Management: <http://www.cinram.umn.edu/>
- Iowa State University Riparian Management Systems: <http://www.buffer.forestry.iastate.edu/>
- Mid-American Agroforestry Working Group: <http://midamericanagroforestry.net/>
- Midwest Cover Crops Council: <http://www.mccc.msu.edu/>
- The Center for Agroforestry, University of Missouri. <http://www.centerforagroforestry.org/>
- The Center for Subtropical Agroforestry, University of Florida. <http://sfrc.ifas.ufl.edu/cstaf/>
- USDA National Agroforestry Center: <http://www.unl.edu/nac/>
- U.S. Department of Agriculture, 2011. USDA Agroforestry Strategic Framework, FY 2011-2016. Washington, DC. 35 p. [http://www.usda.gov/documents/AFStratFrame\\_FINAL-lr\\_6-3-11.pdf](http://www.usda.gov/documents/AFStratFrame_FINAL-lr_6-3-11.pdf).
- U.S. Department of Agriculture, Office of Secretary. 2013. USDA policy for agroforestry. Departmental Regulation 1073-002. <http://www.ocio.usda.gov/document/departmental-regulation-1073-002>
- World Agroforestry Centre: <http://www.worldagroforestry.org/>

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# Notes

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# 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. And, 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 line out 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



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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 re-assessed 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.

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**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

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## 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 legend 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 National Arboretum website: <http://www.usna.usda.gov/Hardzone/ushzmap.html>

To locate a Plant Hardiness Zone Map specific to your State go to the following website and click on your State: <http://www.growit.com/bin/US-DAZoneMaps.exe?MyState=MO>

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).

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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 one of three ways:

- *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 principle 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/>) or the Soil Data Mart online at (<http://soildatamart.nrcs.usda.gov/>).

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.

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**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.



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## 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



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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 Appen-

dices 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://uextension.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

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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 Workbook. 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.

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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 veg-

etation 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

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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



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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 adver-

tising 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

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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, fertil-



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izer, 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.

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.

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:

## Additional Resources

Handbook for Agroforestry Planning and Design. University of Missouri Center for Agroforestry. 2013. [www.centerforagroforestry.org](http://www.centerforagroforestry.org)

Conducting a Simple Timber Inventory, The University of Tennessee Institute of Agriculture, <https://uextension.tennessee.edu/publications/Documents/PB1780.pdf>

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

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# 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 some-

times called intercropping and multi-cropping. 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.

### 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 the 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 sustain-

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ability 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 chemical (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 chemical 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 the tree products that may not be present in the local area*
- *Trees may be an obstacle to crop cultivation if not carefully planned and designed*
- *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 the 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:*

- A. *Light Competition*
- B. *Root Competition for Water and Nutrients*
- C. *Allelopathy*

### A) **Light Competition (above ground)**

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



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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. Taken together, 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.*), or heads out in the late fall, such as milo. A tree species should be incorporated that best accommodates the light needs of that specific crop (e.g., a tree species that breaks dormancy late for winter wheat or a species that drops its leaves early for milo - a good example of a tree that satisfies both needs is black walnut).

- *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. By 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.

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## 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

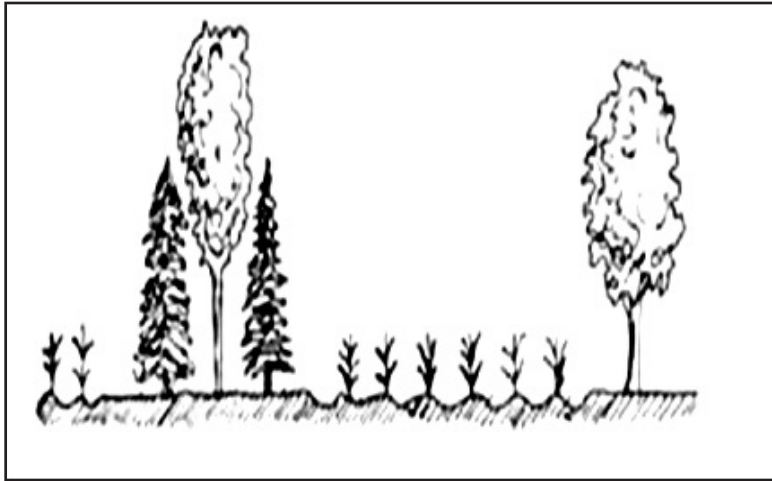
With a conservation perspective in mind, slope length relates to the spacing needed to reduce water erosion. The light requirement for the crop or forage to be grown in the alleyway must be considered prior to tree establishment. Finally, alley width must be set as multiples of the widest field equipment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

ther 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:*

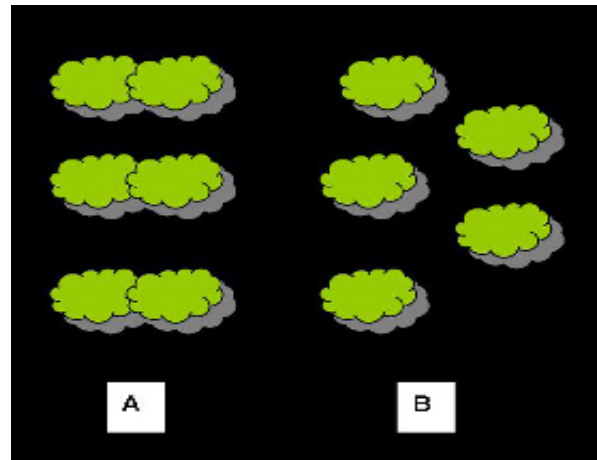
- *Benefit from competition between tree rows*
- *Wildlife habitat*
- *Plant-Insect relationships*
- *Economics*

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).



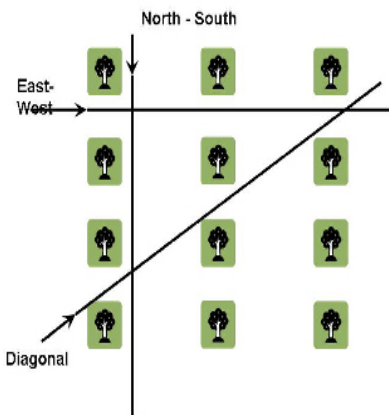
Crown competition between adjacent trees (A) as compared to the increased growing space available to individual trees when planting in an offset configuration (B). Double or triple rows of long-needled hard pines (e.g., cold tolerant loblolly or pitch x loblolly hybrids) can be grown either as (A) or (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 within-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 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.*
- *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*
- *Be adapted to a variety of sites and soils*
- *Deep-rooted with minimal roots at the soil surface to minimize competition with crops in the alleyway.*
- *Have 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)
- Have 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.

Plant Materials: Trees for Alley Cropping
<b>Black walnut:</b> 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.
<b>Pecan:</b> 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.
<b>Oaks:</b> The wood has a high value and the acorns are good wildlife food. The oaks are relatively slow growing and produce fairly dense shade.
<b>Chestnuts:</b> 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.
<b>Nut or fruit bearing shrubs:</b> The hazelnut, paw-paw, blueberries, etc. could be used as stand-alone hedgerows or in combination with other taller tree species

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.

*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 orchardgrass 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
- Seed production, 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 out 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 agencies is the USDA Natural Resource Conservation Service (NRCS), which offers the Environmental Quality Incentive Program (EQIP) that may be utilized toward agroforestry practices like alley cropping.

The EQIP program is designated for environmental concerns associated with livestock 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

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



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practices, EQIP 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 listing 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.

- 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)
- Nutrient Management (590)

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

(Numbers in parentheses are NRCS Conservation Practice Codes.)

**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.

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## Success Story

### Paul Smith

*20-acre alley cropping practice, Northwest Missouri, 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.”

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“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.”

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## 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.

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## **Additional Resources**

### ***National Agroforestry Center:***

<http://nac.unl.edu/alleycropping.htm>

### ***The Center for Agroforestry at the University of Missouri:***

<http://www.centerforagroforestry.org>

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

### ***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)

### ***From the United Kingdom:***

<http://www.agroforestry.co.uk/silvoar.html>

Manage Insects on Your Farm. <http://www.sare.org/publications/insect.htm>

### ***For additional information on the characteristics of individual forage species:***

Forages Vol. 1: An Introduction to Grassland Agriculture by Barnes, Miller, & Nelson, 1995, Iowa State University Press

Southern Forages by Ball, Hoveland, & Lacefield, 1991, Potash and Phosphate Institute Pasture Management Guide for Northern Missouri by USDA NRCS, Ingalls, John J., 1998. From USDA SARE.

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## **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 landowners 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.



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# Notes

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# 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 silvopasturing 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

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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 Grazing (MiG) 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.

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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 degrees 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 anytime. 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 hardwood 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 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:

- 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 recharge 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



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



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

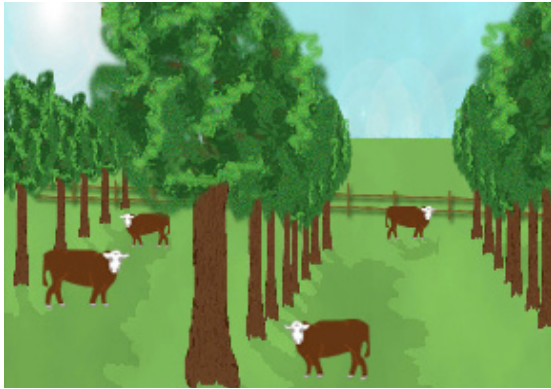
Typically, reforestation is designed to produce quality trees for wood production. Consequently, initial planting densities do not often coincide with producing good livestock forage. Even where good forage is available, supply decreases dramatically once the canopy closes past 50 percent. If trees are 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. Obstacle planting in a 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 a 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)
- Diversified landscape is created
- Farm production is enhanced

#### 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 effect 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

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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. How-



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## 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*

ever, 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.



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

### 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 select 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. 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.

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### 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*
- *Problems of forestry*
- *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*

### 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



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## 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.”

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## 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

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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.

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## 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.

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

USDA NRCS: Information Sheet [http://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrc-s144p2\\_010420.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrc-s144p2_010420.pdf)

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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.

USDA National Agroforestry Center: <http://nac.unl.edu/silvopasture.htm>

Fike, J. H., Buegler, A. L., Burger, J. A., and Kallenbach, R. L. 2004. Considerations for establishing and managing silvopastures. Online. *Forage and Grazinglands*. doi:10.1094/FG-2004-1209-01-RV. <http://www.plantmanagementnetwork.org/pub/fg/review/2004/silvo/>

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

Mississippi State Univ.: <http://msucares.com/crops/forages/newsletters/09/4.pdf>

### **Grazing Systems**

University of Missouri Extension (Grazing and Watering): <http://muextension.missouri.edu/explorepdf/envqual/EQ0379.pdf> <http://muextension.missouri.edu/explorepdf/envqual/eq0380.pdf>

National Sustainable Agriculture Information Service - ATTRA :

Managed Grazing around Riparian Areas: <https://attra.ncat.org/attra-pub/summaries/summary.php?pub=116>

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

<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>

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## 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.***



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## 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...

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# Notes

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# 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 bio-engineered 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 floodplain, 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 condition, flood regime, 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 landowner objectives, upland forest buffers could provide some of the same benefits as these other two agroforestry practices.

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### 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:*

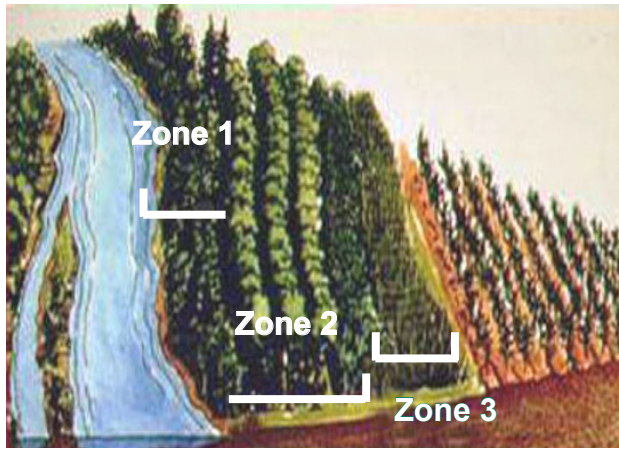
**Zone 1** – A zone closest to the stream bank that can include a mixture of fast growing native bottomland trees, shrubs, grasses and forbs that are designed to grow rapidly to stabilize stream banks. This vegetation should be able to tolerate periodic flooding and is not harvested to provide natural 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 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 an 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 existing the 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, as they are usually only 6-16 ft. (2-5 m) wide, do not have specific zones.

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) rewetted 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 downcutting of the channel both up- and downstream of the channelized section. Once downcutting 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 chan-

nel. 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 steep, 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 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.

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

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.



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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 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

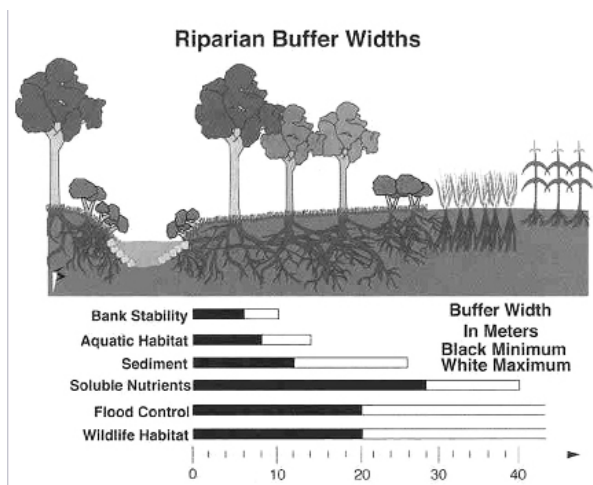
**Width:** Widths of Zones 1, 2, and 3 can vary depending on the physical characteristics of the site and the functional requirements needed to improve water quality and aquatic habitat. USDA Conservation Reserve Program (CRP) requirements will also dictate allowable widths of each of the zone. If CRP 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 30-50 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.

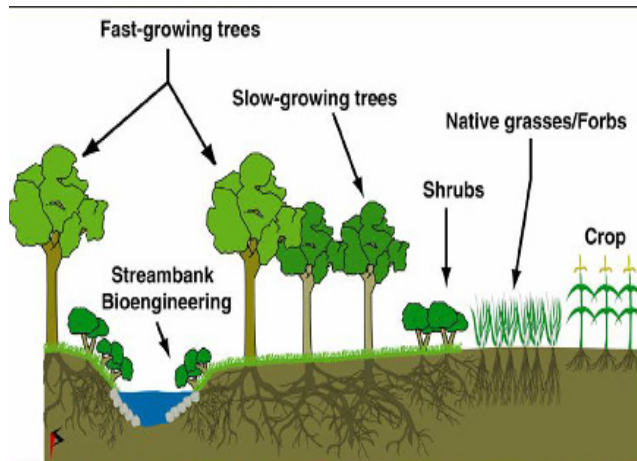
including that moving down a grass waterway. If gullies exist from the edge of the field through the native plant community, a grass/forb filter zone should be added or widened. While buffers along the channel of an individual property can significantly reduce the sediment and nutrient load from the 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 should be conducted to determine the fate of any concentrated flow entering the zone



**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 the important riparian buffer functions.*

- Replace shrub rows with trees, or tree rows with shrubs, to increase timber product or floral product options or provide more diverse wildlife habitat. In either case, permanent woody roots are maintained, but use 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 in 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. 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, [www.extension.iastate.edu/](http://www.extension.iastate.edu/))*

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 10-15 feet between rows and 8-10 feet 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 prepara-

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tion 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

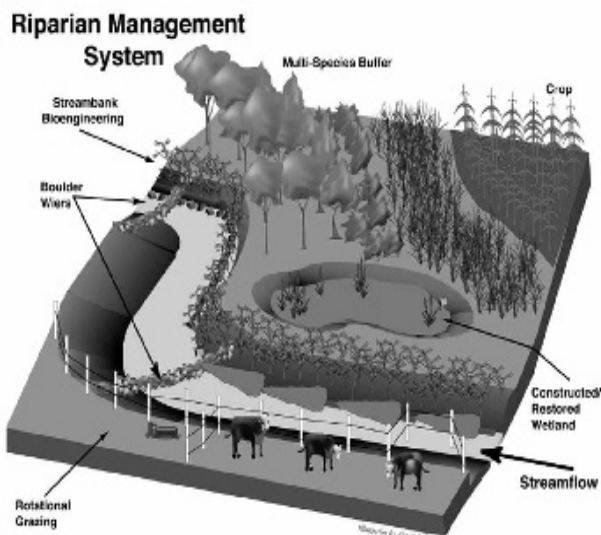
**Managing an Existing Streamside Forest for a Riparian Buffer System.** Buffer function should be a primary consideration in management. Therefore, management of existing buffers should focus on either maintaining or enhancing buffer function. Although plant materials may be alive and growing, they 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 waterways 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 discing 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 (overseeding 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 redrilling. 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 grasses 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) 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 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 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.

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 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

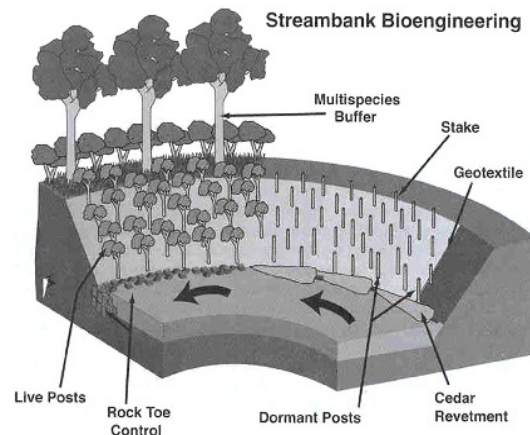
### Specific Considerations for Stability: Stream Bank Structures

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

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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 stream bank prior to rock placement.

**Tree revetments.** In smaller streams, (1-3 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 be used. The dense branches provide significant friction that slows water and drops sediment, creating a stable toebank 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 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. This fiber mat 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. Installa-

tion 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 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 diameter and 10 to 20 feet 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 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 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 deep reduces the critical bank height at low flow, thus reducing bank erosion. (See Figure 3, page 8).

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**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 deep with an average size of 15 ft by 100 ft. 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 na-

tive 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 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 population 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, including a list of additional species of woody plants commonly used in the floral industry and retail and wholesale nursery stock sources online at [http://snrs.unl.edu/forestry/woody\\_florals.htm](http://snrs.unl.edu/forestry/woody_florals.htm).

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](http://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 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.

The Conservation Reserve Program Continuous Sign-up (CRPCS) program offers direct benefits to landowners establishing a forested riparian buffer. CRPCS is a voluntary program

that focuses on funding conservation practices (CP) protecting environmentally sensitive land, including wetlands and riparian areas. Landowners with eligible land who wish to enroll that land in the CRPCS may sign up at any time during the year.

**Available funding through the Continuous Conservation Reserve Program (CCRP) can include:**

- Annual soil rental rate payments that can be up to 120 percent of the average soil rental rate for the area.
- Annual maintenance payments of \$5 to \$10 per acre.
- Cost share payments up to 50 percent of the establishment cost.

**Along with these three payments, CCRP also has two one-time incentive payments available for certain CP's, including:**

- A signing incentive payment (SIP) equal to \$10 per acre per number of contract years.
- A practice incentive payment (PIP) equal to 40 percent of the establishment costs.

**Several CRPCS practices allow for tree planting, including:**

- CP16A Shelterbelts
- CP22 Riparian buffers
- CP23 Wetland Restoration

Riparian buffers have become a priority for most USDA agencies. Under the requirements of the CRPCS's riparian forest buffer practice (CP22), 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 wide and cannot exceed 180 feet. Buffers along third order streams must be at least 100 feet wide. Riparian forest buffers along the Missouri and Mississippi Rivers may be increased to 300 feet. Buffers may be extended beyond 180 feet or 300 feet for the purpose of improving water quality benefits.

NRCS Standard 391 identifies the guidelines for establishing a riparian forest buffer for the CRPCS. For more information, contact your local USDA/ FSA office.

Additional USDA programs to establish and maintain riparian forest buffers are offered through the Natural Resources Conservation Service (NRCS); 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."

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

Brief description of the CRPCS funding and design characteristics that support the establishment of riparian forest buffers.

## 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.

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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.

Working from these three points of reference will best ensure the success of an upland or riparian buffer for years to come.

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## 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."

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### 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."

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## 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***

The University of Missouri Center for Agroforestry -- [www.centerforagroforestry.org](http://www.centerforagroforestry.org)

Iowa State University Extension (See publications list for "Stewards of our Streams" series on riparian buffers.) [www.extension.iastate.edu/](http://www.extension.iastate.edu/)

Healthy Land, Healthy Water: Riparian Management Systems (A resource web site from the Iowa State Agroecology Issue Team of the Leopold Center for Sustainable Agriculture) [www.buffer.forestry.iastate.edu/](http://www.buffer.forestry.iastate.edu/)

Science-based Trials of Rowcrops Integrated with Prairies (STRIPs) (Research involving upland native grass buffers at Iowa State University) <http://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 /](http://www.dnr.mo.gov/)

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

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](http://www.grownative.org)

### ***Federal Resources***

USDA Agricultural Research Service (ARS) (Search for "buffers" to find research projects and publications) [www.ars.usda.gov](http://www.ars.usda.gov)

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

The USDA National Agroforestry Center -- [www.unl.edu/nac/](http://www.unl.edu/nac/)

### ***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/](http://www.treesforever.org/)

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

Includes the basics of establishing a riparian buffer practice.

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

"Stewards of our Streams: Maintenance of Riparian Buffers." For more information visit [www.extension.iastate.edu](http://www.extension.iastate.edu). <http://www.extension.iastate.edu/Publications/PM1626C.pdf>

## 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 on a continued basis 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 rainfall 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), Conservation Reserve Program Continuous Sign-up (CRPCS), 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 after passage of a new Farm Bill).

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# 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:
  - Windbreaks for Homes
  - Windbreaks for Livestock Odor Reduction
  - Living Snow Fences
  - 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 develop-

## ***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

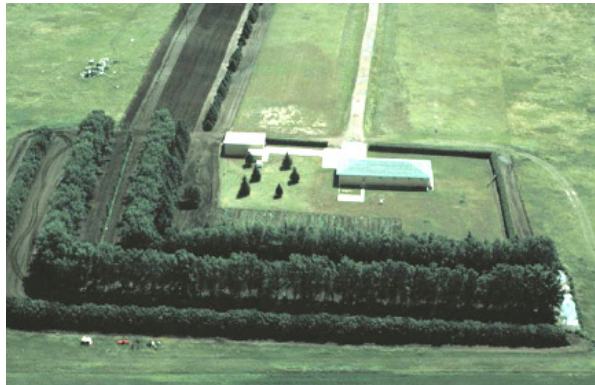
ing an understanding of the interactions between the windbreak (trees, shrubs and grasses) and the adjacent land area, its layout can be most effective at meeting the goals for which it is, or has been, established. By understanding the needs of each of the windbreak's component parts, the windbreak 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 (downwind) 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 windbreak 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 perpen-




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

 <b>Open Wind Speed 20 mph Deciduous 25-35% density</b>					
H distance from windbreak	5H	10H	15H	20H	30H
Miles per hour	10	13	16	17	20
% of open wind speed	50%	65%	80%	85%	100%


  

 <b>Open Wind Speed 20 mph Conifer 40-60% density</b>					
H distance from windbreak	5H	10H	15H	20H	30H
Miles per hour	6	10	12	15	19
% of open wind speed	30%	50%	60%	75%	95%

 <b>Open Wind Speed 20 mph Multi Row 60-80% density</b>					
H distance from windbreak	5H	10H	15H	20H	30H
Miles per hour	5	7	13	17	19
% of open wind speed	25%	35%	65%	85%	95%

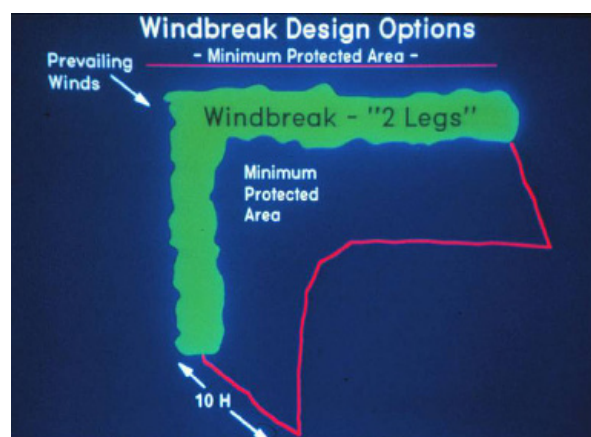
 <b>Open Wind Speed 20 mph Solid Fence 100% density</b>					
H distance from windbreak	5H	10H	15H	20H	30H
Miles per hour	5	14	18	19	20
% of open wind speed	25%	70%	90%	95%	100%

**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 angles 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 composi-

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tion 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***

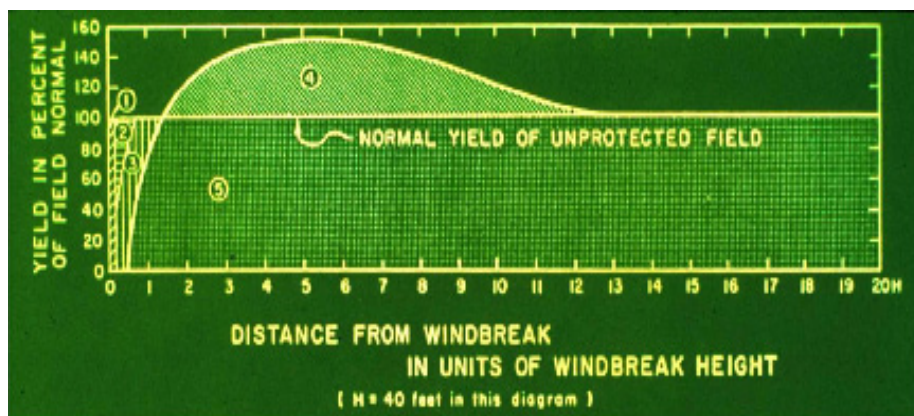
- Enhance crop yield
- Protect soil from wind erosion
- Shelter livestock and crops
- Capture water runoff and nutrients
- Improve irrigation efficiency
- Filter and reduce dust
- Help control odors
- Screen unsightly areas
- Provide wildlife travel corridors and habitat
- Protect structures (homes, 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) provide conservation system that can tolerate 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

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 impacted the most from competition and are able to gain good quality forage.

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



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



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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.)

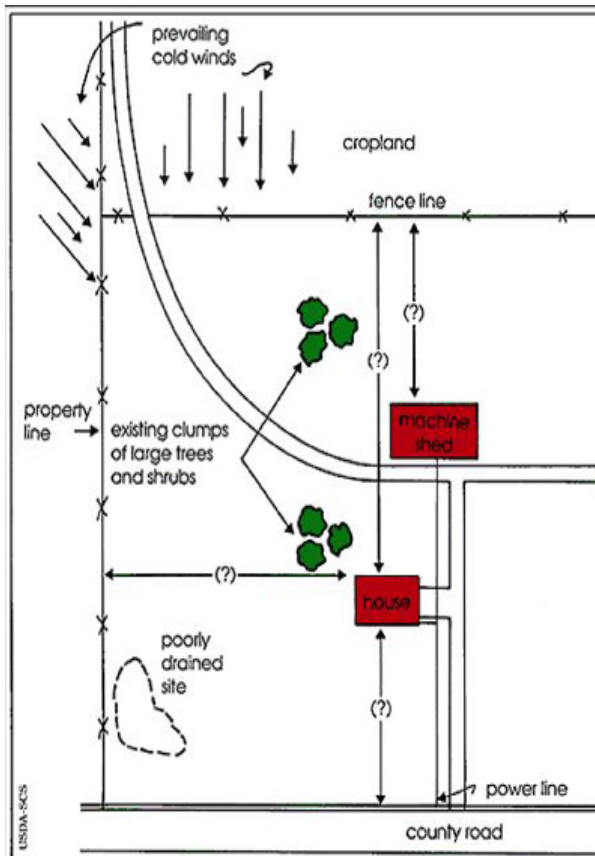


Fig. 4. Area sketch for site evaluation.

- 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

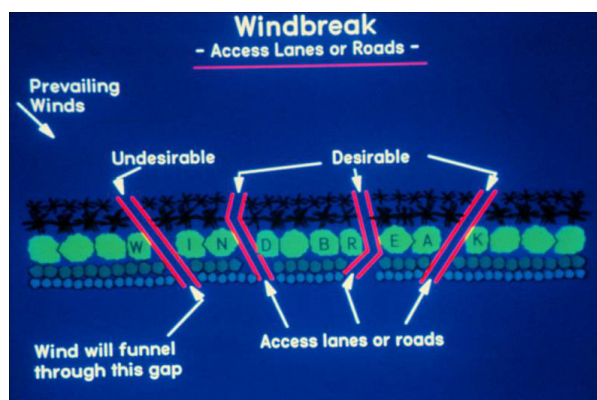
Coat Description	Critical Temperature
Summer coat or wet	59°F
Fall coat	45°F
Winter coat	32°F
Heavy winter coat	18°F

*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

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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](http://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 landowner 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 marketable 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 the 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.

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## 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 a 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

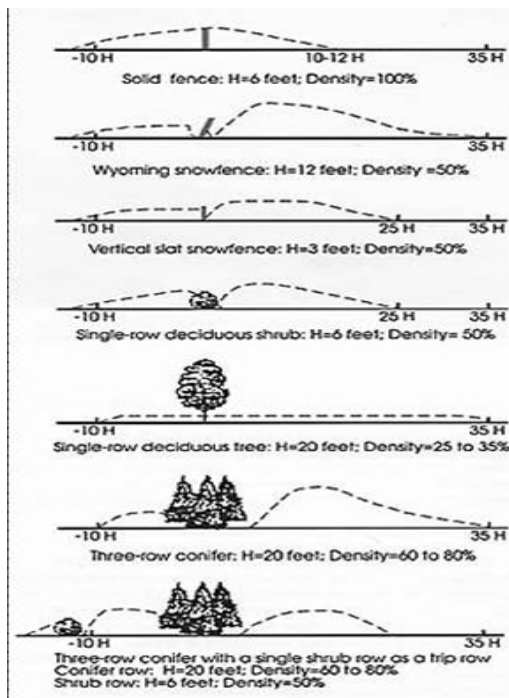
- For wind protection only, the tallest row needs to be 2-5H (H = planned height of the tallest row) from the primary area needing protection.
- However, for wind and snow protection, the most windward row needs to be 100 to 200 feet from the windward edge of the primary protection area. The distance 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 <http://nac.unl.edu/documents/morepublications/ec1767.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, <http://nac.unl.edu/documents/workingtrees/brochures/wtc.pdf>*





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## 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 snowdrifts. 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.



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

- Refer to the above Windbreak Design for Snow figure for more guidance about snow behavior adjacent to different windbreak designs.
- Go to Working Trees: Living Snow Fences, <http://nac.unl.edu/documents/working-trees/brochures/livingsnowfenceforweb.pdf>, and Windbreaks for Snow Management, <http://nac.unl.edu/documents/morepublications/ec1770.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

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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 Live-stock Production Facilities, <http://nac.unl.edu/documents/agroforestrynotes/an41w04.pdf>

#### 4) Windbreaks for Wildlife Benefits

##### 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://nac.unl.edu/documents/morepublications/ec1771.pdf>



*Quail find excellent habitat in field windbreaks.*

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## 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.”

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**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.”



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## 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 at right for a listing of incentives offered by these federal agencies or consult the UMCA publication “Funding Incentives for Agroforestry in Missouri.”

<b>Federal Agency and Programs Offered</b>	<b>Programs Available for Wind-breaks</b>
<b>USDA/FSA</b>	
Continuous Conservation Reserve Program (CCRP)	CS,LE,IP,M
<b>USDA/NRCS</b>	
Environmental Quality Incentives Program (EQIP)	PP
Conservation Stewardship Program (CSP)	CS,LE
Wildlife Habitat Incentive Program (WHIP)	PP
<b>USDA/NIFA</b>	
SARE Producer Grants	G

**Key to Programs:**  
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



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## Additional Resources

### **Windbreak Resources – USDA National Agroforestry Center**

<http://nac.unl.edu/windbreaks.htm> This page has many windbreak references, but suggests 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**

National Windbreak/Shelterbelt Establishment Practice Standard

NRCS State Windbreak/Shelterbelt Establishment Practice Standards and Specifications:

1. Electronic Field Office Technical Guide: [http://efotg.sc.egov.usda.gov/efotg\\_locator.aspx](http://efotg.sc.egov.usda.gov/efotg_locator.aspx)
2. Locate your state on the map then your county
3. Choose Section 4 of FOTG, then Conservation Practice Folder and scroll to Windbreak

### **Illinois**

Illinois Windbreak Manual – Illinois Department of Conservation, Extension and NRCS: [http://web.extension.illinois.edu/forestry/iwm\\_complete.pdf](http://web.extension.illinois.edu/forestry/iwm_complete.pdf)

Essential Elements for Windbreak Design – University of Illinois Extension: [web.extension.illinois.edu/cfiv/homeowners/081208.html](http://web.extension.illinois.edu/cfiv/homeowners/081208.html)

### **Iowa**

Planning Farmstead Windbreaks - Iowa State Extension

[www.extension.iastate.edu/Publications/PM1716.pdf](http://www.extension.iastate.edu/Publications/PM1716.pdf)

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

[www.extension.iastate.edu/Publications/PM1717.pdf](http://www.extension.iastate.edu/Publications/PM1717.pdf)

### **Minnesota**

Field Windbreaks – Minnesota Department of Agriculture Conservation Funding Guide

[www.mda.state.mn.us/protecting/conservation/practices/fieldwindbreak.aspx](http://www.mda.state.mn.us/protecting/conservation/practices/fieldwindbreak.aspx)

Windbreaks and Living Snow Fences – University of Minnesota Extension: [www.myminnesotawoods.umn.edu/2009/01/windbreaks-and-living-snow-fences/](http://www.myminnesotawoods.umn.edu/2009/01/windbreaks-and-living-snow-fences/)

Selecting Trees and Shrubs in Windbreaks - University of Minnesota Extension:

[www.extension.umn.edu/agroforestry/components/selecting-trees-and-shrubs-in-windbreaks.pdf](http://www.extension.umn.edu/agroforestry/components/selecting-trees-and-shrubs-in-windbreaks.pdf)

### **Missouri**

Planning Tree Windbreaks in Missouri – University of Missouri Extension [extension.missouri.edu/explorepdf/agguides/forestry/g05900.pdf](http://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](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_010805.pdf)

### **Nebraska**

Windbreak Design – University of Nebraska Extension NEBGuide G1304: <http://nfs.unl.edu/documents/wind-breakdesign.pdf>

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## Additional Resources, con't

### **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-wisconsins-topsoil/](http://www.cias.wisc.edu/crops-and-livestock/windbreaks-trees-as-technology-for-protecting-wisconsins-topsoil/)

Windbreaks That Work – Wisconsin Department of Natural Resources: [dnr.wi.gov/topic/forestmanagement/documents/pub/FR-070.pdf](http://dnr.wi.gov/topic/forestmanagement/documents/pub/FR-070.pdf)

Tree and Shrub Species for Windbreaks – USDA NRCS-Wisconsin: <ftp://ftp-fc.sc.egov.usda.gov/WI/technotes/forestry-tn4.pdf>

### **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.

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## 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.



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# Notes

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# 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.

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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 monetary value of NTFPs is difficult to estimate due to the informal nature of many markets. Nevertheless, several product- and region-specific estimates suggest that the value of the industry is substantial. For example, in 2011 consumer sales of herbs and botanicals in the U.S. reached \$5.28 billion. Raw materials to supply that industry were valued at \$500 million (Nutrition Business Journal, 2012). Ginseng exports were valued at \$51.9 million in 2007; \$13.6 million for cultivated ginseng and \$38.3 million for wild ginseng (Mitchell and Chang, 2009). McLain and Jones (2005) estimate that the aggregate annual value of NTFP harvests in North America likely runs in the tens of billions of dollars.

### 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 salad. 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 and straw harvested in pine forests is used frequently 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

Forest Farming Method	Management Intensity
<b>Woods Grown</b>	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.
<b>Wild-Simulated</b>	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.
<b>Managed Wild Population</b>	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.
<b>Wild-Harvest or Wild-Craft</b>	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.

is actually a diseased willow with cankered stems, often are carved and polished by craftsmen 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 the products being produced but often relates to tradeoffs between time and money.

There are three recognized methods of forest farming: woods grown (sometimes referred to as forest gardening), 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 wild-craft) marketable NTFPs from their forest. If sustainable wild-harvesting methods are used, products 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. A successful forest farmer stated that it 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 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 manage-

ment 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. Also, each forest farming operation should contribute to overall forest health and productivity.

### ***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.



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## 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. In 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 for Landowners” from the Missouri Department of Conservation online at [mdc.mo.gov/forest/private/forest\\_manag.pdf](http://mdc.mo.gov/forest/private/forest_manag.pdf). (See additional resources at the end of this chapter). To gather 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.”

## 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;



Forest farming of log grown shiitake mushrooms, Ozark Forest Mushrooms, Timber, Mo.

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### **Examples of Forest Farming Products with Markets**

**Medicinal NTFPs:** Ginseng, goldenseal, black cohosh, bloodroot, mayapple, 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 Spanish 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.

- 4) Decide on a production method and operational investments; and
- 5) Thoroughly investigate technical resources and engage technical experts.

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](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).

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, matsutake, 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 also be reached through the Internet. However, by



**Top:** High value medicinal herb markets have been increasing in recent years.

**Bottom:** Pineneedles harvested into bales and sold for landscaping mulch.



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.

### 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.

### 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 profitable 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.







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 to the city 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."

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## Additional Resources

### **Internet Sources: Understory Crops**

- eXtension Forest Farming Community - [http://www.extension.org/forest\\_farming](http://www.extension.org/forest_farming)
- NC State University Cooperative Extension: (numerous publications) <http://ncherb.org>
- Non-Timber Forests Products - <http://www.sfp.forprod.vt.edu/>
- National Agroforestry Center (many resources on numerous Forest Farming Products) - <http://nac.unl.edu/index.htm>
- UM Center for Agroforestry: (publications on a variety of products and practices) - <http://www.centerforagroforestry.org/pubs/index.asp#pubs>
- Missouri Alternatives Center: (topics alphabetically organized) - <http://agebb.missouri.edu/mac/links/index.htm>
- Association for Temperate Agroforestry: (many topics) - <http://www.aftaweb.org/ATTRA>
- National Sustainable Agriculture Information Service: (numerous publications) - <https://attra.ncat.org/horticultural.html#Agroforestry>

### **Forestry Consultation**

#### **UMCA DVD**

Visit [www.centerforagroforestry.org](http://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>

### **In Print**

Chamberlain, J.L., D. Mitchell, T. Brigham, T. Hobby, L. Zabek, and J. Davis. 2009. Forest Farming Practices. IN: North American Agroforestry: An Integrated Science and Practice. 2nd Edition. (H.E. Garrett, editor). Agronomy Society of America, Madison, WI. pp. 219-255.

Persons, W.S. and J.M. Davis. 2007. Growing and marketing ginseng, goldenseal, and other wood-



## 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). And, 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.

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# 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 which include a diver-

sity of plantings, produce 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) aesthetics, 2) ecological, 3) economic, and 4) recreational. 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 on seed-eating mice and others. Landowners 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) endless entertainment at feeding stations.

### Summary of benefits

**Aesthetic** – Wildlife provide music to our ears and beauty to our eyes

**Social** – Wildlife help in providing a sense of place and attract families, photographers, birdwatchers, hunters and anglers

**Ecological** – Wildlife, such as amphibians, indicate high-quality habitat that provides clean water and unpolluted soil. Some wildlife species provide soil aeration services, such as moles, while other wildlife species disperse seeds, such as birds and mammals.

**Economic** - Wildlife can provide you with an economic return when you open your land to others for birdwatching, hunting, guiding or agritourism. Indirectly, pollinators provide billions of dollars worth of pollinating services, while bats provide billions of dollars in insect “pest” control.

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## 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 climes, 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 charac-



teristics of wildlife will in part, determine the feasibility of managing for them 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 other wildlife species. However, there are many wildlife species, particularly smaller bodies 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. One important example of this has to do with cowbirds, a bird that lays its 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 limits dispersal in amphibians and thereby decreases



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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 on the land, 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 disappears 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 and 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 wood 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 wood 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 property on which structures, crops, standing timber, and water features are delineated. 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.

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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 with 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 i.e. 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 will 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 damage in agroforestry fields. 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 value of the wood.

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 redtop 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 (but 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 (< 10m<sup>2</sup>) 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 but that must stay moist.

## 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.



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## 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 provides 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



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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

Agri-tourism 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



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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 others.

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 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.

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## 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) (<http://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/](http://www.nwtf.org/)); Quail Forever (QF) ([www.quailforever.org/](http://www.quailforever.org/)); and Ducks Unlimited (DU) ([www.ducks.org](http://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.

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## Additional Resources

### ***Agritourism and Lease Hunting***

Agricultural Marketing Resource Center

[http://www.agmrc.org/commodities\\_\\_products/agritourism/agritourism-businesses/](http://www.agmrc.org/commodities__products/agritourism/agritourism-businesses/)

University of Missouri Extension: <http://muextension.missouri.edu/explorepdf/agguides/wildlife/G09420.pdf>

Whiterock Conservancy

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

### ***Wildlife Habitat Management***

A Bird's Eye View: A Guide to Managing and Protecting Your Land for Neotropical Migratory Birds in the Upper Mississippi River Blufflands

<http://dnr.wi.gov/topic/wildlifehabitat/documents/wcbmp.pdf>

A Landowner's Guide to Woodland Wildlife Management

<http://woodlandinfo.org/sites/woodlandinfo.org/files/pdf/UWEX/G3578.pdf>

Agroforestry and Wildlife Management Go Together on Small Farms

<http://www.ars.usda.gov/is/ar/archive/dec04/farm1204.pdf>

Basics of Managing Wildlife on Agricultural Lands (IN)

<http://www.extension.purdue.edu/extmedia/FNR/FNR-193-W.pdf>

Best Management Practices for Woodcock and Associated Bird Species

<http://dnr.wi.gov/topic/wildlifehabitat/documents/wcbmp.pdf>

General Management for Wildlife (MO)

[http://mdc.mo.gov/documents/landown/wild/wmml\\_2000.pdf](http://mdc.mo.gov/documents/landown/wild/wmml_2000.pdf)

Habitat Management Guidelines for Amphibians and Reptiles of the Midwestern United States

<http://www.mwparc.org/products/habitat/>

Wildlife Management for Missouri Landowners

[http://mdc.mo.gov/sites/default/files/resources/2010/05/5354\\_3245.pdf](http://mdc.mo.gov/sites/default/files/resources/2010/05/5354_3245.pdf)

Xerces Society (for information about providing habitat for pollinators)

<http://www.xerces.org/pollinator-conservation/>

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# Notes

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# Chapter 9: Marketing Principles

## In this chapter:

- **Marketing agroforestry products**
- **The “black box” of agroforestry enterprises**
- **Data collection**
- **Analyze of 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, heartnuts, 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.



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## 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, trade shows, 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 the 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.

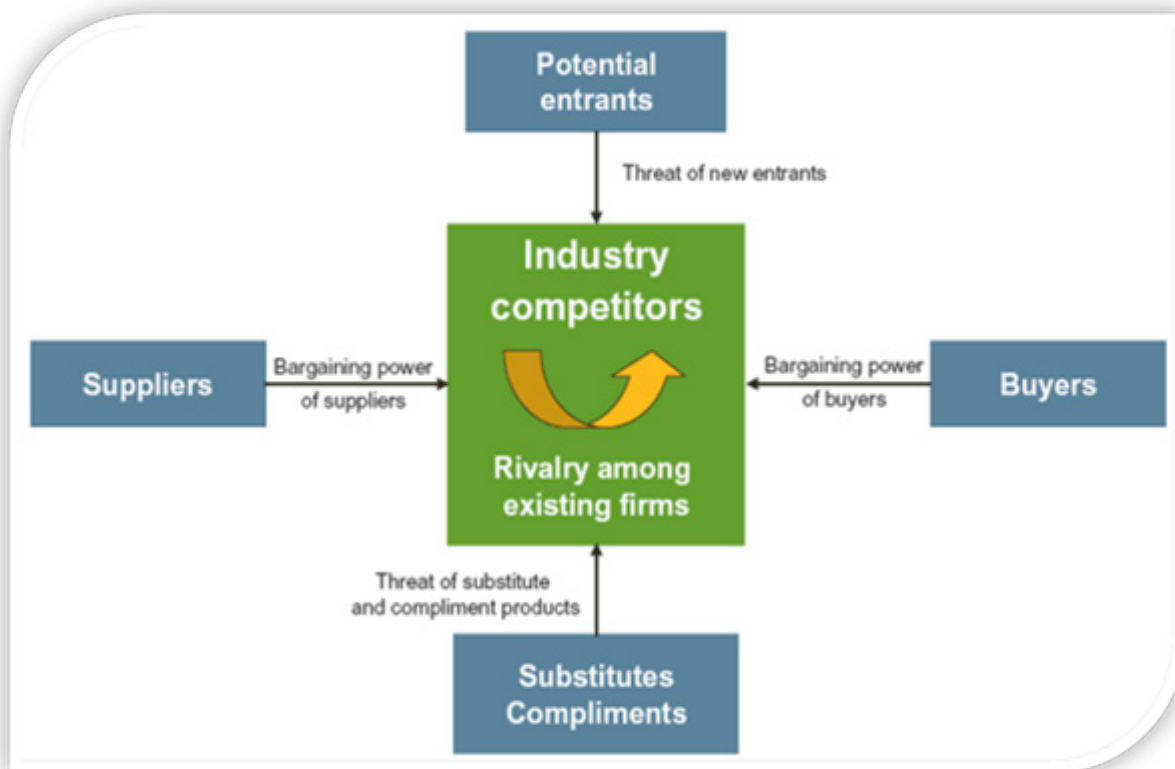


Fig. 1. Porter’s Five Forces Model

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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 together 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 Wyl-dewood 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



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## 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

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

**Right:** Paw-paw samples and sales at the Farmers Market. **Below:** Chestnuts sold in a local natural products store



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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.

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**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 “freshness” 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 business’ 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.

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## 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 \$0.13 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



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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.

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. 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.

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### 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 Easleys' hardwood business cut exactly what the customer wanted, including fence boards, bridge decking and hog farrowing crates. At the same time, the Easleys began their own primary market research to study the 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 Easleys moved their business in a new direction from its original markets.



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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 Easleys 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 Easleys 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 Easleys' 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 Easleys' 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 Easleys' 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."

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“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 cooling 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, planing 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 <sup>®</sup>	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



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## Additional Resources

### **Online Marketing Resources:**

- <http://ohioline.osu.edu/ae-fact/0008.html> - Direct Marketing as a Value-Added Opportunity for Agriculture, Ohio State University Fact Sheet
- <http://www.sfp.forprod.vt.edu> – Non-Timber Forest Products, The Center for Forest Products Marketing and Management, Virginia Polytechnic Institute and State University, and The Southern Research Station, USDA Forest Service, Blacksburg, Virginia
- <http://www.ibiblio.org/pfaf/database/commonM.html> - Plants For A Future Database, Plants for a Future, Blagdon Cross Plant Research and Demonstration Gardens, Ashwater, Beaworthy, Devon, EX21 5DF, England
- <http://www.ces.ncsu.edu/chatham/ag/SustAg/marketing.html> - Growing Small Farms, North Carolina Cooperative Extension.
- <http://www.sare.org/Learning-Center/Books/Building-a-Sustainable-Business> - Building a Sustainable Business. A Guide to Developing a Business Plan for Farms and Rural Businesses. Developed by the Minnesota Institute for Sustainable Agriculture.
- <https://attra.ncat.org/publication.html> - National Sustainable Agriculture Information Service Publication List
- <http://www.centerforagroforestry.org/profit/> - University of Missouri Center for Agroforestry resources
- <http://nac.unl.edu/documents/morepublications/sfp1.pdf> - Scott Josiah, University of Nebraska, Lincoln, Marketing Specialty Forest Products
- <http://nac.unl.edu/documents/morepublications/sfp2.pdf> - Scott Josiah, University of Nebraska, Lincoln, Productive Conservation: Growing Specialty Forest Products in Agroforestry Plantings
- [http://www.agmrc.org/business\\_development/strategy\\_and\\_analysis/](http://www.agmrc.org/business_development/strategy_and_analysis/) - Agricultural Marketing Resource Center. Resources for Business Strategy and Analysis.
- <http://extension.missouri.edu/p/G648> - Break-even Pricing, Revenue and Units.
- <http://extension.missouri.edu/p/G649> - Selecting an Appropriate Pricing Strategy.

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- Gold, M.A., M.M. Cernusca and L.D. Godsey. 2009. Agroforestry product markets and marketing. Chapter 11. In: Garrett, H.E. (ed). North American Agroforestry: An Integrated Science and Practice. 2nd Edition. Agronomy Society of America, Madison, WI.
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- Gold, M.A., L.D. Godsey and M.M. Cernusca. 2005. Competitive market analysis of Eastern red cedar. *Forest Products Journal* 55(12):58-65.

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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?

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# Notes

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# 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.



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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 encour-

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aged 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)
- Wetland Reserve Program (WRP)
- Wildlife Habitat Incentive Program (WHIP)
- Conservation Security 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.

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### *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.

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.

## **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.

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## **Additional Resources**

### ***Economic Budgeting Websites:***

- <http://www.pubs.ext.vt.edu/category/agricultural-financial-mgmt.html>
- <http://extension.missouri.edu/main/DisplayCategory.aspx?C=77>
- <http://www.agrifoodbc.ca/communities>

### ***Funding Incentive Websites:***

- <http://www.fsa.usda.gov> – USDA Farm Service Agency homepage.
- <http://www.nrcs.usda.gov> – USDA Natural Resource Conservation Service homepage.
- <http://www.sare.org> – Sustainable Agriculture Research and Education (SARE) homepage.
- <http://www.attra.org/attra-pub/summaries/betterrural.html> – 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.na.fs.fed.us/pubs/misc/flg> - Forest Landowners Guide to Internet Resources: States of the Northeast, US Forest Service Northeastern Area and the Northeastern Area Association of State Foresters.

### ***Tax Incentive Websites:***

- <http://www.timbertax.org> – National Timber Tax Website
- <http://www.irs.gov> – Internal Revenue Service Website

## 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.

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# Notes

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## 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?*

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## 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.

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## 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
<b>Trees</b>									
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 leaf opaca	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 - 8, 8	WB	O, NT	B	M, X	F-I	70-120'	○	Diseases: foliar fungal/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, HW		D-M	I	80-100'	○ - ●	Missouri native
Black locust <i>Rosinia pseudoacacia</i>	1 - 8	RB, AC, SP, WB	LV	U	M-D	F	40-80'	○	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	50-80'	●	Missouri native
Black walnut -juglans nigra	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-O, X	I	50-100'	● - ●	Missouri native
Blue spruce <i>Picea pungens</i>	1 - 8, 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, HW, W	B-U	M-D, X	S	70-80'	○ - ●	Commonly used in CRP Missouri native
Cherrybark oak <i>Quercus pagoda</i>	8 - 8	AC, RB	HV, W, O	B	M, X	I-F	100'+	● - ○	Excellent market Missouri native
Chinkapin oak <i>Quercus muhlenbergii</i>	1 - 5, 7, 8	WB	LV, HW, 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-O	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

Region: see UNCA Region map / Agroforestry Application: AC=alley cropping, SP=silvopasture, WB=windbreak, RB=riparian forest buffer, FF=forest farming, O=to add diversity / Markets: HV=high value wood products, LV=low value wood products, NT=non-timber forest products, F=fruit, W=edible food or shelter, O=ornamental or Christmas trees, E=environmental / Site: B-bottomland, U=upland / Soil Moisture: W=wet, M=moist, D=dry, X=well-drained / Growth Rate: V=very fast, F=fast, Intermediate, S=slow / Height: maximum range in feet under optimal site conditions / Light Preference: ○=full sun, ●=partial shade/shade, ●-○=full shade

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, MT	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 <i>Amillaria</i> root rot Invader or pest species Missouri native
Green ash <i>Fraxinus pennsylvanica</i>	1 - 8	RB, AC, SP, WB, FF	LV, MT	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	MT, LV, O	B-U	W-O	F-V	80-110'	○	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 haviana</i>	8	RB	LV, HV, W	B	W-M	F	100'	● - ○	Self prunes better than pin oak High flood tolerance
Orange-orange <i>Machaonia pomifera</i>	1 - 3	WB	LV, HV, W	B-U	W-O	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

Regions: see USFCA Region map // Agroforestry Applications: AC=alley cropping, SP=silvopasture, WB=windbreak, RB=riparian forest buffer, FF=forest farming, O=to add diversity // Markets: HV=high value wood products, LV=low value wood products, MT=non-wood forest products, F=fruit, W=wildlife food or shelter, O=ornamental or Christmas trees, E=environmental // Site: B=bottomland, U=upland // Soil Moistures: W=well, M=moder, D=dry, X=well-drained // Growth Rate: V=very fast, F=fast, I=intermediate, S=slow // Height: in some range in feet is near optimal site conditions // Light Preference: ○=full sun, ●=partial shade/sun, ●=full shade

Common Name Scientific Name	Region	Agroforestry Application	Markets	Site	Soil Moisture	Growth Rate	Height	Light Preference	Notes
Red (striped) elm <i>Ulmus rubra</i>	3, 4	RB	LV, NT	B	M-D	I	40-70'	O	Missouri native
Red maple <i>Acer rubrum</i>	1-6	RB, AC, WB, FF	LV, O	BAU	W-D	F	50-70'	I	Missouri native
Red mulberry <i>Morus rubra</i>	3, 5	RB	F	B	M, X	I	40-50'	O-I	Missouri native
Red pine <i>Pinus resinosa</i>	1-6, 8	WB	W, NT, O	U	M-D, X	S	<50'	I-O	Short-lived
River birch <i>Betula nigra</i>	1, 3, 6	RB	LV, O, E	B	M	I	50'	O-I	Missouri native
Sassafras <i>Sassafras albidum</i>	2-4, 8	D	W, NT	U	D-M, X	I	30-50'	O	Missouri native
Scarlet oak <i>Quercus coccoloba</i>	3, 5, 7, 8	AC, SP, WB, FF	LV, HV	U	D-M	I-F	70-80'	O	Fastest growing oak Missouri native
Scotch (Scott's) pine <i>Pinus spresbire</i>	7	WB, AC	O	BAU	M-D	S-I	35-60'	O-I	Many disease and insect problems Short-lived
Shagbark hickory <i>Carya ovata</i>	1-6	RB, WB	W, LV, F	U-B	D-M	S	70-80'	I-O	Missouri native
Shellbark hickory <i>Carya laciniosa</i>	1, 3, 8	RB	W, LV, F	B	W-M	S	80-100'	O-I	Missouri native
Silingle oak <i>Quercus imbricaria</i>	1-6	WB	LV, HV, W	U-B	M-D	S	50-60'	O-I	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'	O	Missouri native
Shamard oak <i>Quercus shumardii</i>	3, 7	AC, SP	LV, HV	BAU	M, X	I	100'	O	Susceptible to oak wilt & insects Missouri native
Silver maple <i>Acer saccharum</i>	1-8	RB, WB	LV, O	B	W-M, D	F-V	60-80'	I-O	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'	O-O	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'	O	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'	O-I	Common in CRP Missouri native
Sweetgum <i>Liquidambar styraciflua</i>	1-8	RB, WB	LV, HV, O, NT	BAU	M, X	I	80-120'	O	Recommended for southern areas Missouri native
Tulip-poplar <i>Liriodendron tulipifera</i>	2-8	AC, WB	LV, HV, O	B	W-M	F	100'	O	Site-sensitive Suffers some wind damage Missouri native
Virginia pine <i>Pinus virginiana</i>	2-8	WB, SP	W, O	BAU	D-M, X	I	40'	O	Tolerant of a variety of soils Prefers clay, loam, or sandy loam Often used in land reclamation

Region: see UMCA Region map // Agroforestry Application: AC- alley cropping, SP- silvopasture, WB- windbreak, RB- riparian forest buffer, FF- forest farming, O- to add diversity // Markets: HV- high value forest products, LV- low value wood products, NT- non-timber forest products, F- fruit, W- wildlife food or shelter, O- ornamental or Christmas trees, E- environmental, U- planted // Soil Moisture: W- wet, M- moist, D- dry, X- well-drained // Growth Rate: V- very fast, F- fast, I- intermediate, S- slow // Height: maximum range in feet under optimal site conditions // Light Preference: O- full sun, I- partial shade, O- full shade

Common Name Scientific Name	Region	Agroforestry Application	Markets	Site	Soil Moisture	Growth Rate	Height	Light Preference	Notes
Washington hawthorn <i>Crataegus pinascifolium</i>	1 - 8	D	W, O	U	M-D	I-S	15-20'	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 - 1	Poorer quality than other red oaks Missouri native
White ash <i>Fraxinus americana</i>	1, 3, 4 7	AC, RB, WB	LV	U-S	M, X	I	70-100'	1 - O	Disease problems Missouri native
White oak <i>Quercus alba</i>	1 - 8	AC, SP, WB, PF	HV, W, LV	B-U	D-M	S	50-100'	1 - 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 - 1	Not drought tolerant
Willow oak <i>Quercus bicolor</i>	3, 7, 8	AC, SP, RB	O, LV, HV	B-U	M	S	50'	O - 1	Missouri native
Common Name Scientific Name	Region	Agroforestry Application	Markets	Site	Soil Moisture	Growth Rate	Height	Light Preference	Notes
<b>Shrubs</b>									
American cranberrybush <i>Viburnum trilobum</i>	6, 8	D	W	B-U	M-W, X	F-I	8-12'	O - 1	Minimum root depth 14"
American plum <i>Prunus americana</i>	1 - 8	RB, WB, PF	W, F	B	M	S-H	<15'	O	Thicket forming Missouri native
Alderwood <i>Viburnum dentatum</i>	1 - 4, 6, 8	D	W	B-U	M-D, X	I-F	<8'	O - 1	Adaptable to varying site conditions
Blackberry, raspberry <i>Rubus spp.</i>	1 - 3, 9	AC, RB, WB	W, F	B-U	D-M, X	F	6-10'	O - 1	Thicket former Missouri native
Blackhaw <i>Viburnum prunifolium</i>	1 - 8	D	W	B-U	M-D	I	12'	O - 1	Missouri native
Buckhorn <i>Rhamnus celtica</i>	5	RB, WB, D	W	B-U	W-D	F	10-20'	1 - O	Alternate host for Oak Rust Can be invasive
Buffalobush <i>Cephaelis 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 selderberry <i>Sambucus canadensis</i>	2, 3	RB, D	W, F	B-U	M-D	F	<10'	O - 1	Edible Good wildlife food source
Cornberry (Blackbrush) <i>Symphoricarpos orbiculatus</i>	1, 3, 5, 8	D	W	U	M-D	I	4-10'	O - 1	Flores 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 - 1	Few disease or insect problems
Delectuous holly <i>Ilex opacifolia</i>	1 - 8	D	W, O	B-U	M-W	S-H	<20'	1 - 1	Adaptable to varying site conditions
Fragrant sumac <i>Rhus aromatica</i>	1 - 8	D	W	U	D	F-I	<10'	1 - 1	Missouri native

Regions: see UMCA Region map if Agroforestry Application: AC=alley cropping, SP=strip cropping, RB=rainforest, WB=wetland, RB=rainforest buffer, PF=forest farming, D=do not add diversity if Markets: HV=high value wood products, LV=low value wood products, NF=non-timber forest products, F=fruit, W=wildlife food or shelter, O=ornamental or Christmas trees, E=environmental, X=Site: B=bottomland, U=upland, W=Soil Moisture: W=wet, M=mod, D=dry, S=well-drained, F=Growth Rate: S=very fast, F=fast, I=intermediate, S=slow, H=Height: maximum range in feet under optimal site conditions, 1=Light Preference: O=full sun, 1=partial shade/burn, 1=full shade

Common Name Scientific Name	Region	Agroforestry Application	Markets	Site	Soil Moisture	Growth Rate	Height	Light Preference	Notes
Gray dogwood <i>Cornus dogwood</i>	1 - 8	D	W, O	B-U	W-MX	I-F	10-15'	●	Thicket forming Can be invasive
Gooseberry <i>Ribes</i> spp.	1 - 3, 8	AC, RB, D	W, F	B-U	M	F	3'	○-●	Thicket forming Missouri native
Hazelnut <i>Corylus americana</i>	1 - 36	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 - 8, 8	D	W	B-U	M	F	10-15'	●	Thicket forming Missouri native
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 - 8, 8	RB, WB	W, O, NT	B	M	I	6-10'	●-○	Thicket forming
Rusty blackhaw <i>Viburnum rufifolium</i>	3, 7	D	W	B-U	M-D	S	<30'	●-●	Missouri native
Serviceberry <i>Amelanchier</i> spp.	3, 7, 8	FF	W, O	U	M-D	I-F	<30'	●	Missouri native
Shrub live oak <i>Leopoldoia bicolor</i>	3	RB, SP, WB	W, E		M-D	F	4-8'	○-●	Good cover and food for game birds and small mammals
Silky dogwood <i>Cornus amomum</i>	1 - 4, 8	WB, RB	W, NT, O, E	B-U	M	F-I	6-10'	●	Thicket forming Missouri native
Whiteoak <i>Eucrymus alopercularis</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>Hicocmata 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



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## Additional Resources

### Online:

- USDA NRCS Plant Database – <http://www.plants.usda.gov/>
- Plant Resource Guide: Materials and Management – <http://www.centerforagroforestry.org/pubs/training/appendix6.pdf>
- University of Connecticut Plant Database of Trees, Shrubs and Vines – <http://www.hort.uconn.edu/plants/a/a.html>
- Grow Native – <http://www.grownative.org/>
- Native Plant Information – <http://www.grownative.org/index.cfm?fuseaction=plants.main>
- Silvics of North American Trees – [http://www.na.fs.fed.us/spfo/pubs/silvics\\_manual/table\\_of\\_contents.htm](http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm)
- MDC Private Lands Division – <http://www.mdc.mo.gov/landown>
- Missouri Flora Database – <http://www.missouriplants.com/>
- Arkansas Home and Garden Plant Database – [http://www.arhomeandgarden.org/plant-of-the-week/archives\\_a\\_d.htm](http://www.arhomeandgarden.org/plant-of-the-week/archives_a_d.htm)
- Grasses of Iowa – <http://www.eeob.iastate.edu/research/iowagrasses/speciescn-nat.html>
- Kansas Wildflowers and Grasses – <http://www.lib.ksu.edu/wildflower/>
- USDA Forest Service Plant Database – <http://www.fs.fed.us/database/feis/plants/>
- The Right Tree Handbook - Minnesota Power – <http://www.mnpower.com/treebook/>

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# Notes

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## 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.

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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:
<b>Alfalfa</b> <i>Medicago sativa</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> </ul>	<ul style="list-style-type: none"> <li>• Hay</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Cool-season</li> <li>• Legume</li> <li>• Persists 5-8 years</li> <li>• Flood intolerant</li> </ul>	<ul style="list-style-type: none"> <li>• Best on well-drained soils</li> <li>• Does best in full sun</li> <li>• Soil pH above 6.0</li> </ul>	<ul style="list-style-type: none"> <li>• Excellent hay</li> <li>• High maintenance</li> <li>• Low to moderate - tree competition</li> </ul>
<b>Alsike clover</b> <i>Trifolium hybridum</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Cool-season</li> <li>• Legume</li> </ul>	<ul style="list-style-type: none"> <li>• Low, well-trees on a variety of soil types</li> <li>• Higher tolerance to soil acidity than Alfalfa</li> </ul>	<ul style="list-style-type: none"> <li>• Sometimes utilized for forage and hay production in mixtures with red clover and grasses</li> </ul>
<b>Annual lespedeza</b> <i>Acutrocarpa sp/ovata or striata</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> </ul>	<ul style="list-style-type: none"> <li>• Wildlife benefits</li> </ul>	<ul style="list-style-type: none"> <li>• Annual</li> <li>• Warm-season</li> <li>• Legume</li> <li>• Tolerates lower pH than other legumes</li> <li>• Tolerates high temperature</li> </ul>	<ul style="list-style-type: none"> <li>• Productive on shallow, infertile soils</li> <li>• Best growth on well-drained soils</li> </ul>	<ul style="list-style-type: none"> <li>• Allow to reseed in late summer</li> <li>• Best used in pastures and most effective when grown in grass sod</li> </ul>
<b>Annual ryegrass</b> <i>Lolium multiflorum</i>	<ul style="list-style-type: none"> <li>• Silvopasture</li> </ul>	<ul style="list-style-type: none"> <li>• Forage</li> </ul>	<ul style="list-style-type: none"> <li>• Annual</li> <li>• Cool-season</li> </ul>	<ul style="list-style-type: none"> <li>• Best under high fertility</li> </ul>	<ul style="list-style-type: none"> <li>• Winter Annual</li> </ul>
<b>Bermudagrass</b> <i>Cynodon dactylon?</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> </ul>	<ul style="list-style-type: none"> <li>• Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Warm-season</li> <li>• Not shade tolerant</li> </ul>	<ul style="list-style-type: none"> <li>• Prefers deep, sandy loam or medium textured soils</li> <li>• Will grow on poorer soils with management</li> </ul>	<ul style="list-style-type: none"> <li>• Grazing tolerant</li> <li>• May winter kill particularly in Northern Missouri</li> </ul>
<b>Big bluestem</b> <i>Anchypogon gerardi</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Wildlife benefits</li> <li>• Erosion control</li> <li>• Hay</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Warm-season</li> <li>• Not shade tolerant</li> </ul>	<ul style="list-style-type: none"> <li>• Prefers deep, well-drained soils</li> <li>• Intolerant of continuously wet soils</li> </ul>	<ul style="list-style-type: none"> <li>• If burned, care must be taken to protect trees</li> <li>• Native</li> </ul>
<b>Birdfoot trefoil</b> <i>Lotus corniculatus</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Cool-season</li> <li>• Legume</li> </ul>	<ul style="list-style-type: none"> <li>• Tolerates poorly-drained, droughty, infertile and acidic soils better than Alfalfa</li> </ul>	<ul style="list-style-type: none"> <li>• Allow stand to naturally reseed every 2-3 years</li> </ul>
<b>Buffalograss</b> <i>Buchloe distachya</i>	<ul style="list-style-type: none"> <li>• Silvopasture</li> </ul>	<ul style="list-style-type: none"> <li>• Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Warm-season</li> <li>• Drought resistant</li> <li>• Soil forming</li> </ul>	<ul style="list-style-type: none"> <li>• Avoid sandy soils</li> </ul>	<ul style="list-style-type: none"> <li>• Withstands heavy grazing</li> </ul>



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"> <li>Silvopasture</li> <li>Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>Wildlife benefits</li> <li>Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>Perennial</li> <li>Cool-season</li> </ul>	<ul style="list-style-type: none"> <li>Grows in wet shaded areas</li> </ul>	<ul style="list-style-type: none"> <li>Native</li> </ul>
Caucasian bluestem <i>Andropogon caucasicus</i>	<ul style="list-style-type: none"> <li>Alley cropping</li> <li>Silvopasture</li> <li>Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>Perennial</li> <li>Warm-season</li> <li>Not shade tolerant</li> <li>Long active growth period</li> </ul>	<ul style="list-style-type: none"> <li>Needs good drainage</li> </ul>	<ul style="list-style-type: none"> <li>Grazing tolerant</li> <li>Don't need to burn</li> </ul>
Creeeping red fescue <i>Festuca rubra</i>	<ul style="list-style-type: none"> <li>Silvopasture</li> <li>Riparian Buffer</li> </ul>	<ul style="list-style-type: none"> <li>Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>Perennial</li> <li>Cool-season</li> </ul>	<ul style="list-style-type: none"> <li>Grows best in well drained, infertile and droughty soils</li> </ul>	<ul style="list-style-type: none"> <li>Shade tolerant</li> <li>Usually used for turf</li> </ul>
Crownvetch <i>Coronilla varia</i>	<ul style="list-style-type: none"> <li>Alley cropping</li> <li>Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>Perennial</li> <li>Deep to root</li> <li>Spreads vegetatively</li> <li>Legume</li> </ul>	<ul style="list-style-type: none"> <li>Best adapted to well-drained, fertile soils with pH 6.0 or greater</li> </ul>	<ul style="list-style-type: none"> <li>Does not tolerate grazing</li> </ul>
Eastern gamagrass <i>Tripsacum dactyloides</i>	<ul style="list-style-type: none"> <li>Alley cropping</li> <li>Silvopasture</li> <li>Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>Wildlife benefits</li> <li>Erosion control</li> <li>Hay</li> </ul>	<ul style="list-style-type: none"> <li>Perennial</li> <li>Warm-season</li> <li>Slow to establish</li> <li>Tolerates temporary flooding</li> <li>Stiff upright stems</li> <li>Forms large clumps or mounds</li> <li>Not tolerant of shade</li> </ul>	<ul style="list-style-type: none"> <li>Deep soils in low areas</li> </ul>	<ul style="list-style-type: none"> <li>Excellent forage</li> <li>Native</li> </ul>
Hop clover <i>Trifolium agrarium</i>	<ul style="list-style-type: none"> <li>Silvopasture</li> </ul>		<ul style="list-style-type: none"> <li>Annual</li> <li>Cool-season</li> <li>Legume</li> </ul>	<ul style="list-style-type: none"> <li>Tolerates poorly-drained, droughty and infertile soils</li> </ul>	<ul style="list-style-type: none"> <li>Used mainly in Southern Missouri</li> </ul>
Illinois bundleflower <i>Desmanthus illinoensis</i>	<ul style="list-style-type: none"> <li>Alley cropping</li> <li>Silvopasture</li> </ul>	<ul style="list-style-type: none"> <li>Wildlife benefits</li> </ul>	<ul style="list-style-type: none"> <li>Warm-season</li> <li>Legume</li> </ul>	<ul style="list-style-type: none"> <li>Grows well on clay or limestone soils</li> </ul>	<ul style="list-style-type: none"> <li>Sometimes used in mix with warm-season grasses</li> <li>Native</li> </ul>
Indiangrass <i>Sorghastrum nutans</i>	<ul style="list-style-type: none"> <li>Alley cropping</li> <li>Silvopasture</li> <li>Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>Wildlife benefits</li> <li>Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>Perennial</li> <li>Warm-season</li> <li>Not shade tolerant</li> <li>grows 4-6 feet tall</li> <li>2-3 years to establish</li> </ul>	<ul style="list-style-type: none"> <li>Deep, moist soils</li> </ul>	<ul style="list-style-type: none"> <li>Native</li> <li>If burned care must be taken to protect trees</li> </ul>

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"> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Erosion control</li> <li>• Vined suppression</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Cool-season</li> </ul>	<ul style="list-style-type: none"> <li>• Grows on a variety of soil types</li> </ul>	<ul style="list-style-type: none"> <li>• Usually used in mixes for grazing</li> </ul>
Little bluestem <i>Scorachyrium scoparium</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Wildlife benefits</li> <li>• Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Warm-season</li> </ul>	<ul style="list-style-type: none"> <li>• Droughty sites</li> <li>• Grows on a variety of soil types</li> </ul>	<ul style="list-style-type: none"> <li>• Mix with warm-season grasses</li> <li>• Native</li> </ul>
Orchardgrass <i>Dactylis glomerata</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Erosion control</li> <li>• Hay</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Cool-season</li> <li>• Shade tolerant</li> <li>• Short lived</li> <li>• Not tolerant of overuse</li> <li>• Bunch grass</li> </ul>	<ul style="list-style-type: none"> <li>• Tolerates moderately poor drained soils, yet is intolerant to flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Mixes well with legumes (alfalfa, ladino clover)</li> <li>• Matures yearly</li> <li>• Moderate - tree competition</li> <li>• Disease problems under some conditions</li> </ul>
Red clover <i>Trifolium pratense</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Erosion control</li> <li>• Hay</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Cool-season</li> <li>• Short lived</li> <li>• Legume</li> <li>• Easy to establish</li> </ul>	<ul style="list-style-type: none"> <li>• Prefers fertile, well-drained medium to heavy textured soils</li> </ul>	<ul style="list-style-type: none"> <li>• Requires reseeding</li> <li>• Best in grass/legume mixture</li> <li>• Common in pastures</li> <li>• Can crowd out grass in seeding year if planted too thick</li> </ul>
Redtop <i>Agrostis gigantea</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Erosion control</li> <li>• Cover crop in orchards</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Cool-season</li> <li>• Long-lived</li> <li>• Sod forming</li> </ul>	<ul style="list-style-type: none"> <li>• Will grow at lower pH and in wetter soils</li> <li>• Adapted to a wide range of soil conditions</li> </ul>	<ul style="list-style-type: none"> <li>• Moderate - competition with trees</li> <li>• Use smooth bromegrass, redtop, alkali clover and ladino clover in fiber strips</li> </ul>
Reed canarygrass <i>Phalaris arundinacea</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Erosion control</li> <li>• Hay</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Cool-season</li> <li>• Grows up to 6 feet tall and dense</li> <li>• Tolerant of wet and drought.</li> <li>• Mat forming - dense</li> <li>• Hard to establish</li> </ul>	<ul style="list-style-type: none"> <li>• Grows well in wet or dry soil</li> <li>• Wet areas</li> </ul>	<ul style="list-style-type: none"> <li>• Recommend low alkaloid variety</li> <li>• Too competitive with trees</li> <li>• Invasive in wet areas</li> </ul>

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"> <li>Silvopasture</li> <li>Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>Wildlife benefits</li> <li>Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>Perennial</li> <li>Warm-season</li> </ul>	<ul style="list-style-type: none"> <li>Droughty sites</li> <li>Grows on a wide variety of well-drained soils</li> </ul>	<ul style="list-style-type: none"> <li>Mix with other native warm-season grasses</li> <li>Native</li> </ul>
Smooth bromegrass <i>Bromus inermis</i>	<ul style="list-style-type: none"> <li>Alley cropping</li> <li>Silvopasture</li> <li>Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>Erosion control</li> <li>Hay</li> </ul>	<ul style="list-style-type: none"> <li>Perennial</li> <li>Cool-season</li> <li>Sod former with good fertility</li> <li>Winter hardy</li> </ul>	<ul style="list-style-type: none"> <li>Best growth on deep, fertile soils</li> </ul>	<ul style="list-style-type: none"> <li>Weeds or companion crops may retard establishment from spring sowing</li> </ul>
Sorghum- sudangrass <i>Sorghum hybrid</i>	<ul style="list-style-type: none"> <li>Alley cropping</li> <li>Silvopasture</li> </ul>	<ul style="list-style-type: none"> <li>Hay</li> </ul>	<ul style="list-style-type: none"> <li>Annual</li> <li>Warm-season</li> </ul>	<ul style="list-style-type: none"> <li>Requires high fertility and moisture</li> </ul>	<ul style="list-style-type: none"> <li>Tall growing, competitive</li> </ul>
Sudangrass <i>Sorghum bicolor</i>	<ul style="list-style-type: none"> <li>Alley cropping</li> <li>Silvopasture</li> </ul>	<ul style="list-style-type: none"> <li>Hay</li> </ul>	<ul style="list-style-type: none"> <li>Annual</li> <li>Warm-season</li> </ul>	<ul style="list-style-type: none"> <li>Requires high fertility and moisture</li> </ul>	<ul style="list-style-type: none"> <li>Tall growing, competitive</li> </ul>
Swainson clover <i>Medicago sp.</i>	<ul style="list-style-type: none"> <li>Alley cropping</li> <li>Silvopasture</li> </ul>	<ul style="list-style-type: none"> <li>Soil improvement</li> </ul>	<ul style="list-style-type: none"> <li>Annual/Biennial</li> <li>Legume</li> <li>Drought tolerant</li> <li>Winter hardy</li> <li>Deep taproot</li> </ul>	<ul style="list-style-type: none"> <li>Not tolerant of acid soils</li> </ul>	<ul style="list-style-type: none"> <li>Improperly cured hay can contain the poison Cytosaurial</li> </ul>
Switchgrass <i>Panicum virgatum</i>	<ul style="list-style-type: none"> <li>Alley cropping</li> <li>Silvopasture</li> <li>Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>Wildlife benefits</li> <li>Erosion control</li> <li>Hay</li> </ul>	<ul style="list-style-type: none"> <li>Perennial</li> <li>Warm-season</li> <li>Long lived</li> <li>Grows 4-8 feet tall</li> <li>Flood and herbicide tolerant</li> <li>Good deep root filtering</li> <li>Slow to establish (2-3 years)</li> </ul>	<ul style="list-style-type: none"> <li>Performs well in wet areas</li> <li>Will grow where many grasses will not</li> <li>Prefers fertile, well-drained sites</li> </ul>	<ul style="list-style-type: none"> <li>Plant thick to avoid weed competition</li> <li>If burned, care must be taken to protect trees</li> <li>Native</li> </ul>
Tall fescue <i>Festuca arundinacea</i>	<ul style="list-style-type: none"> <li>Alley cropping</li> <li>Silvopasture</li> <li>Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>Erosion control</li> <li>Hay</li> <li>Seed</li> </ul>	<ul style="list-style-type: none"> <li>Perennial</li> <li>Cool-season</li> <li>Drought tolerant</li> <li>Hardy</li> </ul>	<ul style="list-style-type: none"> <li>Tolerates many soil conditions</li> </ul>	<ul style="list-style-type: none"> <li>May be too competitive with trees</li> <li>Endophyte friendly varieties recommended</li> <li>Grazing tolerant</li> <li>Good fall pasture</li> </ul>

Common Name Scientific Name	Agroforestry Application	Valued for ...	Growth Characteristics	Site Requirements	NOTES:
Timothy <i>Phleum pratense</i>	<ul style="list-style-type: none"> <li>• Alley cropping</li> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Erosion control</li> <li>• Hay</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Cool-season</li> <li>• Winter hardy</li> <li>• Short lived</li> <li>• Bunch grass</li> </ul>	<ul style="list-style-type: none"> <li>• Prefers well-drained, moist soils</li> <li>• Not tolerant of droughty sites</li> </ul>	<ul style="list-style-type: none"> <li>• Inherent of overgrazing</li> <li>• Use in a mixture with other cool season grasses and legumes</li> <li>• Low – competition with tree</li> </ul>
Virginia wildrye <i>Elymus virginicus</i>	<ul style="list-style-type: none"> <li>• Riparian Buffer</li> <li>• Silvopasture</li> </ul>	<ul style="list-style-type: none"> <li>• Wildlife benefits</li> <li>• Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>• Cool season</li> <li>• Perennial</li> <li>• Slow to get started</li> </ul>	<ul style="list-style-type: none"> <li>• Grows in moist sandy soils</li> <li>• Prefers medium textured soils</li> </ul>	<ul style="list-style-type: none"> <li>• Should be used in conjunction with other grasses</li> </ul>
Western wheat grass <i>Paspoglyum amthii</i>	<ul style="list-style-type: none"> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Wildlife benefits</li> <li>• Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Cool-season</li> </ul>	<ul style="list-style-type: none"> <li>• Grows well on low, heavy soils</li> </ul>	<ul style="list-style-type: none"> <li>• Produces an open but uniform sord</li> </ul>
White/Ladino clover <i>Trifolium repens</i>	<ul style="list-style-type: none"> <li>• Silvopasture</li> <li>• Riparian buffer</li> </ul>	<ul style="list-style-type: none"> <li>• Wildlife benefits</li> <li>• Erosion control</li> </ul>	<ul style="list-style-type: none"> <li>• Perennial</li> <li>• Cool-season</li> <li>• Legume</li> <li>• Not drought tolerant</li> </ul>	<ul style="list-style-type: none"> <li>• Does best in wet soils and seasons</li> <li>• Performs poorly on shallow, droughty soils</li> </ul>	<ul style="list-style-type: none"> <li>• Use in combination with grasses</li> </ul>
<b>GENERAL NOTE:</b>	<ul style="list-style-type: none"> <li>• Warm season grasses may need prescribed fire for management which may not be compatible with agroforestry</li> </ul>				

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## Additional Resources

### Online:

- For a number of publications on specific forages and grasses, visit:  
<http://muextension.missouri.edu/explore/agguides/crops/#Forages>
- Plant Resource Guide: Materials and Management – <http://www.centerforagroforestry.org/pubs/training/appendix6.pdf>
- Establishing Forages – <http://muextension.missouri.edu/explore/agguides/crops/g04650.htm>
- Seeding Rates, Dates and Depths for Common Missouri Forages – <http://muextension.missouri.edu/explore/agguides/crops/g04652.htm>
- USDA NRCS Plant Database – <http://www.plants.usda.gov/>
- University of Connecticut Plant Database of Trees, Shrubs and Vines – <http://www.hort.uconn.edu/plants/a/a.html>
- Grow Native – <http://www.grownative.org/>
- Native Plant Information – <http://www.grownative.org/index.cfm?fuseaction=plants.main>
- Silvics of North American Trees – [http://www.na.fs.fed.us/spfo/pubs/silvics\\_manual/table\\_of\\_contents.htm](http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm)
- MDC Private Lands Division – <http://www.mdc.mo.gov/landown>
- Missouri Flora Database – <http://www.missouriplants.com/>
- Arkansas Home and Garden Plant Database – [http://www.arhomeandgarden.org/plant-of-the-week/archives\\_a\\_d.htm](http://www.arhomeandgarden.org/plant-of-the-week/archives_a_d.htm)
- Grasses of Iowa – <http://www.eeob.iastate.edu/research/iowagrasses/speciescn-nat.html>
- Kansas Wildflowers and Grasses – <http://www.lib.ksu.edu/wildflower/>
- USDA Forest Service Plant Database – <http://www.fs.fed.us/database/feis/plants/>
- The Right Tree Handbook - Minnesota Power – <http://www.mnpower.com/treebook/>



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# Notes

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## 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

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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.

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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*

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*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



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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 Land-owners” 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

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# Notes

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## **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]



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# 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

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’

## Evaluate 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

# 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
<b>1. Management time</b> – When will the new activity not be in conflict with existing activities?	
<b>2. Labor</b> – Times of year when labor is most available.	
<b>3. Equipment and facilities</b> – For animals, storage, value-added processing, time of year available.	
<b>4. Specialized farm equipment</b> – Identify special farm equipment, such as tractors, ATVs, spray equipment, etc.	
<b>5. Irrigation</b> – Water source available.	
<b>6. Plant material</b> – Your own sources of seed, seedlings, cuttings and larger trees, or will you need to purchase them?	
<b>7. Livestock</b> – Cattle, sheep or other animals. What are their needs, and when are those greatest (i.e. calving)?	
<b>8. Materials</b> – Sawdust or shavings, manure and straw, or pine straw, for mulch, etc.	
<b>9. Other</b>	

# 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)					
<b>Labor and management hours available</b>					
Principal Manager					
Team Member 1					
Team Member 2					
Team Member 3					
Hired Labor					
<b>Total Hours Available</b>					
<b>Direct labor and management hours needed by enterprise</b>					
Enterprise 1					
Enterprise 2					
Enterprise 3					
<b>Total labor hours needed</b>					
<b>Total labor hours available (from above)</b>					
<b>Additional labor hours required (total hours needed minus total hours available)</b>					
<b>Excess labor hours available (total hours available minus total hours needed)</b>					

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# 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	



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# 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?

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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?

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### **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?

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Are other wildlife species causing crop damage? \_\_\_\_\_  
If yes, what species?

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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?

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## 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.)?

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Do you or other family members hunt on the property?

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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).

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### *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.

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# 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) \_\_\_\_\_



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# 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

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---

Barn 1

---

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Barn 2

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Other

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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).

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## *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. \_\_\_\_\_

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## 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?

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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					

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# 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)?

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Do you plan to borrow money from a bank for the enterprise?

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Is there a grant program that could provide some startup money? \_\_\_\_\_

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## 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>		





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# Biophysical Site Assessment

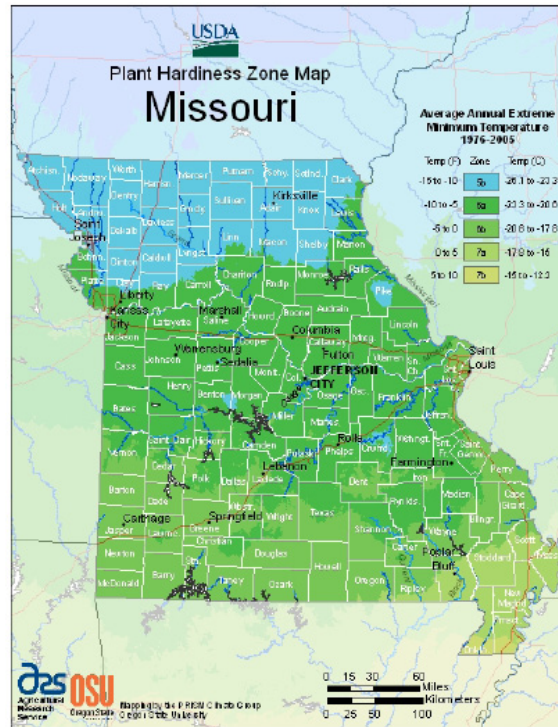
## Step 5: Climate Assessment

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.

<b>Development Area</b>	
<b>Hardiness Zone:</b> Include frost-free days, first and last frosts (see heat zone map on the next page).	
<b>Indicator Plants</b>	
<b>Other Useful Climate Information:</b> <ul style="list-style-type: none"><li>- Mean annual rainfall</li><li>- Mean annual snowfall</li><li>- Average temperatures</li><li>- Open ground: Average date of spring thaw and fall freeze</li></ul>	

# 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.

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# 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 ranges 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

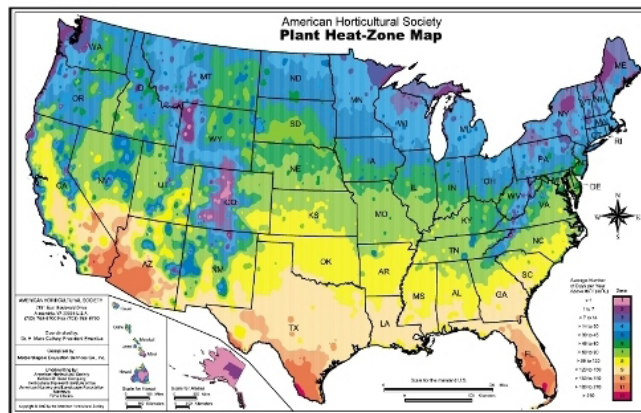
ZONE 8: 90-120

ZONE 9: 120-150

ZONE 10: 150-180

ZONE 11: 180-210

ZONE 12: 210+



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# 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.	

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# 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.



# Biophysical Site Assessment

## Step 8: Timber and Non-Timber Forest Crop Inventory

In addition to telling you what products you might have for sale, the number and quality of plants revealed by your vegetation inventory will provide additional information on site conditions. Photocopy and fill in for each development area.

### Timber Inventory Summary

Development area:

Area (ac):

Plot #s:

Plot Area (ft<sup>2</sup>):

Plots/ac:

Tree Inventory					
Tree species	Percentage of each	Age (opt'l)	Height (opt'l)	Crown closure (%age)	Density (trees/ha)

---

# Biophysical Site Assessment

## Step 8: Timber and Non-Timber Forest Crop Inventory

In addition to telling you what products you might have for sale, the number and quality of plants revealed by your vegetation inventory will provide additional information on site conditions. Photograph and fill in for each development area.

### ***Non-Timber Inventory Summary***

Development area:

Area (ac):

Plot #s:

Plot Area (ft<sup>2</sup>):

Plots/ac:

Non-Timber Inventory					
Harvestable species	Total # of plants (ea. species)	Cover (%) (ea. species)	Harvestable vs. non (%)	Size of plants	Info on plants outside plots

---

# 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**

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---

**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**

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**New enterprise (once it is established)**

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**Non-natural-resource employment (current job)**

---

---

**Other**

---

---

**TOTAL**

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# Agroforestry Development Ideas

## Step 10: Listing 'Best Bets'

The list you make in this step should include all the plants that can grow on your land, and the products that can be derived from them. This list represents a summary of the information you have gathered so far. Photocopy the table below if you are assessing more than one development area.

It is also very useful to consider which Government (State and Federal) Programs are available to provide funding incentives for a broad range of agroforestry activities, from practice establishment through value-added and product marketing.

Development Area	Available Government Incentive Programs:	
'Best Bet' Plants	Potential Products	Volumes (indicate when available)



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## 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.

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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*				
<b>Total</b>					

\*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
<b>TOTAL</b>	<b>69</b>	<b>62</b>	<b>54</b>	<b>59</b>	<b>55</b>

\*Rated on a scale of 1 to 10, with 1 being least compatible and 10 being most compatible

# Evaluate the 'Best Bets' in the Context of the Industry

## Step 11: SWOT Analysis

Start the evaluation with an assessment of internal factors (strengths and weaknesses) and external factors (opportunities and threats). (Refer to the Training Manual, Chapter 9 – Marketing Principles for this exercise)

Internal Factors	External Factors
Strengths	Opportunities
Weaknesses	Threats

---

# Evaluate the 'Best Bets' in the Context of the Industry

## Step 12: Porter Five Forces Model

Identify potential barriers to entry, information about suppliers and buyers, competition and substitute products, and summarize the information in the following worksheet. (Refer to the Training Manual, Chapter 9 – Marketing Principles for this exercise)

<b>Potential entrants (Barriers to entry)</b>
<b>Suppliers – Bargaining power of suppliers</b>
<b>Buyers – Bargaining power of buyers</b>

---

# Evaluate the 'Best Bets' in the Context of the Industry

## Step 12: Porter Five Forces Model, con't

<b>Substitutes</b>
<b>Competitors</b>

---

# 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:		
<b>Product</b>			
<b>Customer Segment</b>	1.	2.	3.
<b>Geographic</b>			
<b>Demographic</b>			
<b>Psychographic</b>			
<b>Needs/ Preferences</b>			





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# 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:		
<b>Product</b>			
<b>Customer Segment</b>	1.	2.	3.
<b>Message</b>			
<b>Tools</b>			
<b>Frequency</b>			
<b>Cost</b>			

---

# 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.

<b>Crop Plant:</b>	
<b>Agroforestry practice (best produced in)</b>	
<b>Where produced (in development area)</b>	
<b>Shade (requirement or tolerance)</b>	
<b>Soil and water (requirement or tolerance)</b>	
<b>Particular plant needs (to produce needed quantity and quality)</b>	
<b>Labor required to grow and harvest (amount and time of year)</b>	
<b>Resource use fit (time, labor and other resources with other activities)</b>	
<b>Compatible crop plants (can be grown with or should not be grown with)</b>	



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# Agroforestry Practice Design and Management

## Step 20: Detailed 'Best Bets' Crop Information (con't)

<b>Crop Plant:</b>	
<b>Compatible livestock (animal and useful interaction)</b>	
<b>Harvest requirements (e.g., by hand, machine, cut tops, dig)</b>	
<b>Post-harvest requirements (e.g., storage, drying)</b>	
<b>Packaging and shipping requirements</b>	
<b>Cost to grow and harvest</b>	
<b>Product(s) on market</b>	
<b>Current market price</b>	
<b>Profit potential</b>	

---

# Agroforestry Practice Design and Management

## Step 20: Detailed 'Best Bets' Crop Information (con't)

<b>Crop Plant:</b>	
<b>Volume (potential production)</b>	
<b>Grade standards in market</b>	
<b>Product influences and trends</b>	
<b>Value-added opportunities</b>	
<b>Other</b>	

# 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

# The Agroforestry Development Plan

## Step 23: Yearly Activity Schedule

This table will represent the work you plan to do in the coming year to develop your agroforestry practice. You should fill in a table for each agroforestry practice. Photocopy as necessary. Be prepared to revise this schedule as necessary.

Agroforestry Practice	Government Incentive Program Special Requirements:			
Time of Year	Management Objective	Specific Tasks	Materials	Labor and Equipment

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# Notes



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## Appendix Section 6: Plant Resource Guide: Materials and Management

Please see <http://www.centerforagroforestry.org/pubs/training/appendix6.pdf> for the full plant resource guide. For your convenience, the Table of Contents follows.

<i>Alfalfa (Medicago sativa L.)</i>	<i>Lespedeza</i>
<i>American Basswood (Tilia americana L.)</i>	COMMON (KUMMEROWIA STRIATA)
<i>American Hazelnut (Corylus americana)</i>	KOREAN (KUMMEROWIA STIPULACEA)
<i>Bald Cypress (Taxodium distichum)</i>	<i>Loblolly pine (Pinus taeda)</i>
<i>Big Bluestem (Andropogon gerardii)</i>	<i>Ninebark (Physocarpus opulifolius)</i>
<i>Bittersweet (Celastrus scandens)</i>	<i>Northern Red Oak (Quercus rubra)</i>
<i>Black Locust (Robina pseudoacacia)</i>	<i>Osage-Orange (Maclura pomifera)</i>
<i>Black Walnut (Juglans nigra)</i>	<i>Passion-flower (Passiflora incarnata)</i>
<i>Blackgum (Nyssa sylvatica)</i>	<i>Paulownia (Paulownia tomentosa)</i>
<i>Blackhaw (Viburnum prunifolium)</i>	<i>Paw paw (Asimina triloba)</i>
<i>Bloodtwig Dogwood (Cornus sanguineum)</i>	<i>Peppermint (Mentha piperita L.)</i>
<i>Bluebells (Mertensia virginica)</i>	<i>Common Persimmon (Diospyros virginiana)</i>
<i>Buffaloberry (Shepherdia canadensis)</i>	<i>Plains Coreopsis (Calliopsis) (Coreopsis tinctoria Nutt.)</i>
<i>Butternut (Juglans cinerea)</i>	<i>Red Clover (Trifolium pratense L.)</i>
<i>Canola (Brassica napus)</i>	<i>Red Maple (Acer rubrum)</i>
<i>Catnip (Nepeta cataria)</i>	<i>Redtop (Agrostis alba)</i>
<i>Chinquapin Oak (Quercus muehlenbergii Engelm.)</i>	<i>River birch (Betula nigra)</i>
<i>Chokecherry (Prunus virginiana)</i>	<i>Sassafras (Sassafras albidum)</i>
<i>Dill (Anethum graveolens)</i>	<i>Scarlet Curls Willow (Salix matsudana 'Scarcuzam' or 'Scarlet Curls')</i>
<i>Dogbane (Apocynum cannabinum)</i>	<i>Scarlet Oak (Quercus coccinea)</i>
<i>Eastern Cottonwood (Populus deltoides)</i>	<i>Serviceberry (Amelanchier arborea)</i>
<i>Eastern Gamagrass (Tripsacum dactyloides)</i>	<i>Shellbark Hickory (Carya laciniosa)</i>
<i>Common Elderberry (Sambucus nigra ssp. canadensis (L.))</i>	<i>Skullcap (Scutellaria lateriflora)</i>
<i>Faba Bean (Vicia faba)</i>	<i>Smooth Sumac (Rhus glabra)</i>
<i>Gray Dogwood (Cornus racemosa Lam)</i>	<i>St. John's Wort (Hypericum perforatum)</i>
<i>Green Ash (Fraxinus pennsylvanica)</i>	<i>Sugar Maple (Acer saccharum Marshall)</i>
<i>Illinois Bundleflower (Desmanthus illinoensis)</i>	<i>Swamp White Oak (Quercus bicolor)</i>
<i>Indiangrass (Sorghastrum nutans)</i>	<i>White Oak (Quercus alba)</i>
<i>Kentucky bluegrass (Poa pratensis)</i>	<i>Wild Plum/American Plum (Prunus americana)</i>
<i>Kentucky Coffeetree (Gymnocladus dioicus)</i>	<i>Witch-Hazel (Hamamelis virginiana)</i>