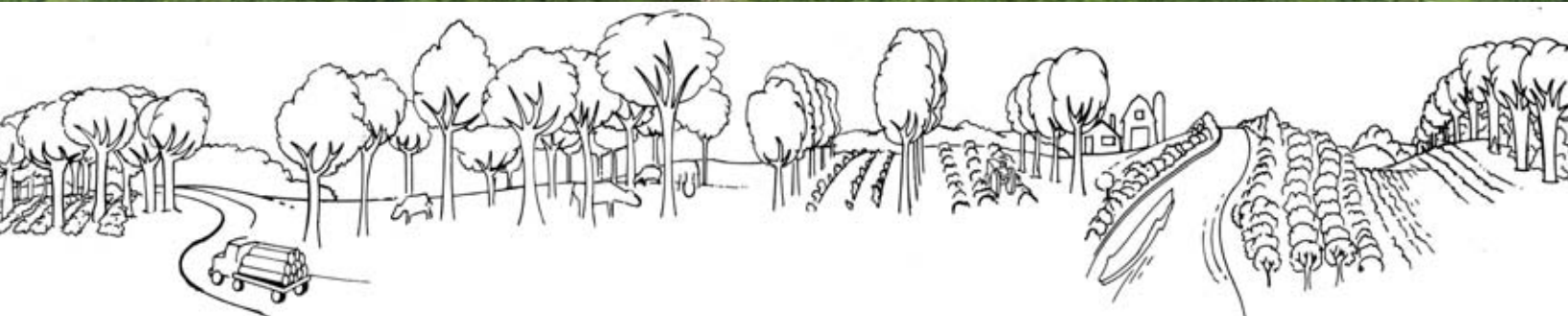


THE UNIVERSITY OF MISSOURI CENTER FOR AGROFORESTRY



2006 ANNUAL REPORT: RESEARCH, PARTNERSHIPS & TECHNOLOGY TRANSFER

a new vision ...



ENHANCING STEWARDSHIP, FARM PROFITABILITY, BIODIVERSITY AND
WILDLIFE HABITAT THROUGH AGROFORESTRY

About the Center

What is Agroforestry?

Agroforestry is new market opportunities. Sustainable Agriculture. Land stewardship. Habitat for wildlife. Improved water quality. Diversified farm income.



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 five integrated practices of agroforestry enhance land and aquatic habitats for fish and wildlife and improve biodiversity while sustaining land resources for generations to come.

The University of Missouri Center for Agroforestry (UMCA), established in 1998, is one of the world's leading centers contributing to the science underlying agroforestry. Interdisciplinary collaboration is one of the outstanding hallmarks of the Center.

Research on the benefits of agroforestry is supported from a broad spectrum of disciplines: forestry, fisheries and wildlife, entomology, plant pathology, agronomy, animal science, horticulture, soils, atmospheric science, agricultural economics and rural sociology.

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

Goals of the Center's Research:

- To generate income and develop new market opportunities for farm and forest landowners
- To protect the environment by reducing non-point source pollution
- To create and improve natural habitats for wildlife
- To mitigate against the impacts of periodic flooding



During the past nine years, the Center for Agroforestry has been hard at work trying to broaden the ways in which we view and practice agriculture for the benefit of the family farm and society as a whole. Agroforestry, as a form of agriculture, is more than just the sum of its parts - trees, crops and livestock. Through proper design and application, agroforestry practices can achieve increased productivity and profit while also enhancing resource stewardship and land conservation.

The Center, in cooperation with our many research partners, is developing the scientific understanding to explain and further improve agroforestry practices. When properly integrated, our research tells us trees will protect crops and improve crop yield. Trees will shelter livestock – and they will reduce animal stress and improve weight gain.

We diligently strive to improve upon our crop trees. A great deal of time and strategic effort is invested to develop improved cultivars of our native pecan and black walnut trees, and to introduce Chinese chestnut as a brand new option for Missouri landowners. In fact, when it comes to northern pecan, eastern black walnut and Chinese chestnut improvement, the Center has the most significant research and technology transfer program in the U.S.A.

The Center represents the state-of-the-art in agroforestry, incorporating all we have learned in our research and from our collaborators and putting it into practice for the benefit of the family farm. We are certainly at the forefront of a new agriculture, and we invite you to join our efforts as we continue building a new vision for farming that fits Missouri's land.

LEADING THE NATION IN RESEARCH

Director's Message

Dear Friends of UMCA,

We are excited and pleased to share with you our Center's 2006 accomplishments. With each year that passes, our understanding of agroforestry and our ability to apply that understanding in designing practices to meet the needs of landowners, continues to grow. We have indeed experienced another year filled with the excitement of discovery. In spite of this, our cup is only half full.

When we began our mission to develop agroforestry technology so many years ago, no one could have even imagined the successes that we would have. Neither could anyone have visualized the opportunities that would be created nor the satisfaction received from watching our work put into practice. Our successes have only served to make us realize how much more there is to learn.

Our vision ... knowledge, success and new options

Our vision is to advance the knowledge of agroforestry so that every practice adopted by a landowner meets — and even exceeds — the needs for environmental benefits and financial gain. To this end, we continue in our development of improved cultivars of black walnut and pecan. We support the most comprehensive Chinese chestnut research and technology transfer effort in the nation, and envision thousands of acres of this valuable species growing in Missouri and the Midwest in the future. Our gourmet mushroom emphasis is quickly leading us to a time when family farms will not only be routinely serving fresh mushrooms at the dinner table, but will experience financial gains from a highly viable new cash crop. New undertakings are leading us into the world of biofuels, directed at helping meet our nation's energy needs while creating yet another potential source of income for the family farm.

While hard at work developing new crops for the family farm, our researchers have never forgotten that the farm is still a place called home. With this understanding comes the challenge to develop technologies that will preserve the integrity and quality of the farm environment so many of us enjoyed while growing up. Our Center echos the sentiments of Aldo Leopold, who said, "A farm can be regarded as a food factory and the criterion for its success is salable products. Or, it can be regarded as a place to live and the criterion for its success is harmonious balance



Photo: Roger Berg's Creative Photo, Inc.

between plants, animals, and people; between the domestic and the wild; and between utility and beauty."

When properly designed and applied, agroforestry can help us meet our financial needs while preserving the integrity, stability and beauty of the family farm. Our vision for the family farm includes alternatives to "help pay the bills" while creating a place for our children to enjoy nature at its best and learn the values that only a family farm can teach. To maintain nature at its best requires an effort on our part to keep our water and air clean.

Our work in designing riparian and upland buffers to keep our waterways clean is becoming widely acclaimed. The EPA recently heralded our findings of the effects of using low concentrations of chlorine to neutralize the active ingredients in the herbicide Balance as being of the highest significance. More recent findings showing the remarkable effects of better designed upland and riparian buffers in promoting the bio-degradation of Atrazine is of colossal significance in our efforts to maintain clean water on family farms and throughout rural areas where corn is grown. We are also working to develop improved windbreaks that are more effective in neutralizing offensive odors from livestock operations.

All of this is part of our Center's vision to help the family farm. As is our Center's goal in everything we do, we are helping develop new technologies and crops that benefit agriculture while preserving and even enhancing our natural resources.

Sincerely,

Gene

"As is our Center's goal in everything we do, we are helping develop new technologies and crops that benefit agriculture while preserving and even enhancing our natural resources."

- Gene Garrett, Director, Center for Agroforestry

The Five Practices of Agroforestry

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Through careful management, agroforestry practices can:

- Diversify products, markets, and farm income;
- Improve soil and water quality;
- Reduce erosion, non-point source pollution and damage due to flooding.
- Enhance land and aquatic habitats for fish and wildlife
- Improve biodiversity while sustaining land resources for generations to come.

In forest farming, high-value specialty crops are grown under the protection of a forest canopy that has been modified to provide the correct shade level. Crops like ginseng, shiitake mushrooms, and decorative ferns are sold for medicinal, culinary, and ornamental uses. Forest farming provides income while high-quality trees are being grown for wood products. Turkey, deer, songbirds and wildlife may find ideal habitat in a forest farming setting.

Properly applied to the forest environment, the forest farming practice can enhance and diversify farm income opportunities, while at the same time making significant improvements to the composition and structure of the forest for long-term improvements in overall health, quality and economic value. By developing an understanding of the interactions between the overstory trees and the understory environment, forest management activities can be used to create an understory capable of growing profitable shade-loving crops. Both long-term tree crops and short-term understory crops can be grown on the same forested land, while managing for a healthier forest.

Silvopasture is the intentional combination of trees, forage and livestock managed as a single integrated practice. In a typical silvopasture practice, perennial grasses and/or grass-legume mixes are planted between rows of trees for livestock pasture. The trees not only provide a long-term investment for nut crops or a timber harvest, but also provide the animals shade in the summer and a windbreak in the winter. In turn, the forage base provides feed for beef cattle which ultimately provides livestock sales for short-term income. A silvopasture practice diversifies farm income; can minimize the need for chemical or mechanical vegetation control; and can reduce hay and feeding costs for livestock.

As a system combined with management-intensive grazed pasture rotation, the integration of grazing livestock into well-managed silvopastures (trees in conjunction with

Forest Farming

Silvopasture

Alley Cropping



INTEGRATED, MANAGED, PROFITABLE

pastures) may provide greater economic returns than livestock grazing in pure pasture settings in the lower Midwestern region, especially during a long-term investment. Research findings from silvopasture study determined that well-managed silvopastures can reduce winter feed costs by approximately 20 percent.

Alley Cropping is planting rows of trees at wide spacings with a companion crop grown in the alleyways between the rows. Alley cropping can diversify farm income, improve crop production and provide protection and conservation benefits to crops. Common examples of alley cropping plantings include wheat, corn, soybeans or hay planted in between rows of black walnut or pecan trees. Non-traditional or value added crops may also be incorporated for extra income, including sunflowers or medicinal herbs planted in between rows of nut trees alternated with nursery stock trees.

Trees selected for alley cropping may include valuable hardwood species, such as nut trees, or trees desirable for wood products. This approach is sometimes called intercropping and multi-cropping. The agroforestry practice of alley cropping diversifies farm enterprises by providing short-term cash flow from annual crops while also providing medium to long-term products from the trees. Rows of trees, shrubs, and/or grasses planted on the contour of a slope will also serve to reduce soil movement down the slope and can protect fragile soils.

Riparian forest buffers are living filters comprised of trees, shrubs, forbs and grasses, including native plants. They enhance filtration of nutrients from surface run-off and shallow ground water. These excess nutrients are utilized for plant growth. Riparian buffers protect the water quality of streams and lakes and are an effective tool for controlling erosion and providing food and cover for wildlife. Decorative woody florals, like red osier dogwood and curly willow, and berries planted in the shrub zone provide additional income

from riparian buffers.

Properly applied on a landscape, the riparian forest buffer can enhance and diversify farm income opportunities, improve the environment and create wildlife habitat. They can be designed to mitigate the impact of land use on the stream or creek, using selected shrubs, grasses, forbs and bioengineered structures adjacent to (or within) a stream. At the landscape level, riparian forest buffers link the land and aquatic environment, and perform vital ecological functions as a part of the network of watersheds that connect forest, agricultural and urban lands.

Windbreaks are planned and managed as part of a crop and/or livestock operation to enhance production, protect livestock, and control soil erosion. Field windbreaks protect a variety of wind-sensitive row, vegetable, orchard and vine crops; control wind erosion; and increase bee pollination and pesticide effectiveness. Livestock windbreaks help reduce animal stress and mortality, reduce feed consumption, and help reduce visual impacts and odors. Windbreaks may also provide excellent wildlife habitat, especially for quail and deer. Windbreaks enhance production and conservation opportunities by modifying air movement and wind speeds.

Riparian Forest Buffers

Windbreaks



“Rural Missouri and the family farm are looking for a new vision — one that includes alternatives to help ‘pay the bills,’ and also preserve the integrity of rural communities. The Center is providing sound science to help realize this new vision.”

- Gene Garrett, Director,
Center for Agroforestry

A Team Effort

The University of Missouri Center for Agroforestry partners with universities, natural resource entities and agricultural organizations and landowners across the Midwest and the nation to preserve and strengthen the family farm and our nation's diverse landscapes.

MU Collaborations

University of Missouri Extension

College of Agriculture, Food and Natural

Resources: *Partnerships with faculty in 10 departments: Animal Science, Horticulture, Forestry, Agricultural Economics, Rural Sociology, Entomology, Agronomy, Plant Pathology, Fisheries and Wildlife and Soils, Environment and Atmospheric Science.*

University of Missouri National Center for Soybean Biotechnology

Food and Agricultural Policy Research Institute (A partnership between the University of Missouri-Columbia and Iowa State University)

University of Missouri Agricultural Experiment Station Outlying Properties:

*Horticulture and Agroforestry Research Center, New Franklin, Mo.
Wurdack Farm, Cook Station, Mo.
The Southwest Center, Mt. Vernon, Mo.
Greenley Memorial Research Center, Novelty, Mo.
South Farms, Columbia, Mo.
Delta Research Center, Portageville, Mo.
Bradford Research and Extension Center, Columbia, Mo.
Thompson Farm, Spickard, Mo.*

External University Partnerships

The Agroecology Issue Team, Iowa State University

Federal and State Agency Partnerships

Federal Collaborations:

USDA Natural Resource Conservation Service
United States Forest Service
National Agroforestry Center, Lincoln, Neb.
USDA Agricultural Research Service - Dale Bumpers Small Farm Research Center, Booneville, Ark.
USDA Agricultural Research Service-Cropping Systems and Water Quality Research, Columbia, Mo.
USDA Forest Service - Central Hardwoods Research Unit, Columbia, Mo.
USDA Forest Service - Hardwood Tree Improvement and Regeneration Center

State Collaborations:

Missouri Department of Conservation
Missouri Department of Natural Resources
Missouri Department of Agriculture

Private Lands and Research Initiatives

Missouri Department of Agriculture
USDA Forest Service - State and Private Forestry Division
U.S. Department Of Energy
USDA-ARS National Germplasm Resources Laboratory
Mid-America Regional Council, Kansas City, Mo.

Professional Associations and Businesses:

Association for Temperate Agroforestry
Missouri Forest Products Association
Missouri Nut Growers Association

The Walnut Council
Chestnut Growers of America
Missouri Northern Pecan Growers, LLC
Missouri Farm Bureau
Missouri Farmers Union
Northern Nut Growers Association
Missouri Tree Farm Association
Missouri Christmas Tree Producers Association

Donors and Friends:

Doug Allen, friend of the Center; has made a planned gift of 521 acres and corresponding resources for the establishment of the Doug Allen Research and Education Site, Laurie, Mo.



“Meaningful interaction is a goal,” says Allen. “We’d like to see interaction between researchers and academia with as many residents of the local community as possible, especially those with limited agricultural income opportunities who may benefit the most from knowledge gained at the site.”

- **Doug Allen**, (above left) friend of the Center for Agroforestry, is working with the Center on the Allen Research and Education Site. The site, a charitable bequest made by Allen to the Center, consists of more than 500 diverse acres of forested, hill and valley land and the corresponding resources to construct a state-of-the-art agroforestry demonstration and teaching facility near Laurie, Mo.

PARTNERSHIPS, STAFF & COLLABORATORS

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Bob Lerch, Ph.D. - ARS/Water
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Richard Schultz, Ph.D. - ISU
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USFS/NAC

Jerry Van Sambeek, Ph.D. - USFS

Doug Wallace, M.S. - NRCS State
Forester

Gary Wells - NRCS/NAC

Bruce Wight - NRCS/NAC

The Center for Agroforestry:

Leading the Nation in Agroforestry Research

- The Center maintains the nation's premier agroforestry research and technology transfer program. Since 1998, the Center has been a featured program receiving annual support from the USDA Agricultural Research Service.
- As a cornerstone of the study of agroforestry, both in Missouri and throughout the U.S., the Center maintains the only comprehensive effort large enough to provide definitive information to the biophysical, social and economic impacts of agroforestry. **World authorities in agriculture** — including Nobel Prize winner Dr. Norman Borlaug and World Food prize winner Pedro Sanchez — have identified the Center as the nation's leading agroforestry program.
- Researchers and collaborators from **10 disciplines** work with the Center to find solutions to Missouri agricultural challenges — forestry, fisheries and wildlife, entomology, plant pathology, agronomy, animal science, horticulture, soils, agricultural economics and rural sociology.
- More than a decade of research has been invested in the **nation's only comprehensive research and market development programs** for growing northern pecans, Chinese chestnuts and eastern black walnuts in orchard settings.
- The Center's 24-channel Flood Tolerance Laboratory is one of the **only outdoor field laboratories** in the U.S. designed specifically to study the impacts of flooding upon plant materials.
- During 2006, more than 40 researchers and collaborators of the Center published **more than 70 articles** in scientific journals and the popular press.

UMCA Research Clusters

Since 2001, UMCA has been supported by and managed three significant USDA - ARS programs, representing more than 50 individual projects. The Center seeks to develop the scientific basis for designing and prescribing agroforestry practices within a "systems context," which allows technology to be used most effectively. To achieve this goal, our research efforts have been organized into eleven research "clusters" to enhance creativity and productivity among a range of investigators from many disciplines. UMCA research continues to serve as a catalyst for stimulating the development of agroforestry throughout the United States.

Clusters include:

1) Nut tree research: Features research on northern pecan, black walnut and chestnut, including field studies, market research and outreach. UMCA supports the nation's most comprehensive research programs for developing the eastern black walnut and Chinese chestnut as nut crops for agroforestry practices.

2) Water quality and riparian forest buffer research: The focus is to demonstrate the environmental benefits of woody/grass buffers on non-point source pollutants. Includes a long-term paired watershed study, an animal bioremediation study and work on riparian forest buffers in collaboration with Iowa State University scientists.

3) Flood tolerance research: A state-of-the-art flood tolerance research facility at the Horticulture and Agroforestry Research Center is used to study the effects of short- and long-term flooding on woody and non woody plants. Results link directly to "green infrastructure" projects in Kansas City with the Mid-America Regional Council and National Agroforestry Center.

4) Socio-economic-marketing research: The cluster's integrated approach responds to the need to facilitate adoption of new practices in agroforestry, which requires understanding of the social and economic dimensions of a given enterprise. These dimensions include institutions, networks, markets, technology, and environment. Research activities provide an understanding of important factors that facilitate or constrain involvement in agroforestry and are directly linked with the technology transfer program.

5) Fast growing hardwood biomass research: Focus is to quantify growth of Populus clones and other species for biomass production, flood tolerance and levee protection.

6) Forest bottomland and wildlife restoration and biodiversity research: Bottomland hardwood restoration and management studies; quantifying effects of bottomland agroforestry practices on wildlife species.

7) Silvopasture Research: Studies include response of cattle and trees in pastures with planted trees; extending the

grazing season with early/late season forages sown under alley cropped pine; effects of managed hardwood forest stands and grazing upon understory shade tolerant forages and stand regeneration.

8) Horticulture research: Ongoing studies with gourmet mushrooms, medicinals, phytochemicals, pine straw, woody and non-woody florals.

9) Tree/Crop interactions: This cluster impacts all biophysical research clusters, with a focus on multiple above and below-ground interactions between trees and crops, and also includes insect predator-prey dynamics.

10) Carbon sequestration cluster: Above/below ground carbon balance studies; excavation of exposed ancient riparian stream wood to reconstruct climate record for past 14,000 years.

11) Technology transfer cluster: Primary research efforts are centered around four outlying university research properties, with a focus on ongoing agroforestry research and land-owner demonstrations in adjacent locations complimented by socio-economic studies. Additional agroforestry research is conducted at University research farms across the state.



The Center for Agroforestry conducts primary research on four farm sites that are part of the University of Missouri Agricultural Experiment Station, representing the economic and ecological diversity of the state. Additional research farm sites are incorporated on a regular basis as the Center expands the depth and breadth of its program.

SCIENCE IN A SYSTEMS CONTEXT



The Horticulture and Agroforestry Research Center (HARC)

New Franklin, Mo.

Aerial view, the 660-acre Horticulture and Agroforestry Research Center (HARC), New Franklin, Mo.

The Horticulture and Agroforestry Research Center (HARC), located at New Franklin, Mo., is the primary research site for UMCA. This 660-acre farm includes several experimental fruit and nut orchards; forest farming, riparian buffer and silvopasture demonstrations; forage shade trials; greenhouses; a flood tolerance laboratory; five lakes and ponds and one of Missouri's oldest brick homes, the 1819 Thomas Hickman House.

The farm, set in the beautiful, rolling Missouri River hills, is also a U.S. National Arboretum Midwest Plant Research and Education

Site. Tours and educational events are hosted regularly.

HARC is one of the University of Missouri's 14 outlying research farms, a network of sites across the state hosting state-of-the-art programs that bring Missouri agricultural land and forest owners new information for reaching maximum income potential and environmental benefits on a variety of land types and ecoregions. The farm opened in 1953 with a focus on horticultural research. In 1993, the agroforestry research program was introduced, and the Horticulture Research Center officially became the Horticulture and Agroforestry Research Center in 1995. A recent land purchase of 118 acres expands the total acreage to nearly 660 acres.

Through an interdisciplinary approach, UMCA leads the nation in key research areas conducted at the HARC farm:

- *Extensive bioremediation, non-point source pollution and shade and flood tolerance studies, including an innovative, outdoor 24-channel flood tolerance research laboratory - one of the most comprehensive flood research sites in the nation.*
- *Projects for producing gourmet, high-value mushrooms, including morel and shiitake.*
- *The U.S. National Arboretum Midwest Plant Research and Education Test Site.*
- *Location of one of Missouri's oldest brick homes, the historic 1819 Thomas Hickman House, now listed on the National Register of Historic Places.*
- *Long-term research programs on the development of eastern black walnut, northern pecan and Chinese chestnut into profitable orchard crops.*

The Horticulture & Agroforestry Research Center (HARC)

Land and Soils – The Missouri River Hills region

Visitors to the research farm often comment on the beautiful, rolling hills and exceptional views. The farm is positioned amidst the Missouri River Hills at one of the highest elevations in Howard County, creating a diversity of establishment sites for researching plant and tree combinations.

Examples of Current HARC Research Projects:

The University of Missouri Center for Agroforestry promotes a remarkable diversity of research at the farm to explore tree, grass, crop and livestock combinations that are optimum for establishing demonstrations of the five agroforestry practices – alley cropping, silvopasture, forest farming, windbreaks and riparian forest buffers.

Pitch x Loblolly Pine and Black Walnut Winter Forage Alley Cropping Study:

This study explores the effects of row spacing on tree growth and tree/forage interactions in an alley cropping practice. Pitch pine / loblolly pine hybrids and black walnut planted in single, double and triple rows are grown to examine the effects of row configuration on these species, emulating an alley cropping practice.

Agroforestry and Grass Buffers to Improve Water Quality: Landowners often look to the USDA-NRCS agency for assistance in selecting conservation practices to qualify for cost-share support and to meet price support payments. To assist NRCS and other natural resource-based agencies, the Center has developed a watershed study at the HARC farm to measure the effects of agroforestry and grass buffers for reducing non-point source pollution from grazing. The study will also provide data for calibrating a GIS model simulating the conservation benefits of agroforestry buffer systems.

Soils samples from the watershed are compared among grazing, grass buffer, agroforestry buffer and control areas to examine how management treatments affect the soil's properties, including the

ability to capture plant nutrients. Runoff samples collected after each rain are analyzed for sediment, bacteria, nutrients and antibiotics.

Pitch x Loblolly Pine Progeny Testing:

Superior selections of Pitch x Loblolly and cold-hardy Loblolly pine are being evaluated for their potential for use by landowners to produce timber and pine straw mulch. The evaluation includes insect and disease pests, cold hardiness, growth rate and length and yield of needles.



Mushroom Trials for Forest Farming:

Researchers are evaluating morels, shiitakes and other gourmet mushrooms for landowner production and profit. Not only can specialty mushrooms be grown on a range of acreage allotments, mushroom cultivation is a sustainable and profitable way to recycle low-value forestry by-products, including non-merchantable stems and branch wood. Utilizing shade levels and understory from a forest farming practice, UMCA scientists and collaborators are determining the best suited types of mushrooms for Missouri soils.

Cottonwood Clonal Trial/ Flood Tolerance Evaluation:

Eastern Cottonwood (*Populus deltoides*) is a fast-growing, "soft" hardwood tree used to produce biomass for products including Oriented Strand Board and pulp and paper production. In 1997, cottonwood clonal trial studies began at the research farm to evaluate cultivars for their growth response and adaptability to Missouri conditions, allowing researchers to identify the best cottonwood cultivars for agroforestry plantings.

In addition to biomass for the construction or paper industries, cottonwood can be grown as a source of biomass for carbon sequestration, fuel and energy production, and levee protection, due to its suitability for floodprone areas. In 2004, a follow-up study was initiated to evaluate survival and growth of the ten most productive cottonwood clones grown under four different flooding regimes.

Silvopastoral Practice:

Through well-managed grazing areas on the farm, researchers are investigating the similarities and differences in cattle performance between traditional open grazing and silvopastoral grazing practices. Factors also being evaluated include the success of electric fences as deterrents to protect young trees from grazing damage; how grazing and forage production affect tree growth; and how trees affect forage growth by utilizing the pine/black walnut alley cropping demonstration area for controlled grazing.

Pine-Straw:

The purpose of this study is to evaluate pitch x loblolly hybrid pines (*Pinus rigida x taeda*) for their suitability for the production of 'pine straw' mulch in Missouri. Pine straw, the naturally shed needles of pine trees, is an excellent mulch material used extensively in the Southeastern United States in landscape plantings. The purpose of hybridizing these two pine species was to

HARC RESEARCH : MORE THAN 60 PROJECTS FROM 10 DISCIPLINES

create a pine with the cold hardiness of a pitch pine and the fast growth rate and long needles of a loblolly. Fifteen different genotypes of this hybrid are being evaluated for cold hardiness, growth rate, needle length and needle yield.

Missouri Gravel Bed for Nursery Stock:

The Missouri Gravel Bed (MGB) is a method, developed at HARC, that allows planting of bare root nursery stock at any time of the year. Dormant, bare rooted trees and shrubs are set into a frequently irrigated mixture of pea gravel and sand. Plants can be removed from the gravel at any time during the summer and fall and field planted bare root, in full leaf with a survival rate equal to or greater than those expected for container-grown or balled and burlapped plants. The main objective of this project is to evaluate the potential of MGB to facilitate planting of trees and shrubs in agroforestry and landscape plantings.

Forage Shade Tolerance Study:

Managing correct shade levels are critical in a successful agroforestry practice. In 1994, researchers began a shade tolerance project by examining 27 forage species (native and exotic legumes, warm season and cool season grasses) for the effect of shade on dry weight production and nutritional value. During the intervening years, additional species have been studied. In 2005, the shade tolerance facility was completely rebuilt and expanded to 15 structures. New treatments added included a treatment that

compares intermittent shade as sunflecks to continuous dense shade. All species are currently being evaluated under 5 shade level treatments: 0% (full sun), 30% shade, 55% shade, 80% shade and 78% shade (sunflecks). Research emphasis has recently switched from cool-season forages to warm-season forages.

The goal of the project is to determine growth and development under different shade conditions to help identify forages suitable for agroforestry practices or for savanna and woodland restoration.

Quail Cover Bundle Habitat Study:



Bobwhite quail populations are declining in the Midwest, an occurrence linked with a loss of suitable habitat — especially woody shrub cover next to feeding areas.



To help regenerate suitable quail habitat, the Missouri Department of Conservation and several private nurseries are now packaging seedling bundles of mixed shrub species for planting along the edge of fields to create nesting and roosting areas. Researchers at the HARC farm are evaluating the survival and growth of five of these shrub species at two different spacings, and studying the species' response to prescribed fire.

Flood Tolerance:

A Flood Tolerance Laboratory was constructed along Sulphur Creek in the Missouri River floodplain at HARC. This facility provides one of



More than \$1 million have been invested in equipment and facilities at the Horticulture and Agroforestry Research Center (HARC) to create the nation's most comprehensive agroforestry research facility.

The Center funds six full-time research specialists to support ongoing research efforts on more than 400 of the 660 acres of land at HARC.

Every year, workshops, trainings and outreach events bring hundreds of landowners, policy makers and natural resource professionals to tour the farm's demonstration areas. In 2006, more than 15 outreach events were held at HARC.

The Horticulture & Agroforestry Research Center (HARC)



the nation's most comprehensive and unique field laboratories for studying the response of plant species to the periodic flooding common to Midwestern floodplains. The laboratory has 24 channels, each approximately 16-ft wide by 300-ft long. Each channel can be independently adjusted for water depth, standing or flowing water, and duration of flooding. Selected grasses, legumes, soybeans and tree species are being evaluated for flood tolerance. The flood tolerance of hardwood planting stock and genetic variation in ecotypes from seed collected from bottomland and upland stands is also being evaluated.

Bioterracing Demonstration: This project demonstrates the value of bioterracing on highly erodible soils. Bioterraces are a combination of trees and shrubs planted in rows along the lands topographic contour to help trap soil and debris as they move down a slope in surface water flow. Over time these same trees and shrubs will also begin to filter sub-surface flow of water through the soil. Depending on the space between the tree/shrub rows, annual crops like milo, corn, soybeans or sunflowers, for example, may be produced.

Nut Tree Improvement: The tree improvement program focuses on identifying and testing selections of black walnut (*Juglans nigra*), pecan (*Carya illinoensis*) and chestnut (*Castanea mollissima*) for inclusion in agroforestry plantings. Major components of this research include (1) evaluating a wide array of nut cultivars on various sites in Missouri and adjoining states; (2) identifying superior rootstocks for grafting; (3) refining orchard management practices; and (4) initiating breeding program(s) to develop improved selections.

Most black walnuts in Missouri are harvested by hand as they drop from wild trees in a forested setting. The Center is developing new cultivars that produce consistent yields, a consumer-preferred flavor and predictable harvest dates — allowing landowners to achieve higher profits from this nut crop. Since its establishment in 1996, a total of 70 different black walnut nut cultivars have

been acquired and placed in a series of grafted orchard collections. Beginning in 2000, a series of careful observations (“descriptors”) were initiated on an annual basis for all of the repository trees. This information allows researchers to learn more about how a species can vary for a number of commercially important characteristics.

The Chinese chestnut, a crop that is largely unknown to Americans since the near extinction of the American chestnut forest from chestnut blight (1900-1950), shows excellent potential for Missouri/Midwestern landowners as a cash income crop. Currently, demand exceeds supply for this sweet, starchy nut that boasts a high nutritive value. Chinese chestnut cultivar research at the HARC farm began in 1996. The research repository includes more than 50 cultivars under evaluation in an orchard setting to determine the best-suited selections for Missouri's promising chestnut industry.

Native Plants Demonstration Area: Native perennial shrubs, forbs, and grasses have been established in demonstration plots in Zone 5 (a climate test area adjacent to the NC-7 Trials, see below) at HARC and in the field. Some of the shrubs and forbs included are false wild indigo, dwarf Amorpha, shining wild indigo, Ouachita false indigo, swamp milkweed, shining blue star, and wild quinine. Grasses included are eastern gammagrass, dropseed, cluster fescue, and river oats. These plots are used for demonstrations during field days.

National Arboretum / NC-7 Trials: Evaluating Rare Plants
A cooperative agreement in 1996 designated HARC as a U.S. National Arboretum Midwest Research and Education Site for Climate Zone 5. Since then, many National Arboretum introductions have been planted, including red maples, alders, disease resistant elms, ‘Green Giant’ arborvitae and other specimens of new and unusual plants. This planting serves as a germplasm repository and evaluation site for newly introduced and rare woody plants with potential ornamental value. A number of species for inclusion in various agroforestry practices are being evalu-

ated and demonstrated within the test site.

Horticultural Research with Orchard Crops: Pest Control Strategies Within an alley cropping or silvopasture practice, a land or forest owner has the opportunity to harvest nuts and fruits from a tree crop while simultaneously growing row crops and/or managing livestock. Horticultural studies on apple crops at the research farm are helping UMCA collaborators understand the effects of insecticides on pest populations, and potentially alter the impact of detrimental moth species. Alternative pest control strategies, such as mating disruption, are also being evaluated for Midwestern conditions. These studies may provide apple growers with objective information regarding the use of environmentally-friendly pest control methods.

A New Vision ...

- *HARC is a showcase for specialty crop production.*
- *In the coming years, the farm will serve as a pivotal research and demonstration site, leading the way toward the future of Missouri agriculture.*

THE ANNUAL MISSOURI CHESTNUT ROAST: A FESTIVAL OF MISSOURI CULTURE & AGRICULTURE



Nut crops produced through agroforestry practices—like chestnuts, walnuts and pecans — can have a direct impact on Missouri’s environment and the health of its soils and water. These specialty crops can add appeal to the shelves of local grocers, and the plates served at local restaurants, while generating revenue for Missouri farms and farm families. The University of Missouri Center for Agroforestry leads the nation’s most comprehensive research programs for cultivating Chinese chestnuts, eastern black walnuts and northern pecans in an orchard setting.

It’s from this desire to see farm families and Missouri communities thrive and remain healthy that the Missouri Chestnut Roast evolved. More than 4,000 people attended the 4th Chestnut Roast last year and learned about sustainable agricultural practices like agroforestry. They were exposed to a variety of Missouri-grown products and met the producers first-hand. They toured the University research farm and left with a new understanding of the benefits of agroforestry to our state.



The annual Missouri Chestnut Roast is much more than a celebration of the industry’s potential in Missouri; it is a showcase of Missouri’s meats, cheeses, breads, wines and other value-added products — and a showcase of the unique agricultural and cultural heritage our state. Guided tours of the 1819 Thomas Hickman House, now listed on the National Register of Historic Places,

help give guests a new understanding for Missouri’s past and its future. With more than ten stops across the farm, guided bus tours of the Center’s research demonstrations are a popular outreach tool.

As one of the premier agricultural events in the state, the annual Missouri Chestnut Roast is showing Missourians and the Midwest the power and potential of agroforestry practices.



The Center coordinates the most comprehensive chestnut research program in the USA, and is in a leadership position in the U.S. industry. By 2020, over 2,000 acres of Chinese chestnut orchards will be producing more than 4 million pounds of chestnuts with a wholesale crop value of more than \$13 million to Missouri producers.



Highlights, Missouri Chestnut Roast:

- The event is set amidst the beautiful Missouri River Hills and historic 1819 Thomas Hickman House, recently added to the National Register of Historic Places
- Showcase of Missouri’s outstanding agricultural products, including wines; jams and jellies; pecan, walnut and chestnut products; locally-produced honey; cheeses and meats
- More than 30 value-added agricultural food vendors and educational exhibitors attended in 2006, free of charge.
- Demonstrations of new research on profitable specialty products produced through agroforestry, including pine straw, gourmet mushrooms and Eastern Red Cedar
- Guided tours of 660-acre Horticulture and Agroforestry Research Center featuring diverse agricultural practices
- Children’s Tent, farm display, family music and activities
- Nearly 1,000 in attendance at first Chestnut Roast in 2003; Attendance exceeded 4,000 in 2006.

Technology Transfer

A primary goal of the Center for Agroforestry is to educate and inform landowners and natural resource professionals about new research in agroforestry, and to demonstrate how this can be applied successfully to their operations. The UMCA Technology Transfer team works side-by-side with landowners, resource professionals and extension agents from across the state, and the Midwest, through on-site consultations, educational workshops and informational exhibits.

Each of these activities creates an "impression" of the Center's research and its resources – and over time, these total impressions will be translated into direct benefits to land and forest owners and their surrounding communities, the natural environment and consumers on a broad spectrum.

During 2006, the Center for Agroforestry participated in more than 40 events across the Midwest to promote the science and practice of agroforestry, often serving as featured speakers.

Five workshops and training events were hosted or co-hosted by the Center to increase the knowledge base of landowners and natural resource professionals toward agroforestry practices, including the Agroforestry Professional Training Workshop, which drew more than 50 professionals from the natural resource-based fields. Many workshops are supported by the Center's Sustainable Agriculture Research and Education (SARE) Professional Development Program (PDP) grant, awarded in 2005.

SARE Grant - Funding for Professional Development

In 2005, a USDA Sustainable Agriculture Research and Education (SARE) Professional Development Program (PDP) grant was awarded to the Center to support trainings targeted to a specific audience - representatives from natural resource-based and professional agricultural organizations.

More than 50 professionals attended the first SARE PDP workshop, an Agroforestry Professional Training Workshop in January of 2006. The workshop utilized a newly updated Agroforestry Training Manual, which includes materials on planning, wildlife, marketing and crop sheets for specific plants. The workshop provided the basic knowledge and informational support for motivating natural resource professionals to get more involved in implementation of agroforestry practices. It also provided a list of participants and their con-

tact information to help enhance networking and partnering among resource professionals working with farmers.

Impacts: Agroforestry Training for Professionals - Jan. 10-11, 2006



Participants included government agency and natural resources professionals, along with members of university extension. Other participants included students, researchers and individuals interested in agroforestry.

Participant feedback revealed that:

- Participants came to the workshop with some knowledge about agroforestry practices (more about forest management, riparian forest buffers and windbreaks and less about marketing and economics). However, a significant gain in knowledge was obtained for all topics presented.
- Attendees were very satisfied with the organization and content of the workshop. The quality of the workshop overall was rated excellent or good by 95% of participants.
- Partnering: The workshop strengthened communication among the core agencies and groups represented. The case study improved participants' ability to recognize the value of partnering with different organizations representatives.

View the new Agroforestry Training Manual online at: www.centerforagroforestry.org (**Publications page.**)

OUTREACH, EDUCATION & EVENTS

Windbreaks Workshop

Believing that the benefits agroforestry can provide to landowners and communities are constantly expanding, the Center coordinated a windbreak workshop focused on how windbreaks can be applied to help manage livestock odors, especially in Confined Animal Feeding Operations (CAFOs). Funded by a SARE Professional Development Program grant, more than 30 individuals from natural resource and government agencies attended the event to learn about utilizing windbreaks for odor mitigation, aesthetic value, livestock health and value-added income opportunities.

Impacts: Windbreaks Workshop

- For the large majority of respondents, the expectations before the conference were met or exceeded on almost all topics.
- A significant gain in knowledge was registered. On a scale of 0 (never exposed before) to 4 (can apply in practice), the average ratings for the specific topics varied from 1.30 to 2.04 before the conference and from 2.65 to 3.83 after the conference.
- The workshop overall was rated excellent (65%) or good (35%) by participants.
- The majority of participants considered that the organization of the workshop was excellent; the content was useful; the presenters created a stimulating interest in topics; and that the time for discussion was excellent.



Building Tomorrow's Agroforestry Leaders



Introduction to Agroforestry Course:

The Center continues to apply its research to a university agroforestry course, drawing upon a real-world case study each semester as a teaching tool. Students present their plans for implementing agroforestry to participating landowners at the conclusion of the course.

Gene Sandner, S & S Seed Farms, landowner from Rocheport, Mo., collaborated with the Center to serve as the agroforestry case study. Sandner plans to use student recommendations to help implement a farm plan that combines profit and wildlife habitat enhancement, while minimizing off-site impacts.

"It was interesting to be the case study for the course. I learned a great deal about windbreaks and riparian forest buffers, especially how they are related to environmental benefits," said Sandner. "It was very worthwhile, and I hope to implement some of the practices on my property."

Hispanic Association of Colleges and Universities: Valerie Mireles assisted the Center during 2006 as an intern in the Shade Tolerance Laboratory. Supported by the Hispanic Association of Colleges and Universities' National Intern Program, Valerie contributed to key research evaluating the shade tolerance of ground covers for use in agroforestry practices.

Future Farmers of America (FFA): The Center for Agroforestry is pleased to have contributed to the Missouri FFA Forestry Contest, held in conjunction with the state FFA Convention. More than 140 students competed in areas including map reading, general forestry knowledge, timber stand improvement and native tree identification. Center staff assist annually, and served as Contest Superintendent in 2006.

Technology Transfer

Specialty Mushroom Production and Marketing Workshop

Utilizing the Center's innovative research program for specialty mushrooms, a hands-on workshop was held Feb. 18, 2006, at the Horticulture and Agroforestry Research Center to teach landowners about cultivating and marketing gourmet mushrooms in a forest farming practice. The workshop is held every other year, part of the Center's work to offer land and forest owners options for additional income from agroforestry practices. Classroom presentations and guest speakers are accompanied by hands-on instruction at the HARC farm.



Impacts: Specialty Mushrooms Workshop

100% of participants indicated that they intend to put in practice the ideas covered in the workshop.

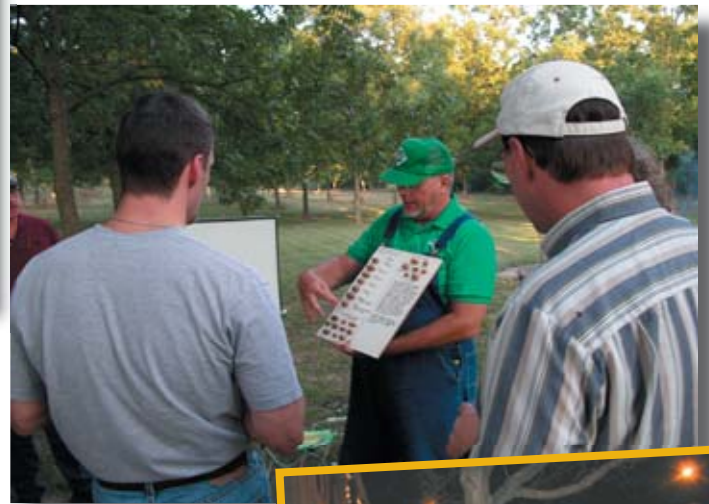
The majority of participants felt that the workshop was great "as is" and wouldn't change anything; 97% of participants would recommend the program to others.

Outdoor log cultivation of shiitake mushrooms (92%) and practical demonstrations of log inoculation (89%) were the highest motivational factors to attend the workshop.

woody florals, specialty wood products, and gourmet mushrooms. Timber management and livestock production in a silvopasture practice were also addressed.

"Through the conversations and interaction at field tours, we hope to help land and forest owners connect with their peers and create a lasting learning environment," said Dusty Walter, Center for Agroforestry technology transfer specialist.

Farmers' Market and Downtown Festivals In addition to cultivar and industry research, the Center works to promote chestnuts to the public to increase demand and awareness for the sweet, starchy nuts. Chestnuts are overwhelmingly popular at the local farmers' market and the annual Living Windows winter festival in downtown Columbia. The Missouri Chestnut Roast, hosted each fall by the Center, brings several thousand Missourians and Midwesterners for agroforestry tours and chestnut samples, helping spur increased demand in the state for chestnuts -- and to increase the popularity of roasted chestnuts at seasonal events.



Agroforestry Trainings in Kentucky Three workshops, three counties, three days — In collaboration with University of Kentucky Forestry Extension, the Technology Transfer Team offered an overview of relevant agroforestry practices as part of an overall initiative to see agroforestry expanded not just in Missouri, but throughout the U.S.

Agroforestry Farm Tour

Working with University of Missouri Extension personnel in collaboration with the Missouri Department of Conservation, the Center helped lead an Agroforestry Farm Tour in Perry County, Mo. Held near the Bootheel region of the state, the tour focused on ways to profit from agroforestry.

Inspiration for the workshop was based upon the opportunities for niche agricultural products the five practices of agroforestry can provide - products including pecans, black walnuts, chestnuts, pumpkins and gourds, decorative

OUTREACH, EDUCATION & EVENTS

Public Relations and Outreach:

From radio program coverage on chestnuts and mushroom production, reaching more than 35,000 listeners, to nation-wide Associated Press news coverage and specialized tours, the Center for Agroforestry continues striving to make "agroforestry" a household name. Media appearances and special events are tailored to the specific audience, from the health benefits of nut consumption to the

possibilities for value-added niche products produced through agroforestry practices.

Articles featuring the Center's nut tree research appeared during 2006 in the *Kansas City Star*, the *St. Louis Post-Dispatch* and *Mid-Missouri Mature Living*, among others. A special episode of "Show Me Ag," a Public Television production, also featured the Center's research to promote income opportunities while sustaining healthy environments.



Newsletters and Informative Guides

The Center produces

the *Green Horizons* and *The Chestnut Grower* newsletters as tools to further increase awareness and application of agroforestry practices. Through features including the landowner spotlight, the events calendar, a new wildlife focus, "tax talk," *Green Horizons* continues to reach a diverse audience with timely and useful information.

The "Agroforestry in Action" series translates agroforestry science into information landowners can apply directly to their acreage.

South Farm Demonstration Area

Based on the success of annual Chestnut Roast, UMCA staff members collaborated with MU and the College of Agriculture, Food and Natural Resources to organize a large-scale outreach event at the MU South Farm, called "South Farm Showcase." Hundreds of families attended the free event to learn more about agricultural innovations at the University of Missouri.

The MU South Farm features several agroforestry demonstrations, including a new project initiated in 2006 - the planting of 2,000 pitch-loblolly pines as part of a whole farm, integrated agroforestry plan. The plan includes a silvopasture practice and two windbreaks.



"While attending the Chestnut Roast, it was really apparent that the Center is knowledgeable regarding the numerous projects underway, the "whys" and potential economic development applications of those research endeavors ..."

- John Campbell, President Emeritus, Oklahoma State University and Professor Emeritus, University of Missouri; author of "Reclaiming a Lost Heritage."

Technology Transfer: Socioeconomic Connections



Socioeconomic Cluster: Facilitating Adoption Of Agroforestry Practices

Understanding the social and economic conditions related to landowner adoption of agroforestry practices is a key component of the Center's research program. Institutions such as natural resources organizations, community educational and outreach programs, networks among professionals and landowners and the markets in which agroforestry products are sold play a critical role in the successful application of agroforestry practices to forest and crop lands.

Primary objectives of the Center's socioeconomic research cluster are to 1) analyze the roles that agriculture and related organizations play in agroforestry adoption and 2) explore the perceptions and attitudes toward agroforestry among landowners, as well as the perceptions of employees of natural resource organizations. Specific research areas include: the socioeconomic, market and policy factors that affect adoption and diffusion of agroforestry practices; factors driving interest in agroforestry practices; and analyzing the markets for traditional and nontraditional Midwestern agroforestry products.

Analyzing markets for traditional and nontraditional Midwestern agroforestry products

Agroforestry differs from traditional farming in terms of production and market systems. The Center's survey of farm operators in Missouri showed concerns with the economics of agroforestry practices, which could impact their decisions to establish these practices. Due to difficulty in estimating the financial requirements and economic returns of agroforestry practices, landowners may reject serious consideration of agroforestry as a viable enterprise.

However, economic and financial information can facilitate land use decisions by landowners. Cash constraints, establishment costs and labor constraints are emerging as significant considerations in adopting agroforestry practices. Benefit-cost models are used in many contexts to improve decisions about allocating resources. Models grounded on farm operator's data and specific conditions are needed to contribute to decision-making — especially to provide a comparison of agroforestry to traditional commodity farming.

"If large scale adoption of agroforestry is to occur, practices must provide economic benefits in conjunction with conservation-oriented benefits. Many landowners, while being environmentally conscious, are reluctant to change land uses unless it has a financial reward." - Larry Godsey, UMCA Economist

The Socioeconomic Cluster is developing a model in Excel™ format, with landowners as the target audience. Outputs will consist of enterprise budgets and financial indicators, such as net present value, internal rate of return, and annual equivalent value. Users will be able to modify the design and management strategies of each practice. A case study approach will be used to test the model using data from early adopters, and a survey will be conducted with the case study participants to determine user friendliness, usefulness, and robustness of model.

Through the creation of user-friendly economic models, landowners will be assisted in making financial management decisions and identifying optimal agroforestry designs.

Socioeconomic research milestones: black walnut financial model

Version 2 of the Black Walnut Financial Model was completed in 2006 and is being tested by members of the black walnut industry. The model is an Excel spreadsheet which asks landowners a series of questions designed for inputting data about their orchard. This tool is designed to assist potential growers in making decisions about tree spacing, nut harvest, and whether to use improved (grafted) or unimproved trees. Management decisions in Version 2 now include initial spacing, use of improved cultivars, marketing nuts, thinning, and pruning. The model has a printable enterprise budget and a cash flow spreadsheet. Visit www.centerforagroforestry.org to access the Black Walnut Financial Model and additional black walnut resources.



INCREASING AGROFORESTRY ADOPTION & DEMONSTRATING ECONOMIC OUTCOMES

Database of land and forest owners practicing agroforestry

A survey has been designed and approved to collect data from agroforestry case studies across the state. The end result will be a database of practicing agroforesters in Missouri. Members of this database will be interviewed for a case study survey -- critical information used to build an overall Agroforestry Financial Model.

Plans for 2007-08 include a riparian forest buffer financial model and a forest farming enterprise budget model.

Tax and economic information

Publications to educate landowners and natural resource professionals on current economic incentives and tax laws are produced regularly by the Center. Information is also compiled to inform landowners of the economic benefits and opportunities of implementing agroforestry practices, ranging from the economics of niche crops to timber taxes. Visit www.centerforagroforestry.org to access the agroforestry tax guide.

Building a Framework for Agroforestry: Ongoing Projects conducted by the Socioeconomic Cluster

Chestnut Marketing Project: Findings from a nationwide market research survey are published in *HortTechnology*. (Source:) Gold, M.A., M.M. Cernusca and L.D. Godsey. 2005. Update on consumers' preferences on chestnuts. *HortTechnology* 15(4): 904-906.

Consumer Attitudes Toward Chestnuts: On-site surveys of thousands of visitors to the annual Missouri Chestnut Roast are revealing key industry insights, including that consumers prefer quality chestnuts over all other attributes. (2006)

Shiitake Mushroom Market Study: A survey sent to shiitake growers nationwide is providing data and direction for launching this profitable industry in Missouri. A shiitake mushroom market analysis will be available on the Center's web site in the fall of 2007.

Red Cedar Mulch Market Analysis: Eastern red cedar is a multi-million dollar industry in the eastern U.S. The Center is working to promote this abundant tree resource and strengthen the existing red cedar industry in Missouri and surrounding states. Steps include producing an industry market analysis for red cedar mulch products, and hosting a multi-state red cedar workshop in August 2007. Visit www.centerforagroforestry.org for more information about the red cedar workshop.



A New Vision ...

Budgets, costs, revenues, taxes and markets are all key factors in informed decision making. The Center is developing detailed and comprehensive information to help landowners make sound decisions.

A new model will be designed to calculate budgeting and cash flow for the five agroforestry practices at the field/farm level.

New Developments



Landowner Gives Acreage, Resources To Establish Agroforestry Teaching/ Research Center

“What we’ll be able to do here is show the local land and forest owners possibilities for additional income they might not have ever considered,” says Allen. “And they can teach us the invaluable knowledge from their own experiences.”

- Doug Allen, friend of the Center for Agroforestry

Like an Ozark stream, Doug Allen is tranquil, purposeful - and utterly intriguing. He demonstrates a commitment toward land stewardship and the welfare of rural Missourians that makes him most unforgettable.

In 2004, Allen began translating this passion for conservation and land stewardship into a planned gift of 521 acres of forested land near Laurie, Mo., to the University of Missouri Center for Agroforestry. Final details of the agreement were completed in the fall of 2006, declaring that Allen will give the acreage to University of Missouri Curators on behalf of the Center to serve as the location of the Allen Research and Education Project Site. A corresponding Allen Endowment Fund will maintain and support the property for agroforestry research.

Gene Garrett, director, Center for Agroforestry, explains the significance of Allen’s generous gift as an outstanding location for agroforestry research that represents Missouri’s diverse soil and land conditions. “Primary agroforestry research is currently conducted at the Horticulture and Agroforestry Research Center near New Franklin, Mo., in what we call River Hills conditions,” says Garrett. “It’s a particular type of soil you can only find in other River Hills areas - but Missouri, as a state, is wonderfully represented by forested acreage more similar to that found on Doug Allen’s property.”

Farming that fits the land

The acreage, comprised of 521 predominantly wooded acres in the Ozark region near Laurie, Mo., is hilly and contains many desirable tree species. Approximately 83 acres of the site are bottomland fields and represent some of the most

fertile ground on the property. Portions of the property feature soil well-suited to growing the Missouri native shortleaf pine - a species the Center is investing research into as a potential source of short and long-term income for landowners.

Integrating conservation and profit

Allen’s interest in natural resources conservation, timber management and production of niche agroforestry crops will be realized on multiple levels at the site. “My hope is to create a model for rural Missourians that demonstrates that they can make extra money off their land and also practice good stewardship,” he says.

Garrett and his team at the Center for Agroforestry have already begun putting this vision into place with the implementation of a riparian forest buffer surrounding one of the property’s creeks. Five species of native shrubs have been planted near the streambank to help stabilize the soil and enhance quail populations.

“One of the first priorities is to return this property to as natural a state as possible, and paralleling this objective is to encourage as diverse a level of native species as can reasonably be established,” says Allen.

Timber management and forest farming demonstrations will show landowners opportunities for economic gain from forested land at the Allen Research site. A natural passion



for somewhat lesser-cultivated agricultural crops - such as gourmet mushrooms, ginseng, black cohosh and other botanicals with medicinal properties - attracts Allen to the agroforestry practice of forest farming. Both Garrett and Allen look forward to evaluating areas for a range of forest farming crops and botanicals. “What we’ll be able to do here is show the local land and forest owners possibilities for additional income they might not have ever considered,” says Allen. “And they can teach us invaluable knowledge from their own experiences.”

BUILDING ON OUR SUCCESSES

The Allen site is already habitat for indigenous and migratory wildlife populations, including dove, quail, deer and turkey, as well as waterfowl and some uncommon birds that are attracted to the lakefront areas. Plans for the site include the establishment of a teaching/research center with lodging for students and research faculty to utilize while conducting research and participating in training programs.

"Meaningful interaction is a goal," says Allen. "We'd like to see interaction between researchers and academia with as many residents of the local community as possible, especially those with limited agricultural income opportunities who may benefit the most from knowledge gained at the site."

Noting that the property is one of the most beautiful places to see a night sky, Allen says he hopes that "those who will be working, researching, learning and living on this property can be very happy in the process, while the knowledge gained and applied here will benefit all Missourians and our natural environment."

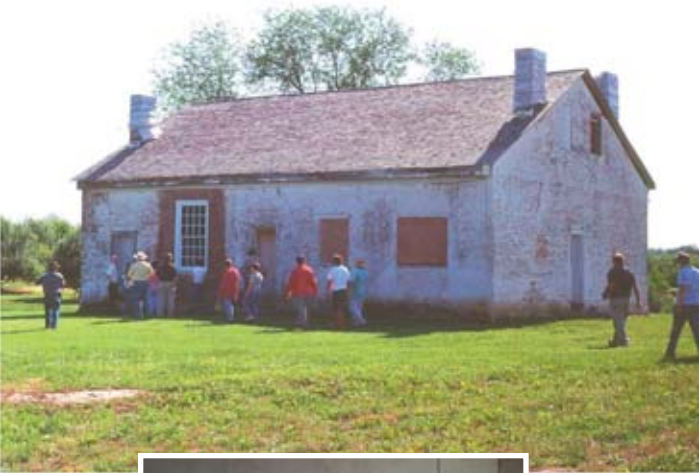
Center Awarded \$1.25 Million for Hickman Homestead Restoration

Nearly 200 years before the Missouri River Hills began yielding innovative plant and tree research, the land that is now the Horticulture and Agroforestry Research Center (HARC) at New

Franklin harbored one of the Midwest's earliest and most intriguing agricultural homesteads.

One of the state's oldest intact brick houses, the Thomas Hickman House, was built in 1819 and stands on the property of the HARC farm. This 1,800 square-foot house represents an outstanding example the southern

"Georgian" cottage design, a distinctive architectural style that hallmarks the early development of the Boonslick region of Missouri. The home rests just two miles from Old Franklin - the site where William Becknell and his party began the legendary Santa Fe Trail in 1821. It was designated to the National Register of Historic Places in July of 2006. *(next)*



A New Vision ...

Plans/goals for Allen Research and Education Project Site

- Demonstrate sustainable forest management
- Create additional habitat for quail and other wildlife
- Establish a festival of shared Ozark knowledge

Plans/goals for Hickman House

- Preserve Missouri's unique early agricultural and cultural history through fully restored home, grounds and gardens
- Welcome guests to the research farm using the Hickman House as an educational and inspirational visitors' center

Plans/goals for windbreaks

- Demonstrate the value of windbreaks for biodiversity and wildlife habitat
- Promote the value of windbreaks for controlling odor from livestock operations
- Document the multiple benefits of windbreaks for crop protection, increased crop yield, and increased livestock production and weight gain

Plans goals for new trainings

- Conduct targeted agroforestry trainings to stimulate and support knowledge of the establishment of new agroforestry practices throughout Missouri and the Midwest.

New Developments

Hickman House Cont.: The goal of this project is to restore the house to its historic condition and open the homestead as a nationally-known visitor center for the HARC farm, telling the story of the region's cultural and agricultural heritage. Recent federal and University funding are bringing this vision close to reality, including the award of a Community Development Block Grant from the City of New Franklin for \$250,000. (A program of the Missouri Department of Economic Development).

Funding achieved during 2005 and 2006 reached approximately \$1.25 million, including \$500,000 awarded in federal funds, secured by U.S. Sen. Kit Bond; and a \$250,000 match presented by MU College of Agriculture and Natural Resources. Restoration goals include the construction of a visitors' center, paved road, interpretive exhibits, period and heirloom gardens, and a fully accessible facility to preserve the region's agricultural/cultural/architectural history.



"The Hickman House has a lot to teach us about Missouri history, about early agriculture and about architecture. We should bring the history of the Hickman House alive to this and future generations of Missourians."

- U.S. Senator Christopher "Kit" Bond

SARE Grant Received for Trainings for Landowners and Natural Resource Professionals



As part of an ongoing commitment to increase the knowledge and adoption of agroforestry practices across Missouri and the Midwest, the University

of Missouri Center for Agroforestry has expanded the depth and reach of its training program. This effort began with a successful Agroforestry Professional Training Workshop held Jan. 10 and 11, 2006, in Columbia, Mo.

In the fall of 2005, the Center was awarded a Sustainable Agriculture Research and Education (SARE) Professional Development Program (PDP) grant to fund a series of agroforestry trainings geared toward a targeted audience: individuals from state and government federal agencies, University Extension personnel, and non-profit and professional organizations dealing with issues that directly impact landowners and their management of forests and farms. More than 50 professionals representing several disciplines in the agriculture, livestock and natural resource-based fields attended the January training. The training was designed to increase core agencies' knowledge about agroforestry practices and the benefits they offer when applied as sustainable farming practices, and to foster the establishment of social networks for assisting resource professionals and landowners in finding answers regarding the establishment and management of agroforestry.

Windbreaks for Odor Abatement: A Critical Issue to Missouri Livestock Operations

Farming operations are constantly changing, and the business of raising livestock is no exception. While smaller producers are integrating and moving towards such niches as organic and hormone free products and managed intensive rotational grazing, larger producers are seeking greater efficiency in mass production -- which often means implementing measures related to biosecurity, and coupled with good public relations, to reduce the concerns of neigh-

PLANNING FUTURE SUCCESSES WITH NEW RESOURCES & PARTNERSHIPS

bors and neighboring communities. In both cases, windbreaks (also known as shelterbelts) can be applied to enhance productivity and environmental benefits.

An important property of a windbreak is its ability to serve as an air filter. Properly designed vegetative windbreaks both modify air movement and allow large portions of air to pass through branch and foliage structures. By controlling air movement and filtering fine dust particles, windbreaks have been shown to remove as much as 47% of the airborne ammonia coming out of exhaust fans of confined animal feeding operations (CAFOs). On the other hand, major reductions in ammonia and dust particles do not translate directly to major reductions in odor perception. Systems approaches involving diet, facility design and windbreaks are required to significantly reduce odor perception.

Achieving policy changes for landowner windbreak establishment: EQIP cost-share program

Confined animal feeding operations are a significant business in Missouri, and yet because of the offensive odors that may be associated with CAFOs, recent court decisions are challenging industry growth. During 2006, Center for Agroforestry personnel, working with the Missouri Department of Agriculture and the Natural Resource Conservation Service, created an opportunity for producers to qualify for EQIP windbreak dollars for odor abatement. The agreement calls for a significant cost-share on large seedling planting stock and drip irrigation to assure fast growth of the trees.

In addition to funding provided for the initial signup period, an additional \$1 million was set aside for a special signup during January 2007 to create windbreaks around animal feeding operations, farmsteads and headquarters. With financial support from the Missouri Department of Agriculture (MDA), the Center is prepared to conduct research to evaluate the effectiveness of properly placed trees, shrubs and grasses on air and water quality near confined animal feeding operations in order to design more effective windbreaks.

Leveraging support for odor abatement research

The Center is a candidate for the Missouri Agricultural and Small Business Development Authority Livestock Odor Abatement Grant, a program of the MDA. Through this initiative, up to \$500,000 in grants will be awarded to assist with the development of odor abatement systems to measurably decrease odor and help livestock producers achieve cost-effective and aesthetically pleasing production facilities. (See pg. 49).

Integrating windbreaks for air movement and visual Enhancement

Additional research on the odor mitigation and environmental benefits of windbreaks is conducted at the University of Missouri South Farm, Columbia, Mo., one of the University's outlying research farms. The Center is establishing several agroforestry demonstrations at the site, including a new project initiated in 2006 - the planting of 2,000 pitch-loblolly pines as part of a whole farm, integrated agroforestry plan. Goals of the plan include implementing a silvopasture practice and two windbreak establishments to help modify air movement and create a visual buffer around the swine research area.

Agroforestry Success Story: Windbreaks for Livestock Odor

Windbreak designs are highly flexible and can be modified to meet both site and producer requirements. At the same time, they serve to actively filter odors from the air; modify air currents to enhance mixing and dilution of odor concentrations; and can improve public perceptions as they enhance the appearance of livestock operations, creating a beautifully landscaped setting. Function, landscape beautification and wildlife habitat can all be featured in the design considerations of a windbreak.

In 2006, the Center began working with the on-site manager of Advanced Pork Systems, LLC (with assistance from local United States Department of Agriculture/Natural Resource Conservation Service field staff) to develop windbreak designs for three confined animal feeding operation facilities. These windbreaks are based on USDA-approved design structures (3-row) and include a row of conifers, a row of hardwoods and row of shrubs.



Riparian Forest Buffers & Water Quality



Riparian forest buffers are an important agroforestry practice offering several key benefits: the protection of water quality; stabilization of stream banks; enhanced food and cover for upland wildlife; improved aquatic habitats for fish and other organisms; and enhanced opportunities to generate farm income through products harvested from the buffer.

Consisting of three distinct zones, man-made riparian forest buffers are planned combinations of trees, shrubs, grasses, forbs and bioengineered structures. Each of the three zones serves a distinct purpose. Zone 1 is the area closest to the streambank, and is a mixture of native trees, shrubs and forbs that stabilize the bank and provide woody debris for aquatic habitat. In Zone 2, fast-growing trees and shrubs that can tolerate periodic flooding are established for nutrient uptake and storage, as well as to slow floodwater. Zone 3 is adjacent to crop fields or grazing lands and uses native grasses and forbs to provide sediment filtering, nutrient uptake and help disperse concentrated runoff from agricultural practices.

During the past decade, in conjunction with a major emphasis in the U.S. Farm Bill to support conservation, great importance has been placed on designing agroforestry-type buffers (riparian and upland) to prevent non-point source pollutants such as sediments, nutrients or pesticides from entering our lakes, ponds and streams.

Center investigators provide some of the most significant research findings available to support major changes in buffer design — including finding that 90% of atrazine was degraded in the root zone of Eastern Gamagrass, compared to 24% in the control study.

UMCA's research on well-maintained, warm-season grass buffers as narrow as 13-foot wide has demonstrated that buffers can effectively remove 75-80% of atrazine, metolachlor and glyphosate (Roundup) from runoff.

During the past decade, in conjunction with a major emphasis in the U.S. Farm Bill to support conservation, great importance has been placed on designing agroforestry-type buffers (riparian and upland) to prevent non-point source pollution such as sediment, nutrients or pesticides from entering our waterways. While the research findings from the Center for Agroforestry have been remarkably significant and provide the basis for our advocating major changes in the way buffers are designed, perhaps no findings are more significant than those recently reported by Center investigators concerning the effectiveness of warm-season grass buffers in reducing the transport of herbicides from agricultural practices.

Utilizing grass buffer designs to reduce the transport of herbicides and surface runoff

Herbicides are among the non-point source pollutants of greatest health concern in the Midwestern United States. More than 70% of the herbicides used in the U.S., such as atrazine, are applied in the Midwest for corn and soybean production. Herbicides and their byproducts are commonly found in wells, surface water run-off and surface drinking water supply throughout Missouri. Many drinking water treatment plants are not equipped to eliminate herbicides and their metabolites from drinking water – a process that can require substantial equipment and costs.

Riparian forest buffer systems have been documented to improve water quality by decreasing pollution and sediment inputs into streams and rivers, thus reducing the potentially negative effects of the application of agricultural chemicals including atrazine and glyphosate. To better understand and improve upon riparian buffers, Center

REDUCING NON-POINT SOURCE POLLUTION & SOIL EROSION

researchers working at the University of Missouri Bradford Research and Extension Center, Columbia, Mo., have conducted field experiments on four types of vegetative buffer strips. The experiment assesses the effectiveness of buffer designs, species composition and buffer length in reducing the transport of herbicides and the formation of less-toxic herbicide byproducts.

The four vegetative filter strips under investigation consist of: 1) tall (traditional) fescue; 2) switchgrass hedge in combination with fescue; 3) switchgrass hedge in combination with native warm-season grass and forbs species; and 4) continuous cultivated fallow as a “no buffer” control.

Key Findings: Utilizing Grass Buffers To Reduce the Transport of Herbicides

- All vegetative filter strips significantly reduced the transport of both dissolved and sediment-bound atrazine, metolachlor and glyphosate in surface runoff.
- **Vegetative buffer strips with native warm-season species were the most effective at reducing transport of all herbicides.**
- **Four meters of native warm-season grass vegetative buffer strips removed about 75-80% of the atrazine, metolachlor and glyphosate in surface runoff.**
- Comparing across treatments, four meters of native warm-season grass vegetative buffer strips resulted in much greater reductions in herbicide transport than eight meters of tall fescue, a cool-season grass.
- The inclusion of native warm-season grass species in vegetative buffer strip designs provides desired reductions in herbicide transport and better wildlife habitat compared to vegetative buffer strip designs that utilize only tall fescue.

Sources: Lin, C.H., R.N. Lerch, H.E. Garrett, C.J. Gantzer, and S.H. Anderson 2007. Utilizing vegetative buffer strips to remove dissolved and sediment-bound atrazine, metolachlor and glyphosate from surface water runoff. Proceedings of the 10th North American Agroforestry Conference June 9-14 2007, Quebec, Canada. (In Press)

Lin, C.H., R.N. Lerch, R.J. Kremer, H.E. Garrett, and M.F. George. 2007 Stimulated rhizodegradation of atrazine by selected plant species. Proceedings of the 10th North American Agroforestry Conference June 9-14 2007, Quebec, Canada. (In Press)

Reducing the transport of three widely used herbicides -- atrazine, glyphosate, and metolachlor -- is a focus of the study. Results indicate that all vegetative filter strips significantly reduced the transport of both dissolved and sediment-bound atrazine, metolachlor and glyphosate in surface runoff.

Uptake and breakdown of atrazine by forage species: A growth chamber study

In a corresponding study involving sophisticated growth chamber technology, eight forage species were tested by Center researchers for their ability to uptake and degrade atrazine during a 100-day growth period. Eastern gamagrass showed the highest capability for promoting bio-degradation of atrazine in the rhizosphere (root zone).

Eastern gamagrass (*Tripsacum dactyloides*) is a warm-season bunch grass native to the eastern United States. At one time, large native stands of Eastern gamagrass were found along creek bottoms, wet meadows and lower slopes of the area east of Oklahoma and Missouri. This highly productive grass is best adapted to wet habitats, and remnant colonies are commonly found in floodplains and along streambanks. Eastern gamagrass is a relative of field corn (*Zea mays*) and is characterized by numerous short, well-developed rhizomes. This species has the potential to provide high-quality forage throughout the summer grazing season.

In the forage growth chamber study evaluating eight species for atrazine degradation, after 100 days of incubation, **more than 90% of atrazine was degraded in the rhizosphere of eastern gamagrass** — as compared to only 24% degradation under natural conditions in the bare soil (control) species. The incorporation of eastern gamagrass into vegetative filter designs may significantly promote the degradation of atrazine that is transported into the filter strip.

The effects of installing a riparian forest buffer on streambank stabilization, wildlife habitat and water quality can be remarkable, as shown in these before and after images taken at Bear Creek in Story County, Iowa. Photos: Tom Schultz.



Riparian Forest Buffers & Water Quality

While many riparian forest buffers have been planted during the past 10 years, little research has been conducted on their effectiveness over time or the long-term management plans needed to maintain their functionality. In response to these concerns, the Iowa State University Riparian Ecosystem Management Team collaborates with the Center to conduct research on watersheds in the Mark Twain Reservoir, as well as watersheds in the Mark Twain Watershed ecoregion and central Iowa watersheds on the Des Moines Lobe.



Grass filters help trap sediment from crop fields, especially sediment that accumulates from gullies.

Evaluating natural riparian forest buffers

Many “natural” and presently planted riparian forest buffers do not support significant perennial ground cover under their present stocking densities. There is evidence that some of these riparian forest buffers without adjacent grass filters are not effectively slowing and spreading surface runoff from crop fields as it enters the buffer – allowing surface runoff and pollutants make their way directly to the stream channel and create

gullies through the buffers.

Ongoing studies have conducted inventories of “natural” riparian forest buffers along first and second order streams in the Mark Twain watershed. Ultimately, the project will determine if the ground cover density of present “natural” riparian forest buffers or that of constructed buffer ground cover is sufficient to slow and spread the flow of surface run-off as it enters the buffer – and if corresponding grass filters established upslope of the riparian forest buffers are necessary to provide that function.

If this study finds natural riparian forest buffers insufficient at reducing non-point source pollution, modifications in species composition and density can be recommended, especially with long-term effectiveness in mind. Utilizing natural riparian forest buffers along with grass filters may provide greater opportunities for producing both woody

fiber crops and additional streambank stability. Reducing tree density to allow understory grass or dense forb growth could improve forest health, provide nut crops and create potential flash grazing opportunities if livestock were kept separate from the streambanks.

Riparian forest buffers and streambank stability

The structure and distribution of tree species in riparian forest buffers also plays a key role in streambank stability. Ongoing and completed studies have shown the effectiveness of riparian forest buffers and grass filters on streambank stability, and are quantifying the impact of other riparian practices on the contribution of sediment and nutrients to the stream channel.



Left: Unfenced streambank corridor showing erosion in a livestock grazing area.



Right: The establishment of a buffer area stabilizes the streambank and serves as a “living fence.”

A dramatic increase in streambank stability is shown when a buffer area (or living fence) of selected shrubs is established. This natural fence helps prevent livestock damage and reduces phosphorus concentration in stream waters near livestock areas.

REDUCING NON-POINT SOURCE POLLUTION & SOIL EROSION

Key Findings: Riparian Forest Buffers and Sediment/Phosphorous Levels

- Stream reaches on 2nd-4th order streams with riparian forest buffers reduce the length of eroding streambank from around 40% for row-cropped and intensively grazed reaches to less than 15% — a figure well within the limits of healthy streams (~20%). This translates into a 7 to 9-fold reduction in both sediment and phosphorus contribution to the stream channel from properly buffered streams. Note: The larger the order number, the larger the stream.
- Livestock access points and streamside loafing areas account for less than 2.7% of the surface area of 15m wide strips along the stream channel, but can contribute up to 72% of the sediment and 55% of the total phosphorus during a major rainfall event. Providing armored access points and narrow live fences (composed of various shrubs with agroforestry benefits) could dramatically reduce those contributions.

Source: Schultz, R.S. 2007. Effectiveness of Riparian Forest Buffers in Headwater Watersheds of the Western Corn Belt Plains Ecoregion. University of Missouri Center for Agroforestry 8th Annual UMCA Program Review. 10-11 Jan 2007. Columbia, Mo.

Soil Core Research Shows Upland Buffers Reduce Runoff In Claypan Soil Areas

Claypan soils cover approximately 14 million acres of Missouri, Illinois, Iowa, Kansas and Oklahoma. In addition to low water and nutrient absorption rates, claypan soils have higher potentials for soil loss and the movement of agricultural chemicals through runoff. Due to these factors, significant levels of non-point source pollution can occur in claypan soils from nearby row-cropped agricultural areas, especially when crops are not in place. Studies to understand improvements in soil physical properties beneath upland buffers — including soil density, soil saturation, number of soil pores and soil pore characteristics — may help researchers understand how to reduce non-point source pollution from agricultural watersheds in claypan areas.

Missouri claypan soil cores have been collected and analyzed for key soil physical properties and to under-

stand the vertical movement of soil water in three experimental treatments: agricultural crop areas, grass buffers and tree/grass (agroforestry) buffers. Analysis of the soil cores included the innovative use of hospital X-ray technology for scanning the samples.



Key findings: Claypan Soil Core Research

- Upland buffer practices improve soil macropore parameters — a soil attribute highly correlated to the soil's ability to absorb excess water.
- The adoption of grass buffers and tree/grass buffers improves soil structure and promotes vertical soil water movement, thereby reducing surface runoff potential. Significantly lower bulk density levels (i.e., less compacted) and more rapid water vertical movement were observed in the buffer areas as compared to agricultural crop areas.
- Soils under the grass and tree/grass upland buffers had significantly higher levels of macropores than the agricultural crop areas, thus the soils in the buffer areas had higher numbers of large pores which can rapidly absorb surplus water to reduce runoff. Levels of macroporosity were three times higher for grass buffers and four times higher for grass/tree buffers, compared to crop areas.
- Total soil porosity (the empty spaces between soil particles that can increase infiltration and promote water storage) was highest for the tree/grass buffer (agroforestry treatment) across all tested soil depths, as compared to the grass and crop treatments.

Sources: Seobi, T., S.H. Anderson, R.P. Udawatta, and C.J. Gantzer. 2005. Influence of grass and agroforestry buffer strips on soil hydraulic properties for an Albaqualf. *Soil Sci. Soc. Am. J.* 69: 893-901.

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Udawatta, R.P., S.H. Anderson, and C.J. Gantzer. 2006. Agroforestry and grass buffer influences on CT-measured pore characteristics. 18th World Congress of Soil Science, Philadelphia, PA. July 9-15, 2006. American Society of Agronomy, 677, South Segoe Road, Madison, Wisconsin 53711. pp 363.

Flood Tolerance & Crop Improvement



Screening Species at the Flood Tolerance Laboratory

Before agricultural practices evolved in the Midwest toward large-scale monocropping systems, floodplains, wetlands and riparian areas were composed of

mixed tree, shrub and herbaceous plant species offered significant benefits toward preserving the landscape and wildlife habitats. Historically, these wetlands and riparian areas acted together to reduce the impacts of periodic flooding and control soil erosion. After fifty years of large-scale monoculture, wetlands, upland prairie, forest and natural riparian vegetation have been plowed over and farmed. Much of the levee breakage which occurred during the 1993 flood was attributed to the lack of vegetative buffers between the river and the levees, combined with a lack of natural floodplain along the river. All primary levees along the Missouri River suffered damage during the flood of 1993.

Agroforestry can be used in floodplains to reestablish trees and herbaceous species in agricultural systems to mimic historical wetlands and riparian vegetation. The diversity of species used in these agroforestry practices are an important component in reducing soil erosion and providing wildlife habitat. To successfully replant the floodplains, or any riparian area, we need to know which species are flood tolerant.

Flood Tolerance Laboratory Expansion

In 2003, a flood tolerance laboratory was completed along Sulphur Creek in the Missouri River floodplain at the Horticulture and Agroforestry Research Center (HARC) in New Franklin, Mo. This facility, one of only a few in the nation, provides a unique field laboratory for studying the response of plant species to the periodic flooding common in Midwestern floodplains. The original laboratory had 12 channels, each approximately 16 feet wide by 600 feet long. Each channel could be independently adjusted for water depth, standing or flowing water, and duration of flooding. The area was instrumented to reveal not only what is happening to different species of annuals and perennials, but also why the observed

effects are taking place.

In addition to restoring floodplains in agricultural areas, the Center collaborates with partners for urban floodwater solutions. As a partner with the Mid-America Regional Council's (MARC) Green Infrastructure project, the Center's flood tolerance research helps support on-the-ground decisions for effective flood control, bioremediation and in guiding proper species selection for flood-prone areas. This research supports best management practices for stormwater and green infrastructure planning in urban areas.

Through funding received in 2006 under a subcontract with MARC, the number of flood tolerance laboratory channels has been doubled from 12 to 24. Each channel is independent of the others and capable of any length of flood time required, utilizing standing or flowing water. The 600-foot long channels have been cut in half to create 24 individual, 300-foot long channels. A levee (berm) was retrofitted down the center of the channels. New pumps, drains and flood control gates have been added to enable each channel to function independently. Equally important, the expansion enables researchers to better determine which specific plant materials are most tolerant of short-, medium- and long-term floods.

Constructed as a response to the devastation of the Flood of 1993, the UMCA flood tolerance laboratory is one of the only outdoor field laboratories in the nation designed to study the long and short-term impacts of flooding upon woody and non-woody plant materials. In 2006, the number of independent channels in the laboratory increased from 12 to 24 — strengthening the precision of flood treatments.



BOOSTING AGRICULTURAL PRODUCTION WITH FLOOD-TOLERANT SPECIES

Identifying Flood-Tolerant Soybeans

Soybeans are a multi-million dollar industry in Missouri, but excess water or flooding during the growing season adversely affects soybean growth and seed yield in the Midwest and across the U.S. Flooding injury causes the plant to physiologically shut down, and soil waterlogging for as little as two days on a clay soil can considerably reduce soybean yield. Soybean may never fully recover from flood injury, and yield losses can be 80 to 90%. Varieties showing yield losses of less than 10% are needed to provide growers protection in poorly-drained fields. Current research shows that germplasm can be identified with greater tolerance to soil waterlogging than existing varieties.

A three-year multidisciplinary research grant for nearly \$114,000 was awarded to the Center by the Missouri Soybean Merchandising Council. Goals of the research include the identification and development of soybean varieties and exotic germplasm with greater tolerance to soil waterlogging than present varieties – leading to breeding programs to produce improved soybean varieties with greater tolerance to waterlogging.

Utilizing state-of-the-art technology at the Center's flood tolerance laboratory, 262 entries of maturity group III and IV soybean Plant Introductions (PIs)* were planted in three replicate hills in 2005 and 2006 at Portageville, Mo., and the Horticulture and Agroforestry Research Center. The soybean PIs were collected from both humid and dry regions of the world, including China,

Japan and Korea. Plots were flooded about two inches deep at bloom until plants in hill plots began to yellow, wilt and die. After a two-week post flood recovery period, plants were rated for injury on a 1 (no injury) to 5 (all plants dead) scale.

In 2007, varieties that displayed the greatest tolerance to waterlogging during 2005 and 2006 testing will be evaluated under flooded versus non-flooded conditions for yield.

** The PI is the number assigned to all plants collected from outside regions upon plant introduction to the U.S.*



Key Findings: Soybean Flood Tolerance

Great variability in water-logging tolerance was found among the soybean entries.

Ranges in water-logging scores, averaged over 2005 and 2006, showed that 9 PIs were tolerant; 103 PIs were moderately tolerant; 105 PIs were intolerant; and 45 PIs were very intolerant.

Thirty-one of the top 50 performing entries for both years were in the top 50 in each year.

Twenty-six out of 30 PIs showing water-logging tolerance originated from wet regions of the world.

Eight out of nine PIs showing the highest level of water-logging tolerance originated from more humid areas of China and were consistent in tolerance over years.

Source: Shannon, J. G., W. E. Stevens, W. J. Wiebold, R. L. McGraw, D. A. Sleper, and H.T. Nguyen. 2006. Breeding soybeans for improved tolerance to flooding. Proceedings of the 60th Annual American Seed Trade Association Soybean Research Conference.

Bottomland Forest & Habitat Restoration

Effects of Agroforestry Practices on Songbird Species in Major Alluvial Floodplains

Missouri's bottomland forests, though prone to flooding, provide excellent locations for wildlife habitat and diversified income through timber production when agroforestry practices are applied.

Songbirds are among Missouri's most conspicuous wildlife, and represent an increasingly popular recreational activity. For example, in 2001 wildlife recreationers in the U.S. spent \$108 billion, or 1.1% of the GDP, on wildlife-related activities, and a large percentage of this was in connection to birds. However, there is growing scientific concern in recent decades about apparent population declines of many American neotropical songbirds.

Two 120-acre MDC Conservation Areas maintained in agricultural crop rotations (Smoky Waters and Plowboy Bend) were used in this study. At each conservation area, the site was split into three 40-acre treatments. One treatment was tillage only, with the acreage left to regenerate by nature. A second treatment included planting oak tree seedlings into tilled ground, and then leaving the area to regenerate. A third treatment combined oak seedling planted with a sowing of redbtop grass to suppress competing vegetation.

Reforestation of Abandoned Bottomland Crop Fields with Oak for Wildlife Habitat

More than 85 % of Missouri's original bottomland forests have been cleared for agriculture production to help supply our nation's need for quality and affordable food. However, some of these millions of acres of cleared land have proven to be marginal for agricultural production due to flooding or long-term damage from the flood of 1993. Today there is an opportunity to restore quality wildlife habitat and productive timber lands by reforesting these marginal and damaged agricultural bottomlands.

The Center's research provides landowners methods for establishing oak trees in floodplains with a diverse list of positive outcomes: to diversify native forests, conserve native bottomland tree species, produce acorns for wildlife, waterfowl habitat and hunting opportunities, and improve timber production using agroforestry practices.

Due to intense competition, oaks and other hard mast producing trees such as pecans and walnuts can be difficult to regenerate in agricultural bottomlands – revealing the need for management techniques that regenerate these desirable tree species and provide multiple economic and ecological benefits to landowners. At the same time, reforestation methods are being evaluated for how they affect songbird use and nesting success in these agricultural bottomlands. Studies are also exploring how to manage the damage to trees that wildlife, including white-tailed deer and eastern cottontail rabbits, cause during the critical regeneration period.



**Background: Redtop grass and trees.
Foreground: Trees and no redbtop grass.
(Smoky Waters Conservation Area)**

This study is evaluating the effects on songbird species when agroforestry practices are applied to bottomland forest areas.

RESTORING VALUABLE FOREST & WILDLIFE HABITAT

Key Findings: Effects of Agroforestry Practices on Songbird Species

- Where redtop grass is established, invasive vegetation and weeds are almost completely controlled, and grassland songbirds colonize abundantly. Songbirds have used the redtop plots for breeding year after year, whereas in other grasslands, many of these species would quickly drop out with increased vegetation growth.
- Shrubland birds were abundant in the tree plantings where natural vegetation was allowed to colonize the former crop fields. In those fields, songbird habitat progressed rapidly from open-grassland to forb and shrubland dominated stages.
- Landscapes with low forest cover are usually associated with high cowbird parasitism and high cowbird abundance. Despite having low (approx. 33%) landscape-level forest cover, research sites experienced low parasitism compared to more forested (approx. 70%) sites in the region (Burhans and Thompson 2006).
- Eastern cottontail rabbits caused damage to trees in the winter months by girdling tree stems or completely clipping off the tree tops at the ground level. Rabbit damage was significantly less for trees grown in large (40 acre blocks) of redtop grass.

Forest Restoration:

- Oak can be established in former bottomland crop fields by planting bareroot or large container-grown oak seedlings. Seedling survival and growth is enhanced when large container seedlings are planted compared to bareroot seedlings.
- After 6 years, survival of large container trees is nearly 100% for swamp white oak and about 80% for pin oak. In contrast, survival of swamp white oak bareroot seedlings was approximately 76%, while that of pin oak bareroot seedlings was 9%.
- Large container trees of RPM® swamp white oak began producing acorns the first year after planting and have consistently produced acorns annually for the past 6 years.
- Planting trees with a cover crop of redtop grass improved survival, height and diameter growth of bareroot and large container oak seedlings, compared to seedlings that grew with the forb-dominated community of plants that colonize recently abandoned agricultural cropfields.
- Planting widely spaced trees with a cover crop such as redtop grass creates an open grassland or savanna that provides critical habitat for songbirds of conservation concern, including the grasshopper sparrow. The redtop grass cover continues to provide habitat for grassland dependent birds 6 years after planting.

Sources:

Burhans, D. E., and F. R. Thompson, III. 2006. Songbird abundance and parasitism differs between urban and rural shrublands. *Ecological Applications* 16: 394-405.

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Dugger, S., Dey, D.C., Millspaugh, J.J. 2004. Vegetation cover affects mammal herbivory on planted oaks and success of reforesting Missouri River bottomland fields. In Connor, K.F., ed. Proceedings 12th Biennial Southern Silvicultural Conference. 24-28 February 2003. Biloxi, MS. General Technical Report SRS-71. Asheville, NC: U.S. Department of Agriculture, Forest Service Southern Research Station. 3-6.

Furey, M.; Burhans, D. 2006. Territory selection by upland red-winged blackbirds in experimental restoration plots. *The Wilson Journal of Ornithology* 118(3): 391-398.

Rabbit damage was significantly less for trees grown in large (40-acre blocks) of redtop grass.



Silvopasture Research



With more than 13 million acres of pasture land dedicated almost entirely to beef production, and ranked number two in cow/calf production in the USA, Missouri is in a position to benefit economically and environmentally from widespread adoption of silvopasture. Utilizing carefully-planned, rotationally-grazed livestock grazing areas in conjunction with managed tree plantings and appropriate forages, the silvopasture practice offers livestock protection, short-term income opportunities and will reduce hay costs and increase livestock weight gain.

Missouri's agroforestry researchers are investigating the similarities and differences in cattle performance between traditional open pasture rotational grazing and cattle in a silvopasture practice (strategically positioned trees in rotationally grazed pastures).

Silvopasture Research with Pine and Oak

In 2006, research featured the clearing of poor-quality hardwoods and the incorporation of shortleaf pine trees on 25 acres of south-facing slopes. The establishment of big bluestem is also planned as part of a silvopasture practice that incorporates warm-season grasses selected for improved shade tolerance. This project holds tremendous potential for benefiting Ozark-area livestock producers. Funding for this work includes a \$43,000 grant from the MU Wurdack Farm Advisory Board.

An experimental and unconventional form of silvopasture is being studied at the MU Wurdack Farm, Cook Station, Mo. A moderately productive tract of Ozark Forest has been thinned to permit approximately 50% of full sunlight to reach the forest floor. A mixture of Kentucky 31 tall fescue, red clover and annual lespedeza were established under the thinned, predominantly, white oak tree canopy. Rotationally grazed livestock were introduced in some of the plots to determine the potential benefit to livestock, the ability of the forage to regenerate under a combination of rotational grazing and tree shade, the

impacts of rotational grazing on tree growth, and the potential for this forest to be successfully regenerated.

Integrating Silvopastures Into Current Forage-livestock Systems

Recent research from across the world shows that forages and livestock in silvopastures respond differently than in traditional pastures. However, on most farms, silvopastures are likely to make up only a portion of the area grazed in a forage-livestock system. Presently there is a need for information about how season-long livestock production might be altered on a farm that includes silvopastures integrated with traditional open pastures and how to incrementally integrate silvopastures into existing forage-livestock systems. This information is of particular interest to farmers who wish to have a diversified operation that includes silvopastures.

At the Horticulture and Agroforestry Research Center, researchers are assessing the integration of silvopastures into cow-calf operations. The objective is to determine the feasibility of introducing silvopasture as part of a whole-farm forage-livestock system.

This experiment has two treatments: cow-calf pairs are maintained in traditional "open" pastures, and cow-calf pairs have access to silvopastures at strategic times in winter, early spring, during heat stress periods in summer and at calving. The animals with access to silvopastures spend approximately 25% of the year in pastures that have trees. The silvopastures include a 12-year old pine-walnut plantation and a 6-year old mixed hardwood plantation. The pasture species used for both treatments are a mixture of tall fescue, alfalfa and red clover. In the silvopasture treatment, cows and calves are moved to silvopastures as forage resources and livestock needs dictate.

The state of Missouri boasts 14 million acres of forested land — but less than 10% of this land is under management. Though research on silvopasture practices and market research within the forest industry, the Center is providing national leadership for increasing the acreage of forested land under active, sustainable management.



INTEGRATING TREES, LIVESTOCK AND FORAGES FOR MAXIMUM PROFIT AND ANIMAL HEALTH

Success Stories - Silvopasture and Shade Benefits

In addition to income opportunities from timber or nut crops, landowner interest in silvopasture recognizes the beneficial role of shade in livestock production. The stress reduction produced by shade can influence the livestock growth process at every stage, from weight gain to calving rates.

The Center is working with two landowners that have developed different approaches to integrating shade with their livestock operations. Bob Eckenfels, landowner near Ste. Genevieve, Mo., implemented a silvopasture plan that includes the use of tulip poplar and loblolly pine. Both are fast growing trees with high success rates in southeast Missouri. Eckenfels' plan establishes these trees around the outside edge of rotationally grazed paddocks. The goal is to achieve open pastures that maximize forage production, yet are surrounded by shade that livestock can use at any time during the day.

In another example, Carl Lueker, Buffalo, Mo., worked with the Center to consider uses for approximately five acres of timber used by livestock, but poorly developed and located on a site not well-suited for timber. In an effort to improve the utility of this land, the Center designed a plan to keep the best trees and create spacing that would allow more light through the canopy. In this way, the healthiest trees are sustained and forage can be produced as a result of increased light availability. The landowner now has a portion of pasture that bulls can use to reduce stress during the weather extremes of summer heat and winter winds.

The Economics of Silvopasture

Introducing commercially valuable tree species into pastures

(silvopasture) has been demonstrated to be highly beneficial to pasture and cattle, improving the bottom line while creating valuable timber and nut trees. In some cases, **landowners who have established a silvopasture practice have received a pasture rental rate that is as much as 33% higher than open pasture.** In addition, the diversification of income by producing multiple incomes from the same area of land serves as an excellent risk hedge. More importantly, the ability to generate income through livestock and hay production as trees mature to a marketable age reduces some of the opportunity costs associated with long-term timber investments.

Source: Godsey, L.D.; Walter, W.D.; Dwyer, J.P.; Garrett, H.E. 2006. A preliminary economic analysis of silvopasture in Missouri's Ozark forests. In: Proc., 15th C. Hardwoods Forest Conf.; 2006 February 27 - March 1; Knoxville, TN.



Key Findings: Silvopasture Research

Although silvopasture systems projects are long-term in nature, some preliminary observations are:

Following a two-year acclimation period with forages seeded into a hardwood silvopastoral setting, early research results indicate that a silvopasture practice consisting of tall fescue and legumes can be productive under grazing pressure if managed correctly.

Cows nursing calves in silvopastures lost approximately 10% less weight over winter, reducing the need for supplementation. This is likely a result of trees protecting the cows from winter winds which led to less cold-stress in winter but also may be attributed to increased forage quality in silvopastures.

Cows that gave birth in silvopastures were less likely to experience calving difficulty, most likely due to the effect of shade easing stress.

A 15% increase in cool-season grass growth was observed during July and August in silvopastures. This is likely due to the effects of shade. As this project develops, further data and financial analyses will be conducted as appropriate.

Sources:

Kallenbach, R.L., M.S. Kerley, and G.J. Bishop-Hurley. 2006. Forage accumulation, quality and livestock production from an annual ryegrass and cereal rye mixture in a pine-walnut silvopasture. *Agroforest. Syst.* 66:43-53.

Market Opportunities



From honey to timber: Missouri Exchange online marketplace broadens opportunities for producers, consumers

From honey to homemade soap, and medicinal herbs to timber and native plant seeds, Missouri's land and forest owners offer a tremendous variety of value-added agricultural products. A new online marketplace, launched in January of 2007, is helping connect buyers and sellers of these products faster than you can say "wild bergamont."

As part of its mission to enhance

"Everyone knows that the small rural producer's link to urban markets is one of the largest challenges to building a stable, sustainable rural community and capturing resource dollars for rural areas ... Missouri Exchange can be a key component in linking producers to urban markets and manufacturers."

- Penny Frazier, Goods from the Woods native plant products company, Ozark region of Missouri



sustainable income opportunities for family farms, the Center for Agroforestry teamed up with Grow Native!, a program of the Missouri Department of Conservation, to bring together buyers and sellers of Missouri-grown products with an innovative, free Web site. The site, called Missouri Exchange, is an online marketplace that allows producers to post products for sale -- and buyers to list products they are looking for -- at no charge to the user. Generating a list of more than 110 members in less than three months, Missouri Exchange is rapidly expanding producers' markets.



"The site is broadening marketing opportunities for Missouri producers who specialize in niche market products," said Larry Godsey, economist, University of Missouri Center for Agroforestry. "One great thing about Missouri Exchange is that you don't have to be a big producer to participate. That's the whole point of this. We want small growers, too."

Local products in a global market

Products on the site include locally grown mushrooms, nuts and herbs; native plants; greenhouse plants; decorative woody florals; specialty wood products and timber products.

"The online market is the fastest growing market area," Godsey said.

"It's convenient, and the Internet provides immediate access to the information. Producers who list merchandise on the Web site have unlimited access to potential buyers throughout the state, throughout the country, even around the world."

Penny Frazier, co-owner and developer of Goods from the Woods, a native plant product and botanicals producer in the

Ozark region of Missouri, is hoping Missouri Exchange will help connect her organic products to a range of buyers, especially in urban areas. As consumer interest in certified organic products rises, Goods from the Woods receives requests for organic native plant materials that are difficult to find in adequate quantity. "Last year, we needed three times more hickory nuts than we could source. It is very hard to find a method for communicating about these plant products, but Missouri Exchange can be a key component in linking producers to urban markets and manufacturers.

"Everyone knows that the small rural producer's link to urban markets is one of the largest challenges to building a stable, sustainable rural community and capturing resource dollars for rural areas," said Frazier. "The site offers a perfect blended venue for those of us whose interests merge agriculture, forestry and non-timber forest products. It can also result in a greater understanding of the increasing value of native plant materials, especially organics."

Creating the perfect match

Buyers and sellers who wish to use www.missouriexchange.com must register on the site and can provide the level of contact information they choose. For example, a grower may post a phone number, an e-mail address, a short biography and a photograph of his or her farm. Others may list only the items they are selling or looking to buy and an e-mail address. No sales are made via the Web site, but once a potential buyer or seller locates the products they are seeking, information can be easily exchanged through email or by phone to enable transactions to occur between parties.

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Registered buyers can browse offers to sell posted by sellers, and then contact the seller through the form provided. The seller will handle the buyer's offer directly. If a buyer doesn't find what he or she is looking for, a request to buy can be posted. At any time, the online directory of products offered can be searched.

"In comparison to sites that handle direct transactions, Missouri Exchange places a great deal of freedom and control in the hands of the buyers and sellers," said Ina Cernusca, market research specialist, University of Missouri Center for Agroforestry. "The site can provide detailed information to precisely match the needs of a producer to a buyer, and vice versa."

In 2006, Grow Native! partnered with the MU Center for Agroforestry to develop the site. Funding for the Missouri Exchange site is provided by a grant from the Federal State Marketing Improvement Program (FSMIP), funneled through the Missouri Department of Agriculture. FSMIP, funded by annual appropriations to the USDA Agricultural Marketing Service, provides matching funds to state agencies to explore new market opportunities for U.S. food and agricultural products.

"It's a very user-friendly site," said

Tammy Bruckerhoff, marketing and business development specialist for Grow Native!. Grow Native!'s charge is to restore the state's biodiversity and increase awareness of native plants and their uses. "We frequently receive requests for places to buy native seeds and plants. Now, buyers can check this Web site for sources," Bruckerhoff said.

Expanding to quality standards and education

The Missouri Exchange site includes product lists and a directory of members. Buyers and sellers can post feedback, ask questions, make offers for products or recommend items to friends. Producers can change prices and update offerings immediately.

Product information will be available to buyers and sellers, including that which may help establish quality standards for niche industries. "A broader market will help provide additional income opportunities for small farmers and landowners. We hope to use feedback from market participants to identify quality standards for products," Godsey said. "Small niche markets often lack quality standards. We hope to post information that can help serve people who wish to participate in those small markets."

Paul Gustafson, Sni Valley Seed Company, Centerview, Mo., has several product listings on Missouri Exchange, specializing in native wildflower seed production. The company is a project Gustafson is leading with plant science students at Grain Valley High School, with a vision to expand into live plant sales.

"Missouri Exchange gives us exposure as to what our small, but viable, business does and offers," said Gustafson. "The one-stop shopping feature makes it a centralized place for everyone to see the niche markets in the state – and hopefully will boost our efforts to improve our plant science program."

The University of Missouri Center for Agroforestry is one of the world's



leading centers contributing to the scientific understanding of agroforestry. Linked with the Center's solid science and research programs are several key collaborations and partnerships with landowners, natural resource professionals, federal and state agencies and non-profit organizations. Through these relationships, UMCA and its partners are producing an expanding list of positive outcomes for landowners, the natural environment and society as a whole. One of the Center's primary goals is to create new income opportunities and markets for farm and forest landowners.

Grow Native! is a joint program of the Missouri Department of Conservation and the Missouri Department of Agriculture. Its objectives include helping protect and restore the state's biodiversity by increasing conservation awareness of native plants and their effective use through partnerships among private industry, non-profit organizations, government agencies and landowners.

Visit www.missouriexchange.com to buy or sell Missouri-grown agricultural products today, including:

- **Native plants and seed**
- **Honey, nuts, breads, fruits**
- **Timber & timber products**
- **Organic cosmetic products**



Market Opportunities



Nut Tree Research

Market Opportunities with Missouri Nuts: Chinese Chestnut Cultivar Performance in Missouri

Twelve years of Chinese chestnut research at the Horticulture and Agroforestry Research Center, combined with in-depth market and consumer research, have Missouri at the brink of a major new industry. The Center has the most comprehensive chestnut research program in the USA and is in a leadership position in the U.S. industry.

By 2020, over 1,000 acres of Chinese chestnut orchards will be producing over 2 million pounds of chestnuts with a wholesale crop value of over \$10 million to Missouri producers.

Missouri River Hill soils and climate are excellent for production of the sweet, starchy and versatile Chinese varieties of the chestnut, which can be planted in an orchard or alley cropping practice. The trees are blight-resistant, much smaller in stature than the American Chestnut, and spread outward like a large fruit tree while producing a significant quantity of nuts. Markets continue to expand both domestically and overseas for chestnuts and products such as gluten-free chestnut flour, showing significant profit potential for Missouri landowners.

UMCA chestnut research objectives are to identify outstanding, locally-adapted cultivars that have traits suitable for commercial chestnut production (e.g., large size nuts, consistent yields, excellent flavor, long storage potential) and to develop field trials to manage these elite cultivars for nut quality and yield. Many cultivars under test in Missouri have now begun bearing commercial quantities of chestnuts.

The Vision The Center's research and technology transfer programs on Chinese chestnut will result in the planting of 1,000 acres in Missouri by 2020 creating a crop value of more than \$10 million.

Chestnut Consumer Research

This project consists of a comprehensive program to stimulate both production and consumption of chestnuts.

A critical step toward reaching this goal was the creation of the Missouri Chestnut Roast Festival, organized with the intention to expose the general public to chestnuts (plus pecans, black walnuts and many other agroforestry specialty crops) by offering information and samples of fresh, roasted and prepared nuts. The event in 2006 drew a crowd of more than 4,000 guests. Consumer surveys have been conducted at the 2003, 2004 and 2006 Chestnut Roast events.

The second phase of the project is focused on producer market research. In late 2005 and 2006 a national survey was conducted to identify and describe the chestnut (*Castanea spp.*) product market value chain. This consisted of a nationwide survey of individuals and businesses active in the U.S. chestnut production and sales.



NEW OPPORTUNITIES FOR VALUE-ADDED PRODUCTS & MISSOURI FARMERS



Results: Chestnut Consumer Surveys, Three Missouri Chestnut Roast Events

The chestnut roast festival attracts many new participants every year along with repeat visitors (17% repeat visitors in 2004, 12% in 2005 and 25% in 2006).

The frequency of chestnut consumption increased from 2003 to 2006. Comparing first time chestnut roast visitors to repeat visitors reveals a dramatic difference in frequency of chestnut consumption. Fifty eight percent of first time visitors had never eaten chestnuts compared to 5% of repeat visitors.

- Only 5% of first time visitors consumed chestnuts 2-3 times per year compared to 15% of repeat visitors.
- Similarly, 8% of first time visitors indicated that they were familiar or very familiar with roasting chestnuts compared to 20% of return visitors.
- In 2003, quality and nutrition/diet/health were the most important attributes that impact the decision to buy chestnuts. In 2006, locally grown products increased in importance. Quality remained the most valued attribute, followed by locally grown and nutrition. Price was the attribute of lowest importance.
- Three year results (2003, 2004, 2006) confirm the initial results indicating that consumers who participate in the Chestnut Roast Festival are not as focused upon price, but instead value product quality, local production and nutritional value. These results support promotion focused on local production and quality in order to receive a premium price.

Source:

Gold, M.A., M.M. Cernusca and L.D. Godsey. 2004. Comparing consumer preferences for chestnuts with eastern black walnuts and pecans. *HortTechnology* 14(4):583-589.

Gold, M.A., M.M. Cernusca and L.D. Godsey. 2005. Update on consumers' preferences on chestnuts. *HortTechnology* 15(4):904-906.



Development of Improved Black Walnut Selections for Use in Agroforestry Practices

As an effort to increase the potential for black walnut production and sales in Missouri, the Center for Agroforestry has invested twelve years of research to develop the nation's only comprehensive black walnut tree improvement program. The Center strives for identification of the best-suited cultivars for Missouri climate and soils.

Since the start of the applied breeding program, approximately 70 different black walnut nut cultivars have been acquired and placed in a series of grafted orchard collections at the University of Missouri Horticulture and Agroforestry Research Center (HARC) in New Franklin, Mo.

The development of improved black walnuts for use in agroforestry practices continues to focus on three broad areas of investigation: identification of well adapted and productive cultivars that are currently available to landowners; evaluation of cultural practices (such as rootstock and harvest date influences) on cultivar performance; and the initiation of an applied breeding program that seeks to maximize future crop yields—both in terms of quality and quantity.

The current value of the Missouri black walnut industry ranges from **\$15-25 million annually**. Missouri contains the only industrial scale black walnut processing facility in the United States, Hammons Products, processing between 15 and 50 million pounds of black walnut annually. More than 99% of this harvest comes from thousands of unmanaged, wild trees scattered across Missouri and the Midwest -- typically harvested by hand as they fall from trees.

Market Opportunities



Work with the University of Missouri outlying farms and centers and Hammons Products has been initiated to establish 10-acre demonstration orchards across the state that show the potential of black walnut for nut production. Project plans include preparations for 10 acres of black walnut at Hammons' Sho-Neff plantation, Stockton, Mo.

The work of the Center and its collaborators' studying black walnut orchards has tremendous potential for Missouri landowners. Hand pick-up of wild black walnuts results in significant inconsistencies in quality, size, flavor and level of ripeness, which complicates production for consumer purchase. In contrast, improved black walnut cultivars, now ready for release to growers, contain higher nutmeat content and offer higher yields than nuts harvested from wild trees. Cultivar nuts are worth 50 to 75 cents per pound to the grower, up to five times the price paid for wild collected nuts.

By 2020, an estimated 2 million pounds of plantation grown cultivar nuts will be produced on 2,000 acres of walnut orchards in Missouri as a direct result of the research conducted by the Center for Agroforestry. The value of this new orchard production will add \$20 million dollars per year to the Missouri economy.

Black Walnut Financial Model

The Black Walnut Financial Model, available on the Center's web site, is an Excel™ spreadsheet designed to assist potential growers in making decisions about tree spacing, nut harvest, and whether to use improved (grafted) or unimproved trees. Updated in 2006, the model can be used to consider how certain management decisions, i.e. tree spacing, will affect the financial performance of the plantation in terms of potential increases and decreases in net present value, internal rate of return and annual value.

The vision ... Missouri's black walnut nut industry ranges from \$15-\$25 million annually. UMCA's research on developing genetically superior cultivars will create new orchards adding \$20 million more per year to Missouri's economy by the year 2020.

NEW OPPORTUNITIES FOR VALUE-ADDED PRODUCTS & MISSOURI FARMERS

Specialty Mushroom Research: From Morel to Truffle

UMCA supports one of only two research programs in the nation working to develop the premium, high-dollar European black truffle as a forest farming crop for landowners, and is finding that this gourmet mushroom grows well in Missouri soil. Research is also being conducted to develop morel, shiitake and other gourmet mushrooms into profitable agroforestry crops.

Through international collaborations and information exchanges, and programs close to home — including a series of guidesheets and annual Specialty Mushroom Workshops — the Center continues to accumulate a practical, scientifically-sound knowledge base for the benefit of Missouri landowners who are entering the specialty mushroom market.

Several truffle fungi (*Tuber* species) are among the most valuable edible mushrooms known. During the 2007 truffle season, the European black truffles are being sold for \$450 to \$960 per pound in the USA. Since the early 20th century, European harvests of these highly prized species have declined steeply, as changing land use patterns have resulted in deterioration of truffle habitat.

The science of mycorrhiza biology and ecology is advancing rapidly, both in general and with respect to truffle cultivation. Over the past 25 years, entrepreneurs around the world have begun cultivating European black truffle species, with scattered successes.

The Center's goal is to help landowners develop gourmet mushrooms as valuable, sustainable agricultural crops that can be incorporated into agroforestry practices.

The Center's research program recently mastered a molecular identification tool

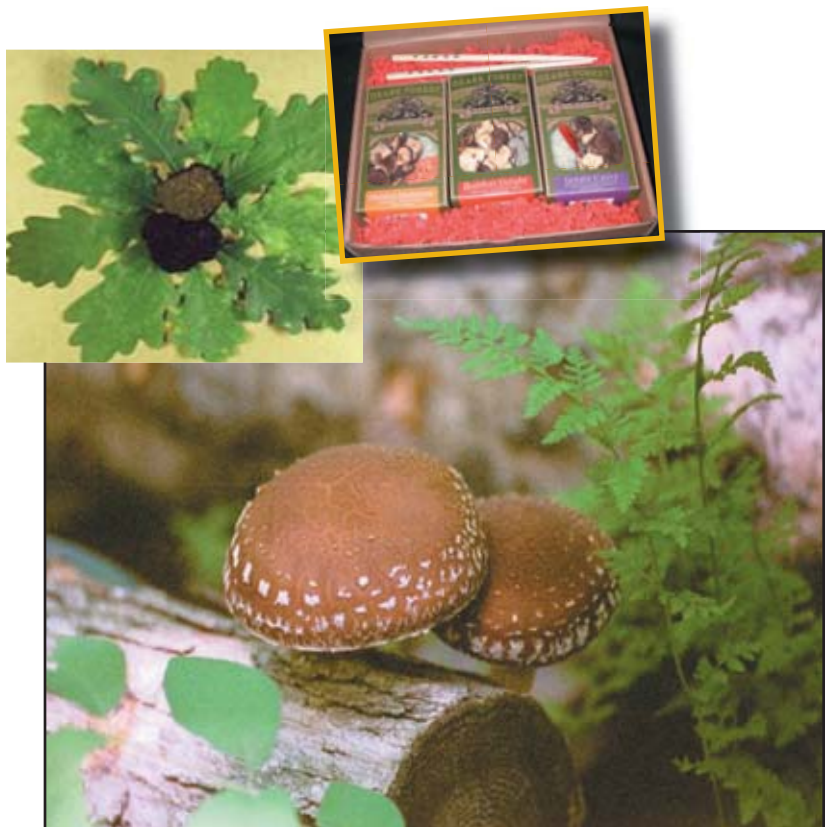
by which fungal DNA is extracted from mycorrhizal root tips, sequenced and identified. This tool is permitting us to systematically survey our truffieres (truffle production areas), and to evaluate the response of seedlings to lime and mulch treatments. This tool has also been employed in the first identification of a native Missouri truffle species, *Tuber lyonii*.

The Center's first truffle production area, established in 1999, is approaching the age when truffles may be harvested.

Published truffle research:

Pruett, G.E., Bruhn, J.N., and Mihail, J.D. 2006. Colonization of oak roots by truffle fungus is influenced by lime and inoculation technique. *Agroforestry Systems*: (In press).

Fresh shiitake mushrooms sell for between \$5 and \$16 per pound. Research is underway on commercial production of morels and European truffles. In some markets, European truffles can bring \$450-960 per pound. The Center conducts one of the only programs in the nation on this gourmet niche crop.



Market Opportunities

Shiitake Market Analysis

In conjunction with HARC farm research and producers' workshops, the Center conducted a nationwide survey of shiitake producers during 2006 to analyze the U.S. shiitake industry. **Findings include:**

- In most cases, shiitake production complements an existing farm operation.
- Respondents that earn more than \$100,000 per year exclusively from shiitake grow on sawdust substrate rather than forest logs.
- Most respondents (78%) sell their shiitake mushrooms fresh. 69% of respondents sell value-added products.
- Barriers to success include labor requirements, start-up funding and issues with organic certification.
- Gourmet restaurants, farmers' markets and on-farm sales are primary outlets for marketing shiitake.
- During the past five years, respondents indicated the price for shiitake mushrooms remained stable or increased up to 25%, with a similar trend expected during the next five years.



Developing Agroforestry, and Associated Nut, Fruit, and Herb Production for Midwestern Farmers: Agroforestry-related Research at the University of Missouri, Southwest Research Center, Mt. Vernon

Agroforestry Research at the University of Missouri Southwest Center, Mt. Vernon, Mo., focuses on evaluating niche crops that can be incorporated into agroforestry practices for increased profit and environmental sustainability.

Key areas include:

- *Development of black walnut as a viable nut crop*
- *Study of northern pecan cultivars and production methods*
- *Alternative native woody fruit/nut crops*
- *Medicinal herbs appropriate for agroforestry*

Northern pecan cultivars and production methods

Pecan (*Carya illinoensis*) is a high-value nut crop with a proven track record of productivity and profitability in southwest Missouri. Due to its higher oil content, the northern pecan features a rich, sweet taste that is more flavorful than southern pecans -- providing opportunities for increased market demand.

Missouri's pecan region is at the northern edge of the natural range of pecan, which presents numerous horticultural challenges, especially cold hardiness and production consistency. To maintain and improve viability of pecan as an important and profitable crop in Missouri, and to expand plantings to additional regions, aggressive long-term research is conducted by the Center. A large 14-year-old pecan cultivar evaluation at the Southwest Center has already yielded much information and will become even more valuable as it comes into full production.



Alternative native woody fruit/nut crops

The native tree and shrub crops of pawpaw (*Asimina triloba*), persimmon (*Diospyros virginiana*), elderberry (*Sambucus canadensis*), hickories (*Carya spp.*), and Ozark chinkapin (*Castanea ozarkensis*) are of great interest to a variety of agricultural producers, as evidenced by large the number of inquiries

received by the Center.

These crops are well-adapted to Missouri's climate and soils, yet all have been neglected from a horticultural research perspective. Basic scientific questions remain unanswered as landowners plant crops with little knowledge or guidance. Several of these species (namely elderberry, pawpaw, and persimmon) are also known for historic and contemporary medicinal use; yet very little is known scientifically about the physiological aspects of various medicinal compounds within the plants themselves. With adequate research, the Center hopes these crops will fill an important niche for innovative producers

NEW OPPORTUNITIES FOR VALUE-ADDED PRODUCTS & MISSOURI FARMERS

and consumers. Elderberry, for example, is a beautiful ornamental plant with many benefits in agroforestry and horticulture, including feeding and protecting wildlife, soil and streambank stabilization, and the use of both flowers and fruit for jams, syrups, natural food colorants, juice concentrates, wines and medicinal products.

Medicinal herbs appropriate for agroforestry

Black cohosh (*Actaea racemosa*; *Cimicifuga racemosa*) is a high-value herbaceous medicinal herb that requires shade and appears to be compatible as an understory plant with tree crops, including black walnut. It can also be grown successfully in a shadehouse setting. The species is among the top ten medicinal herbs consumed in North America and Europe, with millions of dollars spent for black cohosh annually; yet virtually no black cohosh is cultivated in the United States, though it is a native species. The Center has been studying the cultivation of black cohosh since 1999 and, more recently, the production of specific medicinal compounds within various plant tissues. As black cohosh pharmacognosy continues to develop and become more sophisticated, it may be possible to produce some of the important medicinal compounds annually from renewable black cohosh tissues, such as leaves and flowers, rather than destructively harvesting the entire plant after several years.

Publications: Niche Agroforestry Crops

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Eastern Red Cedar: From “Trash” to “Cash”

The Center for Agroforestry research has determined that red cedar is already a **\$60 million industry**, with a rapidly expanding national market for an undervalued and abundant local natural resource. Missouri has the fourth largest eastern red cedar (*Juniperus virginiana*) resource in the United States. Demand is increasing rapidly, along with prices.

The Center is actively involved in organizing this industry to gain market share, create awareness and develop value-added opportunities for Missouri and surrounding states for this underutilized species. In collaboration with fellow researchers and stakeholders, UMCA is initiating additional work to explore the phytochemistry of eastern red cedar to create additional value-added products from cedar. Additional plans include the launch of an online marketplace exclusively for eastern red cedar.

As a collective effort from several Midwestern natural resource and forest entities, a workshop is planned for August 2007 explore the opportunities provided to Missouri land and forest owners through this abundant species - including timber, mulch, aromatic products and oils. (Visit www.centerforagroforestry.org for more information about the Eastern Red Cedar Conference.)



A New Vision

- Establish a thriving and diverse gourmet mushroom industry.
- Establishment of major chestnut and black walnut industries
- Strengthening red cedar industry to increase its commercial potential
- Strengthen market connections for Missouri specialty crop producers

2006 Publications

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Tree-ring Research with Ancient Midwestern Wood: Collaborative Research within Floodplain Reforestation

The Center's support for detection of the climate record for the past 14,000 years, through tree-ring dating from ancient wood in Missouri streams, has led to a \$300,000 grant award from the National Science Foundation (NSF).

In a groundbreaking project, Center researchers are working to develop an oak tree-ring chronology for the past 14,000 years — information that will enable scientists to relate growth of Midwestern oaks to global climate events that affect the weather and productivity of our forests and fields in the Midwest.

Tree-ring research of Midwestern ancient oak wood indicates that the construction of tree-growth records thousands of years in length is possible. These records are invaluable, containing long-term information about climate and plant growth variability for a region that is a global source of food commodities. In addition, research conducted on ancient riparian forests is shedding light on our understanding of carbon sequestration, aquatic habitat and climate change.

Support for research on the dynamics on large wood in Missouri streams, part of the Center's floodplain initiative, has been enhanced by the award of an NSF grant of \$300,000.



Bringing the vision to reality ...



*We're getting there ...
and you can be part of the
vision.*

A vision for the future of agroforestry in Missouri takes courage. A commitment to natural resources. A strong desire to see family farms succeed. And it takes innovative thinking that looks to systems-based approaches to agricultural and environmental challenges.

We invite you to collaborate with the Center for Agroforestry as we continue building a future for Missouri land and forest owners, as well as for cleaner water, cleaner air and the preservation of our state's precious resources.

*Recommendations:
As presented to Governor Matt Blunt*

Legislative Goals: Develop state legislation that is designed in such a way that it provides a substantial (up to 75%) cost-share to Missouri landowners who wish to establish agroforestry practices for both conservation and entrepreneurial benefits. It is believed

that conservation practices that add economic and environmental benefits to the landowner's balance sheet are more likely to be sustained in the long-run.

Policy Changes Achieved: In 2006, Center for Agroforestry personnel — working with Missouri Department of Agriculture (MDA) Director Fred Ferrell and his staff, and Natural Resource Conservation Service State Conservationist Roger Hanson and his staff — created the opportunity for producers to qualify for EQIP windbreak dollars for odor abatement. The agreement calls for a significant cost-share on large seedling planting stock and drip irrigation to assure fast growth of the trees.

In addition to funding provided for the initial sign-up period, an additional \$1 million was set aside for a special sign-up during January 2007 to create windbreaks around animal feeding operations, farmsteads and headquarters. With financial support from the MDA, the Center is prepared to conduct research to evaluate the effectiveness of properly placed trees, shrubs and grasses on air and water quality near confined animal feeding operations in order to design more effective windbreaks. Throughout this process, the Center's goals are to help develop technologies that benefit Missouri's agriculture while preserving our natural resources and strengthening rural communities.

Delivering Knowledge: Strengthen the cooperation between the University of Missouri's agroforestry technology transfer program and the Missouri Department of Conservation's (MDC) landowner assistance program in delivering agroforestry technology to the user. Increase cooperation between the MDC and the Center in providing in-service, agroforestry training for agency personnel.

New Markets: Strengthen current UMCA efforts to launch new black walnut and chestnut industries throughout Missouri by providing 3 years of financial support for a full-time Center nut tree horticulturist.

Maximizing Economic Returns: Strengthen current Center efforts to develop rotationally-grazed livestock production through the introduction of trees into pastures for maximum landowner economic gain. This will be accomplished by providing 3 years of financial support for a full-time Center silvopasture scientist.

LEVERAGED GRANTS & FUNDING

It is a top priority for the Center to work in collaboration with partners across the nation, and the globe, on developing the scientific base for agroforestry and associated market opportunities. The Center seeks to fund ongoing research through external sources, helping to preserve core resources to ensure the long-term success of the Center as the nation's leader in agroforestry research and development.

Planned Gifts and New Developments:

Doug Allen Research and Education Site. Doug Allen, friend of the Center, is working with the Center on plans for the Allen Research and Education Site. The site, a planned gift by Allen to the Center, consists of more than 500 diverse acres of forested and valley land and the corresponding resources to construct a state-of-the-art agroforestry demonstration and teaching facility near Laurie, Mo. A corresponding Allen Endowment Fund will maintain and support the property for agroforestry research.

Restoration of the 1819 Thomas Hickman Homestead: Located on the Center's HARC farm in New Franklin, Mo., the Thomas Hickman House is one of the oldest brick homes west of the Mississippi, and a rare architectural treasure telling the story of Missouri's early agricultural history. Now listed on the National Register of Historic Places, funding was received in 2006 from the Missouri Department of Economic Development for \$250,000 as a Community Development Block Grant from the City of New Franklin to help fund restoration work of the home and grounds. (Garrett)

Flood Tolerance Research/ Floodplain Initiative:

"Survival and Growth of Planted Oak Seedlings in Flooded Environments from Seed Sources Collected Along a Hydrological Gradient". Funded by Missouri Department of Conservation, Research Science Division. Awarded August 2005 for two years. \$62,200. (Coggeshall, Van Sambeek, Gwaze)

"Identification of Soybean Germplasm for Tolerance to Soil Waterlogging". A grant was funded for 3/1/2005 - 2/29/2008 by the Missouri Soybean Merchandising Council to help fund research to improve the flood tolerance of soybeans. \$113,829. (Shannon and McGraw)

Flood Tolerance Laboratory Expansion: "Stormwater and Green Infrastructure Management." Through funding received in 2006 under a subcontract with the Mid-America Regional Council, the number of channels at the Flood Tolerance Laboratory has been increased from 12 to 24. \$29,400. (Gold)

Bottomland Forest Regeneration: The MDC funded additional research on bottomland forest regeneration at Duck Creek Conservation Area and Mingo National Wildlife Refuge. This work evaluates methods for establishing pin oak regeneration in existing bottomland forests. \$17,000 per year. (Dey)

Oak Tree-Ring Chronology: Research on the dynamics on large wood in Missouri streams has been awarded an NSF grant to continue work in developing a master oak tree-ring chronology for the past 14,000 years, and to relate growth of Midwestern oaks to global climate events that affect the weather and productivity of our forests and fields in the Midwest. This grant helps support the Center's work in restoring habitat and forested areas to floodplains. \$300,000. (Guyette, Stambaugh and Lupo)

Shade Tolerance and Forages:

Forage quality: USDA Natural Resource Conservation Service funded a research proposal to evaluate forage quality of big bluestem accessions grown in the Shade Tolerance Laboratory. \$12,000. (Van Sambeek and Wallace)

U.S. Golf Association: Shade tolerance evaluations were included as part of the funded research proposal by the ARS (\$10,000) and U.S. Golf Association (\$30,000) to evaluate poverty grass (*Danthonia spicata*) for use on golf courses. (Navarrete-Tindall, Fresenburg and Van Sambeek)

Tree/Crop Interactions:

"Improving the Environment and the Economic Stability of Small Farms Through an Alternative Agroforestry Practice." University of Missouri Research Council Grant URC-06-042. \$4780. (Stamps and Linit)

"Resource Conservation with Herbaceous Cropland Field Borders." Missouri Department of Conservation 0011877. \$10,000. (Stamps, McGraw, Woods, Linit, Godsey)

"Ecology and Diversity of the Insect Community in Alternative Crops and Nut Trees." Missouri Agricultural Experiment Station Project. \$12,000. (Linit)

Silvopasture Research:

Silvopasture Research and Demonstration Site: Funding for this work includes a 2006 grant from the Wurdack Farm Advisory Board to support clearing of poor-quality hardwoods and the incorporation of 2,000 shortleaf pine trees on south-facing slopes, with future establishment of big bluestem grass to create a silvopasture practice that incorporates warm-season grasses selected for improved shade tolerance. This project holds tremendous potential for benefiting Ozark-area livestock producers. \$43,000. (Dwyer and Walter)

Odor Mitigation and Windbreaks

Livestock Odor Abatement: In 2006, Center for Agroforestry personnel — working with the Missouri Department of Agriculture (MDA) and the Natural Resource Conservation Service — created the opportunity for producers to qualify for EQIP windbreak dollars for odor abatement. The agreement calls for a significant cost-share on large seedling planting stock and drip irrigation to assure fast growth of the trees. An additional \$1-million was set aside by the MDA for a special sign-up during January of 2007 to create windbreaks around animal feeding operations, farmsteads and headquarters. (Garrett, Walter and Gold)

Bioremediation of Herbicides:

USDA-ARS Cropping Systems and Water Quality Research Unit, Columbia, Missouri. \$35,000. (Lerch and Lin)

Adsorption of the isoxaflutole degradate diketonitrile to hydrous iron and aluminum oxides. United State Geological Survey/ Missouri Water Resources Research Center. \$22,000 for 2006-07. (Goyné, Lerch and Lin)

USDA-ARS/Department of Soil Science, University of Missouri-Columbia. \$2,500.

Socioeconomics and Marketing:

"Missouri Alternative Products Online Marketplace for Missouri's Entrepreneurs." Award received as a subcontract through Missouri Department of Agriculture via the Federal State Market Improvement Program (FSMIP) to create the online marketplace for Missouri agricultural products, Missouri Exchange. (www.missouriexchange.com) \$50,000. (Gold, Godsey, Cernusca)

Niche Agroforestry Crops:

"Investigations into the Propagation of Ozark Chinkapin." Awarded by the Northern Nut Growers Association for restoration work of the endangered Ozark Chinkapin. \$4,993. (Thomas)

"Truffle Cultivation in North America and Europe." University of Missouri European Union Center award to help fund researchers' attendance to 2007 research meeting in Bologna, Italy. \$3500. (Bruhn and Mihail)

Effect of Nitrogen Applications on Growth of Chinese Chestnut

Grant Funded: Northern Nut Growers Association, funded for March 1, 2005 to December 31, 2006. \$3655. (Warmund)

Student Research Support:

Dennis Priest, Biological Aide supported by the USDA Forest Service, assisted half-time with summer maintenance of the Flood Tolerance Laboratory.

Valerie Mireles, Summer Intern; research with the Flood Tolerance Laboratory supported by the Hispanic Association of Colleges and Universities' National Intern Program.

A new vision ...

We are striding ahead toward a brighter future. Built upon sound science, innovative technology, a commitment to the needs of landowners and expert collaborations, our vision is coming into focus.

As stated by John Campbell, author of *Reclaiming a Lost Heritage* and past president of Oklahoma State University, “Hopefully the story will get out to Missouri’s citizens and legislative leaders that the Center’s timely and comprehensive efforts are certainly exciting and impressive.”

Our vision, by 2020...

- *The Center will make significant impacts upon Missouri farmers through increased and diversified income opportunities.*
- *As environmental stewards, our leadership will create better-managed forests and farms and cleaner water to benefit landowners, the communities they live in and the entire state.*
- *Through the application of new agroforestry technologies, increased and enhanced wildlife habitat will help preserve Missouri’s valuable species and diversity.*

We encourage you to contact the Center for Agroforestry directly to discuss our vision in more detail.



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