

THE UNIVERSITY OF MISSOURI CENTER FOR AGROFORESTRY

Putting Science into Practice

*2007 Annual Report:
Research, Partnerships & Technology Transfer*



Enhancing Stewardship, Farm Profitability, Biodiversity &
Wildlife Habitat through Agroforestry

AboutThe Center

What is Agroforestry?

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



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

Agroforestry helps landowners 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 across the university.

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.

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. Our efforts don't stop at research; the Center is truly unique in that we actively work to get the word out about agroforestry and into the hands of landowners through collaboration, workshops, newsletters and other publications and informational exhibits. We put the science into practice.



Goals of the Center's Research

Through research, field application and technology transfer, demonstrate agroforestry's ability to

- Develop new market opportunities
- Generate income
- Reduce non-point source pollution
- Mitigate against impacts of periodic flooding
- Create and improve wildlife habitat
- Sequester carbon

Research Highlights2007

contents

2 About the Center	16 Markets & Socioeconomic Research	26 Forest Farming
3 Director's Message	18 New Developments	28 Nut Trees
4 The Five Practices	20 Riparian Forest and Upland Buffers	30 Tree/Crop Interactions
5 Research Clusters	22 Flood Tolerance Lab	31 Elderberry
6 Partnerships	23 Bottomland Restoration & Wildlife	32 2007 Publications
7 Staff & Collaborators	24 Silvopasture	35 2007 Grants
8 HARC: New Horizon	25 Windbreaks	
13 Missouri Chestnut Roast		
14 Technology Transfer		

Edited by Michelle Hall, UMCA Senior Information Specialist, & Mike Gold, UMCA Associate Director and MU Research Professor of Forestry

Director's Message



Photo: Roger Berg's Creative Photo, Inc.

In 1997, The Fifth Conference on Agroforestry in North America was held at Cornell University in Ithaca, N.Y. I was in attendance and after sitting through a three-day meeting, was pleased by how far I felt North American agroforestry had advanced since our First Conference held in Guelph, Ontario, just eight years earlier.

However, in an open discussion held on the last day of our meeting, a USDA scientist stood and remarked that he was very disappointed in the fact that much of what he had heard during the conference was anecdotal in nature and he encouraged each of us to work towards developing a stronger scientific foundation for agroforestry.

The past two decades have witnessed a renaissance in temperate zone agroforestry research, marked by vigorous intellectual activity. Many of us were challenged by that researcher's remarks and have led initiatives to create a scientific base in support of agroforestry. The Center for Agroforestry at the University of Missouri is so pleased to have been one of several programs across the U.S. and Canada that has endeavored to put science into the practice of agroforestry!

Another exciting year has come and gone and we continue in our efforts to develop new technologies that benefit agriculture while preserving and enhancing our natural resources. We experienced many successes during 2007 and are so pleased to be able to share a few of them with you in this report.

We are very encouraged by the successes we are experiencing in our nut culture research. Our agroforestry chestnut research has become focused in four areas: developing and testing the best cultivars for the Midwest; conducting marketing research; increasing consumer awareness and demand; and creating "grower clusters." Our long-term goal is to help develop a thriving U.S. chestnut industry. With U.S. production at less than 2 million pounds annually, we must import 10 to 12 million pounds just to meet current demands. With a yield potential of more than 1 ton per acre and prices that range from \$2 to \$4 per pound or more, this creates real opportunities for family farms that are looking for new crops that can help pay the bills. For those of you interested in learning more, you will find an updated version of our publication, "Growing Chinese Chestnuts in Missouri" on our Web site.

Those of you interested in walnut will be pleased to know that our breeding program for nut production is already

paying dividends. Our tree improvement specialist has recently revealed to me that two trees that he created by crossing parents with uniquely different, but desirable, characteristics came into heavy production at the "ripe old" age of 4 and have a high percentage kernel – precociousness (i.e., early bearing) is very desirable. These trees are heavy with female flowers again this year, perhaps suggesting that they will bear regularly instead of being alternate bearing as many black walnut are. Our Center is currently evaluating the economics of black walnut orchard management for nut production. To help individuals interested in exploring the opportunities of black walnut as an orchard species, in 2007 our Center published a guide, "Growing Black Walnut for Nut Production." This guide is available upon request or can be accessed from our Web site and is a "must read" for anyone interested in this valuable species.

Although not a nut tree, another species that our Center is truly excited about is a hybrid created between loblolly pine (the cornerstone of the southern pine industry) and pitch pine. The outcome of this cross is a tree that looks and grows like loblolly but is cold tolerant like pitch pine. While we are interested in this cross for wood production, our Center is even more interested in it for its needles. Its long needles (often 6 inches in length) are valuable as a landscape mulch. Our research has revealed that a 12-year-old plantation can yield 100 to 200 bales of needles (called pine straw) per acre every other year valued at \$3 to \$5 per bale to the landowner. A net of \$100 to \$350 per acre or more can be realized while the landowner waits for the lumber potential of the trees to be realized.

All of this and more in the area of new farm products, in concert with our findings that have clearly demonstrated the value of agroforestry practices to improve air and water quality, keeps our Center at the forefront in recognition for creating science in support of agroforestry practices. While there are many new discoveries that remain to be made and many new agroforestry technologies that remain to be developed or improved upon, to the advantage of the family farm, our Center has done much towards helping agroforestry come of age as a science.

The family farm is looking for solutions – we now know, as a result of rigorous scientific undertakings, that agroforestry technologies contain some of the solutions to the problems faced by the family farm. Our Center takes great pride in having helped develop the solutions – we now welcome the opportunity to work with the landowner to put them into practice!

– Gene Garrett, Director,
University of Missouri Center for Agroforestry

The Five Practices Of Agroforestry

FOREST FARMING

In forest farming, high-value specialty crops are grown under the protection of a forest canopy 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 short-term income while high-quality trees are being grown for wood products. Turkey, deer, songbirds and other wildlife may find ideal habitat in a forest farming setting.

SILVOPASTURE

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. 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.

ALLEY CROPPING

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 also may be incorporated for extra income. Mixes can include 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. Rows of trees, shrubs and/or grasses planted on the contour of a slope also will serve to reduce soil movement down the slope and can protect fragile soils.

RIPARIAN FOREST AND UPLAND BUFFERS

Riparian forest and upland buffers are living filters comprising 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 forest and upland 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 forest and upland buffers.

WINDBREAKS

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. These strategically placed rows of trees and shrubs also enhance production and conservation opportunities by modifying air movement and wind speeds.

“The family farm is looking for solutions – we now know, as a result of rigorous scientific undertakings, that agroforestry technologies contain some of the solutions to the problems faced by the family farm.”

- Gene Garrett, Director, Center for Agroforestry



UMCA Research Clusters

Since 2001, the University of Missouri Center for Agroforestry has been supported by and managed three significant USDA-ARS grant programs. These grants fund more than 60 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, research efforts have been organized into 11 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.

UMCA RESEARCH CLUSTERS

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

Water quality and riparian forest and upland buffers The focus is to quantify environmental benefits of woody/grass buffers on non-point source pollutants. Includes paired upland watershed study, an animal bioremediation study and work on riparian forest buffers in collaboration with Iowa State University scientists.

Flood tolerance 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 trees and plants. Results link directly to “green infrastructure” projects in Kansas City with the Mid-America Regional Council and National Agroforestry Center.

Socio/economic/marketing 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 understand-

ing of important factors that facilitate or constrain involvement in agroforestry and are directly linked with the technology transfer program.

Fast-growing hardwood biomass and warm-season grass Focus is to quantify growth of *Populus* clones and other species for biomass production, flood tolerance and levee protection.

Forest bottomland and wildlife restoration and biodiversity Studies look at bottomland hardwood restoration and management; quantifying effects of bottomland agroforestry practices on wildlife species. Research also includes minimizing rabbit damage and enhancing mourning dove harvest opportunities in alley cropping practices.

Silvopasture/shade tolerance 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; and effects of managed hardwood forest stands and grazing upon understory shade tolerant forages and stand regeneration.

Horticulture Ongoing studies include those on gourmet mushrooms, redcedar phytochemicals, elderberry, pine straw and the Missouri Gravel Bed.

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.

Carbon sequestration This cluster includes above- and below-ground carbon balance studies.

Technology transfer Efforts are centered around four outlying university research properties, with a focus on ongoing agroforestry research and landowner demonstrations in adjacent locations complemented by socio/economic/marketing studies.



A TeamEffort

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

MU Collaborations

University of Missouri Extension

College of Agriculture, Food and Natural Resources Partnerships with faculty in 10 departments: Animal Sciences, Horticulture, Forestry, Agricultural Economics, Rural Sociology, Entomology, Agronomy, Plant Pathology, Fisheries and Wildlife, and Soil, Environmental and Atmospheric Sciences.

University of Missouri National Center for Soybean Biotechnology

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
Chetopa Experiment Station, Kansas State University

Federal and State Agency Partnerships

Federal Collaborations

USDA Agricultural Research Service - Dale Bumpers Small Farms Research Center, Booneville, Ark.

USDA Forest Service - Central Hardwoods Research Unit, Columbia, Mo.

National Agroforestry Center, Lincoln, Neb.

USDA Natural Resource Conservation Service

USDA Agricultural Research Service - Cropping Systems and Water Quality Research, 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

Special recognition is extended to the Dale Bumpers Small Farms Research Center, Booneville, Ark., whose financial and collegial support have provided the impetus for the advancement of agroforestry from a practice to a science.

Missouri Natural Resources Conservation Service
Missouri Resource Conservation and Development

Professional Associations and Businesses

Association for Temperate Agroforestry
Forrest Keeling Nursery
Hammons Products Company
Missouri Northern Pecan Growers, LLC
Missouri Forest Products Association
Missouri Nut Growers Association
Missouri Walnut Council
Chestnut Growers of America
Missouri Farm Bureau
Missouri Farmers Union
Missouri Tree Farm Association
Missouri Christmas Tree Producers Association
Missouri Consulting Foresters 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.



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.

partnerships, staff & collaborators

UMCA FACULTY & STAFF

Harold E. "Gene" Garrett, Ph.D.
Director/Professor - Forestry

Michael Gold, Ph.D.
Associate Director/Professor - Forestry

Bonnie Beckett
Administrative Assistant

Ina Cernusca, M.B.A.
Research Associate/Marketing Specialist

Mark Coggeshall, M.S.
Tree Improvement Specialist/
Research Analyst

Larry Godsey, M.S.
Research Associate/Economist

Michelle Hall
Sr. Information Specialist

Ken Hunt, Ph.D.
Research Scientist

Chung-Ho Lin, Ph.D.
Research Assistant Professor - Forestry

William Reid, Ph.D.
Adjunct Associate Professor - Kansas State
University

Julie Rhoads, M.S.
Technical Training Specialist/Events
Coordinator

Ranjith Udawatta, Ph.D.
Research Assistant Professor - Soil,
Environmental & Atmospheric Sciences
(SEAS)

Dusty Walter, M.S.
Technology Transfer/Research Specialist

HARC FARM STAFF

Ray Glendenning, Farm Manager, HARC

Brandon Adamson, Forestry

Kenny Bader, Forestry

Nancy Bishop, HARC

Aaron Brown, Wildlife

Parker Fadler, Forestry

Jimmy Houx, M.S., Agronomy

Dustin Schwandt, Forestry

Randy Thiessen, Horticulture

John Thompson, Agronomy

Terry Woods, M.S., Entomology

ASSOCIATE FACULTY & STAFF

Francisco Aguilar, Ph.D., Forestry

Steve Anderson, Ph.D., SEAS

Carla Barbieri, Ph.D., Parks, Recreation &
Tourism

Bruce Barrett, Ph.D., Entomology

Johann Bruhn, Ph.D., Plant Pathology

John Dwyer, Ph.D., Forestry

Milon George, Ph.D., Forestry

Keith Goyne, Ph.D., SEAS

Rob Kallenbach, Ph.D., Agronomy

Monty Kerley, Ph.D., Animal Sciences

David Larsen, Ph.D., Forestry

Marc Linit, Ph.D., Entomology

Bob McGraw, Ph.D., Agronomy

Jeanne Mihail, Ph.D., Plant Pathology

Josh Millspaugh, Ph.D., Fisheries &
Wildlife

Peter Motavalli, Ph.D., SEAS

Rose-Marie Muzika, Ph.D., Forestry

Steve Pallardy, Ph.D., Forestry

Bob Pierce, Ph.D., Fisheries & Wildlife

Sandy Rikoon, Ph.D., Rural Sociology

Terrell Stamps, Ph.D., Entomology

Chris Starbuck, Ph.D., Horticulture

Andy Thomas, M.S., Horticulture

Corinne Valdivia, Ph.D., Agricultural
Economics

Michele Warmund, Ph.D., Horticulture

EXTERNAL COLLABORATORS

Gary Bentrup, M.S., U.S. Forest Service/
National Agroforestry Center

David Brauer, Ph.D., Agricultural Research
Service/U.S. Department of Agriculture

David Burner, Ph.D., ARS/USDA

Dan Dey, Ph.D., USFS

Michael Dosskey, Ph.D., USFS/NAC

John Kabrick, Ph.D., USFS

Robert Kremer, Ph.D., ARS

Bob Lerch, Ph.D., ARS/Water Quality

Nadia Navarrete-Tindall, Ph.D.,
Horticulture, Lincoln University

Rob Myers, Ph.D., Jefferson Institute

Richard Schultz, Ph.D., Forestry, Iowa
State University

Michele Schoeneberger, Ph.D., USFS/NAC

Jerry Van Sambeek, Ph.D., USFS

Doug Wallace, M.S., NRCS State Forester

Gary Wells, B.L.A., R.L.A., NRCS/NAC

Bruce Wight, B.S., C.F., NRCS/NAC Lead
Agroforester

Leading the nation

Gene Garrett, director, UMCA, has been named Chair of the Missouri Forest Resources Advisory Council (MoFRAC), a renewed forestry coordinating council for the state, and serves on the Global Coordinating Committee for the Second World Congress on Agroforestry.

Mike Gold, associate director, UMCA, was named President of the Chestnut Growers of America for 2007-2008.

The Center for Agroforestry will host the 2009 North American Agroforestry Conference.

The department of forestry at the University of Missouri is in the top 10 in the nation, according to the Chronicle of Higher Education's third annual survey of scholarly productivity. Many UMCA faculty associates are also part of the MU department of forestry.

Green Horizons, a newsletter jointly produced by the Center for Agroforestry and MU Forestry Extension, was named Top Newsletter for 2007 by the Association of Natural Resource Extension Professionals.

During 2007, more than 50 researchers and collaborators of the Center published nearly 90 articles in scientific journals and the popular press.

UMCA's research farm undergoing major transformation

Big changes are just over the horizon at the University of Missouri Center for Agroforestry's Horticulture and Agroforestry Research Center (HARC).

The farm is the site of one of the state's oldest intact brick houses, the Thomas Hickman House, built in 1819. Thanks to funding from the Missouri Department of Economic Development through a Community Development Block Grant from the City of New Franklin; federal funds secured by U.S. Sen. Kit Bond; a Save America's Treasures grant from the National Park Service; and a match presented by the MU College of Agriculture, Food and Natural Resources, the 1,800-square-foot home is undergoing rehabilitation to bring it back to its historic condition.

The restored home is planned to open in late summer 2008, as a visitor center for the HARC farm, telling the story of the region's cultural and agricultural heritage through interpretive exhibits and period and heirloom gardens, in addition to introducing visitors to ongoing projects at the research farm.

"We are thrilled to be preserving a part of history for future generations," said Dr. Gene Garrett, Director of

the Center for Agroforestry and Superintendent of the Horticulture and Agroforestry Research Center. "It will be important as an attraction to draw visitors to the farm. And while they're there, we'll teach them about agroforestry."

The Hickman House represents an outstanding example of 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. The house was designated to the National Register of Historic Places in July of 2006.

Rehabilitation efforts have included pouring a new foundation; restoring original window size and replacing panes and sashes; reroofing the roof in period materials; removing paint from and stabilizing exterior brick; refinishing original floors and woodwork; and restoring interior plaster. In addition, the four chimneys have been rebuilt from a state of disrepair and a summer kitchen is being reconstructed based on archeological and historical information.



Above and clockwise: West side of the 1819 Hickman House, currently under restoration. The original stone foundation at the Hickman House was recently reinforced with concrete in 4-foot sections. Cracks in the original interior plaster reveal brick walls. Original log floor joists are uncovered.

building & growing

Current construction at HARC doesn't end with a new but historic visitor's center; the research farm is also about to become the site of a \$3 million Learning Center for education, training and research. The new building will have room for events large and small.

LEARNING CENTER SPECS
300-seat auditorium that can be divided into spaces for 50, 100 and 150 people

Office space for staff and researchers

Two classrooms equipped with presentation equipment to accommodate 25-30 people each

Conference room for 25

Two laboratories

"This learning center will jump us light years ahead in terms of our ability to serve the general public," Garrett said. "Right now, we have no opportunity to bring groups to the farm, sit them down and interact with them."

Garrett said at the moment, groups can tour the farm, but as far as having a venue to discuss what they have seen after a tour – well, there's just no space for that. He said he has led meetings in the equipment barn at HARC in the past.

"Our educational opportunities will be greatly enhanced," he said. "The building will have space for meetings of all sizes. In addition, we will now have reasonable office space for our workers. It will enhance productivity and make the farm more appealing."

The learning center will be built on the highest point at HARC, with the "best view of the farm," Garrett said. In addition, the center's location is near the farm's botanical gardens; a path will be constructed between the two. Construction materials for the building will include stone and colored concrete.

The learning center is scheduled for completion in late spring 2009; ground will be broken in late summer 2008. The center will be funded by the state of Missouri's Lewis and Clark Discovery Initiative.

HARC is the primary research site for the MU Center for Agroforestry. The farm includes experimental fruit and nut orchards; forest farming, riparian buffer and silvopasture demonstrations; greenhouses; shade and flood tolerance laboratories; and five lakes and ponds.

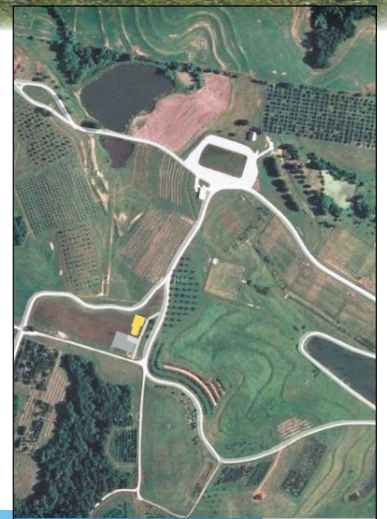
HARC is one of the University of Missouri's 17 outlying research farms, a network of sites across the state hosting programs that bring Missouri

farm and forest landowners 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; the Horticulture Research Center officially became the Horticulture and Agroforestry Research Center in 1995. A recent land purchase of 120 acres expands the total acreage to nearly 660.

Visitors to the research farm often comment on the beautiful 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.



Above: Architectural rendering of the front view of the new Learning Center. Right: Google Earth view of HARC containing the site of the Learning Center (in yellow); parking lot (in grey). Below: Side views of the Learning Center. Center images are courtesy University of Missouri, Campus Facilities, Planning, Design and Construction.



HARCResearch

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 optimal for establishing demonstrations of the five agroforestry practices – alley cropping, silvopasture, forest farming, windbreaks and riparian forest buffers.



“soft” hardwood tree used to produce biomass. In 1997, cottonwood clonal trial studies began at the research farm

Pitch x Loblolly Pine and Black Walnut Winter Forage Alley Cropping Study This research 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 U.S. Department of Agriculture-Natural Resources Conservation Service 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.

Cottonwood Clonal Trial/Flood Tolerance Evaluation Eastern Cottonwood (*Populus deltoides*) is a fast-growing,

to evaluate cultivars for their growth response and adaptability to Missouri conditions, allowing researchers to identify the best cottonwood cultivars for agroforestry plantings.

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 10 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. Research utilizing the pine/black walnut alley cropping demonstration area for controlled grazing is examining 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, animal health, reproduction, weight gain and beef quality.

Forage Shade Tolerance Study Throwing trees into the mix, managing correct shade levels is 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. In subsequent years, additional species have been studied. In 2005, the Shade Tolerance Laboratory was completely rebuilt and expanded to 15 structures.

PINE STRAW: CREATING A NEW INDUSTRY IN MISSOURI

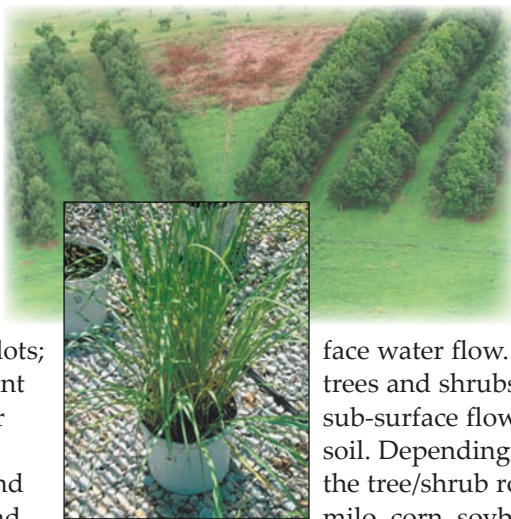
Pine straw, the accumulation of naturally shed needles of pine trees, is commonly baled and sold in the southeastern U.S. as landscape mulch. A well-managed plantation in full production can gross up to \$1,000 per acre from sale of pine straw bales. However, loblolly pine, the predominant species used for pine straw plantations in the south, may not be considered tolerant to the colder conditions in Missouri. Shortleaf, the only pine species native to Missouri, is not well suited to pine straw production due to its namesake short needle length.

UMCA researchers are evaluating the potential of cold-tolerant selections of loblolly pine and pitch x loblolly hybrid pines for production of pine straw in Missouri. These pine have cold hardiness for Missouri with a similar needle length to loblolly. Fifteen genotypes have been evaluated at HARC for their potential for pine straw production. In 2007, nine years after the initial planting, a seed orchard was created from the trees shown to be superior in the study. In the near future, Missourians will be able to use the seed created to plant their own pine straw-producing tree plantation, alley cropping practice or silvopasture enterprise.

more than 60 projects from 10 disciplines

New treatments include one comparing intermittent shade as sunflecks to continuous dense shade. All species are currently being evaluated under five shade level treatments: 0 percent (full sun), 30 percent shade, 55 percent shade, 78 percent shade (sunflecks), and 80 percent shade. Research emphasis has recently switched from cool-season forages to warm-season forages, including big and little bluestem. Forages tested in the Shade Tolerance Laboratory are subsequently field tested.

Plans for the Shade Tolerance Laboratory in 2008 include initiating screenings of little bluestem accessions; identifying big bluestem accessions for release and establishment of production plots; determining plant responses under cherrybark oak tree canopies; and installing soil and microenvironment monitoring plots.



Missouri River floodplain and is one of the nation's most comprehensive and unique field laboratories for studying the response of plant species to the periodic flooding common to Midwestern floodplains. 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 collection from bottomland and upland stands is also being studied.

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 land's 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 also will 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, pumpkins or sunflowers may be produced.

Quail Cover Bundle Habitat Study Bobwhite quail populations are declining in the Midwest, due to the 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 quail nesting and roosting areas. Researchers at HARC 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 The laboratory lays adjacent to Sulphur Creek in the

Nut Tree Improvement The nut tree improvement program focuses on identifying and testing selections of black walnut (*Juglans nigra*), pecan (*Carya illinoensis*) and Chinese 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. In contrast,

NURSERY STOCK ALWAYS AVAILABLE WITH MISSOURI GRAVEL BED

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 mix 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 that expected for container-grown or balled and burlapped plants.

The major research emphasis in 2006-2007 was improving the effectiveness of the Missouri Gravel Bed as a method to facilitate the establishment of trees and shrubs in agroforestry plantings. Although the Missouri Gravel Bed has many advantages, pea gravel has low water-holding capacity, requiring frequent irrigation and nutrient application. Studies tested whether adding calcined clay to the gravel bed mix would be advantageous.

Studies showed total porosity and available water were significantly greater with the addition of at least 20 percent calcined clay than with the standard MGB medium. Sand can then be eliminated from the mixture if at least 20 percent calcined clay is added. A field scale evaluation of this study is now underway.

Source: Bohnert, C. 2006. Effects of amending a gravel based growing medium with calcined clay on medium physical properties and growth of Gymnocladus dioicus seedlings. University of Missouri-Columbia. M.S. thesis.

HARC Research



the Center is working to promote black walnut as a profitable orchard crop, 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 the establishment of the cultivar repository in 1996, 70 black walnut nut cultivars have been acquired and placed in a series of grafted orchard collections. Beginning in 2000, a list of careful observations (“descriptors”) were initiated on an annual basis for all of the cultivars. This information allows researchers to learn more about how a species can vary for a number of commercially important characteristics (e.g., yield). In 2007, researchers authored a guide for landowners, “Growing Black Walnut for Nut Production.”

Chestnut is a crop largely unknown to Americans since the near extinction of the American chestnut forests from chestnut blight (1900-1950). The Chinese chestnut shows excellent potential for Missouri/Midwestern landowners as a cash income crop. Currently, wholesale and retail prices are high, and demand exceeds supply for this sweet, starchy, nutritious nut. Chinese chestnut cultivar research at the HARC farm began in 1996. The research repository includes more than 60 cultivars under evaluation in an orchard setting to determine the best-suited selections for Missouri’s promising chestnut industry.

National Arboretum/NC-7 Trials: Evaluating Rare Plants A cooperative agreement in 1996 designated HARC as a U.S. National Arboretum Midwest Plant Research and Education Test 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 climate 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 evaluated and demonstrated within the test site.

Native Plants Demonstration Area Native perennial shrubs, forbs and grasses have been established in demonstration plots in Zone 5 at HARC and in the field. Shrubs and forbs include false wild indigo, dwarf Amorpha, shining wild indigo, Oua-

chita false indigo, swamp milkweed, shining blue star and wild quinine. Grasses included are eastern gamagrass, dropseed, cluster fescue and river oats. These plots are used for demonstrations during field days.

Horticultural Research with Orchard Crops: Pest Control Strategies Within an alley cropping or silvopasture practice, a farm or forest landowner has the opportunity to harvest nuts and fruits from a tree crop while simultaneously growing row crops and/or managing livestock. Studies 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, also are being evaluated for Midwest conditions.

HARC: LEADING THE NATION IN AGROFORESTRY RESEARCH

More than \$3 million has 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 five full-time research specialists to support ongoing research efforts on more than 400 of the acres of land at HARC.

Every year, workshops, trainings and outreach events bring thousands of landowners, policy makers and natural resource professionals to tour the farm’s demonstration areas.

Site of extensive bioremediation, non-point source pollution and shade and flood tolerance studies, including an innovative, outdoor 24-channel flood tolerance research laboratory.

Projects for producing gourmet, high-value mushrooms, including truffle, morel and shiitake.

U.S. National Arboretum Midwest Plant Research and Education Test Site.

Long-term research programs on the development of eastern black walnut, northern pecan and Chinese chestnut into profitable orchard crops.

Roast brings consumers to the land

Helping the family farm is what the Missouri Chestnut Roast is all about. The 5th annual roast, held Saturday, Oct. 13, 2007, was a celebration of agricultural specialty crops in the state. Through chestnut roasting, attendees were introduced to a burgeoning Missouri crop with great market potential. Booths of Missouri agricultural products such as cheese, wine, honey and nuts brought buyers and sellers together. And information about crops such as chestnuts helped landowners understand how diversifying their farm can increase their income.



The roast is sponsored by the University of Missouri Center for Agroforestry, the College of Agriculture, Food and Natural Resources, and held at the Horticulture and Agroforestry Research Center, New Franklin, Mo.



The Center for Agroforestry's goals include creating new income opportunities and markets for farm and forest landowners, and the Missouri Chestnut Roast is a perfect example.

At the roast, Missouri specialty crop farmers sell their products with no vendor fee; thousands of Midwestern families learn about Missouri specialty crop agriculture with no admission cost; and producers and consumers are connected in a larger system of partners working to preserve the state's precious forest and agricultural lands.

"The Roast brings the products to the people and the people to the products. It introduces attendees to the bounty and possibilities of Missouri agriculture," said Mike Gold, associate director, Center for Agroforestry.

Annual UMCA surveys show the Missouri Chestnut Roast not only creates the opportunity for people to taste chestnuts for the first time but also increases the likelihood they will buy and consume chestnuts. Eleven percent of first-time visitors consumed chestnuts 2-3 times per year compared to 23 percent of repeat visitors.

New for '07 were vendors showcasing roasted pine nuts, gourmet mustard and pecan candies; a MU Raptor Rehabilitation Project presentation; an additional cooking demonstration; book readings by a local children's author; and sales of wildflower plants and seeds.

"What keeps people coming back is that the Roast is a lot of fun. Music, food, scenery, learning opportunities, kids' activities – it truly has something for everyone. And it's free!" said Julie Rhoads, UMCA event coordinator.

RAIN CAN'T DOUSE ATTENDEES' SPIRITS



"Held rain or shine" hadn't meant much at the Missouri Chestnut Roast -- until the 5th annual event.

Oct. 13 brought a steady drizzle to mid-Missouri, the Chestnut Roast included. Although the ground was damp, spirits were not, as vendors, entertainers, staff and volunteers prepared for the day's festivities. Would the crowds also turn out?

The answer: Yes. The fourth annual roast in 2006 had seen more than 5,000 attendees. While this year's event didn't draw as large of a crowd, estimates are that 2,000 people came to sample chestnuts, tour the farm, listen to bluegrass music and check out the vendors and exhibitors. One family drove down from Iowa specifically to purchase pine straw, for example.

"It made us see how much the Roast means to the people of mid-Missouri," said Julie Rhoads, event coordinator. "For people to come out on such a dreary day is a testament to the importance of the event."

Roast is 'nutty' good time

Event set in beautiful Missouri River Hills and on the doorstep of the historic 1819 Thomas Hickman House

Showcase of Missouri's niche agricultural products, including wines; jams and jellies; nut products; honey; cheeses and meats

Demonstrations for cooking with chestnuts, and chance to buy chestnut trees and nuts, sample roasted and braised chestnuts and see chestnut trees growing in Missouri

Guided walking and bus farm tours and specialty product demonstrations

Live bluegrass music

Children's activities including straw bale maze, balloons and nutty ice cream

Technology Transfer

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

PROMOTING AGROFORESTRY

In 2007, the UMCA Technology Transfer team participated in about 40 agricultural and natural resources-related conferences and events, serving as featured speakers at many of the events. From the National Small Farms Trade Show to the Chestnut Growers of America meeting, and the Missouri Woodland Owners Conference to the Ozark Renewable and Sustainable Living Expo, the team reached thousands of land and forest owners with new research findings and information on the benefits of agroforestry and specialty crops.



The Center for Agroforestry sets up exhibit booths at numerous conferences and events throughout the year. Each exhibit is tailored to the particular event and audience, and can include an informational poster, copies of Center publications and chestnut and other agricultural product examples.

UMCA staff cooked and/or served chestnut dishes, including chestnut chili, braised chestnuts and fire-roasted chestnuts, at five events in mid-Missouri in fall 2007 to introduce consumers to the taste and potential of this versatile nut.

FOCUS GROUPS FOR POTENTIAL CHESTNUT PRODUCERS

In an effort to expand the chestnut industry, the Center for Agroforestry hosted focus group meetings in January and February in Pleasant Hill and Mt. Vernon, Mo., to gauge interest in growing chestnuts and to provide growing and marketing information to the landowners based on Center research. The attendees were identified before the meeting as potential chestnut producers, as they were all landowners already producing fruit or other nut crops. Nearly 80 percent of attendees said they would be interested in growing chestnuts based on the information received.

Other UMCA events: 2007

February Missouri Woodland Owners tour of HARC

May ARS Forage Workshop

October Missouri Chestnut Roast (see pg. 13)

SILVOPASTURE FORUM

A silvopasture forum was held in March at MU's Wurdack Farm and offered information for natural resources professionals and landowners interested in silvopasture. The history and background of silvopasture was presented, along with an overview of management intensive grazing systems and information about selecting appropriate forages. Missouri Environmental Quality Incentives Program (EQIP) and silvopasture practice standards were also addressed. During the afternoon, participants were given a tour of silvopasture research at the Wurdack Farm.

STATE FFA FORESTRY CONTEST

The Center for Agroforestry hosted 140 Missouri FFA students at the University of Missouri Basket Wildlife Area in conjunction with the Annual State FFA Convention in April. Teams competed for awards and were tested on their knowledge of forestry tools, native tree identification, timber stand improvement, forestry cruising, map reading and general knowledge of forestry and agroforestry practices.

MISSOURI EXCHANGE WORKSHOP

This informational day, held in July, promoted the new Missouri Exchange online marketplace Web site and brought buyers and sellers together face-to-face. The workshop featured information on selling fresh and niche agricultural products, a Web site tutorial, local food and agricultural product samples, and networking among attendees and speakers.



outreach, education & events

Workshop speakers discussed opportunities for marketing niche and fresh agricultural products to restaurants, marketing of alternative products, native plants and the GrowNative! program, and the rise of the local food movement in the United States.

Participants exhibited their products, which included gourmet mustards, baked goods, pickled walnuts, honey ice cream, fresh produce and herbs, native plants and fresh pecans and pecan candies.

The luncheon of fried chicken, stuffed peppers, vegetables, shiitake mushrooms, fresh rolls and cheesecake promoted local foods – all ingredients were brought in from area farms before preparation by University of Missouri chefs.



EASTERN REDCEDAR CONFERENCE AND TOUR

A collaborative effort by a diverse group of researchers and stakeholders, the Eastern Redcedar: Challenge or Opportunity? conference held in Springfield, Mo., in August brought together

landowners, foresters and the redcedar industry to discuss managing and marketing this oft-maligned native tree species. Workshop topics included redcedar timber stand management, log grading, pruning and thinning stands, insects and disease, marketing, mechanical harvesting and a portable sawmill demonstration. The pre-conference tour featured a visit to several redcedar processing facilities.

PUBLIC, MEDIA RELATIONS

Keeping landowners, the public, the media, natural resources professionals and decision makers up-to-date with the University of Missouri Center for Agroforestry's achievements is an important task. Tools for accomplishing these goals include informational guides and brochures; newsletters; news releases; media contacts; advertising; radio, television and print articles; and the Web site. In 2007, large-scale promotional efforts focused on both the new Missouri Exchange online marketplace Web site and the 5th annual Missouri Chestnut Roast event.



Articles about the Center for Agroforestry appeared in the AAA Midwest Traveler in late 2007; and Farm Journal in December 2007. In addition, many news stories about the Missouri Chestnut Roast could be found in area media in October, including radio reports and interviews and articles in the Columbia Daily Tribune and the Maneater, MU's student newspaper, for example.

Informational guides

In 2007, UMCA created the first known guide on cultivating black walnut for nut production rather than for timber. The guide is part of the Center's line of "Agroforestry in Action" publications, which help landowners implement practices with step-by-step instructions. Other guides include those on shiitake mushroom production, growing pecan, economic budgeting and riparian forest buffers, for example.



Along with guides for landowners, UMCA creates informational pamphlets for consumers of niche agricultural products grown in agroforestry practices, including guides on the nutritional benefits of chestnuts, black walnuts and pecan. New in '07 was a four-fold booklet for chestnut buyers, detailing shelling, cooking and nutritional information, along with four recipes showing the nuts' versatility.

Newsletters

UMCA Technology Transfer reaches out to landowners in one of the most direct ways possible – quarterly newsletters. Green Horizons, a Center for Agroforestry publication, provides readers with information about forestry- and agroforestry-related topics. The Chestnut Grower, the official newsletter of the Chestnut Growers of America, is the pulse of the chestnut industry in the U.S.

In 2007, Green Horizons was named Top Newsletter by the Association of Natural Resource Extension Professionals.

ALLEN FARM EFFORTS

The Allen Farm plays an increasingly important role in the Center for Agroforestry and School of Natural Resources, serving to demonstrate land use practices that work in concert with the environment and are economically viable. Further, in the coming years the property will serve as an educational environment that offers learning and research opportunities for a multitude of natural resource disciplines. Putting science into practice, in fall 2007 the University of Missouri Advanced Forest Resource Management class presented Mr. Allen with a 5-year management plan that quantified the farm's resources and provided management recommendations.

In addition, 42 acres were prepared for planting to warm season grass in the spring of 2008 to create fields of warm season grass and forbs that will, in conjunction with adjacent riparian forest buffers, complement one another as bobwhite quail habitat.

Markets & Socioeconomic Research

The UMCA socio/economic/marketing cluster looks at human and economic dimensions of agroforestry including individual attitudes, knowledge, incentives and social-economic-cultural characteristics; role of institutions in constraining or facilitating agroforestry; and markets for new products. The market aspect looks at developing a detailed understanding of the marketplace for different agroforestry products and all the forces that impact these markets from both sides: the producer and consumer. Projects and publications include market directories and analyses; budgeting, tax and funding how-to guides; and hands-on financial models for agroforestry practices, all to aid landowners.

Chestnuts & consumers

NEW CHESTNUT PREFERENCES STUDY

How vital are various chestnut product characteristics to consumers? Most importantly, consumers are 10 times more likely to choose Missouri chestnuts and 5 times more likely to select U.S. chestnuts compared to imported nuts. Preference for medium-sized chestnuts (which Missouri-grown Chinese chestnut trees tend to produce) is almost twice that for small ones. Consumers are 1.31 times more likely to select organic nuts compared to conventional. (Females are most likely to choose organic). Also of interest: Price is the attribute that factors in least in influencing respondents' decision to purchase chestnuts.

"All results support promotion focused on local production and quality to receive a premium price."

- Ina Cernusca, marketing specialist, Center for Agroforestry

UMCA studies show some landowners more likely to adopt agroforestry practices

Determining what factors influence landowners' embrace of agroforestry practices can help tailor the message to match up with the genuine interests of potential adopters.

In 2007, UMCA studies found a variety of factors can help predict how receptive a landowner will be to implementing agroforestry practices, including the following:

- * *Landowner education will likely lead to increased adoption*
- * *Younger landowners are more likely to adopt agroforestry practices*
- * *Advice from other landowners/farm operators increases likelihood of adoption*
- * *Believing monetary benefits of trees is important, increases likelihood to adopt*
- * *Number of subscriptions to conservation magazines increases likelihood (landowners not farming are more interested in conservation magazines as a source of information, while farm operators rely more on farming magazines. Part-time farmers straddle farming and conservation)*
- * *Part-time farmers are more likely to adopt agroforestry practices*
- * *Being concerned with the costs of establishing trees lowers interest in agroforestry adoption*

"Who the landowners are, their values and their affiliations affect their decisions about trees and agroforestry," said Corinne Valdivia, MU research associate professor, agricultural economics.

"These studies are the first to point out the importance of economic benefits from trees as a variable affecting adoption," she said. "Findings highlight the importance of information in developing knowledge, as well as the networks and sources of information, such as magazines. Economic gains are a motivating factor in the adoption of agroforestry."

Findings point to a larger reliance than in previous studies on conservation institutions at the state level, like the Missouri Department of Conservation, as well as the importance of University Extension. Previous research has found Extension and federal agencies as main sources of information. Information from other farmers is also significant. Potential targets for adoption include younger landowners and landowners with higher education.

Sources: Lucht, J. 2007. *Paths to agroforestry: Landowner types, land use and perceptions*. University of Missouri-Columbia. M.S. thesis.

From Olivier, A., and S. Campeau, eds. *Proceedings of the 10th North American Agroforestry Conference*. Quebec City, Quebec, June 10-13: Fregene, E., and C. Valdivia. 2007. *Policy and program incentives for the adoption of agroforestry in Missouri*. p. 583-592.
Valdivia, C. 2007. *The effect of land fragmentation on habitus, field, and agroforestry in the Midwest, USA*. p. 621-633.

MISSOURI EXCHANGE HAS MANY SATISFIED CUSTOMERS

What a busy first year it's been.

The University of Missouri Center for Agroforestry and Grow Native!'s Missouri Exchange Web site has marked its first year with rapid growth. Since early 2007, the site has grown to 350 members, received up to 22,000 hits per month and added new product categories and features, including a "Tip of the Week."



Missouri Exchange is an online marketplace where Missouri agricultural and value-added producers can market their products – for free. The Web site, available at www.missouriexchange.com, specializes in niche agricultural products, such as native plants, herbs, decorative and specialty wood products, meat, eggs, cheese and other products for which markets may not already be in place locally. The site showcases Missouri's diverse agricultural offerings, links sellers to the market, helps locate sources for hard-to-find products and educates consumers and producers. The site creates opportunities for buying locally, which benefits the environment and the economy.



Potential buyers can reduce search time to find products that meet their standards and specifications. Sellers also reduce marketing costs by increasing the exposure of their business, advertising their products and increasing markets at no additional cost to them.

"We have listened to Web site users throughout this first year, adding more product categories and subcategories to better fit the goods producers are looking to sell or consumers would like to buy," said Web site administrator Ina Cernusca, research associate and marketing specialist with the Center for Agroforestry. "Through the new 'Tip of the Week' and 'Did you Know?' sections, users are encouraged to get more involved in the Web site by sending tips and interesting information about the products they sell. The site is becoming more and more interactive and user friendly, and we are excited about the direction in which it is going."

A September 2007 survey showed 27 percent of registered users visit the site several times a month or more, with 31 percent spending more than 10 minutes at the site. Members were generally satisfied with the Web site and 92 percent would recommend it to a friend.

Missouri Exchange also works to educate both producers and sellers about products, some of which might not be familiar to the general public. Uses for the products, typical market value and quality standards are included for the products featured.

JUST HOW DELICIOUS ARE HARC CHESTNUTS?

Chestnuts grown at the Horticulture and Agroforestry Research Center were sold at Clover's Natural Market in Columbia, Mo., in fall 2007 for the first time. The nuts flew off of the shelves as fast as HARC workers could harvest them! A survey was given to all those purchasing the nuts at Clover's and at other selling points, including the Columbia Farmer's Market and the Downtown Columbia Living Windows Festival. Survey results showed that 100 percent of purchasers liked the chestnuts, would buy again and would recommend them to a friend. Eighty-seven percent of respondents preferred Missouri-grown chestnuts.

Also in the past year, UMCA and Grow Native! sponsored a workshop to explain and promote use of the Web site; more such workshops are planned. Grow Native! is a joint program of the Missouri Department of Conservation and Missouri Department of Agriculture.

"Our first year has been a great learning and growth experience and we look forward to many more years of helping Missouri agricultural producers find markets for their products," Cernusca said.

Source: Godsey, L.D., M.A. Gold., and M.M. Cernusca. 2007. Online marketing for alternative products. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 507. Abstract.

New **Developments**

Grant to help promote Missouri specialty crops, including chestnuts, wine grapes

The Missouri Department of Agriculture (MDA) was awarded in fall 2007 a specialty crop grant for more than \$208,000 from the U.S. Department of Agriculture's Agriculture Marketing Service program to enhance the competitiveness of Missouri specialty crops and to teach FFA youth the importance of specialty crops as a value-added opportunity. In cooperation with the University of Missouri Center for Agroforestry and the MU Institute for Continental Climate Viticulture and Enology, MDA will educate FFA students and potential growers in the Lexington, Mo., and surrounding areas and connect them with local leaders and mentors involved in agriculture.



"It is imperative that we train and motivate the next generation of Missouri farmers. Through this grant, students will learn from specialists and leaders in the produce and horticulture industry how to grow, sell and market the specialty crops," said Katie Smith, MDA director. "These FFA students will be given a great opportunity to become involved in entrepreneurial skills including direct marketing and advertising local specialty crops and have hands-on experience of selling produce and horticultural crops, flowers and value-added products at their community markets."

The Specialty Crops Program also will enhance rural development across the state in many ways, providing Missourians with more opportunities to become engaged in or purchase specialty crops. Wireless electronic benefits transfer machines will be placed in 17 eligible farmers' markets to provide underprivileged citizens the opportunity to purchase fresh produce with food stamps and WIC coupons. MDA will begin holding a Wine, Grape and Chestnut Field Day annually and will establish the Specialty Crop Fall Festival in Lexington in 2010 to educate Missourians about the economic and environmental benefits of specialty crops.

In addition, MDA, the MU Center for Agroforestry, MU Extension and the Institute for Continental Climate Viticulture and Enology will conduct workshops for FFA students and potential growers providing knowledge of soil, climatological and financial requirements as well as experience in the cultural practices necessary to achieve profitable vineyard and chestnut orchard production.

"The specialty crop grant award will serve as an important catalyst to Missouri's specialty crop industry, helping launch a new commercial chestnut industry while training a new generation of FFA students to grow up with the new industry," said Michael Gold, associate director, MU Center for Agroforestry. "This is the next step toward a bright new future for specialty crops in our state."

DID YOU KNOW? Viticulture is the study of grape production; enology researches wine production.

– Missouri Department of Agriculture News

Specialty crops grant goals

Introduce a new generation of Missouri farmers to chestnut production

Familiarize more Farmer's Market customers with niche Missouri crops

Develop a cluster of chestnut growers in the Lexington, Mo., River Hills region

Train a new generation of farmers in specialty crop production and marketing

building on our successes

REDCEDAR: FROM INVASION TO INNOVATION

Abundant Missouri resource may have antibiotic, cancer-fighting properties

Eastern redcedar is the most widely distributed tree-sized conifer in the eastern United States, although its many industrial uses are not widely known and it is considered an invasive weed tree in many regions. Building on ground-breaking national redcedar market research, a new study at the University of Missouri Center for Agroforestry also could help redcedar go from “trash to cash” for landowners.

Chung-Ho Lin, research assistant professor of forestry with the Center for Agroforestry, has found redcedar leaves and fruit to have compounds that may help fight bacteria, fungi, agricultural pests and weeds, malaria, and the production of melanin, which can help skin have a more youthful appearance and even prevent skin cancer. Lin presented his preliminary research findings at the Central Hardwoods Forest Conference, April 2008.

Lin said he has spoken with landowners who have acres and acres of redcedar but no idea what to do with it. He is working to change that common problem.

“Since redcedar spreads so rapidly, landowners can cut their trees for the wood, leaves and fruit without concern about the future regeneration of the species,” Lin said.

Lin and MU students Mark Hymbaugh and Amber Spohn studied the fruit, leaves, branches, roots, sawdust, oil, resin and bark of the redcedar to determine which parts might have beneficial compounds. They extracted chemicals from each tree part and then tested these compounds on bacteria, fungi, weeds and melanin to see if growth was inhibited. Chemical compounds found in the leaves and fruit had the most promising results, although levels of activity varied. Now, the potent compounds in the extracts showing high bioactivities will be further isolated and purified for chemical characterization. Ninety-five percent purity is needed to confirm that the chemicals identified are useful for the pharmaceutical and cosmetic industries, Lin said.

“Every chemical has a ‘fingerprint,’” he said. “We use the fingerprint of the unknown compound and compare it to known chemical fingerprints in an existing database.”

At least two antibacterial chemicals in the redcedar needles (leaves) have been isolated; these chemicals are



similar to others found in past studies that have proven effective against a wide range of bacteria. In addition, other chemicals have shown promising inhibitory effects on melanin development and tyrosinase activity. This means they have great potential for skin care application for preventing and healing pigmentation after sunburn, freckles, liver spots, etc. Best of all, this class of chemicals has been proven safe for external skin application.

The research also focuses on assessing the application of these chemicals in the agricultural, pharmaceutical and cosmetic industries.

“Value-added phytochemical products from eastern redcedar have the potential to create new industries in regions such as Missouri with an abundant redcedar resource,” Lin said.

Mike Gold, research professor and associate director of the Center for Agroforestry, said the goal of the Center is to help landowners around the state and country get the most from their land. Through agroforestry practices, landowners diversify products, markets and farm income; improve soil and water quality; and reduce erosion, non-point source pollution and damage due to flooding.

“The Center is interested in finding new uses for redcedar, an abundant Missouri resource. These trees have been classified as a weed, yet are extremely common in this state. Looking to find productive uses from the beneficial compounds in redcedar will help create additional markets for the trees, where none existed previously,” Gold said.

Riparian Forest and Upland Buffers

Riparian forest and upland buffers are an important agroforestry practice that protect water quality, stabilize streambanks, diversify food and cover for upland wildlife, improve aquatic habitats for fish and other organisms and enhance opportunities to generate farm income through products harvested from the buffer. Riparian ecosystems may consist of numerous land uses, including designed and planted buffers, natural forest buffers of trees and/or herbaceous plants, grass filters and areas with row crop agriculture. While many buffers have been planted over the last 15 years, little research has been conducted on their efficacy over time or on the long-term management needed to maintain their continued functionality. In UMCA research, soil samples from watersheds 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 nutrient run-off.

ISU BUFFER RESEARCH

The goal of much of the UMCA-supported work of Iowa State University forestry scientists in northeast Missouri is to determine whether the density of present "natural" or constructed buffer ground cover is sufficient to slow

and diffuse concentrated flow and/or if grass filters upslope of the riparian forest buffers are necessary to aid in providing that function. Are naturally occurring forest riparian areas serving as effective buffers? Are they as effective as engineered buffers? Could

Non-point source pollution: Pollutants, such as sediments, nutrients or pesticides, that originate upslope of a stream, lake or pond.

they be enhanced with a grass filter strip? Findings have shown that adding more grass filters in watersheds – in addition to naturally occurring riparian forest buffers – could reduce sediment runoff.

Specific studies look at:

Whether riparian forest buffers or grass filters provide better stream bank stability. Findings showed streamside forest buffers unexpectedly had higher rates of erosion than other treatments. However, this study shows the need to take into consideration the stage of channel development and the composition and structure of the plant community. Identifying these relationships will allow better riparian buffer design and management prescriptions to be made for specific channel conditions.

Whether buffers put too much nitrous oxide into the air – in addition to nitrogen – as they take up harmful nitrates in groundwater through a process called denitrification. Findings show the emission of nitrous oxide from riparian buffers and filters is less than in adjacent crop fields. Therefore the environmental benefits of riparian buffer systems remain intact.

Sources: *Helmert, M., T. Isenhardt, C. Kling, T. Moorman, W. Simpkins, and M. Tomer. 2007. Agriculture and water quality in the Cornbelt: Overview of issues and approaches. Choices 22(2): 79-85.*

Knight, K. 2007. Effectiveness of naturally-occurring riparian forest buffers and grass filter strips at buffering concentrated flow from row crop fields to streams in northeast Missouri. Iowa State University. M.S. thesis.

UMCA BUFFER RESEARCH

Research focus is to quantify environmental benefits of woody/grass buffers on non-point source pollutants. In 2007, vegetative buffer strips were shown to significantly reduce the transport of both dissolved and sediment-bound

ANTI-BIOTICS

The Center for Agroforestry is investigating whether agroforestry buffers may not only mitigate the flow of pesticides and sediment to adjacent agricultural water sources, but also veterinary antibiotics. In larger production facilities, antibiotics are frequently given to animals to promote health and growth. The drugs are retained in their feces, which are commonly used to fertilize agricultural land and could be transported to streams, lakes or ponds as runoff.

Three veterinary antibiotics have been selected for investigation by UMCA scientists, representing different classes of drugs.

Studies are underway to determine how well different vegetative buffers absorb the drugs; so far, hybrid poplar is most promising. Future studies will look at not just the antibiotics themselves, but the drugs when contained within manure, to see if this influences the fate and transport of the pharmaceuticals.

Source: *Bei, C., K.W. Goynes, S.H. Anderson, R.P. Udawatta, and C.H. Lin. 2007. Veterinary antibiotic sorption to agroforestry buffer, grass buffer and cropland soils. Agronomy Abstracts 2007. Annual Meetings, New Orleans, La., Nov. 4-8. American Society of Agronomy, 677 South Segoe Road, Madison, WI 53711.*



cleansing run-off water, easing erosion

herbicides in surface runoff compared to the control. Four meters of native vegetative buffer strips removed about 75-80 percent of three herbicides in surface runoff. The 4-meter strips, consisting of native warm-season grasses, particularly switchgrass and eastern gammagrass, also were much more effective than 8 meters of tall fescue buffer strip designs.

Buffers improve soil physical properties by increasing macroporosity, which rapidly channels surplus flow and allows movement of water and air into the soil. However, porosity determined by traditional procedures often lacks detailed information on pore characteristics; sometimes porosity is determined by indirect procedures. In 2007, UMCA researchers began using computed tomography (CT) scanning to provide additional data on pore characteristics previously unavailable with traditional methods. Using the CT scanner, measurements showed much greater porosity in agroforestry treatments compared to traditional pastured land.

Buffers work to reduce non-point source pollution from row crop areas by improving soil hydraulic properties and decreasing surface runoff. UMCA research is now looking to see if soil properties change when buffers are established where animals are allowed to graze. Research showed agroforestry and grass buffers maintained higher values for soil hydraulic properties compared to grazed pasture systems.

Studies are also looking at the layers of soil below agroforestry treatments. While studying the effects of agroforestry and grass buffers on subsurface soil layers, researchers found nitrate concentrations were lower in all depths under agroforestry areas than in row crop fields. In addition, a study is examining whether permanent vegetation with deep roots and longer active transpiration and growing season will reduce non-point source pollution from row crop agriculture by removing excess water and nutrients. Results show establishing agroforestry practices maintained lower soil water content during the growing season until rain recharged the area. During the recharge period, soils under the buffer stored more water.

Up next: Research will look at the complex impact of the agroforestry buffer on microclimate and evapotranspiration (ET) of the crop area. In 2007, findings showed that buffers increase potential evapotranspiration. Further investigations will compare the calculated potential ET to observed variations in soil moisture and monitor the changes in microclimate as the trees continue to grow, to get a better idea of the interactions. ET is a term used to describe the sum of evaporation and plant transpiration from the earth's land surface to atmosphere.

2008 studies will continue to examine buffers' effect on reducing non-point source pollution; subsurface loss of nutrients and agrochemicals; soil dynamics; and microclimate.

Source: Udawatta, R.P., S.H. Anderson, C.J. Gantzer, and H.E. Garrett. 2008. Influence of prairie restoration on CT-measured soil pore characteristics. Journal of Environmental Quality 37: 219-228.

COMBINING FORCES

One UMCA project combines two of the Center's clusters for a unique project – testing how riparian buffers respond to flooding. This project looks at soil characteristics and chemical make-up, microbial and enzyme activities, and germination and growth of plant materials within a flooded buffer.

The goal of the project is to examine the changes in soil chemical properties that occur with periodic flooding and how those changes may affect the growth of vegetation. Results are still being processed, but preliminary analyses suggest changes in inorganic-N (ammonia) and TSP (sodium phosphate) due to flooding are likely to be temporary.

An explosive idea

With financial support from the Department of Defense through a collaboration with Lincoln University, UMCA researchers are investigating whether buffers can serve as cost-effective remediation schemes for sites contaminated with munitions explosives. So far, grasses including warm-season switchgrass and eastern gammagrass have shown promise in breaking down TNT, RDX.

Source: Lin, C.H., J. Yang, R.N. Lerch, A.L. Spohn, and H.E. Garrett. 2007. Enhanced rhizodegradation of munitions explosives TNT and RDX by selected grass species. Nov. 4-8, ASA-CSSA-SSSA International Annual Meetings, New Orleans, La. Abstract.

Flood Tolerance Laboratory

The Flood Tolerance Laboratory at the Horticulture and Agroforestry Research Center was constructed along Sulphur Creek in the Missouri River floodplain. The lab has 24 channels, each approximately 6 meters wide by 80 meters long. Each channel can be independently adjusted for water depth, standing or flowing water and duration of flooding. Researchers are looking at identifying flood-tolerant trees, grasses and legumes for use in Midwestern agroforestry buffers, floodplains and urban “green infrastructure” plantings. In addition, studies test soybean varieties for waterlogging tolerance. Agroforestry can be used in floodplains to re-establish trees and herbaceous species, in agricultural systems to mimic historical wetlands and riparian vegetation. The diversity of species used in these agroforestry practices is an important component in reducing soil erosion and providing wildlife habitat.

OAKS

The establishment of tree species to provide food, such as acorns, for wildlife on flood-prone, riparian sites in Missouri can be a challenging task. Making sure these species will survive is important for improving both water quality and wildlife habitat.

Several tree species occupy a range of sites within the state and the possibility exists that some seed sources may produce seedlings better adapted for use in establishing new riparian buffers; most seed is collected from upland seed sources that may be maladapted to flood prone sites. Presently there is a lack of knowledge on the genetic variation for these species in terms of their commercially important characteristics; their genetic response to flooding events is completely unknown. This is especially true for oaks. Trials will determine whether there is a genetic component to flood tolerance within and among a number of important hardwood tree species.

Flooding treatments will be imposed in spring 2008 on the seedlings planted in the flood tolerance lab in the spring 2007. In addition, plans call for the flooding of the study trees in 2008 based upon 2007 flooding calendar of the Mississippi River, for a more “natural” cycle. Based upon results from these tests, flood tolerant seedlots will be identified. All seedlots used in the 2007 planting year are also growing in the Missouri Gravel Bed at HARC and can be used as a source of seedlings for establishing “flood tolerant” seedling seed orchards. In the future, such orchards will serve as the future source of acorns for reforestation efforts in Missouri.

Sources: Coggeshall, M.V., J.W. Van Sambeek, and S.E. Schlarbaum. 2007. Genotypic variation in flood tolerance of black walnut and three southern bottomland oaks. In: Buckley, D.S., and W.K. Clatterbuck, eds. Proceedings of 15th Central Hardwood Forest Conference: 629-637.

Walsh, M.P. 2007. Variation in the flood tolerance of three Midwestern oak species. University of Missouri-Columbia. M.S. thesis.

SOYBEANS

Having long been cultivated in the monsoon climates of Southeast Asia, soybeans show a greater natural tolerance for excessive water than corn or cotton; they are a good choice for bottomland areas that may not otherwise be able to be cultivated.

However, excess rain and over-irrigation on poorly drained fields or low-lying areas can result in flooding and soil waterlogging. Soybean may never fully recover from flooding injury and yield losses can be 80 to 90 percent.

Studies have identified waterlog-tolerant soybeans by measuring yield losses under flooded and non-flooded conditions in lines selected from more humid regions of China, Japan and Korea.

Plots are flooded and then allowed a recovery period before being rated for injury; 262 varieties have been evaluated, showing great variability in water-logging tolerance. Some entries showed very little effects from the flooding, while others died. The top nine entries are under evaluation for yield in flooded vs. non-flooded conditions.

The goal of the Flood Tolerance Lab soybean research is to find varieties in which yield losses are less than 10 percent when waterlogged

Bottomland Restoration and Wildlife

Reforestation efforts by public land managers and private landowners within the lower Missouri River and upper Mississippi River frequently result in failure. Reasons for these failures include use of species poorly adapted to frequent flooding or wet site conditions, competition from light-seeded hardwoods, depletion of soil nutrients following row cropping and altered soil properties. Restoration efforts are very important however, as they typically aid re-emergence of wildlife, in addition to improving water quality. 2007 UMCA bottomland restoration research looked at aiding survival and growth of oak seedlings in alkaline bottomland soils by using fertilizer to correct soil pH; determining whether small patches of renewed wetland can sustain beneficial wildlife populations; and whether mourning doves and agroforestry can work in harmony in a bottomland setting.

AMENDING SOIL FOR OAKS

Research aims are to increase the survival and growth of oak seedlings by amending soil pH and increasing the availability of soil nutrients in swamp white and pin oak seedlings in a Missouri River bottomland. In addition, studies are evaluating how long the fertilizers persist in the sandy soils. This evaluation of fertilizer treatments and effects on soil properties and nutrient content will be helpful to anyone interested in reforesting bottomlands with oaks.

PATCHING TOGETHER A HABITAT

This project has investigated the role of various types, sizes and locations of forest patches in sustaining wildlife in the 100-year floodplain of the Mississippi River in southeast Missouri. Fifteen 4-square-mile study sites were randomly selected to represent landscapes containing various amounts and types of forest including agroforestry patches.

Findings suggest that while nest survival does not differ substantially between habitats, differences in breeding density influence the relative productivity of the two forest types – native floodplain forest fragments and cottonwood plantations. Finally, findings suggest that, at least for some species, the forests in highly fragmented landscapes may act as ecological traps; further research is needed. It does appear that plantations increase the overall forest structure in the landscape and may mitigate effects of fragmentation.

TRACKING MOURNING DOVE

Mourning dove offer an abundant and economically valuable resource for landowners. Mourning dove are a natural

fit with agroforestry because they are feasible on small areas and provide lease hunting opportunities over crops.

The project is determining how dove respond to various management practices in an agroforestry setting and if there are disadvantages to planting trees in these areas. The hope is that dove will use fields converted to agroforestry practices and that hunters are still successful in those fields.

Leg bands and radio transmitters have been attached to doves to assess abundance and field use. Initial results suggest the establishment of alley cropping practices does not reduce the number of mourning doves harvested. Fields may be as small as 5 acres and still be productive.

MOURNING DOVES: “Most abundant and important North American migratory game bird and will likely receive more hunting pressure as other small game populations continue to decline.” - Schulz et. al, 2003*

Research will provide landowners with information and guidelines to integrate the alley cropping agroforestry practice with lease hunting opportunities. In addition, research is taking into consideration that wildlife benefits will undoubtedly change as the trees grow.

Future directions include performance tests of tree plantings; effects of deer and rabbit foraging; optimal sunflower management; bird use of agroforestry fields and availability for harvest; harvest statistics; seasonal survival by age and gender; and obtaining wildlife benefits and economic returns in an agroforestry setting.

Source: Schulz, J.H., J.J. Millspaugh, T.W. Mong, D. Dey, and R. Bredeisen. 2007. Mourning dove demographics and harvest management in an agroforestry complex. Webless Migratory Game Bird Research Program. U.S. Fish and Wildlife Service. Abstract.



**Schulz, J.H., J.J. Millspaugh, B.E. Washburn, and D. Zekor. 2003. Enhancing sport hunting opportunities for urbanites. Wildlife Society Bulletin 31: 565-573.*

Silvopasture

Silvopastoral management creates an environment where trees, forage and livestock can be developed to their full economic potential. Numerous greenhouse, field and pasture studies show silvopastures can be productive complements to traditional pastures. But there is limited research on how silvopastures fit into a “system.” Converting all of a pasture system to silvopasture is unlikely on a wide scale. UMCA silvopasture research seeks to determine the feasibility of introducing silvopasture as part of a whole-farm forage/livestock system.



PINE RESTORATION AND SILVOPASTURE

This new UMCA project looks at pine restoration and silvopasture establishment in the Ozarks. The study seeks to characterize the tree/grass/cattle biological and genetic interactions and economic opportunities associated with a pine and warm-season grass silvopasture practice, and evaluate genetic performance – establishment, survival and growth – of the 24 “best” shortleaf pine seed sources (derived from the Missouri Tree Improvement Program) and select pitch-loblolly pine hybrid varieties.

Questions to address include:

Which seedlots of native shortleaf pine will perform best on these south- and west-facing Ozark sites?

Which warm-season grass accessions perform best when planted on these sites?

What effect will the warm-season grasses have on growth and development of pine on these sites?

What are the differences in livestock condition and gain between cattle grazed only in the silvopasture practice versus cattle managed only on open pastures?

The goal of the project is to extend grazing earlier into spring, into the summer months under shade and later into fall to improve condition and productivity of cattle and manage for high quality, higher value pine timber, which will open up new marketing opportunities.

SILVOPASTURE BENEFITS COW, FORAGE GROWTH

UMCA researchers are working to see if there are tangible benefits to combining managed intensive grazing silvopastoral practices with conventional cow/calf and stocker calf production systems. Findings so far have been very promising: cow/calf pairs given access to silvopastures at strategic times during the winter, early spring, heat-stress periods in summer and at calving, fared very well compared to pairs maintained in traditional “open” pastures.

Cows nursing in silvopastures lost approximately 10 percent less weight over winter, reducing the need for supplementation by about 12 percent. This is likely due to the windbreak effect of the trees, which provides cows a more comfortable environment and reduces the need to use metabolic energy to maintain body temperatures during cold weather. In summer, two distinct advantages were found for systems that included silvopastures. First, cows giving birth in silvopasture were 12 percent less likely to experience calving difficulty and weaned heavier calves. Second, researchers observed a 15 percent increase in cool-season grass growth during July and August in silvopastures compared to the open pastures.

With “strategic use,” cow/calf producers could lower winter feeding costs, extend the grazing season into winter and into summer, and decrease calving problems by integrating silvopastures into their existing systems. In aggregate, cow/calf systems that include 25 percent of the pasture area as well-managed silvopastures could increase livestock income by nearly 15 percent.

Overall returns in the integrated system were about \$43.63 greater per pair than in the traditional system

Sources: Kallenbach, R.L. 2008. Annual Review presentation. University of Missouri Center for Agroforestry.

Can windbreaks make concentrated livestock operations 'invisible' to the nose and eye? The science behind the headline

Large animal operations, known as CAFOs, or Confined Animal Feeding Operations, are part of the current trend in farming in many areas, and Missouri is no exception. Often, these large farming operations, which typically house hundreds or thousands of animals, such as hogs, bring strong objection from surrounding communities. One major public concern facing these facilities is malodor due to the sheer number of animals, according to Dusty Walter, UMCA technical training specialist.

In response to odor concerns from large animal production facilities, many new approaches are being researched, developed and applied, Walter said. These include adjusting feed and diet, and biological air filters that use microbial activity to inhibit odor, both potentially impacting the odors that leave animal holding buildings.

TREES BREAK MORE THAN WIND?

The 'odor' break includes three rows of vegetation around much of the facility. Row one (closest to the buildings) is pitch-loblolly pine; row two is red maple alternating with pin oak while row three features Alleghany viburnum. Hence the design provides an evergreen row, a deciduous row and a shrub row.

"Windbreaks also have been added to this list of new approaches," he said.

To provide sound science to the study of windbreaks and odor control, the University of Missouri Center for Agroforestry was awarded a grant in late summer 2007 for \$111,000 from the Small Business Development Authority in the Missouri Department of Agriculture to study the effects of windbreaks on CAFO odors.

Efforts leading to awarding this grant can be traced to a 2006 collaborative agroforestry workshop with Missouri USDA NRCS that emphasized proper design of windbreaks used around CAFOs.

Although research is ongoing to develop a better understanding of how and why windbreaks impact odor perceptions, combinations of trees and shrubs in windbreak configurations have been shown effective at changing the movement of odor particles, Walter said. Trees and shrubs create a living filter that removes dust particles from the air, and many of the chemical compounds that can cause the odors we smell are attached to those particles. Additionally, windbreaks alter air currents.

In fall 2007, Center staff planted about 800 trees and shrubs around a facility in northcentral Missouri. The facility is composed of five buildings and the

windbreak itself has a footprint of approximately 20 acres, involving 3,400 linear feet of the three-row design.

Walter said the goal for the project is to determine if windbreaks for odor abatement are both effective and cost efficient for large agricultural operations. Another feature of using a windbreak for this purpose is that the trees can serve to landscape the site and create a more pleasing appearance.



White rows show the CAFO buildings from overhead. The black lines are where the wind/odor breaks have been constructed.

The next step is to maintain the windbreak through weed control and irrigation. In addition, testing is beginning on air samples taken at varying distances from the facility (up to a mile radius) to identify concentrations of odorous gasses including ammonia and hydrogen sulfide, volatile organic compounds and particulates. This testing will determine the effect of the windbreak on odor concentration and movement. Stay tuned.

Forest Farming

UMCA: Fungi experts

The University of Missouri Center for Agroforestry supports one of the nation's most comprehensive research programs for shiitake and other gourmet mushrooms, including the morel and European truffles, in an effort to help establish mushrooms as a profitable agroforestry crop in Missouri and the Midwest. The Center is one of only two research programs in the nation working to develop gourmet European black truffle cultivation as a forest farming crop for landowners.

Current successes indicate premium, high-dollar mushrooms can be established in Missouri soil and may be very successful when grown in agroforestry practices.

Not only can specialty mushrooms be grown on a range of acreage allotments, but mushroom cultivation also can be a sustainable and profitable way to recycle low-value forestry by-products. Utilizing shade levels and understory from a forest farming practice, UMCA scientists and collaborators are determining the best suited mushrooms for Missouri growers.

The Center has hosted specialty mushroom workshops, bringing together researchers, niche-product experts and landowners to explore the potential of the market.



SHIITAKE

Interest in fresh shiitake mushrooms is increasing with gourmet chefs, farmers' markets and household consumers, as information spreads about their nutritional benefits and rich, versatile taste.

Cultivating shiitake mushrooms allows forest landowners and home gardeners an opportunity to utilize trees thinned from their woodlots as well as branch-wood cut from the tops of larger trees. When the mushrooms are harvested and marketed, the result is a relatively short-term payback for long-term management of wooded areas.

UMCA experts have been working since 1999 to determine the best logs, strains and spawn for growing shiitake in Missouri. Their research was quite "fruitful" in 2007 as numerous research questions were answered, including:

- Sugar maple logs outperform oak as mushroom hosts (especially when sugar maple are harvested in February).

- Wide-temperature shiitake strain outperforms warm- and cold-weather strains.
- Sawdust spawn outperforms dowel or thimble.
- Fruiting is most abundant in years two and three after logs are inoculated. Although fruiting will continue for about six years, gradually declining, contaminant wood-decay fungi will become increasingly prevalent.
- Chilled immersion water improves mushroom yield; well water is recommended over surface water when force fruiting (soaking logs in water to simulate natural rainfall and encourage mushrooms to fruit).
- Force-fruiting compresses and increases production of logs to three years (spawn run plus two).
- The efficacy of force fruiting depends on ambient temperatures and the spawn strain used. Cold-weather strains respond poorly to force fruiting.



enlightening growers on crops kept in the dark

Morel

Studies are looking to determine when and where morels are most likely to fruit. In 2007, timing of fruiting was noted in sites at HARC, along with the soil moisture at fruiting microsites. In addition, an experiment wounded elm, pecan and shellbark hickory to stimulate morel fruiting and to determine which trees are more likely to be sites of morel fruiting.



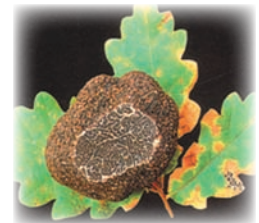
Stropharia

Studies looked at different growing treatments, including straw vs. wood chips as substrate; using weed barriers vs. no weed barrier; and initiating production mid vs. late summer. Findings show greater mushroom weight was produced on straw compared with wood chips. Greater mushroom weight also was found when no weed barrier was used.



Truffle

Truffles, which grow in the wild in Europe, also can be cultivated in plantations. Producing truffles outside of their native range is a growing industry. Cultivation of the highly prized and valuable burgundy truffle, *Tuber aestivum*, in plantations has been the subject of intense research for the past nine years at the University of Missouri Center for Agroforestry.



Coming in 2008

Updated Agroforestry in
Action guide: Growing
Shiitake Mushrooms in an
Agroforestry Practice

Truffles are a type of ectomycorrhizal fungi. These fungi form mutually beneficial relationships, symbioses, with tree roots. The fungus receives carbon and other essential organic substances from the tree and in return helps the tree's root system take up water, mineral salts (e.g., phosphorus, etc.) and metabolites. These fungi can also fight off parasites, predators such as nematodes and soil pathogens. Indeed, most forest trees are highly dependent on their fungal partners and in areas of poor soil, could possibly not even exist without them.

UMCA research has taken an in-depth look at greenhouse production of seedlings with roots infected with the burgundy truffle fungus. Methods for the production of truffle-colonized seedlings are rarely published. In a greenhouse study, researchers tested the effect of lime type (truffles require very high soil pH levels), inoculation technique and truffle source (truffles are found throughout a wide area in Europe) on oak growth and mycorrhizal colonization. Book-type containers and a peat-based medium produced smaller but well colonized seedlings. Finally, the study noted that after two years of field growth, both *Tuber* colonization levels and native ectomycorrhizal species richness and abundance increased, indicating that native species, in the short term, do not displace the introduced *Tuber spp.* If all goes according to plan, after infection and the establishment of truffle plantations, known as truffières, truffle production will begin in four or more years.

There is still much to learn about the optimum climate, soil conditions and management regimes required to establish a truffle industry in Missouri. The challenge for Center for Agroforestry researchers is to ensure growers are provided with proper guidance when making biologically based, long-term business decisions.

Sources: Mihail, J.D., J.N. Bruhn, and P.E. Bonello. 2007. Spatial and temporal patterns of morel fruiting. *Mycological Research* 111: 339-346.

Pruett, G.E., Bruhn, J.N., and Mihail, J.D. 2008. Colonization of pedunculate oak by the burgundy truffle fungus is greater with natural than with pelletized lime. *Agroforestry Systems* 72: 41-50.

MUSHROOMS WORLDWIDE

With the help of a grant obtained in 2007 from the European Union (EU), a collaboration has been established between MU's Johann Bruhn and Jeanne Mihail and scientists at Uppsala University, University of Bologna and University of Urbino to conduct parallel experiments in Gotland, Sweden, northern Italy and in the U.S. to evaluate the microbial communities associated with successful *T. aestivum* truffières.

NutTrees

UMCA's nut cluster features research on pecan, black walnut and chestnut, including field studies, market and consumer research and outreach. The Center supports the nation's most comprehensive research programs for developing the eastern black walnut and Chinese chestnut as nut crops for agroforestry practices. For new orchards to succeed, reliable cultivar information and optimum orchard management techniques are essential. Field trials look at cultivar traits such as bud break, flowering, nut yield and nut weight to see which cultivars should be recommended for the Midwest and which cultivar crosses might yield the best trees. Studies also include those on fertilizer, pests, optimal harvest dates and characteristics of a marketable nut, both in taste and price.

CHESTNUTS

In 2007, chestnut research at the Horticulture and Agroforestry Research Center included thinning secondary burs to enhance nut yield and studying biology of the lesser chestnut weevil.



Secondary burs

The scoop: Some chestnut cultivars

produce two sets of flowers (primary and secondary), one much later in the season. These secondary flowers (which become burs with more chestnuts inside) may not have adequate time to mature but compete with primary nuts for plant nutrients. In addition, two sets of burs can contribute to limb breakage, due to extra weight.

The study: UMCA researchers found removing these secondary burs en-

hanced the nut weight per shoot in the primary burs as well as the number of shoots bearing primary burs in the subsequent growing season.

In addition, a group of trees whose primary burs were damaged by spring freeze during the study had secondary burs with marketable nuts.

The results suggest retaining either primary or secondary burs, but not both, is the best bet.

The next step: Researchers will see if certain cultivars produce secondary burs more often and if there is a way to control or remove secondary bur formation.

Source: Enderton, D.J. 2007. Increasing Chinese chestnut primary nut weight and bur production by hand removal of secondary burs. University of Missouri-Columbia. M.S. thesis.

Chestnut weevil

The scoop: Chestnut weevils are the most important insect pests of chestnut in this country. Because commercial chestnut production is a relatively new industry, little is known about the biology and chemical ecology of the native species of chestnut weevils, including the pest's life cycle and population dynamics. This information helps identify vulnerable periods in the pest's life



cycle that can be exploited by various management tactics. The development of a successful pest management program begins with the foundation of basic biological information.

The study: This research revealed a completely new finding in 2007 – the data confirmed the lesser chestnut weevil has two emergence periods not previously noted in literature: one in late spring (newly documented) and one in late summer.

In addition, studies showed:

- Peak weevil activity is in the fall, coinciding with the development and ripening of the nuts.
- Weevils remain underground close to two years before emerging as adults.
- Adult weevils have capability for longer flights – .25 km average – than previously thought.

The next step: Research will examine the roles of plant volatiles as possible attractants for chestnut weevils.

WEATHER OR NOT

An early spring freeze hit Missouri fruit and nut crops hard in 2007 as above-average temperatures forced buds to break, while the ensuing cold snap killed the new buds. The peach and pecan crop in the state was nearly completely devastated; the wine grape crop heavily damaged. Ninety-five percent of the pecan nut crop at the Horticulture and Agroforestry Research Center was lost; cultivars varied on amount of loss.

Other crops, including chestnut, were less impacted by the freeze. The Center for Agroforestry saw a harvest approaching 75 percent of a full crop from its chestnut trees at HARC. Ken Hunt, research scientist, said one-fourth of the cultivars were mostly unaffected.

Hunt said this is just another reason why the Center emphasizes diversification of crops; even if one crop fails in a season due to weather, pests or low prices, another crop could sustain the production that year.

pecan, chestnut, black walnut

UMCA data confirmed the lesser chestnut weevil has two emergence periods – not previously noted in literature

Source: *Keeseey, I.W. 2007. The seasonal occurrence, soil distribution and flight characteristics of Curculio sayi (Coleoptera: Curculionidae) in Mid-Missouri. University of Missouri-Columbia. M.S. thesis.*

BLACK WALNUTS

In 2007, UMCA published the first guide dedicated to growing black walnuts for nut production. In keeping with this line of thinking, Center researchers have been looking at an accurate way to determine harvest dates for black walnuts and a lexicon for describing black walnut flavors.

Hybridization

The scoop: Researchers will begin to allow trees to open pollinate rather than using laborious hand pollination. The most promising crosses will be identified by molecular DNA fingerprinting to trace the male (pollen) parent tree. In addition, black walnut program researchers are determining the influence of temperature (both heat and cold) on different cultivar characteristics.

Fingerprinting work on black walnut cultivars at HARC recently has shown there are 65 different cultivars. This work will directly benefit breeding efforts in terms of minimizing clonal identity mistakes due to mislabeling problems.

Harvest

The scoop: To determine if a black walnut tree is ready for harvest, the common wisdom has been to press your thumb into the husk of fruits and see if the impression leaves a dent. Some say 5 percent of fruit per tree must be 'dentable' before harvesting. Others say it must be up to 50 percent. UMCA's goal is to find a more reliable, quantifiable method to determine when nuts

are ready to harvest. In addition, kernel color was assessed at different harvest dates. The goal is to find more information on the relationships between husk softening, harvest date, kernel size and color for black walnut cultivars.

The study: Husks were tested by the 'dent' method and with a durometer to assess firmness before, during and after the average harvest date. Husk color was measured using a spectrophotometer. After cracking the nuts, kernel color was determined.

Recommendations are now to harvest when 100 percent of the husks dent with the thumb.



Kernel color measured by the spectrophotometer did provide a reliable color classification.

Source: *Brawner, S.A. 2007. Husk softening and kernel characteristics of three black walnut cultivars at successive harvest dates. University of Missouri-Columbia. M.S. thesis.*

NEW GUIDE, ERA FOR BLACK WALNUT PRODUCTION

The new UMCA guide "Growing Black Walnut for Nut Production" represents the "fruit" of an interdisciplinary collaboration that includes the nut tree research cluster at the Center for Agroforestry, the nut research program of Kansas State University, the Missouri and Northern Nutgrowers Association membership and the enthusiastic support of Hammons Products Company, Stockton, Mo. -- the largest processor and supplier of eastern black walnuts for both food and industrial uses in the U.S. The guide is the only one of its kind in the world and represents more than a decade of research on growing black walnut trees in an orchard practice.

"Black walnut has always been recognized as one of Missouri's most valuable timber species. With the application of knowledge from this guide, black walnut may soon become known as one of our most valuable orchard species," said Gene Garrett, director, UMCA.

Through orchard production, a consistent, top-quality nut can be harvested to meet consumer demand for a milder flavor and lighter color while retaining the black walnut's unique flavor and revered heart-healthy source of fat. Nutmeats are packaged for snacking or cooking and incorporated into candies and jellies. Known for excellent abrasive properties, black walnut shell can be ground to different sizes for industries including cosmetics, oil drilling, fiberglass, wood and stone.

Utilizing breeding and cultivar evaluations, outreach with growers and collaboration with industry representatives nationwide, the Center for Agroforestry is striving toward a goal of establishing 2,000 acres of black walnut orchards in Missouri by 2025.

Economic Impacts: With an estimated harvest of 750,000 pounds of black walnut nut meats and a retail value of \$12 per pound, the direct contribution to Missouri's economy from black walnuts could reach \$9 million. The value of the walnut "shell" would add an additional \$1.8 million. Using common multiplier effects generated by the impact of farm production as it moves through the value chain to the consumer (4x), projected growth in black walnut production results in more than \$40 million being moved into Missouri's economy.

Tree/Crop Interactions

This UMCA cluster studies the complex interactions between trees and crops that are inherent to agroforestry. In any system, trees and crops may compete for light, water and nutrients or have complementary needs. The goal is to successfully manage these interactions. In 2007, MU Center for Agroforestry tree/crop interactions research focused around two areas: determining the vegetative-free zone necessary for successful establishment of black walnut trees in tall fescue; and reducing insecticide use in a system by including forages and trees to encourage beneficial insects.

PROMOTING BENEFICIAL INSECTS

A crop management system that reduces insecticide use in forages while providing both short-term returns (forage) and long-term profits (nuts/wood) would greatly benefit the farm owner.

This UMCA project compared crop yields and beneficial insect pest populations between various alley cropped and conventional agricultural systems.

Findings show that insect diversity was twice as high in alley-cropped alfalfa compared to traditional, monocropped alfalfa. In addition, data shows wider alley widths (80 feet between tree rows) retain the benefit of insect diversity of that of narrower alleyways (40 feet) while increasing yields to near traditional alfalfa rates.

The research has been replicated with other crops and data appear to confirm these results.

*Sources: Stamps, W.T., T.V. Dailey, and N.M. Gruenhagen. 2007. Infestation of European corn borer, *Ostrinia nubilalis* in Midwestern USA fields with herbaceous borders. *Agriculture, Ecosystems and Environment* 121: 430-434.*

*Stamps, W.T., T.L. Woods, R.L. McGraw, and M.J. Linit. 2007. The ecology and economics of insect pests and biodiversity in an alley cropping system in the Midwest. *Entomological Society of American Annual Meeting, San Diego. Poster.**

GIVING TREES THEIR SPACE

Millions of acres of tall fescue pastures reside in Missouri. The greatest potential for increasing the adoption of silvopasture in the state is to add trees to these pastures. However, trees do not establish easily in tall fescue. The goal is to develop guidelines for establishing trees in existing tall fescue pastures.

Prescriptions for vegetation-free zones around trees are inconsistent in the literature and

information is not easily accessible by land managers. 2007 UMCA research findings show a minimum vegetation-free radius of 4 feet should be implemented to optimize tree growth and survival.

*Sources: Houx, J.H. III, and R.L. McGraw. 2007. Establishing trees in pasture to create silvopasture. *Agronomy Abstracts (CD-ROM), ASA Madison, Wis. Abstract.**

*Houx, J.H. III, and R.L. McGraw. 2007. Silvopasture tree establishment as affected by three pasture grass species. In: Olivier, A., and S. Campeau, eds. *Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 271. Abstract.**

“Alley cropping appears to have a very significant positive impact on the beneficial insects in the agroforestry practice.”

*- W. Terrell Stamps,
MU research scientist, entomology*

ALLEY-CROPPED TALL FESCUE SEED PRODUCTION

The scoop: Seed yield was much lower in alley-cropped tall fescue than open-grown tall fescue when nitrogen treatments were administered -- researchers believe the competition for nitrogen is much greater in alley-cropped fields.



Elderberry



Elderberry is an exciting crop being researched at the University of Missouri Southwest Center, Mt. Vernon, Mo., where many agroforestry-related studies are underway. Elderberry, or *Sambucus canadensis*, is a native Missouri crop and is part of the honeysuckle family. Elderberry is a multi-stemmed shrub that fruits on old and new wood. The berries have been used in medicinal products for years, and also can be found in wine and jelly, for example. At the Southwest Center, research is looking at elderberry pruning treatments and cultivar performance, among other studies.

PRUNING TECHNIQUES

Elderberry pruning is laborious and costly. Considering the labor involved with selective pruning, studies are showing that pruning to the ground every other year may be an excellent, cost-effective way to manage the elderberry plant, thereby keeping it vigorous and productive.

The elderberry pruning research looked at two growing locations, three cultivars and four pruning treatments over five years.

Annual pruning may have other important advantages, however. For example, even though research shows annual pruning yielded less overall, such a pruning management method might improve predictability and uniformity of ripening. Researchers also believed annual pruning might reduce erlophyid mite and bacterial leafspot infestation because of the annual removal of infested branches, but data did not support this concept.

CULTIVARS: COMING SOON!

UMCA researchers plan to release two new elderberry cultivars in 2008 (“Wyldeewood” and “Bob Gordon”), while continuing to evaluate more than 60 cultivars. A soil fertility and plant nutrition study will be established in ‘08.

Cultivar ‘Gordon B’ had a larger berry and yielded nearly triple that of ‘Adams 2,’ probably the most common elderberry cultivar in production today. These yield results are across five years, two locations and all four pruning treatments, so researchers are confident Gordon B is a truly superior cultivar for the Midwest. Elderberry plants at Mountain Grove, Mo., yielded higher than those at Mt. Vernon. Researchers do not entirely understand why, but the plants at Mountain Grove were established on raised soil ridges, which may have important benefits for elderberry.

MARKETING STUDY UNDERWAY IN 2008

UMCA’s socio/economic/marketing cluster is launching an elderberry marketing study in 2008. The focus will be on gaining understanding of the size and scope of the national elderberry market and the competitive forces that impact the market from both the producer and consumer perspectives.

Elderberry:

Versatile Native Crop

Berry can be used in...

Wine

Jelly

Syrup

Chocolate & fudge

Food coloring

Medicinal products

Wildlife plantings

Ornamental plantings

Riparian plantings

2007 Publications

BOTTOMLAND RESTORATION/ WILDLIFE HABITAT/ FLOOD TOLERANCE

Coggeshall, M.V., and J.W. Van Sambeek. 2007. Scion and rootstock effects on precocity and acorn production in swamp white oak. April 22-27. Abstracts for Second National Conference on Ecosystem Restoration. Kansas City, Mo.: 60.

Coggeshall, M.V., J.W. Van Sambeek, and S.E. Schlarbaum. 2007. Genotypic variation in flood tolerance of black walnut and three southern bottomland oaks. In: Buckley, D.S., and W.K. Clatterbuck, eds. Proceedings of 15th Central Hardwood Forest Conference. e-Gen. Tech. Rep. SRS-101. Asheville, N.C.: U.S. Department of Agriculture, Forest Service, Southern Research Station: 629-637.

Kabrick, J.M., D.C. Dey, and J.R. Motsinger. 2007. Evaluating the flood tolerance of bottomland hardwood artificial reproduction. In: Buckley, D.S., and W.K. Clatterbuck, eds. Proceedings of 15th Central Hardwood Forest Conference. Gen. Tech. Rep. SRS-101. Asheville, N.C.: U.S. Department of Agriculture, Forest Service, Southern Research Station: 572-580.

Schulz, J.H., J.J. Millsbaugh, T.W. Mong, D. Dey, and R. Bredesen. 2007. Mourning dove demographics and harvest management in an agroforestry complex. Webless Migratory Game Bird Research Program. U.S. Fish and Wildlife Service. Abstract.

Steele, K.L., J.M. Kabrick, and D.C. Dey. 2007. How do you successfully restore bottomland hardwoods? April 22-27. Abstracts for Second National Conference on Ecosystem Restoration. Kansas City, Mo.: 326.

Van Sambeek, J.W., R.L. McGraw, J.M. Kabrick, M.V. Coggeshall, I.M. Unger, and D.C. Dey. 2007. Developing a field facility for evaluating flood tolerance of hardwood seedlings

COMING IN '08

Garrett, H.E. (ed.) 2008. North American Agroforestry: An Integrated Science and Practice. 2nd Edition. American Society of Agronomy, Inc., Madison, WI.

Chapters from Center for Agroforestry associates include:

Garrett, H.E., R.L. McGraw, and W.D. Walter. Alley Cropping Practices.

Godsey, L.D., R. Grala, S. Grado, E. Mercer, and J. Alavalapati. Agroforestry Economics and Policy.

Gold, M.A., M.M. Cernusca, and L.D. Godsey. Agroforestry Product Markets and Marketing.

Gold, M.A., and H.E. Garrett. Agroforestry Nomenclature, Concepts and Practices.

Millsbaugh, J.J., J.H. Schulz, T.W. Mong, D. Burhans, W.D. Walter, R. Bredesen, R.D. Pritchert, and D.C. Dey. Agroforestry Wildlife Benefits.

Schulz, R.C., R.P. Udawatta, T.M. Isenhardt, J.P. Colletti, and W.W. Simpkins. Riparian and Upland Buffer Practices.

Valdivia, C., L. Zabek, J. Arbuckle, M. Gold, and C. Flora. Human Dimensions of Agroforestry.

and understory ground covers. In: Buckley, D.S., and W.K. Clatterbuck, eds. Proceedings of 15th Central Hardwood Forest Conference. e-Gen. Tech. Rep. SRS-101. Asheville, N.C.: U.S. Department of Agriculture, Forest Service, Southern Research Station: 727-733.

Walsh, M.P. 2007. Variation in the flood tolerance of three Midwestern oak species. University of Missouri-Columbia. M.S. thesis.

Walsh, M.P., M.V. Coggeshall, D. Gwaze, J.W. Van Sambeek. 2007. Genetic variation in flood tolerance of bur, white, and swamp white oak collected along a hydrological gradient for restoring bottomland forests. April 22-27. Abstracts for Second National Conference on Ecosystem Restoration. Kansas City, Mo.: 356.

FOREST FARMING

Bruhn, J.N., M.J. Batchelder, and T. Brenneman. 2007. GenBank Accession EU268567 Tuber *lyonii* ascocarp, Strain GACal-hounCountyfb.

Bruhn, J.N., M.J. Batchelder, and G.E. Pruett. 2007. GenBank Accession EU268568 Tuber *lyonii* ascocarp, Strain MOHARCNS5Cfb.

Bruhn, J.N., G.E. Pruett, A.J. Williams, and M.J. Batchelder. 2007. GenBank Accession EF202593 Tuber *lyonii* ascocarp, Strain MOHARCCS25Bfb.

Bruhn, J.N., G.E. Pruett, A.J. Williams, and M.J. Batchelder. 2007. GenBank Accession EF202594 Tuber *lyonii* ectomycorrhizae, Strain MOHARCS25Bem.

Mihail, J.D., J.N. Bruhn, and P.E. Bonello. 2007. Spatial and temporal patterns of morel fruiting. Mycological Research 111: 339-346.

Pruett, G.E., Bruhn, J.N., and Mihail, J.D. 2008. Colonization of pedunculate oak by the burgundy truffle fungus is greater with natural than with pelletized lime. Agroforestry Systems 72: 41-50.

Thomas, A.L., R.J. Crawford Jr., G.E. Rottinghaus, J.K. Tracy, W.L. Applequist, B.E. Schweitzer, L.J. Havermann, S.F. Woodbury, J.S. Miller, M.R. Eilersieck, and D.E. Gray. 2007. Occurrence of 23-epi-26-deoxyactein and Cimracemoside A in various black cohosh tissues throughout the growing season. HortScience 42(3): 535-539.

NUT CROPS

Brawner, S.A. 2007. Husk softening and kernel characteristics of three black walnut cultivars at successive harvest dates. University of Missouri-Columbia. M.S. thesis.

Coggeshall, M.V., and M.R. Warmund. 2007. Early production of Eastern black walnut (*Juglans nigra* L.) cultivars in Missouri. July 16-19. American Society of Horticultural Science Annual Meeting. Scottsdale, Ariz. HortScience 42(4): 956. Poster.

Enderton, D.J. 2007. Increasing Chinese chestnut primary nut weight and bur production by hand removal of secondary burs. University of Missouri-Columbia. M.S. thesis.

Keesey, I.W. 2007. The seasonal occurrence, soil distribution and flight characteristics of *Curculio sayi* (Coleoptera: Curculionidae) in Mid-Missouri. University of Missouri-Columbia. M.S. thesis.

Keesey, I.W., and B.A. Barrett. 2007. Data on the seasonal occurrence and oviposition preferences of the lesser chestnut weevil (*Curculio sayi*) in mid-Missouri. Entomological Society of Missouri, North Central Branch Meeting: Winnipeg, Manitoba, Canada; March 27. Poster.

Keesey, I.W., and B.A. Barrett. 2007. Seasonal occurrence of the lesser chestnut weevil, *Curculio sayi* (Coleoptera: Curculionidae) in mid-Missouri. 10th North American Agroforestry Conference, Quebec City, Quebec, June 10-13. Poster.

journals, books & proceedings

- Keeseey, I.W., and B.A. Barrett.** 2007. The flight characteristics, soil distribution and season occurrence of *Curculio sayi* (Coleoptera: Curculionidae) in mid-Missouri. Entomological Society of America, Annual Meeting, San Diego, Calif.; Dec. 9-12. Poster.
- Reid, W., M.V. Coggeshall, and H.E. Garrett.** 2007. Growing black walnut for nut production. University of Missouri Center for Agroforestry. "Agroforestry in Action" publication. 16p.
- Thomas, A.L., and W.R. Reid.** 2007. Productivity and characteristics of six black walnut cultivars in Missouri. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 197. Abstract.
- Warmund, M.R., and M.V. Coggeshall.** 2007. Rest completion of Eastern black walnut (*Juglans nigra* L.) cultivars. July 16-19. American Society of Horticultural Science Annual Meeting. Scottsdale, Ariz. Poster.
- Warmund, M.R., and M.V. Coggeshall.** 2007. Rest completion in Eastern black walnut cultivars. HortScience 42(4): 956. Abstract.
- RIPARIAN FOREST AND UPLAND BUFFERS**
- Bei, C., K.W. Goyne, S.H. Anderson, R.P. Udawatta, and C.H. Lin.** 2007. Veterinary antibiotic sorption to agroforestry buffer, grass buffer and cropland soils. Agronomy Abstracts 2007. Annual Meetings, New Orleans, La., Nov. 4-8. American Society of Agronomy, 677 South Segoe Road, Madison, WI 53711. Abstract.
- Bricknell, L., S.H. Anderson, S. Kumar, and R.P. Udawatta.** 2007. Animal traffic effects on soil hydraulic properties relative to agroforestry and grass buffers. Missouri Natural Resources Conference. Jan. 31-Feb. 2, Tan-Tar-A Resort, Osage Beach, Mo. Abstract.
- Gantzer, C.J., S.H. Anderson, R.P. Udawatta, and A.R.O. Shmuel.** 2007. Discriminating power of 3-dimensional micrometer-scale pore parameters to assess compaction of a Hamra soil. X-ray Computed Tomography of Soil. Aug. 19-22, University of Guelph, Guelph, Canada. Abstract.
- Helmerts, M., T. Isenhardt, C. Kling, T. Moorman, W. Simpkins, and M. Tomer.** 2007. Agriculture and water quality in the Cornbelt: Overview of issues and approaches. Choices 22(2): 79-85.
- Kim, D., R.C. Schultz, T.M. Isenhardt, W. Simpkins, T.B. Parkin, J.W. Raich, and T.E. Loynachan.** 2007. Emission of the greenhouse gas nitrous oxide (N₂O) from riparian forest buffers, warm-season and cool-season grass filters and crop fields. In: ASA-CSSA-SSSA Annual Meeting, Nov. 4-8, New Orleans, La. Poster.
- Knight, K.** 2007. Effectiveness of naturally-occurring riparian forest buffers and grass filter strips at buffering concentrated flow from row crop fields to streams in northeast Missouri. Iowa State University. M.S. thesis.
- Kumar, S., S.H. Anderson, L. Bricknell, and R.P. Udawatta.** 2007. Animal traffic effects on soil hydraulic properties relative to agroforestry and grass buffers. Agronomy Abstracts 2007. Annual Meetings, New Orleans, La., Nov. 4-8. American Society of Agronomy, 677, South Segoe Road, Madison, WI 53711. Abstract.
- Lerch, R.N., C.H. Lin, and N.D. Leigh.** 2007. Reaction pathway of the diketone nitrile degradate of isoxaflutole (Balance™) with hypochlorite in water. Journal of Agricultural and Food Chemistry 55: 1893-1899.
- Lin, C.H., K.W. Goyne, R.J. Kremer, R.N. Lerch, A.L. Spohn, and H.E. Garrett.** 2007. Rhizodegradation of sulfamethazine and tetracycline and the associated impacts on soil microbial activities. Nov. 4-8, ASA-CSSA-SSSA International Annual Meetings in New Orleans, La. Abstract.
- Lin, C.H., R.N. Lerch, H.E. Garrett, and M.F. George.** 2007. Ability of forage grasses exposed to Atrazine and Isoxaflutole (Balance™) to reduce nutrient levels in soils and shallow groundwater. Communications in Soil Science and Plant Analysis 38: 1119-1136.
- 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. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference, Quebec City, Quebec, June 10-13. p. 113-121.
- Lin, C.H., R.N. Lerch, H.E. Garrett, and M.F. George.** 2007. An improved GC-MS/MS method for determination of atrazine and its chlorinated metabolites uptake by forage plants-laboratory and field experiments. Communications in Soil Science and Plant Analysis 38: 1753-1773.
- Lin, C.H., R.N. Lerch, H.E. Garrett, Y.X. Li, and M.F. George.** 2007. An improved HPLC-MS/MS method for determination of isoxaflutole (Balance™) and its metabolites in soils and forage plants. Journal of Agricultural and Food Chemistry 55: 3805-3815.
- 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. Fourth International Conference on Phytotechnologies, Sept. 24-26, Denver, Colo. Abstract.
- 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. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference, Quebec City, Quebec, June 10-13. p. 95-105.
- Lin, C.H., B.M. Thompson, H.Y. Hsieh, R.J. Kremer, R.N. Lerch, and H.E. Garrett.** 2007. Introduction of atrazine-degrading *Pseudomonas* Sp. Strain ADP to enhance phytoremediation of atrazine. Nov. 4-8, ASA-CSSA-SSSA International Annual Meetings in New Orleans, La. Abstract.
- Lin, C.H., J. Yang, R.N. Lerch, A.L. Spohn, and H.E. Garrett.** 2007. Enhanced rhizodegradation of munitions explosives TNT and RDX by selected grass species. Nov. 4-8, ASA-CSSA-SSSA International Annual Meetings in New Orleans, La. Abstract.
- Lin, C.H., J. Yang, R.N. Lerch, A.L. Spohn, and H.E. Garrett.** 2007. Enhanced rhizodegradation of munitions explosives TNT and RDX by selected grass species. Fourth International Conference on Phytotechnologies, Sept. 24-26. Denver, Colo. Abstract.
- Udawatta, R.P., S.H. Anderson, C.J. Gantzer, and H.E. Garrett.** 2008. Influence of prairie restoration on CT-measured soil pore characteristics. Journal of Environmental Quality 37: 219-228.
- Udawatta, R.P., S.H. Anderson, P.P. Motavalli, and H.E. Garrett.** 2007. Soil water dynamics under agroforestry and grass buffers. Agronomy Abstracts 2007. Annual Meetings, New Orleans, La., Nov. 4-8. American Society of Agronomy, 677, South Segoe Road, Madison, WI 53711. Abstract.
- Udawatta, R.P., N.I. Fox, P.P. Motavalli, and K. Nelson.** 2007. Agroforestry and grass buffer effects on microclimate of a corn-soybean rotation. Agronomy Abstracts 2007. Annual Meetings, New Orleans, La.,

2007 Publications

Nov. 4-8. American Society of Agronomy, 677, South Segoe Road, Madison, WI 53711. Abstract.

Udawatta, R.P., N.I. Fox, P.P. Motavalli, and K.A. Nelson. 2007. Microclimate differences in agroforestry and grass buffers. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 65-73. Abstract.

Udawatta, R.P., R.J. Kremer, H.E. Garrett, and S.H. Anderson. 2007. Soil aggregate stability and enzyme activity in agroforestry and row-cropping systems. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 165-175. Abstract.

Wu, S.H., K.W. Goynes, R.N. Lerch, C.H. Lin, and S.H. Anderson. 2007. Adsorption of the Isoxaflutole Degradates to Aluminum and Iron Hydroxide Oxides. Nov. 4-8. ASA-CSSA-SSSA, New Orleans, La. Abstract.

SILVOPASTURE

Casler, M.D., K.P. Vogel, C.M. Taliaferro, N.J. Ehle, J.D. Berdahl, E.C. Brummer, R.L. Kallenbach, C.P. West, and R.B. Mitchell. 2007. Latitudinal and longitudinal adaptation of switchgrass populations. *Crop Science* 47: 2249-2260.

Cherney, J.H., and R.L. Kallenbach. 2007. Forage systems for the temperate humid zone. In: Barnes, R.F., C.J. Nelson, K.J. Moore, and M. Collins (eds.) Forages Vol. II: The science of grassland agriculture, 6th ed. Blackwell Pub. Profess., Ames, Iowa. p. 277-290.

Curtis, L.E., and R.L. Kallenbach. 2007. Endophyte infection level of tall fescue stockpiled for winter grazing does not alter the gain of calves nursing lactating beef cows. *Journal of Animal Science* 85: 2346-2353.

Van Sambeek, J.W., N.E. Navarrete-Tindall, H.E. Garrett, C.H. Lin, R.L. McGraw, D.C. Wallace. 2007. Ranking the shade tolerance of forty-five candidate groundcovers for agroforestry plantings. *The Temperate Agroforester* 15(4).

Walter, W.D., D.C. Dey, and J.P. Dwyer. 2007. Epicormic response when converting hardwood forests to silvopasture. In: Buckley, D.S., and W.K. Clatterbuck, eds. Proceedings of 15th Central Hardwood Forest Conference. e-Gen. Tech. Rep. SRS-101. U.S. Department of Agriculture, Forest Service, Southern Research Station. p. 425-432.

SOCIO/ECONOMIC/MARKETING

Arbuckle, J.G. Jr. 2007. Competing agri-environmental paradigms in technology transfer: Negotiating the nature of agroforestry in Missouri. University of Missouri-Columbia. Ph.D. dissertation.

Cernusca, M.M., M.A. Gold, and L.D. Godsey. 2007. Competitive market analysis – shiitake mushroom producers. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 297-306.

Fregene, E., and C. Valdivia. 2007. Policy and program incentives for the adoption of agroforestry in Missouri. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 583-592.

Godsey, L.D., M.A. Gold, and M.M. Cernusca. 2007. Online marketing for alternative products. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 507. Abstract.

Godsey, L.D., W.D. Walter, J.P. Dwyer, and H.E. Garrett. 2007. A preliminary economic analysis of silvopasture in Missouri's Ozark forests. In: Buckley, D.S., and W.K. Clatterbuck, eds. Proceedings of 15th Central Hardwood Forest Conference. e-Gen. Tech. Rep. SRS-101. U.S. Department of Agriculture, Forest Service, Southern Research Station. p. 418-424.

Gold, M.A. 2007. Developing the infrastructure to stimulate agroforestry production in the U.S. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 549-550. Abstract.

Lucht, J. 2007. Paths to agroforestry: Landowner types, land use and perceptions. University of Missouri-Columbia. M.S. thesis.

Lucht, J. 2007. Pathways to agroforestry: Landowner types, land use and perceptions. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 593-604.

McCoy, R.L. 2007. Using focus groups to learn about landowner knowledge/willingness to establish chestnut orchards and enhance technology transfer efforts. University of Missouri-Columbia. M.S. project report.

Valdivia, C. 2007. The effect of land fragmentation on habitus, field, and agroforestry in the Midwest, USA. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 621-633.

TECHNOLOGY TRANSFER

Gold, M.A., and R.L. McCoy/ M.M. Hall, eds. 2007. The Chestnut Grower. Newsletter of the Chestnut Growers of America. Vol. 9, Nos. 1-4, Winter, Spring, Summer, Fall.

TREE/CROP INTERACTIONS

Houx, J.H. III, and R.L. McGraw. 2007. Establishing trees in pasture to create silvopasture. *Agronomy Abstracts (CD-ROM)*, ASA Madison, Wis. Abstract.

Houx, J.H. III, and R.L. McGraw. 2007. Silvopasture tree establishment as affected by three pasture grass species. In: Olivier, A., and S. Campeau, eds. Proceedings of the 10th North American Agroforestry Conference. Quebec City, Quebec, June 10-13. p. 271. Abstract.

Houx, J.H. III, R.L. McGraw, and T.A. Settle. 2007. Feasibility of tall fescue seed production in an alley-cropping system. *Agronomy Abstracts (CD-ROM)*, ASA Madison, Wis. Abstract.

McGraw, R.L., W.T. Stamps, and M. Linit. 2007. Yield and maturation of alfalfa in a black walnut alley-cropping practice. The American Society of Agronomy. New Orleans, La. Poster.

Stamps, W.T., T.V. Dailey, and N.M. Gruenhagen. 2007. Infestation of European corn borer, *Ostrinia nubilalis* in Midwestern USA fields with herbaceous borders. *Agriculture, Ecosystems and Environment* 121: 430-434.

Stamps, W.T., T.L. Woods, R.L. McGraw, and M.J. Linit. 2007. The ecology and economics of insect pests and biodiversity in an alley cropping system in the Midwest. Entomological Society of American Annual Meeting. San Diego. Poster.

BOTTOMLAND RESTORATION/WILDLIFE HABITAT/FLOOD TOLERANCE

Coggeshall, M.V., J. Van Sambeek, and D. Gwaze. "Survival and growth of planted oak seedlings in flooded environments from seed sources collected along a hydrological gradient." \$62,200. Missouri Department of Conservation, Research Science Division. (2005-2007.)

Shannon, G., R. McGraw, D. Sleper, and H. Nguyen. "Identification of soybean germplasm for tolerance to soil waterlogging." \$113,829. Missouri Soybean Merchandising Council. (2005-2008.)

FOREST FARMING

Bruhn, J.N., J.D. Mihail, C. Weden, E. Danell, A. Zambonelli, M. Iotti, and E. Barbieri. "Truffle cultivation in North America and Europe." \$3,500. European Union. (2007.)

NUT CROPS

Gold, M.A., K.L. Hunt, M. Warmund, L.D. Godsey, M. Coggeshall, and M.M. Cernusca. "Exploring rural development with local youth through specialty crops." \$67,150. Missouri Department of Agriculture via USDA Specialty Crop Block Grant Program. (2008-2010.)

REDCEDAR PHYTOCHEMISTRY

Kremer, R.J. Chemical supplies and service. \$3,500. USDA-ARS/Department of Soil Science. (2006-2007.)

Lerch, R.N. ISCO FOXY 200TM X-Y fraction collector. \$6,000. USDA-ARS, Cropping Systems and Water Quality Research Unit. (2007.)

RIPARIAN FOREST AND UPLAND BUFFERS

Goyne, K., R.N. Lerch, and C.H. Lin. "Adsorption of the isoxaflutole degradate diketetonitrile to hydrous iron and aluminum oxides." \$22,000. United States Geological Survey/Missouri Water Resources Research Center. (2006-2008.)

Kremer, R.J. USDA-ARS/Department of Soil Science, University of Missouri-Columbia, MO 65211. \$2,500. (2007.)

Lerch, R.N. USDA-ARS, Cropping Systems and Water Quality Research Unit, Columbia, Missouri 65211. \$25,000. (2007.)

Lerch, R.N. USDA-ARS, Cropping Systems and Water Quality Research Unit, Columbia, Missouri 65211. \$15,000 (match fund). (2007.)

Lin, C.H. "Phytoremediation of munitions explosives." \$35,000. Lincoln University Cooperative Research and Extension Programs. (2007.)

SHADE TOLERANCE

Garrett, H.E., and J. Van Sambeek. "Shade effects on Ozark big bluestem accessions with temperate agroforestry potential." \$12,000. USDA Natural Resource Conservation Service. (2005-2007.)

SOCIO-ECONOMIC-MARKETING

Gold, M.A., L.D. Godsey and M.M. Cernusca. "Missouri alternative products online marketplace for Missouri's entrepreneurs." \$50,000. Awarded as subcontract through Missouri Department of Agriculture via the Federal State Market Improvement Program (FSMIP). (2006-2007.)

SOIL QUALITY

Udawatta, R.P., C.J. Gantzer, R.J. Kremer, S.H. Anderson, and H.E. Garrett. "Synchrotron Microtomography (CMT) and Scanning Electron Microscopy (SEM) examination of microbial resilience and spatial distribution of microhabitats as influenced by Prairie Ecosystem Restoration (PFCA). \$16,000. Prairie Fork Conservation Area. (2008-2010.)

STUDENT SUPPORT

Fregene, E. .25 FTE Graduate Research Assistant, MS Agricultural Economics. Matching funds.

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

Yong, J. Lincoln University Cooperative Research and Extension Programs. \$3,000.

TREE/CROP INTERACTIONS

Linit, M.J., and W.T. Stamps. "Ecology and diversity of the insect community in alternative crops and nut trees." \$60,000. Missouri Agricultural Experiment Station Project. (2006-2010.)

Linit, M.J., and W.T. Stamps. "Resource cropland and herbaceous cropland field borders." \$10,000. Missouri Department of Conservation. (2006-2007.)

Stamps, W.T. "Improving the environment and economic stability of small farms through an alternative agroforestry practice." \$4,780. University of Missouri Research Council Grant. (2006-2007.)

TECHNOLOGY TRANSFER

Gold, M.A., and W.D. Walter. "Agroforestry Training for Professionals in Missouri and the Midwest." \$47,890. USDA SARE. (2006-2008.)

Gold, M.A., and W.D. Walter. "Agroforestry Training for RC&D Personnel." USDA SARE. \$11,574. (2008-2009.)

WINDBREAKS

Garrett, H.E., W.D. Walter, and M.A. Gold. "Livestock odor abatement grant proposal." \$110,000. The Small Business Development Authority, Missouri Department of Agriculture. (2007-2008.)

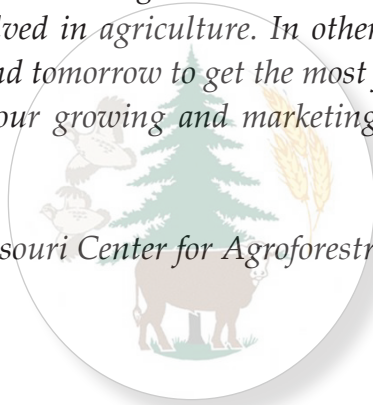


Putting Science into Practice

“Putting science into practice” isn’t just a catchy phrase. It’s what we do. The University of Missouri Center for Agroforestry supports comprehensive research on many facets of agroforestry, including windbreaks, forest farming, silvopasture, riparian forest buffers and alley cropping. And when our research yields findings that could help landowners, we pass them along directly, through publications, newsletters, workshops and meetings. Everything we do is with the end goal of helping landowners get the most from their land, while at the same time sustaining the land for future generations. We help farmers today and tomorrow.

Here’s just one example: In 2007, the Center for Agroforestry received a grant, in cooperation with the Missouri Department of Agriculture, to enhance the competitiveness of Missouri specialty crops and teach FFA youth the importance of specialty crops as a value-added opportunity. Technology transfer specialists will educate FFA students and potential growers in Lexington, Mo., and surrounding areas and connect them with local leaders and mentors involved in agriculture. In other words, we’re teaching the farmers of today and tomorrow to get the most from their land through agroforestry, putting our growing and marketing research on nut crops into practice.

The University of Missouri Center for Agroforestry – putting science into practice.



 **Center for Agroforestry**
University of Missouri-Columbia

Director: H.E. “Gene” Garrett, Ph.D.

203 ABNR

Columbia, MO 65211

(573) 884-2874

e-mail: umca@missouri.edu

www.centerforagroforestry.org

In 2007, UMCA...

Began restoration on historic 1819 house located on primary research farm (see pg. 8)

Celebrated 5th anniversary of Missouri Chestnut Roast, a festival of culture and agriculture (pg. 13)

Launched online marketplace for niche Missouri agricultural products (pg. 17)

Introduced the next generation of growers to niche crops like chestnut (pg. 18)

Found potential antibacterial and skin-cancer-fighting compounds in redcedar, a common, low-value Missouri tree (pg. 19)

Undertook testing on whether agroforestry buffers can stop contamination of water and soil by animal antibiotics (pg. 20)

Planted trees and shrubs to gauge odor-blocking capabilities around large animal production facilities (pg. 25)

Identified two emergence periods for the chestnut weevil - one not previously noted in literature (pg. 28)

Published nation’s first black walnut nut culture guide (pg. 29)