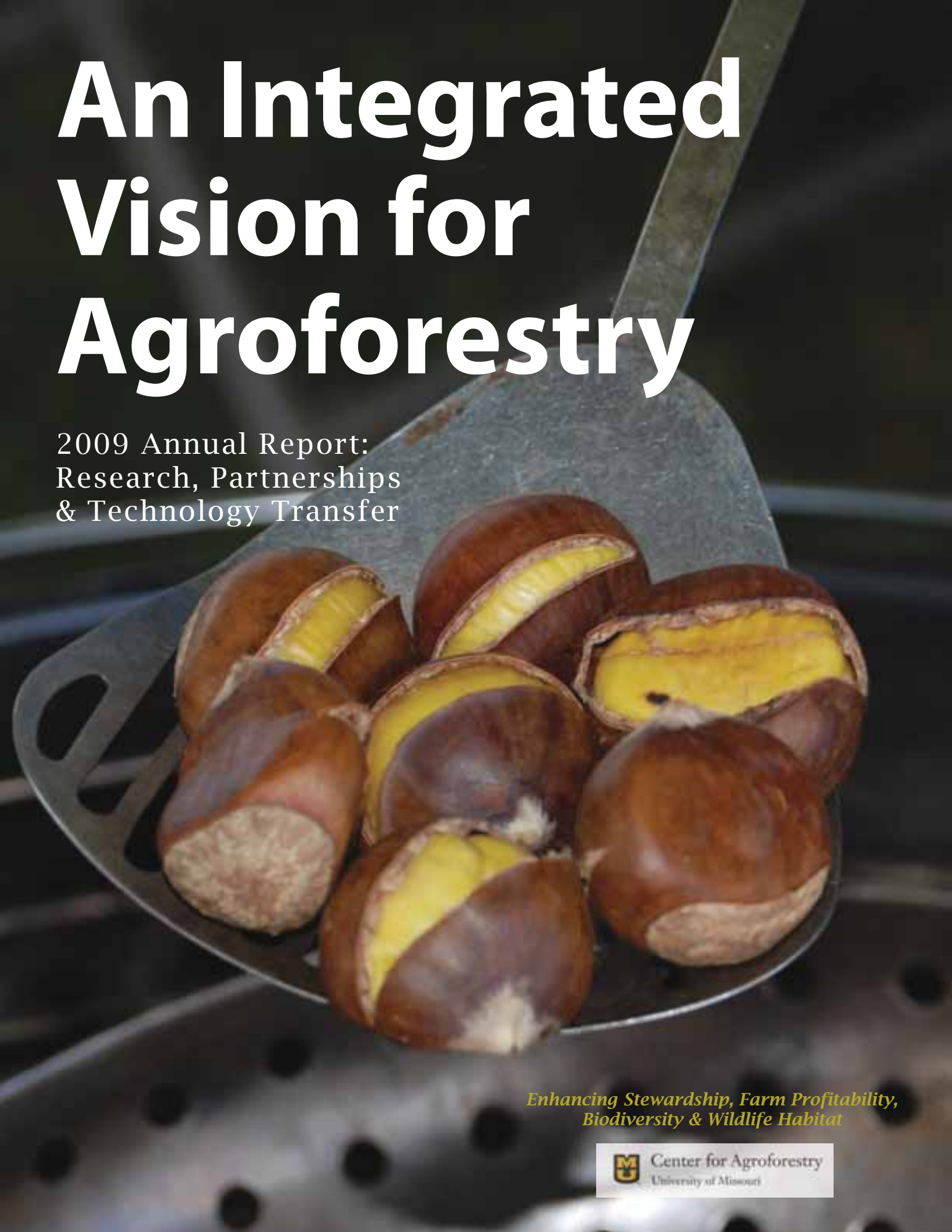
An Integrated Vision for Agroforestry

2009 Annual Report:
Research, Partnerships
& Technology Transfer



Enhancing Stewardship, Farm Profitability, Biodiversity & Wildlife Habitat

Center for Agroforestry
University of Missouri

ABOUT THE CENTER

Agroforestry provides new market opportunities, habitat for wildlife, and is a form of sustainable agriculture and land stewardship. It can provide improved water quality and diversified farm income.

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

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. The Center strives to support the long-term future of rural and urban working farms by achieving economic, environmental and social sustainability. The Center's long-term research, teaching and technology transfer efforts help make a better Missouri, U.S. and world by:

- *Discovering, integrating and applying new agroforestry knowledge and technologies to promote economic, environmental and social vitality.*
- *Educating and training students, professionals, scientists, leaders and general public who are empowered to make a difference locally, regionally and globally.*

2009 was a busy year including many major developments at the MU Center for Agroforestry. In 2009, UMCA:

- *Appointed a new director, Dr. Shibu Jose*
- *Received approval for research agenda for next four years in collaboration with the Agricultural Research Service*
- *Hosted the international 11th North American Agroforestry Conference*
- *Sent two representatives to the 2nd World Congress of Agroforestry, Kenya*
- *Dedicated the Thomas Hickman House (circa 1819)*

UMCA'S GOALS

- Create new income opportunities and markets for farm and forest landowners
- Protect the environment by reducing non-point source pollution
- Create and improve natural habitats for wildlife
- Mitigate against the impacts of periodic flooding in rural and urban areas

Contents

EDITED BY

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

ON THE COVER

Chestnuts roast on an open fire at the seventh annual Missouri Chestnut Roast

DIRECTOR'S MESSAGE

Greetings from the University of Missouri Center for Agroforestry! As many of you know, the Center has gone through a leadership change during the reporting year. Dr. H.E. "Gene" Garrett, founding director, has retired after his outstanding service of nearly 35 years to the University of Missouri, the Center for Agroforestry, and the agroforestry profession. This is my first opportunity as director to present our annual report to you and I do so with great honor and pride.

The University of Missouri Center for Agroforestry is one of the premier centers of its kind in the world dedicated to agroforestry research, teaching and technology transfer. Our mission is to support the long-term future of rural and urban working farms and forests by achieving economic, environmental and social sustainability. The Center's long-term research, teaching and technology transfer efforts help make a better Missouri, U.S. and world by (1) Discovering, integrating and applying new agroforestry knowledge and technologies to promote economic, environmental and social vitality; and (2) Educating and training students, professionals, scientists, leaders and general public who are empowered to make a difference locally, regionally, nationally and globally.

The University of Missouri Center for Agroforestry is pleased to welcome its new director. Shibu Jose became director of the Center in November 2009. Upon the retirement of previous director Gene Garrett Dec. 31, Jose assumed an endowed professorship, the H. Gene Garrett Chair of Agroforestry.

Dr. Jose comes to MU from the University of Florida in Gainesville, where he served as a professor of forest ecology, School of Forest Resources and Conservation.

Jose is editor-in-chief, Agroforestry Systems, and associate editor, International Journal of Ecology and Journal of Forestry

For more information about Dr. Jose's background and accomplishments, go to http://www.centerforagroforestry.org/pubs/news/news043.asp

Our strength lies in the 22 core Center faculty and staff, over 50 associated faculty, staff and external collaborators, and over 20 graduate students and postdoctoral research associates who define, design and carry out more than 70 research and tech transfer projects. We also find strength in our diverse clientele base and friends who believe in agroforestry as a major form of future global land use. In difficult economic times like these we can fully appreciate the diverse opportunities agroforestry offers to the family farm. The annual report highlights the research and tech transfer accomplishments of our faculty, staff, students, partners and collaborators. The impacts of our research and tech transfer activities have reached far and wide. For example:

- *Center's long-term woody and non-woody biomass research is leading to the development of integrated biomass feedstock production systems – potential income opportunity from marginal cropland*
- *Redcedar, an abundant Midwestern tree, contains chemicals that can fight MRSA, an antibiotic-resistant staph bacteria – potential income opportunity for small farms and new high-tech industries*

- *Buffer strips of trees and grasses can trap and break down veterinary antibiotics from manure – another environmental benefit of buffers and silvopasture*
- *11th North American Agroforestry Conference, bringing together researchers from across the world – this was one of 40 tech transfer activities in 2009 that reached an estimated 9,000 people directly*

The increasing realization that agroforestry offers solutions to many of the environmental and economic challenges that we face today will help spur adoption. We will work together to help realize agroforestry's potential. I appreciate your continued support of our program and look forward to another exciting and productive year in 2010.

– Shibu Jose, Ph.D., H.E. Garrett Endowed Professor and Director, University of Missouri Center for Agroforestry

FIVE PRACTICES OF AGROFORESTRY

alley cropping

Alley cropping is planting rows of trees at wide spacings while a companion crop grows 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. Trees selected for alley cropping may include valuable hardwood species, such as nut trees, or trees desirable for wood products.

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 grown for wood products. Wildlife may find ideal habitat in a forest farming setting.

riparian forest & 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 and berries planted in the shrub zone can provide additional income.

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 widely spaced trees for livestock pasture. The trees not only provide a long-term investment with nut crops or a timber harvest, but also provide animals shade in the summer and a windbreak in the winter. In turn, the forage base provides feed for cattle and other livestock. A silvopasture practice diversifies farm income; can minimize the need for vegetation control; and can reduce hay and feeding costs for livestock and improve animal health.

windbreaks

Windbreaks are planned and managed as part of a crop and/or livestock operation. Field windbreaks protect a variety of wind-sensitive crops; enhance production and conservation; 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 also may provide excellent wildlife habitat.

UMCA RESEARCH CLUSTERS

Since 2001, the University of Missouri Center for Agroforestry has been primarily supported by USDA-ARS grant programs. These grants fund more than 60 individual projects. The Center continues 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 serves as a catalyst for stimulating the development of agroforestry throughout the United States and Canada.

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

Horticulture
Ongoing studies include those on gourmet mushrooms, redcedar phytochemicals, elderberry, pawpaw and pine straw.

Tree/crop interactions
Impacts all biophysical research clusters, with a focus on above- and below-ground interactions between trees and crops; also includes insect predator/prey dynamics.

Water quality and riparian forest and upland buffers
The focus is to quantify environmental benefits of woody/grass buffers on non-point source pollutants including antibiotics. Includes paired upland watershed 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 effects of short- and long-term flooding on trees, shrubs, grasses, legumes and crops.

Biomass/fast-growing hardwood and warm-season grass bioenergy
The focus is to quantify growth of Populus clones, sweet sorghum, willow, switchgrass and other species for biomass production. Future studies will feature replicated trials from Columbia, Mo., to Booneville, Ark.

Forest bottomland and wildlife restoration and biodiversity
Studies look at bottomland hardwood restoration and management, quantifying effects of bottomland agroforestry practices on wildlife species.

Silvopasture/shade tolerance
Studies include response of cattle, forage and trees in silvopastures with planted trees; extending the grazing season with early- and late-season forages; effects of integrating forages and rotational livestock grazing into managed white oak stands to determine impacts on tree growth, regeneration, forage quality and animal weight gain and health on north-facing slopes in the Ozarks; and establishment of drought tolerant shortleaf pine and warm-season grasses on south-facing slopes in the Ozarks.

Socio/economic/marketing
The cluster's integrated approach works to understand the social and economic dimensions of a given enterprise, including institutions, networks, markets, non-market valuation and technology. Research activities provide an understanding of factors that facilitate or constrain involvement in agroforestry.

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

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

PARTNERSHIPS

The University of Missouri Center for Agroforestry partners with universities, natural resource entities, agricultural organizations and landowners across the Midwest and the nation to foster an integrated approach to farming across diverse landscapes.

MU Collaborations

University of Missouri Extension

College of Agriculture, Food and Natural Resources

Partnerships with faculty in 15 departments: Animal Sciences; Horticulture; Forestry; Agricultural Economics; Rural Sociology; Entomology; Agronomy; Chemistry; Plant Pathology; Fisheries and Wildlife; Parks, Recreation and Tourism; Biological Engineering; Veterinary Pathobiology; MU Life Science Center; and Soil, Environmental and Atmospheric Sciences

University of Missouri National Center for Soybean Biotechnology

University of Missouri Center for Sustainable Energy

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.; and Thompson Farm, Spickard, Mo.

External University Partnerships

The Agroecology Issue Team, Iowa State University
Chetopa Experiment Station, Kansas State University
Environmental Science, Lincoln 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, West Lafayette, Ind.

State Collaborations
Missouri Department of Conservation
Missouri Department of Natural Resources
Missouri Department of Agriculture
Missouri Natural Resources Conservation Service
Missouri RC & Ds

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 535 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 five 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.

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

STAFF & COLLABORATORS

DIRECTOR Shibu Jose, Ph.D.

ASSOCIATE DIRECTOR Michael Gold, Ph.D.

UMCA FACULTY & STAFF

RESEARCH SPECIALIST - FORESTRY Kenny Bader, B.S.
RESEARCH SPECIALIST - FORESTRY Aaron Brown, B.S.
RESEARCH ASSOCIATE PROFESSOR - PLANT SCIENCES Johann Bruhn, Ph.D.
RESEARCH ASSOCIATE/MARKETING SPECIALIST Ina Cernusca, M.B.A.
TREE IMPROVEMENT SPECIALIST Mark Coggeshall, Ph.D.
RESEARCH SPECIALIST - FORESTRY Parker Fadler, B.S.
RESEARCH ASSOCIATE/ECONOMIST Larry Godsey, M.S.
SENIOR INFORMATION SPECIALIST Michelle Hall, B.A.
RESEARCH SCIENTIST Ken Hunt, Ph.D.
RESEARCH ASSISTANT PROFESSOR - FORESTRY Chung-Ho Lin, Ph.D.
ADMINISTRATIVE ASSOCIATE Tricia Oswald, B.S.
EVENTS COORDINATOR Julie Rhoads, M.S.
RESEARCH SCIENTIST - PLANT SCIENCES Terrell Stamps, Ph.D.
RESEARCH SPECIALIST - FORESTRY John Thompson, M.S.
RESEARCH ASSISTANT PROFESSOR - SOIL, ENVIRONMENTAL & ATMOSPHERIC SCIENCES (SEAS) Ranjith Udawatta, Ph.D.
TECHNOLOGY TRANSFER/RESEARCH SPECIALIST Dusty Walter, M.S.

HARC FARM STAFF

SUPERINTENDENT Ray Glendening, B.S., Ag. Economics
Nancy Bishop
Matt Kramer, M.S.

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
John Dwyer, Ph.D., Forestry
Neil Fox, Ph.D., SEAS
Felix Fritschi, Ph.D., Plant Sciences
Keith Goyne, Ph.D., SEAS
Hong He, Ph.D., Forestry
Jimmy Houx, Ph.D., Agronomy
Jason Hubbart, Ph.D., Forestry/SEAS
Rob Kallenbach, 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
Bob Pierce, Ph.D., Fisheries & Wildlife
Sandy Rikoon, Ph.D., Rural Sociology
Chris Starbuck, Ph.D., Horticulture
Hank Stelzer, Ph.D., Forestry
Andy Thomas, M.S., Horticulture
Corinne Valdivia, Ph.D., Agricultural Economics
Michele Warmund, Ph.D., Horticulture

EXTERNAL COLLABORATORS

Gary Bentrup, M.S., USFS/NAC
David Burner, Ph.D., USDA/ARS
Dan Dey, Ph.D., USFS
Michael Dosskey, Ph.D., USFS/NAC
David Gwaze, Ph.D., MDC
Tom Isenhart, Ph.D., Iowa State University
John Kabrick, Ph.D., USFS
Robert Kremer, Ph.D., USDA/ARS
Bob Lerch, Ph.D., USDA/ARS
Leigh Ann Long, M.S., Iowa State University
Mike Looper, Ph.D., USDA/ARS
Andy Mason, Ph.D., USDA/NAC
Allison Miller, Ph.D., St. Louis University
Rob Myers, Ph.D., Jefferson Institute
Nadia Navarrete-Tindall, Ph.D., Lincoln University
Dan Pote, Ph.D., USDA/ARS
Randy Raper, Ph.D., USDA/ARS
William Reid, Ph.D., Kansas State University
Michele Schoeneberger, Ph.D., USFS/NAC
Richard Schultz, Ph.D., Iowa State University
Steve Shifley, Ph.D., USFS
Richard Straight, M.S, USFS/NAC
Irene Unger, Ph.D., Westminster College
Jerry Van Sambeek, Ph.D., USFS
Doug Wallace, M.S., NRCS National Agroforester
Gary Wells, B.L.A., R.L.A., NRCS/NAC
Bruce Wight, B.S., C.F., NRCS National Forester

GRADUATE STUDENTS

Andrew Biggs, M.S., Warmund, Plant Sciences
Bei Chu, Ph.D., Goyne/Anderson, SEAS
Cammy Drost, M.S., Lerch, SEAS
Larry Godsey, Ph.D., Dwyer, Forestry
Sakinah Haque, M.S., Schultz, Natural Resource Ecology & Management
Sandeep Kumar, Ph.D., Anderson/Udawatta, SEAS
Ian Keesey, Ph.D., Barrett, Plant Sciences
Katy Menzel, M.S., Stelzer, Forestry
Ben Moore, M.S., Motavalli, SEAS
Nick Othe, M.S., Schultz, NREM
Bodh Paudel, M.S., Udawatta/Anderson, SEAS
Rachel Peacher, M.S., Schultz, NREM
Anoma Senaviratne, Ph.D., Udawatta/Anderson, SEAS
Stacey Smith, M.S., Dwyer, Forestry
Mustafa Tufekciuglu, M.S., Schultz, NREM
Sara Venables, M.S., Schultz, NREM
Kristen Veum, Ph.D., Goyne/Motavalli, SEAS
James Wagner, M.S., Starbuck, Plant Sciences
Doug Wallace, Ph.D., Van Sambeek, Forestry
Dusty Walter, Ph.D., Dwyer, Forestry

HORTICULTURE & AGROFORESTRY RESEARCH CENTER

The Horticulture and Agroforestry Research Center, a 660-acre farm, is the primary research site for the MU Center for Agroforestry. The farm includes experimental fruit and nut orchards; forest farming, upland buffer and silvopasture demonstrations; greenhouses; shade and flood tolerance laboratories; a teaching vineyard; and five lakes and ponds. HARC is one of the University of Missouri's 16 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. The farm is positioned amidst the rich loess soils of the Missouri River Hills at one of the highest elevations in Howard County and contains Missouri River floodplain soils, creating a diversity of establishment sites for researching plant and tree combinations.

SELECTED HARC PROJECTS

The University of Missouri Center for Agroforestry promotes a remarkable diversity of research to explore tree, grass, crop and livestock combinations optimal for establishing demonstrations of the five agroforestry practices.

HARC research includes:

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 paired watershed study at HARC to measure the effects of tree and grass buffers for reducing non-point source pollution from grazing. The study also will provide data for calibrating a GIS model simulating the conservation benefits of agroforestry, upland buffer systems.

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 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 six of these shrub species. Of the shrubs, seedlings of false indigo had the best survival, early growth and readily sprouted after spring burns.

Pitch x Loblolly (Walnut) Silvopasture Study. This research explores the impact of pine trees on forage yields and animal weight gain and health as part of a whole-farm forage/livestock system. Pitch pine/loblolly pine hybrids and black walnut were planted in single, double and triple rows.

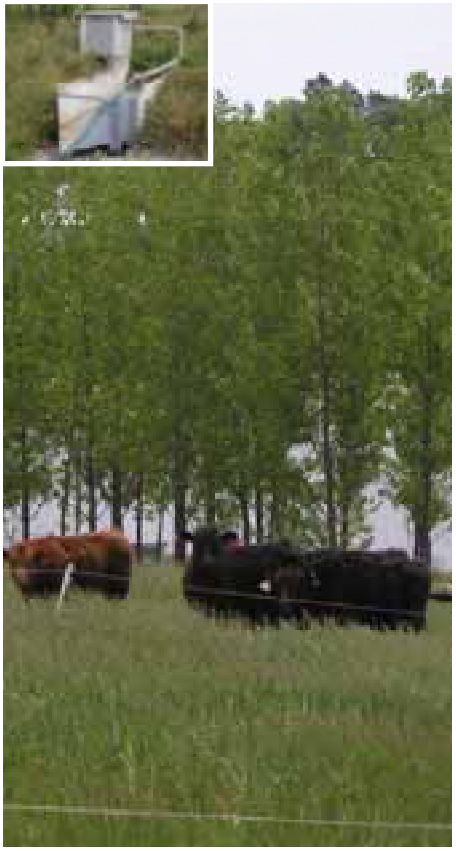
Forage Shade Tolerance Study. Throwing trees into the mix makes selection of shade-tolerant forages critical in a successful agroforestry practice. The shade tolerance laboratory at HARC is the perfect place to study this aspect of agroforestry, with five different shade treatments: full sunlight; 70 percent, 45 percent and 20 percent full sunlight; or a "sunfleck" treatment. Studies look at yield and quality of forage grown under the various shade treatments.

Recent results have shown little and big bluestem to be shade tolerant; little blue can tolerate lower quality sites, while big blue is best planted on better sites. Both grasses are now headed for field testing.

Flood Tolerance Laboratory. The laboratory lays adjacent to Sulphur Creek in the 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, sweet sorghum 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 also was evaluated; results show swamp white oak and bur oak were the most flood tolerant species.

Pawpaw Cultivars. 'Susquehanna' appears to have great potential as an improved cultivar for growers of this native Missouri fruit. In 2009, 75 percent of the fruit produced by 'Susquehanna' trees were above 200 grams – the size growers prefer for selling at Farmers' Markets. Trees of many of the cultivars tested at HARC can be purchased from Forrest Keeling Nursery, Elsberry, Mo., or Stark Bros. Nursery, Louisiana, Mo.

Pine Straw. Studies show production of pine straw mulch may be an enterprise allowing utilization of marginal land to generate income. Pine straw, the naturally shed needles of pine trees, is the most commonly used mulch in the southeastern U.S. Although pine straw makes an excellent mulching material, it is not readily available in the Midwest. Research at HARC has shown selections of loblolly pine and hybrids between pitch and loblolly pine are cold hardy and have needles suitable for baling. When the project is completed, Missouri landowners should have access to pine seed-



Top: *Workers bale pine straw in the demonstration area at HARC.* ***Bottom:*** *Cattle graze in the paired watershed area at HARC.* ***Bottom inset:*** *Paired watershed study equipment, measuring effects of tree and grass buffers for reducing non-point source pollution from grazing.*

HARC RESEARCH PROJECTS

lings selected for their ability to produce pine straw in the state.

Trees planted at HARC in 1999 are now at commercial scale and produced 80 60-pound bales per acre (which translates to more than 200 20-pound bales per acre – the industry standard) in 2008 and 2009.

In summer 2009, researchers began analyzing crown volumes, needle length and needle yields.

Left: *A group tours the recently planted teaching vineyard at HARC.* ***Above:*** *HARC features an innovative, outdoor flood tolerance research laboratory.*

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 four full-time research specialists to support ongoing research efforts on more than 500 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 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 Zone 5 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 and alley crops.

CHESTNUT ROAST/HICKMAN HOUSE DEDICATION

It was standing room only the morning of Oct. 17, 2009, when the MU Center for Agroforestry dedicated the long-awaited rehabilitation of the historic Thomas Hickman House at UMCA's Horticulture and Agroforestry Research Center, New Franklin.

As the ceremony was ending and tours of the home beginning, the Missouri Chestnut Roast kicked off its seventh year of celebrating Missouri specialty agricultural products, including the versatile chestnut.

The Thomas Hickman House, built in 1819, is one of the oldest intact brick homes in the state and is on the National Register of Historic Places. Although the home had fallen into decay by the mid 1900s, Dr. Gene Garrett, past superintendent of the Research Center and former director of the MU Center for Agroforestry, vowed to restore the home when the Center took over the farm in the 1990s.

Top: (left to right) *MU Deputy Chancellor Michael Middleton; Gene Garrett, HARC superintendent; and U.S. Sen. Kit Bond cut the ribbon at the ceremony for the Thomas Hickman House.* ***Above right:*** *The parlor at the house now includes period furnishings as well as a portrait of Hickman's sister, on loan from a local family.* ***Left:*** *The Chestnut Roast's crowds gather to sample and purchase Missouri agricultural specialty products.*

The $1.3 million rehabilitation project to bring the house to its historic condition was funded by Jim Weathers, who lived in the house as a small boy; the Missouri Department of Economic Development through a Community Development Block Grant for 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 from funds provided to the College of Agriculture, Food and Natural Resources by Al and Mary Agnes McQuinn.

In addition to the rehabilitation efforts, the home has been furnished in period style, and contains displays and artifacts of the history of the Hickman family and the area. Many helped bring the project to completion. Neighbors have shared area Native American artifacts to display in the home. A man who saved window panes from a destroyed 19-century building in the area donated them for historical accuracy. Bricks for the summer kitchen and various chimneys came from another period area home. A related family loaned two portraits of the Hickman family. Others have donated period furniture, clothing, or their time or money for securing items to display. HARC Superintendent Ray Glendening researched the Hickman family and created a family tree going back to the 1500s – now viewable in the home. Other items displayed – including buttons, coins and utensils – were found on-site during an archeological dig by University of Missouri experts a decade ago.

THE HIGHLIGHTS: ROAST '09

Event set in beautiful Missouri River Hills

Tours of new vineyard in addition to farm and Hickman House tours

Live bluegrass music

Children's activities including edible insects and cockroach races

Cooking with chestnuts demonstration

Meat, cheese, nut and other specialty product vendors

Fresh-roasted, Missouri-grown chestnuts!

TECHNOLOGY TRANSFER

One of the primary goals of the Center for Agroforestry is to educate and inform landowners and natural resource professionals about new research in agroforestry, and to demonstrate how this research can be successfully applied to their operations. The UMCA Technology Transfer team works to bring knowledge of the practices of agroforestry and the Center's ongoing research to landowners, forest and farm organizations, natural resource professionals and extension agents from across the state, nation and world through on-site consultations, educational workshops and other events, publications, newsletters and informational exhibits.

CHESTNUT WORKSHOP SERIES

In 2009, UMCA offered a series of chestnut production workshops. Four, day-long sessions spanned the chestnut growing season, from March to September.

The Missouri Department of Agriculture's Specialty Crop Block Grant program helped to sponsor the series. The workshops, which were held at the MU Horticulture and Agroforestry Research Center, were aimed at current and prospective growers, extension agents and interested FFA students.

Forty landowners signed up for the entire series and post-workshop feedback was overwhelmingly positive. Every attendee rated the workshops either "excellent" (91 percent) or "good" (9 percent) in a survey administered at the final meeting.

Instructors included UMCA staff and affiliates Michael Gold, Ken Hunt, Mark Coggeshall, Bill Reid and Michele Warmund. Outside experts and veteran growers also contributed, including Dr. Greg Miller, Empire Chestnut Co., and Debbie Milks of Chestnut Charlie's. Course topics included site selection, planting, graft planning and pruning; grafting; orchard maintenance, weed control, insect scouting, pest management and disease control; and harvest, marketing and sales.

The workshop series is back for a second year in 2010.

PUBLICATIONS

In 2009, UMCA created two new guides, "Succession Planning for Woodland Owners" and "Understanding Casualty Loss of Timber."

"Succession Planning" helps owners of family forestland assess their situations and prepare for a successful transition to the next generation of owners. Two major tax concepts are involved in determining a casualty loss deduction: "adjusted basis" and "fair

Below left: *Bill Reid (in plaid shirt) performs a grafting demonstration at the second installment of UMCA's 2009 chestnut production workshop series.*
Below right: *Ina Cernusca, right, hands out fresh roasted chestnut samples at the Downtown Columbia Living Windows Festival, Dec. 4, 2009.*

market value." The new "Casualty Loss" guide is an explanation of these concepts and includes two case studies illustrating their application in determining a deduction for damaged timber.

The Technology Transfer group also updated the guides "Growing Black Walnut for Nut Production" and "Growing Chinese Chestnut in Missouri" in 2009.

NEW e-NEWSLETTER

The Center launched a monthly e-newsletter in fall 2009, "Action in Agroforestry," focusing on Center affiliates and staff, recognizing awards and honors and discussing research, outreach and the impact of the Center. The goal is to help everyone affiliated with the Center stay up-to-date. See back issues online at http://www.centerforagroforestry.org/pubs/action/archive.asp

ALLEN RESEARCH AND EDUCATION PROJECT

The 535-acre Doug Allen Research and Education Site has become a focal point of activities emphasizing integration of wildlife and resource stewardship. In June 2009, quail habitat was enhanced by establishing three blocks of shrubs to augment the forest edge along a creek bottom. Additional shrub blocks, to be established in the spring of 2010, will become a foundational component to quail research designed to better understand their habitat preferences.

WURDACK FARM

MU's Hugo Wurdack Farm, Cook Station, Mo., will soon expand the scope of its silvopasture research and demonstrations, with both pine and hardwood silvopasture practices.

In addition to hosting the North American Agroforestry Conference (see pg. 16), the four-part chestnut production workshop series and the 7th Annual Missouri Chestnut Roast (see pg. 11), in 2009 UMCA Technology Transfer co-hosted an Opportunities in Agroforestry Workshop, LaCrosse, Wis., South Central FFA Forestry Contest, Rolla, and the State FFA Forestry Contest, Columbia. Team members presented and/or exhibited at three University of Missouri farm field days, in addition to the Annual Missouri Small Fruit and Vegetable Conference; 5th National Small Farm Conference; Shannondale Tree Farm 60th Anniversary; and National Small Farms Trade Show. Finally, UMCA Technology Transfer members roasted chestnuts at the Columbia Farmers' Market and Columbia Living Windows Festival, and sold pawpaw at the Farmers' Market in 2009.

MARKETS & SOCIOECONOMICS

The UMCA socio/economic/marketing cluster looks at human and economic dimensions of agroforestry including individual attitudes, knowledge, incentives and social-economic-resource characteristics; role of institutions in constraining or facilitating agroforestry; specialty crop financial decision models; knowledge of markets for new products; role of agroforestry in agritourism; and networks that facilitate access to information about agroforestry practices. The cluster also created and administers the Missouri Exchange Web site, an online marketplace for buyers and sellers of Missouri agricultural products. See the interactive site at www.missouriexchange.com

AGROFORESTRY, AGRITOURISM & ADOPTION

UMCA surveys have shown a changing structure in agriculture, and in the characteristics of landowners, reflected in their livelihood strategies. Researchers have identified "ruralist" and "productivist" landowners, based on their use of the land, interest in adopting agroforestry and the differences in recreational multifunction (occurs when farms provide different services along with food production). This approach will help understand the main paths for diffusion of agroforestry information according to the different types of landowner.

Researchers have determined:

**Messages to productivists should emphasize the economic benefits of agroforestry; those directed to ruralists should emphasize the conservation benefits.*

**Touring farms with active tree management is helpful for productivists; state and federal extension agents appear to be best to approach ruralists.*

**Printed materials are effective for both groups.*

Next up, a survey will examine the perceived benefits of agroforestry and recreational activities of family farms to current and potential Missouri consumers.

Source: Barbieri, C., and C. Valdivia. "Recreational multifunctionality and its implications for agroforestry." In M.A. Gold and M.M. Hall (eds.). Agroforestry Comes of Age: Putting Science into Practice. Proceedings, 11th North American Agroforestry Conference. 475-484.

At left: *Products from crops grown in agroforestry practices, such as elderberry concentrate, black walnuts and pecans, can be found on the shelves of more and more stores.*

ELDERBERRY MARKET

Researchers have completed a mail survey of U.S. elderberry growers; more in-depth phone interviews are underway. So far, the study respondents indicate demand is strong, has increased over the past five years and will continue to increase.

FINANCIAL DECISION MODELS

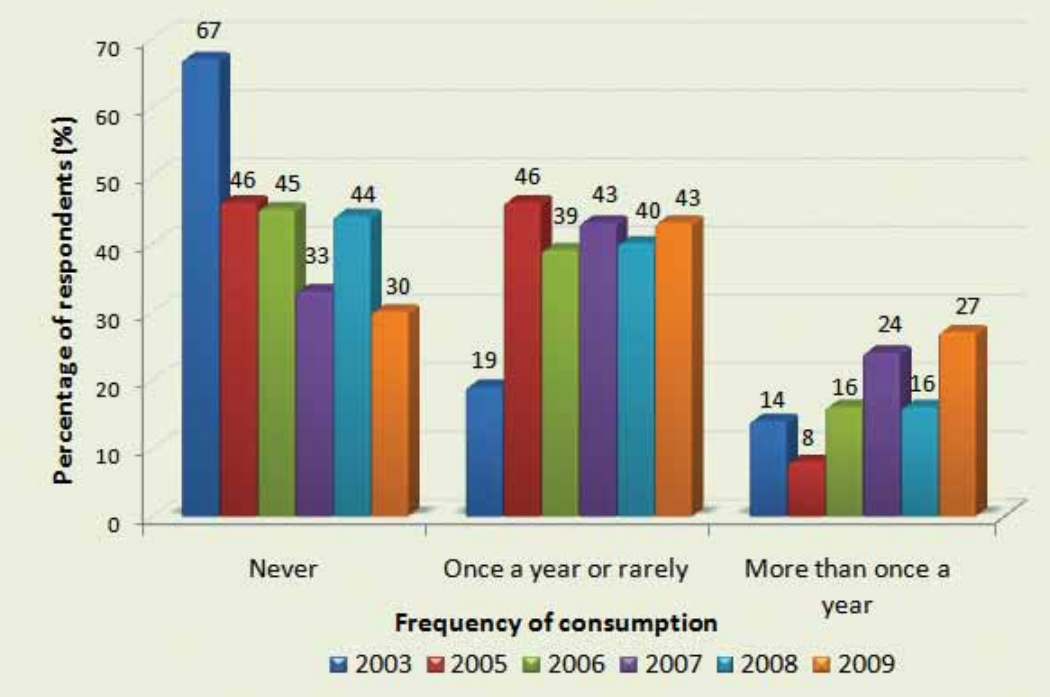
UMCA has created various models to aid in financial decisions and budgeting when implementing agroforestry practices. The models include various questions about a practitioner's plans for the practice, and then give different outputs to aid in decisions, including the "annual equivalent value," which compares the value of an agroforestry practice to planting annual crops, for example. Models have been completed on black walnut; chestnut, pine straw and others are in the works.

IMPACT OF MISSOURI CHESTNUT ROAST

In 2009, UMCA researchers administered the first "after event survey." The survey evaluated Missouri Chestnut Roast participants' experience with the festival, evaluated the festival impact on participants' behavior and revealed participants' awareness about chestnuts and other nuts, agroforestry and agritourism in the region.

Among the findings:

- First-time visitors drove farther to attend.
- Participants spent an average of two hours at the festival.
- Attendees spent an average of $25 at the event.
- Friends and family, MU e-mail, and the local Columbia Daily Tribune were the most influential advertising channels.
- 85 percent rated their overall experience at the festival "good" or "excellent."
- Samples of roasted chestnuts were rated the highest attraction.
- 90 percent would recommend the festival to others.
- The Roast had an impact on the behavior of participants in terms of buying more Missouri specialty products; increasing potential of agroforestry adoption (for people who own land); and increasing potential of agritourism in the region.



Impact of Missouri Chestnut Roast on frequency of chestnut consumption over time.

UMCA hosts international conference

Agroforestry promotes tree/shrub/crop/animal land use practices incorporating "Four I's": intentional, intensive, interactive, integrated. The 11th North American Agroforestry Conference, which the University of Missouri Center for Agroforestry hosted in 2009, added one more "I" to the mix – innovative. The conference showcased the diverse ways people across this country, continent and planet put the science of agroforestry into practice.

And that's the way it was meant to be – "Putting Science into Practice" was the theme of this biennial meet-up, held May 31-June 3, at Stoney Creek Inn, Columbia, Mo. A highlight was the four talks – including two keynotes – given by landowners who truly are putting science into practice. Attendees heard from Nicola MacPherson, owner and operator of Ozark Forest Mushrooms, Timber, Mo. In addition, Chris and Jennifer Cunningham, Jay Springs Lamb Company, Pinantan, British Columbia, Canada, spoke about their silvopasture practice and innovative marketing featuring grass-fed, free-range lamb.

At the Monday night landowner show-and-tell, three others shared the secrets of their enterprises – Terry Durham of Eridu Farms, Hartsburg, Mo., and Penny and George Frazier, Goods from the Woods, Salem, Mo. Durham provides locally adapted cultivars of elderberry to Midwest growers and bottles the juice from his own production. The Fraziers harvest natural plants, fruits, nuts and other "goods from the woods" sustainably on their land, creating a variety of innovative value-added products.

Pre- and post-conference field trips brought some of the attendees to the farms or stores of these innovative landowners. In addition, the group visited Shepherd Farms, which combines pecan trees, eastern gammagrass seed production and buffalo. Field trips also included tours of University of Missouri farms and Jefferson Farm and Gardens educational facility, Columbia, Mo.

Back at the Stoney Creek Inn, researchers from across the globe gave oral and poster presentations on a wide variety of topics, including carbon sequestration/carbon markets, bioenergy, forest farming, agroecosystem interactions, production and management, soil and water quality, and economics and marketing.

Left: *Andy Gordon, left, professor at the University of Guelph, Ontario, Canada, presents Gene Garrett with a lifetime achievement award as Garrett's wife, Joyce, looks on.* ***Far left:*** *Mark Coggeshall, (in yellow shirt), UMCA tree improvement specialist, presents on black walnut breeding during a tour at HARC.* ***Below:*** *Harvesting oyster mushrooms at Ozark Forest Mushrooms field tour stop.*

Presentations at the Monday evening conference banquet reflected on the past, present and future of agroforestry. As part of these talks, Gene Garrett, former director of the MU Center for Agroforestry, was honored with a lifetime achievement award by the Association for Temperate Agroforestry.

As part of the conference, UMCA's Michael Gold and Michelle Hall edited and distributed the 517-page proceedings.

The conference was sponsored by the Association for Temperate Agroforestry, the MU College of Agriculture, Food and Natural Resources, U.S. Forest Service-Northern Research Station, USDA SARE, USDA CSREES, and USDA National Agroforestry Center.

During 2008 and 2009, UMCA researchers isolated more than 17 biologically active compounds from leaves and fruit of the Eastern Redcedar *(Juniperus virginiana)*, a common but invasive, low-value tree. Missouri alone has about 384 million Eastern Redcedar trees. Many of these compounds have unique, commercially significant qualities. Some of the isolated compounds have been shown to be:

**Effective against melanoma (in mice)*

**Anti-inflammatory (compare to hydrocortisone)*

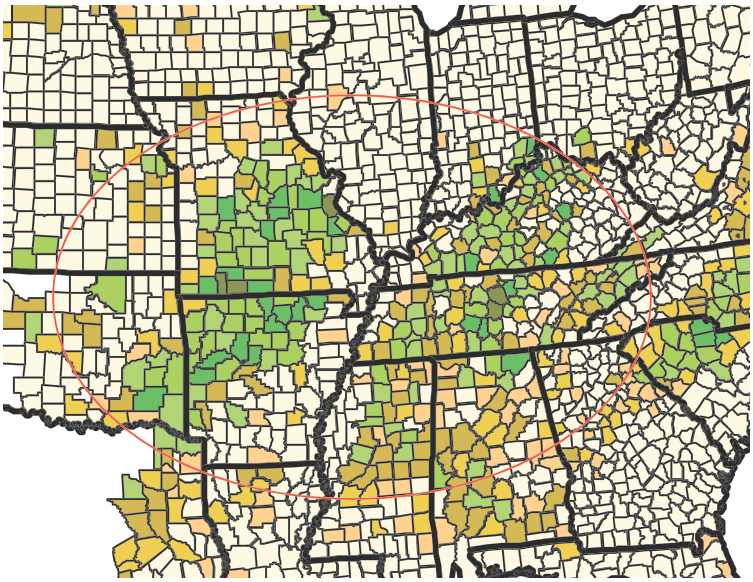
**Anti-bacterial against anthrax sporulation*

**Anti-bacterial against staph and MRSA, antibiotic-resistant staph bacteria; listeria; strep throat; chronic cough*

**Effective in fighting acne-causing bacteria*

**Melanin inhibiting (prevents sunburn, sunspots, freckles, liver spots, etc.)*

Researchers see a number of commercial applications for the compounds found in Redcedar; they believe they can be formulated into a wide variety of organic personal care products such as lotions, creams, sprays, shaving creams, ointments, wound dressings, adhesive bandages, and hand sanitizers.



The Eastern Redcedar Resource: Trees on timberland (U.S. Forest Service - FIA Data). The darker green the county is shaded, the more Eastern Redcedar trees.

Source: Lin, C.H., B.M. Thompson, H.Y. Hsieh, R.J. Kremer, R.N. Lerch, M.M. Cernusca, and M.A. Gold. 2009. Screening and testing phytochemicals in eastern redcedar (Juniperus virginiana) for Development of Potential Entrepreneurial Opportunities. In M.A. Gold and M.M. Hall (eds.). Agroforestry Comes of Age: Putting Science into Practice. Proceedings, 11th North American Agroforestry Conference. 109-114.

UMCA looks to future with biofuel

The University of Missouri Center for Agroforestry has recognized since its inception the need for research on biofuel as the country works to limit its dependence on fossil fuels. In 1998, cottonwood clonal trial studies began at HARC to evaluate growth response and biomass production. The study aims to determine if cottonwood could work in agroforestry plantings such as buffers, while concurrently creating a biomass industry.

This research was certainly timely and now, with numerous biomass power generation facilities under construction or consideration across the state – including an upgrade of the MU Power Plant to handle greater use of lower-cost, renewable fuels, such as biomass – UMCA is pleased to be expanding its efforts in terms of research and collaboration in the bioenergy field.

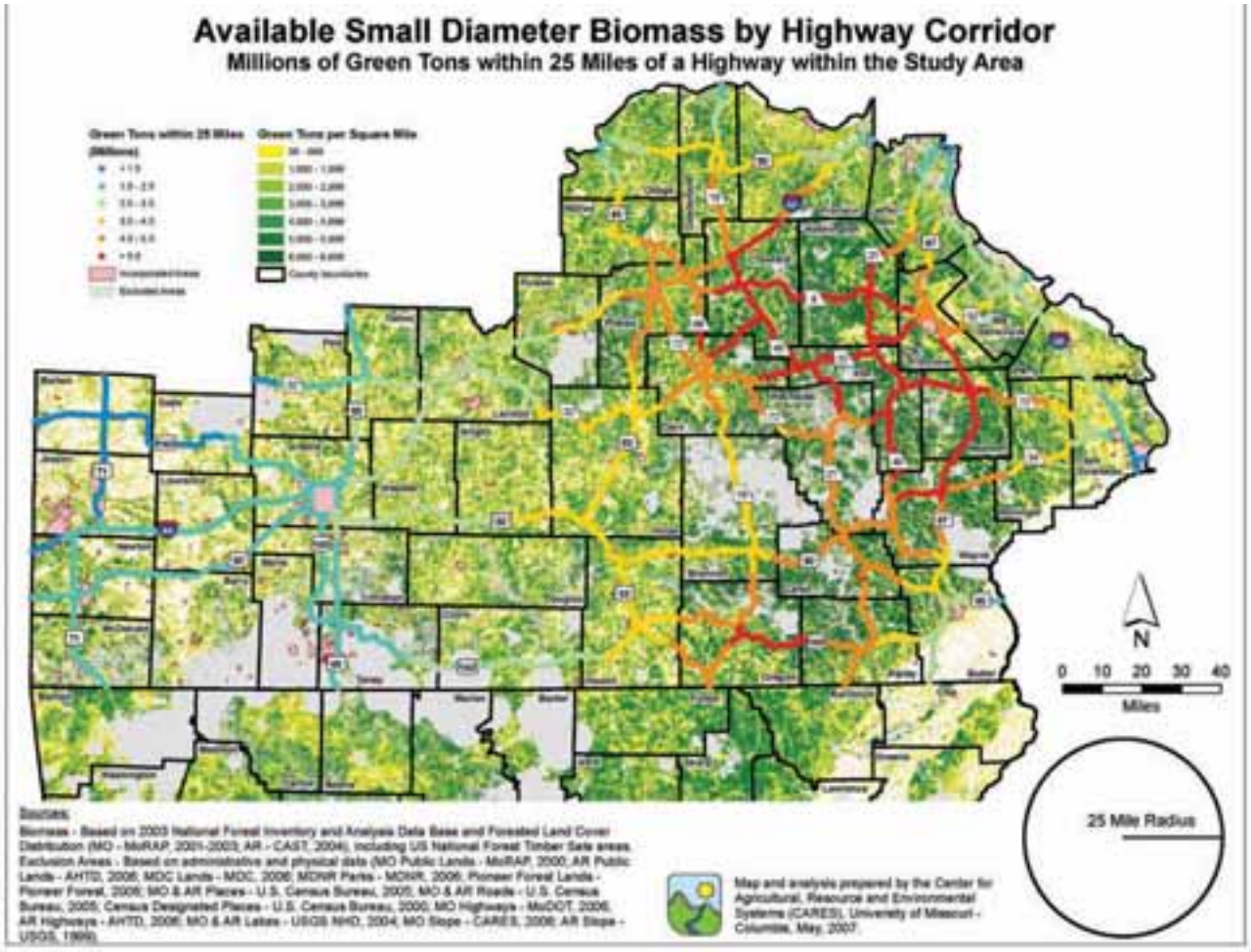
Work with Dr. Hank Stelzer, MU Extension Forester, gauges the resources already available in the state through biomass spatial analysis. Sweet sorghum is another promising biofuel crop that can be grown on drier sites not suitable for corn production and, UMCA researchers hope, on sites prone to periodic flooding or waterlogging. Collaborative research with the Dale Bumpers Small Farms Research Center, Booneville, Ark., looks to see if sugarcane can be selected for cold tolerance north of its presumed range limit. Finally, research supervised by Francisco Aguilar, UMCA collaborator, looks at the economic feasibility of woody biomass harvesting.

UMCA is committed to the future of biomass research. The Center will soon fill a postdoctoral research associate position in Biomass Feedstock Production Systems. In addition, UMCA officials are looking to create a network of researchers and others interested in biofuel across the state.

Whether aiming to make the most of biomass opportunities already in place in the region, or forging ahead researching the best possible crops to turn marginal or multi-use agricultural fields into dedicated energy plantations, UMCA is proud to be addressing head-on an area of such importance to the future of agriculture and U.S. energy independence.

SPATIAL ANALYSIS OF WOODY BIOMASS FOR BIOENERGY PRODUCTION IN MISSOURI

Before regional economic and environmental impacts from combining renewable energy production and sustained forest management can be assessed, one must first be able to spatially determine how much woody biomass is located where and its potential availability. Supported by a $50,000 grant from the Missouri Forest Foundation, Dr. Hank Stelzer, MU Extension Forester, in collaboration with the MU Center for Applied Research and Environmental Systems (CARES) developed an interactive, online geographical information database. This user-friendly spatial analysis tool allows potential bioenergy entrepreneurs, community leaders, and policy makers to develop customized reports that will not only provide them with available woody biomass information, but also information on relative harvesting pressure within their area of interest and community resource data. Dr. Stelzer used the tool to identify three communities in the Missouri Ozarks for potential bioenergy development and was awarded a $44,000 USDA Forest Service Jump-Start Energy grant



to facilitate a series of town hall meetings to build community and regional wood-to-energy partnerships. One partnership developed from those town hall meetings was recently awarded a "Fuels for Schools" woody biomass grant funded through The American Recovery and Reinvestment Act (ARRA). Efforts are underway to expand the spatial analysis tool statewide and incorporate options that will allow the user to query the database with regard to ownership, slope and actual transport haul time.

COTTONWOOD CLONAL TRIAL/FLOOD TOLERANCE EVALUATION

Eastern cottonwood *(Populus deltoides)* is a fast-growing, "soft" hardwood tree used to produce biomass. In 1998 a cottonwood clonal screening trial, containing 70 clones, was established at HARC to evaluate cultivars for their growth response and adaptability to Missouri conditions, allowing researchers to identify the best cottonwood cultivars for agroforestry plantings.

Researchers have found differences in biomass production per tree between clones. The next step will be to install a larger field study with the cottonwood clones and other species showing potential for biomass energy.

The identification of cottonwood or cottonwood hybrid clones for woody biomass production is an important step in meeting Missouri's need for energy independence. The use of cottonwood for combustion, heat and power is one step closer to reality, according to researcher John Dwyer.

SWEET SORGHUM RESEARCH

Sweet sorghum has the potential to contribute significantly as a feedstock for renewable fuel pro-

duction. Unlike starch-based biofuels such as corn, no fermentive pretreatment is required to produce the substrates (such as glucose, sucrose, fructose) for ethanol production. Further, large quantities of biomass are produced that also could contribute to renewable fuel production. In addition, one of the primary advantages of sweet sorghum is its tolerance of poor site conditions. It can be grown on drier sites not suitable for corn production, and, researchers hope, on sites prone to periodic flooding or waterlogging.

UMCA researchers Drs. Felix Fritschi and James Houx planted 12 varieties of sweet sorghum at two planting dates in the summer of 2008. Although data is still being analyzed, sweet sorghum did not appear to be impacted by flooding, as no plants died during or following flooding. Larger plants from the first planting date appeared to be less impacted than smaller ones.

SUGARCANE RANGE

David Burner of the Dale Bumpers Small Farms Research Center, Booneville, Ark., as part of the MU Center for Agroforestry's Collaborative Agreement with the ARS, has been working with diverse biofuel grasses.

Sugarcane is any of a variety of species of tall perennial grasses of the genus *Saccharum*. Native to warm temperate to tropical regions of Asia, they have stout, jointed, fibrous stalks that are rich in sugar, and measure 6 to 19 feet tall. All sugar cane species interbreed, and the major commercial cultivars are complex hybrids.

Sugarcane, for one, has high yield potential although much of Arkansas and all of Missouri fall out of the northern limit above which cane crops do not mature or fail to stubble. Researchers want to see if sugarcane can be selected for stubble cold tolerance north of this presumed range limit.

Stubble cold tolerance, which refers to the ability of plants to regrow after overwintering, depends on genetics and environment.

Researchers have found numerous sugarcane clones that have shown stubble cold tolerance; selection is needed for stubble longevity and yield. The best sites might have deep soil and irrigation, such as in delta, or riverbank, areas. So far, researchers think range expansion of cane is possible.

Up next is testing the second stubble in 2010 – 110 progeny advanced after first stubble, about 20 percent.

Other components of the UMCA's ARS research plan involving biomass include bamboo establishment from rhizomes; sugar partitioning in gammagrass and switchgrass stems; and effect of annual, perennial herbaceous and woody biofuel cropping systems on productivity and soil nutrients across a latitudinal gradient.

ECONOMIC ANALYSIS OF WOODY BIOMASS HARVESTING IN THE MISSOURI OZARKS

This study was initiated to investigate the productivity and economic feasibility of a fully mechanized integrated harvest system that collects solid hardwood products and low-quality hardwoods converted to fuel chips for biomass energy needs.

This research was conducted by MU master's student Adam M. Saunders under adviser and UMCA collaborator Dr. Francisco Aguilar; results are preliminary.

An integrated mechanized timber harvest thinning treatment to remove small diameter trees and merchantable saw logs was conducted on 30 acres of the Missouri Ozarks in summer 2009. Two silvicultural treatments (single tree selection and shelterwood strips) were applied to reduce basal area to different levels. A harvest system feasibility analysis was completed to estimate productivity, costs and prices needed to attain economic viability (break-even point). Time in motion data was collected on all system components to understand how the extra efforts to gather small diameter and slash material affects the cost structure of a mechanized timber harvest thinning. A sensitivity analysis was conducted to find break-even points at varying diesel input costs, equipment purchase costs, hauling distances, stumpage prices, and government production subsidy.

Results indicate that an average of 15.50 tons of fuel chips and 35.72 tons of solid hardwood products was removed per acre. The cost per ton to harvest, skid and process at road side for the fuel chips and solid hardwood products was $19.20 per ton and $11.17 per ton respectively. Contracted fuel chip

hauling cost $12 per ton and solid hardwood hauling averaged $4.16 per ton. Stumpage was assumed to be $5 and $9.95 per ton respectively. Average observed prices at the gate for these two products were $26 per ton and $32.64 per ton leading to a profit/loss of $-10.20 per ton and $7.36 per ton for the fuel chips and solid hardwood products respectively.

Future research will better understand the economic feasibility of harvesting both solid hardwood products and fuel chips. Future harvest studies need to test different equipment options and be conducted on sites with different characteristics. For example, this study site had limited slope, which is not representative of the majority of the Ozarks forest. It would be useful for future economic feasibility harvests to occur on sites with a greater percent slope to better understand how this variable affects operational efficiency.

In addition, operating in a younger, more densely stocked stand would also be preferred in the next study harvest. These sites are in the greatest need of management due to overcrowding and are difficult to thin profitably because the average tree size is small. A small percent of the revenues from thinning these stands will be derived from solid hardwood products; a majority will come from pole size trees between 3 and 8 inches at breast height (4.5 feet off the ground) and will be processed into fuel chips.

Finally, the concept of arranging thinnings in long narrow strips should be further explored. Approaching a harvest in this manner makes it more difficult in terms of research because the exact area of treated forest would not be uniform between strips and the area would not be known prior to harvest layout. However, this approach would be more similar to the thought process that a forester or logger would go through when planning a timber harvest and thus be more useful to foresters and loggers wanting to utilize this harvest method for production purposes.

Fuel chip markets are unbalanced between buyers and sellers, giving the buyers considerable market power. Buyers are able to keep raw product prices low which limit the feasibility of harvesting fuel chips. An increase in competition between buyers will likely elevate fuel chip prices and result in more logging operations making the additional efforts to harvest fuel chips. As indicated by this study harvest, fuel chip prices will need to be in the 28 to 38 dollars per ton range with short hauling distances for logging operations to break even on their efforts.

TREES AS ODOR BARRIERS

UMCA researchers are working to see if a three-row vegetative environmental buffer (VEB) design around a confined animal feeding operation facility can diminish odor.

Air sampling in a one-mile radius around a north Missouri facility began in 2008, and is ongoing. Samples are taken four to six times each season at various locations, including intervals of distances downwind from the buffer.

VEBs stop odor in various ways

- *Particles adhere to leaves*
- *Particles absorb into leaves*
- *Foliage alters air currents to dilute odor*

So far, 25 major volatiles have been confirmed and quantified, the most comprehensive testing ever performed on the practice. All are malodorous and some are confirmed health hazards. Research shows most of the volatiles drop out, or are significantly reduced in concentration, over very short distances. Much impact has yet to even be gauged, as the trees and shrubs are still young and the area is still mostly open.

Finally, researchers are working with modeling software to simulate the dispersion of the odorous pollutants.

With a better understanding of the impact on the movement of odor-causing volatiles, researchers believe newly designed VEB technologies will benefit farms with confined animal feeding operations.

NUT TREES

UMCA's nut cluster features research on pecan, black walnut and chestnut, including field studies, market and consumer research, financial decision modeling 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 proven orchard management techniques are essential. Studies also include those on fertilizer, pests, grafting techniques, applied breeding and, in collaboration with the socio/economic/marketing research cluster, characteristics of a marketable nut.

CHESTNUT

In 2010, researchers will take on a variety of projects, including determining the effect of moisture levels in the growing media on whip and tongue grafting success of Chinese chestnut seedlings.

As trees come into commercial production and yields increase, some cultivars including Orrin, Willamette, Simpson, Layeroka and Shing, have shown a major decrease in nut size.

In 2009, researchers focused on a number of aspects, including:

Spacing and Pruning. Plantings with various tree spacing and pruning techniques have been established to determine effects of pruning on nut yield, size and quality. Good early nut yield and nut size in a tight spacing of 4 x 8 meters for open center-pruned Qing trees show promise.

Low-Cost Harvesting Equipment. Chestnut producers have identified the high cost and scarce availability of labor during the harvest season as major limitations to profitable production of chestnuts. While most producers are hand-harvesting chestnuts with the aid of a "nut wizard," UMCA researchers are currently modifying an inexpensive commercially available paddock vacuum to reduce chestnut harvest costs. Preliminary results indicate pick-up time of nuts can be reduced by 50 percent with the paddock vacuum as compared to a nut wizard. Further work on improving efficiency of nut sorting and an economic analysis of the vacuum for the mechanical harvest of chestnut trees is in progress.

Bur and Nut Production. More than 65 chestnut cultivars are being evaluated at HARC, but not

A CHESTNUT TASTE TEST

In October 2009, as part of a UMCA study, expert food scientists tested the texture and flavor of various chestnut cultivars, including Peach, Eaton, Qing, Auburn Homestead, Colossal (from three locations around the country), Bouche de Betizac, and Marrone di Castel del Rio. Descriptive sensory terms were identified – data analysis is in progress.

all trees bear nuts at an early age. UMCA researchers have recently identified characteristics associated with early bearing trees with good productivity. Early fruiting and sustained yields occur on trees with shoots that have the capacity to produce a high percentage of primary flowers and/or primary and secondary flowers in consecutive years. These results will guide producers in selecting cultivars for planting. In related studies, it was found removal of chestnut burs produced in late July resulted in larger nut size at harvest and enhanced nut production in the following growing season. Future studies will work towards development of cost-efficient methods for removing secondary burs produced in July.

Chestnut Weevil. UMCA researchers are aiming to establish an integrated pest management strategy for chestnut weevil, the most important economic pest of chestnut in the U.S. Studies are looking to see what makes chestnut weevils so host specific – what makes a chestnut attract a weevil?

Researchers have found obvious differences in response to plant tissue volatiles based on the season insects were collected. Anatomical differences were also noted in the insects; researchers hypothesize adult weevils are active in the spring to feed on catkins, which provide a required nutritional element for reproductive system development. This hypothesis will be tested further in 2010.

Further work also will look to evaluate adult weevil physiological responses to chestnut volatiles via a new approach – electroantennagraphy.

PECAN

In 2006, 2008 and 2009, nut phenological descriptions of 10 pecan cultivars were collected at HARC and at Chetopa, Kan. Data will be evaluated to determine how pecan cultivars adapt and compensate to differing latitude and climatic variation, such as growing season length.

In addition, pecan nut casebearer *(Acrobasis nuxvorella)* and pecan weevil *(Curculio caryae)* were collected at HARC and Brunswick, Mo., and sent to Texas A&M for genetic diversity testing based on provenance research. Data from HARC on the two pecan pests were inputted onto the Beltwide Pecan

IPM PIPE Web site for area pecan growers to use as a tool in making decisions on whether and when to use insecticidal sprays.

2010 is anticipated to be a good year for pecan production; researchers hope data collected will help solidify cultivar recommendations for northern latitude pecan.

BLACK WALNUT

Conversion of Older Orchards by Grafting to Improved Cultivars. The feasibility, practicality and profitability of converting a mature ungrafted seedling-derived black walnut orchard to a grafted, productive orchard of improved nut-producing cultivars are unknown. Grafting onto large, established rootstocks should be feasible and inexpensive, but will require diligent care and training until healed (about five years post-grafting). Grafting onto mature rootstocks also should result in very rapid growth of scions with significant nut production likely within five years. However, the chief drawback is the potential weakness and long-term healing of the graft union. This study was initiated in May 2009 using a 20-year-old orchard on an excellent site at Hammons' Sho-Neff plantation. Fifty-six trees were grafted at various heights, with an equal number of control (ungrafted) trees maintained. Initial graft success was 97 percent.

Wild black walnuts, on average, have 7 to 10 percent nutmeat. Improved cultivars typically yield about 30 percent.

Chilling Requirements. Black walnut trees require a number of chilling hours within a specific range of temperatures to produce shoots, flowers and nuts. When too few chilling hours occur, growth and yield

are reduced. Trees that receive enough chilling hours in February or March are susceptible to spring frost injury. UMCA researchers have determined the number of chilling hours required for 20 walnut cultivars and developed a model to predict the susceptibility of walnut trees to frost based on annual temperatures. This information will be used to aid producers in selecting cultivars best adapted to their planting site and avoiding crop loss due to spring frosts.

Source: Warmund, M.R., M.V. Coggeshall, and W.T. Stamps. 2009. Rest completion of eastern black walnut. J. Amer. Pomol. Soc. 63 (2):42-50.

Ambers. Ambers (see photo below), characterized by dark brown shriveled kernels, have been a major limiting factor in marketable yield. In some years, 68 percent of the black walnuts on a tree can be lost due to ambers. Researchers are currently identifying cultivars that are the most resistant and susceptible to ambers and are isolating microbes associated with affected kernels. Control strategies will be developed to ensure profitable black walnut production.

Applied Breeding Program. The black walnut applied breeding program at HARC is evaluating the progeny of controlled crosses between the best available cultivars to determine if the second generation combines the parents' best traits. In 2009, scionwood from the best performing control-pollinated individuals (38 crosses and nine parents) were grafted and will be planted at HARC, the MU Southwest Center and at Sho-Neff (Hammons Products Inc.) in spring 2010.

To gain greater insight into the effect of rootstock origins on cultivar performance, 13,300 open-pollinated nuts representing the 12 most common black walnut cultivars grown in Missouri have been sown in the nursery at HARC. They will be used as a source of understocks beginning in spring 2010. One popular cultivar will be grafted onto the 12 different rootstock sources and planted in 2011 on at least two sites in Missouri.

In another black walnut rootstock study, the cultivar 'Surprise' has outperformed all of the cultivars across all rootstock sources in nut productivity at two sites at age 5.

Up next, to move toward an advanced breeding program, researchers are creating a new black walnut trellis orchard with the new generation of promising crosses. (See image of current trellis below.)

Another future black walnut study will look at Thousand Cankers disease, currently killing black walnut west of the Rockies and a new concern in the Midwestern U.S. The walnut twig beetle *(Pithyophthorus juglandis)* and associated fungus *(Geosmithia morbida)* work in concert – the beetle opening the pathway and the fungus colonizing the inner bark and forming small cankers at each entry point. Cankers eventually clog the phloem and kill the tree.

RIPARIAN FOREST & UPLAND BUFFERS

Riparian forest and upland buffers are an important agroforestry practice that protects water quality by slowing surface runoff, improving infiltration, reducing sediment transport, removing nonpoint source pollutants, stabilizing streambanks, increasing diverse food and cover for upland wildlife, improving aquatic habitats for fish and other organisms and enhancing opportunities to generate farm income through products harvested from the buffer. The Iowa State University Agroecology Issue Team has been working closely with the University of Missouri Center for Agroforestry for the past 10 years to evaluate the performance of riparian and upland forest buffers and develop management plans to maintain the benefits of the buffer over time. The USDA National Agroforestry Center has created "Conservation Buffers: Design Guidelines for Buffers, Corridors and Greenways," to help in buffer planning and design, http://www.unl.edu/nac/bufferguidelines

ISU RIPARIAN FOREST BUFFER RESEARCH

The goal of much of the UMCA-supported work of Iowa State University scientists in northeast Missouri is to determine if the density of present "natural" forest buffers or constructed buffer ground cover is sufficient to slow and diffuse concentrated flow and/or if grass filters upslope of the narrow riparian forest buffers are necessary to aid in providing that function.

Research highlights the importance of minimizing cattle access and preventing gullies in buffer areas. In addition, findings show conservation practices can be very effective in reducing stream bank erosion, but proper placement throughout the watershed determine their level of effectiveness.

In 2009, researchers noted a highly significant seasonal effect – the time of the year is very important to the efficacy of buffers, contaminant flux and erosion. Ongoing studies continue to improve our understanding of the systems' dynamics. For example, highest nitrate-nitrogen concentrations occur in the spring when subsurface drain tiles are most active at the top of the watershed.

Gullies. Researchers are in the process of characterizing and mapping gullies to determine the factors that influence their development. Characteristics measured include soil type, slope, volume and land use.

Gullies that cut through buffers can deliver surface runoff and pollutants to streams. Previous ISU research has shown forest buffers with less tree density and more ground cover result in more effective buffering of runoff by preventing the creation of deep gullies.

Social Factors. ISU researchers are beginning to look at the social factors that go into the adoption of conservation practices, specifically along a watershed in southeast Iowa. Previous studies have been hard pressed to find variables that

RIPARIAN FOREST & UPLAND BUFFERS

UMCA researchers are adding poplar to the list of possible species to aid in degradation of munitions explosives, in addition to grasses, such as warm-season switchgrass and eastern gammagrass.

always predict adoption of conservation practices.

The ISU team is conducting interviews with farmers/landowners, citizens involved in the restoration of the watershed, and public officials, to form a case study of the watershed. They predict people with strong relations with NRCS agents, strong environmental attitudes and knowledge who are involved in the community are most likely to adopt conservation practices.

Revisiting Buffers. Many buffers in the ISU primary study area, the Bear Creek Watershed, have not been revisited in many years. Work will begin in 2010 to analyze soil quality parameters, including carbon dynamics, microbial biomass and infiltration. Many sites have previously been sampled, allowing for a direct assessment of changes over time.

UMCA UPLAND BUFFER RESEARCH

Research focus is to quantify environmental benefits of agroforestry (tree/grass) and grass buffers on non-point source pollutants. *Recent findings include:*

- Researchers have found, on average, that the two buffer treatments produced only 30 percent and 59 percent of runoff of the control treatment, respectively. Control watersheds without buffers lost 36 percent more soil than the average for watersheds with agroforestry and grass buffers. The control treatment lost 4 and 3.2 times more total nitrogen than the agroforestry and grass buffer treatments, respectively.
- Trees and undisturbed grass buffer vegetation improve infiltration and water holding capacity of soils.
- Buffers with trees seem to be more effective than grass alone, probably due to improved soil properties and greater resistance to surface flow.
- Fifteen meter-wide buffers effectively controlled runoff during years with above-normal precipitation.
- Although large runoff events trigger significant amounts of non-point source pollution within watersheds, smaller events that occur more frequently account for a greater proportion of total nutrient loss than the infrequent large events. A well established buffer, including upland buffers, is essential to control non-point

***Top:** A buffer keeps cropland run-off from reaching an adjacent stream. **Bottom:** Products like curly willow can be grown in a buffer area and sold to floral shops, for example, making the buffer not only environmentally friendly, but budget friendly as well.*

source pollution in runoff from more frequent small events and infrequent large events.

Antibiotics and Herbicides. Researchers are working to determine the optimal tree and grass buffer design to reduce contaminant transport by establishing design criteria and determining seasonal effectiveness of different buffers. It appears buffers' effectiveness is increased up to four meters in width; in wider buffers the benefits diminish. In addition, tall fescue appears to work well as a buffer in addition to being easy to maintain.

Finally, research shows buffers trap the contaminants when dissolved, as well as when in sediment.

Root Length Density. One of the main environmental benefits of growing trees near agricultural crops is to capture nutrients, lost from the crop root zone, by the extensive deep root system of perennial vegetation. Tree roots and the roots of perennial warm-season (prairie) grasses penetrate deeper into the soil than roots of annual crops. The extensive deep root system of the trees and warm-season grasses intercept percolating nutrients; thereby reducing the impact on soil and water quality. UMCA researchers are looking at the differences in root length density and root and soil carbon content within buffers and grazed pastures. Agroforestry buffers had the highest root lengths, followed by grass buffers. Rotational grazed and continuously grazed buffers had the lowest root lengths. Tree and perennial grass root systems extract water and nutrients from deeper in the soil profile. Root carbon content also was higher in buffer zones – a measure of improved soil structure.

Dissolved Organic Carbon. UMCA research on soil organic matter content is ongoing. Preliminary results suggest vegetative buffers significantly increase soil carbon concentrations in surface soils relative to no-till managed cropland. Spectroscopic studies of soil organic matter also indicate changes in the chemistry – quality – of organic matter in soil planted to vegetative buffers as compared to cropland. Cumulatively, this research will provide scientists and the public with a better understanding of changes in soil organic matter as influenced by land management practices and how land management practices can provide essential ecosystem services.

A look at the artificial rainfall simulation at UMCA's buffers and antibiotics study site, MU Bradford Farm, Columbia, Mo.

BayerCrop Science has changed their label worldwide for the herbicide isoxaflutole (Merlin®) based on recent research findings by UMCA researcher Chung-Ho Lin. Bayer now recommends not mixing isoxaflutole with water containing high levels of chlorine, or its efficacy may be reduced. The utilization of metabolite profiling through tandem mass spectrometry in one of Lin's projects led to the discovery of the rapid degradation of herbicide Balance™ (isoxaflutole) to an inactive form by hypochlorite ions in tap water. Several stable chlorinated by-products also were first identified and characterized from this work.

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. For example, scientific theory suggests a more diverse plant community supports a more diverse insect community, with the side benefit of reducing pest insects. The UMCA Tree/Crop Interactions project team is examining various aspects of the impact of alley cropping on crop yield and predator/prey pest dynamics.

PROMOTING BENEFICIAL INSECTS

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

The studies have found using winter annual crops that do not compete with the trees, as summer crops do, is key. The economics of growing winter wheat (see photo below right) and canola suggest both can be grown with high profitability in wide or narrow alleyways, and that alley cropped winter crops can equal the profitability of traditionally grown winter crops or high-value forages such as alfalfa. In all studies, results show a common positive response by insects to the practice of alley cropping and not a response predicated on the individual plant or practice design.

Up next:

- Looking at the effects of orchard management on pollinators – an important topic with the recent honey bee colony collapse.
- Investigating the use of electromagnetic radiation as a non-toxic post-harvest pest control method for nut pests.

POVERTY GRASS IN NEUTRAL SHADE

Poverty grass *(Danthonia spicata)* is a native grass frequently found on poor soils in semi-open woodlands and prairies. Researchers want to see if it could work as a turf grass in degraded soils managed without irrigation and fertilizer. Seed from several Missouri sources are being evaluated for their shade tolerance.

Significant differences were found among four seed sources for percentage of plants flowering during the first growing season and average plant dry weight.

Plants under sunlight looked to have the highest forage yields; however yields for plants under 50 to 80 percent of full sunlight were seldom statistically different. Forage yields markedly declined under 20 percent full sunlight, the light levels in closed woodlands.

Additional 2009 findings in Tree/Crop Interactions research cluster:

- Tree saplings planted within a mix of warm-season grasses tended to have significantly less deer and rodent damage than saplings in plots without warm-season grasses.
- Studies looked at native grasses as living mulches when establishing walnut, pecan and oak seedlings – to keep from having to use mechanical or chemical weed control. Vegetation surveys in summer 2008 and 2009 showed percent cover of the native grasses was the greatest for Virginia wildrye, followed by river oats, and then cluster fescue.

Silvopastoral management creates an environment where trees, forage and livestock work together and can be developed to their full economic potential. Numerous greenhouse, field and pasture studies show silvopastures can be productive complements to traditional rotationally grazed 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 combining rotationally grazed open pasture with rotationally grazed silvopasture into an overall production system.

Researchers are working to develop silvopasture systems landowners can easily implement and profitably use to produce livestock products and high-quality forest products simultaneously.

A new study will be implemented at three locations: HARC, New Franklin, Mo.; MU Southwest Center, Mt. Vernon, Mo.; and Dale Bumpers Small Farms Research Center, Booneville, Ark. The treatments will include a traditional open pasture and an integrated silvopasture, with 25 percent silvopasture and 75 percent open pasture. Cow/calf pairs will be grazed in a year round system with silvopastures grazed at strategic times to benefit livestock. Pine trees range in size from newly planted to 14 years.

Data collected will include seasonal forage growth and nutritive value; tree growth; pasture utilization; and livestock performance including calf birth and weaning weights, cow conception rates, annual carrying capacity, cow body condition, calving ease, and annual feed costs.

Above: *The 11th NAAC tour group views the pine silvopasture area at HARC.* ***Right:*** *MU's Wurdack Farm will soon have one of the most comprehensive silvopasture demonstration areas in the state, with both pine and hardwood silvopasture practices in use.*

HORTICULTURE

TRUFFLE

UMCA researchers are the first to isolate and identify the bacterial populations of the Burgundy truffle – bacteria are thought to play a role in truffle production. A key 2010 activity will determine whether nitrogen-fixing bacteria occur within Burgundy truffle mycorrhizae. Studies are ongoing to determine if seedlings should be co-inoculated with selected bacterial strains, along with the truffle fungus itself.

Mycorrhizal fungi form symbiotic associations between the fungus and the roots of a plant.

Field studies continue to maintain and monitor truffieres. Periodic searches are made using a trained dog. Though fruiting has not been detected yet, truffle fungus mycorrhizae continue to survive in the field.

Other studies are looking to refine the liming and irrigation strategy and determine root colonization efficiency.

MOREL

Monitoring of natural morel fruiting at the Horticulture and Agroforestry Research Center continued in 2009, with the goal of characterizing environmental conditions which trigger fruiting and/or govern fruiting intensity. Data from 10 years of monitoring will be used to model morel fruiting patterns.

ELDERBERRY

Two locally adapted (Mo., Kan., Ark., and Okla.) cultivars, Wyldewood and Bob Gordon, will be released in 2010.

Collaborative research on elderberry has shown initial promise in preventing and/or treating prostate cancer by inhibiting a pathway that may eventually lead to cancer. Elderberry fruit or juice could potentially offer a cheap and effective alternative to cyclopamine for cancer therapies, and/or serve as a second-generation inhibitor, if resistance is found to the first-generation drugs currently in clinical trials.

The study is being conducted by researchers with the MU Departments of Biochemistry, Veterinary Pathobiology, and Animal Science; the MU Center for Phytochemical and Phytonutrient Studies; Northwest A&F University, China; and University of Yucatan, Mexico. Andy Thomas, MU Southwest Center, an associate faculty member of the MU Center for Agroforestry, is also an investigator on the study.

Refereed

Aguilar, F.X., M.M. Cernusca, and M.A. Gold. 2009. Exploratory assessment of consumer preferences for chestnut attributes in Missouri. HortTechnology 19(1):216-223.

Anderson, S.H., R.P. Udawatta, T. Seobi, and H.E. Garrett. 2009. Soil water content and infiltration in agroforestry buffer strips. Agrofor. Syst. 75:5-16.

Angima, S.D., R.L. Kallenbach, and W.W. Riggs. 2009. Forage yield of selected cool-season grasses in response to varying rates of nitrogen. Online. Forage and Grazinglands doi:10.1094/FG-2009-0129-01-RS.

Angima, S.D., R.L. Kallenbach, and W.W. Riggs. 2009. Optimizing hay yield under lower nitrogen rates for selected warm-season forages. J. Integrative Biosci. 7:1-6.

Arbuckle, J.G., C. Valdivia, A. Raedeke, J. Green, and J.S. Rikoon, 2009. Non-operator landowner interest in agroforestry practices in two Missouri watersheds. Agroforestry Systems 75:73-82.

Bailey, N.J., P.P. Motavalli, R.P. Udawatta, and K.O. Nelson. 2009. Soil CO2 emissions in agricultural watershed with agroforestry and grass contour buffer strips. Agrof. Syst. 77: 143-158.

Brauer, D., A. Ares, and A. Thomas. 2009. Cultivars of eastern black walnut trees *(Juglans nigra L.)* have greater nut yields than native trees at similar trunk cross-sectional areas. Journal of the American Pomological Society 63(2):42-50.

Bruhn, J.N., J.D. Mihail, and J.B. Pickens. 2009. Forest farming of shiitake mushrooms: An integrated evaluation of management practices. Bioresource Technology 100:6472-6480.

Bruhn, J.N., and J.D. Mihail. 2009. Forest farming of shiitake mushrooms: Aspects of forced fruiting. Bioresource Technology 100:5973-5978.

Hagan D., S. Jose, M. Thetford, and K. Bohn. 2009. Production physiology of three native shrubs interplanted in a young longleaf pine plantation. Agroforestry Systems 76:283-294

Jose, S. 2009. Agroforestry for ecosystem services and environmental benefits: An overview. Agroforestry Systems 76:1-10.

Pruett, G.E., J.N. Bruhn, and J.D. Mihail. 2009. Greenhouse production of Burgundy truffle mycorrhizae on oak roots. New Forests 37:43-52.

Schilling, K.E., J.A. Palmer, E.A. Bettis III, P. Jacobson, R.C. Schultz and T.M. Isenhart. 2009. Vertical distribution of total carbon, nitrogen and phosphorus in riparian soils of Walnut Creek, southern Iowa. Catena doi:10.1016/j.catena.2009.02.006

Stamps, W.T., R.L. McGraw, L. Godsey, and T.L. Woods. 2009. The ecology and economics of insect pest management in nut tree alley cropping systems in the Midwestern United States. Agriculture, Ecosystems and Environment 131:4-8.

Stamps, W.T., E.A. Nelson, T.L. Woods, and M.J. Linit. 2009. Seasonal abundance and activity of ground-dwelling predators in conventionally-grown and alley cropped forages in the Midwestern United States. Journal of the Kansas Entomological Society 82:46-62.

Thomas, A.L., P.L. Byers, and M.R. Ellersieck. 2009. Productivity and characteristics of American elderberry in response to various pruning methods. HortScience 44(3):671-677.

Udawatta, R.P., R.J. Kremer, H.E. Garrett, and S.H. Anderson. 2009. Soil enzyme activities and physical properties in a watershed managed under agroforestry and row-crop system. Agric. Ecosyst. Environ. 131:98-104.

Valdivia, C., and C. Poulos. 2009. Factors affecting farm operators' interest in incorporating riparian buffers and forest farming practices in northeast and southeast Missouri. Agroforestry Systems 75:61-71.

Veum, K.S., K.W. Goyne, P.P. Motavalli, and R.P. Udawatta. 2009. Runoff and dissolved organic carbon loss from a paired-watershed study of three adjacent agricultural watersheds. Agr. Ecosyst. Environ. 130:115-122.

Warmund, M.R., M.V. Coggeshall, and W.T. Stamps. 2009. Rest completion of eastern black walnut. Journal of the American Pomological Society 63(2):64-71.

Warmund, M.R., J. Elmore, M.A. Drake, and M.D. Yates. 2009. Descriptive analysis of kernels of selected black and Persian walnut cultivars. J. Sci. Food and Agric. 89(1):117-121.

Warmund, M.R., J.E. Elmore, K. Adhikari, and S. McGraw. 2009. Descriptive sensory analysis of light, medium and dark colored kernels of black walnut cultivars. J. Sci. Food and Agric. 89:1969-1972.

Warmund, M.R., and M.V. Coggeshall. 2009. Chip budding of 'AU-Super' Chinese chestnut scions on AU-Cropper and Qing seedling rootstocks. Acta Hort. 844:115-118.

Warmund, M.R. 2009. Fertilizer applications affect foliar nitrogen, chlorophyll, shoot growth and yield of 'Qing' Chinese chestnut. Acta Hort. 844:451-456.

Zamora, D., S. Jose, J.W. Jones, and W.P. Cropper. 2009. Modeling cotton production in a pecan alleycropping system using CROPGRO. Agroforestry Systems 76:423-435.

Zamora, D., S. Jose, and K. Napolitano. 2009. Competition for 15N labeled nitrogen in a loblolly pine-cotton alleycropping system in the southern United States. Agriculture Ecosystems and Environment 131:40-50.

Books/ Chapters

In Garrett, H.E. (ed.). 2009. North American Agroforestry: An Integrated Science and Practice. 2nd Edition. Agronomy Society of America, Madison, Wis.:

Garrett, H.E., R.L. McGraw, and W.D. Walter. "Alley cropping practices." Chapter 7.

Godsey, L.D., R. Grala, S. Grado, E. Mercer, and J. Alavalapati. "Agroforestry economics and policy." Chapter 12.

PUBLICATIONS 2009

Gold, M.A., M.M. Cernusca, and L.D. Godsey. "Agroforestry product markets and marketing." Chapter 11.

Gold, M.A., and H.E. Garrett. "Agroforestry nomenclature, concepts, and practices." Chapter 3.

Jose, S., E.J. Holzmueller, and A.R. Gillespie. "Tree-crop interactions in temperate agroforestry." Chapter 4.

Millspaugh, J.J., J.H. Schulz, T.W. Mong, D. Burhans, W.D. Walter, R. Bredesen, R.D. Pritchert Jr., and D.C. Dey. "Agroforestry wildlife benefits." Chapter 10.

Schultz, R.C., R.P. Udawatta, T.M. Isenhart, J.P. Colletti, and W.W. Simpkins. "Riparian and upland buffer practices." Chapter 8.

Valdivia, C., L. Zabek, J. Arbuckle, M. Gold, and C. Flora. "Human and institutional dimensions of agroforestry." Chapter 13.

Jose, S. (ed.). 2009. Agroforestry for Commodity Production: Ecological and Social Dimensions. Springer Science, The Netherlands. 250p.

In Jose, S. (ed.). 2009. Agroforestry for Ecosystem Services and Environmental Benefits. Springer Science, The Netherlands. 266p.:

Jose, S. "Agroforestry for ecosystem services and environmental benefits: An overview."

Zamora, D., S. Jose, J.W. Jones, and W.P. Cropper. "Modeling cotton production in a pecan alleycropping system using CROPGRO."

Proceedings

In M.A. Gold and M.M. Hall (eds.). Agroforestry Comes of Age: Putting Science into Practice. Proceedings, 11th North American Agroforestry Conference. 517p.:

Aguilar F.X., M.M. Cernusca, M.A. Gold, and C. Barbieri. "Frequency of consumption and preferences for chestnuts in Missouri." 493-504.

Barbieri, C., and Valdivia, C. "Recreational multifunctionality and its implications for agroforestry." 475-484.

Barbieri C., M.M. Cernusca, M.A. Gold, and F.X. Aguilar. "Attendance motivations behind the Missouri Chestnut Roast festival." 505-512.

Berges, S.A., L.A. Schulte, T.M. Isenhart, and R.C. Schultz. "Bird species diversity in riparian buffers, row-crop fields and grazed pastures of two agriculturally dominated watersheds." 287-296.

Chu, B., K. Goyne, S.H. Anderson, R.P. Udawatta, and C.H. Lin. "Veterinary antibiotic sorption to agroforestry buffer, grass buffer and cropland soils." 31-40.

Isenhart, T.M. D-G. Kim, and R.C. Schultz. "Emission of the greenhouse gas nitrous oxide from riparian forest buffers, warm-season and cool-season grass filters, and crop fields." 143-153.

Kallenbach, R.L. "Integrating silvopastures into current forage-livestock systems." 455-461.

Knight, K.W., R.C. Schultz, C.M. Mabry, and T.M. Isenhart. "Riparian forests with and without grass filters as buffers of concentrated flow from crop fields." 365-375.

Kumar, S., S.H. Anderson, R.P. Udawatta, and R.L. Kallenbach. "Agroforestry and grass buffer influences on water infiltration for a grazed pasture system." 191-200.

Kumar, S., S.H. Anderson, and R.P. Udawatta. "CT-measured macropores as affected by agroforestry and grass buffers for grazed pasture systems." 163-172.

Lerch, R.N., C.H. Lin, and H.E. Garrett. "Utilizing vegetative buffer strips to remove dissolved and sediment-bound herbicides from surface runoff." 41-42.

Lin, C.H., B.M. Thompson, H.Y. Hsieh, R.J. Kremer, R.N. Lerch, M.M. Cernusca, and M.A. Gold. "Screening and testing phytochemicals in eastern redcedar *(Juniperus virginiana)* for development of potential entrepreneurial opportunities." 109-114.

Lin, C.H, K.W. Goyne, R.J. Kremer, R.N. Lerch, and H.E. Garrett. "Rhizodegradation of sulfamethazine and tetracycline and the associated impacts on soil microbial activities." 349-358.

Lin, C.H., B.M. Thompson, H.Y. Hsieh, R.N. Lerch, R.J. Kremer, and H.E. Garrett. "Introduction of atrazine-degrading *Pseudomonas sp.* strain ADP to enhance rhizodegradation of atrazine." 183-190.

Lin, C.H., W.D. Walter, H.E. Garrett, and R.N. Lerch. "Controlling swine odor with natural windbreak." 339-348.

Lin, C.H., B.M. Thompson, H.Y. Hsieh, R.J. Kremer, R.N. Lerch, and H.E. Garrett. "Introduction of atrazine-degrading *Pseudomonas sp.* strain ADP to enhance phytoremediation of atrazine." 183-190.

Lin, C.H, K.W. Goyne, R.J. Kremer, R.N. Lerch, A.L. Spohn, and H.E. Garrett. "Rhizodegradation of sulfamethazine and tetracycline and the associated impacts on soil microbial activities." 349-358.

Udawatta, R.P., H.E. Garrett, and R.L. Kallenbach. "Agroforestry and grass buffer effects on water quality on grazed pasture watersheds." 173-182.

Udawatta, R.P., S.H. Anderson, P.P. Motavalli, and H.E. Garrett. "Agroforestry interactions and soil water use by corn-soybean watersheds." 203-211.

Willett, C.C., S.A. Berges, R.N. Lerch, and R.C. Schultz. "Streambank erosion rates of small Missouri streams." 17-26.

Yakimenko, E., S.H. Anderson, and R.P. Udawatta. 2009. Assessment of CT-measured porosity in Russian soils using fractal dimension and lacunarity. In C.H. Dagli, et al. (eds.) Proceedings of the Artificial Neural Networks in Engineering Conference. St. Louis, Mo. ASME Press, New York. 147-155.

Zeng, Y., C.J. Gantzer, S.H. Anderson, and R.P. Udawatta. 2009. Fractal analysis of CT-measured porosity for claypan soils. In C.H. Dagli, et al. (eds.) Proceedings of the Artificial Neural Networks in Engineering Conference. St. Louis, Mo. ASME Press, New York. 115-122.

Posters

Keesey, I.W., and B.A. Barrett. 2009. Preliminary data on chestnut plant volatiles as attractants to the lesser chestnut weevil, Curculio sayi *(Coleoptera: Curculionidae)*. Entomological Society of America, North Central Branch Meeting, St. Louis, Mo. March 15-18.

Keesey, I.W., and B.A. Barrett. 2009. Identification of plant volatiles and their effect on the behavior of the lesser chestnut weevil, Curculio sayi *(Coleoptera: Curculionidae)*. Entomological Society of America, Annual Meeting, Indianapolis, Ind. Dec. 13-16.

Kovacs, M., A.O. Smith, B. Thompson, and C.H. Lin. 2009. Introduction of atrazine-degrading *Pseudomonas sp.* strain ADP to enhance phytoremediation of atrazine. Missouri Life Science Week.

Navarrete-Tindall, N.E., and J.W. Van Sambeek. 2009. Evaluating poverty grass and other native cool-season grasses for multiple uses. Lincoln University Research Symposium. Jefferson City, Mo.

Smith, A.O., M. Kovacs, B. Thompson, and C.H. Lin. 2009. Screening and evaluation of potential beneficial therapeutics found in Eastern redcedar leaves. MU Life Science Week.

Stamps, W.T., T.L. Woods, R.L. McGraw, and M.J. Linit. 2009. The ecology and economics of insect pests and biodiversity in an alley cropping system in the Midwest. North Central Branch Entomological Society of America, Annual Meeting, St. Louis, Mo.

Stamps, W.T., and T.L. Woods. 2009. Arthropod ecology and biodiversity in agroforestry versus conventional cropping practices. Entomological Society of America, Annual Meeting, St. Louis, Mo.

Van Sambeek, J.W. 2009. Database for estimating tree responses of walnut and other hardwoods to ground cover management practices. Sixth International Walnut Symposium, Melbourne, Australia.

Veum, K.S., K.W. Goyne, P. Motavalli, and R. Kremer. 2009. Effects of agronomic and conservation management practices on organic matter and associated properties in claypan soils. CD-ROM. ASA, CSSA, SSSA International Annual Meetings, Pittsburgh, Pa. Nov. 1-5.

Abstracts

Byers, P., A. Thomas, J. Avery, C. Finn, P. Perkins-Veazie, H.Y. Johnson, and S. Gu. 2009. Elderberry research and development in Missouri. HortScience 44(4):982.

Coggeshall, M.V., J.W. Van Sambeek, and M.R. Warmund. 2009. Use of logistic analysis to define oak afforestation success rates on flood prone sites in Missouri. American Society of Horticultural Science Annual Meeting, St. Louis, Mo. July 25-28. HortScience 44(4):1080.

Coggeshall, M.V. 2009. Black walnut: A new nut crop for the Midwest. American Society of Horticultural Science Annual Meeting, St. Louis, Mo. July 25-28. HortScience 44(4):973.

In M.A. Gold and M.M. Hall (eds.). Agroforestry Comes of Age: Putting Science into Practice. Proceedings, 11th North American Agroforestry Conference. 517p.:

Cernusca, M.M., M.A. Gold, C. Barbieri, and F.X. Aguilar. "Comparing motivations for first time and repeat visitors at the Missouri Chestnut Roast festival." 513.

Coggeshall, M.V., and M.R. Warmund. "Nut productivity and spacing requirements of eastern black walnut cultivars used in Midwestern agroforestry-based plantings." 427.

Keesey, I.W., B.A. Barrett, and C.H. Lin. "Preliminary data on chestnut plant volatiles as attractants to the lesser chestnut weevil, Curculio sayi *(Coleoptera: Curculionidae)*." 337.

Kult, K. "Quantifying the impacts of concentrated flow on grass filters and riparian forest buffers." 29.

Lin, C.H., R.N. Lerch, H.E. Garrett, and R.P. Udawatta. "Implementation of contour vegetative buffers for mitigating atrazine in ground water." 201.

Thomas, A.L., J.T. Prindle, and J.S. Chism. "Early production and value of grafted black walnuts in Missouri." 465.

Tufekcioglu, M. "Streambank erosion from grazed pastures, grass filters, and buffers over a six-year period." 27.

Veum, K., K. Goyne, P. Motavalli, R.P. Udawatta, and H.E. Garrett. "Buffer effects on runoff, dissolved organic carbon and sediment loss in a corn-soybean rotation using a paired watershed approach." 45.

Goyne, K.W., S.H. Wu, R.N. Lerch, and C.H. Lin. 2009. Adsorption of isoxaflutole degradates to hydrous metal oxides. 46th Annual Meeting of the Clay Minerals Society, Billings, Mont. The Clay Minerals Society, Chantilly, Va. June 5-11. 141.

Kumar, S., R.P. Udawatta, and S.H. Anderson. 2009. Root length density and carbon content influenced by agroforestry and grass buffers under grazed pasture systems in a Hapludalf. ASA-CSSA-SSSA 2009 International Annual Meetings, Pittsburgh, Pa. Nov. 1-5.

Lin, C.H., B.M. Thompson, H.Y. Hsieh, R.J. Kremer, R.N. Lerch, and H.E. Garrett 2009. Introducing biological agents for bioremediation of atrazine. 6th International Phytotechnology Conference St. Louis, Mo.

Miller, A., J. Knouft, and K. Hunt. 2009. Decoupling phenological events in temperate tree taxa: Local climate influences timing of budbreak and flower initiation, but not nut maturity, in *Carya illinoinensis* grown in a common garden. Botany and Mycology Conference, Snowbird, Utah. July 25-29. Abstract ID: 682.

Thomas, A.L., and P.L. Byers. 2009. Characteristics of elderberry fruit in response to genotype, environment, and pruning management. HortScience 44(4):1149.

Thompson, B., C.H. Lin, H.Y. Hsieh, R.J. Kremer, R.N. Lerch, and H. E. Garrett 2009. Detection and quantification of atzA in rhizosphere soil and enhanced bioremediation of atrazine by *Pseudomonas sp.* strain ADP. Missouri Life Science Week.

PUBLICATIONS 2009

Udawatta, R.P., H.E. Garrett, and J. Hefner. 2009. Spatial and vertical variation of soil carbon in a row crop watershed with buffers. ASA-CSSA-SSSA 2009 International Annual Meetings, Pittsburgh, Pa. Nov. 1-5.

Udawatta, R.P., H.E. Garrett, and R.L. Kallenbach. 2009. Water quality improvements on grazed pasture watersheds as influenced by agroforestry and grass buffers. ASA-CSSA-SSSA 2009 International Annual Meetings, Pittsburgh, Pa. Nov. 1-5.

Warmund, M.R., and M.V. Coggeshall. 2009. Genetic variability among eastern black walnut cultivars. American Society of Horticultural Science Annual Meeting, St. Louis, Mo. July 25-28. HortScience 44(4):1174.

Yang, H., J. Yang, C.H. Lin, B. Thompson, H.Y. Hsieh, R.N. Lerch, and H.E. Garrett. 2009. Bioremediation of munitions explosives TNT and RDX by selected native grass species. 1890 Land Grant Universities 15th Biennial Research Symposium, Atlanta, Ga. March 28-April 1.

Thesis

Berges, Sara. 2009. Ecosystem services of riparian areas: Stream bank stability and wildlife habitat. M.S. Thesis. Iowa State University.

Technology Transfer

Coggeshall, M.V., and W.D. Walter. 2009. Eastern black walnut and agroforestry. The Temperate Agroforester 17(1). http://www.aftaweb.org/

Godsey, L. 2009. Understanding Casualty Loss of Timber. University of Missouri Center for Agroforestry. "Agroforestry in Action." AF1014-2009. 12p.

Gold, M.A., and M.M. Hall, eds. 2009. The Chestnut Grower. Newsletter of the Chestnut Growers of America. Vol. 11, Nos. 1-4, Winter, Spring, Summer, Fall.

Hunt, K., M. Gold, W. Reid, and M. Warmund. 2009. Growing Chinese Chestnuts in Missouri. University of Missouri Center for Agroforestry. "Agroforestry in Action." AF1007-2009. 16p.

Reid, W., M.V. Coggeshall, H.E. Garrett, and J.W. Van Sambeek. 2009. Growing black walnut for nut production. University of Missouri Center for Agroforestry. "Agroforestry in Action." AF1011-2009. 16p.

Stelzer, H.E., and M.M. Hall. 2009. Green Horizons. Missouri forestry newsletter. Vol. 13, Nos. 1-4, Winter, Spring, Summer, Fall.

Walsh, M.P., J.W. Van Sambeek, M.V. Coggeshall, and D. Gwaze. 2009. Flood tolerance of oak seedling from upland and bottomland sites. Missouri Department of Conservation (MDC). Science Note. Volume 4. No. 23.

Warmund, M.R. 2009. Pest Alert: Oriental Chestnut Gall Wasp, Dryocosumus kuriphilus Yasumatsu. http://extension.missouri.edu/publications/DisplayPub.aspx?P=PA100

Watson, D., and L. Godsey. 2009. Succession Planning for Woodland Owners. University of Missouri Center for Agroforestry. "Agroforestry in Action." AF1013-2009. 12p.

GRANTS 2009

AGROFORESTRY

Garrett, H.E. "Agroforestry technology transfer program." $30,500. Missouri Department of Conservation. (2008-2009.)

Garrett, H.E. "An analysis of agroforestry's physical, biological, ecological, economic and social benefits." $1,723,029. USDA-ARS. (2008-09.)

Garrett, H.E. "Knowledge to increase adoption of agroforestry practices on small farms." $203,242. USDA-ARS. (2008-09.)

Garrett, H.E. "Tree improvement program." $30,000. Missouri Department of Conservation. (2008-2009.)

Muzika, R.M., F.X. Aguilar, J.A. Hubbart, D. Larsen, B. Cutter, R. Guyette, H. Stelzer, and C.H. Lin. "Integrating disciplinary diversity in graduate student education to support forest resource management decisions." $256,000. USDA National Needs Program. (2009.)

BOTTOMLAND RESTORATION/FLOOD TOLERANCE

Schlarbaum, S.E., and M.V. Coggeshall. Research Joint Venture Agreement. "Coordinating oak regeneration and management research and silviculture practices." $5,000. Awarded to University of Tennessee. USDA Forest Service Northern Research Station. (2009.)

NUT CROPS

Geyer, W., and J.W. Van Sambeek. Research Joint Venture Agreement. "Establishment of seed orchards from existing genetic

plantings to provide improved hardwood seedlings in the Plains states." $5,000. Awarded to Kansas State University. USDA Forest Service Northern Research Station. (2009-2010.) *Walnut Council Foundation awarded K-State $2,500 over the next five years as part of match.*

Coggeshall, M. "Screening of Juglans and Carya for resistance to the 1000 cankers disease and evaluation of insecticidal controls for use in management." $12,975. Awarded to University of Missouri, Colorado State University, Purdue University, University California/ Davis, Center for Improving Perennial Plants for Food and Bioenergy. USDA/CSREES Agriculture and Food Research Initiative. (2009-2010.)

Warmund, M.L. "Evaluation and characterization of ambers in selected black walnut *(Juglans nigra L.)* cultivars." $4,995. Northern Nut Growers.

Warmund, M., L. Godsey, and M. Gold. "An economic analysis of a paddock vacuum for the mechanical harvest of chestnut trees." $9,185. Missouri Department of Agriculture Specialty Crop Block Grant.

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, USDA Specialty Crop Block Grant Program. (2008-2010.)

REDCEDAR PHYTOCHEMISTRY

Lerch, R.N. In-kind contribution, GC-MS/MS analysis, injections. $7,500. USDA-ARS, Cropping Systems and Water Quality Research Unit. (2009.)

Thompson, B., and H.Y. Hsieh. In-kind contribution, conducting assays, providing cell line. $24,000. Department of Veterinary Pathobiology, College of Veterinary Medicine. (2009.)

Wong, T. In-kind contribution, service and consulting. $1,000. Department of Chemistry, University of California, San Francisco. (2009.)

RIPARIAN FOREST & UPLAND BUFFERS

Lerch, R.N. In-kind contribution, analysis, Bradford runoff project. $25,000. USDA-ARS, Cropping Systems and Water Quality Research Unit. (2009.)

Lerch, R.N. In-kind contribution, analysis. $15,000. USDA-ARS, Cropping Systems and Water Quality Research Unit. (2009.)

Udawatta, R. In-kind contribution, soil physical and biological property. $2,000. USDA-ARS. (2009.)

Lin, C.H., and J. Yang. "Introduction of biological agents for enhancing rhizodegradation of munitions explosives." $105,000. Lincoln University Cooperative Research and Extension Programs. (2007-2010.)

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." $16,000. Prairie Fork Foundation. (2008-10.)

Isenhart, T., K. Schilling, and R. Schultz. "Quantifying the effect of perennial vegetation on soil and water quality."$125,436. Leopold Center for Sustainable Agriculture. (2009-2012.)

Simpkins, W., R. Schultz, and T.M. Isenhart. "Quantifying the role of perennial vegetation in removing nitrate from groundwater in riparian buffers." $84,054. Leopold Center for Sustainable Agriculture. (2007-2010.)

Russell, J.R., D. Morrical, J. Kovar, and T. Isenhart. "Pasture management effects on nonpoint source pollution of Midwestern watersheds." $598,461. USDA-CSREES. (2006-2009.)

SHADE TOLERANCE

Garrett, H.E., and J.W. Van Sambeek. "Shade effects on Ozark little bluestem accessions with temperate agroforestry potential." $5,000. USDA Natural Resource Conservation Service. (2008-09.)

Van Sambeek, J.W. In-kind contribution, biological technician for assisting forage harvests, tree measurements, and research plot maintenance. $4,000. USDA Forest Service. (2008-09.)

SILVOPASTURE

Dwyer, J.P., and W.D. Walter. Shortleaf pine research. $43,000. Wurdack Farm Endowment Fund. (2007-2009.)

Fritschi, F.B., R.L. Kallenbach, J.G. Shannon, and R.E. Sharp. "Drought simulators critical to translational research in plant science." $1,558,125. Life Sciences Trust Fund. (2009.)

Kerley, M.S., and R.L. Kallenbach. "Improving the energetic efficiency of beef cattle." $462,110. Cooperative State Research and Education and Extension Service. (2009.)

TREE/CROP INTERACTIONS

Linit, M.J., and W.T. Stamps. "Ecology and diversity of the insect community in alternative crops and nut trees." $70,000. Missouri Agricultural Experiment Station Project. (2006-2011.)

Fritschi, F.B., and J.H. Houx III. "Examination of N management in alternative double cropping systems." $79,180. Missouri Agricultural Experiment Station. (2009-2011.)

TECHNOLOGY TRANSFER

Gold, M.A. "Agroforestry Online Training." $20,000. USDA Natural Resources Conservation Service National Agroforestry Center. (2008-2009.)

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

The University of Missouri Center for Agroforestry is dedicated to working with landowners, natural resource professionals and other stakeholders the world over to keep lands sustainable, both environmentally and economically. The Center supports comprehensive research on the 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.

Our research extends from the field, to the lab, to the markets, to the bottom line; we want landowners to have all the information possible in front of them when looking into which agroforestry practices and specialty crops might be beneficial to their farms.

The University of Missouri Center for Agroforestry – an integrated approach.

Center for Agroforestry
University of Missouri

Director: Shibu Jose, Ph.D.
203 ABNR
Columbia, MO 65211
(573) 884-2874
umca@missouri.edu
www.centerforagroforestry.org

2009 UMCA highlights