



The Center for Agroforestry
University of Missouri

A Global Center for Agroforestry, Entrepreneurship and the Environment

A Global Vision for Agroforestry



***2010 Annual Report:
Research, Education, Outreach & Partnerships***

ABOUT THE CENTER

2010

A Global Vision for Agroforestry

The Center for Agroforestry at the University of Missouri

A Global Center for Agroforestry, Entrepreneurship and the Environment

AGROFORESTRY PROVIDES new market opportunities, habitat for wildlife, and is a form of sustainable agriculture and land stewardship.

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

The Center for Agroforestry at the University of Missouri (UMCA), established in 1998, is an interdisciplinary research, teaching and outreach program that draws on the expertise of University faculty in natural resources, agriculture, plant and social sciences. The Center coordinates agroforestry activities for Missouri and adjacent areas of the Midwest, working closely with numerous collaborators.

The Center's 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 outreach 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, and
- Educating and training students, professionals, scientists, leaders and the general public who are empowered to make a difference locally, regionally and globally.

2010 was a busy year including many major developments at The Center for Agroforestry. In 2010, UMCA:

- Created a Road Map to guide the Center for the next 10 years;
- Approved a new name: The Center for Agroforestry: A Global Center for Agroforestry, Entrepreneurship and the Environment;
- Hosted its inaugural Agroforestry Symposium.

EDITED BY

Michelle Hall, CAFNR Marketing Communications Coordinator, Paige Pritchard, UMCA Information Specialist Intern, & Mike Gold, UMCA Associate Director and MU Research Professor of Forestry

ON THE COVER

Photos of multiple different agroforestry practices illustrate the diverse nature of the field. CLOCKWISE FROM TOP LEFT: Cows graze in silvopasture, phytochemical research is performed, a souvenir ornament is displayed at the 8th Annual Missouri Chestnut Roast, corn grows alongside Black Walnut to demonstrate alley cropping.

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DIRECTOR'S MESSAGE

Dr. Shibu Jose, Ph.D.,
H.E. Garrett Endowed Professor and Director

As my first full year as Director of The Center for Agroforestry at the University of Missouri comes to a close, my once outsider now insider opinion remains unchanged. We do indeed possess a national and global treasure in the form of one of the premier centers in the world dedicated to agroforestry research, teaching and outreach.

As you may be aware, The Center has historically received “earmark” funding through a partnership with the USDA Agricultural Research Service (ARS) at Booneville, Arkansas and this has been a highly productive and meaningful partnership. At the close of 2010 and into 2011, Congress created a moratorium on earmarks and as a result we lost our annual core funding this reporting year. Thanks to our ARS colleagues, we received a no-cost extension of our existing ARS funding. This support, combined with funding made available through the MU College of Agriculture Food and Natural Resources, helped us bridge the funding gap for 2010. Center personnel have also been busy preparing and submitting a variety of proposals during the past year to continue to support our mission.



With a strong and experienced core team working closely with a wide array of collaborators, our program is proving to be diverse, flexible, and able to react quickly to opportunities. In other words, we are both strong and resilient. The Center has long been a leader in developing agroforestry practices for the temperate zone worldwide with wide ranging impacts based on our research, education and outreach programs. The annual report highlights a few of the research and outreach accomplishments of our faculty, staff and students. For example:

- Center faculty and staff were PIs or Co-PIs on grants totaling nearly \$2 million, covering a broad spectrum of biophysical and socioeconomic research and outreach activities in agroforestry.
- The Center launched a new online M.S. focus area in agroforestry which has attracted students from the U.S. and abroad.
- Center personnel and stakeholders worked together in completing the “Road Map 2020”, a visioning document for the next decade.
- Our Center name was changed to “The Center for Agroforestry: A Global Center for Agroforestry, Entrepreneurship and the Environment” to better reflect the full scope of our program.
- The Center has entered into formal memoranda of understanding with four overseas institutions to facilitate international collaborations.

The hard work of our faculty, staff, students, and visiting scientists and support of our stakeholders are responsible for our success, especially for our ability to weather the budget difficulties in such a way that we are able to continue to advance and grow. We appreciate your continued support of our program and look forward to another productive year in 2011.

– SHIBU JOSE, Ph.D., H.E. Garrett Endowed Professor and Director,
The Center for Agroforestry at the University of Missouri

THE FIVE PRACTICES OF AGROFORESTRY

forest farming

In forest farming, high-value specialty crops are grown under the protection of a forest canopy modified to provide the correct shade level. Crops like ginseng, truffles, 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.

silvo-pasture

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.

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 specialty crops also may be incorporated for extra income. Trees selected for alley cropping may include valuable hardwood species, such as nut or fruit trees, or trees desirable for wood products.

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, nuts and berries planted in the shrub zone can provide additional income.

wind breaks

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 limit spray drift of pesticides. 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.



Over the past decade, The Center for Agroforestry has been primarily supported by USDA-ARS grant programs, funding 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 research “clusters” to enhance creativity and productivity among a range of investigators from many disciplines.

RESEARCH CLUSTERS

SPECIALTY CROPS

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. Additional specialty crop foci include gourmet mushrooms, pawpaw, elderberry and pine straw.

MEDICINALS/PHYTOCHEMISTRY

Ongoing studies include those on redcedar phytochemicals and elderberry in conjunction with MU’s Center for Botanical Interaction Studies.

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.

ENVIRONMENTAL SERVICES

The objective is to quantify environmental benefits of agroforestry 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. In addition, researchers are working to see if vegetative environmental buffers can help to reduce odor from large farming operations.

BIOMASS/BIOFUELS

The focus is to quantify and enhance growth of *Populus* clones, sweet sorghum, willow, switchgrass and other species for biomass production. Studies feature replicated trials along a latitudinal gradient from Columbia, Mo., to Booneville, Ark.

WILDLIFE INTEGRATION

Studies have looked at bottomland hardwood restoration and management, quantifying effects of bottomland agroforestry practices on wildlife species. Additional work involves assessment of wildlife benefits associated with upland agroforestry practices.

SILVOPASTURE

Research 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. Features replicated trials ranging from New Franklin, Mo., to Booneville, Ark.

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.

OUTREACH

Efforts are centered around active training programs for resource professionals and landowners, with a focus on the application of ongoing agroforestry research and landowner demonstrations complemented by socio/economic/marketing studies.

EDUCATION

The Center funds about 20 graduate students per year on various projects and now offers an online graduate degree program and pending graduate certificate in agroforestry.

PARTNERSHIPS

The Center for Agroforestry at the University of Missouri 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

Mid-America Agroforestry Working Group (MAAWG)

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.

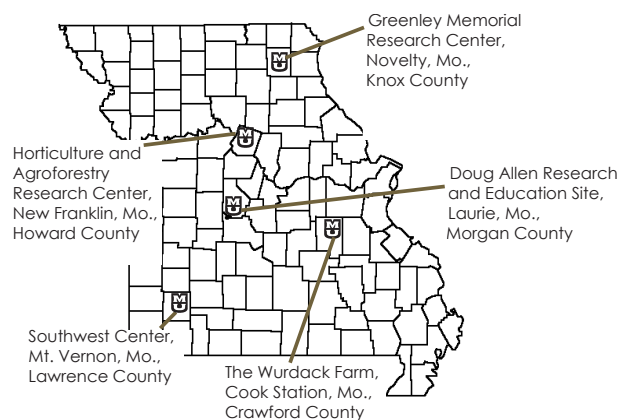
INTERNATIONAL COLLABORATIONS

National Sun Yat-sen University, Kaohsiung, Taiwan

Quaid-i-Azam University, Islamabad

Uppsala University, Sweden

Abomi Calavi University, Benin, West Africa



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 global advancement of agroforestry.

STAFF & COLLABORATORS

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ASSOCIATE DIRECTOR Michael Gold, Ph.D.

UMCA FACULTY & STAFF

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HORTICULTURE & AGROFORESTRY RESEARCH CENTER

One of the University of Missouri's 16 outlying research farms

The Horticulture and Agroforestry Research Center, a 660-acre farm, is the primary research site for The Center for Agroforestry. 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.

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 660 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.

In 2010, HARC expanded by leasing new nearby land. In addition, staff worked to reclaim land from past experiments. Altogether this means over 30 additional acres for new projects – including a biomass plantation featuring willow, cottonwood, poplar and black walnut.

SELECTED HARC PROJECTS

The Center for Agroforestry at the University of Missouri 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:

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.

AGROFORESTRY, GRASS BUFFERS TO IMPROVE WATER QUALITY
Landowners often look to the U.S. Department of Agriculture-Natural Resources Conservation Service (NRCS) 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

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.

Photo of HARC by Dave Larsen, MU Forestry Department



calibrating a GIS model simulating the conservation benefits of upland, agroforestry 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. Recent research shows planting spacings of 2 x 2 or 3 x 3 meters are too wide to effectively exclude invasive species, even when periodically burned.

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 tree hybrids and black walnut were planted in single, double and triple rows.

FORAGE SHADE TOLERANCE STUDY

Studies look at yield and quality of forage grown under various shade treatments. The shade tolerance laboratory at HARC is the ideal place to study this aspect of agroforestry, with five different shade treatments: full sunlight; 70 percent, 45 percent and 20 percent of full sunlight; or a “sunfleck” treatment. The sunfleck treatment was recently updated to use artificial trees instead of using fabric shade cloth. Researchers hope this helps the PAR to have less variation (PAR stands for photosynthetically active radiation – this refers to a range in the light spectrum which most green plants use during photosynthesis).

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 outdoor 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.



TOP: HARC’s new teaching vineyard. MIDDLE: Pine straw demonstration area at HARC. BOTTOM: One of many chestnut orchards at the Horticulture and Agroforestry Research Center, New Franklin, Mo.

HARC RESEARCH PROJECTS

In addition, the flood tolerance of hardwood planting stock and genetic variation in ecotypes from seed collected from bottomland and upland stands has been evaluated. Findings suggest selections for flood tolerance based on measuring post-flood survival and growth following spring flooding can be strengthened by including results of overwinter survival and possibly by the amount of new growth on the shoots the following growing season. When using overwinter mortality as a measure of tolerance to short-term flooding, the most flood tolerant species were shown to be swamp white oak and pin oak.

New data confirm earlier flood tolerance investigations that defined genetic differences in response to flooding among seedling families of both bur oak and swamp white oak. Results confirm similar genetic differences also exist for northern red, pin, Shumard and white oak. Previous results suggested no significant gains in flood tolerance were achieved using acorns derived from specific seed sources (or stands) along a hydrologic gradient for bur and swamp white oak.

The most important result of these investigations to date is the recognition that genetic variation in flood tolerance does exist both among and within most oak species native to Missouri. Within-species flood tolerance is based at the seedlot (i.e., individual mother tree) level and probably not at the level of stand origin. These results indicate there should be opportunities to exploit this individual tree through traditional tree improvement techniques.

Next up, a flood tolerant seedling seed orchard will be established to serve as a source of acorns for reforestation seedlings that can be used to establish riparian buffers.

PINE STRAW

Pine straw, the accumulation of naturally shed needles of pine trees, is an excellent landscape mulch material. In the southeastern U.S., it is the No. 1 mulch used in landscape plantings. However, loblolly pine, one of the primary southern pine species used for pine straw plantations in the south, is not native to Missouri and may not be tolerant to the colder conditions in Missouri. Shortleaf, the only pine species native to Missouri, is not well suited to pine straw production due to its namesake short needle length.

Needle length and yield were estimated in winter 2010 by collecting samples from six randomly selected individual trees from each of 20 families. While the trees are still being evaluated, data collected to date indicate most or all of the families in the study would be suitable for pine straw production. Mean needle lengths ranged from 6.3 to 6.7 inches for pitch x loblolly families and from 6.9 to 7.4 inches for loblollies. Fallen needle weight showed considerable variability, from 5.3 to 8.8 lbs for pitch x loblolly families and from 8.1 to 11 lbs for pure loblolly.

All families in the study had excellent survival and growth – trees have had 99 percent survival total. Based on growth and needle characteristics, hardy loblolly families appear slightly superior to pitch x loblolly families for pine straw production under study conditions. However, while some pitch x loblolly families appear acceptable, improved pitch x loblolly seed is not commercially available.

Researchers are looking to create a production guide for growing pine straw, seed orchard demonstration plots and learning the effects of pine straw on soil and growth of plants. Researchers indicate that pine straw can not only be grown in a plantation setting, but also could be used in multiple row windbreaks for supplemental income.



Harvest festival of culture and agriculture, family day out, specialty product showcase, agroforestry field day, history lesson

BUT FIRST AND FOREMOST, the Missouri Chestnut Roast is a chestnut extravaganza!

The 8th Annual Missouri Chestnut Roast was held Saturday, Oct. 16, 2010, at the MU Horticulture and Agroforestry Research Center, New Franklin. Beautiful weather meant a large, happy crowd!

New for 2010 were a Black Market BBQ sauce booth; nut cracking booth with the Missouri Nut Growers Association; Cooper's Oak Winery booth; meeting of the Forestry and Woodland Association of Missouri; Pappy's Gourmet booth with gourmet relishes and pepper jelly; and Fahrmeier Family Vineyards and Winery and Fahrmeier Farms booth with fall produce, pumpkins and wine.

Continuing highlights included tours of the rehabilitated, furnished Hickman House; guided tours of 660-acre Horticulture and Agroforestry Research Center featuring diverse agroforestry practices and specialty crops; free fresh-roasted, Missouri-grown chestnuts; educational booths from Missouri value-added specialty crop agriculture vendors and University agricultural and environmental research programs; showcase for Missouri's outstanding agricultural products, including pecan, walnut and chestnut products, cheeses, wines and beers, ice cream, pepper products, BBQ sauces, elderberry products, children's activities and live music; and beautiful Missouri River Hills scenery.



TOP: Chestnut sampling. ABOVE RIGHT: **The chestnut roast festivities are seen from the Hickman House.** ABOVE LEFT (TOP): **Enjoying the straw bale maze.** ABOVE LEFT (BOTTOM): **Goatsbeard Farms cheese booth was a popular place.**

HICKMAN HOUSE GETS ITS TIME IN THE SPOTLIGHT!

The Hickman House, an historic 1819 Georgian cottage and one of the oldest brick homes still standing in the state, occupies a picturesque spot on the MU Horticulture and Agroforestry Research Center farm. Since the completion of its historic rehabilitation in 2009, it has garnered attention from publications and people alike!

The house was featured in the 20-page spread, "Our beloved CoMo," alongside other historic local homes in the Spring 2010 issue of MIZZOU magazine, the magazine of the MU Alumni Association. In addition,

the house took the cover of Rural Missouri magazine in November 2010.

A local holiday historic home tour brought many visitors to the home in winter 2010 (in addition to hundreds of attendees at the Missouri Chestnut Roast).

Finally, Ray Glendening, home historian and HARC superintendent, accepted an award from the Missouri House of Representatives and the Missouri Alliance for Historic Preservation for rehabilitating the house, on behalf of HARC, The Center for Agroforestry and other people crucial to the project. The ceremony was held March 3, 2010, in the capitol rotunda.

OUTREACH

The Center's outreach activities introduce the benefits of agroforestry practices, and the products and environmental benefits created through their use, to agricultural and forest landowners, natural resource professionals and consumers. The results of a multi-faceted, long-term sustained commitment of knowledge creation, information sharing and transfer include: greater adoption of agroforestry practices, establishment of new specialty crops and associated value-added industries, increased consumer demand for specialty crops, reduced non-point source pollution, increased habitat and wildlife biodiversity, and increased opportunities for agritourism and economic development in rural areas.

NEW 'LOOK' FOR THE CENTER

Marketing the Center took a big leap in 2010, with a new name and focus, Web site and a Facebook page!

It's official! We have become The Center for Agroforestry at the University of Missouri: A Global Center for Agroforestry, Entrepreneurship and the Environment. The new name was approved by Center faculty and staff in May 2010 and was given the official go-ahead from the MU College of Agriculture, Food and Natural Resources and the School of Natural Resources.

"We are excited to position ourselves as a global leader in agroforestry research, teaching and outreach," said Shibu Jose, Center director. "Our new name will convey this mission clearly."

The Center's name is still abbreviated "UMCA."

In addition, The Center for Agroforestry unveiled its new Web site Nov. 23, 2010. The site has a completely new look, which involved nearly a year's work. The College of Agriculture, Food and Natural Resources communications team created the new design to better reflect MU's Web look, while the people at AgEbb implemented the design and will continue to update the site. The project was a huge undertaking, as UMCA has one of the largest sites AgEbb maintains. Some pages were reconfigured and many menus have changed.

"We hope the new site is more informative, user-friendly and easier to navigate," Jose said. "Take some time to explore the site and please let us know if you have suggestions for further improvement."

Do you really "like" us?! Now you can – officially! The Center for Agroforestry is on Facebook. This page allows friends of UMCA to connect with us and keep up-to-date on news another way by "liking" us through your profile. Here's how it works: Log in to your profile on Facebook. Search for "The Center for Agroforestry." Click the "like" button at the top of our profile. When we post a link or other bit of news to our wall, it will show up on your "Newsfeed," where updates from all of your friends can be found.

CHESTNUT WORKSHOP SERIES

The popular four-part series was back for a second year in 2010. 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 are aimed at current and prospective growers, extension agents and interested FFA students.

About 60 landowners have gone through the workshop series the past two years and post-workshop feedback has been overwhelmingly positive. Attendees rated the workshops, on

FAR RIGHT: The UMCA chestnut roasting booth was very popular at the Great River Road Chestnut Roast in late October 2010. TOP LEFT: Andy Mason presents the keynote presentation at the inaugural agroforestry research symposium, January 2010. BOTTOM LEFT: Mike Gold presents at a 2010 chestnut workshop. The series is held at the Horticulture and Agroforestry Research Center.



average, either “excellent” (90 percent) or “good” (10 percent) in surveys administered after the final meeting.

The workshop series is back for a third year in 2011.

INAUGURAL SYMPOSIUM

The Center for Agroforestry sponsored its first-ever agroforestry symposium in January 2010, bringing together friends of agroforestry from across the U.S.

The Center invited interested parties from across the country and around the globe to access its Inaugural Agroforestry Research Symposium online, via a Webstream. Anyone could view the video, in real time. This is in addition to the land-owners, natural resource professionals and university officials who attended the symposium along with UMCA researchers.

Presenters included keynote speaker Andy Mason, director of the USDA National Agroforestry Center, who spoke on “Agroforestry in America: New Opportunities for a Sustainable Future.” The symposium was followed by a day and half of UMCA program review. The Center plans to make the research symposium and its accompanying Webstream an annual event each January.

MORE CHESTNUTS ROASTING ON AN OPEN FIRE!

2010 was the busiest year ever for roasting chestnuts around the state. Two additional chestnut roasts were held to complement UMCA’s centrally located Missouri Chestnut Roast – one in the eastern part of the state and one in the west.

The Center for Agroforestry co-sponsored the new field day and festival Sept. 24-25, 2010, at Fahrmeier Farms near Lexington, Mo. The Specialty Crops Field Day and Santa Fe Trail Food and Wine Festival introduced prospective growers to agroforestry crops, establishing a vineyard, fruit crops and market farming; 200 FFA students from four chapters participated, in addition to prospective growers. At the festival, participants sampled Missouri wines, saw local chefs in action, and learned more about wine and local cuisine. UMCA was, of course, on hand roasting fresh, Missouri-grown chestnuts at the event.

The Inaugural Great River Road Chestnut Roast was held Oct. 30, 2010, at Forrest Keeling Nursery in Elsberry, Mo. Festivities included HARC chestnuts roasting on an open fire, in addition to superb tours of the high quality nursery stock, craft and agricultural vendors, cooking demonstrations, live music and much more!

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 were established in the spring of 2010; three areas of edge feathering were completed over the summer of 2010. Treatments cover both the upper and bottom edges of each warm-season grass field. Demonstration plans include alley cropping with an emphasis on nut trees intercropped with wildlife food; buffers for habitat (quail); forest management and shiitake; pine plantings; and forest management for herbal medicinals.

ADDITIONAL OUTREACH ACTIVITIES

* Nine talks were given at seven outlying University of Missouri Farms and Centers in 2010. Over 800 FFA students and 300 producers/farmers attended the talks.

* A casualty loss course was offered to the Missouri Consulting Foresters for SAF Continuing Education Credit.

* The UMCA Outreach Team co-hosted a workshop at the Allen Research and Education Farm to highlight farm activities and offer the opportunity to view woodcock nuptial displays.

* The Center co-hosted the South Central FFA Forestry Contest, Rolla, and the State FFA Forestry Contest, Columbia. Additional events Outreach team members attended, organized technical sessions at, gave presentations and/or staffed an exhibit booth at, gave specialty crop demonstrations and participated in marketing and sales in 2010 included: the MO Natural Resources Conference, Osage Beach; MO Organic Association conference, Columbia; MO Tree Farm Conference,

Cape Girardeau; National Agroforestry Stakeholder Meeting, Washington D.C.; Farm to Table Festival, Columbia; Elderberry Workshop, Jefferson City; Thomas Jefferson Farm Field Day, Columbia; Missouri State Fair, Sedalia; MU South Farm Showcase, Columbia; National Society of American Foresters Convention, Albuquerque, N.M.; MU Farmers Market, Columbia; Columbia Farmers Market (pawpaw and chestnut booths); and the Living Windows Festival, Columbia.

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; the role of institutions in constraining or facilitating agroforestry; specialty crop financial decision models; knowledge of markets for new products; the 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



Chestnuts are sorted according to size to sell at the 8th annual Missouri Chestnut Roast, Oct. 16, 2010.

Sources: Barbieri, C., and C. Valdivia. 2010. Recreation and agroforestry: Examining new dimensions of multifunctionality in family farms. *Journal of Rural Studies* 26(4):465-473.

Barbieri, C., and C. Valdivia. 2010. Recreational multifunctionality and its implications for agroforestry diffusion. *Agroforestry Systems* 79(1): 5-18.

HUMAN, ECONOMIC DIMENSIONS OF AGROFORESTRY

This ongoing research effort focuses on three areas: the individual attitudes, knowledge, incentives (structure and policies), and socio-economic-resource characteristics (social, economic, cultural, and natural capitals) that lead to the adoption of agroforestry practices; the role of institutions in constraining and facilitating agroforestry; and the networks that facilitate access to information about agroforestry practices.

Results show that the higher the perception of intrinsic and economic values of agroforestry, the more recreational use of the land. The more recreational use of the land, the higher perceived knowledge of agroforestry, the higher the willingness to adoption agroforestry practices, and the higher the perceptions of the economic and non-economic values of agroforestry. Recognizing agroforestry as a competitive advantage to develop agritourism could help promote agroforestry adoption.

RECREATION AND AGROFORESTRY

A study of the relationship between agroforestry adoption and the recreational function of the farmland identified two types of Missouri landowners: the *Productivist* and the *Ruralist* based on the types of recreational services they offer on their lands. The two types of landowners have different behavior and understanding of agroforestry, and they should be approached differently when promoting agroforestry. Messages conveyed to *Productivist* should emphasize the economic benefits of agroforestry, while messages to *Ruralist* should emphasize the conservation benefits of agroforestry. Touring farms with active tree management is a good way to disseminate agroforestry practices among *Productivist*, while state and federal extension agents appear to be more suitable to approach *Ruralist*. Both groups can effectively be reached using printed materials, especially through official conservation magazines.

In studying the relationship between recreational multifunctionality and the practice of agroforestry, results showed that the recreational use of the land is positively associated to the perceived knowledge of agroforestry and willingness to adopt agroforestry. The higher the perception of intrinsic (i.e., planting trees for wind protection and carbon sequestration) and economic (i.e., perceived economic benefits and flood protection) values of agroforestry, the more recreational use of the land.

Examining the economic and non-economic barriers preventing agroforestry adoption in Missouri showed that the costs of establishing/managing the trees, the time required to manage trees, and the lack of tree management experience are barriers perceived as most influential in adopting agroforestry practices.

PERCEPTIONS OF LANDSCAPE BENEFITS

Agriculture serves multiple functions to society, including the provision of a landscape valued for its aesthetics and recreational opportunities. Agroforestry is multifunctional as it offers a wide range of biophysical, economic and social benefits to farmers and overall society. Although agroforestry has been associated with the recreational function of a farm, there is a lack of knowledge about consumers' perceptions of the recreational value of agroforestry landscapes.

Our research examines the perceived impact of agroforestry landscapes on the recreational appeal of Missouri farms. Specifically, we are examining the perceived benefits of agroforestry landscapes; identifying visual components of agroforestry landscapes more appealing to the public; and contrasting different perceptions of the recreational value of agroforestry landscapes between metropolitan and non-metropolitan residents.

ELDERBERRY MARKET

A combination of mail and phone survey methods have been used to study the nation's elderberry market. Results show:

- A nascent industry with mostly small-scale participants ready for growth.
- Demand trends are favorable and prices are good across the value chain.
- Challenges include a limited domestic supply of fruit, few regionally adapted varieties suitable for commercial production, and high labor costs.
- The lack of affordable mechanical harvesting equipment limits future production potential and industry growth. Based on identified market size and demand, opportunities exist to increase the domestic elderberry industry across the value chain.

In 2010, the Center was awarded a grant from the North Central Region Sustainable Agriculture Research and Education, "Developing Successful Marketing Strategies for Elderberry Growers and Value-Added Processors: A Model for Specialty Crop Development in the U.S. Midwest." "The grant will use an integrated approach to contribute to the creation and development of an elderberry regional industry as a model for specialty crop development in the Midwest," said project coordinator and UMCA associate director, Mike Gold. The project will increase knowledge about the elderberry

market in the region. An elderberry financial decision tool will be developed to support producer decision making for on-farm and associated enterprise opportunities. A comprehensive outreach program, including a landowner guide for growing elderberry, will disseminate results of this project. In addition to Gold, key players in the grant include Ina Cernusca, UMCA marketing specialist; Francisco Aguilar, assistant professor of forest economics, MU Forestry, Larry Godsey, UMCA economist, Andy Thomas, MU Southwest Center; Patrick Byers, Regional Horticulture Extension Specialist, MU Extension; Terry Durham, elderberry producer; and John Brewer, Wyldewood Cellars.

ELDERBERRY CONSUMER PREFERENCES

This survey aims to measure consumer preferences for selected elderberry product characteristics and determine the level of importance each product attribute has on stated consumer purchasing patterns, and analyze demographic information on the sampled consumers to match elderberry product preference with particular demographic profiles.

Through preliminary research, two market segments were identified: very health conscious (more likely to be females and on average older – 46-55) and less health conscious (more likely to be male between 36-45). Both segments identified the price, organic certification, origin of cultivation and natural claim as being the most important attributes in making elderberry juice purchasing decisions. A national survey will be conducted in 2011.

IMPACT OF MISSOURI CHESTNUT ROAST

In 2009, UMCA researchers administered the first "after-event survey"; to evaluate Missouri Chestnut Roast participants' experience with the festival, the festival impact on participants' behavior and participants' awareness about chestnuts and other nuts, agroforestry and agritourism in the region. Results show:

- Overall satisfaction predicts intention to return and intention to recommend the festival to others.
- Increased knowledge and awareness about chestnuts aided by satisfaction at the festival predicts an increase in the number of potential customers for chestnuts, black walnuts, northern pecans and other Missouri specialty products showcased at the festival.
- Increased awareness about the New Franklin area and the Hickman House increase the potential of agritourism in the region as a result of the festival, especially for older people who live in rural areas.
- Farmers who live in a rural area are the most likely festival participants to adopt agroforestry as a result of the festival.

Online agroforestry masters degree program launches

AGROFORESTRY HAS BEEN GAINING ATTENTION among landowners and natural resource professionals for its environmental and economic benefits. With this increase in recognition, the need for trained professionals in agroforestry also has been expanding.

That's where The Center for Agroforestry at the University of Missouri comes in. The Center has introduced an agroforestry option to build within an existing master of science degree in forestry. The courses will be offered through MU Direct Online. A 12-hour graduate certificate in agroforestry is in the approval process.

The master's curriculum is a 30-credit non-thesis degree through the forestry department at the University of Missouri with a 16-credit required core including a professional paper, optional 3-credit field internship and elective course work. In addition to the students admitted to the agroforestry program, which must be done through the MU Graduate School, both graduate and undergraduate students from other disciplines are welcome to enroll in individual online courses for credit.

"Professionals across the U.S. and overseas are looking for courses; individual courses, certificates and graduate degrees in agroforestry," said Shibu Jose, UMCA director. "Hundreds of Peace Corps volunteers, for example, work every year on agroforestry-related projects.

The master's in forestry with a focus in agroforestry is designed to be a flexible degree to meet the advanced educational goals of a wide range of students, such as professionals working in natural resources around the globe who already have an undergraduate degree in a related field. Furthermore, the online master's is open to all individuals holding accredited bachelor's degrees who wish to expand their breadth and depth of knowledge in the field of agroforestry.

"We hope to increase enrollment of graduate students in courses related to agroforestry," Jose said. "The ultimate outcome of this project will be 'society-ready graduates' who are capable of making positive changes in the agriculture, natural resources and environmental sectors in the U.S. and elsewhere in the world."

Course options include a core of four courses: Agroforestry Theory, Practice and Adoption (highly recommended to take this course first); Agroforestry Economics and Policy; Ecological Principles of Agroforestry; and Agroforestry for Watershed Restoration. The first two courses listed will be offered in 2011. In addition, a number of associated courses round out the program.

Faculty come from The Center for Agroforestry and the School of Natural Resources, including the departments of forestry, and soil, environmental and atmospheric sciences.

The Center for Agroforestry received funding from the University of Missouri System, the MU College of Agriculture, Food and Natural Resources, and the School of Natural Resources to add the agroforestry option to the existing graduate forestry degree program.

For more information about the program or individual courses, go to <http://mudirect.missouri.edu/degreeprograms/agroforestry/index.aspx>.



Redcedar compounds fight MRSA

by CAFNR Communications

A **TRANSDISCIPLINARY TEAM** of scientists at the University of Missouri has found preliminary evidence that a compound from an invasive native tree that hinders farming and grazing could be a new anti-microbial agent effective against a dangerous infection plaguing hospitals.

Methicillin-resistant *Staphylococcus aureus* (MRSA), a “super-bug” resistant to most medications, sickened more than 94,000 people in 2005 and killed more than 19,000 in the U.S., according to the Centers for Disease Control.

A chemical compound that can kill MRSA was found in needles from Redcedar trees.

The team, consisting of agroforestry, biochemistry and veterinary pathobiology researchers, shared their research results in 2010 with colleagues at the International Conference on Gram-Positive Pathogens in Omaha. Their next step is to discover exactly how the compound works, determine if the compound has any toxic effects and evaluate other potential disease-fighting compounds isolated from the tree.

If their work is ultimately successful, physicians will have a new tool to fight deadly staph infection and Missouri farmers will have a new market for a tree found around the state.

The Eastern Redcedar (ERC) is one of the most widely distributed American tree species. There are about 500 million in Missouri; their range extends from Kansas to the east coast.

A study to determine uses for ERC trees was conducted a decade ago by another team of researchers from The Center for Agroforestry. Their findings on the chemistry of ERC led

to the current work on the medical uses of ERC.

In 2007, Chung-Ho Lin, a research assistant professor in UMCA, was given the assignment to find a commercial use for ERC trees with funding from The Center for Agroforestry.

“I was told to find an entrepreneurial use for this ‘trash tree’ so land owners could put their energy into profiting from them instead of cutting them down,” Lin said. “I thought it was a fun challenge.”

Lin aimed his initial investigation at building on existing research showing anti-bacterial potential of ERC-derived compounds and rumors of its effectiveness as a traditional herbal remedy for acne. Then he developed a series of purification processes to isolate the bioactive compounds.

So far, three patents have been filed as a result of this research.

- Purification of anti-microbial, anti-fungal and anti-inflammatory diterpenoids from Eastern redcedar (*Juniperus virginiana*)
- Purification of the bioactive saponin Esculentoside D. from *Phytolacca latbenia*
- Use of tricyclic diterpenoids from Eastern redcedar (*Juniperus virginiana*) for preventing and ameliorating the development of melanin and hyperpigmentation

Three invention disclosures have been submitted to MU for patent application.

Biofuel efforts ramping up

The Center for Agroforestry is involved in a variety of projects examining potential biofuel crops. Studies include:

- Economics of woody biomass harvesting: Determine the economic structure of integrated (timber and biomass) harvesting.
- Physical availability of woody biomass: Determine the total availability of woody resources for energy from timberlands.
- Social availability of woody biomass: Evaluate how social perspective (private ownership, for example) influences availability.
- Public policy promoting woody biomass: Explore the impact of public policy on the use of woody biomass.

BEST CROPS FOR THE JOB

This study compares annual crop, perennial grass, and short-rotation woody crop production systems for biofuel feedstock production across a latitudinal gradient from central Missouri to central Arkansas.

A wide range of plant species and production systems have been suggested as potential sources of biofuel feedstock. Systems that have garnered particular attention include perennial switchgrass, short rotation woody crops (willow and poplar), and annual crops (corn, soybean and sweet sorghum). Corn and soybean are widely grown in Missouri and Arkansas and are currently the most important sources for bioethanol and biodiesel production in the U.S., but alternatives such as production of switchgrass, sweet sorghum and short-

rotation woody trees for biofuel feedstocks could diversify small farm income streams and provide ecosystem services.

In addition, they offer small farms the flexibility of alternative uses; switchgrass and sweet sorghum can be used for grazing or as stockpiled forages. Sweet sorghum is also used for small-scale molasses production on numerous farms in the Midwest and Southeast. Short-rotation woody crops could be used for pulp or left to accumulate more biomass and harvested in later years.

Plots were established in 2010 at USDA-ARS, Booneville, Ark., Southwest Center, Mt. Vernon, Mo., and at the Horticulture and Agroforestry Research Center, New Franklin, Mo. A screening of willow and cottonwood genotypes was conducted at Booneville and the Southwest Center to compare the growth of the willow and cottonwood genotypes chosen for the study with a broader set of clonal material.

Preliminary research suggests that sweet sorghum bagasse has potential as both a direct combustion biofuel feedstock and as livestock forage.

In 2011, researchers plan to establish willow clones at Booneville and at the Southwest Center, and plant another biofuel species into the current study.

RPM TREES AS BIOMASS

This study is part of a Mizzou Advantage grant to establish biomass/bioenergy plantations to educate landowners on

management and determine the economic data. So far, researchers have determined that trees established using the Root Production Method (RPM) had up to twice as much above-ground biomass weight as the bare-root trees of the same age.

These results suggest RPM trees could be used in an agroforestry practice as a way of increasing carbon sequestration and biomass production. In addition, RPM trees can be used as a fast-growing addition to vegetative environmental buffers, windbreaks and shelterbelts.

SEE IT IN OPERATION

Researchers are establishing and maintaining an operation-scale bioenergy plantation to educate private landowners on how to manage and economically produce green energy. As part of a Mizzou Advantage grant, willow, cottonwood and silver maple will be planted.

SPOTLIGHT: MEDICINALS/SPECIALTY CROPS

TRUFFLE

The goal of UMCA truffle research is to develop reliable guidelines and production methods for cultivation of the Burgundy black truffle in the central and south-central U.S.

MU plant pathology research scientists Dr. Johann Bruhn and Dr. Jeanne Mihail are working to develop a seedling inoculation system for introduction of key “helper” bacteria along with the Burgundy truffle fungus; develop a system for inoculation of existing trees in the field, to shorten the time to orchard production; and guide the establishment of privately owned research and demonstration truffières in Missouri and Arkansas.

In the field and lab, UMCA researchers are working to identify the most abundant strains of bacteria isolated from Italian Burgundy truffles, some of which

may prove critical to improved truffle cultivation either as helper bacteria or as plant growth-promoting bacteria. For comparison, researchers also will identify bacteria from truffières in Sweden and in Missouri.

Though fruiting has not yet been detected, truffle fungus mycorrhizae continue to survive in the field. UMCA’s truffière should begin to yield fruit in the near future.

Studies will continue to explore means for introducing functionally important bacteria into both greenhouse seedling production systems and plantation establishment methods. Other studies include determining the best lime sources for optimal soil pH.

Researchers have recently published a landowner guide ready for describing the growth of Burgundy black truffle in Missouri. This oft-requested guide fea-

tures sections on choosing a tree species, characteristics of a good plantation site, site preparation, plantation maintenance, harvesting and cooking with truffles.

ELDERBERRY

UMCA researchers Andy Thomas and Patrick Byers are beginning to study viruses and microscopic eriophyid mites that affect elderberry and are establishing a four-year replicated nitrogen fertility study at two sites (Mt. Vernon and Mountain Grove, both in southern Missouri.)

The cultivar “Wyldeewood” was released in 2010; “Bob Gordon” is scheduled to be released in early 2011.

UMCA researchers are also working on plans to host an international elderberry symposium – the first ever of its kind – in 2013.

MU center to study elderberry



IN 2010 THE UNIVERSITY OF MISSOURI WAS AWARDED \$7.6 MILLION to become one of five new National Institutes of Health Botanical Research Centers.

MU’s Center for Botanical Interaction Studies is one of five in the country selected to lead interdisciplinary and collaborative research on botanical dietary supplements.

The majority of Americans take dietary supplements, spending \$25 billion a year on such products as herbs and other botanicals.

“Despite their widespread use, the safety and efficacy of these products have not been adequately studied,” said Dennis Lubahn, principal investigator of the project and a professor of biochemistry and child health in the School of Medicine and College of Agriculture, Food and Natural Resources.

The Center for Botanical Interaction Studies will focus on five different plants and their abilities to aid in the prevention of strokes and prostate cancer, as well as improve resistance to infectious diseases. Botanicals that will be studied include soy; garlic; elderberries; sutherlandia, a common medicinal plant in Africa; and Picrorhiza, an herb that grows primarily in the Himalayan mountains.

A team of more than 20 scientists at MU – including those affiliated with the Center for Agroforestry – will study how the botanicals use antioxidant properties to protect people from disease.

SPOTLIGHT: GOING GLOBAL

THE CENTER FOR AGROFORESTRY AT THE UNIVERSITY OF MISSOURI has worked hard to conduct basic and applied research and implement agroforestry practices in Missouri and the Midwest since its inception in 1998. In 2010, UMCA expanded their view globally, with international collaborations in the form of visiting scholars, memoranda of understanding and presentations in far-off countries. Agroforestry is commonly used in many developing countries, with multiple plant and animal species on the same piece of land managed as a single production system. Exchanging knowledge with cultures where agroforestry has been around for centuries, and sharing the Center's research findings and techniques with others world-wide, is a new focus at UMCA. In 2010, for example, the Center broadcasted its inaugural symposium to a world-wide audience via the Web.

A NEW 'UNDERSTANDING'

The Center for Agroforestry has established formal research or other collaborative ties with three international universities:

- UMCA signed a formal Memorandum of Understanding with National Sun Yat-sen University, Kaohsiung, Taiwan. Dr. Chung-Ho Lin has worked with the Taiwanese university.
- UMCA signed a formal Memorandum of Understanding with Quaid-i-Azam University, Islamabad, the top national university in Pakistan.
- UMCA signed a formal Memorandum of Understanding with University of Abomey Calavi in Benin. Professor Brice Sinsin, the Chancellor of the University and an agroforestry researcher, visited The Center prior

to signing the agreement.

- In conjunction with a Memorandum of Understanding under development with Uppsala University spearheaded by Dr. Johann Bruhn, Sweden, colleagues from both UU and MU will study bacterial communities of Swedish Burgundy truffle mycorrhizae.

WORLD-WIDE AUDIENCE

Shibu Jose was part of a group of international experts who shared experiences in native species reforestation and land restoration projects, Jan. 21-22, 2010, in Panama.

The Environmental Leadership and Training Initiative, ELTI, and the Native Species Reforestation Project, PRORENA, joint initiatives of the Smithsonian Tropical Research Institute and the Yale School of Forestry and Environmental Studies, hosted the group at the Smithsonian's Earl S. Tupper Center.

Jose was one of the invited experts to the conference. He chaired a session on "Native Trees in Agroforestry and Silvopastoral Systems," giving talks both to kick off and close the panel.

In addition, Jose gave a sub-plenary talk at the XXIII International Union of Forest Research Organizations World Congress on the future of North American agroforestry.

The Congress took place Aug. 23-28, 2010, in Seoul, Republic of Korea, and was themed "Forests for the Future: Sustaining Society and the Environment." It drew more than 2,700 participants from 92 countries, the largest number of

participants in the Congress' history.

GOOD HOSTS

In 2010, the Center hosted visiting scholars from around the globe, including:

Nazif Ullah, who spent six months at the Center. Nazif arrived in Columbia in late February 2010 from Quaid-i-Azam University, Islamabad, the top national university in Pakistan. He is a Ph.D. student studying biochemistry; his stay was supported by the Higher Education

Shibu Jose explained that the study program to visit another, developed country, is "highly competitive" in Pakistan. Nazif approached Jose about the possibility to study with him while Jose was at the University of Florida; Nazif said he decided to contact Jose due to papers Jose had published on phytochemicals and black walnut allelopathy. Although Jose had since joined The Center for Agroforestry, both he and Nazif said the resources at The Center were better suited for Nazif.

Nazif's research looks at bioactive phytochemicals in plants indigenous to Pakistan. Extracts were shipped from Pakistan, for analysis in MU's labs. Nazif also helped with similar research alongside UMCA's Chung-Ho Lin, looking at bioactive phytochemicals in Eastern Redcedar.

Dr. Daouda Sidibe of Mali's Institute for Rural Economic Development collaborated with UMCA researchers for 10 weeks in the fall of 2010 as part of the Norman Borlaug Fellowship Program sponsored by the USDA Foreign Agriculture Service. Dr. Francisco Aguilar,



ABOVE LEFT: Dr. Daouda Sidibe, from Mali's Institute for Rural Economic Development. ABOVE RIGHT: Nazif Ullah, visiting scholar from Pakistan.

assistant professor, forestry, served as mentor to Sidibe, as part of the program. Sidibe holds a B.S. in Fisheries and Aquaculture (Institute PR de Katibougou), M.S. in Forestry (Wageningen Agricultural University, Nether-

lands), and a Ph.D. in Agroforestry (University of Wales). He made contact with experts at The Center and across the region to help with his work back in Mali, which includes forestry extension; Sidibe also toured HARC and attended the Missouri Chestnut Roast.

“My goal is to collect as much information as possible; to create contacts with researchers in many fields to develop collaborations; to create networking between my institute in Mali and the School of Natural Resources in Missouri; to acquire knowledge and experience in the area of natural resources management,” he said. “Agroforestry is a science, so the techniques can be modified and adapted to many situations.”

Norman E. Borlaug International Agricultural Science and Technology Fellowships help countries strengthen sustainable agricultural practices by providing scientific training and collaborative research opportunities to visiting researchers, policymakers and university faculty.

Dr. Thi Ho, Division Manager, Cuulong Delta Rice Research Institute worked with Dr. Chung-Ho Lin and Dr. Felix Fritschi from Sept. 2010 (into 2011) conducting research entitled: Exploration of novel allelopathic compounds from the roots, shoots and leaves of popular rice varieties cultivated in the Mekong Delta of Vietnam, sponsored by the Vietnam Education Foundation (VEF).

Dr. Lei Yang, Professor of Civil Engineering at National Yi-Shan Sun University, worked with Dr. Chung-Ho Lin from 2009-2010 conducting research on phytoremediation of petroleum pollutants. He was sponsored by the Taiwanese National Science Council.

Dr Ning Li, Associate Dean and Professor of Environmental and Biological Engineering at Chongqing Technology and Business University, and nine colleagues, visited the lab or Dr. Chung-Ho Lin in November of 2010, to review the bioremediation research being developed at UMCA.

Dr. Chuanren Duan, Associate Professor, College of Bioengineering at Chongqing University, China, worked with Dr. Chung-Ho Lin from Sept. 2010 (into 2011) conducting research on the bioremediation of munitions explosives. He was sponsored by the China Scholarship Council.

Three senior officials from Mongolia visited with Dr. Chung-Ho Lin and The Center for Agroforestry for two weeks during February of 2010 to explore collaborative opportunities with the government of Mongolia. Visitors included the Deputy Director of the Mongolian Forestry Bureau; the Vice-Chairman of the Buir City Council and the Vice chairman of Keyoungian banner (equivalent to a county in Mongolia).

Chung-Ho Lin International Collaboration and Presentations 2010:

Chung-Ho Lin gave an invited workshop entitled “Decontamination of Dioxin at the An-Shun Site in Taiwan-Bioremediation and Phytoremediation Technologies” to the Taiwanese National Science Council, Taiwanese EPA and China Petrochemical Development Corporation held at the National Yi-Shan Sun University, in December of 2010.

Chung-Ho Lin presented a workshop entitled “Assessing the Strategic Plan for Decontamination of Munitions Explosives Residues in Military Bases” to the Taiwan EPA, Taiwan DOD, and National Yi-Shan Sun University in Taiwan, December 2009-January 2010.

Chung-Ho Lin presented an invited workshop entitled “Introducing Biological Agents for Bioremediation of Dioxin: Assessing its Potential for Decontaminating the An-Shun Site in Taiwan” in collaboration with scientists from the University of Michigan, Brookhaven National Laboratory, Missouri University of Science and Technology, and CH2M Hill. The workshop was presented to members of the China Petrochemical Development Corp, National Yi-Shan Sun University and the Taiwanese EPA, December 2009-January 2010.

SPECIALTY CROPS

UMCA's specialty crops cluster features research on pecan, black walnut, chestnut, elderberry and pawpaw, including field studies, market and consumer research, financial decision modeling and outreach. The Center supports the nation's most comprehensive research programs for developing 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. Research enhances the availability of quality nursery stock and increases production efficiency and profitability for growers.

CHESTNUT

POLLINATOR DISTANCE

In 2010, a 'Qing' delayed graft failure study was converted into a pollination study. Pollinator tree rows are 30, 60, 90 and 120 feet on the west side of the 'Qing' rows. In addition, one treatment row has pollinator trees 30 and 120 feet on either side. First-year data show much better pollination (more pollinated nuts per bur) where pollinator trees are close by. The 'Qing' row 120 feet from a pollinator had 70 percent blank burs while the 'Qing' row with pollinators 30 feet on either side had 18 percent blank burs.

GERMINATION AND GROWTH POTENTIAL OF CHINESE CHESTNUTS FOR SEEDLING PRODUCTION

Researchers looked to see the most desirable chestnuts to use when producing seedlings. Seedlings are preferred by some growers for their lower cost compared to grafted cultivars. A study was conducted using side and wafer (middle) nuts of varying nut weight classes (2 to 18 g) to evaluate percent germination and seeding vigor. Wafer chestnuts in weight classes of 10, 14 and 16 grams had greater percent germination (93-99%) than side chestnuts of similar weight classes (80-84%). By the end of the first growing season, seedlings produced from side and wafer chestnuts from 14-18 grams had the greatest dry weights. Thus, wafer chestnuts in the heavier weight classes appear to be the most desirable for seedling production.

PROPAGATION OF CHESTNUT TREES

Grafted chestnut trees start bearing at an early age and are more productive than seedling trees. However, chestnut trees do propagate. A study was conducted in 2010 to determine the effect of three moisture levels in the growing media on whip-and-tongue grafting success of Chinese chestnut seedling rootstocks. Stock grafted at 48, 56 or 62 percent soil moisture content had 75, 25 and 20 percent bud take, respectively. Results from this study will enhance nursery propagation of chestnut trees and should reduce tree cost.

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 were the results in a tight spacing of 4 x 8 meters for open center-pruned 'Qing'. However, tight spacing also requires increased management and labor costs.

TASTE TEST

Various chestnut species share several common sensory attributes but vary in intensity ratings of descriptors: peelability, initial firmness, dissolvability, and flavors. Of these attributes, sweetness has been associated with consumer acceptance and can be promoted in the marketplace.

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. This project is the first step towards an effective sustainable management strategy of chestnut weevils and is essential for the continued growth of the chestnut industry.

In 2010, researchers completed identification of the volatile organic chemical (VOC) profile of chestnut plant tissues, identifying 45 and selecting 31 for further examination. Fourteen chestnut VOCs appear to be the most important to host location by adult weevils. Volatiles coming off of the bur spike were the most attractive to female weevils, which was surprising to researchers.

BLACK WALNUT

AMBERS

At HARC, 16 cultivars were evaluated for ambers. In 2010, 'Davidson' and 'Thomas/Myers' had less than 3 percent ambered nuts/tree. However, 'Emma K' trees averaged 16 percent ambered nuts with other cultivars producing less than 10 percent ambered nuts.

Anatomical studies revealed the embryo axis of ambered kernels is reduced in length in late July and never fully develops as compared to those in unaffected kernels by harvest. Certain bacteria were cultured from ambered kernels while these bacteria were absent in non-ambered kernels.

WALNUT DESCRIPTORS

The long-term goal of this work is to characterize all of the accessions in our repository collection as well as identify

specific cultivars to include as potential parents in an applied breeding program. In 2010, a total of 21 different phenological and morphological “orthodox” descriptors (e.g., date of budbreak) were recorded for all black walnut cultivars planted in replicated clonal repositories at HARC. These descriptor data continue to guide our efforts to develop new cultivated varieties through our applied breeding program by providing insights as to which cultivars are both productive and well-adapted to Missouri growing conditions. Nut productivity data was collected on all trees for the ninth consecutive year, along with individual tree diameters. These data provide us with cumulative yield and annual cropping information based on both tree size and tree age.

Genotyping work in collaboration with the University of Notre Dame, Indiana, will lead to the creation of two black walnut mapping populations.

MARKER-ASSISTED SELECTION

Marker-Assisted Selection will enable us to grow trees for 10 days instead of 10 years to see if they have the traits we’d like. In 2010, we were successful in establishing a full sib black walnut seedling population (n=290) (mother and father (pollen source) both known) that will be used to develop a “genetic linkage map” for this species. This map will enable us to define those regions of the black walnut genome that are associated with specific traits of interest, such as high nut kernel percentage. Ultimately, this capacity to relate specific “gene markers” to commercially important traits will allow us to select individuals based on their genetic makeup at a very young age, rather than waiting years to assess a specific trait such as disease resistance. This tree breeding approach is called “marker assisted selection” (or MAS), and it will allow us to greatly increase the efficiency of our black walnut breeding program.

TAKING LEAD WITH THOUSAND CANKERS

The Black Walnut Breeding Program is looking for resistance to Thousand Cankers Disease (TCD) to determine if genetic differences in TCD tolerance/resistance may exist within black walnut in a “real world” environment (e.g., in the presence of both the fungus that causes TCD and the insect that helps spread it).

FOURTH CLONAL REPOSITORY ESTABLISHED

A total of 45 new accessions were established in a fourth clonal repository at HARC in fall 2010. These recent additions



Photo of black walnut by Liz Huff, Owner, Catalpa Restaurant, Arrow Rock, MO.

represent promising new nut selections supplied by members of the Northern Nut Growers Association, Rutgers University, University of Nebraska, Morton Arboretum and Arnold Arboretum. Six of the accessions will serve as pollen sources for the production of interspecific walnut hybrids that may have value in a future breeding program targeted towards Thousand Cankers Disease resistance. Data will be added to the Web-based black walnut cultivar summary, available online at <http://extension.missouri.edu/publications/DisplayPub.aspx?P=XM1001>

MEASURING TREE CROWN SHAPE

Black walnut trees planted eight to 15 years ago at the MU Southwest Center and the Horticulture and Agroforestry Research Center possess different tree crown shapes and branching patterns. A new project has been designed jointly with Dr. Dave Larsen, MU department of forestry, to quantify crown

SPECIALTY CROPS

shape and structure differences so they can be used in analysis of production and quality. Geneticists have long known black walnut trees possess strong genetic traits that vary by family. In addition, there is an environmental factor that interacts with genetics to produce the observed crown size and shape characteristics of a given tree crown. As part of the study, Larsen will use measurement and photographic techniques developed in other forestry research projects.

ZINC DEFICIENCY

A study was conducted over four years at the Southwest Center to evaluate the importance and effect of zinc foliar sprays on the performance of mature, nut-producing black walnut trees (two cultivars). Results show the zinc didn't make much difference in the trees' performance.

AND ON TO THE FUTURE

A new 9-acre grafted orchard on lands owned by Hammons Products Company near Stockton, Mo., is planned for fall 2011 to be established for rootstock study. This orchard will be large enough to not only facilitate future economic analyses, but also enable researchers to overlay additional treatments in a systematic arrangement to learn the benefits of specific cultural practices over time.

PECAN

NEW CULTIVAR

USDA has released 'Mandan'; tests are ongoing to determine if it is a fit for Missouri.

GENETIC DIVERSITY OF THE OVERALL PECAN POPULATION

Descriptors for bud break, time of flowering and nut shuck split for 2004-2010 were summarized and sent to Dr. Allison Miller, evolutionary biology and population genetics assistant professor, St. Louis University, for her work on genetic diversity of the overall pecan population. Most of HARC's collection has been sampled and is being utilized in developing genetic markers to better characterize genetic diversity based on provenance and important phenological horticultural descriptors.

Northern pecans offer a valuable source of breeding materials for crop improvement, including local adaptation to colder temperatures, and selection for early nut maturity, which may allow trees extra time at the end of the season to accu-

mulate resources, decreasing variability of alternate bearing.

Miller and her team will estimate the genetic variation within the HARC collection and between native and improved trees. In addition, they will associate genetic distance and geographic distance in native accessions. Comparing HARC trees with other pecan collections – what proportion of the total genetic variation for the species is housed within the HARC collection? They have found that genetic variation exists among northern and southern pecan accessions. They will also integrate the genetic data with phenological data to answer the following questions – is there an association between genetic distance and phenological distance? Do genetically similar cultivars exhibit similar phenological traits?

ADAPTABLE?

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.

PAWPAW

The HARC pawpaw cultivar trial is part of a multi-location yield test in collaboration with The Pawpaw Foundation and Kentucky State University; established rootstocks were grafted in place starting in the spring of 2002. Fruit yields were excellent due to high rainfall and moderate temperatures during most of the 2008-2010 growing seasons. HARC yield data compares favorably with a previous pawpaw cultivar trial by Kentucky State, except for a poorer performance by 'Overlees' at HARC. 'Shenandoah', with its overall good yield, pulping characteristics and flavor may be the best general purpose cultivar tested.

In addition to production research, activities are ongoing to study the market and increase consumer awareness. UMCA has organized pawpaw sales and samples at the Columbia Farmers' Market (2008-2010) and sales at Clovers Natural Market (2008). An informational booklet, follow-up survey and a self-addressed, postage-paid envelope were provided for each pawpaw sold to obtain "after-purchase" information. Despite the pawpaw's highly perishable nature, 60 percent rated the taste "very good" and 35 percent "good."

ENVIRONMENTAL SERVICES

Riparian forest and upland buffers are an important agroforestry practice that protects water quality by slowing surface runoff, improving infiltration, reducing sediment transport, removing non-point 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. In addition, researchers are working to see if vegetative environmental buffers can help to reduce odor from large farming operations.

The Iowa State University Agroecology Issue Team has been working closely with The Center for Agroforestry at the University of Missouri for the past 10 years to evaluate the performance of riparian and upland forest buffers and develop management plans to maintain the benefits of buffers over time. Researchers are working to model all current data and scale studies up to larger watersheds.

UMCA UPLAND BUFFER RESEARCH

The Center for Agroforestry's long-term non-point source pollution buffer research in 2010 led to the award of a major NRCS Mississippi River Basin Initiative (MRBI) grant to lead UMCA researcher Dr. Ranjith Udawatta to monitor "edge of field" water quality in response to adoption of approved conservation practices at multiple sites in northeast Missouri.

DEGRADING ANTIBIOTICS, HERBICIDES

Buffer systems tend to harbor atrazine microbial enzyme degraders. Research results suggest that all vegetative buffer systems tested significantly reduced the transport of both dissolved and sediment-bound atrazine, metolachlor and glyphosate (herbicides) in surface runoff by 58 to 72 percent. Four to eight meters of any tested vegetative buffer system also reduced dissolved sulfamethazine (antibiotic) transport in the surface runoff by more than 70 percent. Tall fescue buffers were overall most effective at reducing dissolved the transport of antibiotics tylosin and enrofloxacin in the runoff. The study has demonstrated

that an optimized buffer design may achieve desired agrochemical reductions and minimize acreage removed from crop production.

Among four selected plant species tested, the degradation of the antibiotic sulfamethazine in the rhizosphere was significantly enhanced by hybrid poplar. This also corresponded with significantly stimulated microbial enzyme activities.

The introduction of *Pseudomonas* ADP into rhizospheres rapidly enhanced the rates of atrazine degradation. The majority of atrazine was transformed into harmless carbon dioxide within 72 hours of inoculation. The research team has now developed the first successful quantitative method for tracking these

atrazine-degrading genes in soils.

SYNTHESIZING ENZYMES

Researchers are working to synthesize a potent atrazine-degrading enzyme in the lab – this compound from the root of eastern gamagrass can degrade atrazine in 20 minutes. The spore-based and nanocarbon-based biocatalysts were successfully developed through collaborative efforts with MU Life Science Center, MU departments of engineering, biopathology, biochemistry, and USDA-ARS. These novel biocatalysts were customized to rapidly degrade organic pollutants including agrochemicals (including atrazine) and explosives (TNT, for example) in the environment. Commercial applications are being assessed; two patents have been filed.



Cattle graze up slope from a tree buffer and water source at the Horticulture and Agroforestry Research Center, New Franklin, Mo.

ENVIRONMENTAL SERVICES

APEX MODELING

This model is used to scale up observed benefits to large and complex watersheds with similar soils and landscapes. Over 20 years, the model predicted an 8 percent reduction in annual average runoff and a 25 percent reduction in annual average sediment yield in the presence of buffers compared to no buffers. Based on their calibrations, it appears the APEX model can be utilized to model watersheds. However, the model was unable to simulate specific tree species used within the agroforestry buffers.

Up next, researchers will calibrate and validate the model for three watersheds for runoff, sediments and nutrients. Once a properly calibrated/validated model is available, it will be used to predict critical locations for buffer placement, buffer dimensions and number of buffers for optimum reduction of non-point source pollution.

Another study calibrated and validated a model to simulate runoff and sediment losses and compare buffer effects on non-point source pollution relative to control watersheds (no buffer). Simulations were run with half and double the measured buffer widths, with full continuously grazed or full rotationally grazed pastures, and with half and double the measured stocking rates, to determine the influence on runoff. Wider buffers, rotationally grazing pastures and less stocking densities resulted in the least runoff. This research also will help models scale up to larger watersheds.

CROP YIELD VARIATION

Although there are invaluable environmental, wildlife, societal and economic benefits to the adoption of buffers along the contours of corn-soybean cropland,

no study has evaluated the buffer effects on crop yield variation. This study used GIS data to compare the yields at different distances from buffers.

Results showed corn yields were reduced by 15-49 percent within 0-5 meters of the grass and agroforestry buffers. Soybean yield was not affected by the buffers. To reduce tree interference on corn yields, annual root pruning may be necessary. In addition, the loss of grain yield may be offset by planting value-added trees within the agroforestry buffers.

Future work involves further investigations into the shade effect of trees on corn yield. Other environmental benefits, such as microbial diversity, should be evaluated to understand the benefits and to aid in conducting a cost-benefit analysis.

SOIL QUALITY

Understanding the response of soil properties to management practices over a period of time helps to evaluate whether the management practices maintain or improve soil quality. Previously, soil quality was used to correlate with plant productivity. However, recent studies have expanded the concept of soil quality as the capacity of soil to function within ecosystem boundaries, to sustain biological productivity, maintain environmental quality, and promote plant and animal health.

Enzyme activities and water stable aggregates have been identified as measurable soil quality parameters for early responses to changes in soil management. However, the research literature lacks information on those parameters in grazing pasture systems with agrofor-

estry buffers. Despite improvement in certain soil quality parameters, grazing systems can result in soil and water quality degradation. Establishment of perennial vegetative buffers with tree and grass species can be a potential solution, as these trees contribute significantly to greater soil carbon sequestration, and improve soil quality and landscape diversity.

Researchers looked at the effects of agroforestry buffers, grass buffers, grazing pastures and row-cropping on various soil quality parameters. One study examined the activities of selected enzymes, water stable aggregates, bulk density, soil organic carbon and total nitrogen as potential soil quality parameters in grazed pastures and row crop systems. Here's what they found:

- Percentage of water stable aggregates was significantly higher in permanent vegetation compared to row-crops; grass buffers had the highest values.
- Significantly higher enzyme activities were found in permanent vegetation treatments compared to row crop, with the exception of one enzyme.
- No significant differences were found in bulk density values, soil organic carbon and total nitrogen contents.

The study shows the establishment of agroforestry and grass buffers in grazing pasture systems helps improve organic matter content in soils, enhances soil microbial activity and helps sustain ecosystem functions.

UMCA researchers discovered that eastern gamagrass rapidly degraded atrazine and hydroxyatrazine. They will now investigate eastern gamagrass root extracts as a source for phytochemicals that degrade atrazine.

BUFFERS AND GREENHOUSE GAS EMISSIONS

Increasing levels of greenhouse gas emissions from agricultural lands has stimulated extensive research to understand the effects of land management practices on soil emissions.

A new study seeks to examine the effects of type and duration of flooding and nitrogen inputs on soil carbon dioxide, nitrous oxide and methane flux; determine the relationships between changes in soil chemical, physical and biological properties with flooding on gas emissions; and assess the use of agroforestry buffers and their effects on soil properties in mitigating greenhouse gas emissions.

ANTIBIOTICS

Researchers are measuring the effects of veterinary antibiotics in soils from agroforestry and grass buffers and cropped areas on the soil microbial community structure and function to determine changes in microbial community characteristics immediately following antibiotic application as well as recovery time.

Results show microbial communities rebound quickly; response curves suggest microbial community function recovers to pre-treatment levels within 63 days. Buffer functions related to the soil microbial community function are predicted to be unaffected by these veterinary antibiotics at test concentrations.

Results also indicate agroforestry buffers, grass buffers and crop systems support different soil microbial communities. Of the three systems, grass buffers support-

ed the greatest overall microbial biomass while the crop/no buffer system supported the smallest amount of microbial biomass. The agroforestry buffer supported the highest populations of total bacteria.

DISSOLVED ORGANIC CARBON

Soil organic matter (SOM) is essential for maintaining crop productivity and soil quality and mitigating pollutant transport through soil. SOM is the largest manageable pool of carbon on earth; increasing SOM can help mitigate carbon dioxide concentration in the atmosphere. Land management techniques, such as agroforestry are hypothesized to influence SOM content, pools, quality and chemistry.

Ongoing research seeks to demonstrate changes in the quantity and forms of carbon and nitrogen in vegetative buffer soils. This work will help elucidate whether or not soil under vegetative buffers sequesters more carbon, which will aid in mitigating atmospheric CO₂ levels and help reduce loss of agrochemicals from farming operations. The ultimate outcome of this research will be the adoption and implementation of more vegetative buffer strips in areas prone to surface water runoff as a means to provide greater ecosystem services in agricultural areas.

ISU RIPARIAN FOREST BUFFER RESEARCH

The goal of much of the UMCA-supported collaboration with Iowa State University (ISU) 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.

RECONNECTING TILES

This study investigates the efficacy of reconnecting drainage tiles to shallow groundwater flow through buffers for removing nitrate. By diverting a fraction of the tile discharge through distributary tiles installed along the top of the buffer, researchers hope to divert a fraction of the tile water into shallow ground water flow through the buffer.

Researchers hope denitrification and sequestration processes known to be active in buffers will remove nitrate before it can enter the adjacent stream.

GULLIES

The main goals of the project are to quantify the amount of sediment, nitrogen and phosphorus contributed to stream flow from stream bank erosion and to identify vegetative communities/land uses that provide the greatest protection from stream bank erosion. What tools can we give our land managers?

ENVIRONMENTAL SERVICES

This is being accomplished by using an erosion pin method to quantify soil losses from stream bank erosion. In addition to the direct impact of streamside vegetation on bank erosion, researchers are also interested in the impact of the numerous gullies that flow directly into the streams through the 15-30 meter-wide strip of riparian forest vegetation. In addition to the sediment these gullies contribute to the stream, they also produce unstable bank conditions in the area of their confluence with the stream channel. Researchers also believe the stream channels in these watersheds are still adjusting their channels in response to the increased discharge from intensive row-crop agriculture and grazing, especially in the last few years with above-normal precipitation events.

Studies show the Water Erosion Prediction Project (WEPP) does not accurately predict ephemeral gully erosion, especially for sediment loss and yield related to ephemeral gullies.

STOCKING RATES AND EROSION

Livestock grazing of riparian zones can have a major impact on stream banks if improperly managed. The goal of this study is to determine the sediment and phosphorus losses from stream bank soils under various livestock stocking rates and identify other factors that have impacts on stream bank erosion in the Southern Iowa Drift Plain.

Results revealed the length of severely eroded stream banks and compaction of the riparian area were positively related to an increase in number of livestock grazing on the pasture stream reaches. While there was no direct relationship between bank erosion and stocking rate, the erosion rates from CRP managed sites were significantly lower than those from grazed pasture sites especially when season, specifically winter/spring, was considered. This suggests use of riparian areas as pasture has major impacts on water quality and channel integrity from increased sediment and phosphorus from bank erosion, and that one of the best ways to reduce this impact would

be the exclusion of livestock from riparian areas.

DOES EROSION GO BEYOND LAND USE?

ISU researchers also are working to determine impacts in addition to land use on stream bank erosion. Study results showed approximately 75 percent of the variability in stream bank erosion can be directly linked to the higher/erosive stream flow and the remaining 25 percent is likely due to stream bank soil antecedent moistures prior to a discharge event, differences in the duration of the high stream stages, and the intensity of the grazing pressure on stream banks.

ODOR ABATEMENT

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.

Data collected through 2010 represent baseline information. The effect from the vegetative environmental buffer on the dispersion of the volatile organic compounds (VOCs), methane and hydrogen sulfide were minimal during the establishment phase. The season of the year has profound effects not only on the composition and concentrations of the compounds, but also dispersion of methane and hydrogen sulfide, which is presumably related to microbial activity or the seasonal facility operation activities.

Researchers also noted that in the case of this particular research location, odor-creating compounds have, so far, been primarily observed within a radius of approximately one-half mile of the facility. As a result, more sampling positions have been established within a radius of approximately one-half mile during 2010 to generate high-resolution data for modeling purposes. Researchers will develop the AERMOD dispersion model and data sets for simulating the effects of the buffers on the dispersion of the odorous compounds before it takes effect.

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

A new silvopasture study is being implemented at three locations: the Horticulture and Agroforestry Research Center, New Franklin, Mo.; MU Southwest Center, Mt. Vernon, Mo.; and Dale Bumpers Small Farms Research Center, Booneville, Ark. The treatments 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.

Data collected will include seasonal forage growth and nutritive value; tree growth; pasture utilization; livestock performance including calf birth and weaning weights, cow conception rates, annual carrying capacity, cow body condition, calving ease and annual feed costs. In addition, this study will measure the respiration rate of cattle, which is a physical sign of heat stress.

STOCKPILING TALL FESCUE IN A SILVOPASTURE

Stockpiling tall fescue for winter grazing of beef cattle in traditional open pasture systems has recently increased in usage since the practice has been shown to decrease winter feed costs substantially. Silvopasture systems have not been extensively studied for stockpiled tall fescue intended for winter grazing. Similar economic advantages may not be imparted to a system if forage and animal response are influenced too heavily by the presence of woody species interspersed throughout the landscape. Forage nutritive value, production and steer average daily gains for the “open”

and “tree” treatments were not significantly different as long as the area occupied by trees was excluded from analyses. When the area occupied by trees was included, the “open” treatment produced more forage than the “tree” treatment. Gain per hectare was significantly different; the “open” treatment produced 424 lbs (193 kg) and the “tree” treatment, 275 lbs (125 kg).

PINE SILVOPASTURE

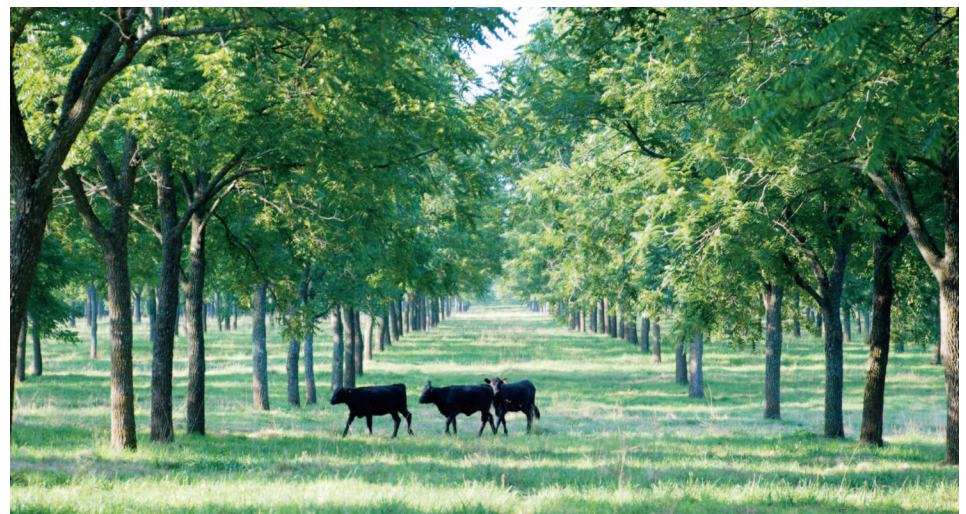
Researchers are looking at two methods: hardwood conversion to pine silvopasture and existing pasture to pine silvopasture. The second method involves a study initiated in 2010.

Both projects aim to develop knowledge, technologies and plant germplasm that permit the sustainable integration of wood fiber, forage and livestock into temperate silvopasture practices that improve farm profitability and optimize environmental benefits.

Findings show:

* Hardwood conversion to pine silvopasture: 30-40 year old shortleaf pine seed can be successfully germinated; outplanted shortleaf survival was excellent.

* Existing pasture to pine silvopasture: Seedling survival is impacted by treatment; control of vegetative competition is essential. Elimination of grass/weed competition is essential to seedling survival. Vole populations impact survival.



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 relationships. 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.

GRASS SODS AS LIVING MULCHES

Studies looked at grass sods as living mulches when establishing black walnut, northern red oak, black locust and pitch x loblolly pine. This study compared the competitive nature of forage grasses grown with trees and evaluated possible interactions between soil moisture, soil nutrients and fertilization. In general, tree growth differences were not attributed to differences in endophyte status, suggesting the tall fescue endophyte has little effect on tree growth in pastures. Lack of consistent interactions with nitrogen fertilizer and/or irrigation indicate neither cultural practice will effectively reduce the detrimental impact of grass sods on hardwood seedling growth. In 2011, researchers will reconfigure plots from this study to begin quantifying how grass sods suppress growth and how much area under tree crowns must be free of grass to have acceptable sapling growth.



A new grafted chestnut planting is intercropped with pumpkins during the establishment phase of the orchard. Photo by Sue Ellen Stouffer of Napton, Missouri.

TIES CLOSER TO HOME

UMCA has spent many years establishing ties with friends of agroforestry closer to home. In 2010, faculty provided their expertise on the national level. UMCA personnel were both invited as speakers (Gene Garrett), and breakout session participants (Shibu Jose and Mike Gold), at a national agroforestry roundtable workshop in Washington, D.C.

The purposes of the workshop were to increase awareness and support for expanding the application of agroforestry across the U.S.; to address the Secretary of Agriculture's priorities, including landscape-scale conservation, climate change, biomass energy, and sustainable agriculture; and to create a strategic

framework to identify the most important future USDA emphasis areas for agroforestry research, development and technology transfer, both nationally and in priority regions/watersheds.

Also in the past year, UMCA (Mike Gold, Mihaela Cernusca and Larry Godsey) collaborated with individuals across the entire region to establish the Mid-American Agroforestry Working Group (MAAWG). The group was created to provide an organization for advancing the science, practice and adoption of agroforestry by landowners and natural resource managers in the Midwest region of the U.S.

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BIOFUEL/BIOMASS

Dwyer, J.P., et al. "Bioenergy plantations: An integral part in the sustainability of the biomass supply chain." \$36,795. Mizzou Advantage Grant. (2010-2011.)

ENVIRONMENTAL SERVICES

Isenhardt, T.M. "Onion Creek Watershed Project." \$540,416. Iowa Department of Agriculture and Land Stewardship. (2010-2014.)

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

Jaynes, D., and T.M. Isenhardt. "Reconnecting Iowa riparian buffers with tile drainage." \$39,881. Leopold Center for Sustainable Agriculture. (2010-2013.)

Lerch, R.N. In-kind contribution, analytical service and supporting staff, Bradford runoff project. \$25,000. USDA-ARS, Cropping Systems and Water Quality Research Unit. (2010.)

Lerch, R.N. In-kind contribution, GC-MS/MS analysis; ESISA analysis. \$15,000. USDA-ARS, Cropping Systems and Water Quality Research Unit. (2010.)

Lin, C.H. "Analysis of TNT using high performance liquid chromatography." \$2,000. Lincoln University Cooperative Research and Extension Programs. (2010-2011.)

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.)

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

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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. (2008-2010.)

Udawatta, R.P., S. Jose, S.H. Anderson, and C.H. Lin. Three separate grants to monitor agricultural watersheds to evaluate effects of terraces, buffers and waterways on NPSP losses. \$340,000. Mississippi River Basin Initiative. (2010-2014.)

Yang, J. "Phytoremediation/bioremediation of munitions explosives and heavy metals in soils." Collaboration with CH. Lin. \$600,000. USDA-NIFA. (2010-2013.)

Yang, J. "Removal of pesticide and heavy metals from aqueous phase by carbon-based nanomaterials." Collaboration with CH. Lin. \$475,000. USDA-NIFA. (2008-2011.)

Yang, J. "Tracking the source and transport of DOM and pathogen in terrestrial aquatic system using fluorescence EEM spectroscopy and molecular biotechnology". Collaboration with CH. Lin. \$499,367. USDA-NIFA-SERD. (2010-2013.)

Yang, J. \$16,000. China Scholarship Council. Collaboration with CH. Lin. (2010-2011.)

MEDICINALS

Gold, M.A., M.M. Cernusca, L.D. Godsey, F.X. Aguilar, E. Barham, A. Thomas. "De-

veloping successful marketing strategies for elderberry growers and value added processors: A model for specialty crop development in the U.S. Midwest. \$105,427. SARE. (2010-2013.)

Lerch, R.N. In-kind contribution, GC-MS/MS analysis, 300 injections. \$7,500. USDA-ARS, Cropping Systems and Water Quality Research Unit. (2010.)

Lubahn, D., et al. "The MU Center for Botanical Interaction Studies." \$7.6 million. National Institutes of Health. (2010-2014.)

Thomas, A., P. Byers, J. Avery, W. Reid, and B. Martin. "Advancement of American elderberry as a Missouri specialty crop by elucidating its pest and disease complex." \$29,611. Missouri Department of Agriculture Specialty Crops Block Grant. (2010-2012.)

Thompson, B., and H.Y. Hsieh. In-kind contribution, conducting assays, providing access to facility, providing cell line. \$24,000. Department of Veterinary Pathobiology, College of Veterinary Medicine. (2010.)

Wong, T. In-kind contribution, service and consulting. \$1,000. Department of Chemistry, University of California, San Francisco. (2010.)

SHADE TOLERANCE

Van Sambeek, J.W. .5 FTE of technical assistance for three months to assist with maintenance of study plots, harvesting and processing of samples. USDA Forest Service. (2010.)

SILVOPASTURE

Dwyer, J.P., and W.D. Walter. Silvopasture research. \$17,062. Wurdack Farm Endowment Fund. (2009-2010.)

Kerley, M.S., and R.L. Kallenbach. "Improving the energetic efficiency of beef cattle." \$462,110. Cooperative State Research and Education and Extension Service. (2010.)

Spiers, D.E., C.A. Roberts, G.E. Rottinghaus, R.L. Kallenbach, T.J. Evans, and R.L. Weaber. "Managed reductions of problems associated with fescue toxicosis at both plant and animal levels." \$272,182. Agricultural Research Service. (2010.)

SPECIALTY CROPS

Coggeshall, M.V. National Science Foundation. "TRPGR: Comparative genomics of environmental stress responses in North American hardwoods." \$357,028 (total NSF award \$3.7 million) (co-PI) Pennsylvania State University, University of Missouri, University of Notre Dame, University of Tennessee, Michigan Technological University, Clemson University, University of West Alabama. (2010-2014.)

Barrett, B.A., W.T. Stamps, and C.H. Lin. "Developing a Strategy for Chestnut Weevil Monitoring." \$15,750. Missouri Department of Agriculture Specialty Crops Block Grant. (2010-2012.)

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.V. "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. (2009-2011.)

Coggeshall, M.V. USDA Forest Service Northeastern Area State and Private Forestry Competitive Grant Initiative "Restoration of at risk forest tree species through germplasm conservation: Recovery and Restoration Disease Resistant Butternut (*Juglans cinerea*)." \$18,000 (subcontract) Investigators: Designated state forestry personnel representing Iowa, Indiana, Connecticut, Pennsylvania and Vermont. (2009-2011.)

Warmund, M.R. "Evaluation and characterization of ambers in selected black walnut (*Juglans nigra* L.) cultivars." \$4,995. Northern Nut Growers. (2009-2011.)

Warmund, M.R. Entering passport and yield descriptor data of *Castanea* accessions at the University of Missouri Horticulture and

Agroforestry Research Center into GRIN. \$8,874. USDA-ARS Germplasm Committee Grant. (2010-2011.)

Warmund, M.R., L.D. Godsey, and M.A. Gold. "An economic analysis of a pad-dock vacuum for the mechanical harvest of chestnut trees." \$9,185. Missouri Department of Agriculture Specialty Crop Block Grant. (2009-2011.)

Warmund, M.R., N. Islam, and W.T. Stamps. "Disinfestation of Asian chestnut gall wasp larvae from chestnut scion wood to produce a clean source of nursery stock." \$27,082. Missouri Department of Agriculture. (2010.)

Gold, M.A., K.L. Hunt, M.R. Warmund, L.D. Godsey, M.V. 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.)

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.)



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.

We work hard to extend that knowledge to landowners, natural resource professionals and policy makers around the state, the region and the globe. Research collaborations with international institutions, attending and presenting at conferences globally and hosting visiting scholars from around the world help us all learn from each other.

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University of Missouri

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2010 UMCA highlights

Approved new name, updated Web site design (pg 12)

Created a new online agroforestry master's program (pg 16)

Found redcedar, a common, low-value Midwestern tree, contains chemicals that have been shown to fight MRSA, an antibiotic-resistant staph bacteria (pg 17)

UMCA researchers are part of a \$7.6 million grant to study botanicals, including elderberry (pg 19)

UMCA is going global – creating international collaborations and hosting visiting scholars (pg 20)

Researchers are establishing demonstration areas for various agroforestry practices, including mushrooms, energy plantations, and silvopasture (pgs 13, 18, 29)