15th NORTH AMERICAN AGROFORESTRY CONFERENCE- ABSTRACT PROCEEDINGS

Association for Temperate Agroforestry

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Concurrent Sessions Schedule at a Glance

TUESDAY, June 29

Concurrent Session 1 (9:45 – 10:45 am)

1. Environmental Benefits
2. Community, Culture, and Communication
3. Economic Insights and Financial Tools
4. New Markets, New Products, New Values
5. Advances in Technology Applications
6. Adoption, Adaptation, and Permanence
7. Climate Concepts and Communication

Concurrent Session 2 (11 am – 12 pm)

1. Environmental Benefits
2. Community, Culture, and Communication
3. Production Science
4. New Markets, New Products, New Values
5. Advances in Technology Applications
6. Adoption, Adaptation, and Permanence
7. Climate Concepts and Communication

Concurrent Session 3: Round Table Discussions (1:15 – 2:15 pm)

1. How to use the values of agroforestry systems to create new incentive mechanisms? (Leader: Lieve Borremans)
2. Interdisciplinary language – Can you speak agroforestry? (Leader: Catherine Bukowski)
3. Plan, plant, preside: Early establishment practices for edible agroforestry (Leader: Matt Wilson)
4. Barriers to adoption: Identifying best strategies for landowner and farmer entry into agroforestry (Leader: Steve Gabriel)
5. Agroforestry adoption for mitigating and adapting to climate change: Dialogue and organizing forum (Leader: Connor Steadman)
6. Launching an AFTA agroforestry policy circle for continuous policy analysis and advocacy for advancing agroforestry in the USA (Leader: Gregory Ormsby-Mori)

Concurrent Session 4 (2:30 – 3:30 pm)

1. Environmental Benefits
2. Community, Culture, and Communication
3. Production Science
4. Producer Panel-Establishing and Managing Silvopasture
5. Special Panel- Snapshot of Temperate Agroforestry in Mexico
6. Adoption, Adaptation, and Permanence
7. Special Panel – The 1890 Agroforestry Consortium: Promoting Sustainable Agroforestry Practices in the Southeast

Concurrent Session 5 (3:45 – 4:45 pm)

1. Environmental Benefits
2. Special Panel – Careers in Agroforestry: Finding a Position When Agroforestry Isn't in the Job Description
3. Special Panel – Snapshot of Temperate Agroforestry in Mexico (CONTINUED)
4. Production Science
5. Producer Panel – Establishing and Managing a Forest Farm
6. Adoption, Adaptation, and Permanence
7. Special Panel – The 1890 Agroforestry Consortium: Promoting Sustainable Agroforestry Practices in the Southeast

THURSDAY, June 29

Concurrent Session 6 (9:30 – 10:30)

1. Environmental Benefits
2. Education and Engagement
3. Production Science
4. New Markets, New Products, New Values
5. Special Panel – Land Access: Emerging Opportunities for Agroforestry Adoption, Leader: Rich Straight
6. Special Panel – Looking Ahead: What is a Regional Agroforestry Working Group, Leader: Kate MacFarland
7. Special Panel – The 1890 Agroforestry Consortium: Promoting Sustainable Agroforestry Practices in the Southeast

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Detailed Agenda

MONDAY, JUNE 26

3:00 – 6:30 pm	Registration Open	Commonwealth Hallway
	Posters Setup	Commonwealth Ballroom
	On-campus lodging check-in available	
5:00 – 6:30 pm	Welcome Reception	Commonwealth Ballroom
6:30 pm	Dinner on Your Own	Town

TUESDAY, JUNE 27

7:30 – 8:30 am	Continental Breakfast and Registration	Commonwealth Ballroom
8:30 – 8:45 am	Welcome – John Munsell, Conference Chair Guru Ghosh, Vice President Outreach and International Affairs at Virginia Tech	Colonial Hall
8:45 – 9:30 am	Plenary Keynote – *Agroforestry in North America: There Has Never Been a Better Time for Scaling Up* Eric Toensmeier, author "Carbon Farming Solution"	Colonial Hall
9:30 – 9:45 am	Break	

9:45 – 10:45 am	Concurrent Session 1			
Track	Speaker 1 – 9:45-10:05	Speaker 2 – 10:05-10:25	Speaker 3 – 10:25-10:45	Room
Environmental Benefits	Speaker: Andrew M. Gordon Title: The ecology of tree intercropping systems in southern Ontario, Canada: 32 years of research	Speaker: Maxime Carrier Title: Crop and forage yield in tree-based intercropping systems: A case study from eight farm experiments	Speaker: Adam Kranz Title: Insect pest and natural enemy responses to structural diversity in a production agroforestry system	Brush Mountain A
Community, Culture, and Communication	Speaker: Lieve Borremans Title: Designing valuable agroforestry systems through integration of modeling and participatory approaches	Speaker: Dean Current Title: Adopting living snow fences: Understanding landowner and promoter knowledge, attitudes and practices	Speaker: Catherine Gowan Title: Washington landowner perspectives on growing bioenergy crops: Concerns, challenges, and advantages	Brush Mountain B
Economic Insights and Financial Tools	Speaker: Steven Kruger Title: RootReport: Tracking nontimber forest products and their markets	Speaker: John Fike Title: Identification of factors driving economies of size in silvopasture in the US Southeast	Speaker: Sonia Bruck Title: Modeling the economic potential of silvopasture in Eastern North Carolina and Northeastern Oregon	Room 300
New Markets, New Products, New Values	Speaker: Michael Farrell Title: Birch sap and syrup production potential in the U.S.	Speaker: Michael Gold Title: A competitive market analysis of the US pawpaw industry	Speaker: Emily Lachniet Title: Developing an Appalachian herb processing hub	Room 342

Advances in Technology Applications	Speaker: Michael Demchik Title: Genetic diversity of American hazelnut in the Upper Midwest, USA	Speaker: Van Ho Title: Exploring health benefits of phytochemicals in black walnuts (*Juglans nigra L.*)	Speaker: Ruoshui Wang Title: Effects of water and fertilizer coupling for an agroforestry system in Loess Plateau of China	Colonial Hall
Adoption, Adaptation, and Permanence	Speaker: Joseph Orefice Title: Silvopasture, it's not a load of manure: differentiating silvopasture from wooded livestock paddocks	Speaker: Eric Stanek Title: Productive agroforestry design preferences of land owners in Central Illinois	Speaker: Catherine Mercier Title: Adoption challenges of a silvopastoral subsistence system: Case study in Ranchillo Alto (Chile)	Room 219
Climate Concepts and Communication	Speaker: Gary Bentrup Title: Agroforestry and climate change: What do we know and what can be done?	Speaker: Henry de Gooijer Title: Agroforestry: An option for building resilient Canadian agricultural systems in a changing climate	Speaker: Alain Olivier Title: Strategies for stimulating the scaling-up of agroforestry practices in Quebec, Canada	Room 238
10:45 – 11:00 am	Break			

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11:00 am – 12:00 pm	Concurrent Session 2			
Track	Speaker 1 – 11:00-11:20	Speaker 2 – 11:20-11:40	Speaker 3 – 11:40-12:00	Room
Environmental Benefits	Speaker: Diane Mayerfeld Title: Moving from woodland grazing to silvopasture: How do we meet environmental and farmer goals?	Speaker: Susanne Hale Title: Intensive silvopasture systems for temperate regions: Sustaining black locust and other fodder crops	Speaker: Jerome Osentowski Title: Indoor and outdoor forest farming for year-round food and medicine production, carbon sequestration	Brush Mountain A
Community, Culture, and Communication	Speaker: Amanda Sames Title: Capacity in context: A new framework for contextualizing community capacity in agroforestry	Speaker: Katie Trozzo Title: Grassroots exploration of forest and tree crop livelihoods in Appalachia	Speaker: Catherine Bukowski Title: Urban agroforestry: Landscapes that communicate cultural change and grow community	Brush Mountain B
Education and Engagement	Speaker: Jim Hamilton Title: Protecting your forest farming a$$ets: Best practices for mitigating ginseng production issues	Speaker: Holly Chittum Title: The Appalachian Beginning Forest Farmer Coalition: Member impacts and future developments	Speaker: William Worrell Title: Holiday greenery: An agroforestry and silvopasture opportunity	Colonial Hall

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Production Science	Speaker: Patrick Shults Title: Quantifying root transfer of plant available nitrogen in alley cropping systems	Speaker: Kevin Wolz Title: Production agroforestry: Augmenting alley cropping with multiple species and tree crops	Speaker: Laura Poppy Title: Alley cropping using shrubs to promote ecological diversity in an agricultural production system	Room 300
New Markets, New Products, New Values	Speaker: Raju Soolanayakanahally Title: Bioactive and essential oil profiles from seeds of Canadian agroforestry species	Speaker: Danh Vu Title: Determination of health-promoting phytochemicals in black walnuts (*Juglans nigra L.*)	Speaker: Michael Demchik Title: Yield and genetic diversity of hybrid hazelnut selections, USA	Room 342
Advances in Technology Applications	Speaker: Rico Huebner Title: Development of a GIS-based decision support system for agroforestry and insights to its application	Speaker: Peter Sforza Title: Agroforestry fact sheets of the future: Virtual reality experiences	Speaker: John Munsell Title: PlantShoe: Mobile app citizen science in support of Appalachian forest farming	Room 219
Climate Concepts and Communication	Speaker: Chad Papa Title: Farmers' attitudes and decision-making in response to climate change in agroforestry systems	Speaker: Ryan Huish Title: Assessing a strategy of climate change adaptation for maple syrup producers	OPEN	Room 238
12:00 – 1:15 pm	Awards Luncheon – AFTA Sub-Committee Reports and Member Awards			Commonwealth Ballroom

1:15 – 2:15 pm	Concurrent Session 3: Round Table Discussions	
	Title	Room
Session 1	How to use the values of agroforestry systems to create new incentive mechanisms? Leader: Lieve Borremans	Room 219
Session 2	Interdisciplinary language – Can you speak agroforestry? Leader: Catherine Bukowski	Brush Mountain A
Session 3	Plan, plant, preside: Early establishment practices for edible agroforestry Leader: Matt Wilson	Brush Mountain B
Session 4	Barriers to adoption: Identifying best strategies for landowner and farmer entry into agroforestry Leader: Steve Gabriel	Room 300
Session 5	Agroforestry adoption for mitigating and adapting to climate change: Dialogue and organizing forum Leader: Connor Steadman	Room 342
Session 6	Launching an AFTA agroforestry policy circle for continuous policy analysis and advocacy for advancing agroforestry in the USA Leader: Gregory Ormsby Mori	Colonial Hall
2:15 – 2:30 pm	Break	

2:30 – 3:30 pm	Concurrent Session 4			
Track	Speaker 1 – 2:30-2:50	Speaker 2 – 2:50-3:10	Speaker 3 – 3:10-3:30	Room
Environmental Benefits	Speaker: Blair English Title: Willow biomass potential under riparian production systems in Manitoba	Speaker: Christian Dold Title: Long-term above-ground biomass production in a red oak-pecan agroforestry system	Speaker: Muhammad Waseem Ashiq Title: Nutrient cycling dynamics in purpose-grown energy crops across Canada	Brush Mountain A
Community, Culture, and Communication	Speaker: Stephen Mann Title: Community ecological enterprise hub: Developing healthy eco-cultural systems	Speaker: Katie Trozzo Title: Agroforestry, permaculture, and… shamanism?	OPEN	Brush Mountain B
Production Science	Speaker: Eric Burkhart Title Documenting the source of "wild" ginseng in Pennsylvania: Insights into forest farming participation	Speaker: Eric Wolske Title: Effects of shade on black currant physiology and productivity	Speaker: Ryan Dibala Title: Shade and nitrogen management effects on growth, yield, and nutritive content of red mulberry	Room 300
Producer Panel – Establishing and Managing Silvopasture	Silvopasture Producers: Chris Fields-Johnson, Milton Nappier, and Todd Repass Leader: John Fike			Room 342

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Special Panel – Snapshot of Temperate Agroforestry in Mexico	Speaker: Miguel Uribe Title: Traditional agroforestry systems: A methodological proposal for its analysis and intervention	Speaker: Alejandro Lara-Bueno Title: Effect of the silvopastoralism with sheep in the regeneration and survival of *Abies hickelii*	Speaker: Andres Anchondo-Ortega Title: Agroforestry for Montezuma quail (*Cyrtonyx montezumae*) habitat conservation	Speaker: Maria Edna Alvarez-Sanchez Title: Influence of ornamentals production practices on the soil quality in Puebla, Mexico	Colonial Hall
Adoption, Adaptation, and Permanence	Speaker: James Allen Title: Dryland agroforestry in the Southwest: Can we combine the old with the new?	Speaker: Christopher Burney Title: Adaptive strategies: Suburban lawns into agroecosystems in the American Midwest	Speaker: Connor Stedman Title: Applying permaculture site analysis and design tools to agroforestry planning		Room 219
Special Panel – The 1890 Agroforestry Consortium: Promoting Sustainable Agroforestry Practices in the Southeast	Speaker: Uma Karki Title: Raising goats in the southern-pine silvopasture system: Challenges and opportunities	Speaker: Srinivasa Rao Mentreddy Title: Alley cropping with specialty vegetable crops in pecan and loblolly pine stands	Speaker: Joshua Idassi Title: Alley cropping system: Intercropping of pecan and moringa oleifera to enhance income opportunities for small scale farmers in North Carolina		Room 238
3:30 – 3:45 pm	Break				

3:45 – 4:45 pm	Concurrent Session 5			
Track	Speaker 1 – 3:45-4:05	Speaker 2 – 4:05-4:25	Speaker 3 – 4:25-4:45	Room
Environmental Benefits	Speaker: Gary Wyatt Title: Establishment and potential snow storage capacity of shrub-willow (salix spp.)	Speaker: Beyhan Amichev Title: The Saskatchewan Prairies shelterbelt carbon legacy	Speaker: Zsolt Keserű Title: A special shelterbelt in Hungary – Changes of the organic matter content of the protected fields	Brush Mountain A
Special Panel – Careers in Agroforestry: Finding a Position When Agroforestry Isn't in the Job Description	Speaker: Kate MacFarland Title: Agroforestry opportunities: Where are the jobs and what is the work?	Speaker: Katie Commender Title: Innovative agroforestry opportunities in the non-profit sector	Speaker: Tracey Coulter Title: Agroforestry coordinator: The evolution of an agroforestry program at the PA Bureau of Forestry	Brush Mountain B

| Special Panel – Snapshot of Temperate Agroforestry in Mexico (CONTINUED) | Speaker: Miguel Uribe

Title: Traditional agroforestry systems: A methodological proposal for its analysis and intervention | Speaker: Alejandro Lara-Bueno

Title: Effect of the silvopastoralism with sheep in the regeneration and survival of *Abies hickelii* | Speaker: Andres Anchondo-Ortega

Title: Agroforestry for Montezuma quail (*Cyrtonyx montezumae*) habitat conservation | Speaker: Maria Edna Alvarez-Sanchez

Title: Influence of ornamentals production practices on the soil quality in Puebla, Mexico | Colonial Hall |

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Production Science	Speaker: Gabriel Pent Title: Winter stockpiled forages, honeylocust pods, and lamb performance in hardwood silvopastures	Speaker: Diomy Zamora Title: Impact of managed woodland grazing: The potential for Silvopasture in Central Minnesota	Speaker: Francis Dube Title: Sustainable silvopastoralism in old Andean Nothofagus forests of southwestern South America	Room 300
Producer Panel – Establishing and Managing a Forest Farm	Forest Farmers: Jon Beegle, Jeremy and Stesha Warren, and Rick Taylor Leader: Holly Chittum			Room 342
Adoption, Adaptation, and Permanence	Speaker: Austin Unruh Title: In pursuit of profitable riparian buffers	Speaker: Sonja Brodt Title: The potential of agroforestry as a pathway to sustainability in California agriculture	OPEN	Room 219

Special Panel – The 1890 Agroforestry Consortium: Promoting Sustainable Agroforestry Practices in the Southeast	Speaker: Uma Karki Title: Management of understory vegetation in woodlands with kiko goats	Speaker: Lila Karki Title: Impact of agroforestry educational program: A case of Alabama	Speaker: Colmore Christian Title: Training of African-American landowners in the Southeast in forest land management approaches	Room 238
4:45-5:30 pm	All-hands AFTA Business Meeting			Colonial Hall
5:00-7:00 pm	Share Fair, Open Poster Presentation, Blitz Talks, and Reception Open Poster Presentations from 5:00-6:00pm Blitz Talks begin at 5:30pm			Commonwealth Ballroom
7:00 pm	Dinner on your own			Town

WEDNESDAY, JUNE 28

7:00 – 8:00 am	Breakfast	Commonwealth Ballroom
8:00 – 8:30 am	Load onto buses	Alumni Mall, Squires
8:30 – 4:30 pm	Field Tour Kentland Farm, Catawba Sustainability Center, The Homeplace, Stone Root Farm	SW Virginia
4:30 – 6:00 pm	Return to Campus for Break	
6:00 – 9:00 pm	Locally Sourced Dinner, Old Time Mountain Music, and Called Square Dancing Poster breakdown by the end of dinner	Commonwealth Hallway and Ballroom

THURSDAY, JUNE 29

7:30 – 8:30 am	Continental Breakfast			
8:30 – 9:15 am	Keynote 2 – *Helping Producers Understand Agroforestry* Victor Harris, Editor-in-Chief Minority Landowner Magazine			Colonial Hall
9:15 – 9:30 am	Break			
9:30 – 10:30 am	**Concurrent Sessions 6**			
Track	Speaker 1 – 9:30-9:50	Speaker 2 – 9:50-10:10	Speaker 3 – 10:10-10:30	Room
Environmental Benefits	Speaker: John Graham Title: Use of a spatially explicit model to assess the impact of agroforestry on wild bees	Speaker: Gary Wyatt Title: Vegetative windbreaks for poultry farms	Speaker: John Falco Title: Host biodiversity and tick-borne disease: Implications for temperate agroforestry	Brush Mountain A
Education and Engagement	Speaker: Emily Sigman Title: The Yale Agroforestry Collaborative: New opportunities for university landscapes & integrated study	Speaker: Hannah Hemmelgarn Title: Agroforestry education for HS agriculture science: Curriculum input to classroom implementation	OPEN	Brush Mountain B
Production Science	Speaker: Gabriel Pent Title: Sheep performance and behavior in silvopasture systems	Speaker: Rafter Ferguson Title: Labor productivity of perennial cropping systems on US permaculture farms	Speaker: John Fike Title: Developing programs to support silvopasture adoption in Virginia, USA	Room 300

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New Markets, New Products, New Values	Speaker: Dean Current Title: Market driven conservation and livelihood improvement, new markets for non-timber forest products	Speaker: Steve Gabriel Title: Breaking open the market with dehydrated mushrooms	Speaker: Auges Gatabazi Title: Yield response of two ginger species to water stress		Room 342
Special Panel – Land Access: Emerging Opportunities for Agroforestry Adoption Leader: Rich Straight	Speaker: Rich Straight Title: Agroforestry headwinds and leasing tailwinds: Motivations from USDA and beyond	Speaker: Keefe Keeley Title: Perennial tenure: Adapting long-term leases and other legal vehicles for agroforestry land access	Speaker: Kevin Wolz Title: Vulcan Farm: A farmer perspective on agroforestry leasing	Speaker: Greg Judy Title: Green Pastures Farm: Using leasing to accomplish your goals	Colonial Hall
Special Panel – Looking Ahead: What is a Regional Agroforestry Working Group Leader: Kate MacFarland	Speaker: Badege Bishaw Title: Pacific Northwest Agroforestry Workgroup: An interdisciplinary collaboration for research and Extension	Speaker: Erik Hagan Title: Northeast/Mid-Atlantic agroforestry working group	Speaker: Mike Gold Title: Mid-American Agroforestry Working Group –What has MAAWG learned in seven years?		Room 219

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Special Panel – The 1890 Agroforestry Consortium: Promoting Sustainable Agroforestry Practices in the Southeast	Speaker: Susan Bambo Title: Adoption of agroforestry practices by small landowners	Speaker: Susan Bambo Title: Expanding silvopasture systems through the conversion of Conservation Reserve Program acreages acres	Speaker: Roa Mentredy Title: Fifteen years of agroforestry research and Extension at Florida A&M University: Challenges and successes	Speaker: Colmore Christian Title: Participation of minorities and underserved landowners in cost-share program in the Southeastern US	Room 238
10:30 – 10:45 am	Break				
10:45 am – 12:00 pm	Agroforestry Policy Forum Leader: Gregory Ormsby Mori, Center for Agroforestry at University of Missouri Panelist: Ana Isabel Moreno Calles, Universidad Nacional Autónoma de Mexico Panelist: Susan Stein, Director of USDA National Agroforestry Center Panelist: Maria Rosa Mosquera Losada, President of European Agroforestry Federation Panelist: Henry de Gooijer, Agriculture and Agri-Food Canada				Colonial Hall
12:00 pm	Closing Remarks – Conference Chair Grad student presentation winners announced				Colonial Hall
1:00 – 5:00 pm	Working Group Space Available				TBD

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Keynote Speakers

Eric Toensmeier

Author and Lecturer

Eric Toensmeier is an appointed lecturer at Yale University, a Senior Biosequestration Fellow with Project Drawdown, and an international trainer. He has studied perennial crops and their roles in agroforestry systems for over two decades. He is the author of *The Carbon Farming Solution: A Global Toolkit for Perennial Crops and Regenerative Agricultural Practices for Climate Change Mitigation and Food Security.*

Victor Harris

Editor-in-Chief, Minority Landowner Magazine

Victor L. Harris completed the forestry program at Tuskegee Institute and earned his Bachelor of Science in forestry at North Carolina State University. He was an area forester with the Virginia Department of Forestry, becoming the first Black forester in the history of the agency, then joined the North Carolina Division of Forest Resources rising to the position of assistant state forester. Harris now publishes *Minority Landowner Magazine*, chronicling the challenges and successes of minority farmers, ranchers and forest landowners across the country. He serves as a national outreach consultant, designing and producing minority landowner forestry and agricultural workshops. He is a North Carolina Registered Forester, and a Fellow of the Natural Resources Leadership Institute. He recently served on the Woodlands Committee of the American Forest Foundation and is a past Board member of the Conservation Trust for North Carolina.

Presentation Abstracts

All abstracts are listed according to – Theme, Concurrent Session, Speaker Order

Links to Themes:

Environmental Benefits

Community, Culture, and Communication

Economic Insights and Financial Tools

New Markets, New Products, New Values

Advances in Technology Applications

Adoption, Adaptation, and Permanence

Climate Concepts and Communication

Production Science

Education and Engagement

Panel Discussions

Environmental Benefits

Concurrent Session 1 (Tuesday 9:45 – 10:45 am) Brush Mountain A

Abstract
Environmental Benefits

Andrew M. Gordon, Naresh Thevathasan

The Ecology of Tree Intercropping Systems in Southern Ontario, Canada: 32 Years of Research

Keywords: intercropping, ecology, carbon, nutrient cycling, biodiversity

Tree-based intercropping is a high-value, environmentally-beneficial agroforestry practice well-suited to the climates and soils found in southern Ontario, Canada. Since 1984, researchers at the University of Guelph, Guelph, ON have been investigating ecological processes, crop responses and management protocols on a 30 ha intercropping research site, where a number of commercially-important tree species were intercropped at variable width with a variety of agricultural crops. This paper reports on the collective research conducted on-site over an approximately 30-year period. Results are presented for studies on row orientation, tree and crop physiology, tree-crop root interactions, economics and aspects of nutrient cycling and carbon-related processes. In addition, data is presented on the population dynamics of insects, birds, earthworms, mycorrhizae and crop weeds and diseases.

Initially, the productivity of C3 agricultural crops intercropped with trees did not differ from those in corresponding sole-stand (conventional) systems of crops. But soil organic carbon content and bird and insect diversity increased in the intercropped area. The abundance and distribution of earthworms was higher closer to the tree rows indicating improved soil health. The C sequestration potential in tree-based intercropping systems varied from 2.5 to 3.7 times more than that reported for conventional agricultural fields in the region, depending upon the tree species. With reduced fertilizer use and more efficient N-cycling, tree intercropping could also lead to the reduction of nitrous oxide emissions from agricultural fields by about 0.7 kg haâˆ’1 yrâˆ’1. With respect to water-quality enhancement, carbon sequestration, and biodiversity conservation, intercropping can be placed above conventional agriculture in terms of long term-productivity and sustainability.

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Abstract
Environmental Benefits

Maxime Carrier, Alain Cogliastro, Anne Vanasse, David Rivest

Crop and forage yield in tree-based intercropping systems: a case study from eight farm experiments

Keywords: alley-cropping, total light transmittance, yield components, competition, soil chemical properties

Tree-based intercropping (TBI) systems may provide important environmental benefits, particularly in terms of protecting soil, water, air and biodiversity. Realistic estimates of the effects of TBI systems on crop and forage yields in different farm contexts are clearly needed if the widespread adoption of TBI systems is to occur in eastern Canada. Yield and yield components of maize (one farm), soybean (two farms), common bean (one farm) and forage (three farms) were measured at four distances from the tree rows (spaced from 25 to 90 m apart) in replicated TBI (aged from 2 to 20 years-old) plots and agricultural system (control) plots. Percent total light transmittance (PTLT) and some soil physico-chemical properties were also measured in these experimental plots. Yield of annual crops was more responsive to TBI systems than was forage yield. Spatial yield patterns varied considerably across TBI systems and farms. The greatest yield variation was generally observed at the tree-crop interface (0.5H, where H = tree height). PTLT was an important driver of this yield variation at 0.5H from the tree row. Soil physico-chemical properties were marginally affected by the different TBI systems. This study is relevant because it was conducted at the farm level under operational conditions, which clearly fills a need that has been identified by stakeholders in eastern North America.

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Abstract
Environmental Benefits

Adam Kranz, Kevin Wolz

Insect Pest and Natural Enemy Responses to Structural Diversity in a Production Agroforestry System

Keywords: polyculture, conservation biological control, agroforestry, associational resistance, alley cropping

Production agroforestry systems are premised on ecosystem services that benefit farmers. Conservation biological control is one service of particular importance in crops with low tolerance for pest damage and chemical control, like organic and sustainably marketed fruits. While natural enemy diversity and abundance have been shown to increase with both increased woody plant structural diversity and alley cropping, these techniques have never been tested together, and reductions in pest damage to crops have been inconsistent across systems. I sampled insect communities in a diverse production agroforestry system with three components--(1) alley-planted hay with rows of (2) shrub crops interspersed with (3) tree crops-and tested three hypotheses about how these vegetation components affect insect communities in neighboring components. Since mowing hay is a severe disruption to the insect community in alleys, both predators and herbivores were predicted to move to alternate habitats, including shrubs and trees. My results supported this hypothesis, with insect abundance in each tree and shrub crop increasing immediately after mowing and declining thereafter. I also hypothesized that shrub species composition affects insect communities in adjacent tree crops both in their equilibrium abundance and in their response to mowing. However, preliminary results do not support any effect of neighboring shrub composition on tree insects or their response to mowing. I will be testing each hypothesis for economically important pests and their natural enemies to inform planting and management decisions to maximize pest control.

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Concurrent Session 2 (Tuesday 11 am – 12 pm) Brush Mountain A
Abstract
Environmental Benefits

Diane Mayerfeld, Nicolas Galleguillos, Keefe Keeley, Mark Rickenbach

Moving from Woodland Grazing to Silvopasture: How Do We Meet Environmental and Farmer Goals?

Keywords: silvopasture, soils, grazed woods, brush, shade

Silvopasture is not "cows in the woods;" rather it involves intensive integrated management of trees, forages, and livestock to maintain environmental quality and optimize both short- and long-term profits for the farmer. But what are the specific environmental impacts of contemporary woodland grazing, and what management will mitigate those impacts? And what management is needed for silvopasture do a better job of meeting farmer goals than grazed woodlands?

A survey of the soil and vegetation impacts of grazing on 16 farm woodlands in southwestern Wisconsin indicates that grazing is associated with more bare ground, more brush, and less litter on the forest floor than ungrazed woodlands. Farmers graze woodlands to provide shade and additional pasture area for livestock, and to keep woodlands open. Some landowners are also interested in silvopasture as a tool to restore savanna habitat. Two research projects in southwestern Wisconsin are investigating the effectiveness of silvopasture management in meeting farmer and conservation goals compared to "cows in the woods." Preliminary observations indicate that silvopasture management can meet farmer objectives of providing shade and forage for livestock, and can at the same time increase soil cover compared to both grazed and ungrazed woodlands. Impacts of silvopasture management on the amount of brush present are not yet clear.

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Abstract
Environmental Benefits

Susanne Hale, Baoshan Xing, Wesley Autio

Intensive Silvopasture Systems for temperate regions: sustaining black locust and other fodder crops

Keywords: climate, carbon sequestration, coppice, goats

Intensive Silvopasture Systems (ISS) - integrating livestock, trees, pasture, and woody browse in sustainable ecosystems - are being widely implemented in Colombia. They have been found to provide 3-5 times as much milk and meat production per animal and allow up to ten times higher stocking rates per acre. The Colombian government has provided farmer incentives, funded by the World Bank, to switch from standard ranching practices to ISS, but is finding incentives become unnecessary as farmers learn about the higher profitability of ISS. Other benefits include lower livestock parasite loads, greater animal health and welfare, higher wildlife biodiversity, higher dung beetle populations, and up to 35 times higher carbon sequestration rates per acre than standard agricultural methods. This presentation will focus on the potential for implementing ISS in temperate regions and developing sustainable browse crops, with a particular focus on black locust. The presenting author is interviewing farmers in the Northeast who are using black locust and other woody fodder crops, learning about methods for sustaining these browse crops over time. Topics to be covered include: black locust as browse crop in Europe; methods for increasing tannin digestibility (browse biodiversity, charcoal, nutritional supplementation); potential design for a temperate-climate ISS system.

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Abstract
Environmental Benefits

Jerome Osentowski

Indoor and Outdoor Forest Farming for Year-Round Food and Medicine Production, Carbon Sequestration,

Keywords: agroecology, forest garden greenhouse, perennial polycultures, carbon farming, climate battery, near-net-zero

The objective at Central Rocky Mountain Permaculture Institute has been to put in practice a sustainable way of life while growing food, medicine, and providing education. This has been done by applying methods of farming such as agroforestry, forest farming, and perennial polycultures. These methods have been found to be regenerative to the environment through carbon sequestration, soil-building, climate change mitigation, and the provision of food security. After 30 years of implementing carbon farming methods, the results are agro-diversity, self-sustaining systems, and a consistent provision of food and medicine. These results are exhibited through polyculture plantings in an outdoor forest garden spanning roughly an acre containing about 200 varieties of fruits, nuts, nitrogen-fixing trees, and medicinal herbs, and two indoor forest garden greenhouses (one Mediterranean and one Tropical) containing about 50 varieties of tropical fruits, beans, herbaceous plants and more. The tropical indoor forest garden greenhouse retains a Zone 11 climate zone in a Zone 6 outdoor climate zone with near-net-zero energy consumption through the use of a climate battery, allowing the greenhouse to serve as a year-round food producer. The effort to source food from the forest gardens are minimal compared to annual crop production. The findings at Central Rocky Mountain Permaculture Institute conclude that agroecological methods are not only beneficial, but necessary in order to revive and regenerate the environment and food security.

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Concurrent Session 4 (Tuesday 2:30 – 3:30 pm) Brush Mountain A
Abstract
Environmental Benefits

J. Blair English, Rhonda Thiessen, Raju Soolanayakanahally

Willow Biomass Potential Under Riparian Production Systems in Manitoba

Keywords: riparian buffer, willow, nutrient interception, biomass, biodiversity

Surface water runoff from agricultural lands and municipal drains can contribute to nutrient loading and eutrophication of downstream water bodies like those in the Lake Winnipeg Basin of Manitoba, Canada. Mitigation strategies to reduce runoff loss or to intercept nutrients prior to entering streams and rivers by agricultural producers are limited and can come at a significant cost. Willows are highly effective in utilizing excess water and nutrients due to their rapid growth and extensive fibrous root system. In summer of 2013, a group of agroforestry researchers from Agriculture and Agri-Food Canada (AAFC) implemented a willow riparian buffer project in the Red River region of central Manitoba. The project was designed to examine the effects of willow cutting planting density on biomass yield, nutrient runoff mitigation and biodiversity enhancement using three intra-row planting densities. The willow riparian buffer was planted using *Salix dasyclados* cultivar "India" in a replicated block design using three intra-row spacing treatments: 0.5 m - single row; 1.0 m - single row; 0.75 m - double row Swedish design; and a control grass plot. First rotation harvest results indicate that the biomass produced from the 0.5m planting density generated the highest yield. Additionally, this project has helped characterize how to select buffer management practices that positively impact low-lying sites, enhancing biodiversity activity and the effects of buffer flooding in both amount and duration that ultimately affect the health and productivity of a riparian willow buffer planting.

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Abstract
Environmental Benefits

Christian Dold, Andrew L. Thomas, Tom J. Sauer, Amanda J. Ashworth, Dirk Philipp

Long-Term Above-Ground Biomass Production in a Red Oak-Pecan Agroforestry System

Keywords: Quercus rubra, Carya illinoinensis, leaf area index, carbon sequestration

Agroforestry systems have widely been recognized for their potential to foster long-term carbon sequestration in woody perennials. This study aims to determine the above-ground biomass in a 16-year-old red oak (*Quercus rubra*) - pecan (*Carya illinoinensis*) silvopastoral planting (141 and 53 trees ha-1, respectively) in Fayetteville, AR, from 2007 through 2016. Diameter at breast height (DBH) from all trees was annually measured since 2007. Six oak and seven pecan trees were felled in 2016, and trunks, branches, leaves and nuts were weighed fresh (FW). Total tree dry weights (DW) were estimated with FW-DW ratios, and total leaf area (LA) was estimated with a FW-LA ratio, which was obtained from leaf samples with known LA. Linear and exponential allometric relationships between DBH, DW and LA explained 83% - 98% of data variation. The derived equations and DBH measurements were used to calculate total oak-pecan planting DW and leaf area index (LAI) over time. Oak DW and LAI (2011 - 2016) increased linearly from 9.1 to 30.4 Mg ha-1, and 0.8 to 2.4 m2 m-2 with growth rates of 4.43 Mg ha-1 yr-1 and 0.34 m2 m-2 yr-1, respectively. Pecan DW and LAI (2007 - 2015) increased linearly from 4.8 to 7.1 Mg ha-1, and 0.7 to 1.2 m2 m-2 with growth rates of 0.23 Mg ha-1 yr-1 and 0.05 m2 m-2 yr-1, respectively. Assuming an above-ground C content of 50%, 15.1 and 3.4 Mg ha-1 of C have potentially been sequestered by these oak and pecan trees during the 6-year and 9-year period.

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Abstract
Environmental Benefits

Muhammad Waseem Ashiq, Naresh Thevathasan, Andrew Gordon, Brent Coleman, Amir Behzad Barzgar

Nutrient Cycling Dynamics in Purpose-Grown Energy Crops across Canada

Keywords: nutrient cycling, poplar, switchgrass, purpose-grown energy crops, uncultivated land

Purpose-grown energy (PGE) crops are expected to contribute up to 40% in global biomass energy mix by 2030. Due to modest nutrient requirement, PGE crops can be grown on lands not suitable for conventional crops (uncultivated lands). In this context, the large extents of uncultivated lands in Canada can be utilized for PGE crops production. It is estimated that growing poplar (*Populus spp.*) on 9.5 million hectares of uncultivated lands in Canada can yield up to 380 million tons of biomass. However, realization of this ambitious production potential depends on the sustainability of PGE crops on uncultivated lands. A key aspect of sustainability is the nutrient cycling which governs PGE crops production. The continued availability of nutrients, especially after rapid growth and successive harvesting of biomass is vital to the long-term sustainability of PGE crop production. Nutrient cycling in PGE for example, nutrient removal through harvest and nutrient inputs via atmospheric deposition, nitrogen mineralization, and litterfall has never been researched in Canada. Accordingly, under the mandate of BioFuelNet Canada, a pan-Canadian research network of woody (poplar - *Populus spp.*) and herbaceous (switchgrass - *Panicum spp.*) PGE crops was established on uncultivated lands in 2014 to study nutrient cycling in different eco-climatic regions across Canada. We will present the results of our two years data analysis on nutrient removal (via harvest) and nutrient input (via atmospheric deposition, nitrogen mineralization, and litterfall). We will also discuss PGE crops role in soil carbon sequestration by presenting data on soil carbon.

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Concurrent Session 5 (Tuesday 3:45 – 4:45 pm) Brush Mountain A
Abstract
Environmental Benefits

Diomy Zamora, Eric Ogdhal, **Gary Wyatt,** Dean Current

Gary Wyatt

Establishment and Potential Snow Storage Capacity of Shrub-Willow (Salix Spp.)

Keywords: living snow fences, shrub willows, blowing snow, drifting snow, willows

Living snow fences (LSFs) are rows of trees, shrubs, grasses, or standing corn that are strategically placed to control drifting snow on rural roadways. LSFs are an agroforestry practice that can provide a range of environmental benefits, including wildlife habitat and carbon sequestration. Blowing and drifting snow adversely affects winter driving conditions and increases road maintenance costs. Despite incentives and financial assistance by state and federal agencies, farmer adoption of LSFs is low, due to concerns about removing cropland from production, among others. There has been an interest in using shrub-willows (Salix spp.) as LSFs, because they have been successfully implemented for LSFs in other states and are considered a short-rotation woody crop for bioenergy production. To evaluate the potential of shrub willow LSFs for multiple benefits in Minnesota, a demonstration LSF in south-central Minnesota was established with three cultivars in planting arrangements of two and four rows replicated four times. This demonstration plot was planted on the state highway right-of-way and no private land was taken out of production. Useful research data from this LSF demonstration plot on shrub willows has been documented on establishment, growth, porosity and potential snow storage capacity, as well as effects on soil quality. A shrub willow and common shrub variety plot was also established and growth data was collected. Findings from the LSF plot and 7 specie variety plot will be discussed.

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Abstract
Environmental Benefits

Beyhan Y. Amichev, Murray J. Bentham, Suren N. Kulshreshtha, Colin P. Laroque, Joseph M. Piwowar

The Saskatchewan Prairies Shelterbelt Carbon Legacy

Keywords: farmyard and field shelterbelts, windbreaks, tree growth curves, carbon sequestration rates, carbon market value

Shelterbelts/windbreaks are a century-old agroforestry practice used in the Canadian Prairies to manage soil erosion and fertility loss from farm land. During a five-year project (2011-2016), several shelterbelt research questions were studied for the Agriculture Greenhouse Gases Program (AGGP) of the Government of Canada. This shelterbelt research program focused on: (1) inventory techniques; (2) biomass growth and carbon pools and fluxes; (3) radial tree growth; (4) carbon sequestration under future climate change scenarios; (5) economic and environmental benefits; (6) carbon monitoring field protocols; and (7) legacy shelterbelt designs. Six shelterbelt species were studied in this project as follows: hybrid poplar (HP: *Populus spp.*), caragana (CG: *Caragana arborescens Lam.*), green ash (GA: *Fraxinus pennsylvanica* Marsh), Manitoba maple (MM: Acer negundo L.), Scots pine (SP: *Pinus sylvestris L.*), and white spruce (WS: *Picea glauca Monch Voss.*). There are 51,653 km of shelterbelts (both farmyard and field shelterbelts) in Saskatchewan with a varying number of tree rows. The estimated average C sequestration rate ranged from 1.9-6.3 Mg C km-1yr-1 (per row) in GA=CG<SP<MM<WS<HP shelterbelts (in ascending order). The total ecosystem carbon stocks for the six species was 10.8 Tg C (1 Tg, teragram=1 million Mg), worth $595 million at $15 price-per-MgCO2-eq. About 4.85 Tg C were C stocks additions from shelterbelt planting, 78% of which (3.77 Tg C) occurred in the period after 1990, regardless of when shelterbelts were planted. The results reported in this paper warrant the exploration of shelterbelt management as a viable strategy to mitigate greenhouse gas emissions in Canada.

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Abstract
Environmental Benefits

Veronika Honfy, Attila Borovics, Janos Raso, **Zsolt Keserű**

Zolt Keserű

A Special Shelterbelt in Hungary - Changes of The Organic Matter Content of The Protected Fields

Keywords: soil, tree height, root competence, crop residues, production

Shelterbelts are fading from the Hungarian landscape, whereas deflation remains a serious problem in most of the arid areas of the country, where the soil is temporarily uncovered due to conventional agriculture. Understanding how shelterbelts work may help to promote them, and encourage farmers to consider afforestation. A shelterbelt (originally a bee pasture) was established in 1998 in Földes, where a land of 5 ha was devided into three agricultural parcels and the shelterbelt (as a border) frames these enclosed crop fields, providing shelter from all directions. The positive effect on the protected crop's yield is widely known, but the changes of organic matter content in the soil under the trees and in the enclosed crop fields has not yet been totally revealed. Our very first results showed that the organic matter content in the top 0-10 cm was the highest under the trees, following the rate measured in the middle of the enclosed crop field, and the lowest rate was found in the edge of the crop field, just by the trees. We assume that the phenomenom can be explained by root competition. If the production of the crops is higher further from the trees, then more crop residues remain in the soil, which results in higher organic matter content in the middle of the agricultural field. At this stage, we raise the number of soil samples and their depths, to be able to provide a proper soil map showing the organic matter content of the shelterbelt system.

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Concurrent Sessions 6 (Thursday 9:30 – 10:30 am) Brush Mountain A
Abstract
Environmental Benefits

John B. Graham

Use of a Spatially Explicit Model to Assess the Impact of Agroforestry on Wild Bees

Keywords: wild bee habitat, lonsdorf model, landscape patterns, temperate agroforestry

The establishment of innovative agroforestry systems could provide valuable refugia for wild bee populations that are currently at risk from habitat loss, toxic substances, and new diseases or parasites. Temperate agroforestry systems can provide habitat for and enhance the diversity and abundance of wild bees while benefiting from the pollination services they provide. However, agroforestry systems take years or decades to establish, and it could take even longer to detect the impact on bee populations. To help predict the effect of agroforestry on bees, modelling approaches can be used. The Lonsdorf model is a spatially explicit model that uses floral and nesting resources and bee species attributes to assess pixel-level impacts of different agricultural land cover on wild bees. Since agroforestry systems increase the structural complexity of agricultural landscapes, using the Lonsdorf model to explore the impact of agroforestry on bees requires extra care in calibrating the model and considering bee foraging behavior in complex landscapes. In this presentation, I present lessons learned from using this model to explore alternative agroforestry crops and landscape patterns.

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Abstract
Environmental Benefits

Gary Wyatt, Dean Current, Diomy Zamora, Mike Reichenbach, Sally Noll

Vegetative Windbreaks for Poultry Farms

Keywords: windbreaks, poultry, disease prevention,

In the spring of 2015, more than 9 million birds in Minnesota's primarily commercial poultry flocks died or were euthanized to prevent the spread of the avian influenza disease. The state verified 108 outbreaks among chicken, turkey and mixed-poultry flocks in 23 counties. Researchers and Extension from the University of Minnesota have collaborated to assess research priorities for addressing avian influenza and to identify research/Extension projects that directly address the causes of avian influenza, the reasons some fowl are more susceptible, and the prevention measures that can be taken. We are evaluating vegetative windbreaks planted at turkey barn facilities to determine if these structures can prevent the transmission of avian respiratory viruses. We'll then share these results and recommendations with turkey growers. Our research objective is to prevent disease transmission using vegetative windbreaks. The research team has conducted a literature review of vegetative windbreaks as it relates to turkey disease control. Surveys have also been conducted among turkey farmers (with and without windbreaks) and Soil and Water Conservation District / Natural Resources Conservation Service (SWCD/NRCS) staff in the region to determine the perceived benefits and challenges of windbreaks near turkey barns; setback distances; and tree and shrub species. Mammals and birds will be monitored at selected turkey barns. Educational fact sheets, videos and teaching modules will be created to inform farmers and the industry of the best management practices for use of windbreaks near turkey barns. The current results of this research project will be reviewed at this session.

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Abstract
Environmental Benefits

John R. Falco, Aniruddha V. Belsare, Matthew Gompper, Shibu Jose

Host Biodiversity and Tick-Borne Disease: Implications for Temperate Agroforestry

Keywords: biodiversity, ticks, lyme, reservoir, competence

The extent at which biodiversity and community composition affects ecosystem functioning becomes increasingly important as human impact on the environment proliferates. Agroforestry has been shown to benefit biodiversity through promotion of niche diversification. Variations in host biodiversity can alter the transmission dynamics of certain infectious diseases; however, the relationships between agroforestry, biodiversity and disease have not been researched. Lyme disease, the most prevalent tick-born infection throughout the Northern Hemisphere, is caused by the bacterial agent *Borrelia burgdorferi*. Research has shown that alterations in host biodiversity can lead to reductions in disease prevalence. The goal of this research is to predict the relationship between host biodiversity and Lyme disease prevalence in silvopasture and open-pasture systems. NetLogo is a multi-agent programmable modelling environment where it is possible to develop and manipulate a simulated ecosystem. In this system, both conventional open-pasture and silvopasture environments were used. In each of these environments white-footed mice, the most competent reservoir hosts for transmission of *B. burgdorferi* are present. Simulations were then run to demonstrate how the inclusion of a non-competent host species, cattle, effects mice population dynamics and the overall prevalence of *B. burgdorferi* within the tick community. The outputs of this model make it possible to predict how disease systems react to changes in biodiversity. Model validation will occur through field data from silvopasture systems in Northeastern United States and Germany. This study demonstrates the potential of agent-based modelling techniques for demonstrating the relationship between agroforestry production practices, host biodiversity and disease emergence.

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Community, Culture, and Communication

Concurrent Session 1 (Tuesday 9:45 – 10:45 am) Brush Mountain B

Abstract

Adoption, Adaptation, Permanence

Lieve Borremans, Kris Meus, Erwin Wauters

Designing Valuable Agroforestry Systems Through Integration of Modeling and Participatory Approaches

Keywords: participatory design, simulation, farm model, adaptation, mutual learning

To create successful agroforestry systems, i.e. systems that take maximal advantage of ecological, social and economic synergies, considerable thought and attention should go to the design phase. Up-to-date in Flanders, the focus during the design phase is mainly on farmers' preferences and the compatibility of trees with local climate, ecological and soil characteristics, legal requirements and crops and/or livestock systems. However, less attention is drawn to how agroforestry implementation influences other farm aspects or how well the proposed agroforestry plot is adapted to current (and changes in) market conditions or public policy. This is a result of the limited contact moments between farmer and designers such as scientists and extension officers, which limit the ability to deepen the discussion and create real mutual learning that is beneficial for all parties. To address this, we propose an approach for the design of valuable agroforestry systems that integrates simulation modeling with participatory techniques. More precisely the design approach entails different cycles of computer modeling which are alternated with farmer interviews (narrative walks) and expert focus groups. Such an approach enables virtual experimentation with different constellations of the agroforestry system and allows the combination of different types and sources of knowledge. The approach is tested for an agroforestry system which has aroused keen interest among farmers in Flanders, i.e. free-range chickens with trees and/or short rotation coppice. The ongoing case study will not only document, more in detail and broader than the plot level, which aspects should be taken into account when combining free range chickens with trees, but will also generate insights about the practical applicability and generated outcomes for the farmers and the designers, of such a participatory design approach.

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Abstract
Community, Culture, Communication

Dean Current, Karlyn Eckman, Gary Wyatt, Dan Gullickson, Diomy Zamora

Adopting Living Snow Fences: Understanding Landowner and Promoter Knowledge, Attitudes and Practices

Keywords: KAP methodology, living snow fence, adoption, knowledge, attitudes

The literature is replete with information about landowner constraints and opportunities related to the adoption of conservation and agroforestry practices. Nonetheless there is little information about how to better prepare agency, soil and water conservation district, and other natural resource professionals and employees to better promote conservation and, in this case, living snow fences. We know who does the promoting and interacting with landowners but little about their knowledge base and interest in promoting a practice. If that person interacting with the landowner does not have the necessary knowledge and/or interest in promoting a practice, that will impact their ability to convince landowners to adopt the practice and the success of any outreach efforts. In this project, we worked with the Minnesota Department of Transportation to develop a training program for their engineering and maintenance staff that are engaged in working with landowners promoting living snow fences and other snow control measures. We began by conducting a Knowledge, Attitudes and Practices (KAP) survey and carrying out several meetings with MnDOT staff before and after administering the survey. We used the information generated by the survey to design and implement a training and outreach program for MnDOT and are now starting to see preliminary results of the effort. We will report on our process with MnDOT employees, the effectiveness of the KAP methodology and the preliminary results of the effort including a 2-3 fold increase in blowing and drifting snow control measures.

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Abstract
Community, Culture, Communication

Catherine H. Gowan, Shiba Kar, Patricia Townsend

Washington Landowner Perspectives on Growing Bioenergy Crops: Concerns, Challenges, and Advantages

Keywords: extension, social sustainability, hybrid poplar, landowner willingness, biofuels

The success of bioenergy efforts will depend, in part, on interested, engaged, and informed landowners who are willing and equipped to grow the appropriate feedstocks. We surveyed landowners in Washington State to gain insight on their knowledge of and interest towards bioenergy crops, with a special focus on growing hybrid poplar. The responses indicate that the majority of landowners surveyed are not familiar with bioenergy crops and almost half of the respondents are not interesting in growing a bioenergy crop. The most important consideration for growing any type of crop is profit, followed by soil preservation and land conservation. Respondents cited several challenges to growing hybrid poplar specifically, including making money, technical assistance and materials, big financial investments, and converting back to other crops. Linear regression analysis showed that interest in growing bioenergy crops is correlated with the perceived importance of profit and soil preservation in cropping decisions. The primary factor correlated with willingness to grow hybrid poplar, however, is an interest in new crops. Our study indicates a need for increased education about bioenergy crops and a potential benefit to targeted messaging to certain types of landowners. The results will be used to shape outreach efforts and communication with landowners about bioenergy crops, as well as provide Extension professionals with an increased understanding of the perceived challenges and advantages to growing bioenergy crops.

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Concurrent Session 2 (Tuesday 11 am – 12 pm)
Abstract
Community, Culture, Communication

Amanda Sames

Capacity in Context: A New Framework for Contextualizing Community Capacity in Agroforestry

Keywords: community capitals, fairness, equity, power

Understanding how agroforestry systems work at the community level is critical. Individual farmers do not make decisions in a vacuum; they are affected by relationships with others, agricultural policies, social norms, and a variety of other social, institutional, political and ecological factors. Adopting and maintaining new agroforestry systems also requires the ability to leverage existing resources in the community to make systemic change. Community capacity, the ability of a community to leverage their resources and assets for collective outcomes, is critical to understanding this process. Implementing and maintaining sustainable agroforestry systems requires community capacity. That capacity may be constrained or supported by the context surrounding the community and agroforestry system. Yet, those contextual factors have not been the subject of systematic study. Questions remain about how to incorporate context into a model of community capacity, and how to account for context in efforts to build community capacity. Here, a novel theoretical framework for understanding community capacity in context is proposed. The framework is based on review of both theoretical and empirical research and includes consideration of the role of natural and economic capitals, fairness, equity, power and expectations. Developing a stronger understanding of context is expected to improve the success of community capacity and agroforestry development efforts by strengthening links between theory and practice, and helping communities respond more effectively to opportunities or threats. A research plan to empirically test the proposed framework will also be discussed.

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Abstract
Community, Culture, Communication

Katie Trozzo, John Munsell, Kim Niewolny, James Chamberlain, Michael Gold

Grassroots Exploration of Forest and Tree Crop Livelihoods in Appalachia

Keywords: forest and tree crops, non-timber forest products, rural communities, markets, social dynamics

Trees, shrubs, woodland plants, and fungi offer numerous products we use and sell for food and medicine. People in Appalachia have harvested products from these species for centuries, yet their viability as a source of livelihood is limited. Markets for these forest and tree crops, also called non-timber forest products (NTFPs), are often characterized as informal and bound by price-points that fail to account for the true costs of the crop and producer labor. Some suggest better stakeholder organization across the market chain would help, but none have explored this at the grassroots. Our research focused on the social dynamics, processes, assets, and challenges of an Appalachian Virginia community over three-years as it sought to develop viable forest and tree crop enterprises. We used an action research framework where the researcher lived in the community and participated in and studied the process. We analyzed over 45 documents created by a producer-group that formed as part of the project and conducted 16 semi-structured interviews with producers and community members. Several growers in the group ultimately stepped up to sell into new forest farming markets. Lessons learned suggest that branding harvested material as forest grown helps, but supply chain communication, stakeholder beliefs, and producer cooperation are likewise critical. Also important is process formalization, from harvest timing to product preparation. Over the course of the project market connections were strengthened and results of the data analysis and harvest transactions suggest there is a greater need at this point for networking rooted in belief-based exploration compared to market-oriented learning or advocacy.

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Abstract
Community, Culture, Communication

Catherine Bukowski, John Munsell, James Chamberlain, Paul Kelsch, Kim Nielwolny

Urban Agroforestry: Landscapes that Communicate Cultural Change and Grow Community

Keywords: community food forest, permaculture, urban agroforestry, perennial polycultures, community capitals framework

In North America over 80% of the population now lives in urbanized areas. As population increases, so too do the demands and expectations on urban land-use planning and design to provide multifunctional services and benefits. Urban agroforestry has potential to meet some of these demands. Community food forests (CFFs) are one form of urban agroforestry that has continually grown in popularity over the last three years across the United States. Food forests, also known as forest gardens, are edible perennial polyculture landscapes modeled after a young forest ecosystem. We define CFFs as forest gardens scaled to the community level, built with community input and generally open to the public for harvesting and recreation. We examined the design and management processes of CFFs with emphasis on the social dynamics. Qualitative research methods were used to analyze interviews with initiative leaders, focus groups on project management phases and video tours of sites. We used the Community Capitals Framework as a lens to understand how these systems contribute to natural, human, social, cultural, economic and built assets in a community. Insights on relation of community food forests to permaculture and agroforestry as fields guiding the design and management were also collected. At the end of a three-year study, research results will be highlighted in terms of what these systems mean for urban application of agroforestry, future forecasts for projects and the role agroforestry practitioners can play, thoughts on how landscapes communicate cultural change and what results are relevant for improving agroforestry outreach, communication, and partnerships.

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Concurrent Session 4 (Tuesday 2:30 – 3:30 pm) Brush Mountain B
Abstract
Community, Culture, Communication

Stephen Mann

Community Ecological Enterprise Hub: Developing Healthy Eco-Cultural Systems

Keywords: agroecology, urban agroforestry, permaculture, regenerative enterprises, ecological enterprises

People throughout the world are seeking ways to increase the well-being of their communities, neighborhoods and families. The harmful effects of environmental degradation are having a disproportionate effect on the poor and marginalized families and communities. There are opportunities for the application of agroforestry practices, agroecological science and permaculture design to restore and enhance the living matrix of urban neighborhoods and at the same time develop community capacity and resiliency. The synthesis of these approaches form a framework for the work of Regenerative Ecological Enterprises that can be productive community development tools at the ecosystem/neighborhood level restoring and enhancing ecosystems services. Community Ecological Enterprises are local regenerative businesses that have ecological and social goals as part of their core business mission. Community Ecological Enterprises look for and respond to opportunities to be of service to the community while meeting the economic needs of the business, its employees and partners. The Community Ecological Enterprise Hub catalyzes neighborhoods in the restoration and protection of their ecosystems by incubating viable ecological enterprises.

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Abstract
Community, Culture, Communication

Katie Trozzo, Beth Abernathy

Agroforestry, Permaculture, and...Shamanism?

Keywords: agroforestry, core shamanism, spirits of the land, permaculture design

Have you ever wondered why certain plantings are a success and others not? Many variables are at play that we often consider including the health of the tree, poor soil quality, or not enough water. But, what if there is more? Rarely, if ever, do people consider the energetics and the spirit of the site as a factor in the outcomes. In indigenous cultures across the world, people connect with elements of the spirit realm to inform how they interact with the land. Though these processes have been lost in many ways within Western culture, we can begin weaving them into the fabric of how we relate and create with the land. Core shamanism has identified the commonalities of shamanic practice across cultures and offers us a tool to create this new tapestry. We will share how we merged the permaculture design process with core shamanic practice to collaborate with the spirits of the land on the design of a 12-acre agroforestry system.

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Economic Insights and Financial Tools

Concurrent Session 1 (Tuesday 9:45 – 10:45 am) Room 300
Abstract
Community, Culture, Communication

Steve Kruger, John Munsell, James Chamberlain, Jeanine Davis, Ryan Huish

RootReport: Tracking Nontimber Forest Products and Their Markets

Keywords: nontimber forest products, human dimensions, markets, conservation

The lack of knowledge about non-timber forest product (NTFP) markets remains an obstacle to the adoption and support of agroforestry practices. Few American NTFPs are systematically tracked, meaning that the size and distribution of harvests, value of products and trends in production over time are often unknown. This increases risk for market participants, including growers, and prevents effective management of wild NTFP populations. RootReport (www.rootreport.frec.vt.edu) was created to measure output for one large NTFP sector: medicinal plants grown in eastern deciduous forests. The project was designed to collect data on harvests, and present that data in a format usable for multiple stakeholder groups. A survey was developed and sent out over 3 years to primary buyers of medicinal plants in 15 states. An online version also connects users with other resources, such as materials about growing and managing NTFPs, and other institutions and organizations that support NTFP production. Most of these resources are currently directed towards increasing the cultivation of NTFPs. Since the bulk of these products are still wild-harvested, effective tracking requires the participation of the traditional supply chain as well as the emerging forest-farming sector. Interviews with buyers helped contextualize data, and identified potential deliverables for research and extension programs. Participants also voiced concerns about our work, and other barriers to participation. This presentation will summarize the types of data gathered by RootReport, and explore the potential benefits as well as the perceived risks of participating in NTFP tracking programs.

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Abstract
Economic Insights and Financial Tools

Gregory E. Frey, **John H. Fike**, John F. Munsell, Marcus M. Comer

John H. Fike

Identification of Factors Driving Economies of Size in Silvopasture in the US Southeast

Keywords: scale

Silvopasture has been shown to be potentially profitable in the US Southeast, but financial estimates have typically ignored the impact of operation size on costs and revenues per unit of land area. Various characteristics of silvopasture systems may have a differential impact when operated at a smaller size or by more resource-limited producers, such as: risk mitigation through diversification, input and labor costs, specialty product marketing, and mechanization of management. Economic characteristics of size in silvopasture could create disincentives or barriers to adoption for certain groups. We utilized literature review of parallel land use systems, interviews with key informants, and documentation and financial analysis of case studies to identify factors leading to potential economies and diseconomies of size in silvopasture as it in the US Southeast. Finally, we characterize silvopasture opportunities that may be appropriate at smaller sizes or for limited-resource households, as compared to those that may be profitable at large scale.

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Abstract
Economic Insights and Financial Tools

Sonia R. Bruck, Badege Bishaw, Fred W. Cubbage, Tamara L. Cushing

Modeling the Economic Potential of Silvopasture in Eastern North Carolina and Northeastern Oregon

Keywords: Loblolly Pine (Pinus taeda), Longleaf Pine (Pinus palustris), Ponderosa Pine (Pinus ponderosa), Blue Mountain Region, Coastal Plain

Silvopasture is the planned and managed agroecosystem in which forage, livestock, and trees or shrubs are integrated in order to enhance individual components. We examined silvopasture, forest, and pasture systems in the coastal plain of eastern North Carolina and Blue Mountain region of northeastern Oregon. In North Carolina we evaluated forest and agroforestry systems using loblolly and longleaf pine species. In Oregon we evaluated forest and agroforestry systems using ponderosa pine. We based the analyses on typical forest and cattle regimes; including yields, costs, and prices obtained from the literature, as well as consulted with experts in the respective subjects. Financial viability of land management investments were modeled and determined using capital budgeting criteria of Net Present Value (NPV), Land Expectation Value (LEV), Annual Equivalent Value (AEV), and Internal Rate of Return (IRR). Fourteen total cash flow models were developed using four and six percent real discount rates. Models suggest loblolly pine timber management and cattle management is more profitable than silvopasture management in eastern North Carolina. Additionally, cattle management is more profitable than silvopasture in northeastern Oregon. Longleaf pine and ponderosa pine are not profitable when solely managed for timber, and benefit economically when combined with livestock.

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Education and Engagement

Concurrent Session 2 (Tuesday 11 am – 12 pm) Colonial Hall
Abstract
Education and Engagement

Jim Hamilton

Protecting Your Forest Farming A$$Ets: Best Practices for Mitigating Ginseng Production Issues

Keywords: ginseng, poaching, vole damage, farm security

The top-three biggest non-disease issues for many wild-simulated and woodsgrown ginseng growers are poaching (theft), deer browse, and voles. Over the last 5 years, Cooperative Extension has been working with ginseng growers in northwestern North Carolina to address these issues. In 2014, Watauga County was home to the first felony conviction of ginseng theft on private property in North Carolina due in part to a coordinated and proactive educational approach directed towards law enforcement and the district attorney's office. Best practices for "ginseng security" on and off the farm will be addressed.

Observations on successful deer & vole mitigation practices will also be presented. On one large ginseng farm in Watauga County, heavy deer browse and active vole damage was observed throughout the summer and fall of 2015 & spring 2016. A number of "capture/kill" and IPM strategies were deployed to mitigate damage. Observations of successful and unsuccessful methods will be discussed. Additionally, recommendations for future quantitative study will be presented.

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Abstract
Education and Engagement

Holly Chittum, John Munsell, Katie Trozzo

Appalachian Beginning Forest Farmer Coalition: Member Impacts and Future Developments

Keywords: forest farming, program evaluation, training, survey

Many forestland owners are incredibly interested in non-timber forest products and forest farming. Non-timber technical support for these and other stakeholders is increasingly in demand, yet we know very little about who to engage and why they are interested. The Appalachian Beginning Forest Farmer Coalition (ABFFC) is a project dedicated to networking and technical programming that improves forest farming opportunities for new and beginning Appalachian producers. Funded by USDA NIFA, the ABFFC is the first of its kind to focus on forest farming in the beginning farmer program.

Academic institutions, governmental, and non-governmental organizations partner on the project and results from 2016 included recruitment of over 700 members and multiday training events which serviced nearly 200. Diversifying instructional delivery created curriculum continuity across multi-regional events, accounted for diverse learning styles, and peer-to-peer learning. Projections were made regarding attendee needs based on expert opinion and input gathered anecdotally from one community of SW Virginia forest farmers.

To buttress this information, the ABFFC conducted a comprehensive evaluation program at technical trainings in 2016, including pre- and post-event surveys and session evaluation cards and listening posts. Results indicate a diverse but sometimes unique group of forestland owners with a keen interest in generally learning more about forest farming, but also particularly about post-harvest handling, product specification, and value-added.

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Abstract
Education and Engagement

William Worrell

Holiday Greenery: An Agroforestry and Silvopasture Opportunity

Keywords: white pine, holiday greenery, silvopasture

White pine plantations can be tipped for greenery to make holiday decorations while a landowner is growing the trees on a timber rotation of 35-40 years. Native greenery (pines, etc.) is used for traditional Christmas decorations (i.e. wreaths, garland, and swags). The raw material used to make the products can be taken from Eastern white pine trees, boxwoods, and evergreen varieties of trees that are used for Christmas trees. The greenery industry has been growing and the demand for the raw material is strong. Landowners can generate income from white pine plantations in the first decade by selling raw material into this industry and then grow the white pine trees to maturity for a timber harvest. Landowners could plant idle lands or poor farmland into white pine plantations and then sell raw material to the holiday greenery industry to earn early income from their forest. There are opportunities to include white pine trees in a silvopasture system and sale white pine tips into the greenery industry for a quicker return on investment.

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Concurrent Session 6 (Thursday 9:30 – 10:30 am) Brush Mountain B
Abstract
Education and Engagement

Emily Sigman, Asha Bertch, Yasha Magarik

The Yale Agroforestry Collaborative: New Opportunities for University Landscapes & Integrated Study

Keywords: campus landscape, socio-ecological gradient, interactive demonstration, urban-rural agroforestry, agroforestry engagement

The Agroforestry Collaborative was formed by a group of Yale graduate students, faculty, and staff working jointly to create interactive agroforestry spaces throughout the Yale campus. The collective currently comprises four sites, developed over the past three years in and around the campus: (1) a central courtyard converted into forest garden located between two campus buildings, (2) a one-acre urban farm with 1/3 developed into an agroforestry berm, (3) a peri-urban half-acre of fruit orchard and perennial crops, and (4) a half acre of forest orchard and edible understory located in the Yale Myers forest.

The aim of the collaborative is to serve a variety of needs, including recreation, research, and education. We see these agroforestry sites as living laboratories for both short and long-term engagement, where students and the public can develop personal relationships with agroforestry systems through training, workshops, and installations. Each individual site functions as an interactive demonstration of agroforestry techniques in the Northeast. Collectively, the sites represent a gradient of socio-ecological conditions for study, including urban-rural, traffic, sunlight, and plot size. These spaces "considered both separately and in aggregate" offer prime field conditions for innovative student and faculty agroforestry research, and we propose several topics for future use and study

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Abstract
Education and Engagement

Hannah Hemmelgarn, Michael Gold

Agroforestry Education for HS Agriculture Science: Curriculum Input to Classroom Implementation

Keywords: experiential education, agroforestry, high school agriculture science, curriculum, professional development program

In 2016, a cohort of agricultural educators from around the state of Missouri attended the first agroforestry curriculum professional development program designed to initiate the integration of agroforestry content into agriculture science high school education.   Thousands of high school students each year gain a foundational understanding of agriculture's diverse focus areas that direct their career paths and the future of agriculture, but the intentional integration of trees with crops and/or livestock has been missing from this realm of education. The University of Missouri Center for Agroforestry's high school agroforestry curriculum takes into consideration the expressed needs and motivations of high school agricultural educators to create a learner-centered, problem-solving and project-based approach broadly termed experiential education. In collaboration with the Missouri FFA and Department of Education, the establishment of an experiential high school agroforestry program provides a context for more widespread understanding and application of agroforestry practices.

In this session, the process of agroforestry curriculum development, educator collaboration, professional development program planning, and project outcomes will be described in order to provide the tools and materials necessary for the expansion of this project to other areas. Experiential agroforestry lesson components and mapping tools for agroforestry education connectivity will be provided.

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Production Science

Concurrent Session 2 (Tuesday 11 am – 12 pm) Room 300
Abstract
Production Science

Patrick Shults, Pascal Nzokou

Quantifying Root Transfer of Plant Available Nitrogen in Alley Cropping Systems

Keywords: nitrogen transfer, sustainability, alley cropping, nutrient cycling, root interactions

To date, research has done little to chip away at the mechanisms influencing below-ground nitrogen relationships between differing species. Due to a common belief that most nitrogen is transferred via the accumulation and subsequent decomposition of biomass, few studies have sought to quantify nitrogen transfer through other identified pathways, such as common mycorrhizal networks and living root exudates. However, studies that have focused on these modes of transfer have shown intriguing results, indicating that root exudates alone can account for between 25-66% of total nitrogen within the recipient species.

To take existing research further, this study focused on the direct transfer of fixed nitrogen from an herbaceous legume (*T. pratense* "Dutch white clover") to two tree species (*Castanea sativa* x *C. crenata* ("Colossal" and *Populus nigra L.*×*P. maximowiczii* A. Henry 'NM6') in a greenhouse study. To accomplish this, tracing methods utilizing 15N nitrogen were used. In this process, the donor species (nitrogen fixer) is fertilized with $K15NO_3$ via foliar application and the recipient crop species is then analyzed for nitrogen isotope ratios after a designated growth period to obtain transfer values.

Our study yielded intriguing results consistent with similar experiments. However, the focus on trees as the target crop and herbaceous legumes as the nutrient donor in this study provides a novel development to the field. The findings of this research can contribute to knowledge regarding sustainable nutrient cycling and help improve yields in cropping systems and forest plantations with little cost to landowners and the environment.

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Abstract
Production Science

Kevin J. Wolz, Sarah T. Lovell, Bruce E. Branham, Evan H. DeLucia

Production Agroforestry: Augmenting Alley Cropping with Multiple Species and Tree Crops

Keywords: alley cropping, multi-species systems, tree crops, polyculture, food

Alley cropping is a common agroforestry practice around the world, typically containing rows of a single timber-producing tree species and an herbaceous crop in the alleys. Despite the effectiveness of this practice to date, two major gaps exist in the current research and application of alley cropping, both of which show great promise in improving these systems and should be a top priority for the agroforestry community. The first gap is the diversification of the woody crop rows by leveraging multiple species and/or multiple canopy layers within the rows. Despite the known potential benefits of multispecies systems, the typical alley cropping system still contains monospecific, single-layer tree rows. The second gap is the utilization of food/fodder-producing fruit and nut trees rather than timber/biomass species within the woody crop rows. Many tree crops have longstanding global markets and even have potential as staple food and fodder crops. Production agroforestry is a novel approach to agroforestry that attempts to tackle these two gaps by integrating multiple tree, shrub, and herbaceous species grown together to produce staple food and fodder crops. Effective PA systems are ready now for implementation on marginal lands, while further breeding, design optimization, and policy incentives would accelerate expansion onto core productive lands. Widespread adoption of production agroforestry will require: (1) emphasis on well-developed tree crops compatible with the maize-soybean supply chain; (2) practical designs for mechanized management; (3) complementary crop combinations that provide both early returns and long-term yields; and (4) strategic implementation beginning with marginal lands.

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Abstract
Production Science

Laura Poppy, Blair English, Raju Soolanayakanahally, William Schroeder

Alley Cropping using Shrubs to Promote Ecological Diversity in an Agricultural Production System

Keywords: alley cropping, managed field boundaries, berry shrubs, nitrogen fixing forage, agronomic

Utilizing the vast collection of seabuckthorn (*Hippophae rhamnoides)* and buffaloberry (*Shepherdia argentea*) germplasm at Agriculture and Agri-Food Canada (AAFC) the study looked at agronomic aspects of an alley cropping system to investigate the bio-physical interactions (e.g. fertility) of the berry producing shrubs with field crops both annual and perennial based. Two study sites were established in 2014: one at Indian Head, SK (clay-loam) and the other at Brandon MB (sandy-loam) featuring three alley cropping treatment widths: Traditional/orchard (5 m), Narrow (15 m) and Wide (26 m) and an Open Field (control). The crop components include a nitrogen fixing forage (Algonquin seed alfalfa) and non-N fixing forage (AC Knowles hybrid brome). In addition, carabids were monitored to determine the influence of the shrub margins on the insects' presence and function; Alfalfa Leafcutter Bees (*Megachile rotundata*) were used for seed alfalfa production and their leaf resources studied to determine if either seabuckthorn or buffaloberry were used during cell construction. Microclimate impacts (wind speed, soil & ambient temperature and snow depth) were recorded to determine impacts and influence of shrubs on the cropping systems. Our future focus is to combine agronomic bio-physical data to determine the dynamic interaction between the shrubs, crops and field boundaries and their effects on the ecological diversity (i.e. microbes, pollinators, carabids) and health and productivity of the surrounding agriculture landscape.

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Concurrent Session 4 (Tuesday 2:30 – 3:30 pm) Room 300
Abstract
Production Science

Eric P. Burkhart, Grady Zuiderveen

Documenting the source of "wild" ginseng in Pennsylvania: insights into forest farming participation

Keywords: American ginseng, forest farming, plant husbandry, survey use

Pennsylvania is one of nineteen states in the United States of America (U.S.A.) that exports wild American ginseng (*Panax quinquefolius* L.) roots into the international marketplace. Given concerns over sustainability, there is a need to understand the wild supply chain along with any husbandry involved in the production of exported roots. Since 2012, we have been employing an ethnobotanical approach which gathers confidential information into wild ginseng supplies from Pennsylvania via an annual survey instrument mailed to people involved in the sale of wild ginseng (gathered from licensed buyer transaction logs). Results indicate that a variety of husbandry practices are used to produce ginseng which ultimately is sold and traded as "wild," ranging from intensive agroforestry (e.g., "forest farming") to enrichment plantings. The first five years (2012-2017) has revealed that 23% to 57% of sellers participating in this survey effort indicated that their 'wild' ginseng originated from intentional planting on forestlands. This scenario presents a dilemma regarding interpretation of "wild" harvest data because current industry reporting mechanisms are inadequate to accommodate the complex range of husbandry practices being utilized, and which often result in "wild" appearing roots. Producer concerns and misgivings about issues such as price gouging, theft, taxation – coupled with a lack of consensus around what actually constitutes "wild" – drives secrecy around forest based husbandry and cultivation. We suggest that annual confidential surveying of root sellers could serve as an important tool to help inform ginseng conservation and management programs, and provide insights into public involvement in forest farming.

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Abstract
Production Science

Eric Wolske, Kevin Wolz, Bruce Branham

Effects of Shade on Black Currant Physiology and Productivity

Keywords: understory, woody perennial polyculture, shade tolerance

This research trial is examining the suitability of black currants (*Ribes nigrum*) as an understory crop in a woody polyculture system. An experiment is being conducted on *Ribes nigrum L.* cv 'Consort' to measure the physiological and growth response to varies levels (0, 20%, 30%, 50%, and 70%) of artificial shade. The study is located at the University of Illinois Fruit Research Farm in Urbana, Il. The experiment was initiated during 2016 on 4-year-old black currants.

Initial data from 2016 shows a 5% reduction in yield from 50% shade, with 70% reducing yield by 28%. Fruit ripening phenology was impacted, with a delayed onset of initial fruit ripening by up to 20 days. Brix was statistically similar across all shade levels. Berry quality data on anthocyanin and vitamin C levels will be completed during the spring. This study will continue for two more years to get a better understanding of the long-term effects of shade on black currant production. These preliminary results indicate that black currants can produce excellent yields under partial shading making them a valuable component of a multi-species agroforestry system as an edible understory crop.

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Abstract
Production Science

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Shade and Nitrogen Management Effects on Growth, Yield, and Nutritive Content of Red Mulberry

Keywords: silvopasture, multi-strata agroforestry, nitrogen provisioning, tree fodder, shade

Silvopasture is an agroforestry practice that sustainably integrates trees, forages, and livestock into a single agroecosystem. Multi-strata cropping in silvopastoral systems is scarce in the United States and there is a paucity of information regarding interactions between plant components - particularly native species - in these systems. Red Mulberry (*Morus rubra*) is a species of concern due to encroachment by non-native White Mulberry (*Morus alba*) and its leaves and fruit are likely to serve as alternative, high quality forage. Illinois Bundleflower (*Desmanthus illinoensis*) is a native perennial leguminous forb, but little is known about its nitrogen fixing capabilities and its production in agroforestry systems. The objectives of this study are to 1) assess the height/diameter growth, leaf area index, non-woody biomass, and nutritive value of Red Mulberry planted across a shade gradient in the understory of Cherrybark Oak (*Quercus pagoda*) plantations 2) analyze differences in the above-mentioned variables for Red Mulberry planted in two forage mixes: Orchardgrass (*Dactylis glomerata*) with Crimson Clover (*Trifolium incarnatum*) and Orchardgrass with Illinois Bundleflower and 3) use N15 stable isotope analysis to determine whether simulated grazing around Mulberry shrubs increases leaf N levels and whether there are differences between forage mixes. We hypothesize Red Mulberry will grow optimally in higher light levels, but that leaf crude protein content will be highest in intermediate light levels. Simulated grazing should significantly increase leaf N levels through release and uptake, but we don't expect to see differences among legume treatments.

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Concurrent Session 5 (Tuesday 3:45 – 4:45 pm) Room 300
Abstract
Production Science

Gabriel J. Pent, John H. Fike

Winter Stockpiled Forages, Honeylocust Pods, and Lamb Performance in Hardwood Silvopastures

Keywords: lamb, grazing, forage, silvopastoral, fodder

In a multifunctional silvopasture system, honeylocust (*Gleditsia triacanthos* var. Millwood) trees were established in pastures to provide large, nutritious pods as supplemental fodder for livestock grazing the forage understory. We compared the productivity of lambs grazing in these honeylocust silvopastures to the productivity of lambs grazing in open pastures and lambs grazing in black walnut (*Juglans nigra*) silvopastures in a randomized complete block design (r=3). Forage availability in the honeylocust silvopastures (5130 ±90 kg ha-1), measured with a rising plate meter, was no different (P=0.7580) from forage availability within the open pastures (5050 ±90 kg ha-1). Forage availability was lowest (P<0.0001) in the black walnut silvopastures (3790 ±90 kg ha-1). Nutritive value estimates of tall fescue (*Schedonorus arundinaceus*) samples indicated little difference in forage quality. With randomly placed quadrats, we estimated the pod productivity of the honeylocust trees to be 4370 kg ha 1. Lambs were naive to honeylocust pods and did not readily consume the fodder until four weeks into the trial. Though treatment had no effect (P=0.3763) on system live weight gains over the six week study, lambs within the honeylocust silvopasture had greater average daily gains (P=0.0251) in the final period (0.12 ±0.02 kg day 1) than lambs within the open pastures (0 ±0.02 kg day-1), indicating that lamb gains were increased as they began to consume pods. These data, though preliminary, suggest that honeylocust silvopastures may improve nutrition for grazing livestock and increase overall forage system productivity.

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Abstract
Production Science

Diomy Zamora, Madeline M. Ford, Dean Current, Joe Magner, Gary Wyatt

Impact of Managed Woodland Grazing: The Potential for Silvopasture in Central Minnesota

Keywords: agroforestry, silvopasture, forage, hardwood, cattle grazing

In Minnesota over 170,000 ha of woodlands are grazed. Most of these woodlands are not specifically managed for timber or cattle resulting in decreased timber value and reduced forage yields. Introducing Silvopasture practices has the potential to increase the benefits from cattle and forest production while providing additional environmental benefits in grazed Minnesota and upper Midwest woodlands. A major constraint to increased adoption of silvopasture practices is the lack of biophysical and economic information on silvopasture options. We will report on a three-year study that examined the potential for silvopasture in Minnesota by comparing production of unmanaged woodland grazing, silvopasture, and open pasture sites. The study was carried out through collaboration with three farmers in Central Minnesota and assessed these three grazing systems on their land. Silvopasture paddocks were established through thinning and seeding woodland areas. The study assessed forage production, forage quality, and livestock performance in terms of weight. Forage production was generally greater in silvopasture systems compared to unmanaged woodland grazing systems, while forage quality was lower in open pasture systems, at least during the first year. Livestock performance was similar between the grazing systems. Results indicate that silvopasture has potential in Minnesota, but more research is needed to develop specific management guidelines as well as monitoring silvopasture practices for longer periods of time. This research plus other silvopasture promotional programs like field tours, updating MN NRCS practice standards for silvopasture and creating a MN silvopasture Best Management Practice manual for landowners will be discussed.

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Abstract
Environmental Benefits

Francis Dube, Marianela Alfaro, Burkhard Müller-Using, Neal B. Stolpe, Erick Zagal, Marcelo Doussoulin

Sustainable Silvopastoralism in Old Andean Nothofagus Forests of Southwestern South America

Keywords: Andisol, Chile, CONAF, soil quality indicators, over-mature forests

The second-growth "Roble (*Nothofagus obliqua*) forests play an important role within the remaining native forests of the Biobio Region of Chile. However, the forest areas are also used as pastures for grazing, and the cattle severely impairs the reestablishment of natural vegetation and also cause soil compaction from trampling and overstocking. Additionally, there is no regulation from the National Forest Service (CONAF) regarding the use of forests for pastures, and the adequate stocking rates for cattle are still unknown. A 30-ha silvopastoral trial was established in a "Roble forest of the Andes with different levels of canopy closure (i.e. open - OP, partly open - PO and partly closed - PC). The main objectives are to: (i) Use native species to effectively rejuvenate the over mature forest resource, and (ii) Assess the effect of canopy closure on the quality and quantity of soil organic matter. At 0-5 cm soil depth, soil organic carbon and microbial respiration in the PC condition were 11 and 13% higher, respectively, than PO and OP. Nitrogen mineralization decreased in the order PC>PO>OP, where PC was 93% higher than AB. Finally, the light fraction of soil aggregates in OP was 68% lower than in PC and OP. This novel silvopastoral system will definitely help restore the most degraded sites through improvement of the soil quality. The knowledge acquired will permit state agencies to assess the global sustainability of these innovative practices in order to develop new standards on the adequate and efficient use of natural resources.

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Concurrent Session 6 (Thursday 9:30 – 10:30 am) Room 300
Abstract
Production Science

Gabriel J. Pent, John H. Fike

Sheep Performance and Behavior in Silvopasture Systems

Keywords: lamb, grazing, forage, silvopastoral, comfort

In some reports of forage and animal productivity in silvopastures, animal gains are similar or better despite lower forage yield. During three summer grazing studies, we compared black walnut and honeylocust-based silvopasture systems with open pastures in a randomized complete block design (r=3). Pastures were rotationally stocked with four to seven lambs depending on forage availability. Ewe lambs (n=3) within each experimental unit were equipped with a vaginal temperature sensor (3 days week-1) while time lapse cameras documented their behavior every 60 seconds (1 day week-1). Forage availability measurements taken with a rising plate meter indicated a trend (P=0.0717) of greater productivity in the honeylocust silvopasture (5020±30 kg ha-1) than in the open pasture (4930±30 kg ha-1), while forage availability was significantly reduced (P<0.0001) in the black walnut silvopastures (3560±30 kg ha-1). However, lamb live weight gains of the open pastures (10.1±1.5 kg period-1) were no different (P≥0.7592) than the gains of the black walnut silvopastures (10.1±1.5 kg/period) and the gains of the honeylocust silvopastures (11.6±1.5 kg period-1). Data from the second and third years indicate that lambs in silvopastures actively followed shade patterns, spending over 90% of daylight hours in the shade. As a result, ewes in the silvopastures had lower vaginal temperatures during most of the day. Lambs in the black walnut silvopastures and lambs in the honeylocust silvopastures spent more time lying down (P≤0.0118) than lambs in the open pastures, indicating that greater levels of comfort for animals likely compensates for any changes in forage characteristics within silvopastures.

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Abstract
Production Science

Rafter Sass Ferguson

Labor Productivity of Perennial Cropping Systems on US Permaculture Farms

Permaculture is an agroecological movement with a distinctive approach to agroforestry, emphasizing the integration of perennial crops into highly diversified farming systems. Despite its broad international presence and high public profile, however, permaculture has received little attention from scientists and scholars. Little is known about either the extent or the performance of perennial cropping systems on diversified permaculture farms. Labor productivity is an especially pressing issue for permaculture farms (as for diversified farming systems generally), which must compete with the high labor productivity of specialized and mechanized industrial farming systems. This gap in our knowledge makes it difficult to assess what resources permaculture may represent to the growing agroforestry community.

This project helps remedy that gap through research conducted at 47 permaculture-sites in 17 states in the continental US, analyzing adoption of perennial cropping systems. To investigate labor productivity, we fit a multilevel model using data from 195 farm enterprises (including multiple classes of production and non-production enterprises) from a subset of 36 farms. Our analysis addresses the relative labor productivity of various enterprise classes, including tree crops and other perennial crops, and the effects of diversification and crop-livestock integration on labor productivity.

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Abstract
Adoption, Adaptation, Permanence

John H. Fike, Greg E. Frey, John F. Munsell, Adam K. Downing, Tim A. Mize

Developing Programs to Support Silvopasture Adoption in Virginia, USA

Keywords: demonstration, outreach

Silvopasture adoption has been limited by a lack of awareness and understanding by both farmers and technical service providers, likely reflecting the limited research and outreach efforts by educators and extension personnel and few successful "on-the-ground" models. Adoption is further challenged by skepticism and mistrust. E.g., many technical service providers representing livestock and forestry were trained to keep these enterprises separate; changing that mentality will take time and effort.

Efforts to promote silvopasture as a credible farm management practice began in Virginia with the formation of a team of researchers, agents and service providers. Securing funds to teach agriculture, forestry, and natural resources personnel was a first step in moving these systems forward. Field days and training were led by local and national experts, and options for creating silvopastures were explored. In a brief survey soon after our initial programming, 75% of participants had learned "quite a bit" or "a lot" and similar numbers even had begun discussing and exploring ways to implement these systems with producers.

Subsequent work has focused on developing several research and demonstration sites, adding farmer-collaborators to showcase these systems, and providing web resources, and educational programming developed for high school students.

Silvopastures are complex systems that require intensive management and will not be adaptable by all producers. Entrenched sentiments about what is appropriate land management may also prevent some technical service providers from recommending silvopasture management. However, initial results indicate high levels of acceptance with strong training and demonstration programming.

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New Markets, New Products, New Values

Concurrent Session 1 (Tuesday 9:45 – 10:45 am) Room 342
Abstract
New Markets, New Products, New Values

Michael Farrell

Birch Sap and Syrup Production Potential in the U.S.

Keywords: birch, sap, syrup, forest farming, FIA

Birch syrup production in North America is a small, underdeveloped industry with significant opportunity for expansion. There has been increased interest among researchers and maple producers to explore the potential of birch trees for sap and syrup production in recent years. The industry has grown steadily as high prices and cost-effective processing technologies have lured more people into the industry. This presentation utilizes data from the US Forest Service Forest Inventory & Analysis (FIA) Program to estimate the total number of tappable birch trees in 21 states (the estimate for Alaska only includes a small portion of the state). With 32 million potential taps, Minnesota contains the greatest paper birch (*Betula papyrifera*) resource. Maine leads in yellow birch (*Betula alleghaniensis*) with 48 million potential taps whereas Pennsylvania's has the largest black birch (*Betula lenta*) resource with 44 million potential taps. Due to the fact that birch sap flow occurs after maple sap flow has ceased, there are promising opportunities for existing maple producers to utilize their equipment to also tap birch trees and process birch sap. The prices for birch syrup are also 3-4 times higher than maple syrup, luring more existing sugarmakers into the birch syrup market. In addition to syrup production, the birch industry could also expand through increased utilization of the sap for beverages and other natural products.

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Abstract
New Markets, New Products, New Values

Michael A Gold, Zhen Cai

A Competitive Market Analysis of the US Pawpaw Industry

Keywords: Porter Five Forces Model, SWOT analysis, specialty crops

The North American pawpaw (*Asimina triloba*) is a relatively undeveloped high-value native specialty fruit crop with multiple opportunities for commercializing value-added products. A nationwide survey has examined the pawpaw value chain including fresh and value-added product markets. Market participants along the pawpaw value chain have been identified through networking with pawpaw growers, processors and enthusiasts. The snowball sampling method helped to identify additional pawpaw market participants. An online survey was administered to examine participants' understandings about the market. Specifically, strengths, weaknesses, opportunities and threats of the pawpaw market have been identified using SWOT analysis. The ease of market entry and exit, buyer and seller power, power of substitute products and competitive rivalry in the industry are also enumerated via use of the Porter Five Forces Model. Findings from this survey will increase our understanding about current pawpaw market, supply and demand trends, and the competitive environment for pawpaw producers and processors.

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Abstract
New Markets, New Products, New Values

Emily Lachniet, Katie Commender

Developing an Appalachian Herb Processing Hub

Keywords: forest farming, forest botanical, NTFP, processing, value-added

Opportunities for forest farmers throughout central Appalachia to successfully and profitably sell non-timber forest products (NTFPs) are limited for several reasons. First, the lack of access to processing infrastructure can severely decrease profitability, as the cost of production is often more than the price obtained for fresh botanicals. Secondly, many forest farmers struggle to produce a sufficient volume to engage larger buyers independently. Appalachian Sustainable Development (ASD) seeks to address these two issues by expanding its local "food hub," Appalachian Harvest (AH), into an "herb hub." With over $12 million in sales since 2000, Appalachian Harvest strives to aggregate local food from over 60 rural vegetable farmers to collectively meet large wholesale demand. Applying this same aggregation concept to forest farmers, AH will serve as a regional consolidator for sustainably grown and harvested NTFPs to meet wholesale demand from buyers willing to pay a premium price for sustainability. A GAP-certified processing center with a dryer and root washer will also be developed to enhance value-added opportunities and provide quality assurance to buyers. This herb hub will serve as a low cost, open source model that can easily be replicated throughout central Appalachia to decrease barriers to successful forest farming ventures.

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Concurrent Session 2 (Tuesday 11 am – 12 pm)
Abstract
New Markets, New Products, New Values

Parul Jain, William R. Schroeder, **Raju Y. Soolanayakanahally**

Raju Y. Soolanayakanahally

Bioactive and Essential Oil Profiles from Seeds of Canadian Agroforestry Species

Keywords: berry seed oils, polyphenols, agroforestry species, carotenoid, defatted residue cake

Speciality high-value berry seed oil rich in antioxidants and poly unsaturated fatty acids (PUFAs) are gaining attention due to their health benefits, thus resulting in a rapidly growing new market segment worldwide. Also, there is growing interest for alternative safe methods for oil extraction, such as supercritical extraction method (SCE) with CO_2. In the present study, supercritical CO_2 extracted seed oil of selected Canadian prairie fruit seed, buffaloberry, chokecherry, dogwood, rose, wolf willow, Russian olive and caragana were analyzed for their content of essential oils and health-promoting antioxidants such as polyphenols, carotenoids, and essential fatty acids. The potential benefits offered by these plants and their bio-active components have sparked interest internationally, and represent opportunities for value-added new product development. Canadian prairie fruit seed oil had high carotenoid content, Î²-carotene (0.31-220 ppm) and lutein (0.3-578 ppm), much higher than oils from red raspberry, and marionberry. Polyphenols ranged from 35-117 ppm, while Î²-sitosterol commonly used in cholesterol-lowering diet ranged from 2920- 7820 ppm. The yields of erucic acid were < 0.1%, much lower than the maximum limit permitted by the Canada Food and Drug Regulations. The seed oils were found to be rich in PUFAs (38.43-78.61%). In addition, the defatted residue cake had high amounts of protein and carbohydrate and low fat which can be used in development of new products for both food and feed industry. Exploring these potential uses would add new bio-economic value to the regions where these berries are grown.

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Abstract
New Markets, New Products, New Values

Danh Cong Vu, Chung-Ho Lin, Mark Coggeshall, Daniel Pote, Michael Greenlief

Determination of Health-Promoting Phytochemicals in Black Walnuts (*Juglans nigra L.*)

Keywords: walnuts, phytochemicals, cancers, health-promoting, metabolites

People have relentlessly been searching for natural treatments from plants as alternatives to synthetic medicines in fighting against the diseases. Consumption of black walnuts has been scientifically proven to have many health benefits including decreased risk of cardiovascular disease, and coronary heart disease. The consumption of black walnuts has also contributed to reducing the risks of type II diabetes, prevention of certain cancers, and the alleviation of symptoms attributed to age-related and other neurological disorders. However, information about the levels of the health promoting phytochemicals and the chemical profiles among different cultivars cross the geographic gradients were lacking. The objectives of this study are to 1) identify and characterize the health-promoting phytosterols, polyphenols, and other health-promoting secondary metabolites in black walnuts using targeted as well as non-targeted global metabolomics approach (XCMS), 2) identify the metabolic pathways of these compounds and elucidate their roles in promoting health and 3) compare the levels of these compounds between different walnut varieties cross the geographic and environmental gradient. The findings of this project will help identify the immediate applications of these compounds, and therefore foster the rural economic development for state of Missouri.

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Abstract
New Markets, New Products, New Values

Jason Fischbach, Lois Braun, **Michael C. Demchik**, Anthony Kern, Keith Turnquist

Michael C. Demchik

Yield and Genetic Diversity of Hybrid Hazelnut Selections, USA

Keywords: filbert, oilseed, microsatellite

The majority of commercial hazelnut plantings in the Upper Midwest of the United States are seedlings from crosses of American hazelnuts (*Corylus americana*) and European hazelnuts (*C. avellana*). We have selected potentially high productivity accessions from these planting for replicated field trials with clonally propagated material at five locations (three of which are producing). The oldest plants are now 8 years old have produced harvests (4 years) with a wide variation in yield and kernel size, where some genotypes produced more than 1,000 lbs of kernels per acre in their 7th year. These selections were found to have elevated levels of genetic diversity when assessed at 10 microsatellite loci. Further analysis using principal component analysis show the locally-developed hybrids tended to group genetically with American hazelnuts from a similar region but separately from European hazelnuts and hybrid hazelnuts developed elsewhere. Overall, the American and hybrid hazelnut germplasm pool in the Upper Midwest represents a genetically broad selection of germplasm with potential to support a commercial hazelnut industry. Results will be presented on genetic diversity of the germplasm pool, yields from the replicated performance trials, and economic viability of the top performing genotypes.

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Concurrent Session 6 (Thursday 9:30 – 10:30 am) Room 342
Abstract
New Markets, New Products, New Values

Dean Current, David Wilsey, Jose Roman Carrera, Jorge Cruz, Juan Trujillo

Market Driven Conservation and Livelihood Improvement, New Markets for Non-Timber Forest Products

Keywords: community, markets, conservation, livelihood, NTFP

Non timber forest products with emerging markets have been touted as providing opportunities for improving livelihoods while they add value to, and therefore help protect important forest areas threatened by deforestation. This presentation will explore the cases of: 1) palm fronds as a cut green (*Chamaedorea spp.*) being managed, harvested and sold to the international market for floral goods (an effort that has been in process for over 10 years) for its' livelihood and conservation values; and 2) a native tree seed, Ramon (*Brosimum alicastrum*), that has a limited market in the United States but with the potential for expansion due to its nutritional, conservation and livelihood benefits. Unique partnerships between importers, wholesalers, faith based organizations, universities and national and international NGO's have contributed to the success of the palm frond effort and initial work has begun to promote greater use of the Ramon seed in the US market. We will present the unique partnerships that have allowed these efforts to move forward, the new products and markets being developed, and the new social and environmental attributes of products that are creating new values for products in traditional markets as well as the model we are using to move these efforts forward.

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Abstract
New Markets, New Products, New Values

Steve Gabriel

Breaking Open the Market with Dehydrated Mushrooms

Keywords: mushrooms, shiitake, dehydration, policy, food safety

Beyond providing practitioners with information on the production details of agroforestry crops, universities and extension needs to offer enterprise planning and policy support to ensure current regulations and markets are primed for the crop. Since 2005, Cornell University has been engaged in the development of Log-Grown Shiitake Mushrooms as a viably agroforestry enterprise. More recently, work has shifted from field research to working directly with farmers to establish viable businesses. This presentation chronicles several initiatives to support farmers by working with state government and industry partners to change state laws regarding dehydration of mushrooms, to further open the market.

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Abstract
Production Science

A. Gatabazi, D Marais, JM Steyn, HT Araya

Yield response of two ginger species to water stress

Keywords: cultivation, dry yield, fresh yield, Irrigation, water use

Cultivation of medicinal plants is essential for human consumption. Ginger is an important medicinal plant appreciated worldwide and is used as a flavouring agent in foods. However, little information is available on the effect of water stress on yield and water use of different of two ginger species. The aim of the study was to examine yield and water use of ginger species in response to water stress. Commercial ginger (*Zinziber officinale*) and wild ginger (*Siphonochilus aethiopicus*) were planted November 2015 under a rain shelter at the Hatfield Experiment Farm of University of Pretoria, South Africa. The experiment was laid out in a complete randomized block design with three blocks. Each experimental unit was 4 m2 with eight rows per treatment. Both inter and intra row spacing was 0.25 m. The irrigation treatments were as follows: 1 (control): Soil brought to field capacity when 20-25% of available soil water (ASW) was depleted; 2: Brought to field capacity when 40-45% of ASW was depleted: Brought to field capacity when 60-65% of ASW was depleted and 4: Brought to field capacity when 80-85% of ASW was depleted. LAI, FIpar, fresh and dry rhizome yield, HI and water use were measured. Results showed significant difference ($P<0.05$) between the treatments in all parameters. LAI and FIpar were increased under well-watered conditions for both ginger species. Wild ginger showed the highest LAI and FIpar than commercial ginger. Wild ginger HI was high with the control treatment. Fresh and dry yield of commercial ginger were significant ($P<0.05$) in both species. Water use improved in both species. The study shows that ginger species respond differently to different water stress.

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Advances in Technology Applications

Concurrent Session 1 (Tuesday 9:45 – 10:45 am) Colonial Hall
Abstract
Advances in Technology Applications

Michael Demchik, Anthony Kern, Lois Braun, Jason Fischbach, Keith Turnquist

Genetic Diversity of American Hazelnut in the Upper Midwest, USA

Keywords: filbert, geographic genetics, oilseed, selection

Although European hazelnut (*Corylus avellana*) dominates world hazelnut production; American hazelnut (*Corylus ameri*cana) presents an interesting source of genetics. In order to effectively include this source of genetics in a breeding program, an understanding of patterns of genetic diversity across the range of hazelnuts is necessary. The objective of this study was to characterize the genetic diversity of American hazelnut across the Upper Midwest. We collected leaf samples from populations across Wisconsin, Minnesota, Iowa and North Dakota. Using microsattelite DNA technology (for 10 loci) we characterized these populations. Overall, the loci that were tested were very polymorphic (7-13 alleles/population). While there was strong population differentiation between some of the populations, there were very high levels of genetic variability found within populations. For these populations, genetic diversity is more strongly represented within population (90%) than between populations (10%). Genetic distance between populations was not correlated with geographic distance (Mantel's test of p=0.19), suggesting that just because populations are further apart does not indicate they are more genetically distant. Taken as a whole, these results suggest that selection for plants to include in a breeding program should occur at the level of high producing plants within populations instead of at the level of high-productivity populations; however, care should be taken to ensure inclusion of plants from populations which are highly differentiated from other sampled populations.

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Abstract
Advances in Technology Applications

Van K. Ho, Jihyun Park, Danh C. Vu, Mark V. Coggeshall, Dan H. Pote, Anuradha Roy, Mike C. Greenlief, Brian P. Mooney, Nahom T. Ghile, Hsin-Yeh Hsieh, Chung-Ho Lin

Exploring Health Benefits of Phytochemicals in Black Walnuts (*Juglans Nigra* L.)

Keywords: bioactive compounds, metabolic pathways, biological functions

Black walnut (*Juglans nigra* L.) is widely distributed throughout the U.S. eastern forest, with the highest concentrations occurring in Missouri. Consumption of walnuts has been linked to many health benefits including reduced risk of cardiovascular disease, reduced levels of cholesterol, stimulated brain functions and prevented certain cancers (e.g., prostate and breast cancers). Black walnut contains more than 50 health-promoting bioactive phytosterols and phytophenolics, such as ss-sitosterol, campesterol, stanol esters, tocopherols, ergosterol, pedunculagin, and stigmasterol. However, systematic characterization of the bioactive compounds in walnuts using modern bioinformatics and metabolomics approach has never been explored. Additionally, the links between the specific compounds and the health benefits have not been well established. Ten cultivars of black walnut grown in Missouri are collected and the potent chemicals are identified and isolated. We conducted bioassay-guided purification to identify the bioactive compounds (e.g., antibacterial, anti-inflammatory and antioxidant) and perform animal studies to evaluate the pharmacokinetic of these compounds in the serum/tissue. The metabolic pathways and biological functions of the identified health-promoting phytochemicals will be elucidated by using XCMS metabolomics platform, transcriptomic analysis, and gene expression in the animal studies. The final goal of this study is to identify the mode of the actions of the bioactive compounds in black walnut.

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Abstract
Advances in Technology Applications

Ruoshui Wang, Huaxing Bi, Fei Gao

Effects of Water and Fertilizer Coupling for an Agroforestry System in Losses Plateau of China

Keywords: apple-maize intercropping, photosynthetic characteristics, plant growth, yield water use efficiency, west Shanxi province

Agroforestry system has become the main agricultural practice recently in losses plateau of west Shanxi province in China. However, it's essential to find a more effective and economical water and fertilizer regulation method in agroforestry of this area to ease the interspecific competition and conserve both the water and soil. A two-year experiment was carried out in the loess plateau of Shanxi Province, China to explore more effective water and fertilizer management in the typical apple-maize intercropping system. The results indicated that the diurnal variation of maize net photosynthetic rate, transpiration rate, apple transpiration rate showed "single peak" curves, while the apple net photosynthetic rate showed a "bimodal" curve in 2014 and 2015. During the two years, plant height, leaf area index and maize yield all reduced with the increase of fertilizer rate. Similarly, the water use efficiency (WUE) and irrigation water use efficiency (IWUE) both reduced with the increase of irrigation amount. Based on the regression analysis, it can be proposed that the optimal amount of irrigation and fertilizer in maize-immature apple tree intercropping system could be applied: N, 144.5 kg·ha-1; P2O, 559 kg·ha-1; K2O 59 kg·ha-1 with irrigation upper limit of 85% field capacity during tassel emerge and filling stage, respectively. The results of this study can provide theoretical basis for water and fertilizer management in intercropping system in the loess region of west Shanxi province of China.

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Concurrent Session 2 (Tuesday 11 am – 12 pm) Room 219
Abstract
Advances in Technology Applications

Rico Huebner, Gerald Busch, Christian Bohm

Development of a GIS-Based Decision Support System for Agroforestry and Insights to Its Application

Keywords: extension service, spatial planning, groundwater protection, soil erosion, landscape aesthetics

Proper placement of modern agroforestry systems (AFS) is a key to successful establishment of such innovative forms of land-use. Awareness of different objectives and expectations on AFS is essential for a broader acceptance by stakeholders in land-use. Therefore the idea arose, to develop a GIS-based decision support tool that incorporates the various aspects of AFS and allows for graphical interpretation.

Readily available geospatial data is collected that serves as appropriate proxies and for calculation. Since the accuracy of the tool is plot specific some data had to be adapted. For indices not based on a field-scale, decision rules were applied. During the process various disciplines were involved, such as farmers, groundwater expert, landscape planers and environmental NGOs. In total, 5 environmental categories with 10 criteria are taken into account.

The GIS-based decision tool allows to evaluate and visualize the combinatory results of the multiple - and in parts contradictory - effects of AFS. As part of a broader participatory process the tool is tested among local actors and experts from various fields. Conclusions for further development and practicability of the tool will be drawn according to the participatory application and evaluation results.

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Abstract
Advances in Technology Applications

Nicholas Polys, **Peter Sforza**, Cully Hession, John Munsell

Peter Sforza

Agroforestry Fact Sheets of the Future: Virtual Reality Experiences

Keywords: data fusion, information visualization, Web3D, virtual reality

Abstract: Forest ecosystems and their services inter-relate many actors and effects across scales of time and space. Introducing non-timber forest products for agriculture (Agroforestry) adds specific constraints and complexities. Resolution of these tradeoffs are determined by site-specific conditions that are not apparent from current fact-sheets abstractions; we are exploring how 3D and Virtual Reality technologies can be used to capture and communicate rich site-specific information. With the emergence of new consumer and mobile electronics, we can extend experiences of time and place with virtual field trips, remote training and consultation, and monitoring. In order to achieve integration and access of wide data sources, open standards and platforms are necessary. We will present our recent applications of Web-based Virtual Reality technology and its capacity to communicate context and locale.

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Abstract
Advances in Technology Applications

John Munsell

PlantShoe: Mobile App and Citizen Science in Support of Appalachian Forest fFrming

The PlantShoe project uses citizen science and GeoDesign to assist forest farmers in the Appalachian Mountains. It advances agroforestry across this broad physiographic region by bringing software developers, geospatial experts, land management specialists, citizen scientists, and forest farmers together in a customizable and collaborative workspace to create and refine a precision agriculture computer application. The PlantShoe GeoDesign application augments siting decisions for farming of four marketable plants native to Appalachia (goldenseal, black cohosh, ramps, bloodroot). The citizen science program provides data from plant locations that advances our understanding of associated habitat and range. Over time, PlantShoe citizen scientists provide data that is used to refine the PlantShoe GeoDesign application. Forest farmers and other stakeholders with experience can discuss and drive the evolution and efficacy of the PlantShoe program through a community forum. Basic project aims and accomplishments will be covered in this presentation, along with concepts related to citizen science 2.0 and precision farming computer systems using GeoDesign methods. Lessons learned about creating GeoDesign systems using best available spatial data for site characterization and assessment for precision planting with regard to biotic and abiotic variables will also be presented. Best practices for citizen science will be shared, as well with an update on user status and security methods to ensure plants, people, and privacy are protected.

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Adoption, Adaptation, and Permanence

Concurrent Session 1 (Tuesday 9:45 – 10:45 am) Room 219

Abstract

Adoption, Adaptation, Permanence

Joseph Orefice, John Carroll

Silvopasture, It's not a Load of Manure: Differentiating Silvopasture from Wooded Livestock Paddocks

Keywords: woodland grazing, soil degredation, adoption, Northeast, permaculture

A confusion exists between pastured woodlands and silvopasture in the northeastern United States. We distinguish between wooded livestock paddocks, using livestock to control woody vegetation, and silvopasture. Two definitive characteristics of silvopastures are: 1) management of livestock type, timing, and impact maintains forage and tree health and rooting zones that stabilize soil in silvopastures 2) trees are actively cultivated in silvopasture systems and stem density is controlled to encourage forage and tree vigor. We also argue for an advancement of silvopasture as a regional farming system in place of poorly managed woodland pasture. Woodland pasture accounted for 264,846 acres of all pastureland in New York and New England in 2012, according to the census of agriculture. There is a timely need for the forestry community to accept silvopasture as a viable alternative to the degraded woodland pastures of the northeastern United States.

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Abstract
Adoption, Adaptation, Permanence

Erik Stanek, Sarah T. Lovell, Chloe Mattia

Productive Agroforestry Design Preferences of Land Owners in Central Illinois

Keywords: design, scenarios, planning, preferences, multifunctional-landscape

Multifunctional perennial cropping systems (MPCs) integrate multiple fruit, nut, timber, and/or bioenergy crops into the agricultural landscape to generate a diversity of ecosystem services while simultaneously producing nutritious food. Previous studies revealed that agricultural landowners lack adequate information to make informed decisions regarding adoption of MPCs, but expressed interest in adopting them. This research aimed to fill that gap by identifying the design preferences, information needs, and adoption barriers and motivators of 15 rural landowners within Central Illinois. Researchers constructed three designs for each participant based on a set normative scenarios and feedback from agroecologists, foresters, and the participants themselves. The three scenarios were classified as (1) Fruit and Nut Production, (2) Conservation, and (3) Cultural. Participants received realistic design visualizations as well as detailed information on MPCs. Two semi-structured interviews (one ex-ante and one ex-post) were used to identify participants' design preferences, barriers, and motivators, and adoption potential. Landowners expressed interest in these novel approaches to agricultural design, especially the integration of edible production into the rural landscape. The strongest motivators for MPCs adoption were found to be the potential for profit, increased species diversity, improved environmental services, and the divergence from conventional cropping. However, these motivators were coupled with an expressed lack of practical application. The findings revealed that a lack of reliable economic, market, and management information severely inhibits adoption potential of MPCs. Farmer preferences and needs identified in this study will be used to help improve future designs and strategies for facilitating the adoption of MPCs.

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Abstract
Adoption, Adaptation, Permanence

Catherine Mercier, Alain Olivier, Francis Dube

Adoption Challenges of a Silvopastoral Subsistence System: Case Study in Ranchillo Alto (Chile)

Keywords: cattle breeding, forest regeneration, poverty, qualitative research

Diffusion and adoption of agroforestry technologies aiming at increasing ecosystems sustainability may face some resistance within communities which livelihood depends on local natural resources. The viability of many agroforestry projects may therefore rely on the inhabitant's perceptions, and how effectively their concerns are addressed. A case study was conducted in Ranchillo Alto, in the Yungay commune (Chile), in order to identify farmers' needs and perceptions about a silvopastoral project. Rural communities in Yungay are characterized by a high level of poverty and mostly rely on subsistence agriculture. With the help of local farmers, researchers from the University of Concepcion developed a silvopastoral project aiming at better managing the area's ancient forest, where firewood has been heavily harvested, in order to restore forest regeneration, while cleaning the most degraded sites to introduce pastures and fodder trees. Semi-directed interviews were conducted with the sixteen inhabitants currently involved in the project, as well as with four experts. All participants were asked about the project's expected challenges and opportunities. The photovoice method, where participants are asked to take pictures of their everyday tasks, and then discuss about them with the interviewer, was also employed. In terms of resources, the participants' main concerns were water shortages, the extent of the investment needed, and the lack of specialized tools and machinery. The need for technical expertise and long-term support was also expressed, as well as some preoccupation about possible loss of cattle from predators. These considerations will guide the development of the project's next phase.

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Concurrent Session 4 (Tuesday 2:30 – 3:30 pm) Room 219
Abstract
Adoption, Adaptation, Permanence

James A. Allen

Dryland Agroforestry in the Southwest: Can We Combine the Old with the New?

Keywords: drylands, homegardens, Native American, Arizona, New Mexico

Agriculture has been practiced in drylands of the Southwest by Native Americans, early Hispanic settlers and European settlers for many years. Some current or past practices clearly fit with common definitions of agroforestry, such as the berry gardens of the long-abandoned Pueblo settlement of Quarai in New Mexico and the homegardens of Hispanic populations in the American Southwest and northern Mexico. Other practices, such as the peach orchards of the Navajo and Hopi, may not fit the definitions quite as well, at least in their current forms. In this presentation I will review some of the traditional agroforestry practices applied in this region and assess the potential for their more widespread use, modification and/or intensification. There appear to be a number of excellent opportunities to build on traditional agroforestry or agricultural practices to benefit the people of this region, particularly but by no means limited to Native Americans residing on the Southwest's many reservations. Food security and inadequate nutrition are significant problems in this region, especially on the reservations, and agroforestry potentially could play a much more significant role in addressing these challenges. Much needs to be done, however, to better understand both current and potential practices, the actual demand for agroforestry, and the potential biophysical, economic and cultural barriers to increasing the application of agroforestry practices in the Southwestern context.

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Abstract
Adoption, Adaptation, Permanence

Christopher Burney

Adaptive Strategies: Suburban Lawns into Agroecosystems in the American Midwest

Keywords: urban, agroforestry, small-stakeholder, market-gardens, permaculture

In the Midwestern United States, we are fortunate to have access to resources we can use to begin experimenting towards resilience and self-sufficiency in food production and clean water through the adoption of technologies such as agroforestry practices. Suburban metropolitan areas have both the land area and market potential to sustain large growth in the number of small stakeholder farmers, permaculturists, and market gardeners. Suburban areas offer an opportunity to mitigate and restore damage to watersheds as they are large contributors to nutrient loading and chemical run-off downstream, they also provide an opportunity to lower resource demands through food production self-sufficiency. There are many potential avenues for the adoption of agroforestry in the suburbs including for-profit and non-profit farming initiatives, home-owners' associations, suburban governments, and city-wide gleaning gardens. Findings will be presented based on three years of an experimental for-profit agroforestry cropping system changing a one-acre suburban yard of wet Midwestern clay soil, into a perennial for-profit farming system in Columbus, OH. This property was designed to mimic small stakeholder and home-garden practices from around the world, utilizing site-specific advantages and native crop species while attempting economic and food-production self-sufficiency.

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Abstract
Adoption, Adaptation, Permanence

Connor Stedman

Applying Permaculture Site Analysis and Design Tools to Agroforestry Planning

Keywords: design, planning, site suitability, permaculture

The integrated ecological design approach of permaculture arose in parallel to the modern agroforestry field. In most global climates, agroforestry practices are considered central components of permaculture-based land design and farm planning. As a result, permaculture design approaches can offer valuable tools and insights to agroforestry researchers and practitioners. Some central features of permaculture design include: holistic consideration of farmer/manager/user goals and objectives; analysis of site-specific ecological and spatial characteristics; integration of individual sites into their surrounding geographic and watershed contexts; and the use of intensive, diversified, nutrient- and water-cycling production systems.

This presentation shares insights and strategies from permaculture site analysis and design with particular relevance to agroforestry. Topics addressed will include holistic goal setting, rapid site suitability assessment, tools and methods for detailed site analysis, and patterns and principles for designing diversified, site-appropriate agroforestry systems.

Connor Stedman, M.S., is an agroforestry practitioner and farm planner with AppleSeed Permaculture LLC, based in the Hudson Valley of NY. He has designed, installed, and managed agroforestry systems in temperate and semi-arid climates across North America.

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Concurrent Session 5 (Tuesday 3:45 – 4:45 pm) Room 219
Abstract
Adoption, Adaptation, Permanence

Austin M. Unruh

In Pursuit of Profitable Riparian Buffers

Keywords: riparian, buffers, profitable, income, adoption

While the conservation benefits of riparian buffers have been well documented, adoption has struggled to meet goals. Many landowners who recognize the benefit of conservation lack the financial incentives to install buffers, or are unwilling to work with existing government conservation programs. To increase adoption of riparian buffers, they must be seen as a source of farm income, not just expense.

To this point, research relating to income options in riparian buffers was reviewed. First, the market and growing potential of three crops that provide both economic and ecological value were reviewed. Those crops were pawpaw (*asimina triloba*), elderberry (*sambucus canadensis*) and woody florals. Each is currently an underdeveloped niche crop.

Second was a review of income opportunities that could be pursued in collaboration with or separate from income-generating crops. Income streams reviewed include conservation funding, rotational grazing, carbon credits and hunting leases.

While no single option is certain to return profit to a landowner, the potential for riparian buffers to generate income grows as multiple income streams are used together. Conservation and agricultural professionals are urged to recognize the multiple benefits provided by riparian buffers, and how each of those benefits can be translated into profit.

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Abstract
Adoption, Adaptation, Permanence

Sonja Brodt, Nina Fontana, Leigh Archer

The Potential of Agroforestry as a Pathway to Sustainability in California Agriculture

Keywords: farmer survey, socio-economic feasibility, livestock-vineyard integration, tree crop-vegetable intercropping

California agriculture is renowned for highly productive and extremely diverse fruit, nut, and vegetable production systems that yield high-quality crops traded world-wide. However, despite high statewide crop diversity, the predominant systems are monocropped and rely on intensive use of external inputs, accompanied by environmental problems such as nitrogen leakage, soil degradation, habitat loss, and depletion of water resources. Some farmers are innovating with more diverse systems that incorporate perennial elements, such as tree crops, vines, and native hedgerows, with annual crops and livestock. These systems, when managed appropriately, offer the possibility of higher profits, more efficient use of nutrients, water, and sunlight, and ecosystem services such as soil health and pest management. However, with the exception of field edge hedgerows and cover cropping in orchards and vineyards, the ecological functioning and socio-economic feasibility of more complex intercropping systems have not been researched in a California context. This study reports on an exploratory survey of agricultural experts and innovative California farmers practicing unusual agroforestry systems, including vegetable and tree fruit alley cropping and vineyard-livestock integration. The study examines economic and agroecological benefits and challenges from the perspective of practitioners, as well as the feasibility for more wide-spread adoption of such systems across California's diverse landscapes. Preliminary results indicate that farm scale and marketing options (small-scale direct versus large-scale wholesale), crop and variety choice, and availability of appropriate equipment technology and skilled labor are factors that can play a large role in the success or failure of agroforestry systems in California.

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Climate Concepts and Communication

Concurrent Session 1 (Tuesday 9:45 – 10:45 am) Room 238

Abstract

Climate Concepts and Communication

Gary Bentrup

Agroforestry and Climate Change: What Do We Know and What Can Be Done?

Agroforestry has been documented to deliver a host of ecosystem goods and services, from food production to protection and enhancement of natural resources. For example, agroforestry systems can improve crop yields (from 6 to 56 percent) by modifying microclimate in ways that also protect soil and water resources. These ecosystem services will become increasingly important under future climate variability and change. Well-designed agroforestry systems can increase per-land-unit area productivity as the trees utilize resources (light, water, and nutrients) through their multi-layered architecture, deeper rooting, and extended growing seasons. By modifying the microclimate, agroforestry can reduce evaporative demand on crops and increase irrigation efficiency, thereby conserving water during drought periods and sustaining yields. Silvopasture systems and windbreaks can support livestock production under a warming climate by reducing animal heat stress and maintaining quality and quantity of forage production. Agroforestry can help protect soil, water, and air quality from extreme weather events by reducing soil erosion, filtering water- and air-borne pollutants, and ameliorating rising stream temperatures. By increasing structural and functional diversity, agroforestry can support biodiversity-based ecosystem services including crop pollination, biological pest control, and habitat connectivity under shifting climate patterns. Agroforestry can also be an important component of a comprehensive GHG mitigation strategy by sequestering C in biomass and soils and reducing GHG emissions on agricultural lands, especially through avoided emissions via energy savings and fuel reductions. This presentation will provide a summary of these benefits and key information gaps identified in a recent scientific assessment.

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Abstract
Climate Concepts and Communication

Tricia Ward, **Henry de Gooijer**

Henry de Gooijer

Agroforestry: An Option for Building Resilient Canadian Agricultural Systems in a Changing Climate

Keywords: temperate zone agroforestry, carbon sequestration, canada

The Canadian food system is based on a model of large-scale, industrial monoculture production of food and other agricultural products for consumers within Canada and internationally. Climate change and associated extreme weather variability is a challenge that is bringing urgency to concerns about the long-term sustainability of Canadian agriculture. In general, it is accepted that the climate is changing and the agriculture sector can no longer operate based on historical normal or average weather conditions. Canada is projected to experience rising temperatures, a lengthening growing season and increasing weather variability and extremes - creating both opportunities and challenges to agricultural operations and working lands. To reduce both biological and economic risks, actions need to be taken now to build resiliency into food production and ecological services in the variable climatic conditions of the future. Canadian farmers and ranchers will need diverse land management alternatives to minimize the risks of shifting climate and markets, while also trying to maximize ecological services - such as carbon sequestration. Agroforestry, the integration of trees and shrubs into agricultural production systems in support of production and other ecological goods and services, is a land-use option that is gaining recognition in temperate regions in both North America and Europe. Increased use of diverse agroforestry practices can play an important role in agro-ecosystems to help establish resilient and sustainable agricultural systems in Canada in the future.

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Abstract
Climate Concepts and Communication

Alain Olivier, Bertrand Anel, Alain Cogliastro, David Rivest

Strategies for Stimulating the Scaling-Up of Agroforestry Practices in Quebec, Canada

Keywords: agroecosystem, financial support, knowledge, policies, technology transfer

A task force stemming from the Agroforestry Committee of the Quebec Reference Center for Agriculture and Agri-food (CRAAQ) was set up in order to draw up a document about the strategies to put in place to stimulate the adoption of agroforestry practices in the province of Quebec, Canada. The study identifies the possible contribution of agroforestry to the resolution of six main issues of the agroecosystem: soil health, biodiversity, water quality, climate change, rural landscape and profitability. The current extent of agroforestry systems in the agricultural landscape is described, and an inventory of the resources available to farmers and landowners who wish to use agroforestry practices is made out: availability and accessibility of practical knowledge, advice, technical services, materials, training and education resources, research, and institutional and policy support. An analysis of the current situation in view of the challenges faced by the agroecosystem brings the task force to make six recommendations: the recognition by the public authorities of the potential of agroforestry systems; an increased technology transfer through the setting up of networks of agroforestry advisors and demonstration sites; the provision of financial support to producers through a program specifically dedicated to agroforestry; the creation of new knowledge through research activities; the development of plant material (trees and crops) specifically selected to perform well in agroforestry contexts; and an increased dialogue between the various actors of the agriculture, forestry, environment and rural development sectors. The implementation of these recommendations should help the scaling-up of agroforestry practices in Quebec.

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Concurrent Session 2 (Tuesday 11 am – 12 pm) Room 238
Abstract
Adoption, Adaptation, Permanence

Chad Papa, Pascal Nzokou

Farmers' Attitudes and Decision-Making in Response to Climate Change in Agroforestry Systems

Keywords: agroecology, systems dynamics, adaptation, decision-making

Understanding the drivers to change in smallholder agroforestry systems is an integral part to increasing food security. Agroforestry systems have been identified as a key component in increasing food security, increasing ecosystem services, and mitigating climate change. Farmers have shown to be able to understand changing climatic parameters along with the importance of climate mitigation through agroecological system responses. However, there is a lack of knowledge to just how important climate narratives play into farmer decision-making and response as compared to other drivers to change such as socio-economic and cultural drivers. An exploratory systems dynamic model was used to analyze focus group responses and socio-economic data on how important climate change narratives affect farmer decision-making and response. Farmers incorporated perceptions of changing climate when it comes to management decisions with regards to using trees as permanent structures in their land management decision, but other factors such as land tenure and soil fertility remain integral to land management decisions. Climate narratives definitely play a role in decision making and adaptation responses, but other factors play an equally important role.

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Abstract
Adoption, Adaptation, Permanence

Ryan Huish, Jacob Peters, Dakota Taylor

Assessing a Strategy of Climate Change Adaptation for Maple Syrup Producers

Keywords: maple syrup, climate change adaptation, agroforestry, sugar maple

Sugar maple (*Acer saccharum*) is a key cultural resource from northeastern Canada to the southern Appalachians. Following current projections of climate change, this cultural icon may be threatened with population range shifts, decreased health, lower sap volume, and inferior sap quality. This may be particularly relevant in the southern extent of its range in the Southern Appalachian Mountains. To help adapt to these changes, some producers have begun tapping alternative maple species that may be more resilient to climate change, including Red Maple (*Acer rubrum*), Box Elder (*Acer negundo*), or Silver Maple (*Acer saccharinum*). During the spring of 2016 and 2017, data was or will be collected on sap volume, quality, and sugar content for each species. Sap quality will be quantified by looking at antioxidants, total phenolic concentrations, and concentrations of maple flavor compounds. Sugar content is quantified in units of Brix using a field refractometer. Current results suggest that there may be several viable alternatives to Sugar Maple for the production of maple syrup, most notably Box Elder, which had the highest sap yield when compared to other species, producing almost double the sap that other species, with an average of 23.80 kg per tap. The sugar concentration of Sugar Maple and Silver Maple sap was around 20% more than the concentrations from Box Elder and Red Maple sap. Results thus far suggest that diversifying maple species as sap sources may be a viable strategy of climate change adaptation for the maple syrup industry.

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Round Table Discussions: Concurrent Session 3

How to use the values of agroforestry systems to create new incentive mechanisms?
Leader: Lieve Borremans, Room 219

Interdisciplinary language – Can you speak agroforestry?
Leader: Catherine Bukowski, Brush Mountain A

Plan, plant, preside: Early establishment practices for edible agroforestry
Leader: Matt Wilson, Brush Mountain B

Barriers to adoption: Identifying best strategies for landowner and farmer entry into agroforestry
Leader: Steve Gabriel, Room 300

Agroforestry adoption for mitigating and adapting to climate change: Dialogue and organizing forum
Leader: Connor Steadman, Room 342

Launching an AFTA agroforestry policy circle for continuous policy analysis and advocacy for advancing agroforestry in the USA
Leader: Gregory Ormsby Mori, Colonial Hall

Special Panels

Concurrent Session 4 (Tuesday 2:30 – 3:30 pm)

Producer Panel – Establishing and Managing Silvopasture – Room 342

Silvopasture Producers: Chris Fields-Johnson, Milton Nappier, and Todd Repass

Leader: John Fike

Special Panel – Snapshot of Temperate Agroforestry in Mexico – Colonial Hall
Abstract
Adoption, Adaptation, Permanence

Miguel Uribe Gomez, Artemio Cruz Leon, Alejandro Lara Bueno

Traditional Agroforestry Systems: A Methodological Proposal for Its Analysis and Intervention

Keywords: ethnoagrophorestry, agricultural knowledge, methodology.

The existence of the Traditional Agroforestry Systems (TAS) is contemporary to the beginnings of agriculture and remains today. Agroforestry as a science dates back to the second half of the last century and has recently increased interest in these forms of resource exploitation. Agroforestry research applies the scientific method, and for the case of intervention processes there are several proposals, among them the Diagnostic and Design method (D&D).

This proposal starts from the ethnosciences with the objective of finding a method that allows the diagnosis of the TAS and the intervention for its development. With the relevant modifications and using the Theory of Comparative Agriculture described by Cochet, as well as adaptations of the methodology used by Apollini, F; Eberhart, C. Diagnostic and Analysis of Production Systems in the Rural Environment, TAS studies were carried out in several communities of the Sierra of Huautla, Morelos. The results lead us to consider in the methodology, that the importance and complexity of the TAS must be approached from the perspective of ethnosciences, deepening in technological, productive strategies, environmental, historical, agronomic, social and economic conditions, as well as the vision and perspective of TAS practitioners, a necessary condition for trying, together with the producers, the search for improvement, which must move towards ethnodevelopment.

The methodology for study must include the vision of ethnosciences, the deepening of aspects of management and the perspective of development, of the TAS practitioners.

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Abstract
Production Science

Marisela Aparicio-Lechuga, **Alejandro Lara-Bueno**, Dante A. Rodriguez-Trejo, Miguel Uribe-Gomez

Alejandro Lara Bueno

Effect of the Silvopastoralism with Sheep in the Regeneration and Survival of Abies Hickelii

Keywords: silvopastoral, sheep, temperate forest, vegetal coverage

In Mexico have been identified around 25,000 plant species, many of them endemic; this biodiversity is threatened by anthropogenic processes (felling, fire and overgrazing), so 261 species have been classified in risk of extinction. The objective of this research was to evaluate the impact of the graze by sheep on the regeneration and survival of *Abies hickelii* seedlings in a temperate forest of conifers. Two experimental sites were established, one was used for natural regeneration and the other for reforestation with *A. hickelii*. Each site was divided into six paddocks, three for grazing of sheep (flock of nine lambs under rotational grazing during 138 days) and three without grazing. In each cycle of grazing, the floristry composition, vegetation coverage, tree seedling height, number of terminal buts nibbles and number of dead trees, were measured. We also evaluated body weight (BW) or average daily gain (ADG) of animals. The impact of grazing on vegetation coverage was significant ($p < 0.05$) in both sampling sites, going from 80 to 30% in natural regeneration and reforestation paddocks. There was decrease of herbaceous species for grazing in both experimental sites. However, the tree seedlings survival of *A. hickelii* was higher than 80% in both sampling sites and dead tree seedlings showed no physical damage due to the presence of the sheep flock. The lambs had average of weight gain of 63 g animal-1 d-1. In conclusion, the negative effects of grazing sheep on the tree seedlings of *A. hickelii* are low; therefore, and it is feasible to promote silvopastoral systems with sheep in temperate forests of *A. hickelii.*

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Abstract
Environmental Benefits

Andres Anchondo-Ortega, Javier Castaneda-Rincon, Miguel Uribe-Gomez

Agroforestry for Montezuma Quail (Cyrtonyx montezumae) Habitat Conservation

Keywords: Cyrtonyx montezumae, alley cropping, hedgerows, profitability

This study presents the development and evaluation of two agroforestry technologies designed to conserve the habitat of *Cyrtonyx montezumae* in the Wildlife Conservation Management Unit (UMA) Ejido El Rosario at Tlaxcala, Mexico. An assessment of the current agroforestry and wildlife conservation activities was conducted through semi-structured interviews with UMA stakeholders and participant observation. To identify priority Montezuma quail habitat in between the community's agricultural parcels, ArcGIS was used. A total of 72 parcels with an area of 270 ha were identified, evaluated, and then classified in two types according to their habitat quality for Montezuma Quail. Type 1 were parcels that lacked shrub cover, and Type 2 were parcels with good quality habitat, but threatened by grazing. Each type of parcel was assigned an agroforestry technology; type 1 parcels were assigned alley cropping and Type 2 hedgerows. Under the assumptions used, the proposed agroforestry technology for Type 1 parcels was profitable only for parcels of five or more hectares and when government subsidies were used to implement them. The technology proposed for Type 2 parcels was profitable given the multiple products that are obtained from the selected plant species. Overall, we found that alley cropping and hedgerows can contribute to Montezuma Quail habitat conservation and that the selection of perennials, such as agave, with multiple uses is key to ensuring profitability of these agroforestry interventions.

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Abstract
Environmental Benefits

Saudizaref Ruiz Moreno, Jesus David Gomez Diaz, Carolina Martinez Ruiz, David Cristobal Acevedo

Influence of Ornamentals Production Practices on the Soil Quality in Puebla, Mexico

Keywords: ornamental plants, physical, chemical and biological soil properties, mountain cloud forest, atrophic impact

This research was conducted in a private property located in Ocotitla, Puebla. The region is characterized by the cultivation of ornamental shrubs, being its main economic activity. The crop of ornamental involves the removal of root ball, which leads to soil loss and deterioration of soil properties. Therefore, the objective of this study is to compare the quality of soil in eleven ornamental production systems (S) and a relict of cloud forest, through chemical, physical and biological indicators, which show the impact of management practices over the soil quality. The results indicate that, in general, the analized properties are better in the relict of cloud forest and systems which already have begun to implement sustainable agroforestry practice, than in S where the extraction of the root ball plant is more intense, because of the amount of the extracted plant and the larger size of the root ball (S-Azalea), or in those where continued fertilization with chicken manure and fertilizers sulfated have significantly increased the contents of some nutrients in the soil, such as calcium and phosphorus (*S-Semilleros* and *S-Arrayan*) and sulfur (*S-Silvopastoril*). It is concluded that despite the intense agricultural activity in the area, soils have largely retained their fertility, possibly because the original soil (*Andosol mollic*) is very fertile and it has a very deep and rich first horizon, which is full of organic matter.

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Special Panel – The 1890 Agroforestry Consortium: Promoting Sustainable Agroforestry Practices in the Southeast – Room 238
Abstract
Production Science

Uma Karki*, Yubaraj Karki, Rishi Khatri, Asha Tillman, Nar Gurung

Raising Goats in the Southern-Pine Silvopasture System: Challenges and Opportunities

Keywords: debarking, forages, Kiko wether, Longleaf pine, Loblolly pine

Pasture-based goat operation is popular among small-scale farmers; however, it may be challenging when forage availability is limited. Grazing opportunity can be increased by developing silvopastures after thinning pine plantations. To successfully manage silvopastures, it is important to understand animals' interaction with trees. The objective of this study was to evaluate the use of goats in the southern pine silvopasture system. Studies were conducted at two sites 1) Atkins Agroforestry Research and Demonstration Site, Tuskegee (Site 1), and 2) Plantersville Silvopasture Demonstration Site, Plantersville, Alabama (Site 2). Site 1 consisted of six acres of long-leaf (*Pinus palustris Mill.*) and loblolly (*Pinus taeda L.*) mixed pine (11-12 years, 147 ±21.1 trees/acre (longleaf 52.14%, loblolly 47.86%). Site 2 consisted of 14 acres of 18-19 years old loblolly pine silvopastures. Both sites were planted with cool- and warm-season forages, and plots were rotationally grazed with goats (Site 1 - Kiko wethers; Site 2 - mixed breed of goats) during the 2015-2016 grazing season. Goat performance (live weight, condition score, and FAMACHA score) was monitored every two weeks, and trees were inspected for possible damage. Goats performed better while grazing cool-season forages during the spring. In Site 1, goats debarked pine trees, especially longleaf pines during spring grazing on cool-season forages. No debarking was observed in Site 2. This study showed that southern pine silvopastures can provide a good grazing opportunity; but, trees can be vulnerable to goats even when they are 11 to 12 years of age.

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Abstract
Production Science

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Alley Cropping With Specialty Vegetable Crops in Pecan and Loblolly Pine Stands

Keywords: alley cropping, specialty vegetable crops, pecan, loblolly, ethnic vegetable crops

Nearly two-thirds of Alabama (about 22 million acres) is forestland, 75% of which is owned by non-industrial private landowners. Many landowners view their forested land as a source of returns from timber rather than as a source of revenue from multiple land use systems that incorporate harvesting and marketing non-timber forest products or agricultural crops. Among agroforestry practices, alley cropping is a versatile practice with flexibility and multiple uses with impacts on soil, environment, economics, and sustainability. The objectives of this research are to: assess growth and yield of six specialty vegetable crops grown between rows of pecan and loblolly trees; ii) to determine changes with time in soil physical and chemical properties in response to alley cropping in pecan and loblolly tree stands; and iii) to determine economically most viable agroforestry alleycropping combination of specialty crop and nut and pine tree stand. Alabama A&M University and TU are working together with funding support from USDA/NIFA-AFRI on alley cropping system involving the production of market-ready specialty vegetables such as: i) Chinese eggplant (*Solanum melongena*) (V1), ii) Indian eggplant (V2), iii) colored bell peppers (Capsicum species) (V3), iv) bitter melon (*Momordica charantia*) (V4), v) poblano/ancho peppers (*Capsicum annuum* var. annuum) (V5), and vi) roselle (Hibiscus sabdariffa) in two different tree production systems: pecan (*Carya illinoinensis*) trees and loblolly pines (*Pinus taeda*). Open field studies showed these vegetables can be grown in Alabama. Their potential for production as alley crops will be determined in this research.

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Abstract
Community, Culture, Communication

Joshua Idassi

Alley Cropping system: Intercropping of Pecan and Moringa oleifera to enhance income opportunities for small scale farmers in North Carolina

Small farmers and woodland owners in North Carolina with fewer than 20 acres are seeking alternative land use systems that will provide them with new market opportunities and also enhance sustainable agriculture and land stewardship. NCA&T research faculty and outreach specialists are assessing the growth and yields potential of pecan and *Moringa oleifera* relative to the needs of limited resources landowners in North Carolina. At the NCA&T demonstration farm, four pecan cultivars were planted – Jackson, Forkert, Elliot and Choctaw. These varieties thrive well in full sun with fertile –drained soils with ph of 6.0 to 6.5 with a high range of elements (NPK). If well maintained, pecan would mature within a period of 12 months. Pecan nuts are a valuable food product that has significant health benefits (as an excellent source of protein and antioxidants*). Moringa oleifera* is tropical plant that possesses many valuable properties including the high protein content of the leaves twigs, the high protein and oil contents of the seeds, the large number of unique polypeptides in seeds that can bind to many moieties, the presence of growth factors in the leaves, and the high sugar and starch content of the entire plant. Using the available information from various resources, NC A&T researchers and outreach specialists will modify the growing practices to suit local soil, weather, pest, and disease conditions. Introduction of *Moringa oleifera* into a farm which has a biodiverse environment can be beneficial for both the owner of the farm and the surrounding ecosystem.

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Concurrent Session 5 (Tuesday 3:45 – 4:45 pm)

Special Panel – Careers in Agroforestry: Finding a Position When Agroforestry Isn't in the Job Description – Brush Mountain B

Abstract

Education and Engagement

Kate MacFarland

Agroforestry Opportunities: Where are the Jobs and What is the Work?

Keywords: agroforestry jobs, job market, education, government, non-profit

Agroforestry educational opportunities through universities, professional development training, and peer learning networks are growing across the country. Do these result in more agroforestry jobs and more agroforestry on the ground? In this session, Kate will share information she's collected on where people are finding jobs that use agroforestry knowledge and experience. Based on conversations with educators and professionals, she will discuss navigating evolving job prospects in agriculture, forestry, and natural resource management in the public, non-profit and private sectors. She will also explore opportunities and challenges for agroforestry proponents and AFTA.

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Abstract
Education and Engagement

Katie Commender

Innovative Agroforestry Opportunities in the Non-Profit Sector

Keywords: agroforestry jobs, job market, education, non-profit

Katie serendipitously discovered agroforestry in 2012 as a Sustainable Forestry AmeriCorps VISTA with a Bachelor's in International Studies. Falling in love with the people, woods and farms of Appalachia, Katie has since developed a multifunctional riparian buffer program with USFWS and trained hundreds of forest farmers on cultivation and marketing. After receiving her Master's in Forestry from Virginia Tech, Katie returned to ASD in 2016 to create a GAP-certified herb processing hub and serve as a regional consolidator for sustainably grown and harvested forest botanicals. Throughout this session, Katie will tell the story of how she became involved with agroforestry, shed light on what her day to day job is like, and offer innovative tips for others looking to enter into the allusive agroforestry job market.

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Abstract
Education and Engagement

Tracey Coulter

Agroforestry Coordinator: The Evolution of an Agroforestry Program at the PA Bureau of Forestry

Keywords: agroforestry jobs, job market, education, government

Originally hired to coordinate the watershed program in the Pennsylvania DCNR Bureau of Forestry, Coulter looked beyond streamside practices to expand watershed protection into upland areas using a variety of agroforestry practices. With agency support, Coulter works with regional and statewide partners to develop an agroforestry program to help landowners strategically establish trees on agricultural lands while protecting surrounding ecosystems. Watershed conservation remains is a critical part of Coulter's effort. Working closely with the Chesapeake Bay Program Forest Workgroup, and the nascent Northeast/Mid-Atlantic Agroforestry Working Group, her office finds opportunities to combine watershed protection while enhancing economic potential in conservation projects. Coulter's unique career path brought elements of supply chain management, agriculture, forest technology and biology, and studies in human dimensions into the development of the program. Hear how each of these disciplines combine in an ongoing effort to develop a long-term agency program.

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Producer Panel – Establishing and Managing a Forest Farm – Room 342

Forest Farmers: Jon Beegle, Jeremy and Stesha Warren, and Rick Taylor

Leader: Holly Chittum

Special Panel – The 1890 Agroforestry Consortium: Promoting Sustainable Agroforestry Practices in the Southeast – Room 238
Abstract
Production Science

Uma Karki, Rishi Khatri, Jerry Bettis, Yubaraj Karki

Management of Understory Vegetation in Woodlands with Kiko Goats

Keywords: canopy coverage, defoliation, Kiko wethers, plant-species composition, understory vegetation

Woodland accounts for around 60 percent of the land cover in the Southeast. Use of goats in this system may utilize the understory vegetation to fulfill their nutrient requirements, and minimize competition for desirable trees present in the system. However, not much information is available regarding the understory plant species that are readily eaten by goats, and the possible threat they may pose to the trees while grazing in the system. Objectives of this study were to 1) identify the woodland vegetation preferred by Kiko wethers, and 2) evaluate the damaging effects Kiko wethers may inflict on the tree species present in woodlands. The study was conducted at the Atkins Agroforestry Research and Demonstration Site, Tuskegee University, Alabama. Twenty-nine Kiko wethers (6-8 months old, 26.8 ±0.67 kg Live Wt.) were rotationally stocked in three (May-July) to five (Sept.-Oct.) plots (one-acre each) in 2015. Plant-species composition at the ground (0-36 in), mid (36-60 in), and high (>60 in) levels was assessed before and after grazing. Before- and after-grazing canopy coverage was appraised using vertical photoplots. Goats' preference for different vegetation and browse-height was collected after grazing each plot. Canopy coverage below five feet decreased ranging from 50% to 75% after grazing. Goats browsed on most of the species present (37), showing most preference for 12 species. Young longleaf pines (*Pinus palustris Mill.*) within the reach of goats were heavily defoliated; however, there was no other significant tree damage. This study showed that Kiko wethers can be used to utilize the understory vegetation in woodlands when the desirable tree vegetation are beyond their reach.

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Abstract
Production Science

Lila B. Karki, Uma Karki, Srinivasa R. Mentreddy, Susan K. Bambo

Impact of Agroforestry Educational Program: A Case of Alabama

Keywords: training, pre-tests, post-tests, evaluation

Tuskegee University Cooperative Extension and other partner institutions are involved in conducting educational programs on agroforestry for field educators and landowners in Alabama. Agroforestry education program at Tuskegee University was initiated in 2010 with silvopasture training program, which was continued until 2013. In collaboration with other 1890 institutions and funding support from Southern SARE, this program was expanded to incorporate other aspects of agroforestry in 2014, and continued since then. The objective of this study was to assess the impact of agroforestry educational programs. Pre-and post-session tests were conducted using pre-structured questionnaire to evaluate the short-term impact of the training sessions. Trainees also evaluated each training topic in terms of usefulness, likeliness to use, and possible improvement of their operations if learned skills and knowledge were applied. Pre-and post-session tests results showed that trainees' skill and knowledge on different aspects of agroforestry were increased significantly ($p<0.001$). Majority of the trainees rated that presented topics were very useful, they were likely to apply the learned skills and knowledge, and expressed that they would benefit from such application. Study on medium- and long-term impact is ongoing.

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Abstract
Education and Engagement

Christian Colmore

Training of African-American Landowners in the Southeast in Forest Land Management Approaches

Small farmers and limited resource landowners do not always have the technical information and knowledge as well as access to available federal and state resources for the effective and sustainable management of their forest land resources. Given the important role that non-industrial forest lands play in the overall management of state forest resources, it is critical that small farmers and limited resource landowners are provided with the basic information and training to be more effective as forest land managers. Against this background Alabama A&M University has been organizing a series of land management training workshops throughout the Southeast US. This presentation will highlight the main features of the training workshop strategy, share the perspectives of participants, and consider the future outlook for such initiatives.

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Concurrent Session 6 (Thursday 9:30 – 10:30 am)

Special Panel – Land Access: Emerging Opportunities for Agroforestry Adoption – Colonial Hall

Abstract

Adoption, Adaptation, Permanence

Rich Straight

Agroforestry Headwinds and Leasing Tailwinds: Motivations from USDA and Beyond

Keywords: leasing, adoption, USDA programs, conservation, socio-economic barriers

Opportunities for Agroforestry Adoption" being organized by Mike Dosskey, USDA National Agroforestry Center. Agroforestry leasing can provide a mechanism to overcome some of the socio-economic barriers to agroforestry adoption. Leasing arrangements can connect farmers who want to do agroforestry with farmers and landowners who don't have the time, resources, or desire to do it themselves. In these agreements, an individual or cooperative would contract the use of specific areas of a landowner's farm that are environmentally sensitive, marginal or unproductive, difficult to farm, or for other reasons to be managed differently than the landowner's main crop. This strategy fits well within the USDA mission and can be supported by numerous USDA technical and financial assistance programs. Conservation programs can help to establish agroforestry practices that provide conservation benefits. Production support programs can help to facilitate development of agroforestry specialty food crops (e.g. Specialty Crop Block Grants) and biofuel feedstock (e.g., Biomass Crop Assistance Program). Profit risk can be reduced through subsidized insurance for some specialty crops and diversified farm operations (e.g., Whole Farm Revenue Protection Program). Initiatives are helping to organize and grow markets for locally-grown foods (e.g., Know-Your-Farmer-Know-Your-Food) and ecosystem services. Additional programs are designed to assist beginning, limited-resource, and specialty crop farmers in developing new rural enterprises. These initiatives and programs represent tailwinds for establishing and growing agroforestry leasing enterprises. Despite the tailwinds, development of leasing enterprises still faces serious challenges. This presentation will provide an overview of the tailwinds and headwinds that will influence the use of leasing arrangements as way to increase agroforestry adoption.

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Abstract

Adoption, Adaptation, Permanence

Keefe Keeley, Kristy Gruley, Erin Hannum, Rachel Armstrong

Perennial Tenure: Adapting Long-Term Leases and Other Legal Vehicles for Agroforestry Land Access

Keywords: rural development, farm business, adoption, social, support

Eaters increasingly demand healthy food systems that restore ecosystems, and they are developing tastes for perennial crops that can be grown in agroforestry systems. Growing ranks of non-farming landowners also seek alternatives to renting their land for annual commodity crops. Farmers without land access and long-term tenure are unable take advantage of these circumstances. We will discuss our work to advance favorable legal frameworks and infrastructure to facilitate innovative agroforestry land access options. Primarily, we explore the viability and best practices of using long-term lease arrangements and other multi-party collaborative frameworks. We describe existing research and educational resources, as well as gaps in knowledge, barriers, and under-utilized strategies from other contexts with promise for facilitating agroforestry land access.

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Abstract
Adoption, Adaptation, Permanence

Kevin J. Wolz*, Cathe Capel*

Vulcan Farm: A Farmer Perspective on Agroforestry Leasing

Keywords: long-term lease, land access, land tenure, legal issues, asset protection

Vulcan Farm is a 10-acre agroforestry farm located in rural Central Illinois. Established in 2015 as an innovative collaboration between Kevin Wolz (farmer) and Cathe Capel (landowner), Vulcan Farm is grounded in a 99-year cash rent lease. The long-lived crops that are at the core of the farm's production (chestnut, hazelnut, plums, currants, and other tree crops) necessitated secure land tenure for Kevin and clear expectations for both parties. Kevin and Cathe worked with Farm Commons and the Savanna Institute to generate an innovative and comprehensive long-term lease strategy that can be used as a model for future collaborative agroforestry ventures.

Key components of the lease include:
(1) splitting the cost of trees to designate their value "as trees" vs. "as food producers",
(2) an initial five-year trial period that hinges the full lease on successful tree establishment,
(3) reserving Cathe's right to graze her sheep in the alleys between rows of trees,
(4) granting Kevin first right of refusal if Cathe or her heirs decide to sell the land,
(5) consideration of responsibilities and payments around the several acres of CRP, and
(6) consideration of potential damages and remuneration should either party fail an aspect of the lease.

We describe the lease creation process, key considerations by both parties, important features of long-term agroforestry leases, and further research that is required to improve future agroforestry leases.

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Abstract
Adoption, Adaptation, Permanence

Greg Judy

Green Pastures Farm: Using Leasing to Accomplish Your Goals

Keywords: leasing, grazing, beginning farmer, leased land

Greg and Jan Judy of Rucker, Missouri run a grazing operation on 1620 acres of leased and owned land, greenpasturesfarm.net. They own 4 farms and lease 12 farms. Greg wrote a book in 2001, entitled "NO RISK RANCHING, Custom Grazing on Leased Land", which gives a complete breakdown on the methods they used to build their operation from scratch. He will talk about the advantages of leasing land as a way to overcome the burden of acquiring capital to purchase land, especially as new grazing entrepreneur. The presentation will describe the positive impacts that active grazing management brings to properties that are sometimes ignored by absentee landowners.

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Special Panel – Looking Ahead: What is a Regional Agroforestry Working Group – Room 219
Abstract
Community, Culture, Communication

Badege Bishaw, Sonia Bruck

Pacific Northwest Agroforestry Workgroup: An Interdisciplinary Collaboration for Research and Extension

The Pacific Northwest (PNW) Agroforestry Workgroup was formed as a result of a workshop held in May 2013 at the Oregon State University North Willamette Research and Extension Center to assess the current status of agroforestry education, research, and outreach activities. Participants to the workshop came from state and federal forestry and natural resources agencies, landowners, and academics. Key issues for this meeting were to explore the progress and challenges faced to promote agroforestry in the region, how to improve water quality for salmon and wildlife, and diversify rural economies through non-timber forest products. A subsequent workshop was held on October 2014 to provide training for mid-carrier natural resources professionals, where experts discussed the different agroforestry practices, agroforestry policy, basic economics of agroforestry, and other related topics such as urban forestry. Recently the Workgroup is expanding to include a core interdisciplinary group of academics from across Oregon State University. We aim to establish long-term agroforestry research and demonstration plots in Oregon, to attract a diverse group of academics and extension to facilitate research amongst graduate and undergraduate students, and to increase landowner awareness of agroforestry options. We believe the PNW Workgroup brings together agroforestry professionals to conduct interdisciplinary research, demonstrations and trainings. Additionally, we aim to remove the barriers between agencies and universities, and create cooperation among scientists, natural resources professionals, and landowners.

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Abstract
Community, Culture, Communication

Erik Hagan

Northeast/Mid-Atlantic Agroforestry Working Group

Keywords: Northeast, Mid-Atlantic, working group, education, networks, wicked p.roblems

The Northeast/Mid-Atlantic (NEMA) Agroforestry Working Group has evolved from a variety of efforts throughout the region. First, the Chesapeake Bay Agroforestry Working Group emerged from the Chesapeake Bay Agreements and the Chesapeake Forestry Workgroup. The 2010 Chesapeake Bay TMDL for nutrients led to state-level Watershed Implementation Plans and the Chesapeake Executive Order Strategy. This strategy includes recommendations for forest restoration and agroforestry, particularly riparian forest buffers. The Chesapeake Bay Agroforestry Working Group had its first in-person meeting in May 2014. During the 2015 NAAC conference in Ames, IA, a larger group came together to form the Northeast/ Mid-Atlantic Agroforestry Working Group, which overlaps with the Chesapeake Group, expanding the geographic and demographic range. Through a Northeast SARE Professional Development Program grant award, NEMA has successfully begun networking across geographic borders, providing professional development trainings, a NEMA regional specific agroforestry webinar series and soon to release a NEMA specific Agroforestry Manual. The NEMA working group is rapidly expanding throughout the region, with hopes of achieving representation from each of the 12 states. As the network grows, we begin to question; what is the role of such networking infrastructure? How can such a network function to create a community of practitioners, researchers and educators who work across a multitude of disciplines, allowing agroforestry principles to apply to social, economic and environmental challenges? With our roots in conservation and sustainable agricultural development, our diverse network seeks to enhance successful application of multifunctional perennial systems in the NEMA region.

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Abstract
Community, Culture, Communication

Mike Gold

Mid-American Agroforestry Working Group – What has MAAWG Learned in Seven Years

Keywords: working group, cross agency, agroforestry, upper Mississippi

In 2009 several agroforestry advocates in the upper Mississippi River valley started talking about how to do a better job of coordinating efforts and advocating for agroforestry. They recognized that agroforestry has the capability for creating innovative, multipurpose systems in support of energy, food & fiber production, and natural resources. They also saw agroforestry's potential to serve as a focal point for initiating and leveraging partnerships and funding within the region to more effectively address such issues as water quality. The focus of the initial meeting was to 1) bringing together a wide range of stakeholders and representatives to determine "core issues" and 2) determine the utility of forming a Midwest working group to gain the needed visibility of agroforestry. After the meeting a charter was developed for the Mid-American Agroforestry Working Group, MAAWG. Charter members included federal, state, and university representatives as well as some nonprofit organizations and private landowners. Since then the MAAWG has been able to support speakers at key regional meetings, support the creation of multi-state Agroforestry Academies and join with Green Lands Blue Waters to reach an even broader audience.

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Special Panel – The 1890 Agroforestry Consortium: Promoting Sustainable Agroforestry Practices in the Southeast – Room 238
Abstract
Adoption, Adaptation, Permanence

Susan K. Bambo, Uma Karki

Adoption of Agroforestry Practices by Small Landowners

Keywords: agroforestry, adoption, small landowners, technologies

Agroforestry practice is an acceptable agricultural land-use that has economic, environmental and social values. There is complexity in adopting agroforestry compared with traditional monoculture agriculture. This is because it requires establishing a mixture of trees, forages and/or livestock in an integrated manner on the same piece of land. The knowledge of all is needed for a successful establishment of the agroforestry system. The study presents case studies of farmers who have adopted agroforestry practices in the southern region of the United States. It looks at how small landowners have been able to learn about the complexity and the type of information useful to their adoption. Also, it highlights on a case basis, the challenges and benefits of adopting the practices. In addition, the resources that have enabled adoption of agroforestry practices are evaluated. Available training programs and centers that can improve small-farmers learning, knowledge and skills are recommended for proper management of agroforestry technologies.

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Abstract

Adoption, Adaptation, Permanence

Angela McKenzie-Jakes, Lawrence Carter, Alfredo Lorenzo, Susan K. Bambo

Expanding Silvopasture Systems Through the Conversion of Conservation Reserve Program Acreages ACROS

Keywords: silvopastures, loblolly pines, goats, cattle, pastures, agroforestry

The Conservation Reserve Program (CRP) established by USDA through the 1985 Farm Bill (Food Securities Act of 1985-P.L. 99-198-Subtitle D) has resulted in over 2 million pine trees(mostly, slash, loblolly and longleaf) being planted throughout the south with Georgia alone said to have more than 700,000 acres of CRP trees. These trees now range in age from 15 to 18 years. Management systems that will make them not only productive and profitable, but also sustainable are now being sought. Among these is silvopasture which integrates trees, forages, livestock and related animals and plant species. After phone interviews with several limited resource farmers, three CRP landowners (one each in Alabama, Florida and Georgia) were identified for the establishment of silvopasture systems on their CRP planted pine lands as demonstartion trials for future adoption. Each landowner was provided with one beef cattle and seven goats for grazing in the alleys resulting from the thinning of two acres of the CRP planted pines. Bahia grass was the main forage grass utilized for the study. Results indicated that these landowners will be favorable to expanding silvopasture systems into their existing land use to improve their economic returns as well as maintain sustainable production over a long period. Challenges and success will be discussed.

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Abstract
Production Science

Rao Mentreddy

Fifteen Years of Agroforestry Research and Extension at Florida A&M University: Challenges and Succes

In 1990, Florida A&M University (FAMU) acquired a 260-acres of land in Quincy, Gadsden County Florida. This became the FAMU Research and Extension Center (FAMU-REC). There were seventy acres of planted loblolly pines on this property. The trees were planted in 1979/1980 at a conventional spacing of 12 ft x 12 ft. From November 2001 to April 2002 the loblolly pine trees were thinned to 12 ft x 42 ft spacing thereby creating alleys in which different pastures were initially tested for their suitability in a silvopastoral system with small ruminants focusing on goats. During the past fifteen years stocking rates, performance of pasture grasses and legumes, loblolly pine trees, as well as liveweight gains for the goats have been evaluated. Field days for limited resource farmers have been conducted as part of FAMU's Master Goat Programs. Adoption of the silvopastoral system by limited resource farmers remains challenging but some successes have been accomplished.

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Abstract
Education and Engagement

Christian Colmore

Participation of Minorities and Underserved Landowners in Cost-share Program in the Southeastern US

It has only been a few years since underserved landowners and minorities have gained access to participation in cost-share programs in Alabama, although in theory access had been open to these groups. Factors which limited these stakeholders access included (a) Natural Resource Conservation Service's, the agency responsible for the cost-share program, limited pool of available and relevant technical personnel (b) the agency's interpretation of program policy guidelines and (c) the low level of underserved and minority landowners' trust and confidence in the transparency and fairness of federal and state agencies and their officials. The experience of a group of minority landowners in Alabama in successfully accessing cost-share resources for its members and lessons learned will be presented.

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Poster Abstracts

Poster Abstract
New Markets, New Products, New Values

Benjamin J. Addlestone, John F. Munsell

Utilizing BayFAST to Simulate Agroforestry Technologies in Virginia's Chesapeake Bay Region

Keywords: multifunctional riparian buffer, nitrogen, nutrient, phosphorous, sediment

The Chesapeake Bay has long supported diverse aquatic and coastal ecosystems and associated economies. In recent decades, the health of the Chesapeake Bay, particularly in Virginia's region, has declined due to sediment and nutrient overload from non-point and point source activities. Despite incentives, many landowners in Virginia's region of the Chesapeake Bay remain hesitant to convert a portion of their land to conservation purposes. Agroforestry, particularly multifunctional riparian buffers, offer multiple environmental and economic benefits to landowners including entrance into the emerging nutrient trading market. The Chesapeake Bay Facility Assessment Scenario Tool (BayFAST), one of a suite of tools developed by the U.S. Environmental Protection Agency (EPA), allows users to define parcels of land and rapidly develop scenarios over time with varying best management practices (BMPs). Outputs that can be compared (e.g., baseline vs. target) include costs, sediment, Nitrogen, and Phosphorous loads. In order to determine how effective multifunctional riparian buffers and associated agroforestry practices are over time in reducing sediment, Nitrogen, and Phosphorous delivery to the Chesapeake Bay and its tributaries, these tree planting strategies will need to be simulated utilizing existing BMPs (e.g., "Forest Buffers"•, "Grass Buffers"•, and "Tree Planting"•). Simulations will occur from a sample of over 650 landowners identified as having an interest in agroforestry and whose open and riparian lands have been determined to have a conservation need. Future work includes scaling up utilizing additional EPA tools to analyze the impact of various conservation practices and adoption rates at the landscape-level.

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Poster Abstract
Environmental Benefits

Salah Alagele, S.H. Anderson, R.P. Udawatta

Biomass Crop and Agroforestry Buffer Effects on Soil Hydraulic Properties Compared to Grain Crops

Keywords: hydraulic conductivity, water retention, pore size distributions

Biomass production systems have been found to improve soil hydraulic properties and water quality relative to row crop management for temperate regions. Objectives of this study were to assess the effects of biomass crops and agroforestry buffers grown on claypan soils relative to a traditional corn (*Zea mays L.*)-soybean (*Glycine max L.*) rotation for hydraulic properties which included saturated hydraulic conductivity (Ksat), soil water retention, bulk density, and pore size distributions. Experiment was conducted in northeastern Missouri, USA. Grain crop production watersheds were established in 1991 with agroforestry buffers and biomass crops established in 1997 and 2012 respectively. Agroforestry buffers consisted of grasses and forbs with pin oak (*Quercus palustris Muenchh.*) trees. Biomass crops included switchgrass (*Panicum virgatum L.*) and native grasses. Undistributed soil cores (7.62 cm diameter by 7.62 cm long) were taken by 10 cm depth increments with six replications from the surface to the 40 cm depth. Samples were evaluated for Ksat, water retention, bulk density, and pore size distributions. Results illustrated that soils under agroforestry buffers and biomass crops had lower bulk density values than row crop management. Hydraulic conductivity values for agroforestry buffers and biomass crops were higher than for row crops, particularly at the surface 0 - 10 and 10 - 20 cm depths. Although the claypan soil dominates in northeastern Missouri, this study showed that biomass and agroforestry buffer practices improve soil hydraulic properties relative to row crop management; they also have valuable economic and environmental benefits.

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Poster Abstract
Environmental Benefits

Amir Behzad Bazrgar, Afshin Soltani, Andrew Gordon, Naresh Thevathasan

Energy and GHG Based LCA of Machinery Used in Agroforestry and Monoculture Cropping Systems in Iran

Keywords: life cycle assessment, global warming potential, sugar beet, emission, non-renewable energy

Iran is in arid and semi-arid zones, and traditional agroforestry systems still exist. In recent decades, the demand for enhanced agricultural yields has resulted in monoculture cropping systems. However, this shift has increased the non-renewable energy consumption in relation to agriculture mechanization. Therefore, we examined the Life Cycle Assessment (LCA) to evaluate non-renewable energy demand and global warming potential of agricultural machinery in-use in agroforestry and monoculture cropping systems of sugar beets production in Iran. A cradle to gate Life Cycle Inventory (LCI) was developed from 68 sugar beet farms in eastern Iran. Field operations and machinery data were obtained from Ecoinvent and adjusted to Iranian conditions. Simapro 7.3.0 was used to model mixed electricity production. SALCA-heavy metal was used to assess heavy metal emissions to water and soil. The soil nitrogen dynamics were modeled using SUNDIAL and nitrous oxide emissions were estimated using an adapted IPCC method. Life Cycle Impact Assessment (LCIA) was performed using EPD, V 1.03 system of SEMC. The results show that global warming potential and non-renewable energy demand associated with one metric ton of sugar beets production in monoculture cropping systems was 18.06 kg CO_2-equivalent, and 280.34 MJ-equivalent respectively, whereas, the respective values for agroforestry systems were 7.8 and 7.1 percent lower. In both systems of sugar beets production, ploughing contributed the highest environmental impacts. Results also indicate that although monoculture systems produced 2.5 times more yield, agroforestry should be integrated in farming systems due to its better energy and environmental performances.

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Poster Abstract
Adoption, Adaptation, Permanence

Gary Bentrup

Agroforestry: Enhancing Resiliency in U.S. Agricultural Landscapes under Changing Conditions

A scientific assessment was conducted on the potential for agroforestry to help adapt agriculture and agricultural lands to threats from climate variability and change. This recently released report entitled Agroforestry: Enhancing Resiliency in U.S. Agricultural Landscapes under Changing Conditions will provide technical input to the National Climate Assessment and can serve as a framework for using agroforestry as a climate-smart agricultural strategy in the U.S. The agroforestry assessment was led by USDA Forest Service scientists and included participation from more than 50 scientific experts from the Forest Service, other federal agencies, research institutes, and universities across the U.S., as well as input by scientists from Canada and Mexico. Based on expert input and information gleaned from over 1000 citations, this document represents the first-ever synthesis on agroforestry as a mechanism to provide climate change mitigation and adaptation services. The report also evaluates the social, cultural, and economic aspects of agroforestry and the capacity of agroforestry systems to provide multipurpose solutions. For instance, indigenous and tribal agroforestry systems of the United States and U.S.-affiliated islands can offer time-tested models that could inform current agroforestry systems. In addition, the report presents U.S. regional overviews as well as international overviews from Canada and Mexico to provide a comprehensive North American perspective and understanding of agroforestry's strengths and limitations. This presentation will provide an introduction to the assessment and will highlight key sections of the report.

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Poster Abstract
Environmental Benefits

Asha Bertsch

Using Agro-Silvopastoral Reforestation to Improve Soil Fertility in Panama's Azuero Peninsula

Keywords: agro-successional, carbon sequestration, cattle, soil degradation, tropical dry forest

Tropical dry forests are the most endangered ecosystem in the Neotropics. In Panama's Azuero peninsula, this ecosystem has been largely replaced by pasture for cattle grazing. Cattle ranching in this region typically consists of clearing and burning forest, heavy use of herbicide, and overgrazing, resulting in soil fertility degradation, erosion and decreased farm productivity.

In 2011, a cooperative of smallholder cattle ranchers known as the Association of Livestock and Agro-Silvopastoral Producers of Pedasi (APASPE), with help from the Environmental Leadership and Training Initiative (ELTI), enacted a project to restore native forest to riparian buffer zones within their pastures. Ranchers were provided seedlings of 21 native fruit and timber species. Given freedom to choose how to manage their reforestation plots, farmers diversified in one of three ways: (1) Agro-successional: several farmers interplanted annual and perennial crops within their reforestation plots, (2) Silvopastoral: several farmers allowed cattle grazing within their plots, (3) Plantation: others chose only to plant the trees.

Five years later, the effects of this reforestation on soil quality have yet to be quantified. My research investigates changes in soil fertility and soil carbon sequestration five years after implementation, and compares how these changes vary across the three management strategies. My results illustrate the potential for this reforestation model, and its variations, to restore degraded soil fertility and increase carbon sequestration. This information will aid ELTI to construct new educational training materials, and will be shared with APASPE members to inform their decisions on further restoration and land management directions.

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Poster Abstract
Advances in Technology Applications

Tobias Carter

Environmental Suitability of Chestnuts as Multifunctional Tree Crops in New England

Keywords: chestnut, New England, habitat modelling, environmental suitability, variety selection,

New England is the northeastern range limit of the native, North American chestnut (*Castanea dentata*). Prior to its near extirpation from its native range by exotic fungal diseases, American chestnut provided a multitude of ecosystem services, not the least of which were timber, fodder and nutritious human food. Various efforts to breed blight-resistant, interspecific, hybrid varieties for ecological restoration as well as timber and nut production are underway nationally. Due to the rarity of chestnut in New England for over half a century, and the nearly ubiquitous ecosystem alteration following European colonization, there is little definitive evidence for the potential geographic distribution of disease-resistant chestnut varieties in present and future climates. Using a diverse dataset of American and Chinese chestnut trees alive in the region today, and a set of gridded (250m) edaphic, topographic, and climatic variables, expert knowledge of chestnut habitat requirements is compared to a statistical-based model in order to estimate the most suitable habitat for both species in New England under present and future conditions. Two Species Distribution Modelling (SDM) methods - the Habitat Suitability Index (HSI) model and the Maximum Entropy (Maxent) model - are used to assess current knowledge of the species distributions, update the ecological profiles of the species in the region, and predict the theoretical range of suitability for hybrid varieties. The model of environmental suitability provides a first step in locating future chestnut plantings, determining the best application of chestnut plantings in a given area, and assessing the economic potential of chestnut as multifunctional species in New England.

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Poster Abstract
Environmental Benefits

Brent Coleman, Naresh Thevathasan, Andrew Gordon, Adam Martin, Marney Isaac

Shade Tree Effects on Intraspecific Leaf Trait Plasticity in a Willow Agroforestry System

Keywords: decomposition, nutrient cycling, resource acquisition, tree-based intercropping, tree-crop interactions

Agroforestry systems enhance nutrient cycling, in part, through modifications to leaf quality and quantity, and subsequently, decomposition rates. However, leaf traits are plastic and thus variable across both temporal and spatial scales in agroforestry systems. Using a temperate tree-based intercropping system with willow, this study examined effects of shade tree functional group (N2-fixer, Non N2-fixer, or monoculture) and distance from shade tree on i) willow leaf traits (leaf area, leaf weight, specific-leaf area (SLA), leaf nitrogen concentration (LNC), and subsequently ii) trait variability influence on decomposition rates in a lab incubation. Willow leaves within agroforestry treatments exhibited greater leaf area, SLA, and LNC than within the monoculture treatment. Willow leaf decomposition followed a two-pooled kinetic model with k_1 values ranging from 0.20 to 0.29 d-1 and k_2 values ranging from 0.0019 to 0.0023 d-1. Willow litter in agroforestry systems presumably provides soils with additional N, potentially reducing required fertilizer inputs.

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Poster Abstract
Adoption, Adaptation, Permanence

Alexander Darr, Nathan Heavers

Rediscovering Sunny Ridge: An Exploration of the Surviving Experiments of J. Russel Smith

Keywords: agroforestry, permanence, J Russell Smith, sunny ridge, experimental farms

Geographer, educator, and conservationist Dr. J. Russell Smith (1874 - 1966) is well known for his 1926 book Tree Crops: A Permanent Agriculture. Despite the wide audience inspired by his book, little attention has been paid to Sunny Ridge, the 2,000-acre nursery and perennial agriculture experimental station he operated on the Eastern edge of the Blue Ridge Mountains in Northern Virginia. This site was abandoned at the time of his death in the late 1960s, has been divided and developed by various new landowners, and has been largely neglected by scholars and conservationists. What remains of Sunny Ridge offers a unique case study for how Dr. Smith sought to test his theories on the ground, and how the practices outlined in his text can withstand the pressures of development and neglect. Through study of aerial imagery, Dr. Smith's archive's, and present-day field excursions, examples of the practices he promoted are identified at Sunny Ridge and discussed so as to further our understanding of the "permanence" of such systems. This paper offers an assessment of the resources that have remained since Dr. Smith departed from Sunny Ridge. It argues that what remains is the equivalent of a long term ecological research site for agroforestry and suggests that Sunny Ridge holds significant clues for how to implement Dr. Smith's theories. It concludes that some aspects of his operation are indeed quite "permanent", lasting half a century with little to no care, and proving to be valuable long range experiments.

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Poster Abstract
Production Science

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Are Woody Species in Semi-Arid Agro Ecosystem of Dutsin-ma, Nigeria Sustainably Managed?

Keywords: sustainability, threats, woody species, agro ecosystems

Current initiatives aimed at assessing sustainability tend to focus on forests which are under some form of formal management. Such a focus ignores the many individual woody species which grow out of forests which are not formally managed but are used intensively by local people. Scientists, therefore conduct research to understand any such ecosystem and identify threats to facilitate conservation and sustainable use of such woody species for people today and for future generations. The agro-ecosystem of Dutsin-Ma Local government is one of such agro-ecosystems in semi-arid region whose woody plant species are threatened. This study therefore assessed threat to sustainable management of woody species within Dutsin-Ma Local Government Area, Katsina State, Nigeria. A detailed survey using a mixture of open and close ended questionnaires during face-to-face interviews was conducted. To make more valid assessment, field observations of various threats were also carried. A simple random sampling technique was used to select Five (5) out of the eleven wards that makes up Dutsin-Ma local government. A total of 50 questionnaires were distributed at ten questionnaires per selected ward. The questionnaire were analyzed using descriptive statistics and well as SPSSM. Respondents claimed that firewood collection, illegal tree felling, land clearing for agricultural production are the important sources of threats to sustainable management of woody species in Dutsin-Ma local government area. Implications of this for management are made.

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Poster Abstract
Environmental Benefits

Ade Ayu Dewayani, Chung-ho Lin, Shibu Jose

Developing Bioremediation Using Pseudomonas Putida and Poplar to Restore Petroleum Contaminated Site

Keywords: bio-remediation, poplar, Pseudomonas putida, restoration

Most of energy source both in Indonesia or USA, for a daily life still derived from petroleum and gas sources. Despite the high demand on petroleum and gas, the mining process to obtain it can be harmful for the environment and public health. Approximately there are more than 750 chemicals that were used for mining process and many of those chemicals behave as an endocrine disruption for human and animals. Health complication includes decreased semen quality in men, higher miscarriages in women, premature menopause and increased risk of birth defects in children. Due to the number of operating petroleum mining and potential of shale gas exploitation, it is necessary to prepare the most cost-effective and environmentally friendly restoration efforts to reduce exposure of remaining toxic chemicals into ecosystem. The aim of this study is to investigate the effectiveness of the bioremediation/restoration approach in removing the pollutants and restoring the soil health of the contaminated sites. This approach synergistically integrates the microbial degrader *Psedeumonas putida* with 20 different clones of poplar trees. The pollutants and its degradation products and degradation kinetics will be determined using SPME (solid-phase micro extraction) followed by GCMS (gas chromatography mass spectrometry) analysis. The persistence of the introduced degraders into the rhizospheres will be monitored by TaqMan real-time quantitative PCR. The soil health and soil microbial community will be characterized using metagenomics deep-sequencing. The outcomes of this research expected to be applied and help to protect the public health and restore the ecological balance for Indonesia, USA and other oil producing countries.

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Poster Abstract
Adoption, Adaptation, Permanence

Chris Fields-Johnson

Pine Plantation to Silvopasture at Briery Creek Forest Farm

Keywords: silvopasture, savanna, sheep, pine, prescribed fire

Briery Creek Forest Farm has been raising sheep on transitional pine silvopasture since 2013. We have been converting a typical loblolly pine plantation to be a savanna-like silvopasture using the foraging activity of the animals, hand-thinning of undesirable woody plants and controlled understory burning. Our basic operational procedures and lessons learned thus far will be discussed.

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Poster Abstract
Environmental Benefits

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Soil Organic Carbon Determination as Influenced by Biomass Crops Grown in Ontario

Keywords: bioenergy, soil organic matter, switchgrass, miscanthus, climate change

Biomass crops such as switchgrass and miscanthus, suitable for Ontario's marginal land, can create a supply of feedstock to help sustain Ontario's emerging bioeconomy. At the same time, these crops also have the potential to sequester atmospheric carbon into the soil as soil organic carbon (SOC). Increases in SOC improve the health and fertility of the soil and can also help to mitigate the effects of climate change. This project seeks to quantify current levels of SOC in existing switchgrass and miscanthus fields across Ontario and facilitate the long-term monitoring of SOC. This will be completed by creating a GIS enhanced database of current SOC levels and developing SOC computer simulation models for approximately 20 biomass fields across Ontario. This research will contribute towards improving our understanding of soil health in biomass cropping systems and the potential of biomass crops to mitigate climate change. This research will also help project partners such as the Ontario Biomass Producers Cooperative and its members potentially claim carbon credits in the future within the context of Ontario Government's new cap/trade initiatives.

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Poster Abstract
Advances in Technology Applications

Van K. Ho, Jihyun Park, Danh C. Vu, Mark V. Coggeshall, Dan H. Pote

Determination of Health-Promoting Phytochemicals in Black Walnuts (*Juglans Nigra* L.)

Keywords: bioactive compounds, mode of actions, XCMS metabolomic platform

Black walnut (*Juglans nigra* L.) is widely distributed throughout the U.S. eastern forest, with the highest concentrations occurring in Missouri. Consumption of walnuts has been linked to many health benefits including reduced risk of cardiovascular disease, reduced levels of cholesterol, stimulated brain functions and prevented certain cancers (e.g., prostate and breast cancers). Black walnut contains more than 50 health-promoting bioactive phytosterols and phytophenolics, such as ss-sitosterol, campesterol, stanol esters, tocopherols, ergosterol, pedunculagin, and stigmasterol. However, systematic characterization of the bioactive compounds in walnuts using modern bioinformatics and metabolomics approach has never been explored. Additionally, the links between the specific compounds and the health benefits have not been well established. Fifteen cultivars of black walnut grown in Missouri are collected and the potent chemicals are identified and isolated. We conducted bioassay-guided purification to identify the bioactive compounds (e.g., antibacterial, anti-inflammatory and antioxidant) and perform animal studies to evaluate the pharmacokinetic of these compounds in the serum/tissue. The metabolic pathways and biological functions of the identified health-promoting phytochemicals will be elucidated by using XCMS metabolomic platform, transcriptomic analysis, and gene expression in the animal studies. The final goal of this study is to identify the mode of the actions of the bioactive compounds in black walnut.

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Poster Abstract
Community, Culture, Communication

Priya Jaishanker, John Munsell, Jim Chamberlain

Sharing Agroforestry Insights in the Age of the Internet

Keywords: communication, video, education, poster

The last few years have seen an explosion in user-created content hosted on the internet. The ubiquity of social media platforms along with a lower price point for high-quality camera equipment has eliminated earlier barriers for content creators. At the same time, agroforestry outreach and technical transfer efforts have received increased attention with several national and large landscape initiatives singling out the need to improve stakeholder communication. With this intersection in mind, we embarked on a mission at Virginia Tech to film agroforestry experts and produce creative and informative educational video packages hosted on YouTube and other online platforms. Our goal was to capture agroforestry in an approachable and aesthetically appealing way, and deliver content in short segments preferred by the YouTube generation. Three years later, our channels have grown to include more than 150 videos featuring forest farming, silvopasture, and multifunctional buffer operations stretching from the southern pines of Alabama through New York's northern reaches of the Adirondacks into Canadian provinces. We have learned much in the process. By combing through our networks and beyond to locate experts, concentrating on testimonials, and marrying narratives with proven practices demonstrated on camera, we have delivered unique, expert perspectives on North American temperate agroforests to online communities around the world. We also have synthesized comments from users that help develop a picture of the impact and reach of these mediums. A summary synthesis results along with a project overview and example videos will be presented as part of this poster.

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Poster Abstract
Advances in Technology Applications

Todd A. Kellerman, Richard C. Carman, Greg C. Liknes, Dacia M. Meneguzzo

A Historical Perspective of Windbreaks in the Great Plains Using GIS

Keywords: GIS, windbreaks, inventory, Great Plains

The Prairie States Forestry Project (PSFP) was initiated in 1935 to combat severe soil erosion from the Dust Bowl years. Over the course of the next 7 years the U.S. Forest Service, working with the Works Progress Administrations and the Civilian Conservation Corps, planted nearly 220 million seedlings in the Great Plains. These plantings, known as windbreaks or shelterbelts, created 18,600 miles of linear strips of trees from North Dakota through Texas. The National Agroforestry Center in Lincoln, NE has been using legal land description section maps with hand-drawn locations of windbreaks, created for the PSFP, to extract historical information about these initial windbreak plantings. The windbreaks in these maps have been digitized for Nebraska using GIS. Other data captured include year planted, species, spacing, number of trees planted, and land ownership. As an example of the type of information available, Antelope County in northeast Nebraska had over 1,200 windbreaks planted between 1935 and 1942, which equates to nearly 443 miles of windbreaks. Comparisons of the historical maps to recent aerial photography is also being conducted using GIS which includes the status (e.g., fully intact, partially removed, fully removed, etc.) of each of these windbreaks. A current collaboration between USDA Forest Service's Forest Inventory and Analysis program and the National Agroforestry Center is using this data to assess windbreak resources in the Great Plains and changes over time.

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Poster Abstract
Environmental Benefits

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Determining Tree Contributions to Soil Organic Matter Beneath Windbreaks

Keywords: windbreaks, shelterbelts, climate mitigation, carbon sequestration, soil organic matter

Tree windbreaks have been extensively planted on the Russian Steppes and on the U.S. Great Plains to alleviate drought conditions and reduce wind erosion. This agroforestry practice is now being evaluated for its climate adaptation (microclimate modification) and mitigation (carbon sequestration in biomass and soil) potential. A series of studies assessing changes in soil properties following windbreak planting has produced data for 15 U.S. and 3 Russian sites representing a broad range of soil types, tree species, and climate conditions. The objective of this study was to quantify tree contributions to soil organic matter using stable carbon isotope techniques. Soil samples were collected to ~1.2 m depth within tree plantings and adjacent crop fields. Plant tissue and reference soil samples were also collected. Samples were analyzed for del13C isotopic composition by dry combustion on a Fison NA 15000 Elemental Analyzer interfaced to a Delta V Advantage isotope-ratio mass spectrometer. Greater than 80% of the soil organic carbon (SOC) in the surface soil layer beneath a 70 yr-old hardwood windbreak in Nebraska was tree-derived. Younger plantings had lower proportions of tree-derived SOC in surface soil layers (31 to 54%). Mean residence times for the tree-derived SOC ranged from 42 to 319 yrs, indicating greater stability of the tree-derived SOC. These results indicate that increased SOC content beneath tree windbreaks can be attributed to decomposition of tree biomass (leaves, roots, and wood) and that this contribution is already significant within 20 yrs of tree planting.

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Poster Abstract
Production Science

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Seasonal Silvopastoral System with Sheep in Pine-Oak Forest: Effects on Vegetation and Soil

Keywords: mixed forest, silvopastoral system, soil litter cover, vegetal diversity

An alternative for sustainable production of natural forage resources is the use of silvopastoral systems. The objective of this study was to evaluate the impact of a silvopastoral system using sheep in a pine-oak forest. The microclimate was characterized (T = temperature; RH = relative humidity), soil, leaf litter and floristry composition, before and after the silvopastoralism. The microclimate was more homogeneous in mixed forest than grassland without trees for both T (coefficient of variation: 21.5 vs 24.8 %) and RH (coefficient of variation: 37.6 vs 39.3 %). Plant species in the experimental area were 10.5% trees, 40.0% shrubs and 49.5% herbaceous, presenting a balanced value of relative importance, although higher values in the species *Cornus excelsa* (27.7%), *Garrya laurifolia* (17.5%), *Symphoricarpos microphyllum* (17.1%), *Bromus carinatus* (16.5%) and *Smilax moranensis* (16.5%). The compacting of the soil showed no significant differences (Mann-Whitney U = 1.79; P>0.05) between the condition before and after the silvopastoralism. The soil litter cover showed similar depth and organic matter content (7.6 vs 7.4 cm and 100 vs 94 %, respectivamente; P>0.05) before and after the silvopastoralism. The results of the micro-histological analysis in sheep feces confirmed that sheep selected herbaceous (*Smilax moranensis*), shrubs (*Cornus excelsa, Viburnum stenocalyx*) and trees (*Garrya laurifolia, Prunus serotina, Crataegus mexican*), whenever the foliage was available to the profile of consumption. In conclusion, mixed pine-oak forest offers sufficient forage food and allows to perform selective herbivory for sheep without consume complete individuals; whereas in the silvopastoralism with sheep, the microclimate and soil contribute to the growth of the regrowth without adversely affecting the regeneration of plant diversity.

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Poster Abstract
New Markets, New Products, New Values

Chung-Ho Lin, Edward Huxel

Biochemical Compounds found in Osage Orange Tree Fruit and their Market Potentials

Keywords: bio-chemicals, feedstock, bioenergy, biofuels, animal feed

Osage Orange (*Maclura pomifera*) tree fruit has been divide into two fractions: fruit seeds and fruit biomass. The objective of the project is to identify key biochemical compounds in each fraction. The seed oil, protein and starch were analyzed for fatty acids, amino acids and sugars content, respectively. Different solvents were used remove biochemical compounds from the fruit mass. The extracts were analyzed by GC-MS and HPLC-MS to identify the bio-chemicals found in the different extracts. The potential markets for the biochemical compounds are presented.

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Poster Abstract
Advances in Technology Applications

Dacia M. Meneguzzo, Greg C. Liknes, Todd A. Kellerman

Scale-Appropriate Land Cover Maps for Agroforestry

Keywords: land cover maps, agroforestry, inventory and monitoring

Trees planted for agroforestry purposes are an important resource yet little information describing their extent and location is readily available in formats that are convenient for resource professionals and decision makers. National forest inventory and natural resource monitoring programs seldom account for these plantings in their official statistics. In addition, most satellite-derived data sets are too coarse to accurately depict small or narrow groupings of trees common in agroforestry practices. Recently, the USDA Strategic Framework included a goal of inventory and monitoring of agroforestry practices. To address this goal, the USDA Forest Service's Forest Inventory and Analysis program and the National Agroforestry Center have developed and implemented an operational land cover mapping process using 1-m aerial photography and object-based image analysis. The resulting high-resolution data sets allow for the identification of agroforestry plantings and can be combined with other location-specific information. This endeavor is the first of its kind in that land cover data sets are being produced at such fine detail for agricultural landscapes and over such a large portion of the central United States. Nebraska and Kansas are the first states to be mapped using the newly developed method. Partnerships with the University of Nebraska-Lincoln and Kansas State University, Kansas Forest Service are an integral part of accomplishing such large mapping efforts. This poster presents a brief overview of the mapping method as well as examples of the types of summary statistics that can be generated over a range of scales from a farm to an entire state.

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Poster Abstract
Adoption, Adaptation, Permanence

Tim A Mize, John H. Fike, John F. Munsell, Adam K. Downing

Perceptions and Understanding of Silvopasture by Extension Agents in the Mid-Atlantic

Keywords: training, conservation, profitability

Silvopasture adoption in the mid-Atlantic and southern USA has been low. Extension agents and programming play a significant role in producer adoption of new technology, and rates of adoption of new agricultural practices are retarded when agricultural professionals are slow to recognize and promote the benefits of new technologies. Because agent understanding of and willingness to engage with silvopastures was unknown, agriculture and natural resource agents in several states of the mid-Atlantic region were surveyed to establish perceptions of the practice and to determine needs for silvopasture programming. Agents in several southeastern states were emailed with links to an electronic survey designed and delivered through Qualtrics. Agents were queried on their knowledge of silvopastures along with a number of factors including their age and education, areas of expertise, and their views of conservation and the impacts of livestock production systems on sustainability metrics. Few agents had attended silvopasture training (25%) and fewer still (16%) had been involved in a silvopasture project. A majority of agents indicated awareness that silvopastures have potential environmental benefits and that trees can positively modify the grazing environment both for livestock and forages. Concerns included issues of whether grazing livestock decreased timber value and if these systems could increase farm profitability. Agents were largely undecided on whether the management required for silvopastures was greater than for traditional livestock grazing systems. Agents indicated that locally-generated information on silvopastures obtained through working demonstrations will be needed to increase buy-in and promotion.

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Poster Abstract
New Markets, New Products, New Values

Florencia Montagnini, Ruth Metzel

Integration of Traditional Knowledge in Sustainable Rural Development Projects in Tropical Regions

There are several examples where indigenous communities have been able to reach local and/or international markets with their agroforestry (AFS) products. What types of AFS products and markets are most suitable; how can smallholders access markets for tree and other AFS products, allowing them to capture more of their value, especially for people who are socially or economically marginalized? We investigated and summarized cases where indigenous non-timber AF products have been incorporated into the local economy. For example, organic yerba mate (*Ilex paraguariensis St. Hill.*) from Argentina, Paraguay and Brazil obtains higher prices than the conventionally grown product. Runa, an enterprise that buys the guayusa leaves (*Ilex guayusa Loes.*) from indigenous people in the Ecuadorian Amazon, promotes growing guayusa in AFS that mimic the traditional systems in indigenous "chakras". This allows innovation upon traditional indigenous knowledge to create a value chain for elaborated high-value drink products sold locally and internationally. We also discuss the role of acai (*Euterpe oleracea Mart.*) fruit juice in the global market, questioning if adding value to the product can ensure sustained income for forest farmers in the Amazon estuary. Coffee, cacao, and Allamblackia are other examples of AFS goods for which value chains have been developed for selling high value products in selected national and international markets. In addition, we present results of international development projects to provide examples of how existing initiatives are contributing to meeting sustainable development goals and targets.

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Poster Abstract
New Markets, New Products, New Values

Jihyun Park, Nahom Taddese Ghile, Michael Greenlief, Chung-Ho Lin, Brian Mooney

Identifying Bioactive Phytochemicals in Spent Coffee Grounds for Cosmetics Application

Keywords: coffee, cosmetics, phytochemicals, skin-whiting, anti-aging

We are consuming about 4,000 tons of coffee every day in the US along. Annually, more than 6 million tons of spent coffee grounds (SCG) are generated worldwide. Conventionally, the uses of the SCG have been only limited to home gardening, compost and landfills. Our preliminary studies suggested that the SCG could be an excellent source of high value phytochemicals for cosmetics application. The present study explores the possible uses of spent coffee grounds as the raw materials for cosmetics industry. The objective of this project is to investigate the chemical profiles and identify the bioactive compounds for cosmetics application through global metabolite analysis. This study will help identify the bioactive compounds in the SCG and their immediate applications for skin care application (e.g., anti-oxidant, anti-inflammatory, skin-whiting, and anti-aging). The findings from this project will provide the opportunities to increase the overall incomes of the coffee production and turn abundant, low-value, renewable materials from the SCG into a lucrative industry.

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Poster Abstract
Education and Engagement

Gabriel J. Pent, John H. Fike, Ayla Wilk, Hannah H. Scherer

Graduate Extension Scholars: Learning the skills of silvopastoralism

Keywords: extension, student, silvopasture, implementation, high school

Virginia producers typically manage cropland and forestlands separately. For forage-livestock producers this frequently results in two lost opportunities: their livestock suffer from environmental extremes (e.g., heat stress in summer) and their woodlands often are less productive and become infested with invasive shrubs and trees. Although integrated silvopastures can address this situation, adoption of these management practices has been limited, in part because producers lack experience and information about how to implement and maintain these systems. To address this situation, knowledge transfer was facilitated through Virginia Tech's Graduate Extension Scholars program. This program paired university graduate students with agriculture teachers and local county 4-H agents around Virginia. In this specific case, students at Randolph Henry High School (Charlotte County, VA) manage a beef herd and have access to the school's loblolly pine (Pinus taeda) stand. The activities developed to demonstrate silvopasture implementation practices included a site visit with resource professionals, timber cruising and marking trees for removal, and soil testing and development of lime and fertilizer recommendations for forage establishment. Learning occurred at multiple levels, as the graduate student gained experience in teaching and curriculum preparation, while the high school students learned about current research topics and began developing the forestry and grazing management skills required to establish silvopastures. Knowledge transfer was not measured directly but is evident, as several parents have asked the high school agriculture teacher for more information on silvopasture establishment for their farms. The project was compiled into an inquiry-based curriculum for use by other teachers.

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Poster Abstract
Advances in Technology Applications

Nicholas Polys, Peter Sforza, Cully Hession, John Munsell

Accessibility and Applications of Virtual Reality Agroforestry

Keywords: virtual reality, Web3D, information visualization, data fusion

Virtual Reality (VR) research has been ongoing for decades; however, only recently has the technology reached a maturity that is suitable for public consumption. Consumer electronics mobile phones, and major media companies are now producing VR content and experiences for mass distribution. In this poster, we review the trends in the field and present our recent accomplishments in cross-platform delivery of site experiences and simulations. We highlight the open Web3D standards and platforms available for practitioners and end-users. From phones to VR goggles to desktops and immersive theaters, we are demonstrating how real data can be accessible through these devices. We see broader impacts of this technology for both research and training: field trips, outdoor labs, and fact sheets will evolve to take people places they could never go physically.

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Poster Abstract
Advances in Technology Applications

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Agroforestry Site Capture and Publishing for Virtual Reality

Keywords: data fusion, information visualization, Web3D, virtual reality

With the increase in public data sources and cost-effective acquisition technologies, a wide range of sensors and sources of data are available for site assessment and analysis. This poster presents our work in the capture and fusion of multi-modal site information for Web3D publishing. From satellites to drones to 3D photos, infrared cameras, and audio recordings, the web offers great publishing opportunities for research and education. While the wide variety of media formats is daunting, we have demonstrated open standards workflows for the development and publication of information-rich Web3D experiences. We detail the challenges and opportunities of multi-source data processing and fusion for these online Virtual Reality (VR) experiences.

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Poster Abstract
Environmental Benefits

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Determining Tree Contributions to Soil Organic Matter Beneath Windbreaks

Keywords: windbreaks, shelterbelts, climate mitigation, carbon sequestration, soil organic matter

Tree windbreaks have been extensively planted on the Russian Steppes and on the U.S. Great Plains to alleviate drought conditions and reduce wind erosion. This agroforestry practice is now being evaluated for its climate adaptation (microclimate modification) and mitigation (carbon sequestration in biomass and soil) potential. A series of studies assessing changes in soil properties following windbreak planting has produced data for 15 U.S. and 3 Russian sites representing a broad range of soil types, tree species, and climate conditions. The objective of this study was to quantify tree contributions to soil organic matter using stable carbon isotope techniques. Soil samples were collected to ~1.2 m depth within tree plantings and adjacent crop fields. Plant tissue and reference soil samples were also collected. Samples were analyzed for del13C isotopic composition by dry combustion on a Fison NA 15000 Elemental Analyzer interfaced to a Delta V Advantage isotope-ratio mass spectrometer. Greater than 80% of the soil organic carbon (SOC) in the surface soil layer beneath a 70 yr-old hardwood windbreak in Nebraska was tree-derived. Younger plantings had lower proportions of tree-derived SOC in surface soil layers (31 to 54%). Mean residence times for the tree-derived SOC ranged from 42 to 319 yrs, indicating greater stability of the tree-derived SOC. These results indicate that increased SOC content beneath tree windbreaks can be attributed to decomposition of tree biomass (leaves, roots, and wood) and that this contribution is already significant within 20 yrs of tree planting.

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Poster Abstract
Adoption, Adaptation, Permanence

Graham Savio

Characterizing Cocoa and Coffee Agroforestry Systems in North Kivu, Democratic Republic of Congo

Keywords: cocoa, coffee, tropical agroforestry, new frontiers

The uplands of eastern Democratic Republic of Congo (DRC) are climatically well-suited for the cultivation of cocoa (Theobroma cacao) and coffee (Coffea arabica and Coffea canephora), but decades of political and civil unrest, inadequate agricultural policy and lack of extension support have prevented this potential from being substantially realized. Coffee cultivation has a decades-long history in the region, and cocoa was introduced relatively recently but has grown rapidly; with increased regional stability and strong world markets, these crops are increasingly recognized for their potential to contribute significantly to farmer incomes and household welfare in the region. This paper aims to describe the current state of smallholder cocoa and coffee production in the province of North Kivu in eastern DRC, with a particular focus on soil fertility, intercropping patterns and diversity, external inputs, crop productivity, and farmers' perceived challenges. The goal of this paper is to inform and enable researchers, market actors and policy-makers to more effectively engage in improving productivity, profitability, and access for smallholder producers in the region.

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Poster Abstract
Environmental Benefits

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Soil Health Influenced by Pgpr and Carbon Sequestration under Perennial Energy Crops in Ontario

Keywords: greenhouse gas emissions, marginal land, microbial diversity, soil organic carbon, renewable energy

To date, the influence of Plant Growth Promoting Rhizobacteria (PGPR) on soil health and potential increase in biomass yields is less understood. In this context, this study will address the above gap by treating energy crops such as, switchgrass (*Panicum virgatum*) and miscanthus (*Miscanthus giganteus*) with PGPR, Azospirillum brasilense N8 (A.b N8) and Variovorax paradoxus JM63 (V.p JM63). When PGPR is applied to soils the plant changes the physical and chemical composition of the soil surrounding the rhizosphere, when compared to the bulk soil, in order to allow PGPR colonization (Vessey, 2003). It is expected that such colonization of PGPR could potentially enhance biomass yields and soil carbon sequestration in grower fields without any external inorganic fertilizer applications. The expected outcomes therefore are to identify promising PGPR that could be widely applied to Ontario grown energy crops and establish soil health indicators (e.g. carbon sequestration, microbial diversity index etc.). The research outcomes will directly benefit many Ontario stakeholders (Ontario Biomass Grower Co-operative - OBPC) contributing to the Ontario bioeconomy; the supply of feedstock.

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Poster Abstract
Production Science

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Productivity and Characteristics of Six Nut-Producing Black Walnut Cultivars in Missouri

Keywords: Juglans, graft, agroforestry, nut yield

Black walnut (*Juglans nigra*) has good potential for commercial nut production in the midwestern USA, but profitability based on improved cultivars in grafted orchards has not been proven. Numerous superior nut-producing cultivars have been selected, yet little information is available on their horticultural characteristics or their potential productivity. A black walnut orchard of 90 trees was established in southwest Missouri in 1993 to compare yields and characteristics among six of the most promising cultivars. Seedling rootstocks were field-grafted, beginning in 1996, to 'Emma K', 'Football', 'Kwik-Krop', 'Sparrow', 'Surprise', and 'Tomboy' in a randomized blocked study. Significant nut production began in 2003, with annual yields and nut characteristics determined through 2016. Harvested nuts were assigned a dollar value based on percent kernel and quality by Hammons Products Co. (Stockton, MO). 'Sparrow' was the most productive cultivar over the long-term, exhibiting a consistent annual-bearing habit. Annual mean dry nut yields for 'Sparrow' exceeded 40 kg per tree by 2016, with a cumulative mean per-tree yield of 285 kg. 'Football' and 'Kwik-Krop' produced nuts with >80% hull; significantly greater than hull produced by both 'Sparrow' and 'Tomboy'. 'Emma K' produced the most valuable nuts with consistent good quality and percent kernel usually exceeding 35%; some lots of 'Emma K' nuts were valued at more than $1.98/kg. The profound differences in nut characteristics, productivity, and value in this study suggest that economic black walnut production can be improved with use of specific cultivars, and by selection and breeding for improved yields and nut characteristics.

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Poster Abstract
Adoption, Adaptation, Permanence

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Traditional Agroforestry Systems: A Methodological Proposal for Its Analysis and Intervention

Keywords: ethnoagrophorestry, agricultural knowledge, methodology.

The existence of the Traditional Agroforestry Systems (TAS) is contemporary to the beginnings of agriculture and remains today. Agroforestry as a science dates back to the second half of the last century and has recently increased interest in these forms of resource exploitation. Agroforestry research applies the scientific method, and for the case of intervention processes there are several proposals, among them the Diagnostic and Design method (D&D).

This proposal starts from the ethnosciences with the objective of finding a method that allows the diagnosis of the TAS and the intervention for its development. With the relevant modifications and using the Theory of Comparative Agriculture described by Cochet, as well as adaptations of the methodology used by Apollini, F; Eberhart, C. Diagnostic and Analysis of Production Systems in the Rural Environment, TAS studies were carried out in several communities of the Sierra of Huautla, Morelos. The results lead us to consider in the methodology, that the importance and complexity of the TAS must be approached from the perspective of ethnosciences, deepening in technological, productive strategies, environmental, historical, agronomic, social and economic conditions, as well as the vision and perspective of TAS practitioners, a necessary condition for trying, together with the producers, the search for improvement, which must move towards ethnodevelopment.

The methodology for study must include the vision of ethnosciences, the deepening of aspects of management and the perspective of development, of the TAS practitioners.

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Poster Abstract
Education and Engagement

Robert Valek, Lisa Schulte-Moore, John Tyndall

PEWI: A Dynamic Land Use & Ecosystem Service Tradeoffs Assessment Tool

Keywords: ecosystem services, simulation, watershed management, land-use decisions, education

PEWI, or People in Ecosystems/Watershed Integration, is a simple web-based learning tool to help people understand human-landscape interactions and ecosystem service tradeoffs. PEWI addresses our need to balance agricultural production with other environmental benefits, including clean water, abundant wildlife, and recreation. The learning tool also aims to generate discussion amongst users about site-appropriate land uses and alternative yields, including timber and woody biomass production from forest land use-types. While PEWI focuses on the US Corn Belt, its lessons can apply to agricultural regions globally. Here we will present the tool and answer questions related to its use in classrooms and with agricultural stakeholders. To play, access background info, or download learning exercises, visit our website: nrem.iastate.edu/pewi.

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Poster Abstract
Environmental Benefits

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Characterization of Hydraulic Fracturing Contamination for Future Agroforestry Restoration

Keywords: hydraulic fracturing, toxic chemicals, fracturing chemicals, HF wells

Hydraulic fracturing (HF) process requires the use of large amount of water and toxic chemicals that are hydraulically injected into the ground to help releasing oil and gas. Recently, this technique has triggered an intense public debate about the potential environmental impacts. These include risks of surface and ground water contamination, air pollution, the triggering of earthquakes, along with the consequential hazard to public health. A 2011 Congressional Report listed over 750 chemicals used throughout this process, including more than 100 known or suspected endocrine disrupting chemicals. There are currently more than 15 million Americans living within one mile of HF operations (82,000 HF wells since 2005), particularly in the rural area. Health complication includes decreased semen quality in men, higher miscarriages in women, premature menopause and increased risk of birth defects in children. Consequently, there are urgent needs for development of robotic analytical techniques and restoration technology to 1) study fate of the hydraulic fracturing chemicals, 2) assess the exposure of community to these harmful hydraulic fracturing chemicals, and 3) develop cost-effective restoration plan using agroforestry bioremediation technology. We have successfully developed the analytical methods to quantify more than 65 hydraulic fracturing chemicals in surface water, ground water and waste water. In addition, the developed methods have been successfully used to assess the exposure of community to hydraulic fracturing pollutants by determining the fracturing chemicals and their metabolites in the urine. The analytical techniques will allow to design, optimize and evaluate the effectiveness of the agroforestry bioremediation/restoration technologies.

Poster Abstract
Environmental Benefits

Susanne Hale, Baoshan Xing, Wesley Autio

Agroforestry and Climate Resiliency, Regional Summary: Southeast and Caribbean

Agroforestry practices are viable for both larger acreages and small land holdings in mitigation, adaptation, and resilience under climate variability. Crop and pasture lands occupy significant area in the Southeastern United States, and forests occupy from 50 to 69 percent of the land within each State in the region. As part of the Lesser Antillean archipelago, the U.S. Caribbean islands provide a diversity of tropical species and a variety of options for agroforestry-based land management. All Southeastern and Caribbean ecoregions have land area capable of supporting agroforestry as a tool for climate-smart agriculture to meet priority elements of the USDA Climate Change Science Plan. The diversity of farms and forest tracts of the region offer many opportunities to integrate trees with crop or pasture systems. Such systems would benefit many of these lands beyond their value for addressing climate change. Agroforestry could be practiced in some form on >50 percent of the land in most States and territories, with consideration of management intent, protected status, and soils and slope limitations. Greater use of scientific tools available can aid decision-making, considering the complexity of agroforestry with its diversity of species, field conditions, and management options in use. Under good management, these systems can help provide increased resiliency and mitigation under changing moisture patterns and temperature extremes. These integrated land use practices can help bridge the gaps in the mosaic of land uses across a region and serve as tools to strengthen the sustainable supply of goods and environmental services to society.

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Poster Abstract
Education and Engagement

William C. Worrell

Income Opportunities with Botanical Herbs

Keywords: ginseng, goldenseal, woodland herbs

Increasing employment opportunities, diversifying jobs and developing entrepreneurial skills are priorities in Southwestern Virginia. The climate, soils, and elevation in Southwest Virginia give landowners good opportunities for growing many herbs especially since several woodland herbs grow naturally in the region. Years of heavy harvesting of the native herb populations have threatened the future of many herb species. Landowners can plant and cultivate native herbs as a crop for alternative income while helping conserve and replenish the native plant populations in the Appalachian Mountains.   Local and global demands for herbs are increasing and market prices continue to rise. Research plots of goldenseal and wild ginseng indicate there are excellent opportunities for significant income to Southwest Virginia in cultivating these and other herbal plants.

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Abstract
Economic Insights and Financial Tools

Zhang Pu, Fred Cubbage

Economic Benefit and Water Resource Utilization of Fruit Industry in Northwest China

Keywords: fruit tree, arid and semi-arid area. economic benefit, water resource

The goal of this research is twofold: to conduct an economic cost-benefit analysis of planting and managing various types of fruit trees in Northwest China, and to evaluate the annual water consumption needed for these trees. Water is an irreplaceable resource and a constraining factor in the social and economic development of arid and semi-arid areas. One such area is the Ba Autonomous Prefecture within Xinjiang Province, which is known to be highly favorable for bearing fruit trees such as apples, pears, grapes, peaches, apricots and red dates. The local Chinese government has been promoting the planting of fruit trees since 1990's. By 2015, the hectarage of fruit trees in the Xinjiang desert area has increased to 1.5 million, and the total fruit production has reached 7 million tons. Because this area has drought, the drip irrigation system of delivering water has proved very successful. Also, the strategic square layout of fruit trees enclosed by a shelterbelt forest effectively prevents the destruction of trees due to extreme weather conditions. In my research, I have investigated the microeconomic costs of the production facility construction (the plan, design, planting placements, etc.), the infrastructure construction (irrigation system and motor-pumped wells), and the production techniques such as species selection, site preparation, planting, pest control, etc. I have also collected macroeconomic data from the local government regarding total planting area of different kinds of fruits and the fruit prices, in hopes of finding the optimal scaling of the fruit industry of this region.

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Poster Abstract
Production Science

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Alkaloid Content in Forest Grown Goldenseal

Keywords: forest farming, goldenseal, medicinal plant chemistry, isoquinoline alkaloids, quality control

Goldenseal (*Hydrastis canadensis*) is an Appalachian forest herb whose rhizome is used to treat inflammation and digestive disorders. Due to overexploitation concerns and significant demand, goldenseal is a crop option for forest farming. Despite its popularity as an herbal medicine, there is little information on the effects of harvest timing and habitat-related production factors on its medicinal constituents (i.e., Berberine, Hydrastine, and Canadine). The need to satisfy market demand with sustainably harvested, quality assured product requires a better understanding of goldenseal chemistry. Results (using High Performance Liquid Chromatography) in central Pennsylvania suggest that time of harvest can dramatically influence the alkaloid content in the dried root and rhizomes. Alkaloid content was found to peak in July (fruiting stage) and October (senescent stage), while samples between those times fell well below current recommended therapeutic and industry constituent levels (c.f., United States Pharmacopeia). My current research further examines harvest timing effects by expanding the range of the previous study to include (1) aerial and root portions; (2) time of day harvested; (3) full seasonal phenology; and (4) drying temperature. Additionally, I am conducting more exhaustive geographic sampling for associated habitat conditions in Pennsylvania and nearby states. The results of this study will identify production, harvest and post-harvest factors that can influence quality control in forest farmed goldenseal. This, in turn, may help forest farmers garner higher prices and a stronger market edge compared with wild crafted product -contributing to conservation of remaining wild populations by creating a more desirable product.

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