

16th NORTH AMERICAN AGROFORESTRY CONFERENCE ABSTRACTS

If there are any errors, please contact Kate MacFarland at katherine.macfarland@usda.gov

Concurrent Session 1

Theme: Accessing Resources, Accessing Markets, and Managing Risk

Format: Panel Discussion

Title: USDA Resources for Implementation

Lauren Cartwright, USDA Natural Resources Conservation Service

Timothy W. O'Connell, USDA Rural Development

Susan Stein, USDA Forest Service

Heather Tritt, Farm Services Agency

Donna Sprenkle, Farm Services Agency

Moderated by moderated by Matthew Smith, USDA Forest Service

How do USDA programs support on-the-ground implementation of agroforestry? This panel will highlight a range of federal resources that provide key support for the practice of agroforestry as well as the processing and marketing of agroforestry products. Panelists from USDA will provide examples of Natural Resources Conservation Service (NRCS), Farm Service Agency (FSA), and Forest Service programs that support agroforestry planning and establishment. Staff of USDA's Rural Development programs will present opportunities that can help to establish or strengthen cooperatives. The goal of this panel is to increase awareness of many USDA services and programs that are underutilized by natural resources professionals due to our lack of awareness of the range of possibilities that they provide.

Keywords: funding, support

Susan Stein: susan.stein@usda.gov

Theme: Advances in Technology Applications

Format: Roundtable Discussion

Title: Bio-Regional Agroforestry Suitability Analysis: Using GIS to assess, inventory, and locate the appropriate implementation of tree crops and agroforestry systems.

Russell Wallack, Terra Genesis

Tim Tensen, TK Design Lab

Andrew Kilduff, TK Design Lab

The BRASA process implements Geographic Information Systems to assess, inventory, and map the appropriate implementation of agroforestry systems and perennial staple crops at a watershed level. This process considers the geology, hydrology, vegetation, and land-use history of a place, in order to design productive agroforestry systems. Additionally, this analysis can be used to advocate for these systems not just as productive forms of agriculture, but also as green infrastructure that can increase drought and flood resilience, decrease erosion and riparian sedimentation, and enhance carbon sequestration. The BRASA process is built on two distinct GIS analyses: elimination and classification. Elimination seeks to assess land use data and exclude unsuitable land - like forests, impermeable surfaces, and water bodies - after which only agriculturally-productive land remains. Classification

explores independent class schemes for systems and crops based on stakeholders' goals. In any given watershed, the BRASA process can be used geolocate and quantify the prioritized crops and agroforestry systems based on the stakeholders' needs. For example, in the Connecticut River watershed in Massachusetts, our team located 104,000 acres out of 1.7 million suitable for chestnut production. These systems can be commercially viable, yet they remain vastly under-implemented in the U.S. Using the watershed view, we hope to create a more compelling case for regional agroforestry initiatives that are attractive to a diverse set of stakeholders focused on climate change adaptation and mitigation, agricultural production, and the conservation benefits of these systems.

Keywords: GIS, chestnut, watershed, and regional

Russell Wallack: russell@terra-genesis.com

Theme: Environmental Benefits

Format: Panel Discussion

Title: Supporting Pacific Northwest Agriculture with Beneficial Insects and Agroforestry

Mace Vaughan, Xerces Society for Invertebrate Conservation and USDA Natural Resources Conservation Service (NRCS) West National Technology Support Center

Gary Bentrup, USDA National Agroforestry Center

Bart Lawrence, USDA NRCS West National Technology Support Center

Beneficial insects provide crucial pollination and biological pest control services in many farming systems found in the U.S. Pacific Northwest. Over 15 major commodities and dozens of crops in the region are dependent on insect pollination from cherries to vegetable seed production. Predator and parasitoid insects also play an important role in suppressing crop pests in these production systems. Pollinators and other beneficial insects are facing many threats, including loss of habitat, limited food resources, and pesticide exposure. Agroforestry can play a central role in supporting insect-based crop pollination and pest control services, especially in organic, specialty, and small-scale agricultural and forest systems commonly found in the Pacific Northwest. This session will summarize the latest scientific information on using agroforestry to support pollinators and natural enemies of crop pests by providing diverse habitat and protection from pesticides. The first presentation will focus on promoting pollinators with agroforestry practices while the second presentation will concentrate on increasing pest control with predator and parasitoid insects. The third presentation will discuss how agroforestry practices can be used to reduce pesticide drift and exposure to pollinators and other beneficial insects. Supporting these services under a changing climate will be important and emerging research suggests that agroforestry practices might offer more resilient habitats needed to cope with climate change and may enhance landscape connectivity to facilitate range shifts for desired insects.

Keywords: pollinator, beneficial insects, pesticide drift reduction, biodiversity, conservation, pest management, and climate change

Mace Vaughan: mace@xerces.org

Theme: Specialty Forest Products

Format: Facilitated Discussion

Title: The future of forest farming: What is it and who will do it?

Eric P. Burkhart, Shaver's Creek Environmental Center, Pennsylvania State University
John Munsell, Virginia Tech

The term forest farming is defined as an agroforestry practice in which understory crops are cultivated in a forest. In the minds of many, forest farming involves agricultural practices such as tillage, soil amendments, and planting stock. However, our work in the Appalachian region of the eastern US suggests that many forest farmers do not employ traditional agricultural practices. Instead, they use a variety of plant husbandry practices, often with natural rather than planted stands of non-timber forest products (NTFPs). If forest farming is to be more widely understood, acknowledged, and adopted, there is a need to better document and describe the full range of husbandry used by forest farmers.

Moreover, rural land transfers and new residents to rural areas are changing farmer demographics and farming objectives. With this session we propose to bring together NAAC attendees involved in NTFPs, specialty forest crops, and/or forest farming in an organized session to discuss and share practitioner examples and personal perspectives. Session facilitators will use this session to build a team that will work on publications (white paper, peer-reviewed review paper) for purposes of "modernizing" our understanding of forest farming and farmers in North America and advancing this practice in the public, policy, and scientific realms.

Keywords: Forest farming, Non-timber forest products, and Agroforestry adoption

Eric P. Burkhart: epb6@psu.edu

Theme: Climate Change Opportunities and Challenges

Format: Panel Discussion

Title: Evidence based Agroforestry Approaches for Enhancing Climate Smart Agricultural Production and Resilient Ecosystems

Kiros Hadgu, World Agroforestry (ICRAF)

Bishaw Badege, Oregon State University

Emiru Hizikias, Mekelle University

Miyuki Iiyama, Japan International Research Center for Agricultural Sciences (JIRCAS) - World Agroforestry (ICRAF)

This Organized Panel Session aims to share the knowledge and experiences about Climate Smart Agriculture (CSA) approaches, which are potentially scalable in Ethiopia and the Sub-Saharan Africa (SSA), based on a recently published book, which compiled evidences of integrated, innovative and climate-smart technologies and practices. The preparation of the book was led by the World Agroforestry (ICRAF), Oregon State University (OSU) and Japan International Research Center for Agricultural Sciences (JIRCAS), and included more than 20 contributions on a range of topics including agriculture, agroforests, water management, soil, ecosystem, rural energy, socio-economic, gender and policy issues.

The book presents evidence-based knowledge and scalable practices, which can be tailored to different biophysical, socioeconomic, policy and institutional contexts. The technologies and practices described in this book include promising options by considering varying contexts and demands, which can potentially enhance accelerated restoration of degraded landscapes, sustainable agricultural production and food-nutrition-energy security while contributing to resilient ecosystems and societies to climate change. The book also provides frameworks and strategies, which improve informed decision-making and facilitate accelerated adoption and scaling up of the technologies and practices in Ethiopia and the

SSA. The book highlights approaches, which are timely and critical towards achieving national and regional development strategies in SSA, while contributing to global initiatives, such as Sustainable Development Goals (SDGs), and Forest Landscape Restoration. The information from the book can be used by different users, such as researchers, extension staff, local communities, practitioners, academics, and policy makers.

Keywords: Food-Nutrition-Energy Security, Informed Decision-Making, Resilience, Restoration, Scaling
Kiros Hadgu: k.hadgu@cgiar.org

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: New Agroforestry Working Group in the American Southwest

Mick O'Neill, New Mexico State University

Andy Mason, USDA Forest Service and National Agroforestry Center (retired)

The Southwest Agroforestry Action Network (SWAAN) is bringing together natural resource professionals and practitioners from a wide range of organizations (conservation districts, extension, permaculture institutes, Tribal, state & federal agencies, and universities) to share information, connect potential collaborators/partners, and generate ideas, research, and project initiatives that will advance the adoption of agroforestry in Arizona, Colorado, New Mexico, and Utah. The scope of forest-agricultural activities considered by SWAAN is broad, including those used by: 1) agricultural producers, often installed with USDA technical and/or financial assistance (alley cropping, forest farming/multi-story cropping, riparian forest buffers, silvopastures, and windbreaks/shelterbelts); 2) indigenous peoples; 3) settlers on Spanish and Mexican Land Grants; as well as 4) permaculture; and 5) food forests in community/urban settings. Since its first teleconference in April 2018, SWAAN has met multiple times and had its first face-to-face meeting, June 4-6, 2019 in Farmington, New Mexico. SWAAN is beginning the development of a geographic database of agroforestry research and demonstration sites in the Southwest. Results are presented from the June 2019 face-to-face meeting, which include a charter for SWAAN that identifies its mission, vision, strategic goals, key partners, and how it will operate. Examples are illustrated of ongoing agroforestry research (e.g., hybrid poplars) and applied practices in the Southwest. We believe the establishment of SWAAN is a unique opportunity to bring together a diverse group of interested parties to share information, increase understanding, and advance adoption of both “modern” and “traditional/indigenous” agroforestry practices and systems.

Keywords: Arizona, Colorado, New Mexico, Utah, Adoption, Collaboration, and Indigenous

Mick O'Neill: moneill@nmsu.edu

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: Chestnut Agroforestry in New England: Regional Initiative, Case Studies, and Gap Analysis

Jono Neiger, Regenerative Design Group

Expanding chestnut production, particularly in chestnut agroforestry systems, offers a great opportunity to improve land use and increase ecosystem services while providing food for a growing population. A regional network is growing whose aim is to build a chestnut industry in New England - a region that

increasingly understands the urgency of food security and the value of a comprehensive and resilient regional food system. The stony and denuded soils of New England uplands provide great opportunities for tree crop production with grazing and alley crop combinations. According to the New England Food Vision's Regional Reliance scenario millions of acres of land that was or could be in agriculture must come back into production. What role might chestnuts and nut tree agroforestry play in revitalizing a regional food system? Currently there are maybe 20-40 acres in chestnuts in New England. There are many barriers to developing nut agroforestry systems and few incentives. In this short talk Jono will describe the aspirations for the regional chestnut initiative, and a case study of several chestnut projects that integrate silvopasture and alley cropping operations. One, at UMASS Amherst at the Agriculture Learning Center, utilizes sheep in alleys as the chestnuts are establishing. There is ongoing research and documentation of the soil conditions, carbon sequestration, and management operations. The other case study is a project that Jono has initiated, Big River Chestnuts, a planting of 7 acres of chestnuts with layout space for silvopasture and/or alley cropping.

Keywords: food security, regenerative agriculture, silvopasture, alley cropping, tree crops

Jono Neiger: jono@rdgland.com

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: "Possibilities": The map that guided the audacious 1930's Prairie States Forestry Project

Tom Sauer, USDA Agricultural Research Service

As the severe drought of the 1930s worsened in the U.S. Great Plains, the Roosevelt Administration directed the U.S. Forest Service to conduct a feasibility analysis for a tree planting program. The resulting report "Possibilities of Shelterbelt Planting in the Plains Region"; was a comprehensive analysis of vegetation, climate, soil, hydrology, economics, and social science of a six state area with the objective of convincing Congress that a tree planting program could alleviate drought conditions. The report contained a seminal map "Location of the shelterbelt zone with factors limiting its westward extension" that became the de-facto symbol of what was officially known as the Prairie States Forestry Project (PSFP). The PSFP organized the planting of 217 million trees from 1935 to 1942 and remains the largest afforestation project in U.S. history. Details on the science behind the development of the shelterbelt zone map and the operation and success of the PSFP will be presented.

Keywords: shelterbelt, tree windbreak, drought, and Great Plains

Tom Sauer: tom.sauer@usda.gov

Concurrent Session 2

Theme: Accessing Resources, Accessing Markets, and Managing Risk

Format: Oral Presentation

Title: Leveraging terroir in North American agroforestry foodways

Sophie Mendelson, University of Missouri

Michael Gold, University of Missouri

Terroir sits at the crosshairs of competing value systems within North American food, land, and identity discourses; as such, it might seem curious to consider the potential for valorization of *terroir* within emerging alternative agro-food systems. But while the word itself may not ultimately serve, the concepts it contains offer an important reframing of consumer and producer values with implications for ecological, economic, and social wellbeing. The current local foods discourse indicates that a growing number of eaters seek to access ideals of authenticity, place-based identity, and resistance to harmful economic and environmental regimes. Through its obligation to simultaneous and interactive ecological, economic, and sociocultural benefits, agroforestry has the potential to “speak” to these longings. This paper: defines *terroir* and relates it to the North American context; articulates the relationship between agroforestry and *terroir*; and identifies opportunities for leveraging *terroir* to bolster agroforestry foodways. Literature concerning local food systems, cultural ecosystems, and social dynamics of agroforestry are examined. Conventions Theory is introduced as a means of conceptualizing the negotiation of “worlds of justification” that structure relationships of exchange between food, landscape, eaters, and producers, and consider where *terroir*-informed agroforestry fits into these coordinations of mutual expectations. By leveraging *terroir*'s position as embedded in both tangible and intangible manifestations of place-based values, proponents of agroforestry have the opportunity to facilitate this process in a way that serves the eaters who seek it, the producers who engage it, and the landscape that forms (and is formed by) it.

Keywords: Agri-food systems, Local foods, Consumers, Markets, Valuing Place

Sophie Mendelson: semghb@mail.missouri.edu

Theme: Accessing Resources, Accessing Markets, and Managing Risk

Format: Oral Presentation

Title: Energy Bars, Beer and Super Foods: A method for, and case of, exploring markets for a non-timber forest product

Dean Current, University of Minnesota

David Wilsey, University of Minnesota

Collin Motschke, University of Minnesota

The University of Minnesota has been working with Community Forest Concessions, the Association of Community Forests of Petén and Rainforest Alliance in the Maya Biosphere Reserve (MBR) in Northern Guatemala. Our focus has been exploring markets for non-timber forest products. A recent initiative has been a value chain analysis and exploration of markets for the seed of the common forest tree *Brosimum alicastrum*, or Ramon. The seed is a nutritious food, gathered by local women's cooperatives, and was an important foodstuff of the Maya Civilization. We will explain: i) our methods for exploring markets for the Ramon seed including options such as energy bars, flour, beer, and the super food market; ii) what we have found through the process and how we have adjusted through those findings; and iii) present the current state of our research/exploration. Just recently we have received a commitment from a local Minnesota microbrewery to can Ramon beer for wider distribution and from the national brewery in Guatemala to start producing a Ramon craft beer. Although the method was used for a NTFP from Guatemala, the same methodology would apply to US products. We have worked through partnerships in the public and private sector, interdisciplinary work at the University and a methodology combining market and product development research with enterprise development options collaborating closely with our Guatemalan partners. The overall goal of the effort is to promote

forest conservation in the globally important Maya Biosphere Reserve and livelihood improvement in the participating communities.

Keywords: Methodology, Value chain, *Brosimum alicastrum*, and Enterprise development

Dean Current: curre002@umn.edu

Theme: Accessing Resources, Accessing Markets, and Managing Risk

Format: Oral Presentation

Title: Woodland Grazing for Minimizing the Costs of Raising Small Ruminants in the Southeast

Lila Karki, Tuskegee University Cooperative Extension

Uma Karki, Tuskegee University, College of Agriculture, Environment and Nutrition Sciences, Cooperative Extension

Shailes Bhattarai, Tuskegee University, Department of Agricultural and Environmental Sciences

Bidur Paneru, Tuskegee University, College of Agriculture, Environment and Nutrition Sciences, Department of Agricultural and Environmental Sciences

Raising animals on concentrates during lean months, when vegetation for grazing is scarce or not enough pastureland to support grazing animals, is economically unfeasible due to a high price of grains and commercial feeds. Use of woodland can complement the production system of small ruminants that is based on grazing/browsing. The objective of this study was to assess the economic impact of woodland grazing on production costs of small ruminants. Woodland grazing studies were conducted in fall 2017, and summer and fall 2018 with goats and sheep (13) in six fenced plots (one acre each) located in the research facility of Tuskegee University. Animals were supplied with water and mineral mix free choice, but no feed or hay was provided during the study. The amount of feed that would be required to raise these animals if woodlands were not used for grazing was calculated at 3% of animals' body weight, and resulting feeding costs were estimated using three common feeding scenarios (commercial feed, hay, and a combination of both). Daily labor required to take care of animals was recorded and used for calculating the labor costs. Use of woodlands for raising small ruminants was found to save in feeding costs by \$2028, \$578, and \$940 respectively with other input costs remaining constant, versus the three scenarios compared. Additionally, labor requirement was reduced by 50%-66% in woodland grazing. Results revealed that woodland grazing can reduce the production costs of small ruminants significantly, especially for farmers and ranchers who own woodlands.

Keywords: grazing economics, feeding cost, small-scale producers, forestland, opportunity cost

Lila Karki: lkarki@tuskegee.edu

Theme: Advances in Technology Applications

Format: Oral Presentation

Title: Mapping tree resources in the Great Plains using high-resolution imagery Speaker: **Phillip Ray Owens**

Todd Kellerman, USDA National Agroforestry Center

Dacia Meneguzzo, USDA Forest Service

Trees in the Great Plains serve important functions on the landscape 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 datasets 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 USDA National Agroforestry Center have developed and implemented an operational land cover mapping process using 1-m aerial photography. Nebraska and Kansas are the first states to be mapped using the newly developed method. The resulting high resolution datasets allow for the identification of these trees and can be combined with other location-specific information. This endeavor is the first of its kind in that land cover datasets are being produced at such fine detail for agricultural landscapes and over such a large portion of the central United States. Partnerships with the University of Nebraska-Lincoln and Kansas State University, Kansas Forest Service are an integral part of accomplishing such large mapping efforts.

Keywords: GIS, windbreaks, and inventory

Todd Kellerman: todd.kellerman@usda.gov

Theme: Advances in Technology Applications

Format: Oral Presentation

Title: Recommendations for policy makers in light of climate change: AFINET

Maria Rosa Mosquera Losada

Nuria Ferreiro Domínguez, University of Santiago de Compostela, Spain

Javier R Riguerio, University of Santiago de Compostela, Spain

Agroforestry is a sustainable land use system that has been categorized as a “negative greenhouse gas (GHG) emissions tool” by the IPCC (*Global warming of 1.5°C. An IPCC Special Report*) at the end of 2018 and can be implemented at the plot, farm and landscape level. Policy makers should develop strategies and direct funding to promote agriculture (croplands and grasslands) and forestry. However, policy makers need tools to evaluate the current situation and the impact of policies that can be linked to the use of Geographic Information Systems based on systematic data gathering. Moreover, a clear definition of agroforestry should provide certain rules that researchers should discuss. This paper aims to show two inventories of agroforestry, based on GIS techniques associated to different systematic ways of sampling. The first one is carried out in Europe using the LUCAS data, which is based on the data sample with several layers by sample visitors. However, this methodology is costly. The second one is based on the NLCD 2011 USFS Tree Canopy cartographic (CONUS) and CropScape - Cropland Data Layer at the USA level of 30 m that makes a surface approach and that may be linked to the satellite images. However, some key aspects should be considered to make the agroforestry inventory effort useful for policy makers, such as the decision-making about the minimum amount of woody perennials that should be present at landscape level to consider it an agroforestry practice, or the distribution of this percentage, and the unit of measurement.

Keywords: GIS, Agroforestry extent

Nuria Ferreiro Domínguez: nuri1982@hotmail.com

Theme: Environmental Benefits

Format: Oral Presentation

Title: Agroforestry Pathways to Enhanced Ecosystem Services & Producer Payments for a Healthier Environment

Colin Mitchell, National Center for Appropriate Technology (NCAT)

This presentation investigates the ecosystem services that can be improved through the use of agroforestry techniques such as silvopasture, windbreaks, alley cropping, and more. The presentation focuses on key ecosystem services that can be improved through agroforestry: soil health, carbon sequestration, water quantity, water and air quality, and biodiversity. Agroforestry techniques can improve soil health through soil erosion reduction, increases in soil organic matter, and beneficial soil microbiology. Carbon sequestration can improve air quality and mitigate climate change through the storage of atmospheric carbon in the biomass of trees and by building soil and mitigating soil loss in agroecosystems. Water quantity can be increased through agroforestry systems by increasing the water holding capacity of soils. Water quality can be increased through the creation of tree belt buffers that reduce sediment runoff and nutrient and pesticide runoff in intensive agricultural systems. Air quality can be improved with similar tree belt buffers on farms by reducing wind chills, protecting crops, reducing odor from feed lots, and limiting wind erosion. Agroforestry can improve air quality in broader terms by limiting particulate matter in the air and reducing noise pollution. Biodiversity conservation can be improved through agroforestry by providing habitats that are more natural habitats than intensive agriculture systems, creating wildlife corridors, and preventing degradation of surrounding habitats. While agroforestry can provide these benefits to the environment, society, and farmers through strengthening of ecosystem services, agroforestry producers can receive payments for enhancing ecosystem services through several sources as ecosystem service markets becomes more robust.

Keywords: Soil health, Carbon sequestration, Water Quality, Air Quality, Ecosystem Service Payments, and Biodiversity

Colin Mitchell: colinm@ncat.org

Theme: Environmental Benefits

Format: Oral Presentation

Title: Environmental and Food Production Outcomes of Woody Perennial Polycultures in the US Midwest

Maayan Kreitzman, Institute for Resources, Environment and Sustainability, University of British Columbia

Harold Eyster

Aldona Czajewska

Noah Sullivan

Matthew Mitchell

Sean Smukler

Keefe Keeley

Kai M. A. Chan

Farm-scale permaculture, or perennial polyculture farming, is a concept that has gained traction in recent years. Commercial-scale systems that integrate multiple woody perennial food crops in the same

field in the temperate North are not well studied. The question of if and how perennial agriculture might offer a viable alternative for food production requires robust primary data from multi-site observational study designs with paired comparisons. To this end, we have carried out an observational study which directly compares multiple ecosystem service-linked environmental markers (soil properties, insects, birds, vegetation) and food production between perennial polyculture fields and adjacent conventional annual fields on 14 farms in the US Midwest. Biophysical data was collected during two visits to each farm over the spring and summer of 2018, on a perennial field and an adjacent annual control field at each site. Each perennial farmer reported food production from the previous year on a questionnaire. Data was analysed using linear mixed-effects models accounting for study design. Perennial fields show significantly higher total soil carbon and active carbon, and less soil compaction (lower bulk density) in the top soil layer (0-15 cm). Perennial fields also had significantly higher bird and insect diversity, and more non-crop vegetative plant cover and diversity. Food production (calories) from perennial fields was significantly lower, but nutritional diversity was higher. Perennial polyculture farms are characterized by several clustered and correlated environmental markers that are linked to important ecosystem services. They lag far behind neighbouring conventional agriculture in total food production (in part due to immaturity of the perennial plantings) but provide a rich variety of nutrients for direct human consumption

Keywords: Polyculture, ecosystem services, food production, biodiversity, field study

Maayan Kreitzman: kreitzman.maayan@gmail.com

Theme: Specialty Forest Products

Format: Panel Discussion

Title: What do we know about specialty forest products? Lessons from the Assessment of nontimber forest products in the United States under Changing Conditions

Marla Emery, USDA Forest Service

Susan Alexander, USDA Forest Service

Frank Lake, USDA Forest Service

Gregory Ormsby Mori, University of Missouri

Nontimber forest products (NTFPs) are vital to the functioning of healthy forests and play vital roles in the cultures and economies of the people of the United States. These plants and fungi are used for food, medicine, and other purposes. They also are important components of many agroforestry systems. The Assessment of nontimber forest products in the United States under Changing Conditions was recently released by the USDA Forest Service and offer a baseline science synthesis of the state-of-the-knowledge on US NTFPs. Panelists in this session summarize key results of importance to agroforestry professionals. NTFPs offer many opportunities for agroforestry systems. However, efforts to realize that potential will be more successful when they incorporate information about current uses and user of NTFPs. Topics to be highlighted by this panel include agroforestry approaches to NTFPs, such as forest farming and factors affecting the adoption of forest farming. A discussion of the economics of NTFPs will delve into market and nonmarket values, as well as contributions of NTFPs to farm and household finances. Panelists will discuss the unique legal and cultural dimensions of NTFPs in tribal cultures and their role in assuring food security for peoples from diverse backgrounds. We will take a deep dive into NTFPs and agroforestry at the regional scale, while considering some future risks to NTFP species.

Keywords: specialty forest products, nontimber forest products, farm income, tribes

Marla Emery: memery@fs.fed.us

Theme: Climate Change Opportunities and Challenges

Format: Demonstration

Title: FoodPlaces: A platform for creating productive landscapes in public and civic spaces

Mario Yanez, Inhabit Earth

Inhabit Earth's mission is to bring about global climate stabilization. There is a growing body of research that suggests that most agroforestry systems perform better than natural forests in sequestering carbon in the soil and above ground biomass. In our work, we have been experimenting with innovative approaches for leveraging urban forests to address complex ecosocial challenges and begin to stabilize climate. Urban Agroforestry: As one might imagine, practicing agroforestry in urban settings is not without its challenges. And yet, in most communities there exists an overabundance of underutilized spaces; particularly in economically-challenged neighborhoods with the most vulnerable populations. The FoodPlaces platform came into being for the sole purpose of making it ridiculously simple and perfectly acceptable for communities to grow food in underutilized public/civic spaces. Using FoodPlaces, practitioners can plan foodscapes - beautiful, functional, and productive landscapes using assemblies of plants that produces food, fuel, fiber, feed (forage/fodder), and or farmaceutical (plant-based medicines). In this session, audiences will explore the FoodPlaces platform and reflect on how they might apply these regenerative practices to their work and to the communities they serve.

Keywords: productive placemaking, urban food forestry, permaculture, foodscapes, and urban agroforestry

Mario Yanez: mario@yanez.earth

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: Projecting agroforestry nutrient trading in Virginia, U.S.A. using landowner surveys and BayFAST models

Adam Beck, Virginia Tech
John Munsell, Virginia Tech
Kelly Cobourn, Virginia Tech
Benjamin Addlestone, Virginia Tech
Katie Trozzo, Virginia Tech
Paxton Ramsdall, Environmental Defense Fund

Agroforestry systems can balance production and conservation objectives on working lands, but incentive program recognition and landowner implementation remain latent. Nutrient credit trading programs present market-based incentives that could accelerate agroforestry adoption. Since 2009, landowners and public and private developers have traded phosphorus in a private market refereed by Virginia's Department of Environmental Quality. Project sites are largely converted to dense pine plantings at a rate of at least 400 stems an acre. Payments to landowners are front-loaded and agricultural uses must be retired. Since credits are not determined by site-specific performance projections, trees are often planted in places and at densities that do not yield the desired reduction of water quality impairment as established by program guidelines. This project uses biophysical and social

data garnered from Landowner surveys and BayFast modeling scenarios to target and scale agroforestry adoption impacts. We use the output to study TMDL contributions under numerous agroforestry conversion scenarios in two sub-basins in Virginia's portion of the Chesapeake Bay watershed. Overall project progress is presented, as well as a case for including agroforestry in water quality incentive programs as a means of achieving scale. Also addressed is our ongoing progress in associating the results with easily accessed tools and data sources to extrapolate outside of the study area.

Keywords: Adoption Interest and Disproportionality

Adam Beck: atbeck@vt.edu

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: Multi-party arrangements: innovative land and capital partnerships for agroforestry

Keefe Keeley, Savanna Institute

Kevin Wolz, Savanna Institute

Jeannine Richards, Savanna Institute

Jess Robinson, Savanna Institute

Severine von Tscherner Fleming, Greenhorns

Kate MacFarland, USDA National Agroforestry Center

Richard Straight, USDA National Agroforestry Center

Access to long-term secure land tenure and to capital are critical for wider adoption of agroforestry. In the U.S. 39% of farmed land is non-owner operated. One-year cash rent leases designed for annual crops most commonly govern use of this land. Long-term agroforestry arrangements could better meet many landowner objectives and public interests. Conventional agricultural financing, too, may suit annual systems, but agroforestry-appropriate capital accords conditions as such. Access to land and capital are common barriers for beginning farmers - key potential agroforestry adopters. Bringing together multiple parties - farmers, landowners, and sources of capital - in suitable land and business arrangements represents a potential strategy for stimulating adoption of agroforestry. Here, we (1) identify the principles of agroforestry-appropriate land and capital (2) highlight exemplary cases of agroforestry on non-owner operated land via multi-party arrangements, including with institutional landowners, (3) develop best practices and potential pitfalls for successful multi-party agroforestry arrangements, (4) assess potential for expanding use of multi-party agroforestry arrangements, and strategies for how it might be realized by collaboration among academics, policy makers, government agencies, civil society organizations, businesses, institutional and individual landowners, and agroforestry practitioners.

Keywords: land access, long-term lease, investment, partnerships, case studies, landowners, and land tenure

Kate MacFarland: katherine.macfarland@usda.gov

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: A Landscape Level Perspective for Agroforestry Planning

Sarah Taylor Lovell, University of Illinois

Gary Bentrup, USDA National Agroforestry Center

North American agroforestry has focused much attention on the five distinct practices and their functions, applications, and designs. Considering practices are planned and implemented on individual farms and ranches to meet producer objectives, a site-scale perspective is the dominant lens through which these interventions are viewed. Incorporating a landscape perspective, however, can add significant value when designing agroforestry practices for enhancing multifunctionality and the provision of ecosystem services, to create more resilient agricultural landscapes. This presentation offers a conceptual model with an overview of key frameworks that guide this approach, from landscape ecology to landscape multifunctionality. With this broader lens, agroforestry offers the opportunity to contribute to a culture-based food supply that could improve human health and build on local knowledge. Various existing methods for assessing landscapes can provide guidance for strategically placing agroforestry practices based on landscape and site conditions. The approach involves looking beyond field boundaries and property lines to determine how a site is influenced by off-site conditions and how the site affects the surrounding landscape. At the landscape scale, connections with other land uses become relevant, and more comprehensive land-based solutions can be developed. Landscape-scale agroforestry research could help to broaden implementation and increase benefits to society.

Keywords: landscape ecology, multifunctional landscape

Sarah Taylor Lovell: stlovel@illinois.edu

Concurrent Session 3

Theme: Accessing Resources, Accessing Markets, and Managing Risk

Format: Panel Discussion

Title: USDA Resources for Agroforestry Research

Matthew Smith, USDA National Agroforestry Center

Susan Stein, USDA National Agroforestry Center

Gary Bentrup, USDA National Agroforestry Center

Kate MacFarland, USDA National Agroforestry Center

As interest in agroforestry expands, so does our collective experience with using USDA programs to support agroforestry research. This panel will provide an overview of programs funded through the National Institute of Food and Agriculture (NIFA) and other agencies that have supported agroforestry research, including the Sustainable Agriculture Research and Education program (SARE). In addition, speakers will provide examples of research projects that have received USDA funding, and insights into how to use some of these programs, such as the NIFA Agriculture and Food Research Initiative, SARE Graduate Student Grants, and the NRCS Conservation Innovation Grant Program. Lastly, participants will be informed of a publication on this topic, produced by the National Agroforestry Center.

Panelists:

Overview of USDA Agroforestry Research Funding Opportunities – Kate MacFarland, USDA National Agroforestry Center

Agroforestry research through SARE - Nicholas Andrews, Oregon State University

Long Term Agroforestry Research and USDA - Sarah Taylor Lovell, University of Illinois

Long Term Agroforestry Research and USDA - John Fike, Virginia Tech

Keywords: research, resources, funding

Matthew Smith: Matthew.Smith4@usda.gov

Theme: Advances in Technology Applications

Format: Oral Presentation

Title: Agroforestry models overestimate photosynthesis of understory crops

Adolfo Rosati, Council for Agricultural Research and Agricultural Economy Analysis (CREA)

Kevin Wolz, Savanna Institute

Lora Murphy, Cary institute of Ecosystem Studies

Luigi Ponti, ENEA

Michael Gold, University of Missouri

No biophysical agroforestry model predicts the exact light pattern available under the trees in each point in time and space. Being averaged in time and/or space, modelled light is less variable than in reality. We tested whether using the more uniform light patterns predicted by models results in overestimation of crop photosynthesis and radiation use efficiency. We measured the light pattern every minute for several days in 24 positions under chestnut orchard canopies of various ages and tree spacings. We also created a spatially explicit, ray-tracing canopy light model and used it to estimate the light pattern under the trees with a time resolution of one minute. We then used the modeled vs. measured light patterns to estimate the daily photosynthesis of an understory wheat leaf. The porosity of the tree canopies in the model was calibrated to match the daily light totals measured with the sensors. Despite this, the modeled light patterns under the tree canopies were substantially different from the measured ones, being much more uniform. This was due to the fact that the model assumes a canopy of uniform porosity, while, in reality, sun rays pass through a complex heterogeneous canopy. Using the more uniform modeled light overestimated daily photosynthesis by about 40%, even when calculating photosynthesis using the light pattern at a minute scale. Averaging light in time increased the overestimation even further. We conclude that, by predicting overly uniform sub-canopy light patterns, current agroforestry models likely overestimate photosynthesis and radiation use efficiency of understory crops.

Keywords: modeling, light, photosynthesis, agroforestry, and crops

Adolfo Rosati: rosatiadolfo@gmail.com

Theme: Advances in Technology Applications

Format: Oral Presentation

Title: Calibration of the 3D Hi-sAFe agroforestry model for hybrid walnut

Kevin J Wolz, Savanna Institute & INRA (UMR-SYSTEM), Montpellier, France

Christian Dupraz, INRA (UMR-SYSTEM), Montpellier, France

Isabelle Lecomte, INRA (UMR-SYSTEM), Montpellier, France

Gosme Marie, INRA (UMR-SYSTEM), Montpellier, France

Reyes Francesco, INRA (UMR-SYSTEM), Montpellier, France

Hi-sAFe is a 3D biophysical model designed to explore the interactions between trees and crops in agroforestry systems. Utilization of any tree species within Hi-sAFe requires parameterization and

calibration of the model for that tree species. We carried out these two steps for hybrid walnut (*Juglans regia x nigra*). Data used for parameterization and calibration came from the literature and long-term experimental plots at the Restinclières Estate near Montpellier in Southern France. The three plots included two alley cropping systems of hybrid walnut and durum wheat (*Triticum durum*) and a pure forestry system of hybrid walnut with a natural ground cover. A total of 21 Hi-sAFe tree inputs were unable to be parameterized directly and were included in the model calibration. Optimal parameter values were searched for using a multi-objective evolutionary algorithm (MOEA) similar to the NSGA-II algorithm. The root mean square errors of the measured vs. modeled diameter at breast height (DBH) in each plot were used as objective functions to minimize. The final Pareto optimal front of the MOEA contained a diversity of tree parameter sets. Accuracy of modeled crop relative yield in one of the plots was used as a final criterion to select the best parameter set. These calibrated Hi-sAFe parameters for hybrid walnut can be used to confidently explore hybrid walnut agroforestry systems across pedoclimatic and management conditions.

Keywords: biophysical modeling, alley cropping, modeling, optimization, 3D, and calibration

Kevin J Wolz: kevin@savannainstitute.org

Theme: Advances in Technology Applications

Format: Oral Presentation

Title: Potential for agrivoltaics and an 'energy canopy'

Chad W Higgins, Oregon State University

Elnaz Hassan Pour, Oregon State University

Majdi Abou-Najim, UC Davis

John Selker, Oregon State University

Agrivoltaic systems are a configuration in which the forest canopy is supplemented or replaced with an 'energy canopy' constructed from solar panels. The solar panels productively harvest solar excess and convert it into a renewable energy source. A three year study was performed at the Oregon State University solar array. Results indicate that the pasture productivity increased by 90%, and the water use efficiency increased by 300%. Further, the local cooling due to the plant Transpiration led to an increase in energy production of the solar panels by ~10%. These energy producing systems would offset current energy demands if adopted on 0.5% of agricultural lands. This presentation will present our field experimental results and global analysis.

Keywords: Solar Panel, Pasture, Energy, and Grazing

Chad W Higgins: chad.higgins@oregonstate.edu

Theme: Environmental Benefits

Format: Oral Presentation

Title: Effect of red cedar windbreaks on soil physical properties in the U.S. Great Plains

Tom Sauer, USDA Agricultural Research Service

Eric Brevik, Dickinson State University

Diomy Zamora, University of Minnesota Extension

John Tyndall, Iowa State University
J.Y. Zhu, U.S. Forest Service
Gary Wyatt, University of Minnesota Extension

Tree windbreaks are used to control wind erosion and improve crop microclimate. Renovation of old windbreaks also creates opportunities to provide feedstock for bioenergy production. Eastern red cedar (*Juniperus virginiana* L.) has great potential for bioenergy production due to its adaptability to a wide range of soil and climate conditions and the physical and chemical characteristics of its biomass. The objective of this study was to evaluate the effect of eastern red cedar windbreaks on soil physical quality in the U.S. Great Plains. Nine sites were selected from latitudes 41-47 deg N and longitudes 94-103 deg W with MAP from 425 to 970 mm and MAT from 4.9 to 9.9 deg C. Tree age varied from 22 to 59 years. Ponded infiltration and penetration resistance at 2.5 cm increments to 30 cm were measured at 9 locations under the trees and in adjacent fields (crop, pasture, or hay). Infiltration rates averaged 137 mm/h (48%) greater and penetration resistance averaged 228 kPa lower under tree cover. Bulk density averaged 0.11 Mg/m³ (9.2%) lower under red cedar trees, equivalent to 0.04 (7.25%) greater porosity. These results suggest that precipitation was more likely to infiltrate and be available for root uptake under the trees. Improvements in soil physical quality following tree planting may improve tree growth in semi-arid areas by increasing available water or allow some marginal lands to be converted back to crop or forage production at a higher level of productivity.

Keywords: infiltration, penetration resistance, bulk density, and porosity

Tom Sauer: tom.sauer@usda.gov

Theme: Environmental Benefits

Format: Oral Presentation

Title: Field Boundary Habitats – Their Role in the Health & Productivity of Agro-Ecosystems

Laura Poppy, Agriculture and Agri-Food Canada
Fardausi Akhter, Agriculture and Agri-Food Canada, Indian Head, SK
Luke Bainard, Agriculture and Agri-Food Canada, Swift Current, SK
Kim Hodge, Agriculture and Agri-Food Canada, Regina, SK
Julia Leeson, Agriculture and Agri-Food Canada, Saskatoon, SK
William May, Agriculture and Agri-Food Canada, Indian Head, SK
Cory Sheffield, Royal Saskatchewan Museum, Regina, SK
Bill Bristol, Agriculture and Agri-Food Canada, Regina, SK (retired)
Tricia Ward, Agriculture and Agri-Food Canada, Regina, SK

Canada contributes significantly to world food production, but this has not occurred without environmental costs. Fragmentation of the agro-ecosystem and associated habitat destruction for monoculture production have contributed to a loss of flora and fauna diversity. Producers often regard field boundary habitats as non-productive land that potentially limits crop production (e.g., source of weeds, reduction in farmable land, host for pests and diseases). Specific information concerning the potential impact of field boundary habitats on adjacent agricultural crops is lacking for Canadian agro-ecosystems. We hypothesize that non-crop field boundary areas provide diversified habitats and influence microclimate thus promoting populations of beneficial arthropods and pollinators while providing multiple ecological services leading to long term environmental and economic sustainability of the agro-ecosystem. To test this hypothesis we: 1. spatially analyzed the extent and distribution of field boundary habitat influences on in-field variability using precision agriculture approaches, such as micro

scale in-field measurements of soil moisture, above and below-ground biodiversity, insect pests, pathogens and weeds, crop metrics from UAV-based sensors; and 2. quantified the benefits of conserving non-crop areas on crop yield and quality. We collected data from 15 sites representing one of two field boundary habitat types in the black soil zones of Saskatchewan, Canada: planted shelterbelt, natural hedgerow, and open field with no field boundary habitat. The intent is to provide science-based information on the functioning and value of field boundary habitats and the extent of their influence into adjacent field crops.

Keywords: shelterbelts, native hedgerows, non crop areas, biodiversity, canola yield, agro-ecosystem, field boundary habitats, carabids, and pollinators

Laura Poppy: laura.poppy@canada.ca

Theme: Specialty Forest Products

Format: Oral Presentation

Title: Pacific Northwest NTFP Production and how local woodland coop is helping producers break through market barriers

Tiffany Hopkins, Oregon State University

This presentation will explore the many non-timber forest products that are gaining popularity in the Pacific Northwest region of the United States including; mushroom collection and production, bigleaf maple syrup production, floral production, firewood production, and essential oil distillation. We will examine methods of NTFP outreach education to small woodland owners from the perspective of Extension. We will explore the six most common market barriers that NTFP producers face and how a local Oregon coop is helping producers break through many of these barriers.

Keywords: NTFP, Specialty Forest Products, and Market Barriers

Tiffany Hopkins: tiffany.hopkins@oregonstate.edu

Theme: Specialty Forest Products

Format: Oral Presentation

Title: The Appalachian Harvest Herb Hub - Successes and Challenges

Katie Commender, Appalachian Sustainable Development

It is estimated that over one-half of native U.S. medicinals are found in Appalachian forests. Many of these species have longstanding markets, some dating back to the 18th century. Today, market value for forest-based medicinal plant products exceeds one billion dollars annually in the U.S. However, aside from ginseng, prices in the traditional supply chain are often less than \$5/dry pound. This translates to a low return on labor, and limited economic incentive for sustainable cultivation and/or management of forest botanicals, many of which are at risk from over-harvesting and habitat loss.

In 2017, Appalachian Sustainable Development created the Appalachian Harvest (AH) Herb Hub in Duffield, VA to explore solutions to these problems, and found both successes and challenges. Nested within one of the oldest food hubs in the country, AH is a shared-use facility that offers training, commercial washing and drying equipment, and aggregation and marketing services to medicinal herb and vegetable farmers. With commercial processing equipment, AH has helped farmers reduce their

manual labor expenses by up to \$34/dry pound. Working with buyers and consumers who are increasingly looking for high quality, sustainably harvested botanicals, AH has helped develop a niche market with premium prices for verified forest farmers. At the same time, AH has faced several challenges, including meeting growing demand, navigating processing regulations, and more. By sharing successes and challenges, ASD hopes the Herb Hub can one day become a replicable model for the forest farming community.

Keywords: forest farming, forest botanicals, marketing, and processing

Katie Commender: kcommender@asdevelop.org

Theme: Specialty Forest Products

Format: Oral Presentation

Title: Neither wild nor cultivated: American ginseng (*Panax quinquefolius L.*) trade surveys in Pennsylvania, U.S.A., provide insights into husbandry of an internationally traded non-timber forest product.

Eric P. Burkhart, Shaver's Creek Environmental Center, Pennsylvania State University, Petersburg, PA, 16669 and Ecosystem Science and Management, Pennsylvania State University, University Park, PA 16802

Pennsylvania is one of nineteen states in the United States of America (U.S.A.) that exports wild American ginseng (*Panax quinquefolius L.*) roots to Asian countries where the species is used medicinally. This study utilized a confidential annual survey instrument over a seven-year period (2012-2018) to gather information from sellers regarding ginseng husbandry behaviors that might influence reported trade volumes in Pennsylvania. 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. As many as one-fifth of sellers indicated that the "wild" ginseng sold originated from intentional planting on forestlands. This scenario presents a dilemma regarding interpretation of "wild" harvest data because current industry reporting mechanisms are in many cases insufficient to accommodate the complex range of husbandry practices being utilized, and which often result in "wild" appearing roots. Seller/producer concerns and misgivings about issues such as price gouging, theft, taxation, coupled with a lack of consensus around what constitutes "wild" collectively drive much of the secrecy around forest-based husbandry and cultivation of this important non-timber forest product.

Keywords: Forest farming, Non-timber forest products, Plant husbandry, American ginseng, and In situ conservation

Eric P. Burkhart: epb6@psu.edu

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: Determining landowner knowledge, attitudes and practices related to adoption of snow control measures

Dean Current, University of Minnesota – CINRAM
Collin Motschke, University of Minnesota – CINRAM

Gary Wyatt, University of Minnesota Extension
Diomy Zamora, University of Minnesota Extension
Dan Gullickson, Minnesota Department of Transportation

The University of Minnesota has been working with the Minnesota Department of Transportation (MnDOT) for a number of years on the costs/benefits and adoption of snow control methods and specifically living snow fences. We recently completed a Knowledge, Attitudes, and Practices (KAP) assessment of landowner knowledge, attitudes and practices related to the adoption and implementation of snow control practices on their properties to keep snow off of state highways and improving public safety. Initial listening sessions with MnDOT personnel and representative community members in problem areas were followed by: i) a pre-promotion gap exercise and KAP survey of landowners in problem corridors; ii) a promotional program which included meetings with landowners in problem corridors and passive promotion to the community in general through different media outlets; and iii) post-promotion KAP survey to measure change following promotion. Constraints to adoption included inconvenience, loss of productive land, and lack of knowledge of MnDOT programs. We will report on the results of our pre and post KAP surveys, constraints to adoption, and strategies to promote adoption based upon the results of the listening sessions, surveys and landowner meetings.

Keywords: community support, KAP methodology, living snow fence, constraints, and incentives

Dean Current: curre002@umn.edu

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: 15-Year Survival and Growth Review of the Davenport Living Snow Fence Demonstration in Washington State

Andrew Perleberg, Washington State University
Donald Hanley, Washington State University
Gary Kuhn, USDA Natural Resources Conservation Service
Dennis Robinson, USDA Natural Resources Conservation Service
Brenda Hanley, Cornell University

The Davenport Living Snow Fence, a dry land Rocky Mountain Juniper (*Juniperus scopulorum*), demonstration was planted in 2003 and provides data on tree growth and survival rates during its first fifteen years. The primary purpose of this planting was to demonstrate implementation. A secondary purpose was to report on tree growth and row variability. While evergreen trees and shrubs make excellent snow fences to reduce wind and trap snow along road sides and other areas where drifting snow may pose problems for drivers, this demonstration evaluated survival and growth, and not intended to measure snow-catching effectiveness. Tree survival (99%) and growth exceeded expectations. Tree height and crown-width growth, coupled with very high survival rates, can be achieved in arid eastern Washington.

Keywords: Washington, Living, Snow, Fence, Dryland, Experiment, and Demonstration

Andrew Perleberg: andyp@wsu.edu

Concurrent Session 4

Theme: Accessing Resources, Accessing Markets, and Managing Risk

Format: Panel Discussion

Title: Agroforestry costs and benefits: Information sharing and collaboration

Gary Bentrup, USDA National Agroforestry Center

Kate MacFarland, USDA National Agroforestry Center

Better understanding and accessibility of establishment and maintenance costs for agroforestry practices, as well as crop yields and markets, is essential to the continued success of agroforestry. For practices established largely for conservation purposes, documenting these costs is essential for estimating budgets and cost share needs, as well as enhancing landowner adoption. For practices established for production, costs must be compared with potential income for business plan development, loans, and other implementation steps. However, recording costs and yields of complex polycultures is challenging and tools are sparse. Many groups and organizations are working to fill in data gaps, improve recordkeeping and share information. This panel will bring together researchers, agency staff, practitioners, and others who are documenting and assessing agroforestry practice costs and yields through tool development, market development, and other efforts. Panelists will share their motivations and approaches, challenges, existing or proposed outcomes, and outreach of the information collected.

Panelists:

“Agroforestry for Food Research” Sarah Taylor Lovell, University of Illinois, Urbana-Champaign

“Chestnut and Hazelnut Market Research” Kevin Wolz, Savanna Institute

“Multifunctional Riparian Forest Buffer Program” Tracey Coulter, Pennsylvania Bureau of Forestry

“Fruit and Nut Compass” John Hendrickson, University of Wisconsin, Madison

Keywords: economic data, crop yield, budgeting, business planning, and record keeping

Gary Bentrup: gary.bentrup@usda.gov

Theme: Advances in Technology Applications

Format: Oral Presentation

Title: Analysis of the structure, morphology and chemical composition of the prickly pear glochids to determine its potential uses

Alonso Ulloa Leiton, Universidad Autónoma Chapingo

Virginia Martínez Rojas, Universidad Autónoma Chapingo

María Edna Álvarez Sánchez, Universidad Autónoma Chapingo

Nopaltepec, Mexico, has agroforestry systems where produced: prickly pear, animals, and seasonal crops. In recent years the production of prickly pear has increased, and this causes a generation of different kind of waste. The increasing in the consumption of the fruit in Mexico has gone from 43,000 tons to 408,000 tons in 35 years, this caused the increasing of glochids production too, from 27950 kg to 265200 kg, taking into consideration a yield of 0.65 g of glochids per kg of fruit. This waste is resistant to decay and combustion and has no utility for producers, hence is stored in plastic bags for its disposal. These plastics bags are dumped in the crops, causing negative environmental impact. Thus, the objective of this research is to determine the structure, morphology, chemical composition and some physical

properties for the prickly pear glochids, to turn it into a product and estimate its negative environmental impact. Using SEM observations it was determined that the glochids has a density of 0.1574 g mL⁻¹; 41.15% is cellulose, 41.20% hemicellulose and 5.27% is lignin. And also, some glands with hair-like glochids appear on the length of the structure, varying from 1667 + - 2992 μm with diameters from 67.3 to 9.56 μm. The results obtained allow to carry out the second part of the project, which consist of evaluating different industrial uses to give a responsible management.

Keywords: SEM, cellulose, environmental impact, glochid, Nopaltepec

Alonso Ulloa Leiton: alonsoulloal91@gmail.com

Theme: Advances in Technology Applications

Format: Oral Presentation

Title: Anti-inflammatory properties of black walnut (*Juglans nigra*) extracts in human pro-monocytic cell line U-937

Khanh-Van Ho, Center for Agroforestry, School of Natural Resources, University of Missouri

Kathy L. Schreiber, Cell and Immunobiology Core, University of Missouri

Danh C. Vu, Center for Agroforestry, School of Natural Resources, University of Missouri

Susan M. Rottinghaus, Cell and Immunobiology Core, University of Missouri

Daniel E. Jackson, Cell and Immunobiology Core, University of Missouri

Charles R. Brown, Department of Veterinary Pathobiology, University of Missouri,

Zhentian Lei, Metabolomics Center, University of Missouri

Lloyd W. Sumner, Metabolomics Center, University of Missouri

Mark V. Coggeshall, United States Northern Research Station, USDA-Forest Service

Chung-Ho Lin, Center for Agroforestry, School of Natural Resources, University of Missouri

Black walnut (*Juglans nigra* L.) is an excellent source for health-promoting compounds. Consumption of black walnuts has been linked to many health benefits (e.g., anti-inflammatory), but anti-inflammatory properties of black walnuts have not been explored. In this study, anti-inflammatory compounds in kernel extracts from ten black walnut cultivars were putatively identified through a metabolomics profiling analysis which revealed differences in anti-inflammatory capacities among these cultivars. Five selective cultivars were further examined anti-inflammatory activities in human pro-monocytic cell line U-937 by evaluating the effects of the extracts on the secretion of 13 human inflammatory cytokines/chemokines using a bead-based, flow cytometric multiplex assay. The extracts of each cultivar at 4 concentrations (0.1, 0.3, 1, and 10 mg/mL) were added to lipopolysaccharides (LPS)-stimulated U-937 cells, a process inducing host inflammatory responses. Results from the cell viability indicated that the kernel extracts were non-toxic to the U-937 cells. Of the 13 cytokines (IL-1β TNF-α, IL-6, IL-8, IL-10, IL-12, IL-17, IL-18, IL-23, IL-33, IFN-α, IFN-γ, and MCP-1) measured, only 6 cytokines were detected under the culture conditions. The secretion of the 6 cytokines by LPS-stimulated U-937 cells was significantly and dose-dependently attenuated by extracts of Sparrow and Surprise compared to control cells, whereas extracts of other cultivars had no or weak inhibitory effects on the cytokine secretion. No inhibitory effect on the secretion of the 6 cytokines if LPS was added before the extracts. The findings suggest that the extracts of black walnuts could be functioning as promising biological candidates for prevention of inflammatory diseases.

Keywords: Anti-inflammatory activity, *Juglans nigra*, and metabolomic profiling

Khanh-Van Ho: vkh6c6@mail.missouri.edu

Theme: Advances in Technology Applications

Format: Oral Presentation

Title: Trees and Shrubs of Multiple Uses in the Southeast of Guanajuato: Mezquites and Huizaches

Rosa García-Núñez, Universidad Autónoma Chapingo
Nidia Reséndiz-Flores, Universidad Autónoma Chapingo
Miguel Hernández-Martínez, INIFAP Celaya Gto.

The arboreal and shrub species of the arid and semiarid zones of Mexico are considered marginal for their sparse contribution as industrial lumber products, and without recognition as non-lumber species of multiple use. There is considerable potential and diversity of species that may be utilized as a sustainable economic alternative for the development of the inhabitants.

The results herein present the diversity of uses of the arboreal and shrub species located in the Arroyo Prieto micro-watershed in the southeast of Guanajuato, Mexico. In parallel, a methodology is proposed to implement a system of mezquite (*Prosopis laevigata* Humb. & Bonpl. ex Willd.) and huizache (*Acacia farnesiana* L. Willd) gum collection system, utilizing an ethylene treatment that will stimulate the physiology of the tree in order to accelerate the gum secretion at low cost.

The experimental design was one of the randomized blocks (DBA) with five treatments, three repetitions, and three sample units by treatment (tree). This statistical analysis was carried out utilizing SAS version 9.3. Both species registered very good gum secretion; however, the huizache showed better results. The exploitation and use of mezquite and huizache gum is a viable alternative to increase the income of many communities where they are developed.

Keywords: Gum, Ethylene, Stimulate, Physiology, Secretion

Rosa Garcia-Nuñez: garcianu51@gmail.com

Theme: Education, Outreach, and Community Engagement

Format: Oral Presentation

Title: Tracing 35 Years of Agroforestry Development in the USA: Past, Present, Future

Mike Gold, Center for Agroforestry, University of Missouri

The past: Although practiced by landowners previous to 1980, there was no formal awareness or recognition of US agroforestry. There was no definition of temperate zone agroforestry, no defined practices, no underlying biophysical or socio-economic science, no academic courses or degree programs, no extension, no literature, no journal and no professional association.

The present: Post 1980, major advances occurred on every dimension of agroforestry. Agroforestry Systems journal launched in 1982, temperate agroforestry research was initiated in Canada and the US. In 1989 the 1st North American Agroforestry Conference (NAAC), Guelph, Ontario. Post 1993 the first North American temperate zone agroforestry textbooks were published.

In the past decade (post 2010), the depth, breadth and pace of agroforestry progress has accelerated. An agroforestry knowledge infrastructure began to take shape in the form of regional agroforestry working groups, the establishment of formally recognized online graduate certificate and MS degree

programs, and the creation of numerous extended duration training programs designed to train educators and landowners. The NGO and private sectors started to engage with landowners about agroforestry.

The future: Looking forward to 2050, a rapid expansion of agroforestry practices will be deployed on the US agricultural landscape. The agroforestry knowledge infrastructure will have matured to support a tipping point of rapid growth and development. The private sector will heavily invest and engage with landowners to deploy diversified agroforestry practices across the temperate zone landscape. A trained cadre of "Professionally Certified Agroforesters" will work with landowners adopting agroforestry.

Keywords: Knowledge Infrastructure, History, Science, Education, Tipping Point

Michael Gold: goldm@missouri.edu

Theme: Education, Outreach, and Community Engagement

Format: Oral Presentation

Title: Updates from the European Agroforestry Federation (EURAF)

Adolfo Rosati, CREA Research Center for Olive, Citrus and Tree Fruit, Spoleto, Italy

Francesca Camilli, IBIMET-CNR, Istituto di Biometeorologia del Consiglio Nazionale delle Ricerche, Firenze, Italy

Gerry Lawson, Centre for Ecology and Hydrology (NERC), Edinburgh, UK

Maria Rosa Mosquera-Losada, Crop Production and Project Engineering Department. University of Santiago de Compostela, Lugo, Spain

João Palma, MV Agroecology Research Centre, Espírito Santo, Mértola, Portugal

Jo Smith, Organic Research Centre, Elm Farm, Hamstead Marshall, Newbury RG20 0HR, UK

Patrick Worms, World Agroforestry Centre (ICRAF)

Founded in 2011 in Paris, EURAF (European Agroforestry Federation) is a federation of national agroforestry associations from 20 European countries. EURAF aims to promote the adoption of agroforestry practices across Europe by lobbying for better policies, organizing European agroforestry conferences, producing newsletters, collaborating with and supporting national agroforestry associations, promoting events, providing networking among agroforestry stakeholders and participating in research and demonstration projects. For more details see EURAF renovated website (www.eurafagroforestry.eu).

EURAF has been involved in several projects, including AGROFE (Agroforestry Education in Europe), AGFORWARD (AGroFORestry that Will Advance Rural Development) aiming at developing innovations in arable crops, livestock and high value trees and linking them to modelling and policy, and AFINET (Agroforestry Innovation Networks) aiming to collect information on farming practices and to develop a knowledge innovation repository.

Since its foundation in 2011, EURAF has organized biennially the European agroforestry conferences (on even years not to overlap with AFTA conferences on odd years). The next conference will be held in Nuoro (Sardinia) Italy, in May 2020. This location was chosen because it is highly representative of Mediterranean agroforestry systems and practices deeply rooted in local traditions, but also looking forward to innovation.

Within the World Congress on Agroforestry (Montpellier, 20-22 May 2019) EURAF is hosting a 'Tour of Europe' to show to the world the diversity of agroforestry in Europe. This will be a colorful display of

photos, videos and demonstrations of agroforestry products from each country, providing an opportunity to share working and research experiences in agroforestry.

Adolfo Rosati: rosatiadolfo@gmail.com

Theme: Specialty Forest Products

Format: Oral presentation

Title: Dangers you ought to be aware of while working in the forest

Paul F. Figueroa, Washington Department of Agriculture (retired)

Andrew B. Perleberg, Washington State University

For years foresters have worked on Federal, State, Tribal and private lands with few hazards unrelated to their work. Extreme weather, steep or rocky slopes, unstable trees, poisonous plants and large and small animals were the greatest safety concerns. Except during hunting seasons, foresters had little to concern themselves with other people creating hazardous situations or conditions in the woods. However, those days have long since passed where foresters of the 1960- through 1980s could feel safe and unconcerned about persons trying to use the land you manage for their own personal gain or criminal activities. Awareness of the hazards for working in today's forests require managers to recognize key elements of who and what they are dealing with. This discussion focuses on: (1) Understanding what elements are key to maintaining your personal safety; (2) Understanding the thought processes of criminals and why is it so different than normal thought processes; (3) Understanding there is a wide variety of attitudes about private land ownership versus public lands; (4) Major issues about land conversion for other people's uses such as garbage dumping; vandalism; trespassing; poaching and theft. Finally, recognizing the tremendous hazards and signs of marijuana grows and the people who tend them; and, recognition and hazards of methamphetamine labs and the people who tend them. When one puts together these key elements about people, thought processes, attitudes and hazards one gets the opportunity to plan for the "What ifs" when hazards are encountered, and their expectation to get home safely each day.

Keywords: hazardous situations; criminal activities; trespass; theft; vandalism; personal safety; marijuana grows; methamphetamine labs

Andrew Perleberg: andyp@wsu.edu

Theme: Specialty Forest Products

Format: Oral presentation

Title: Food Forests - Building Edible Community Landscapes

Gary Wyatt, University of Minnesota Extension

Diomy Zamora, University of Minnesota Extension

Mike Reichenbach, University of Minnesota Extension

Dean Current, University of Minnesota, Center for Integrated Natural Resources and Agricultural Management (CINRAM)

People are familiar with community gardens but have you heard of community food forests? A food forest combines trees, shrubs, vines, perennials and self-seeding annuals to produce vegetables, fruits and nuts. Rather than individually maintained gardens, the entire food forest is open to the public for harvest. These plantings provide healthy foods while protecting soil and water resources. Food forests

are established in community green spaces and riparian areas. Volunteer groups are transforming public areas to Community Food Forests, maintained and utilized by local residents. Learn more about food forests, plants, designs and resources including the MN Harvester Handbook. A Productive Riparian Buffer demonstration project using edible fruits and nuts from woody plants will also be discussed.

Keywords: Forest Gardens, Edibles from woody plants, Edibles, Local Foods, Community Food

Gary Wyatt: wyatt@umn.edu

Theme: Specialty Forest Products

Format: Oral presentation

Title: Evaluating Commercial Specialty Mushroom Production for Diversified Farms and Small Woodland Owners in Western WA

Patrick Shults, Extension Forester, Washington State University

Justin O’Dea, Washington State University

Stephen Bramwell Washington State University

Forest-grown specialty mushroom production may be an economical, low-impact, ecologically-appropriate enterprise for diversified farms and small woodland owners in western WA and the greater western Pacific Northwest (PNW). Nonetheless, to date, there has been little Extension research, publications, or formalized programs in the PNW on this subject as a commercial enterprise. In contrast, several northeastern and midwestern agroforestry Extension initiatives have developed commercial-scale, forest-grown specialty mushroom production systems and enterprise budgets. These systems use harvested hardwood as a substrate and mushrooms are cultivated under existing forest canopy. In contrast to the environments that these systems were developed in though, the western PNW environment has 1) markedly milder winter temperatures, 2) more limited choices of native hardwoods, and 3) markedly drier, lower-humidity summers. Nonetheless, our densely-forested, high precipitation environment should be naturally-conducive to producing mushrooms. We propose a project that evaluates the adaptability of production systems developed by Extension in the eastern US for several species of specialty mushrooms to the western PNW. Using three research sites in two distinct regions of western WA, we will evaluate 1) multiple species of locally available hardwoods for their potential to sustain mushroom production 2) production systems that mitigate effects of sustained low-humidity summers, and 3) estimate commercial forest-grown mushroom production potential for the western PNW context. Project results will be disseminated at regional forestry and agriculture events in year two, and used for leveraging further funding from external grants.

Keywords: forest farming, shiitake, mushroom logs, Pacific northwest

Patrick Shults: patrick.shults@wsu.edu

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: 25 years on: Australian farmers validate an alternative model for agroforestry development

Rowan Reid, Bamba Agroforestry Farm

Since 1993 the Otway Agroforestry Network has been implementing an innovative extension model that has redefined agroforestry and challenged the paradigm that farmers won't grow trees without proven models, direct subsidies and demonstrations. The result is the spontaneous adoption of a multiplicity of unique designs across hundreds of farms; a diversity that reflects that inherent within our community. At the landscape level we have improvements in water quality, biodiversity, economic resilience, carbon sequestration and aesthetics.

Agroforestry development should be guided by landowner needs and aspirations. Our model focuses on: 1. Exploring how trees can address landholder problems, reduce risk (climate, animal welfare, land degradation, biodiversity, diversification, mental health, nutrient retention etc.) and achieve their aspirations; 2. Providing local education for farmers where science and practice are delivered within the context of their interests (e.g. Master TreeGrower); 3. Training, then paying, farmers to act as Peer Mentors to help others design personally-appropriate agroforestry systems; 4. Researching markets and production options for tree products and services; and, 5. Networking with community, government, interest groups and industry.

The Otway Agroforestry Network is now the largest farmer group of its kind in Australia. Charles Massy wrote: "This organization is undoubtedly the most innovative, constantly evolving and forward-looking farmer-driven agroforestry network in the nation" (Call of the Reed Warbler). This paper tells our story.

Rowan Reid: rowan.reid@agroforestry.net.au

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: Results of the Pre-Test Assessing Adoption of Agroforestry in West Tanzania

Sonia Bruck, Oregon State University Department of Forest Ecosystems and Society & The World Agroforestry Centre

Badege Bishaw, Oregon State University

Olli-Pekka Kuusela, Oregon State University

The World Agroforestry Centre (ICRAF) has promoted agroforestry adoption in Tabora District, Tanzania since 1989. Agroforestry methods introduced include: (1) intercropping with pigeon pea, cassava, maize, cow-pea, and *Gliricidia sepium* for increased food yield and enhanced nitrogen fixation, and (2) woodlots for sustainable firewood production, erosion control, and to discourage deforestation of adjacent open-access Miombo Woodlands. The woodlands make-up the largest area of deciduous tropical woodland and dry forests in the world, yet are being deforested at a rapid rate for firewood and charcoal to cure tobacco.

We have conducted a pre-test of our survey exploring technology adoption of pigeon pea and cassava intercropping and plantings of *Gliricidia sepium* in three villages (Mpenge, Isenga, and Ngokolo). Those who currently use agroforestry practices are referred to as "adopters", and those who do not are referred to as "nonadopters." The 150-question pretest was disseminated by trained enumerators. The survey was read to each participant at a location and time of their choosing; their answers were recorded by the enumerator in a survey cell-phone application.

The survey instrument addressed constraints that influence adoption decisions including: risk expectations, planting prices and expected prices of goods, access to seed and difficulty of management, distances to markets, hours spent working on and off farm, community engagement, self-efficacy, and

others. We also make use of the Household Food Insecurity Access Scale (HFIAS) to assess food security of adopters and nonadopters.

We will be returning to Tanzania in June 2019 to collect approximately 600 questionnaires across the Mbola villages following a revision of the pre-test.

Keywords: ICRAF, Food Security, Intercropping, *Gliricidia sepium*

Sonia Bruck: sonia.bruck@oregonstate.edu

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: Integrative Agroforestry in a Community of the Sierra Madre Oriental

María Edna Álvarez Sánchez, Universidad Autónoma Chapingo

Lorena López-Alfaro, Universidad Autónoma Chapingo

Ángela Fontes-Carrillo, Colegio de Posgraduados

The objective was to implement agroforestry and ecological technologies based on a methodological model in a traditional agroecosystem of ornamental production on a farm located in the northern mountains of Puebla, Mexico. Deforestation and predatory extraction of non-timber forest products, incompatibility of ornamental-agricultural production with cloud forest (bn), and socio-ecological degradation are factors that have contributed to the social, ecological, and productive vulnerability of the community. The proposed comprehensive methodological model of agroforestry intervention, which includes the psychosocial care component, allowed resolving conflicts and governance among producers; dialogue between the social partners to come together in one purpose was reopened. The above made it possible to modify the system of ornamental production conformed by *Chamaecyparis lawsoniana* (A. Murray) Parl., *Rhododendron simsi* Planch., *Pinus greggii* Engelm. ex Parl., and *Pinus patula* Schltdl. & Cham. to a silvopastoralist; as well as the production of guava and the native fungus *Entoloma* sp. Likewise, it was possible to restore 10 hectares of the farm with endemic and emblematic species of the bn. In order to provide more production options, a participatory territorial order was proposed to identify production detonator projects.

Keywords: Integral methodological model of agroforestry Intervention, ornamental production system, cloud forest

María Edna Álvarez Sánchez: edna_alvarez30@yahoo.com.mx

Concurrent Session 5

Theme: Accessing Resources, Accessing Markets, and Managing Risk

Format: Oral Presentation

Title: Private and societal values of agroforestry systems in southern Quebec: how to enhance voluntary adoption?

Caroline Simard, University of Quebec in Outaouais

Sylvie Wood, University of Quebec in Outaouais
Jérôme Dupras, University of Quebec in Outaouais
David Rivest, University of Quebec in Outaouais

Agricultural practices in southern Quebec have intensified over the past decades with impacts for biodiversity and water quality, especially in the Lake Champlain basin. The region has experienced recurring algal blooms over the last 20 years. Riparian buffer strips have been identified as one possible agro-environmental solution. Current public and private programs to encourage the uptake of agro-environmental practices to control nutrient pollution in Quebec have met with limited success to date. Socio-economic factors and the discrepancy between short-term interests of farmers and long-term interests of society have been major drivers slowing their adoption. Using Lake Champlain watershed in southern Quebec (Canada) as case study, the objectives of this study were: 1) to examine the economic value of marketable products and non-market ecosystem services yielded by three scenarios of riparian forest buffer management over the next 50 years using a cost-benefit analysis; and 2) to assess the effectiveness of the new agri-environmental policy Prime-Vert (2018) implemented in Quebec to enhance voluntary adoption using discounted cash flows analysis. Our economic model uses data set from WBVECAN simulation tool and adds new economic indicators to assess risk and option values for farmers. The scenarios were designed to include contrasting socio-economic goals (minimal area, maximal biomass production, ecological and aesthetic value). Scenarios differs in terms of width, species composition and ecological complexity of the planted buffers. Preliminary results suggest that none of the scenarios achieve rentability from farmer's point of view. However, when we consider the societal value of non-market ecosystem services such as water quality improvement and habitat provision for species, all scenarios become socially profitable. These results provide a rationale for market-based instrument such as payments for ecosystem services. We will also discuss how this approach can inform the public regulator on the timing of payments and how to consider risk and option values for farmers in order to enhance the voluntary adoption of agri-environmental practices.

Keywords: Riparian buffers, agro-environmental practices, cost-benefit analysis, linear programming, discounted cash flows analysis, ecological services, and option value

Caroline Simard: simc30@uqo.ca

Theme: Accessing Resources, Accessing Markets, and Managing Risk

Format: Oral Presentation

Title: Opportunities and Recommendations for Enhancing Agroforestry Economics

Susan Stein, USDA Forest Service
Katherine MacFarland, USDA Forest Service
Gary Bentrup, USDA Forest Service

The United States Department of Agriculture's Interagency Agroforestry Team convened a workshop in March 2018 entitled "Enhancing Rural Economies through Agroforestry." The purpose was to lay the foundation for assessing economic opportunities, for producers and others in the agricultural community, to practice and benefit from agroforestry. Over the course of three days, producers, researchers and professionals from public, private, and non-profit sectors examined opportunities for enhancing economic opportunities to practice, and benefit from, agroforestry. Examples included agroforestry land leases, private investments, innovative approaches for expanding and accessing markets; and integration of multifunctional riparian forest buffers into nutrient trading programs. This

oral presentation will provide highlights of the workshop and summarize recommendations for future research and technology transfer.

Keywords: markets, supply chain, and investment

Susan Stein: susan.stein@usda.gov

Theme: Production Science

Format: Oral Presentation

Title: Agroforestry Specialty Crop Development for the Midwest

Gregory Ormsby Mori, Center for Agroforestry, University of Missouri

U.S. agricultural and rural communities face ongoing challenges - economic and environmental, that threaten the sustainability of small family farms. Specialty fruit and nut crops and Non-Timber Forest Products produced in agroforestry systems may help to introduce environmentally, economically and socially sustainable agricultural systems that create new opportunities for farmers, ranchers, forest landowners, and families in rural communities.

The Center for Agroforestry's (UMCA) specialty crop development program includes work on pecans, chestnuts, black walnuts, elderberry, pawpaw, pine straw, shiitake and other forest grown mushrooms and medicinal plants. Following an integrated, comprehensive, long-term approach UMCA model involves cultivar selection and breeding, testing field production techniques, market and consumer studies, sound financial decision support tools and grower training to bring specialty crops into the sustainable agriculture mainstream.

Marketing of niche specialty crops may present opportunities for small producers but is more likely to achieve success when "pulled" along by market forces and following a market-oriented approach. However, lack of detailed market information, presents challenges.

An important tool guiding UMCA market research is the Porter Five Forces Model (Porter1980), useful for analyzing competition within an industry among producers, bargaining power of suppliers and buyers, potential for substitutes and threat of new entrants and the interaction between these "forces". Another important dimension of UMCA's work includes phytochemical research to elucidate and test unique compounds with potential for value-added products.

This presentation provides an overview and update on UCMA's ongoing efforts to develop specialty crops for use in agroforestry systems in the Midwest.

Keywords: specialty crops, market development, midwest, and agroforestry

Gregory Ormsby Mori: ormsbyg@missouri.edu

Theme: Production Science

Format: Oral presentation

Title: Food Forests in Cities and Smaller Communities of the American Southwest

James Allen, Northern Arizona University

Andy Mason, USDA Forest Service and National Agroforestry Center (retired)

Food forests are composed of multiple plant species, which typically include overstory and midstory tree species along with shrubs, herbaceous species and vines. In the American Southwest the number of food forests is increasing in large urban areas such as Phoenix, Arizona, as well as in smaller communities throughout the region. Based on site visits and interviews with practitioners, we will describe some of the food forests that have been established in these settings, including examples that are privately-owned or that have been created in public spaces for demonstration and educational purposes. For each of these food forests, we investigated (mostly in a qualitative manner) the reasons for establishment, size, species selection, soil management, and water use. The food forests that have been established have clearly demonstrated the potential of this practice, even for the hottest and driest parts of this region. We believe that broader adoption could lead to significant cumulative effects on food security and the provision of ecosystem services such as carbon sequestration, biodiversity, and climate amelioration. We will conclude by discussing research needs and what we see as the opportunities and potential barriers to wider adoption of this agroforestry practice.

Keywords: Arizona, New Mexico, Adoption, Ecosystem Services, and Food Security

James Allen: james.allen@nau.edu

Theme: Production Science

Format: Oral Presentation

Title: Vegetation Height and Diurnal Period Influenced the Behaviors and Distribution Patterns of Small Ruminants in Woodlands During Fall

Shailes Bhattrai, Tuskegee University
Uma Karki, Tuskegee University
Bidur Paneru, Tuskegee University

Woodlands have a great potential to expand the grazing opportunity for small ruminants. However, animals' access to vegetation available beyond certain height is limited. Therefore, height management is important to increase the utilization of woodland vegetation. The study objective was to determine the effect of vegetation height and diurnal periods on small ruminants' behaviors and distribution patterns in woodlands. Study site consisted of six woodland plots (0.4-ha each) comprising the mixture of southern pines, hardwood trees, and numerous understory plant species. The non-pine species were either cut to one of the heights from the ground level (0', 3', 5') or left uncut (control). Kiko wethers (8; 74 ± 2.1 kg live weight) and Katahdin rams (5; 88 ± 4.6 kg live weight) were rotationally stocked in separate plots (3 plots/species), and their diurnal (dawn-dusk) behaviors and distribution patterns monitored when they were in each plot. Data were analyzed in SAS 9.4. Both animal species visited the control area the least. Wethers (42%) and rams (31%) spent maximum time in open space (0' and along the fence line), where they lied down predominantly during midday (1100h-1500h) ($p < 0.01$) versus morning (dawn-1100h) and post-midday (1500h-dusk) hours. The predominant behavior of wethers was browsing (51%) and of rams grazing (55%), both of which mostly occurred during post-midday ($p < 0.05$) versus morning and midday hours. Wethers browsed predominantly (19%) in 3' area, while rams grazed predominantly (27%) in 0' area. Vegetation height and diurnal periods significantly influenced animals' behaviors and distribution patterns in woodlands.

Keywords; Browsing, Grazing, Katahdin rams, and Kiko wethers

Shailes Bhattrai: sbhattrai5555@tuskegee.edu

Theme: Education, Outreach, and Community Engagement

Format: Oral presentation

Title: Stimulating interest in silvopasture among farmer-members of an organic farm marketing cooperative

Mark Kopecky, Organic Valley/CROPP Cooperative

CROPP Cooperative is a farmer-owned marketing cooperative with over 2,000 members in 36 states, Canada, the United Kingdom, and Australia. CROPP markets organic dairy, meat, eggs, and produce under the brand names Organic Valley, Organic Prairie, and Mighty Organic. The vast majority of cooperative members are dairy farmers. Under USDA organic production rules, all organic dairy cows must be grazed on pasture for a minimum of 120 days during the growing season, but CROPP farmers typically graze their cattle for much longer periods. Grazing dairy cattle in intense summer heat can lead to serious declines in forage intake and milk production. Silvopasture is one practice that can improve cow comfort and forage intake during these times, but farmer understanding and acceptance of this practice is quite low. This session describes the educational efforts we've undertaken to help farmers understand the practice and its potential benefits. These efforts have been successful in stimulating interest in silvopasture among dairy farmers, and farmers in several regions have asked for educational programs to help them understand the practice better. Although silvopasture adoption is still fairly rare, we're hopeful that some innovative farmers in these regions will adopt the practice and serve as examples for others to do likewise.

Keywords: Grazing, dairy, forage, heat

Mark Kopecky: mark.kopecky@organicvalley.coop

Theme: Education, Outreach, and Community Engagement

Format: Oral presentation

Title: Indoor and Outdoor Forest Farming for Year-Round Food and Medicine Production, Carbon Sequestration, Soil-Building, and Climate Change Mitigation.

Jerome Osentowski, Central Rocky Mountain Permaculture Institute

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 and minimal backup with wood burning sauna and pellet stove, allowing the greenhouse to serve as a year-round food producer. The effort to source food from the forest gardens is 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.

Keywords: Food Security, Forest Farming, Agroecology, Greenhouse, Perennial Polyculture, Climate Battery, and Agroforestry

Jerome Osentowski: jerome@crmpi.org

Theme: Specialty Forest Products

Format: Oral presentation

Title: Case Study of Forest Grown Ginseng, as told by United Plant Savers and Mountain Rose Herbs

David Doty, Mountain Rose Herbs

Jennifer Gerrity, Mountain Rose Herbs

Susan Leopold, United Plant Savers

This talk will present the data of the FGV ginseng product (root, leaf and tincture) being sold thru Mountain Rose Herbs. American ginseng has been overlooked as a domestic product due to its Asian demand and illegal sale and harvesting. The FGV program was designed to tap into a domestic market and to promote conservation. Lessons learned will be shared and hopefully a model put in place for sustainable forest grown botanicals.

Keywords: forest-grown, ginseng, value added product, and botanicals

David Doty: david@mountainroseherbs.com

Theme: Specialty Forest Products

Format: Oral presentation

Title: Phytochemical Changes in Ramps (*Allium tricoccum*) Across Seasonal and Reproductive Development

Teal Jordan, Pennsylvania State University

Eric Burkhart, Pennsylvania State University, Shaver's Creek Environmental Center

Margot Kaye, Pennsylvania State University, Department of Ecosystem Science and Management

Joshua Lambert, Pennsylvania State University, Department of Food Science

Ramps/Wild leeks (*Allium tricoccum*) are a wild perennial species of the onion family, native to the deciduous forests of eastern North America. Ramps are known throughout Appalachia for their unique onion and garlic flavor and have expanded in popularity in recent years. While a rising number of producers wish to manage ramps as an agroforestry crop, knowledge of their nutritional and medicinal composition remains limited. Our research focuses on quantifying phytochemicals in ramps that are important drivers of perceived quality and putative human health benefits as they vary in relation to plant development and seasonality. For this study, we harvested ramps in April to November 2018 from established populations throughout Pennsylvania at key developmental stages from spring emergence through the maturation of leaves, flowers, fruits, and into seasonal dormancy. Using new and previously developed laboratory methods, we are quantifying allicin, the organosulfur compound responsible for the scent and major health-promoting properties of garlic (*Allium sativum*), the total phenolic compounds, and the total anthocyanin content in the collected ramps. Comparisons are being made between developmental stages and reproductive status, between harvest locations, and between parts

of the same plant (i.e. bulb, leaves, inflorescence, etc.). Our results are intended to support the development of scientifically based, sustainable ramp harvesting and consumption, including leaf-only harvests, by establishing baseline information around crop quality and phytochemistry in relation to plant part and developmental stage.

Keywords: Non-timber forest products, Appalachia, wild leeks, forest farming, phytochemistry.

Teal Jordan: rtj5@psu.edu

Theme: Specialty Forest Products

Format: Oral presentation

Title: Agroforestry and forest herbs: the effect of harvest time and forest site on alkaloid content in forest grown goldenseal (*Hydrastis canadensis* L.).

Eric Burkhart, Pennsylvania State University, Shaver's Creek Environmental Center
Grady Zuiderveen, Ecosystem Science and Management, Pennsylvania State University

Goldenseal (*Hydrastis canadensis* L.) is an Appalachian forest herb, native to eastern North America, 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 Pennsylvania suggest that time of harvest can dramatically influence the alkaloid content in the dried root and rhizomes as well as the above ground herb. Alkaloid content was found to peak in May (flowering stage) in all parts of the plant, with samples at other harvest times falling below current recommended therapeutic and industry constituent levels (c.f., United States Pharmacopeia). The results of this study help identify production and 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.

Keywords: Forest farming, Phytochemistry, Non-timber forest products, and Quality control

Eric Burkhart: epb6@psu.edu

Theme: Climate Change Opportunities and Challenges

Format: Oral presentation

Title: Tree Fodders: Silvopasture for a Changing Climate

Steve Gabriel, Cornell University Small Farms Program and Wellspring Forest Farm

While research offers evidence of environmental, nutritional, and medicinal benefits tree fodders provide to livestock systems, they are often overlooked as silvopasture is described to agroforestry practitioners. Focusing on just four species (Willow, Poplar, Black Locust, and Mulberry), tree fodder systems can be developed that offer a wide range of solutions to on-farm challenges, while also meeting larger climate mitigation targets.

An analysis of these species and associated research indicates where we have clear knowledge, and where more work needs to be done. In addition to better understanding the implications from a research standpoint, the concept of tree fodders must be introduced in a way that is approachable from the landowner and farmer perspective. This presentation offers a summary of recent work to develop research and extension goals for tree fodders use in North America.

Keywords: silvopasture, tree fodder, and climate change

Steve Gabriel: sfg53@cornell.edu

Theme: Climate Change Opportunities and Challenges

Format: Oral presentation

Title: Initial Performance of Red Mulberry (*Morus rubra*) Along a Shade Gradient: An Overlooked Supplemental Livestock Forage?

Ryan Dibala, University of Missouri

Shibu Jose, University of Missouri

Climate change creates uncertainty for the future of agriculture, particularly due to an increase in droughts that result in loss of range productivity. The integration of perennial shrubs into pasture is one way to diversify forage resources and compensate for losses caused by droughts during the summer forage gap. While fodder yield and nutritional quality of white mulberry (*Morus alba*) has been widely studied, there remains a paucity of information for its native congener red mulberry (*M. rubra*). We report on the initial survival, growth, yield, and nutritive value of *M. rubra* seedlings planted under a cherrybark oak (*Quercus pagoda*) canopy at four densities: 3x3m (D), 6x6m (S-D), 9x9m (S-O), and 12x12m (O). Despite summer drought conditions, 81.25% of seedlings survived, with odds of seedlings surviving in D significantly lower than those surviving in S-O and O. *M. rubra* growth increased with decreasing tree density, but yield was not reduced under moderate overstory densities (S-D and S-O), at least not in the short term. Nutritive value surpassed the quality of many common pasture forages, with CP values up to 24.10%, relatively low fiber fractions, and high Ca and P concentrations. Our results indicate that producers are likely to optimize leaf fodder quantity and quality by planting *M. rubra* in understories of 60 - 70% of that found in the open. Due to high protein/mineral content and relatively low fiber fractions, *M. rubra* could serve as a highly nutritional supplemental forage to livestock in multi-strata silvopastures during drought conditions.

Keywords: Tree-shrub interactions, multi-strata agroforestry, forage production, and silvopasture

Ryan Dibala: ryan.dibala@gmail.com

Theme: Climate Change Opportunities and Challenges

Format: Oral presentation

Title: Carbon Sequestration and its Potential Economic Impact in Coffee Agroforestry Systems in São Paulo, Brazil

Nícolás Gonçalves, University of California, Merced

Alexandre Uezu, Instituto de Pesquisas Ecológicas

Laury Cullen Jr., Instituto de Pesquisas Ecológicas

Daniel Andrade, Universidade Federal de Uberlândia

Alan Batista, World Resources Institute Brasil

Land use change by humans is a primary driver of biodiversity loss, especially true for Brazil's reality. Brazil's Forest Code forecasts a reforestation debt of 21 ± 1 Mha in private properties. Agroforestry is a land use change option for reforesting and restoring ecosystem services, such as carbon sequestration. Therefore, we aimed at quantifying carbon sequestration and its potential economic impact of 20 Coffee Agroforestry Systems (CAS) in São Paulo, Brazil. Sixteen of which were two-years-old and four of which were 16 years old. Carbon and tree biomass were estimated using allometric models. We used three economic feasibility parameters in a 16 year economic modeled scenario: Net Present Value (NPV), Internal Rate of Return (IRR) and, payback period. Discount rate and carbon price applied was 11% and US\$ 5.1 Mg CO₂e-1, respectively. Total mean carbon stock in young and old CASs was 1.38 ± 0.63 Mg C ha-1 and 56.69 ± 32.63 Mg C ha-1, respectively. All CASs presented a payback period of two years, mean NPV of US\$ 36,341.49 and mean IRR of 90.76%. Carbon revenue impact on NPV and IRR was US\$ 111.65 and 0.23%, respectively. Our results indicate that CASs are a sustainable and economically viable land use with high potential for meeting the Nationally Determined Contribution (NDC) of the Paris Agreement. On the other hand, low carbon sequestration economic impact does not encourage the adoption of this type of system, increasing controversies related to ecosystem services valuation and markets.

Keywords: Coffee agroforestry systems, Carbon sequestration, Economic feasibility, and Land use

Nícolas Gonçalves: nicolasmgon@gmail.com

Theme: Adoption, Implementation, and Evaluation

Format: Panel Discussion

Title: Advancing Agroforestry through the Private Sector: Agroforestry Consultants and Beyond

Kate MacFarland, USDA National Agroforestry Center

Gary Bentrup, USDA National Agroforestry Center

The private sector is an important intermediary between landowners/producers and agronomy and forestry research, with consulting foresters and crop consultants playing an increasingly significant role in producer decision making. In agroforestry, we are seeing this trend as well, as consulting foresters and crop consultants learn more about agroforestry and share that knowledge with landowners and as consultants start to specialize in agroforestry practices. In this panel, consultants who work with clients to establish and manage agroforestry practices will share their experiences. Questions addressed will include: How did you learn about agroforestry? How do you describe agroforestry to potential clients? What are the characteristics of the clients you work with? What kinds of agroforestry practices are people most interested in? What reasons do clients give when choosing for or against agroforestry? How much of your business relates to agroforestry? What client services do you provide and what are clients most interested in? What business model do you use?

Panelists:

Shane Hetzler, Trout Mountain Forestry

Jude Hobbs, Agro-Ecology Northwest

Connor Stedman, Terra Genesis International

Ethan Steinberg, Propagate Ventures

Keywords: adoption, consultant, TSPs

Kate MacFarland: Katherine.macfarland@usda.gov

Concurrent Session 6

Theme: Accessing Resources, Accessing Markets, and Managing Risk

Format: Panel Discussion

Title: Land access for agroforestry: examples and case studies

Kate MacFarland, USDA National Agroforestry Center

Gary Bentrup, USDA National Agroforestry Center

Land access and tenure is a challenge for all new and expanding producers, but there are special challenges presented by agroforestry systems due to their perennial and long-term nature. Many producers are taking innovative approaches to land access for agroforestry, including leasing. Through these relationships, producers can establish or maintain new or existing agroforestry systems for the production of tree and shrub crops and non-timber forest products on landowners' property. This relationship allows beginning farmers to get started while also benefitting the landowner through more diversified income sources and enhanced conservation outcomes. While leasing and renting farmland is very common, agroforestry leases are less common and include legal challenges such as long term commitments. This panel will provide case studies across a wide range of land access types, reflecting a diversity of agroforestry practices, business arrangements, landowner types, and regions of the U.S.

Panelists:

"Working with The Nature Conservancy to help landless forest farmers access land" Katie Commender, Appalachian Sustainable Development

"Accessing and learning from American Chestnut Foundation orchards for multifunctional outcomes" Erik Hagan, Windswept Farm

"Reaching out to and working with absentee private landowners" Kevin Wolz, Savanna Institute

Keywords: land access, leasing, and economics

Kate MacFarland: Katherine.macfarland@usda.gov

Theme: Production science

Format: Oral presentation

Title: Southern Pines Performed Better in Silvopastures than in Woodland Grazing System

Uma Karki, Tuskegee University

Shailes Bhattra, Department of Agricultural and Environmental Sciences, College of Agriculture, Environment and Nutrition Science, Tuskegee University

Sanjok Poudel, Currently at Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

Bidur Paneru, Department of Agricultural and Environmental Sciences, College of Agriculture, Environment and Nutrition Science, Tuskegee University

Southern pines are important tree species in both silvopasture and woodland systems. Information on how southern pines perform in these systems, especially when grazing animals are included in the system, is limited. The objective of the study was to determine the growth of southern pines (loblolly, *Pinus taeda* and longleaf, *Pinus palustris*) in silvopastures and woodlands. Studies were conducted in silvopastures and woodlands, with six plots in each system (0.4-ha per plot). Silvopastures were developed from the existing woodlands in 2014 by removing the non-pine vegetation, thinning the pines to a desirable level (294 trees/ha), and planting suitable cool- and warm-season forages. Woodlands consisted of longleaf and loblolly pines, hardwood trees, and several understory plant species. Understory vegetation present in both systems was managed with the rotational stocking of Kiko wethers (2015-2016) or both Kiko wethers and Katahdin rams (2017-2018). Tree height and diameter at breast height (DBH) were measured in fall 2018. Both loblolly and longleaf pines performed better in silvopastures versus woodlands, with a greater DBH (28%) and basal area (64%) in the former system ($p < 0.0001$). Tree species showed a significant effect ($p < 0.001$) on all growth parameters within each system, with loblolly pines having the greater height (7-9%), DBH (27-43%), and basal area (62-107) than longleaf pines. Results show that silvopastures offer a better environment for a faster growth of southern pine trees versus woodlands, when the understory vegetation present in both systems is managed with grazing animals.

Keywords: DBH, Loblolly pine, Longleaf pine, Rams, Tree height, Wethers

Uma Karki: ukarki@tuskegee.edu

Theme: Production science

Format: Oral presentation

Title: Vegetative Windbreaks for Poultry Farms

Gary Wyatt, University of Minnesota Extension

Diomy Zamora, University of Minnesota Extension

Dean Current, University of Minnesota, Center for Integrated Natural Resources and Agricultural Management (CINRAM)

Mike Reichenbach, University of Minnesota Extension

Sally Noll, University of Minnesota, Department of Animal Science

Kevin Janni, University of Minnesota, Department of Bioproducts and Biosystems Engineering

Amanda Sames, University of Minnesota

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. Our research objective is to prevent disease transmission using vegetative windbreaks. Surveys have 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.

Keywords: Windbreaks, Poultry, Disease prevention,

Gary Wyatt: wyatt@umn.edu

Theme: Production science

Format: Oral presentation

Title: Syntropy in Practice: Managing Succession Dynamics to Produce Quality Food, Draw Down Carbon, and Generate Sustainable Livelihoods

Matt Dami, PermaDynamics

Klaus Lotz, PermaDynamics

Frida Keegan, PermaDynamics

Josh Lotz, PermDynamics

Vanessa Keegan, PermaDynamics

Syntropic agriculture mimics the natural succession dynamics of a forest ecosystem, increases complexity and resilience, and at the same time accelerates these processes to generate human inclusive habitats. Our farm in Northland, New Zealand, coalesces the design principles and ethics of permaculture, the spirit of biodynamics, and the driving force of syntropy to cultivate nutrient-dense food, sequester more carbon than we use, generate creative, abundant livelihoods for our whole family, and educate our local community in healthy, sustainable lifestyles. Through the regenerative agriculture practices employed in both our temperate and subtropical food forests, we are able to show that food and other forest products can be produced in ways that enhance the quality and vitality of our ecosystem and help mitigate climate change. Syntropy in practice entails intensive pruning and mulching, a diverse, complex plant community, and correct timing of human intervention in the system. These methods generate the greatest amount of biomass possible and pump huge amounts of plant sugars into the soil, thus invigorating the entire ecosystem, above and below ground. This model of a sustainable, perennial-based food-producing system has enabled us to engage positively with our community through course/workshop-based education and direct marketing of produce. In so doing, we have noticed increased local focus on a healthy diet that sustains not only us but the whole ecosystem, the need for direct action for climate change mitigation, and a general awareness of humans as part of a living, interconnected system.

Keywords: biochar, permaculture, climate change, and resilience

Matt Dami: mattdami@gmail.com

Theme: Adoption, Implementation, and Evaluation

Format: Oral presentation

Title: Restoring productivity of unmanaged woodland grazing in Minnesota using Silvopasture

Diomy Zamora, University of Minnesota Extension

Maddie Ford, University of Minnesota Department of Forest Resources

Sophia Vaughan, Minnesota Pollution Control Agency

Gary Wyatt, University of Minnesota Extension
Joe Magner, University of Minnesota College of Food Agriculture and Natural Resource Sciences,
Department of Biological and Ecosystems Engineering
Dean Current, Center for Integrated Natural Resources and Agricultural Management
Dusty Walter, University of Missouri, College of Agriculture, Food, and Natural Resources

Unmanaged woodland grazing is a common practice among livestock producers in Minnesota, USA. It is a practice that is suboptimal for grazing animals, degrades potentially productive trees, reduces species diversity, and increases soil erosion resulting in reduced water quality. Woodland grazing without proper management is estimated to occur on 268,000 hectares in Minnesota, USA. As a beneficial alternative to unmanaged woodland grazing, silvopasture can be employed to increase forage growth, increase tree and livestock health and productivity, increase soil health, and improve water quality on those lands. This project had two major objectives: 1) to assess the impacts of silvopasture as an alternative to unmanaged woodland grazing practices, and 2) to increase awareness and adoption of silvopasture practices through outreach activities, such as the development of a Silvopasture Learning Network (SLN). The purpose of this network is to facilitate farmer-to-farmer learning, promotion, and information sharing to expand natural resource conservation practices. We established three research sites to measure the impacts of silvopasture on water quality as influenced by infiltration rate, plant species diversity, forage production and quality, and livestock weight gain. These parameters were compared among three established systems in each research site: 1) conventional open pasture, 2) traditional unmanaged woodland grazing, and 3) silvopasture. Results show that silvopasture can influence water quality, soil health, species diversity, forage availability, and livestock health. Silvopasture promotion and adoption are without any challenges. At this presentation, we will share an innovative approach of scaling up silvopasture through the development of a SLN. Understanding the benefits of silvopasture and increased networking opportunities may be the links that encourage producers to convert marginal unmanaged woodland grazing to silvopasture and thus allowing for a higher level of productivity and environmental benefits.

Keywords: productivity, silvopasture learning network

Diomy Zamora: zamor015@umn.edu

Theme: Adoption, Implementation, and Evaluation

Format: Oral presentation

Title: Animal welfare benefits and production challenges in silvopasture

Diane Mayerfeld, University of Wisconsin-Madison
Rhonda Gildersleeve, Homer Ridge Organic Dairy
Eric L. Kruger, University of Wisconsin-Madison
Mark Rickenbach, University of Wisconsin-Madison
Daniel M. Schaefer, University of Wisconsin-Madison

Farmers and resource professionals look to silvopasture as an agroforestry practice that can improve environmental and economic outcomes compared to the common practice of allowing livestock to graze woodlands. Two key reasons why farmers practice woodland grazing are to improve animal welfare by providing access to shade and to increase the farm's supply of forage. We compared animal welfare on unshaded pasture, silvopasture, and grazed woodland in a replicated trial in southwestern Wisconsin. We also compared forage availability, quality, and use in the silvopasture and grazed woodland treatments. Silvopasture was established by thinning a woodland and planting a mix of cool season

grasses in the understory. The woodland treatment area was also thinned, but nothing was planted in the understory. In both the silvopasture and grazed woodland paddocks cow-calf pairs could move freely between unshaded pasture and the areas with trees. Both the silvopasture and grazed woodland treatments improved animal welfare compared to unshaded pasture, despite mild summer temperatures experienced during the study period. Results on forage availability, quality, and use were mixed. Both treatments provided forage of adequate nutritional quality for beef production, but a number of forage management challenges emerged that have implications for silvopasture design, especially when converting existing woodlands.

Keywords: silvopasture, forage, grazed woods, and welfare

Diane Mayerfeld: dbmayerfeld@wisc.edu

Theme: Adoption, Implementation, and Evaluation

Format: Oral Presentation

Title: How and why might livestock producers in Virginia, U.S.A. adopt silvopasture?

Philadelphia Wilkens, Virginia Tech

John Munsell, Virginia Tech

John Fike, Virginia Tech

Gabriel Pent, Virginia Tech

Gregory Frey, US Forest Service and North Carolina State

Silvopastures are on the rise in Virginia in large part because of multi-institutional public/private partnerships and a cost-share program initiated by the state's Natural Resources Conservation Service in 2011. As efforts continue, it is vital to reach out to potential adopters and study their expectations and interests. A survey was conducted of 307 livestock producers in Virginia who are enrolled in seven NRCS livestock production limitation cost-share initiatives. One-hundred and forty producers (46%) responded and reported that they largely prefer thinning existing forestland to create silvopasture. They are less inclined to plant trees in pastures. Concerns about economic opportunities and land-use options are common hurdles to adoption. Respondents trended toward silvopasture adoption if those concerns could be abated by positive outcomes, such as more shading for livestock or environmental benefits. Still, there are many more challenges reported by producers, such as timing, tree mortality, and forage establishment. Factors leading to preferences for adoption were assessed. Results suggest that livestock performance and reducing risk in production was most important, which aligns with literature on uncertainty in agroforestry adoption. Findings of this study contribute to the next phase of silvopasture adoption in Virginia and beyond.

Keywords: Cost-share, Land-use, survey, NRCS, livestock producer, acreage, and silvopasture

Philadelphia Wilkens: wilkensp@vt.edu

Theme: Policy in Practice

Format: Oral presentation

Title: Edible Green Infrastructure in the Mid-Atlantic: Policy Approaches and Drivers at the Municipal Level

Sarah E. Coffey, Department of Forest Resources and Environmental Conservation at Virginia Polytechnic Institute and State University, Blacksburg, Virginia, U.S.A.

John F. Munsell, Department of Forest Resources and Environmental Conservation at Virginia Polytechnic Institute and State University, Blacksburg, Virginia, U.S.A.

Curtis R. Friedel, Department of Agricultural, Leadership, and Community Education at Virginia Polytechnic Institute and State University, Blacksburg, Virginia, U.S.A.

Rico Hübner, Chair Group for Strategic Landscape Planning and Management at Technical University of Munich (TUM), Freising, Bavaria, Germany

Edible green infrastructure (EGI) is multifunctional space in neighborhoods, towns, and cities consisting of annual and perennial species or is a community food forest including trails, benches, sheds, or tables. Edible gathering places containing perennial species increase the level of permanence of the environmental services—such as improving soil, air, and water quality, reducing heat island effect, and sequestering carbon—while providing local food and fiber. Despite the growing evidence for the social, environmental, and economic benefits of EGI, it is rarely supported in planning/land use and zoning ordinances. However, EGI projects are on the rise and many are the product of intentional policy building at the municipal level. Our purposeful sample of cities like Baltimore, Maryland, and Madison, Wisconsin, have all passed ordinances or other policy measures in support of EGI. We draw on policy process frameworks to compare and understand the approaches and primary drivers of EGI action and adoption at the municipal level. We also intend to study opportunities and barriers to developing EGI ordinances in smaller towns by surveying mayors. Our hypothesis is that EGI policies are the result of a balance between organic civic organization and action, like-minded and vocal elected officials, and environmental and food justice problems. By studying the history of EGI policy in the U.S.A., our research contributes to urban agroforestry policy processes and informs those that want to enact smart and cooperative EGI policy. As we shift from rural to suburban/urban populations, urban agroforestry is increasingly important in our communities.

Keywords: edible green infrastructure, urban agroforestry, policy development, and Mid-Atlantic

Sarah Coffey: secoffey@vt.edu

Theme: Policy in Practice

Format: Oral presentation

Title: How can integrating Western and Indigenous agroforestry science, practice, and management enhance both ecological and socio-ecological resilience?

Colleen Rossier, University of California - Davis

Does integrating Western and Indigenous science, practice, and management have the potential to not only enhance the culture and health of local Indigenous communities, but to in fact, enhance the functionality and resilience of an agroforestry landscape as a whole?

Is partnership with Indigenous communities in their ancestral homelands a key missing ingredient in forest/agroforest ecosystem management as it is practiced in the U.S. – and around the world?

Might such integration result in not-only greater ecosystem functionality and resilience, but also greater socio-ecological system functionality and resilience?

In this study, we explore these questions by examining a specific Indigenous agroforestry landscape in Northern California, and a specific cultural plant food: evergreen huckleberry (*Vaccinium ovatum*, Karuk:

púrith, Yurok: *chee-gery*). We identify areas of mutual agreement between the Karuk Tribe and the U.S. Forest Service (USFS) as well as some of the challenges faced by the current USFS management system. In particular, we ask whether the USFS “coarse-filter/fine-filter” approach is sufficient for ecological management. We examine the types of knowledge produced by the Karuk and Yurok people, and identify ways that partnering with Indigenous peoples may enhance the functionality and resilience of US forest/agroforests as well as the broader socio-ecological systems of which they are a part. This research is based on qualitative data from semi-structured interviews with 18 Indigenous scientist-practitioner-managers of Karuk and Yurok descent as well as quantitative data collected at 105 forestry plots. All research was conducted in collaboration with the Karuk and Yurok Tribes. We conclude that integrating Indigenous and Western sciences and management practices has great potential, particularly through 1) the use of Indigenous focal species in management and monitoring; 2) enabling Indigenous practitioners to guide future research; and 3) utilizing fully collaborative planning, adaptive management, and monitoring processes. We also include specific findings for how to manage evergreen huckleberries (*Vaccinium ovatum*) within an agroforestry context.

Keywords: TEK, Karuk, Native American, huckleberry

Colleen Rossier: cerossier@ucdavis.edu

Theme: Climate Change Opportunities and Challenges

Format: Panel Discussion

Title: Agroforestry Plant Materials for a Changing Climate

Gary Bentrup, USDA National Agroforestry Center

Although the implementation of agroforestry systems can alleviate climate-related stressors to agriculture, they too may be vulnerable to climate-related impacts. Changing climatic conditions will impact plant survival and function, which, in turn, determines agroforestry’s utility as an adaptation and mitigation option. Tree and shrub species have multiple points of climate vulnerability: winter chilling requirements, springtime freeze risk, heat and water stress, pollination constraints, and disease and pest damage. Future success may require development and introduction of new species and cultivars better adapted to current and future climatic conditions. Time and resources will need to be invested in improved seed sourcing, field evaluation trials, and enhanced predictive capability for modeling shifts in growing zones. In this session, panelists will share their thoughts, experience, and research on adaptable plant material for agroforestry applications. Questions to address will include: What are the most pressing research needs concerning this topic? What are the most promising tools and research methods for addressing these questions? What strategies, resources, and guidelines are currently available to aid producers in selecting plant material to create more resilient agroforestry systems?

Panelists:

Sonja Brodt - UC Davis Sustainable Agriculture Research and Education Program

Mike Gold - Center for Agroforestry, University of Missouri

Matthew Smith - USDA National Agroforestry Center

Ron Revord – Center for Agroforestry, University of Missouri

Keywords: climate change, adaptation, mitigation, resilient, and selection

Gary Bentrup: gary.bentrup@usda.gov

Concurrent Session 7

Theme: Accessing Resources, Accessing Markets, and Managing Risk

Format: Panel Discussion

Title: Public Private Partnerships in developing Cooperative Marketing Opportunities for Enhancing Chestnut (*Castanea spp.*) Production and Conservation: A Pennsylvania example.

Erik Hagan, Windswept Farm

Tracey Coulter, PA Department of Conservation and Natural Resources

Steve Hoy, The American Chestnut Foundation

Kate MacFarland, USDA National Agroforestry Center

American chestnut culture has been a tradition in Pennsylvania since pre-colonial times, but the arrival of the chestnut blight in the early 1900s destroyed early efforts for commercial production. Still, the tradition persists and resistant Chinese chestnuts are common on farms and homesteads across the state. The Pennsylvania Chapter of the American Chestnut Foundation was founded in 1994, aimed at producing blight-resistant American chestnuts to repopulate Pennsylvania's forests and farms. Since then, thousands of trees have been planted, many now coming into production. Nuts not needed for research are available to begin to restore not only the iconic tree, but also commercial chestnut production in Pennsylvania. Tracey Coulter, Kate MacFarland, and Erik Hagan will describe the collaboration between multiple public and private partners to research, document, disseminate, and enact best management practices for creating chestnut production cooperatives in the Northeast. Capitalizing on state and federal funding programs, these efforts will result in the development of resources and a business model for chestnut processing facilities in Pennsylvania, focusing on sustainable tree cropping systems and supplementing with native species to reach niche marketing opportunities. The project seeks to culminate in an appropriate scale launch of a chestnut cooperative in Pennsylvania while enhancing the efforts of the American Chestnut Foundation's restoration efforts. Join this session to discuss how we can work together across sectors to enhance processing, marketing opportunities for a wide range of crops.

Keywords: Chestnuts, Cooperatives, Aggregation, Partnerships

Erik Hagan: erik.hagan@gmail.com

Theme: Production Science

Format: Oral Presentation

Title: Silvopasture production characteristics in the Coastal Plain of North Carolina

Alan Franzluebbbers, USDA Agricultural Research Service

Matt H. Poore, North Carolina State University

Silvopasture can offer beef cattle relief from heat and humidity that are prevalent in the long summers of the Coastal Plain of North Carolina. We determined forage yield characteristics, early timber production values, and beef cattle responses from two adjacent fields with and without trees used for cattle grazing mixed swards of native warm-season grasses. *Pinus palustris* (longleaf pine), *Pinus taeda* (loblolly pine), and *Quercus pagoda* (cherrybark oak) plots were planted in triplicate lines surrounding either 12- or 24-m-wide alleys in 2007. Following 6 years of *Zea mays* (corn)-*Glycine max* (soybean)

rotation in alleys, forage mixtures of *Panicum virgatum* (switchgrass), *Andropogon gerardii* (big bluestem), *Sorghastrum nutans* (indiangrass), and *Tripsacum dactyloides* (eastern gamagrass) were established in 2014 (tree pasture) and 2015 (open pasture). Beef cattle were stocked in the middle of summer 2016 and every summer since then. Tree survival was better with *P. taeda* than others, but all had survival rates >85%. Diameter at breast height in the 9th year averaged 16 cm for *P. taeda*, 12 cm for *P. palustris*, and 6 cm for *Q. pagoda*. Forage biomass cut for hay was 5 to 7 Mg ha⁻¹ in 2017. Nutritive value of grazed warm-season native grasses was consistent, but relatively low at 6.5% protein. Animal gains are being assessed in both rough-haired and slick-haired Angus x Senepol heifers. Our results will be useful to landowners in the region considering thinning timber to silvopasture or planting trees in perennial pastures to develop long-term viability of agricultural landscapes.

Keywords: *Pinus palustris*, *Pinus taeda*, *Quercus pagoda*, native warm-season grasses, beef cattle

Alan Franzluebbbers: alan.franzluebbbers@ars.usda.gov

Theme: Production Science

Format: Oral Presentation

Title: Silvopastoral Systems and Climate Change Mitigation in Central Tunisia

Mounir Louhaichi, International Center for Agricultural Research in the Dry Areas (ICARDA) - Jordan

Jamel Kailene, Direction Générale des Forêts, Tunisia

Serkan Ates, Oregon State University

Slim Slim, Ecole Supérieure d'Agriculture de Mateur, Tunisia

Mouldi Gamoun, ICARDA - Tunisia

Hloniphani Peter Moyo, ICARDA - Jordan

Bechir Tarchi, Ministry of Agriculture - Tunisia

Sawsan Hassan, ICARDA – Jordan

Oumeima Ben Rhomdhane, Ecole Supérieure d'Agriculture de Mateur, Tunisia

Azaiez Ouled Belgacem, ICARDA – UAE

Livestock farming is part of rural community's culture and is crucial for human well-being and livelihood. However, absence of desirable forages, lack of diversification and reduced livestock mobility have led to reduced animal production and degradation of rangelands. The objective of this study, initiated in December 2017, is to establish a pilot silvopastoral system (SPS) in Central Tunisia to negate this trend and mitigate the anthropogenic effects of climate change through building a more integrated and resilient production system. In particular, choosing persistent pasture species and the use of SPS, in which trees and shrubs are combined with pastures may offer a sustainable restoration of degraded resources in semi-arid agro-ecologies. Native legume species such as *Hedysarum coronarium* and tree species such as *Ceratonia siliqua* and *Pistacia lentiscus* can be used in SPS to improve soil restoration, carbon sequestration, income diversification and biodiversity conservation. Results from this study indicate higher production ($p < 0.05$) in sulla planted areas (2.3 t DM/ha) than nonplanted areas (1.2 t DM/ha), while soil N, total C and the pastoral value were also higher in sulla planted areas compared with nonplanted areas after six months of establishing the SPS. Successful SPS have great potential for scaling up across similar ecosystems in the Mediterranean basin. Incentives such as provision of seeds, seedlings, water harvesting techniques along with technical assistance can stimulate the adoption of SPS, thus contributing to climate change mitigation while preserving rural livelihoods. Emphasis is now centered on participatory rational grazing to consolidate all efforts into an integrated package. Our

findings help guide local silvopastoral communities and public land managers in the development of effective and resilient SPS to endure climate shocks and sustain ecosystem services..

Keywords: agroforestry, carbon sequestration, diversified silvopastoral systems, semi-arid environments, Mediterranean basin, local community, ecosystem services

Mounir Louhaichi: mounir.louhaichi@oregonstate.edu

Theme: Education, Outreach, and Community Engagement

Format: Roundtable Discussion

Title: Indigenous Partnerships for Agroforestry: Initiating a Decolonized Process

Hannah Hemmelgarn, University of Missouri

Traditional agroforestry has been practiced by Indigenous peoples for millennia, yet there is little active collaboration in temperate North America between agroforestry research and outreach professionals and those Native peoples who have maintained their cultural practices with the land. Removal of First Nations populations between the late 19th and mid-20th centuries left only patches of remnant Tribal lands, many of which are distant from their traditional home places. Much reparation is yet to be achieved, but many of these diverse cultures are thriving. The University of Missouri Center for Agroforestry (UMCA), the National Agroforestry Center, and others recognize an opportunity to learn from and with Native peoples in temperate North America as we work together to preserve, improve, and grow agroforestry opportunities. During this discussion-based session, we will have an open conversation to broaden our understanding of contexts for establishing leaderful structures and relational accountability in partnership with Tribal communities; how non-native people in academia can honor the Indigenous roots of agroforestry and foreground Native voices; and why efforts to decolonize our work is important.

Speakers:

Frank Lake, USDA Forest Service

Colleen Rossier, University of California Davis

Rowen White, Indigenous Seed Keepers Network & Sierra Seeds

Theme: Policy in Practice

Format: Oral Presentation

Title: A systematic map of evidence on the impacts of agroforestry interventions in temperate countries

Sarah Brown, University of Illinois at Urbana-Champaign

Daniel C. Miller, Department of Natural Resources and Environmental Sciences, University of Illinois Urbana-Champaign

Agroforestry has risen to prominence as a land-use strategy to help address global climate change and provide other environmental, economic, and social benefits. As policy debates on the potential and future of agroforestry continue to evolve, research, policy, and investment focused on temperate agroforestry have increased substantially over the past three decades. However, systematic knowledge

on the human-environment impacts of interventions, defined as any program or policy designed to support the adoption and practice of agroforestry, remains lacking. Evidence of the social-economic and biophysical impacts of various agroforestry interventions spans many disciplines and addresses a broad range of outcomes, thus creating an opportunity and need to synthesize the evidence for easier exchange of knowledge and best practices.

To address this research need, we examined the research showing the impacts of agroforestry interventions in temperate countries to provide a systematic map of the literature to aid researchers and policy-makers in developing strategies for future research initiatives and policy formation. We included all studies published between 1990 and 2018 that provide evidence on the impacts of agroforestry interventions on agricultural productivity, ecosystem services, and human well-being. We find few studies performing quantitative impact evaluations of agroforestry policies and programs, highlighting a clear need for future research. We show that an abundance of evidence exists on the impacts of specific agroforestry practices, which provide knowledge that is useful for shaping future agroforestry policies; however, studies have primarily focused on productivity, profitability, and environmental outcomes, with limited study of social outcomes.

Keywords: Policy, Impacts, and Evidence synthesis

Sarah Brown: saraheb3@illinois.edu

Theme: Policy in Practice

Format: Oral Presentation

Title: Agroforestry Policy Development in the USA

Gregory Ormsby Mori, Center for Agroforestry, University of Missouri

While some countries have adopted fully articulated policies for agroforestry, the USA still lacks a formal policy. Agroforestry development has been limited in scope, assisted through policies in a range of sectors - agriculture, forestry, conservation, rural development, at different levels of government.

This presentation will provide an overview of agroforestry policy development in the USA and an update from ongoing policy analysis and the formation of an AFTA led policy working group. The trajectory of agroforestry in the USA, the history and recent advances for agroforestry policy development, from the Forest Stewardship Act of 1990, establishment of a National Agroforestry Center, through successive farm bills and the Agroforestry Strategic Framework 2011- 2016, to the ongoing effort to formulate a new strategic framework and articulate a formal agroforestry policy statement will be discussed.

Absent a coherent agroforestry policy statement, numerous policies and programs exist which are supportive for advancing adoption (e.g. NRCS programs). These and relevant developments, including opportunities with the 2018 Farm Bill activities, presenting opportunities for agroforestry will be discussed, along with the role of multi-stakeholder partnerships and regional working groups in advancing agroforestry adoption and policy development at various scales.

Policy gaps and barriers, including programs presenting dis-incentives to agroforestry adoption (e.g. counter-cyclical payments, crop insurance etc.) and other obstacles to investing in longer term perennial crops and more sustainable practices which could be addressed by policy measures, will be discussed. Presentation will conclude with a discussion of key policy recommendations and priorities for advancing agroforestry in the US.

Keywords: policy, agroforestry, incentives, and constraints

Gregory Ormsby Mori: ormsbyg@missouri.edu

Theme: Policy in Practice

Format: Oral Presentation

Title: The agroforestry governance nexus: an exploratory assessment in Germany and Europe

Rico Hübner, Technical University of Munich

Modern agroforestry activities in Germany can draw on 15 years of research, albeit its implementation and diffusion into practice still lags behind. To realize agroforestry benefits at an impactful scale, it is necessary to analyze the factors promoting or hindering their adoption.

One part in the puzzle to research these factors involves studying regional governance models defined by multi-institutional networks and partnerships focused on agricultural sector change. The research amongst the agroforestry scene in Europe with a closer look at Germany aims on identification and analyzing their activities systematically. Since mutual relations are seen crucial for this approach, dynamic Social Network Analysis (SNA) is applied together with qualitative research through interviews of key stakeholders and evaluation of event documentations.

While early adopters, innovators and scientists were still considered outsiders and many agroforestry sites primarily had a research purpose, the agroforestry sector is currently under change. New agroforestry governance mechanisms appear, forming multi-actor initiatives involving farmers, business companies, engaged citizens and thus gaining more attention by politics and regaining access of the topic into the classical mechanisms such as policy. New governance mechanisms also emerge from changing and new phenomena in the agroforestry scene, such as urban agroforestry, the rising role of new types of farmers and the slowly growing acceptance of this land use being suitable for climate change adaptation to strengthen farm resilience.

Keywords: multi-actor governance, social network analysis, governance landscape

Rico Hübner: rico.huebner@tum.de

Theme: Climate Change Opportunities and Challenges

Format: Roundtable Discussion

Title: Silvopasture: How can we get farmers to plant more trees?

Steve Gabriel, Cornell Small Farms Program and Wellspring Forest Farm

In systems where trees are actively planted, silvopasture offers one of the best solutions for carbon sequestration among all agriculture and land use approaches. Given this, why aren't farmers planting more trees? This round table will organize participants to share their collective experiences and consider what actions and strategies can lead to an increase in silvopasture systems where trees are planted on farms around the North American continent. Those interested in this topic coming from any perspective are welcome to participate given they are willing to actively contribute to the conversation.

Keywords: silvopasture, climate change, and tree planting

Steve Gabriel: sfg53@cornell.edu

Poster Presentations

Theme: Adoption, Implementation, and Evaluation

Title: Nutritional assessment of *Moringa oleifera* Lam plantations to optimize oil production

María Edna Alvarez Sánchez, Universidad Autónoma Chapingo
Margarita Esther Mejía Solís, Universidad Autónoma Chapingo
Edna Álvarez-Sánchez, Universidad Autónoma Chapingo
Ranferi Maldonado Torres, Universidad Autónoma Chapingo
Gustavo Almaguer-Vargas, Universidad Autónoma Chapingo

The objective of this study was to provide fertilization recommendations for the production of *Moringa oleifera* seed and oil, in plantations of 2 and 6 years old. Fertilization treatments were formulated from soil and foliar nutritional analyzes (Kenworthy balance indices), at the beginning and at the end of the experiment. The variables evaluated were: seed yield, oil concentration and foliar nutrient concentrations. Fertilization had no influence on the yield components and significantly decreased the oil concentration. The final Kenworthy balance index showed that initial nutritional deficiencies were corrected, but K, Fe, Cu, Zn, and Mn were increased to excess levels. These nutrient concentrations are negatively correlated with oil content. Alkaline soil conditions and water quality interfere with optimal nutrition management of the plantation.

Keywords: nutritional diagnosis, Kenworthy balance indices

María Edna Alvarez Sánchez: edna_alvarez30@yahoo.com.mx

Theme: Advances in Technology Applications

Title: Tree Advisor: Selecting Woody Plants for Agroforestry in the Great Plains

Gary Bentrup, USDA National Agroforestry Center

The USDA National Agroforestry Center has developed an online plant selection guide to help planners select better species of trees and shrubs to achieve a suite of user-defined purposes for an agroforestry practice. In this tool, over 90 species of trees and shrubs are rated for 14 different purposes in the northern and central Great Plains. Purposes rated in this guide include: 1) alley cropping, 2) aquatic habitat, 3) carbon sequestration, 4) flood protection, 5) native ecosystem restoration, 6) particle drift reduction, 7) pollinator habitat, 8) polluted runoff treatment, 9) streambank stabilization, 10) storm & wastewater treatment, 11) wetland restoration, 12) wildlife habitat, 13) visual aesthetics, and 14) view & noise screen. "Higher rated" species of trees and shrubs are those that function relatively better than other species for specific purposes. Ratings were developed by considering geographic suitability of each species for 12 different sub-regions and plant characteristics that make a species relatively better (or worse) for each specific purpose. The guide also allows searching for specific plant attributes including products that can be produced from the species. The online guide enables the user to quickly develop a short list of the better species to use which can be refined based on suitability under local site conditions, commercial availability, and availability of locally-adapted cultivars and hybrids. This tool may serve as a template for developing multi-purpose woody plant selection guides for other regions.

Keywords: decision support tool, plant selection, multi-functional, multipurpose, trees, and shrubs

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Theme: Environmental Benefits**Title: Assessing elderberry hedgerows for commercial production in California**

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Katie Fyhrie, Cloverleaf Farm, Davis, CA

Katie Uhl, Food Science and Technology Department, University of California, Davis

Native hedgerows on farm edges benefit wildlife (including an endangered beetle species), pest control, carbon storage and runoff, but hedgerow planting by farmers in California is limited, often due to establishment and maintenance costs. What if hedgerows could provide a source of farm income, to offset costs? California's native blue elderberry *Sambucus nigra ssp. caerulea* is already often planted in hedgerows, and grows in a wide range of conditions, from arid interior valleys to coastal areas and into the mountains, with strong potential to adapt to a changing climate and growing water constraints. In the meantime, with growing consumer interest in health foods and herbal remedies, elderberry product sales nationwide have shown tremendous growth while European and Midwestern suppliers struggle to keep up, and almost no commercial supply originates in California. Although native blue elderberry is an important traditional food for California native tribes, who continue to gather elderberry from the wild, little is known in the commercial agriculture and food sector about growing, marketing, or food chemistry of California elderberries.

This 2.5-year study is working with 5 farmers across 3 growing regions of the state to assess the growing and marketing potential of both native blue elderberry and North American cultivars (*Sambucus canadensis*). The project is also analyzing the berries for organic acids, sugars, and phenolics content, to compare with known analysis of European and North American cultivars. This poster presents preliminary results on tree growth, analysis of compounds, and marketing potential.

Keywords: ecosystem services, pharmacological crops, climate adaptation, and conservation incentives

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Theme: Adoption, Implementation, and Evaluation**Title: Physical and Sensorial Quality of Coffee (*Coffea arabica* L.) in Coatepec, Veracruz, Mexico**

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Luisa Amador-Atlahua, Departamento de Suelos. Universidad Autónoma Chapingo

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The evaluation of the appreciation of the coffee when drunk in the cup in agrosystems of *coffea arabica* L. is necessary to generate alternatives to assure the quality and differentiation of coffee in Coatepec, Veracruz, Mexico. This study was carried out with the objective of evaluating the physical and sensorial quality of the Typica and Mundo Novo varieties. Eleven samples of coffee cherries were processed through wet benefit to evaluate their physical and sensory characteristics. The physical characteristics were evaluated according to the international standards of the SCAA (Specialty Coffee Association of America). According to the T-test, the results indicated that there were no significant differences between the two varieties with respect to physical quality such as size, shape and grain defects. The physical characteristics were analyzed using the principal component technique and multiple linear regression. The results showed that two of the seven components explained 73.67% of total variability. The first explained 47.24% and correlated negatively with the following variables: taste, residual taste, acidity and global appreciation. The second explained 26.43% and correlated positively with the body

and balance variables. The results of the multiple regression model indicated that aroma, taste, body, balance and global appreciation were the most important variables to define the total quality of these types of coffee. Finally, the results indicated that there were no significant differences in relation to the physical quality of the grain and the cup appreciation between varieties, since both obtained scores of 80 points and were considered to be very good quality coffees.

Keywords: Typica, Mundo Novo, Sensory quality of coffee, and principal component technique

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Theme: Production Science

Title: Shrubs and herbaceous plants in ecological rehabilitation processes in a semi-dry climate

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Restore degraded ecosystems increases biodiversity by means of recovery, rehabilitation and restoration. Ecological restoration starts the recovery of degraded ecosystems where restoration active (speed recovery, by succession assisted) and one of the most widely used in our country to recover degraded soils is the use of legumes species due to its capacity of adaptation to limiting conditions of humidity and rapid growth. Soil degradation is very common in dry climates in the Northwest of the State of Mexico and the objective of this study is to assess the state and dynamics of the physicochemical and biological properties of soil in the community of San Felipe Teotitlán due to the use of shrubs such as (*Atriplex canescens*, *Dalea zimapanica*, *Leucaena collinsi*, *Leucaena leucochepala* y *Macroptilium atropurpureum*), and herbaceous (*Bouteloua curtipendula*, *Cynodon dactylon*). The reduction of soil degradation is planned will have impact on the community bringing social, economic and ecological benefits in areas degraded, and a projection of the natural processes of ecological restoration through the use of legumes will be generated. Results show that the reforestation and survival was 95 %. The initial physical characterization (6 samples) determined a soil, with changing real density of (2.49 a 2.53 g/cm³), % moisture content to PPW and FC varied (13 a 21.49 %) and (19.38 a 33.30 %) respectively. From the initial characterization of the physicochemical and biological properties, it is concluded that the perspective of ecological restoration is pro for the survival of introduced plant species.

Keywords: Reforestation, Restoration, Shrubs, Herbaceous

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Theme: Climate Change Opportunities and Challenges

Theme: Soil organic carbon comparison in riparian buffer systems and adjacent agricultural systems in southern Ontario, Canada

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Riparian buffer systems (RBS) are promoted for their ability to reduce non-point source pollution from agriculture, decrease streambank erosion, and enhance biodiversity. More recently, RBS have been promoted as a means of sequestering atmospheric CO₂ as plant biomass pools and in surrounding soils through litterfall decomposition and fine-root turnover. The objectives of this study were to quantify the influence of two soil textures (clay, loam), two tree vegetation types (deciduous, coniferous), and two age classes (<15 years [young], >15 years [mature]) on soil organic carbon (SOC) sequestration. Soils were collected to a depth of 30 cm from eight RBS sites in the Grand River watershed in southern Ontario, Canada, representing each potential treatment combination. Soil samples were also collected from adjacent agricultural fields at each site. SOC was determined using the dry combustion method; soil bulk density was determined to allow SOC stocks to be calculated. Results indicate that mature RBS soils had significantly greater SOC stocks, irrespective of soil texture or tree vegetation type, than adjacent agricultural fields ($p < 0.001$). Conversely, although young RBS did exhibit numerically higher levels of SOC than adjacent agricultural fields, these differences were not yet found to be significant ($p = 0.226$). Overall, the mature deciduous clay site showed the greatest response in SOC sequestration, whereas the young coniferous loam site was least affected among the RBS.

Keywords: Agroforestry, climate change mitigation, soil organic carbon stocks, carbon sequestration
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Theme: Education, Outreach, and Community Engagement

Title: Farmmaps - A farmer to farmer database and networking tool

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Antonio Airton Lima, University of Minnesota
Aidan Read, University of Minnesota

Farmmaps is a platform to encourage farmer to farmer networking but also a source of information on installed agroforestry and conservation practices that can be used for identifying farms and practices for field days and other outreach activities. Initiated in 2016 as a database of cases of soil health and sustainable agricultural practices, the database and tool is currently being expanded to include snow control measures including living snow fences, silvopastoral systems and has the potential to register other agroforestry practices. It allows farmers and extensionists to identify farmers who have successfully implemented agroforestry and conservation practices and contact those farmers for advice in implementing practices on their lands. The project includes an electronic database, case studies that can be downloaded and printed and a computer/smartphone GIS application that allows farmers/extensionists to identify cases on a map and contact the landowner to discuss the practices. The rationale behind the application is the belief that, in many cases, farmers are more comfortable interacting with other farmers who have successfully implemented practices and who better understand the constraints and opportunities the practices provide from a farmers perspective. The tool and case studies have been developed in collaboration with the Sustainable Farming Association of Minnesota and Regional Sustainable Development Partnerships in Minnesota, part of UMN Extension.

Keywords: soil health, agroforestry, and database

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Theme: Environmental Benefits

Title: Impact of tree windbreaks on annual crops - carbon uptake and water use

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Dave Wedin, University of Nebraska Lincoln
Thomas J Sauer, USDA-ARS

Tree windbreaks had been extensively planted in the Midwestern US during the Dust Bowl period in the 1930s to combat severe wind erosion. Many shelterbelts are still present, surrounding agricultural fields, thus protecting the ecosystem and securing crop production. However, shelterbelts may adversely impact crop carbon and water cycling, and yield. The objective of this study was to quantify carbon and water cycling in field windbreaks and the associated effects on crop growth. We monitored net ecosystem production (NEP) and evapotranspiration (ET) in a soybean (*Glycine max*) -red cedar (*Juniperus virginiana*) windbreak for the 2018 growing season in Mead, NE, with an eddy covariance station. In addition, plant growth parameters were measured with distance from the windbreak. First results show that growing season NEP was 144 g C m⁻² and ET was 529 mm, which is similar to conventional Midwestern soybean production without shelterbelts. There was no significant difference ($p < 0.05$) in soybean dry weight, specific leaf area, and pod dry weight with distance to the windbreak. Crop height was significantly ($p < 0.05$) different among locations which might be an effect of high rainfall early in the season. Yet, viable seed dry weight and number of seeds was lower nearer to the windbreak. Preliminary results suggest that the shelterbelt had little impact on carbon and water fluxes of the soybean crop but may have generated a negative edge effect on yield. We conclude that windbreaks can contribute to food-security in conventionally managed fields and protect ecosystems.

Keywords: Net ecosystem production, evapotranspiration, red cedar, soybean, and crop growth

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Theme: Policy in Practice

Title: Agroforestry Policy in Europe

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Policy is one of the main drivers of agricultural land management in Europe because Community Agricultural Policy spends around the 40% of the EU budget representing €55 billion per year. There are two main pillars in the CAP, the first deals with the direct payments and the second with the rural development. Lack of consistency between Pillars have been recognized as one of the main drawbacks to adopt agroforestry in Europe by farmers. Eligibility was always proposed by the EU and it was a key aspect in the previous and current CAP and usually penalizes those areas where woody perennials (trees

or shrubs) were present. The forthcoming CAP aims at providing Member States with more responsibility on the way that CAP is implemented including eligibility, but makes compulsory to provide results which will be linked to results-based payments. CAP Strategic Plans are currently being developed. This paper shows the role that agroforestry may play in those strategic plans.

Keywords: Extension, CAP, eligibility

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Theme: Production Science

Title: Characterization of the anti-tumor taccalonolides isolated from black bat flower (*Tacca chantrieri*) in Indonesia

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Taccalonolide is identified as a novel microtubule stabilizing agents (MSAs) that has an ability to inhibit cell proliferation during the mitotic stage of cell cycle suitable for cancer treatment, however the exact mechanism of action hasn't been well described. Taccalonolide is often extracted from the rhizome of plants from genus *Tacca*, a native species in the tropical region such as SE Asia. The objectives of this research are to 1) identify all bioactive chemicals and the analogs of taccalonolides from *T. chantrieri* using metabolomic approach, 2) quantify the abundance of the chemical in different tissues, to evaluate the effect of stress condition (via treatment(s)) on the production of Taccalonolide, and 3) to identify the possible target through molecular genetic approach. We utilized liquid chromatography tandem mass spectrometer (LC-MS/MS) and XCMS platform to identify and quantify the bioactive compound with anti-tumor properties. As a preliminary experiment, parts of *Tacca chantrieri*, a black bat flower, from Indonesia and Australia were extracted and analyzed using ultra-performance liquid chromatography coupled with high-resolution mass spectrometer (UPLC-HRMS). Taccalonolide A, a major taccalonolide compound in the plant, is successfully detected in the leaves, stem, and rhizome of the plants. Based on the targeted analysis, the concentrations of Taccalonolide E are higher than that of taccalonolide A. Current efforts are to investigate the possible mode of actions using the molecular genetic approach. This research will hopefully improve the perceived value of this species as well as providing a more sustainable source of Taccalonolide.

Keywords: Microtubule stabilizing agents, LCMS-MS, and XCMS

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Theme: Advances in Technology Applications

Title: Switchgrass (*Panicum virgatum*) bioactive compounds profiling through untargeted and targeted analysis.

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Agroforestry system has a promising potential for producing biomass feedstock for bioenergy. Switchgrass (SW; *Panicum virgatum*) has been used in the US agroforestry systems for almost two decades. Nevertheless, there is no such research conducting on metabolomic profiling of the value-added chemicals from it. By identifying multiple high-value products, a biorefinery supply chain can maximize the value derived from the biomass feedstock. The objectives of this study are to 1) identify and characterize the valued bioactive phyosterols and phytophenolics in switchgrass using global metabolomics approach (XCMS), 2) compare the chemicals profiles between four varieties of switchgrass (Liberty, Alamo, Kanlow, and Showme), 3) quantify the bioactive compounds. The compounds extracted from four switchgrass cultivars were analyzed by ultra-high pressure liquid chromatography coupled with mass spectrometry (UPLC-MS). The ion chromatograms were submitted to XCMS platform operated by Center for Metabolomics at the Scripps Research Institute. The spectra were annotated and the compounds were identified and categorized by the integration of the METLIN, the world's largest metabolite database. Using this platform, we have found 137 putative compounds with various health-promoting bioactivities that have not been reported in switchgrass from the previous studies. Principal component analysis shows that the bioactive compounds profiles are significantly different among all four cultivars. Up to the latest, concentrations of seven compounds were successfully quantified by using high performance liquid chromatography coupled with tandem mass spectrometry (HPLC-MS/MS). We anticipate that our findings will increase the overall revenues of the chain production and benefit all the participants involved in the supply chain of cellulosic biorefinery industry.

Keywords: switchgrass, metabolomic, and profiling

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Theme: Specialty Forest Products

Title: Nontimber Forest Products in the United States

Marla R. Emery, USDA Forest Service
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James L. Chamberlain, USDA Forest Service

Nontimber forest products (NTFPs) are fundamental to the functioning of healthy forests and play vital roles in the cultures and economies of the people of the United States, including in agroforestry systems. This poster provides results from the Assessment of Nontimber Forest Products in the United States Under Changing Conditions.

Keywords: specialty forest products, nontimber forest products, farm income, tribes

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Theme: Production Science

Title: Forage and Heifer Responses to Silvopasture Management

John Fike, Virginia Tech

Silvopasture management involves intentional integration of trees, forages, and livestock with goals of greater productivity and improved environmental quality. In the South, providing shade may be an important motivator for implementing silvopasture systems given the large losses in livestock production associated with heat stress. The objectives of this study were to determine the effects of trees on forage availability and nutritive value and to compare cattle gains and body temperatures in silvopastures and open pastures. Angus beef heifers were grazed in open pastures and performance compared with heifers grazing in thinned oak and thinned pine-based silvopastures during 2017 and 2018. Compared to the open pastures, forage availability was lower in the pine silvopastures in 2017 and lower in the hardwood silvopastures in 2018. Forage TDN was greater in the newly planted silvopastures in 2017, but pastures had similar nutritive value in 2018. Heifer ADG were lower in the open pastures during June 2017. Lower weight gains of heifers in pine and hardwood silvopastures later in the summer of 2018 may reflect lower forage availability in some silvopastures or the compensatory gain of heifers in the open pastures. Heifers in the silvopastures had lower afternoon core and external temperatures compared to heifers in the open pastures. Silvopasture systems can reduce animal heat stress during summer months while improving land productivity.

Keywords: Nutritive value, Heat stress, and Average daily gain

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Theme: Environmental Benefits

Title: Nutritional Input From Nitrogen Fixing Tree Species To A Coffee Agroforestry System

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Coffee in Mexico is produced under the shade of many trees, including some nitrogen fixing species, in agroforestry systems. However, there are no studies focused on quantifying this nutrient input in coffee crops or on the optimal conditions for bacterial nodule growth. In other countries, it has been observed that biological nitrogen fixation depends on physical elements, such as shade, spacing and tree age; and chemical elements, such as the availability of necessary nutrients for bacteria, pH, and so on. This study was carried out in the municipality of Huatusco, Veracruz, and the objective was to quantify the nutritional input from *Inga vera*, *Erythrina poeppigiana* and *Erythrina* sp. coffee agroforestry systems through foliar and soil analyses, as well as through electron scanning microscopy to observe nodular activity. After doing these analyses, the results were contrasted with the *Juglans pyriformis* agroforestry system to recognize the nutritional input in the observed coffee crops and propose optimal nutritional management through the right use of fertilization to assure the proper functioning of bacterium nodules and thus achieve maximum yields.

The collection of leaves, soil and nodules was carried out and analyzed in laboratories to determine the nutritional status of the crop, as well as the active presence of bacterium. In *Erythrina* sp. nodules, bacteria were easily found. In *Erythrina poeppigiana* few nodules were found. In *Inga vera* nodules, bacterium were smaller than the ones found in *Erythrina* sp. nodules.

Keywords: nodules, biological nitrogen fixation, nutritional management, and maximum yields

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Theme: Environmental Benefits

Title: Bird diversity in two Agroforestry systems and a Mountain Cloud Tropical Forest

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The conservation of biodiversity and agricultural production must involve a balance with sustainable bases, with agroforestry systems being an option to this need. Therefore, with the objective of evaluating the diversity of birds in two agroforestry systems and a natural forest (traditional coffee system (CT), silvopastoral system (SSP) and Mountain Cloud Tropical Forest (MCTF)) located in the municipality of Huatusco, Veracruz, Mexico. A systematic sampling from 16 chosen units was applied in an area of 52 hectares. Bird tracking was carried out from August 2018 to January 2019 using Counting in points with fixed radius and intensive search. A total of 122 individuals distributed in 10 orders were registered; 19 families; 42 genera and 52 species. Of the total number of species found, 21 were exclusive of CT, 11 of the SSP and 5 of MCTF. The most representative species were *Melanerpes aurifrons* (7.37%) and *Cardellina pusilla* (6.55%). The wealth index was 52.22, although the average values were 33.02, 24.19 and 9.88 for the TC, SSP and MCTF respectively. The diversity recorded was H' : 19.9, however the CT presented (H' = 2.91); SSP (H' = 2.65); and MCTF (H' = 1.59). The Jaccard-index shows a similarity of 19.84% for TC, 5.74%, SSP and 3.33% MCTF. This study demonstrates that agroforestry systems are an option that favors the conservation of biodiversity by providing niches of opportunity to species that use different production systems as part of their habitat.

Keywords: ecological niche, endemic, protection-special, Kruskal-Wallis

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Theme: Advances in Technology Applications

Title: Identifying Antibacterial Compounds in Black Walnuts (*Juglans nigra*) Using A Metabolomics Approach

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Black walnut (*Juglans nigra* L.) is one of the most economically valuable hardwood species and a high value tree for edible nut production in the United States. Although consumption of black walnut has been linked to multiple health-promoting effects (e.g., antioxidant, antimicrobial, anti-inflammatory), the bioactive compounds have not been systematically characterized. In addition, the associations between different black walnut cultivars and their health-promoting compounds have not been well established. In this study, the kernels of twenty-two black walnut cultivars selected for nut production

by University of Missouri Center of Agroforestry (Columbia, Missouri) were evaluated for their antibacterial activities using agar-well diffusion assay. Among the selected cultivars, four black walnut cultivars (i.e., Mystry, Surprise, D.34, and A.36) exhibited antibacterial activity against a gram-positive bacterium (*Staphylococcus aureus*) whereas other cultivars showed no effect on the inhibition of this bacterium. The antibacterial compounds showing the strongest activity were isolated with bioassay-guided purification and identified using a metabolomics approach. Six antibacterial bioactive compounds responsible for antimicrobial activity were successfully identified. Glansreginin A, azelaic acid, quercetin, and eriodictyol-7-O-glucoside are novel antibacterial compounds identified in the kernels of black walnuts. The metabolomics approach provides a simple and cost-effective tool for bioactive compound identification.

Keywords: black walnut, *Juglans nigra*, antibacterial, metabolomics approach, and bioactive compound identification

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Theme: Environmental Benefits

Title: A *Bacillus Thuringiensis* Spore Expression System for Bioremediation

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Owing to human activities, a large number of organic chemicals including petroleum products, industrial solvents, pesticides, herbicides, and pharmaceuticals contaminate soil and aquatic environments. Remediation of these pollutants by conventional approaches is both technically and economically challenging. *Bacillus* endospores are highly resistant to most physical assaults and are capable of long-term persistence in soil. Spores can be engineered to express on their surface important enzymes for bioremediation purposes. We have developed a *Bacillus thuringiensis* spore platform system that can display a high density of proteins on the spore surface. The spore surface-tethered enzymes exhibit enhanced activity and stability relative to free enzymes in soil and water environments. A number of active enzymes have been expressed using this system, such as a cysteine protease, staphopain A in the absence of its inhibitory partner staphostatin, and a nuclease from *Staphylococcus aureus*. In this study, we fused an enzyme, AtzA, important for the degradation of the herbicide Atrazine, to the surface of *Bacillus* endospores. Spores expressing AtzA were assayed for atrazine detoxification in liquid and soil environments using HPLC quantification. We successfully demonstrated the capacity of this spore-based enzyme display system to detoxify atrazine in soil. The kinetics of the the AtzA catalyzed reaction and the enzymatic stability of the spore decorated AtzA were determined.

Keywords: BACILLUS THURINGIENSIS SPORE EXPRESSION SYSTEM, Atrazine, AtzA, and Bioremediation

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Theme: Education, Outreach, and Community Engagement

Title: Agroforestry Inventory: Translating Research to Landowners

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Inventory of agroforestry practices on the landscape over large areas and in a readily available format is currently lacking. Windbreaks and riparian forest buffers serve a variety of functions on the landscape particularly in agricultural areas of the central US. Many of these trees were planted under the auspices of the Prairie States Forestry Program of the 1930's and 1940's. Some evidence indicates widespread removal of these trees, yet no coordinated, widespread effort is currently being done to inventory and monitor these trees. The USDA Forest Inventory and Analysis program and USDA National Agroforestry Center have formed a targeted task team working closely with partners and state forestry agencies and universities in this region to lead the effort of accounting for these important ecological resources. Using high-resolution imagery and advanced computer-learning algorithms, the team has created a GIS dataset of windbreaks that are being used for targeted conservation efforts. This dataset can then be combined with other data such as windbreak conditions and landowner information. Tools for Engaging Landowners Effectively (TELE) implementation using these methods can help convince landowners the benefits of windbreaks and direct them to financial assistance when available.

Keywords: windbreaks, inventory, and GIS

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Theme: Adoption, Implementation, and Evaluation

Title: Community Participation Towards Silvopastoral Restoration

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The successful establishment and management of silvopastoral systems has the potential to provide multiple ecosystem services and outputs for rural communities. For these systems to be sustainable, the participation of both men and women should be ensured to harness innovative capacities and create long-term mitigation effects of climate change and human population increases. Given that men and women often perceive and value shrub and tree-related resources differently, the aim of this pilot project initiated in December 2017 was to involve the local community, particularly women and the youth, on agroforestry practices in central Tunisia. This project targeted community household involvement through distributing seedlings, based on the number of livestock owned by each household farmer and their willingness to irrigate and protect seedlings from herbivory. A total of 3200 spineless cactus cladodes and 800 seedlings of carob tree, tree medic and old man saltbush were distributed to farmer households for transplanting on community rangelands in March 2018. A follow-up monitoring to estimate survival rate after 10 months revealed that establishment rates of the transplanted seedlings varied from 73% (carob tree), 91% (tree medic) and 96% (old man saltbush) to 100% (cactus). These results indicated a high survival rate of transplanted seedlings and the strong community participation in protecting and irrigating seedlings. However, since relatively more men than women

participated in these activities, more emphasis is needed to stimulate, promote the visibility and value of women's labor for effective adoption, given the increased labor intensity that silvopastoral system implementation requires.

Keywords: local community, ecosystem services, shrubs, carob tree, Central Tunisia, survival rate, gender, climate change.

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Theme: Environmental Benefits

Title: Nutrition for rapid growth of mahogany plants (*Swietenia macrophylla* King)

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Currently there is overexploitation of mahogany (*Swietenia macrophylla*). In the field, this has compromised the stability of ecosystems and limited their development. The production of quality plants in the shortest possible time during nursery growth becomes a challenge for the sustainable management of this species. In this research, a nutritional management proposal to promote the rapid development of mahogany breezes through fertilization treatments and CO₂ supply is presented. In mahogany birzales grown in 5L pots, the following was evaluated: balanced mineral nutrition; addition of compound (20 g kg⁻¹); inoculation with mycorrhizal multisypa (5 g kg⁻¹); and injections of CO₂ (1000 μmoles mol⁻¹, flow of 5 to 7 L, applying one hour, twice a week for two months). The complete factorial design generated 16 treatments. The evaluated variables were: height, total biomass, and photosynthetic rate. Structural changes of the stem in histological sections were also observed. The mineral nutrition associated with CO₂ supply significantly increased the height and total biomass. There was also a significant increase in diameter of vascular vessels and thickness of the last ring. CO₂ fertilization and their interactions with the rest of the studied factors favored the photosynthetic activity.

Keywords: growth and development, mineral nutrition, composting, mycorrhizae and CO₂.

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Theme: Environmental Benefits

Title: Contribution to the study of the agro forest entomology system of the *Lippia myriocephala* tree as a source of fuel and means of reproduction of the larva *Phassus triangularis*

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A contribution was made to the study of the tree *Lippia myriocephala*, host of the edible larva *Phassus triangularis* of crops associated-veneer-tumb of trees-chipping (milpa-roza-tumba-pica) agricultural system, in Ejido Patelná, Tumbalá, Chiapas. The contribution was conducted in vegetation sequences of 1.0, 2.5, 5.0 and 7.0 years. The two species (*Lippia myriocephala* tree and *Phassus triangularis*) can be used for the design of an agroentomoforestal system where fuel, protein for human consumption and basic grains can be obtained. All this in a small space; what can contribute to the reduction of deforestation and to the reactivation of wasted spaces. This study presents quantitative parameters of tree firewood quality, a proximal analysis of the properties of *Lippia myriocephala* as a food source for the larva, as well as the ecology of *Phassus triangularis*.

Keywords: quality of firewood, bromatological analysis, milpa-roza-tumba-pica

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Theme: Education, Outreach, and Community Engagement

Title: The Agroforestry Academy - Impacts on Adoption

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Michael Gold, University of Missouri

The Agroforestry Academy (AFA) at the University of Missouri Center for Agroforestry (UMCA) is a week-long temperate agroforestry training program that takes place in central Missouri each July. Initially funded by SARE as a “train-the-trainer” curriculum for natural resource professionals in 2013, the AFA now serves farmer/landowners and educators alike. Through classroom lectures, field trips, and a case study design project, participants learn the five core practices of temperate agroforestry in addition to financial and regulatory considerations. Six years, out, the Academy has 150 graduates. This research represents the first follow-up effort with AFA participants, with the purpose of developing a more thorough understanding of how the AFA influences the ability of participants to adopt agroforestry practices in their own professional contexts, as well as how UMCA might better support participant agroforestry adoption going forward. This project involves both an initial interview phase, as well as subsequent participatory survey development and implementation. Preliminary analysis of interview data demonstrates that the AFA is embedded in a larger “path” of continuous learning that participants navigate as they incrementally incorporate agroforestry practices into their lives. Preliminary analysis also indicates the importance of hands-on learning and guided practice opportunities; the potential (and challenges) of attuning to the unique personal interests and contexts of each participant; and the significant and dynamic role that social factors play leading up to, during, and following participation in the Academy.

Keywords: agroforestry outreach, agroforestry education, long-term evaluation, temperate agroforestry, and survey

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Theme: Specialty Forest Products

Title: Cooperative Marketing of Special Forest Products in Oregon

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The Oregon Woodland Cooperative (OWC) is a producer co-op representing about 75 family forest landowners in Oregon. Originally founded (1980) to help members realize more value from small-scale

timber harvests, the Co-op is now focused on helping members market non-timber products from their forests. Its principal business at present is marketing bundled firewood, harvested and processed by members, to grocery stores in the Portland area. During the winter holidays, the Co-op markets conifer boughs from member forests to local florists. Co-op members also produce and sell essential oils distilled from native conifers, and craft items made from their own wood, through two closely-affiliated companies. With an established brand and a large customer base, OWC helps members realize more return than they would selling as individuals. To maintain consistent quality and retain customer loyalty, members follow detailed product protocols developed by OWC. The Co-op retains a relatively small percentage of gross sales, passing most of the revenue along to producing members. OWC acts as a distributor for equipment designed for firewood processing and forest management, and offers them to members at a substantial discount. Through meetings, work days and field demonstrations, Co-op members share their knowledge on non-timber products as an integral part of sustainable forest management.

Keywords: Firewood, essential oils, conifer greens, crafts, and non-timber products

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Theme: Climate Change Opportunities and Challenges

Title: Silvoarable practices as a mechanism to enhance climate adaptation

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Adaptation to climate change is becoming more and more relevant in the recent years due to the changing environment that the European Union is facing, but also due to the higher frequency of extreme events than before. Mediterranean countries placed in the South of Europe are the member states that will be more prone to suffer environment changes within Europe. One of those problems, is the appearance of frequent extreme events like extreme heats or floodings. The combination of crops with woody perennials is a good strategy to reduce both events, but adequate crop varieties should be selected to allow optimal growth during the shading period. This study aims at evaluating the effect of artificial shading in greenhouse experiments developed to grow several varieties of wheat, maize, oat and triticale. Several varieties of each crop were tested following a randomized block design with three replicates under 0, 30 and 50% of shading effects. It was found that there is enough genetic variability

for crops to grow in different shade conditions. The results were used to test 3 varieties of each crop under Castanea and Walnut tree silvoarable species which ends in recommendations of varieties for farmers to have more resilient farms.

Keywords: cereals, resilience, shade

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Theme: Climate Change Opportunities and Challenges

Title: Carbon sequestration potentials of diverse riparian buffer systems in Southern Ontario

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Riparian buffer systems (RBS), in addition to reducing non-point source pollution from agriculture, are being promoted as a land-use capable of sequestering CO₂ into stable carbon (C) pools (tree biomass and soil organic carbon (SOC)). The objectives of this study therefore were to quantify (a) carbon stocks in above- and belowground biomass, (b) SOC sequestration, and (c) system level C pools, in diverse RBS types (Planted rehabilitated buffer <50 years old [RA], Natural forest buffer >50 years old [NF], grass buffer [GB], and adjacent agricultural fields [AG] as controls). Biomass C pools were greatest in NF (52.8 ± 0.85 Mg C ha⁻¹), followed by RA (25.6 ± 0.64 Mg C ha⁻¹), and lowest in GB (3.4 ± 0.17 Mg C ha⁻¹). Mean SOC stocks (0-60 cm) were highest in the in RA (232.3 ± 13.1 Mg ha⁻¹), which was significantly higher (p<0.05) than AG (149.5 ± 11.0 Mg ha⁻¹), but not statistically different than NF (201.3 ± 21.3 Mg ha⁻¹) and GB (218.2 ± 11.3 Mg ha⁻¹). At a system level (biomass + SOC), the RA recorded the highest C stocks (257.9 ± 13.74 Mg C ha⁻¹) followed by NF (254.1 ± 22.2 Mg C ha⁻¹), GB (221.6 ± 12.2 Mg C ha⁻¹), and AG (149.5 ± 11.0 Mg C ha⁻¹). Results from the study suggest that tree-based buffer types have higher potential for atmospheric CO₂ capture in biomass and at the system level than grass-based buffers, which tend to have higher sequestration potential over conventional agriculture fields.

Keywords: Agroforestry, climate change mitigation, riparian buffer systems, soil organic carbon

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Theme: Environmental Benefits

Title: Resolving conflict between oak conservation and organic hazelnut production

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Alejandro Brambila, University of Oregon

Lauren Hallett, University of Oregon

Taylor Larson, My Brothers Farm

Betsey Miller, Oregon State University

Filbertworm (*Cydia laiferreana*) is a polyphagous moth that burrows into acorns of Oregon white oak (*Quercus garryana*) and hazelnuts (*Corylus* spp.). Filbertworm source populations in remnant oak habitat can lead to cyclical infestation in neighboring hazelnut stands. This makes these remaining oak stands, which are mostly on private agricultural land, a potential liability to hazelnut production in Oregon – which accounts for over 90 percent of the US production. Oregon white oak habitat is one of the most

reduced habitats in Oregon and is of conservational concern. We're testing a novel way to mitigate hazelnut filbertworm infestation through pig grazing in oak woodland and organic hazelnut understories. Removal of infested nuts interrupts the developmental stage in the filbertworm life cycle. We hypothesize that controlled grazing will reduce filbertworm populations, nut infestation rates, and herbaceous cover. During Spring and Summer of 2018 we conducted baseline filbertworm inventories via pheromone-lured sticky traps in the canopy and ground-based emergence traps in oak woodland and organic hazelnut orchard on My Brothers Farm in Creswell, Oregon. Grazed and ungrazed plots were established in the woodland and orchard. Domestic pigs (*Sus domesticus*) were rotated through two-acre pastures in late September/early October with four to five days in each. Understory vegetation was sampled along transects in each plot and acorn density/infestation rates were inventoried before and after treatment. Preliminary results display a reduction of infested acorns in the oak woodland and no effect on understory vegetation. Ongoing filbertworm, acorn, and vegetation monitoring will continue through Fall of 2019.

Keywords: Filbertworm, Silvopasture, and pigs

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Theme: Production Science

Title: Performance of Katahdin Rams in Southern-pine Silvopasture and Woodland Grazing Systems

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Sheep are natural grazers, usually preferring forbs and succulent grasses and can also adapt to eating branches and twigs. Their ability to utilize diversified vegetation makes them a potential candidate to integrate into the silvopasture and woodland grazing systems. However, the performance of sheep in silvopastures or woodland grazing system has not been well studied. This study aimed to determine the performance of Katahdin rams in southern-pine silvopastures and woodland grazing systems. The study site consisted of three 0.4-ha longleaf (*Pinus palustris* Mill.)-loblolly (*Pinus taeda* L.) mixed-pine silvopasture plots and three 0.4-ha southern pine-hardwood mixed woodlands. Silvopasture plots were planted with different cool-season forages and woodlands consisted of 28 different plant species. Six Katahdin rams were rotationally stocked in each grazing system for 10 weeks. Live weight, FAMACHA score, and body condition score (BCS) were monitored fortnightly. Average daily gain (ADG) was calculated from the live weight data. Animals had overall ADG of 0.22 ± 0.034 kg while stocked in silvopastures and ADG of -0.1 ± 0.04 kg while stocked in woodlands. Their initial and final BCS was 3.3 ± 0.24 and 3.5 ± 0.18 for silvopasture and 4.0 ± 0.00 and 3.7 ± 0.11 for woodlands, respectively. Their overall FAMACHA score was 1.5 ± 0.09 for silvopastures and 1.4 ± 0.09 for woodlands. FAMACHA score was negatively correlated with live weight ($r = -0.74$ for silvopasture; $r = -0.58$ for woodland) and BCS ($r = -0.73$ for silvopastures; $r = -0.38$ for woodlands). Development of silvopasture with cool-season forages can extend the grazing opportunity for sheep, ultimately improving their performance. However, feed supplementation may be required to improve their performance in woodlands.

Keywords: Average daily gain, Body condition score, FAMACHA, Longleaf pine, and Loblolly pine

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Theme: Production Science**Title: Agroforestry Alley Cropping with Specialty Crops among Loblolly Pine and Pecan Stands.**

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Combining agricultural crops with tree production in Agroforestry system ensures effective land utilization and sustainability of natural resources. An agroforestry alley cropping study was conducted in North Alabama with the objective of determining soil physical properties and potential yields of specialty crops two *Solanum* varieties, two *Capsicum* varieties and two leafy vegetables *Ocimum basilicum* and *Hibiscus sabdariffa* among newly established stands of *Pinus taeda* (timber) and *Carya illinoensis* (pecan). Six-week-old greenhouse grown plants were transplanted on to raised beds covered with plastic with a drip tape underneath. Changes in soil physical properties and crop yields were determined in both pine and pecan stands. The differences in fruit yield between pine and pecan stands weren't significant. The seasonal total fresh fruit weights of 'Bartha' eggplant (100.9 Kg in Pine and 137.7 kg in Pecan) were higher than that of Chinese eggplants (47.6 kg in Pine and 41.5 kg in Pecan). Similarly, the 'Sweet' peppers (15 and 10.1 kg in Pine and Pecan) were higher than those of Ancho (7.3kg and 7.7 kg in Pine and Pecan). Mean fresh fruit weight plant⁻¹ of Bartha was approximately 25% and 23% higher than the Chinese eggplants in Pine and Pecan stands, respectively. Leafy vegetables, basil and sorrel, produced 2.7 kg in Pine and 3.04 kg in Pecan stands; and 7.45 kg in Pine and 7.26 kg in Pecan stands, respectively over the season. The study showed that specialty vegetable crops planted in early June offer potential for continuous cash flow beginning July through November..

Keywords: Environment, soil, sustainable, agro-forestry systems

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Theme: Adoption, Implementation, and Evaluation**Title: The governance of agroforestry in the United States: Virginia and Missouri**

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This study looked at the governance of agroforestry in Virginia and Missouri in the United States. It sought to identify which institutions and systems are in place to support agroforestry, what are the key motivating and limiting factors for agroforestry implementation, whether the objectives laid out in the USDA Agroforestry Strategic Framework have been met, what new modes of governance are present in the agroforestry context in the U.S., and whether there is variability between the states with respect to promotional and/or inhibiting factors of implementation. The study employed a qualitative analysis of semi-structured interviews conducted with relevant stakeholders in both states, as well as stakeholders in the federal government. The analysis used both a grounded theory approach to identify

emerging concepts and themes, as well as an inductive approach, where predefined themes of governance were identified.

Results suggest a crucial role for state agencies in the successful implementation and advancement of agroforestry. Financial and environmental benefits appear to be the most important motivating factors for implementing agroforestry systems across stakeholder groups. Challenges to successful implementation include the complexities of changing a farming system, lack of resources and information, and limited mechanisms for effective short-term planning. Interviewees often expressed need for increased funding for research and demonstration sites and suggested that consumers can and should play an important role in shaping farmers and landowners' decisions to implement agroforestry systems. Implications for next step development programs are considered.

Keywords: implementation, NRCS, limitations, and grounded theory

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Theme: Education, Outreach, and Community Engagement

Title: Community Territorial Planning with an Agroforestry Approach in Xaltepuxtla, Puebla, Mexico

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Xaltepuxtla is a marginalized community located in the Sierra Norte de Puebla. Part of its territory belongs to the Natural Resources Protection Area of the Necaxa River Hydrographic Basin. It has remnants of the Mountain Cloud Tropical Forest, affected by deforestation that has impacted the levels of capture of the storage vessels of the region. The main economic activity of the population is the cultivation of ornamental plants, characterized by the extraction of plants by root ball and sale of foliage with negative repercussions in the ecosystem. Since 2012, researchers have restored links with the community. This process has contributed to resolving conflicts, achieving restoration and implementation of agroforestry technologies. The producers have requested projects for productive diversification and alternative systems to improve the income of the farmers and the productivity capacity of the systems. In addition, conserve and take advantage of natural resources in a sustainable way. Responding to this need a Community Territorial Planning was made including participatory workshops that consider the history of the community, maps of the properties, available natural resources, also analysis of the problems and possible solutions, field trips, semi-structured interviews and an analysis of Strengths, Opportunities, Weaknesses and Threats (SWOT), all this things allow us to identified some trigger projects as: establishment of Management Units for the Conservation of Wildlife, specifically of tree ferns and orchids; aquaculture production; improvement of ornamental nurseries and the production of *Pleurotus ostreatus* and *Entoloma abortivum* edible mushrooms. Such projects achieve conservation and sustainable use of the socio-ecosystem.

Keywords: bioproductive-systems, landscape, degradation, potential

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Theme: Advances in Technology Applications

Title: Quantification of Bioactive Phytochemicals in Spent Coffee Grounds by Liquid Chromatography Tandem-mass Spectrometry (LC-MS/MS)

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Nowadays, coffee is one of the most popular beverages in the world and have the important role in the modern life. The solid residue created is spent coffee ground (SCG). Every day, there are about 4,000 tons of coffee consumed in the United States and more than 6,000,000 tons of SCG are generated worldwide. Whereas SCG has little commercial value and has been treated as solid waste, the chemical profiles from our previous metabolomics analysis suggested that SCG is a rich source of bioactive compounds that have shown beneficial effects on human health and can be reused as animal feed, biofuel, biodiesel, or bioethanol production, adsorbent and activated carbon. So far, more than 150 potential compounds have been identified by using XCMS metabolomics platform. The objectives of this study are to: 1) compare the chemical profiles between the three coffee cultivars (Ethiopia coffee (Yirgacheffe), Costa Rican coffee (Tarrazu), and Hawaiian coffee (Kona Blend), 2) quantify and characterize the most promising bioactive compounds in SCG using high performance liquid chromatography coupled with tandem mass spectrometry (HPLC-MS/MS), and 3) explore potential new applications in cosmetic, personal care products and pharmaceutical industries. We have succeeded develop the methods to quantify more than 28 compounds in SCG. We expect that the low cost SCG can be become a new resource materials in the future for nutritional supplements, pharmaceutical, and cosmetics applications.

Keywords: Spent coffee grounds and LC-MS/MS

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Theme: Production Science

Title: Bioenergy Production and Soil Health Potentials of Eastern Red Cedar Windbreaks in the U.S. Great Plains

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Eastern red cedar (*Juniperus virginiana*) is native to much of the U.S. and offers protection and food for wildlife. However, because it is an aggressive species, eastern red cedar, if not controlled, can take over open areas and pasture changing the intended use of the land. Red cedars are often used in conservation plantings such as windbreaks, however, its use for bioenergy and its potential to improve soil health has not been assessed. Targeting marginal lands for woody bioenergy production avoids some of the competition for food production and may improve soil health, and provide other ecosystem services.