Agroforestry: Focus Areas, Key Challenges & Research Priorities

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Outline:

- NAC In-Brief: who we are & how we work
- Challenges facing us on agricultural lands
- Agroforestry: a part of the Climate-Smart toolbox
- Research challenges and priorities in agroforestry
U.S. Temperate Agroforestry is gaining momentum:

- USDA Interagency Agroforestry Team formed
- USDA Agroforestry Strategic Framework (2011-2016)
- Agroforestry Executive Steering Committee (8 USDA agencies) to guide Framework implementation
U.S. Temperate Agroforestry is gaining momentum:

Strategic Goal 1 - Adoption: increase use of agroforestry

Strategic Goal 2 - Science: advance understanding of and tools for applying agroforestry

Strategic Goal 3 - Integration: incorporate agroforestry into an all-lands approach to conservation & economic development
U.S. Temperate Agroforestry is gaining momentum:

Objective 2.1 – PLAN: Identify, assess, and prioritize interagency agroforestry science and technology needs, opportunities, and investments.
Agroforestry & Climate Change: Reducing Threats and Enhancing Resiliency in Agricultural Landscapes (May 2014, Nebraska City, NE)

- **Purpose**: to produce a USDA technical report on the potential of agroforestry to serve as a mngt option for both GHG mitigation & climate change adaptation tool. → to feed into the 2017 National Climate Assessment

- **Focus**: on many areas in agroforestry where the scientific research is growing and benefits can be seen; as well as on the major gaps that impede our understanding and application, and therefore, what are those major research priorities.
USDA National Agroforestry Center (NAC)

- Authorized in the 1990 Farm Bill, initiated 1992, & located in Lincoln, Nebraska
- A long-standing partnership between Forest Service R&D and S&PF, and, since 1995, the Natural Resources Conservation Service
- NAC works to increase agroforestry science, assistance and application by working through and relying on a *national network of partners* . . . .
- Leveraging resources needed to conduct priority research, develop technologies and tools, and provide education & training as guided by the *USDA Agroforestry Strategic Framework*. 
USDA National Agroforestry Center (NAC)

- NAC’s customers are the resource professionals who work with farmers, ranchers, woodland owners, Tribes, and communities.

- Purposely small but purposely efficient.

- Currently staffed by FS personnel: a FT Director (WO – June 30, 2014) and a staff of 10 that includes both research (2.75 SY) and technology transfer program staff.
From agricultural lands:
We want it all.
To provide for a growing population: We will want more of it all.
Realizing Agriculture’s Potential under Climate Change?

- Temperature Change
- Sea Level Rise
- Precipitation Change
- Carbon Dioxide
- Extreme/Erratic Weather Events

CLIMATE CHANGE
• Current erratic & extreme weather events
hot, dry Midwest weather threatens to erode crop yields in the U.S. Temperatures will average as much as 14 degrees Fahrenheit above normal during the next 10 days, with little rain expected in the Midwest.
In April, devastatingly dry, dusty, windy conditions on the southern Great Plains fueled concerns of a “New Dust Bowl.”

The “Terrible Teens” drought, which for many parts of the southern Great Plains began in the fall of 2010 and has lasted for more than 3½ years,

Continued to take a severe toll on rangeland, pastures, and winter wheat.
Climate disruptions to agricultural production have increased in the recent past and are projected to increase further over the next 25 years — with increasingly negative impacts on most crops and livestock.
Kansas 2013…..
DRY CONDITIONS + desiccating winds
Eastern Colorado April, 2014

DRY CONDITIONS + 20-50+mph winds
Rolling a Bad Combination

2012 – Worst Drought Since 1936

2013 Wettest Spring On Record In Iowa
May 2013

- Avg. field erosion of more than 5 tons/ac
- In 15 of those townships, avg. erosion of 7.5-to-13 tons/ac

May 25-29, 2013

Soil Erosion

IMPACTS

- Current productivity
- Longer-term productivity

Avg. field erosion of more than 5 tons/ac
In 15 of those townships, avg. erosion of 7.5-to-13 tons/ac
IMPACTS

→ Current productivity

→ Longer-term productivity
2012-2013 BAD COMBINATION

IMPACTS

→ Current productivity

→ Longer-term productivity

→ LOCAL to REGIONAL level degradation of water quality (i.e., Gulf Hypoxic Zone)
Current loss and degradation of critical agricultural soil and water assets by increasing extremes in precipitation will continue to challenge agriculture...unless innovative conservation methods are implemented.
Many Actions for Building Climate-Ready Agriculture

- Conservation tillage
- Crop rotations
- Crop species
- Irrigation management
- Fertilization (type, timing, placement)
- Grazing (species, rotations)
- Cover crops
- Perennial crops
- Eliminate fallow
- Converting (i.e., cropland to pasture)

Agroforestry: providing ReLeaf to Ag
Agroforestry is...

...the intentional combining of agricultural and forestry elements to create productive and sustainable farms, ranches, and woodlands.
Agroforestry isn’t...

... ....AFFORESTATION

It doesn’t displace agriculture ~
Rather it is a management activity to help support agriculture & ag lands.
Agroforestry is...

- a suite of productive conservation practices that can help provide profits & other benefits at the **farm-scale**
- a means to address environmental issues at the **landscape/watershed-scale**
Risk management difficult in monocultures and annual-only systems.

Mixing in woody plants offers:
- Crop/income diversification
- Structural and functional diversity
- Linking lands & people
Agroforestry: Working Trees

Alley Cropping | Silvopasture | Forest Farming
Riparian Forest Buffers | Windbreaks | Special Applications

...the right trees in the right places for the right jobs.

http://nac.unl.edu
Agroforestry: One Strategy, Many Benefits

- Diversity of income
- Crop protection & enhancement
- Livestock protection
- Pollinator services
- Biological pest control
- Protection of soil resources
- Water & air quality
- Wildlife habitat
- Recreational opportunities
- Aesthetics

.....and more.

.....the right trees in the right places for the right jobs.

http://nac.unl.edu
Agroforestry: A ‘Leatherman’ w/in the ‘CC-Integrated’ Toolbox for Agriculture

Mitigation
- Sequestering carbon (C)
- Reducing GHG emissions

Adaptation
- Reducing threats & enhancing resilience
- Facilitating species migration

….While providing other services

Microclimate modification: crops

- Yield increases due to wind protection (Kort 1988)
  (average of 15% in winter wheat, 25% in soybeans, 12% in corn)

- Higher grain yields in alley-grown wheat during drought compared to the control. (Rivest et al. 2013)
Livestock shelterbelts increased feed efficiency 13-50% in winter and milk production by 9-76%. (Hintz 1983)

Cattle provided with shade reached their target body weight 20 days earlier than those without shade. (Mitolöhner et al. 2001)
Habitat diversification: Connectivity

Critical travel corridors in the highly fragmented ag/urban landscape.
Habitat diversification

- Agroforestry plantings provide critical habitat to native pollinators, and
- Natural enemies to crop pests.
Protection of soil resources by reducing wind velocity. 
*(Tibke 1988)*

- 2°C increase in annual temp. (CC-predicted level) could increase wind erosion by 15-18%. 
  *(Lee et al. 1996)*
Protecting water quality through interception of ‘excess’ N.

Ratio of erosion increase to annual rainfall increase is on the order of 1.7. (Nearing et al. 2004)
Diversified production opportunities

Reducing risk & building resiliency by providing both annual and longer-term (but higher value) income opportunities.

Alley Cropping

Silvopasture
High Potential for Silvopasture in southeastern USA
Alley Cropping/Silvopasture Systems

- Not prime ‘Corn/Soybean’ land
- Already experiencing erratic & extreme events
**Alley-Silvopasture System Study: NC**

<table>
<thead>
<tr>
<th>Year</th>
<th>Crop</th>
<th>Condition</th>
<th>Net Returns ($/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>Soybeans</td>
<td><strong>DROUGHT</strong></td>
<td>-107</td>
</tr>
<tr>
<td>2008</td>
<td>Corn</td>
<td><strong>DROUGHT THEN FLOOD</strong></td>
<td>-120</td>
</tr>
<tr>
<td>2009</td>
<td>Soybeans</td>
<td><strong>DROUGHT</strong></td>
<td>-113</td>
</tr>
<tr>
<td>2010</td>
<td>Corn</td>
<td><strong>DROUGHT</strong></td>
<td>-324</td>
</tr>
</tbody>
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Yields based on field data; costs and prices on NCSU crop budgets


Tree Survival at 2011: 88+%
Silvopasture – Southeast
Mack Evans, M. A. Evans Enterprise, Georgia

2003 – Started with pine stands in need of thinning and cleanup:

- Fuel-load reduction
- Cow-calf operation in longleaf and loblolly silvopastures
- Growing longleaf pine for pulp and saw logs
- 2008 – Added contract pine straw operation
Microclimate Benefits - Livestock

- Improved feed intake
- Improved weight gain
- Improved milk production
- Improved animal condition
- Improved breeding efficiency

(Walters 2011)

Silvopastures could be key to help mitigate ‘thermal environmental challenges’ presented under climate change.
Agroforestry: Challenges & Research Needs

GOAL:
To move agroforestry into the mainstream as

1. A set of practices w/ viable markets & rural enterprises driving adoption, and

2. A system integrated at a landscape level with other sustainable land-use options.
Research Priorities

NAC Research & Development Program:

Conducts agroforestry research & development to determine:

- How they work
- Where to best place them
- How to best build them
- How to best translate into use

Over the range of geographic settings and land uses into which agroforestry can be placed.
Agroforestry: Challenges & Research Needs

Goal 1: Adoption
- Refine Efforts
- Information Delivery
- Assess

Goal 2: Science
- Theory & Tools
- Interactive Feedback & Development
- Field test or model test
- Assess

Problem Area: Understanding of agroforestry-related biophysical and socio-economic information

Problem Area: Effective delivery of agroforestry information to key customers/audiences

Illustration by Gary Bentrup, USFS-NAC
Agroforestry: Challenges & Science Delivery Needs

**Goal 2: Science**
- Theory & Tools
- Interactive Feedback & Development
- Field test or model test

**Goal 1: Adoption**
- Refine Efforts
- Information Delivery

**Problem Area: Understanding of agroforestry-related biophysical and socio-economic information**

**Problem Area: Effective delivery of agroforestry information to key customers/audiences**

Illustration by Gary Bentrup, USFS-NAC
Agroforestry: Challenges & Science Delivery Needs

1. Being able to communicate about agroforestry
Agroforestry: Challenges & Science Delivery Needs

- **Common platform** of knowing & communicating the role of agroforestry as a tool in ag-lands.

  *Meeting the ‘NOW’*

- **To inform** how our research can be used....*and* what research we need to be doing & HOW.
Meeting I&E needs
Tailoring the I&E

Wide Range of Stakeholders

Knowing what agroforestry information is needed.
Knowing what form that information needs to be in.
Agroforestry: Challenges & Science Delivery Needs

Meeting the ‘NOW’

Guidelines & Tools

Science

Synthesis

Communication

- Internally
- Externally
Diversity & Multifunctionality

To facilitate multifunctional/multi-use planning & design.

To facilitate the consideration of landowner &/or community issues in the buffer planning process.

http://nac.unl.edu
Agroforestry: Challenges & Science Delivery Needs

1. Being able to communicate about agroforestry
2. Being able to demonstrate the value of agroforestry
The Value of Agroforestry

- **Entity Level**: Need for enterprise budgets
- **Entity/Beyond Entity Level**: Need for getting a handle on the many services/impacts, and then being able to put a value on them (*includes on-site & offsite*)
- **Regional-to-National**: Need to be able to put a value on these contributions at the regional-to-national scale where policy/program decisions are made.

*Being able to assess agroforestry’s contributions – Both tree products and tree services!*
The Value of Agroforestry

- **Entity Level**: Economic information that incorporates the variety of geographic locations, practice designs, and management activities that can occur.
  - (Optimal Scale for Silvopasture in the US South – SRS & VSU)
  - (Enterprise Budgets for Agroforestry – MO Agroforestry Center)

- **Entity/Beyond Entity Level**: Valuation methods for assessing the economics of ecosystem services: Sequestered C, Water/Air/Soil Quality, Transportation Safety, Wildlife, Energy Conservation, Property Values.....

  Kulshreshtha & Kort (2009): “The external benefits to society can be worth as much as the private benefits to producers.”

- **Regional-to-National**: INVENTORY!!
  1. Know how much is out there - both going in & coming out!
  2. Inclusion in the National GHG Inventory......
Agroforestry: Challenges & Science Delivery Needs

1. Being able to communicate about agroforestry
2. Being able to demonstrate the value of agroforestry
3. Developing predictive capability
Lack of Agroforestry ‘Science’

Inclusion of agroforestry into US discussions & Decision-Support Tools has been LIMITED due to LACK OF THEORY / PREDICTIVE CAPABILITY REPEATED & REPEATABLE DATA!
Agroforestry: Research Need

1. Repeated & repeatable data
2. Statistically sound field studies
3. Standardized methods & protocols
4. Developing information/information over time & space in these long-lived, highly interactive systems

Indications of potential are there – but we are lacking data!
USDA Development of Technical Methods & Tools for Farm-Scale GHG Estimation

BENEFITS of COMMON PLATFORM for GHG ACCOUNTING in AGROFORESTRY

1. **Consistency:** The methods & estimates should be internally consistent w/ other years and, to extent possible, with other USDA inventory efforts.

2. **Comparability:** Estimates of emissions and sequestration reported by one entity be comparable to those reported by others.

3. **Accuracy:** Estimates should be accurate in that they are systematically neither over or under true emissions or removals as far as can be judged.

4. **Cost-Effectiveness:** Balance between the relative costs & benefits of additional efforts to improve the inventory or reduce uncertainty.

http://www.usda.gov/oce/climate_change/techguide
A COMMON FRAMEWORK for GHG Assessments in Agriculture - WHY?

“Enhances measurement & predictive capacity for estimating greenhouse gas emissions across a range of spatial and temporal scales.”

Agroforestry: Challenges & Science Delivery Needs

1. Being able to communicate about agroforestry
2. Being able to demonstrate the value of agroforestry
3. Developing predictive capability
4. How do you build/incentivize agroforestry for large-scale, landscape-level adoption?

*Agroforestry systems are more complex than monoculture systems ~ high spatial & temporal variability!* ‘Designer Landscape Features’
Application of Agroforestry on America’s farms, forest & ranches supports the Secretary’s priorities targeting landscape-scale conservation, climate change, clean & abundant water for communities, and sustainable agriculture by

1) providing jobs and increased wealth in rural communities;

2) supporting sustainable production of food, fiber, and bioenergy; and

3) ensuring cleaner water, climate-resilient landscapes, increased carbon storage, and improved wildlife habitat.
Rethinking the Tools: Waterbreaks

Flooding Services
- Protect levees from breaching
- Increase bank stability
- Increase sediment deposition
- Reduce gully creation
- Trap debris

Nonflood Services
- Increase wildlife habitat (food, shelter, travel)
- Enhance water quality
- Protect soil quality
- Provide alternative income (products & hunting leases)

Climate Change Services
- Protect ag. lands from degradation
- Reduce risk by diversification
- Sequester greenhouse gases
- Reduce greenhouse gas emissions
- Provide refugia for biodiversity
Targeting: Better matching land use & mngt to land capability & needs

BufferBuilder: to enhance WQ protection using the least land

Field 147 ac
Buffer 10 ac
Constant 35%

Field 147 ac
Filter 10 ac
Target 72%
Diversity & Multifunctionality

- Building in greater flexibility/resiliency to address future climate & economic shifts
- Connecting energy/food-fiber prod/nat. resource objectives across the landscape

<table>
<thead>
<tr>
<th>General landscape setting for an agroforestry practice</th>
<th>Potential services influenced by agroforestry</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-field operation</td>
<td>Mixed feedstock</td>
</tr>
<tr>
<td>Upland/edge-of-field location</td>
<td>✓</td>
</tr>
<tr>
<td>Riparian location</td>
<td>✓</td>
</tr>
<tr>
<td>Rural/urban interface location</td>
<td>✓</td>
</tr>
</tbody>
</table>
Using Agroforestry as an Integrated Forest Management Tool to Build Resilient Landscapes

Guiding Principles

- Diversity
- Multifunctionality
- Targeting
- A new Private Lands Paradigm
Agroforestry: Challenges & Science Delivery Needs

PRIORITY AREAS:

1. Developing clear, consistent communication
2. Developing an understanding of agroforestry’s customers and their needs
3. Developing locally, CC-adapted plant materials & arrangement
4. Developing information & tools to guide planning & design of practices to build resilient operations
5. Developing information to guide planning & design of systems to build resilient landscapes
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www.nac.unl.edu

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www.usda.gov/wps/portal/usda/usdahome?
navid=agroforestry

Thank You!