Agroforestry Extension for the PNW

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Goal: Discuss the status of sustainable agriculture in the PNW and the role that trees on the farm can play in sustainable agriculture, with particular emphasis on carbon storage.

1. Global Grant Challenges related to agriculture and forestry
2. A quick snapshot of PNW agriculture and the manifestation of these challenges
3. Targeted high-impact strategies for integrating trees into PNW ag systems
4. An angle for agroforestry integration not often considered …
Global Grand Challenges
Facing 21st Century Agriculture
Beyond the Boundary

Climate Friendly Farming™

Reduce GHG Emissions

Restore Soil Carbon

Replace Fossil Fuels w/ Biomass

CO₂  N₂O  CH₄  CO₂
What does our regional agriculture system look like?
Historical Carbon Loss from Agricultural Soils

Difference in total soil organic C between native and cultivated soils by soil type near Pullman, WA (0-20 cm).

Portions of these data were published by Purakayastha et al. 2008; Yorgey et al. 2010
Pendleton Long-Term Experiments

Long-term Soil Carbon Trends w/ Mitigation

The importance of perennial plants for soils
## Pushing the envelope of C Sequestration

<table>
<thead>
<tr>
<th>Cropping Method</th>
<th>Global Warming Potential (lbs CO2 equiv / acre / year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>1014.6</td>
</tr>
<tr>
<td>No-till</td>
<td>124.6</td>
</tr>
<tr>
<td>Organic</td>
<td>364.9</td>
</tr>
<tr>
<td>Early Successional</td>
<td>-1877.9</td>
</tr>
</tbody>
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Kellogg Biological Station (Michigan) LTER  [http://lter.kbs.msu.edu/]
Snow Fences, Wind Breaks: Reducing Wind and Water Erosion

Significant $$$ saved for snow removal
Trees for biocontrol habitat enhancement, an under-explored opportunity?
Forage trees as a climate change resiliency strategy for livestock production?
The down-side of integrating trees and agriculture: Someone will have to pay ...

Figure 1. Aerial photograph of the visually apparent tree-crop interaction for winter wheat crops growing adjacent to two rows of trees (each row with a different height) at the Columbia Basin Agricultural Research Center (CBARC) near Pendleton on June 12, 2003. The boxed diagram highlights an experimental area (55 x 240 ft.) composed of six replicates of 11 seed treatment variables growing in 5 x 40-ft. plots oriented in the east-west direction.
Bioenergy Development: Inter-cropping Switchgrass and Hybrid Poplar

Figure 3. Switchgrass inter-planting on June 9&12, 2011.

Figure 4. Drill rows through poplar harvest debris.

Figure 5. Drill rows through poplar harvest debris. Note N-immobilization.

August, 2011

GHG sampling began in July, 2011

Tree Monitoring & Growth

Estimated Global Economic Mitigation Potentials from Agriculture & Biofuels

- **Direct Agricultural Emissions**: 10-12% (Current Global GHG), 20-25% (Historical CO2)
- **Biophysical Mitigation Potential**: High estimate
- **Economic Mitigation Potential at a Given Price per t CO₂e**
  - $100: 5000 MMT CO₂e
  - $20: 1500 MMT CO₂e
- **Economic Mitigation Potential of Biofuels**: $20

*Smith et al. 2008, IPCC 2007*
A new cluster of specialty forest products?
Connecting trees and agriculture through soil amendments

Removing 20% of total C
annually ~10% of
Washington’s Net CO₂

176,000 MT of synthetic N fertilizer inputs in 2001

At least 16.9 Million Dry Tons Biomass in Washington
Soil Carbon *Can Be* Increased Significantly Using Residual Organic Residuals

Jenkinson et al. 1990
Current Generation organic Amendments

- Composts, biosolids, manures, etc.: 
- Recovered C, N, other nutrients, microbial activity, etc. 
- Agronomically expensive to purchase and land apply
Next Generation organic Amendments

- Precise, multi-functional amendments derived through bioenergy systems
- All the benefits of 1st Gen Amendments in a “drop-in fertilizer”
- High impact agronomic and environmental benefits
Woody biochar as an agricultural soil amendment

Acknowledgments: Hal Collins, USDA ARS
Center for Sustaining Agriculture & Natural Resources

Science in Action to Improve the Sustainability of Agriculture, Natural Resources and Food Systems

- Organic and Biologically Intensive Ag
- Small Farms / Beginning Farmer Education
- Climate Change Mitigation & Adaptation
- Biomass Energy and Products
- Local & Regional Food Systems
- Environmental & Food Footprints
- Water Quantity and Quality

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Transforming PNW Agriculture

Next Generation Organic Soil Amendments

Compost Technology & Use

Biofumigation

Sustainable Ag Policy

Organic Wheat Variety Release

Parasitoid Biocontrol

Biodigesters & BioFertilizers

Biological Nitrogen Supply
Soil Carbon Dynamics

C added in residue and roots

oxidation

methanogenesis

humification

leaching

Aquatic Systems

SOC Pool

CO₂, CH₄

CO₂, CH₄

CO₂, CH₄

Erosion

Deposition

Redistribution across the landscape

Adapted from Lal 2001, with assistance from Elizabeth Allen
Global Inventories that Include Both Direct and Indirect Emissions from Agriculture

% of total global emissions

- IPCC 2007
- Bellarby 2008
- World Bank 2007

Direct Emissions
- IPCC 2007: Low Estimate
- Bellarby 2008: Low Estimate
- World Bank 2007: Low Estimate

Direct & Indirect Emissions
- IPCC 2007: High Estimate
- Bellarby 2008: High Estimate
- World Bank 2007: High Estimate