Soil Considerations in Agroforestry

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What Functions Would We Like our Soil to Provide?

- Produce food, feed, fiber, biofuels & medicine
- Capture, filter, and store water
- Cycle and recycle nutrients
- Resilience to drought, flood & temp extremes
- Protect plants from pathogens and stress
- Detoxify pollutants
- Store C and moderate release of gases
- Resist erosive forces
How does NRCS Define Soil Health?

The continued capacity of the soil to function as a vital living ecosystem that sustains plants, animal and humans.
Downward Spiral of Soil Degradation

↑ Tillage
↓ Residue
↓ Diversity

↑ Crusting
↑ Surface Compaction

More SOM ↓ Nutrients ↔ Topsoil ↔

↓ Infiltration
↑ Erosion

↑ Crusting
↑ Surface Compaction

↓ Infiltration
↑ Erosion

↓ Nutrient Availability
↑ Disease

↓ Crop Yields
↑ Hunger
↑ Malnutrition

Ponding ↑ H₂O Storage ↓

Adapted from Building Soils for Better Crops, 3rd ed.

NRCS | SHD | Introduction to Soil Health | v2.0
Soil Health in Popular Press

Healthy Soil: Good for the Farmer, Good for the Planet
By Renovation International | May 03, 2018 08:38 AM EST

Secrets of Life in the Soil
By Rachel Cowen, Nature magazine on September 13, 2010

Can American soil be brought back to life?

BIG FOOD TAKES SOIL HEALTH SERIOUSLY
FROM SOIL HEALTH SUMMIT, MCDONALD’S SUSTAINABILITY DIRECTOR TALKS INVESTING IN SUSTAINABILITY PROGRAMS.

Minnesota Farmers Use Buried Underwear to Test Soil Health
Some southern Minnesota farmers are using underwear as a creative way to test soil health.

Can Dirt Save the Earth?
Agriculture could pull carbon out of the air and into the soil — but it would mean a whole new way of thinking about how to tend the land.

State of the US potato industry: Tariffs, transportation, soil health top issues
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The 4 Principles that Conserve the Soil Ecosystem

1. Minimize Disturbance
2. Maximize Living Cover
3. Maximize Biodiversity
4. Maximize Continuous Living Roots
Soil Health Principles to Support High Functioning Soils

Maximize Living Roots

Minimize Disturbance

Maximize Soil Cover

Maximize Biodiversity

Feed
Fuel Soil Biology
Improve Resilience
Improve SOM

Protect
Soil Aggregates
Organism Habitat
SOM
How Soil Health Principles Support Soil function – PROTECT

- Maintain stable aggregates
- Manage erosion
- Buffer temperature
- Reduce evaporation
- Maintain soil organic matter
Why Maximize Soil Cover?

• ↓ Erosion
• ↑ Infiltration
• ↓ Evaporation
• ↔ Soil Temp

• Habitat for Soil Organisms ↑
• Food for Biota ↑
• ↔ Compaction from Machines & Livestock
How Soil Health Principles Support Soil Function – FEED

- Stimulate below-ground diversity
- Increase SOM
- Improve nutrient cycling
- Enhance plant growth
- Break pest cycles
- Increase predator & pollinator populations

Maximize Living Roots

Maximize Biodiversity
How Do We Maximize Living Roots?

- Grow crops in the off-season
- Avoid fallow & ↓ re-cropping interval
- ↑ time in perennial crops
- Manage rotations & forage height

What Practices?

- Alley Cropping (311)
- Multi-Storied Cropping (379)
- Silvopasture (381)
- Forage & Biomass Planting (512)
- Prescribed Grazing (528)
How Do We Maximize Biodiversity?

- ↑ diversity of crop rotations
- Integrate livestock & graze cover crops
- ↑ time in diverse perennial crops

What Practices?

- Alley Cropping (311)
- Multi-Storied Cropping (379)
- Silvopasture (381)
- Forage & Biomass Planting (512)
- Prescribed Grazing (528)
- Conservation Crop Rotation (328)
- Cover Crop (340)
- Forage & Biomass Planting (512)
- IPM (595)
- Prescribed Grazing (528)
What Practices can be used in Agroforestry to Promote Soil Health?

- Alley Cropping (311)
- Multi-Storied Cropping (379)
- Windbreak and Shelterbelt Establishment (380)
- Silvopasture (381)
- Windbreak and Shelterbelt Renovation (650)
- Cover Crop (340)
- Residue & Tillage Mgmt. (329/345)
- Conservation Cover (327)
- Mulching (484)
- Forage & Biomass Planting (512)
- Prescribed Grazing (528)
Social & Economic Considerations
Adopting Soil Health and Agroforestry Practices

• “Requires not only an understanding of the physical resource data but also social data.”
• Awareness a understanding key human social & economic considerations can assist with implementation & long term adoption

What is the current perception of Agroforestry in your region?
What keeps people from implementing & how have others overcome these obstacles?
Attributes promoting technology adoption

**Personal**
- Above average income
- Formal education
- High participation in ag groups
- Greater reliance on mass media
- Willing to take risks

**Farm**
- Farm Size
- Diversity
- Owner operator
- Smaller scale & low to medium gross sales may be more likely to adopt soil health

**Practice**
- Economically feasible
- Observable; easy to use
- Compatible with producer beliefs
- Flexibly fit with the rotation
What are Some Obstacles to Agroforestry Adoption?

- Lack of technical information
- Lack of community support (socially or economically)
- Inter-Agency organizational barriers
- Landlord/tenant relationships
- Economic
  - Installation cost
  - Management capability
  - Risk aversion
Economic Considerations

• How many producers have used these arguments to not implement agroforestry practices?
  - It costs too much
  - Lack of time to manage
  - Uses too much water
  - Don’t have the right equipment
Agroforestry Practices as a Farm Investment

• There are immediate costs, risk and uncertain long-term benefits
• The investment does not have a guaranteed payoff
• Find long-term users to show benefits, to inspire and maintain long-term investments by farmers

Source: adapted from Meta-Economics-of-Cover-Crops2.pdf, Midwest Cover Crops Council
FIVE STAGES OF ADOPTING AN INNOVATION:

1. AWARENESS

2. INTEREST

3. EVALUATION

4. TRIAL

5. ADOPTION

Rogers and Shoemaker, 1971
Improved Soil Function can Lead to Benefits for the Producer

• Potential Benefits
  ▪ Reduced Erosion
  ▪ Increased Soil Organic Matter
  ▪ Increased Nutrient Cycling
  ▪ Increased Drought Resilience
  ▪ More Available Water
  ▪ Improved Filtering and Buffering
  ▪ Reduced Pest and Disease incidence
  ▪ Reduced Risk
How can we help landowners evaluate the impact on their farm (& society)?

**BENEFITS**
- Soil
- Water
- Air
- Plants
- Animals
- Energy
- “Human”

**COSTS**
- Land
- Labor
- Capital
- Management
- Risk
How do Economists Compare?

Partial Budget Approach

We are looking at **WHAT CHANGES** – Before and After (or between “Baseline” and “Alternative(s)”)

<table>
<thead>
<tr>
<th>Positive Effects</th>
<th>Negative Effects</th>
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<tbody>
<tr>
<td>“+”</td>
<td>“-”</td>
</tr>
<tr>
<td>Increased Revenues</td>
<td>Increased Costs</td>
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<tr>
<td>Reduced Costs</td>
<td>Decreased Revenue</td>
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Agroforestry Practice Benefit-Cost Templates aka “T-Charts”

**Silvopasture Establishment (Ac) 381**

**Definition:** An application establishing a combination of trees or shrubs and compatible forages on the same acreage.

**Major Resource Concerns Addressed:** Soil productivity and livestock habitat.

**Benchmark Condition:** Sparse woodlot adjacent to pasture land.

**Date:** October, 2016  **Developer/Location:** Hal Gordon, OR

<table>
<thead>
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<tbody>
<tr>
<td><strong>Soil</strong></td>
<td><strong>Land</strong></td>
</tr>
<tr>
<td>• Sheet, rill, wind, gully and streambank erosion is reduced by establishing a combination of trees, shrubs and forages which reduce erosion by water.</td>
<td>• Cultural resources may be harmed during earth moving or tree planting.</td>
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<td>• Permanent vegetation, roots, vegetative matter and livestock waste may increase soil organic matter.</td>
<td>• Change in land use and land in production.</td>
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<td>• Tree root penetration and organic matter counteracts soil compaction from livestock.</td>
<td><strong>Capital</strong></td>
</tr>
<tr>
<td>• Contaminants taken up by forage plants will be returned to the soil as manure.</td>
<td>• Additional field equipment may be required (crop, hay or livestock).</td>
</tr>
<tr>
<td></td>
<td>• Installation, materials &amp; planting costs.</td>
</tr>
<tr>
<td></td>
<td>• Annual operation and maintenance costs to maintain vegetation and manage pests.</td>
</tr>
<tr>
<td></td>
<td><strong>Labor</strong></td>
</tr>
<tr>
<td></td>
<td>• Increase in labor managing tree and</td>
</tr>
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<td>forage plants.</td>
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Categories not as easy to quantify

(but important to consider)

- Changes in labor (timing)
- Soil health characteristics difficult to tie to actual dollars spent or saved
  - *e.g.* earthworms, SOC
- Risk
  - *e.g.* increased soil health can help reduce crop loss due to weather extremes
- Social Impacts
Things to Remember

1. Adopting a soil health and agroforestry conservation system is a long-term investment.

2. Just like soil degradation does not happen overnight, improving soil health also takes time.

3. There are agroforestry benefits that result in economic benefits that may not be easily measured, such as reduced risk of yield variability.

4. To realize the greatest benefits from a Agroforestry Soil health system, we must find what works best for a producer given THEIR objectives and goals.
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