Investing in Your Soil: The Role of Organic Matter in Soil Function

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Investing in Your Soils Overview

- Why invest?
- Differences between organic/ecological nutrient management & conventional
- Soil investment strategies (lessons from nature)
  - Role of organic matter in soil function
  - How do plants and soil interact?
  - Soil management and water
- Resources
- One farmer’s view of soil management
Reasons to invest in your soil’s function

• Without sufficient organic matter, soil function can be severely impaired....
• Well-managed soils store and cycle both nutrients and water more effectively AND help protect water quality above and below ground.
• All farmers are required to develop N management plans (ILRP), and due to SGMA, likely have to report on water usage.

Our soils aren’t ready for the stresses that climate change will bring...
Table 1. Estimates of all degraded lands (in million km²) in dry areas (Dregne and Chou, 1994).

<table>
<thead>
<tr>
<th>Continent</th>
<th>Total area</th>
<th>Degraded area †</th>
<th>% degraded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>14.326</td>
<td>10.458</td>
<td>73</td>
</tr>
<tr>
<td>Asia</td>
<td>18.814</td>
<td>13.417</td>
<td>71</td>
</tr>
<tr>
<td>Australia and the Pacific</td>
<td>7.012</td>
<td>3.759</td>
<td>54</td>
</tr>
<tr>
<td>Europe</td>
<td>1.456</td>
<td>0.943</td>
<td>65</td>
</tr>
<tr>
<td><strong>North America</strong></td>
<td><strong>5.782</strong></td>
<td><strong>4.286</strong></td>
<td><strong>74</strong></td>
</tr>
<tr>
<td>South America</td>
<td>4.207</td>
<td>3.058</td>
<td>73</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51.597</strong></td>
<td><strong>35.922</strong></td>
<td><strong>70</strong></td>
</tr>
</tbody>
</table>

† Comprises land and vegetation.
How is ecological soil management different from conventional?

- It attempts to relink the C and N cycles in management of agricultural soils, which were severed by Haber-Bosch process.
- It’s more dependent on healthy soil microbiology, which in turn....
- ....Makes management less precise due to number of variables: Soil temp, moisture, tillage, OM%, C:N ratios of various inputs, including cover crops.
How is ecological soil management different from conventional?

- Slower release (especially N)
- Often higher P applications (with manure & manure-based compost)
- Soil quality builds and provides returns over time

![Graph showing N availability over years](image)

Courtesy of Dan Sullivan OSU Crop & Soil Science
What lessons (soil investment strategies) from nature can be applied to our agricultural systems?

Regular additions of **organic matter** to the soil

- Compost, cover crops, green manures, manures, plant residue (leave the straw, invest in your soil!!)

Diverse sources of organic matter (encourages complexity)
What lessons (soil investment strategies) from nature can be applied to our agricultural systems?

- Protect the soil surface (living plants or mulch)
- Keep soil disturbance, physical (tillage) or chemical disturbance, to a minimum
- Try to match inputs/nutrient availability with crop demand
Regular Additions of Organic Matter &... Reduce Soil Disturbance
Diverse sources of organic matter... ....will influence the soil ecology
Protect the Soil (Living Plants) & Diverse Sources of Organic Matter

Up to 20% of carbon (or more) fixed by photosynthesis in plants is transferred to the soil as root exudates.
Exudates encourage microbial growth and the microbes improve uptake of nutrients by plants.

Plant roots exude:
- Water
- Sugars,
- Amino acids,
- Organic acids,
- Vitamins,
- Plant hormones,
- Growth substances,
- Mucilage, and
- Proteins

Signaling and enzyme feedback systems

Exudates encourage microbial growth and the microbes improve uptake of nutrients by plants.
TIP OF A ROOT WITH MYCORRHIZAE ATTACHED
(MAGNIFICATION = 100X)
Picture is of arbuscules—where fungi and plants exchange nutrients.
Protect the Soil (Living Plants) & Diverse Sources of Organic Matter
SOIL MICROBES

PLANT

CARBON COMPOUNDS

SOIL NUTRIENTS

Adapted from Dirk Redecker
A microscopic view of an arbuscular mycorrhizal fungus growing on a corn root. The substance coating them is glomalin, revealed by a green dye.

*From: “Glomalin: Hiding Place for a Third of the World’s Stored Carbon” 2002, Kristine Nichols USDA ARS*
40-60% of the soil microbial biomass is associated with microaggregates (<250 micrometers)
Soil Aggregates and Water Infiltration

Soil structure = infiltration

No soil structure = no infiltration

Increasing soil organic matter can help increase water infiltration into the soil, the root zone, and ultimately, the water table...
Soil Organic Matter and Available Water Capacity
Inches of Water per Foot of Soil


<table>
<thead>
<tr>
<th>Percent SOM</th>
<th>Sand</th>
<th>Silt Loam</th>
<th>Silt Clay Loam</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0</td>
<td>1.9</td>
<td>1.4</td>
</tr>
<tr>
<td>2</td>
<td>1.4</td>
<td>2.4</td>
<td>1.8</td>
</tr>
<tr>
<td>3</td>
<td>1.7</td>
<td>2.9</td>
<td>2.2</td>
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<tr>
<td>4</td>
<td>2.1</td>
<td>3.5</td>
<td>2.6</td>
</tr>
<tr>
<td>5</td>
<td>2.5</td>
<td>4.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>
Principles of Soil Management To Maintain or Increase Soil Function:

Regular additions of *organic matter* to the soil

- Compost, *cover crops*, green manures, plant residue (leave the straw, invest in your soil!!)

Diverse sources of organic matter (encourages complexity)

Protect the soil surface (living plants or mulch)

Keep soil disturbance, physical (tillage) or chemical disturbance, to a minimum

Try to match inputs/nutrient availability with crop demand
Cover Crops

Photo: Rex Dutour

Photo: Rex Dutour
Cover crop in new orchards
Recycling Old Orchards (30+ tons an acre of C)
A mulching opportunity
Resources
Soils & Compost

Healthy soil can improve crop and livestock production. The publications and other resources listed here offer information on how to assess, improve, and maintain soil health for both croplands and pastures. Several publications address fertilization and composting specifically for organic production. Soil management can also play an important role in protecting water quality, and additional resources are listed on that topic.

Publications

NOTE: Some of the following documents are available as Adobe Acrobat PDFs. Download Acrobat Reader.

A Brief Overview of Nutrient Cycling in Pastures - IP221
PDF Price: FREE
- Summary - Download PDF - Buy Print Copy - View Now

Alternative Soil Amendments - IP054
PDF Price: $0.99 for non-members
- Summary - Buy PDF - Buy Print Copy

Alternative Soil Testing Laboratories Database
- View Now

Arsenic in Poultry Litter: Organic Regulations - IP266
PDF Price: FREE
- Summary - Download PDF - Buy Print Copy - View Now

Assessing the Pasture Soil Resource - IP128
PDF Price: FREE
- Summary - Download PDF - Buy Print Copy - View Now

Biochar and Sustainable Agriculture - IP358
PDF Price: FREE
Resources for Soil Assessment and Management

Web Soil Survey:  
http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

SARE’s Building Soils for Better Crops

Cornell’s Soil Health Training Manual

Good Farmers—generally wise advice with experience behind it.

NRCS: Soil Biology Primer and lots of other information about soil management and function & EQIP and CSP Programs
Resources for Soil Assessment and Management

Ohio State University’s, *The Biology of Soil Compaction* Fact Sheet (2009)

The Organic Center’s *Assessing Soil Quality in Organic Agriculture* (2006)

Resources for Soil Assessment and Management


Soil Quality: What’s Relevant to Growing Almonds?
www.almonds.com/sites/default/files/content/attachments/soil_quality.pdf
Questions?

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