Soil Health Summit
Wednesday, November 15th, 2017

In collaboration with East Stanislaus RCD and USDA-NRCS:

Featuring technical trainings, research updates, carbon farm workshop, and networking with soil health professionals.
Cover Crop: Challenges and Opportunities in California

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cover crop benefits

- Prevent soil erosion
- Scavenge nitrogen
- Improve soil health
- Increase yields
- Build soil organic matter
- Improve rainfall infiltration
- Economic returns
- Provide nitrogen (legumes)
- Reduce soil compaction
- Encourage pollinators and beneficial insects
- Control weeds

Illustration by Carlyn Iverson.
Agro-chemical based - representative of typical California Central Valley system

Intermediate system – Fertility from WLCC and some supplemental inorganic fertilizers; occasional pesticides and herbicides

Managed according to USDA guidelines – WLCC and organic fertility from composted chicken manure
Runoff as Percentage of Rainfall, UC Davis

CONVENTIONAL
LOW INPUT
ORGANIC

Precipitation (mm)
Percent of Runoff
Cover Crops
Precipitation

Kabir & Horwath
Grower-Collaborator Field Site

Winter Fallow (NCC)  Winter Cover Crop (CC)
Discharge Hydrograph Comparing in Grower’s Fields

Storm event 1

Storm event 2

Kabir & Horwath
## Total Winter Discharge Comparisons in Grower’s Fields

<table>
<thead>
<tr>
<th></th>
<th>Fallow (NCC)</th>
<th>Cover Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation Discharged as Runoff</td>
<td>16.3%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Average Peak Runoff Velocity</td>
<td>0.52 m/s</td>
<td>0.24 m/s</td>
</tr>
</tbody>
</table>

Kabir & Horwath
Soil Surface and Water Flow Pattern

Good aggregated soil

Soil Seals and crusts

(Adapted from Building Soils for Better Crops, 3rd edit)
January 8, 2017

Adjacent Field – Same Day

Photo: T. Rolfes
After a Storm Event in Solano Walnut Orchard

Poor Soil Structure & Poor Soil Health

Healthy Soil with Good Structure

Photo: Kabir, Feb 07, 2017
Almond Orchard: Fallow and Cover Crop in Yolo County

Photo: Kabir, Feb. 21, 2017
Orange Grove

Kabir: Feb. 16, 2017

Photo: Chuck Ingels
Cover Crop Enhance SOM

Soil Organic Matter (SOM)

- Cover Crops provide a continual live root to harvest additional sunlight

Upward Trend

- 1993: 1.7 to 2.0%
- Present: 3.7 to 4.3%

Brown Ranch, ND

2001

0.5% SOM

Sano Farm, Fresno, CA

2016

3% SOM
SOM Boosts Water Holding Capacity

(Hudson, 1994, as redrawn in Franzluebbers, 2010)
Spring Weed Pressure

- Cover crop
- No cover crop

Photo: Jay Fuhrer, NRCS
## 2007 Herbicide Expenses

<table>
<thead>
<tr>
<th>Field</th>
<th>Treatment</th>
<th>Herbicide Applications After Pea Harvest</th>
<th>Cost per application = $12.00/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>Cover Crop No Manure</td>
<td>July 1x</td>
<td>Sept None</td>
</tr>
<tr>
<td>Middle</td>
<td>No Cover Crop Manure</td>
<td>July 1x</td>
<td>Sept 1x</td>
</tr>
<tr>
<td>South</td>
<td>No Cover Crop No Manure</td>
<td>July 1x</td>
<td>Sept 1x</td>
</tr>
</tbody>
</table>
Cover Crop Attract Beneficial Insects
Vetch Cover Crops and Beneficial Insects

Pirate bugs
Lady beetles
Misc. parasitoids
Predatory thrips

Pests: aphids and flower thrips

Dagouavich, UCCE
Sweet Corn Tassels in Cover Crop and Fallow plots
Aboveground Benefits

• Protect soil from erosion
• Mitigates chemicals runoff from the field
• Increases organic matter and water holding capacity
• Reduces nutrient inputs and herbicide use
• Promotes beneficial insects thus prevent pest outbreak
• Increase crop yield
Belowground Process

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Same Field

June 16, 2009
- Corn planted into last year’s cover crop residue

July 1, 2009
- Rapid residue decomposition
Effects of Crop Residues on Earthworms Activity

Brady & Weil
The Hidden World Under Our Feet

Modified from Rose & Elliott
## What Do They Weigh?

<table>
<thead>
<tr>
<th>Organism</th>
<th>Weight Range (lbs/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria</td>
<td>2,000 - 2,500</td>
</tr>
<tr>
<td>Fungi</td>
<td>1,000 - 15,000</td>
</tr>
<tr>
<td>Protozoa</td>
<td>20 - 300</td>
</tr>
<tr>
<td>Nematodes</td>
<td>10 - 300</td>
</tr>
</tbody>
</table>

**Sources:**

Dr. Nyle C. Brady and Dr. Ray R. Weil

*Soil Biology Primer. Dr. Elaine R. Ingham*
Bacteria & fungi in a acre of land equivalent to

Feed the Underground Herd!
Soil Aggregate Stability

Hyphal length = 19.06 + 0.74 (%WSA)

Kabir and Koide, 2002
Belowground benefits

• Increase microbial population thus increase mineralization
• Improve soil biology
• Increase soil aggregate stability
## Management Challenges of Cover Crops Planting

- Delay in planting of cash crop
- Choice of cover crops for more benefits
- Economic loss
- Nutrient tie-up
- Frost Damage
- Pest and Disease may carry over to the main crop
- May interfere harvesting of crops
Majority of California Cropland
Cover Cropping in the Furrows
Winter Killed Cover Crops

- Foxtail millet
- Buckwheat
- Cowpea
Choice of Cover Crops based on Season

Fall

Winter

Spring
May interfere with Almond Harvesting
# C:N ration in Cover Crops
(Nutrients Availability & Decomposition Rate)

<table>
<thead>
<tr>
<th>Material</th>
<th>C:N Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>rye straw</td>
<td>82:1</td>
</tr>
<tr>
<td>wheat straw</td>
<td>80:1</td>
</tr>
<tr>
<td>oat straw</td>
<td>70:1</td>
</tr>
<tr>
<td>corn stover</td>
<td>57:1</td>
</tr>
<tr>
<td>rye cover crop (anthesis)</td>
<td>37:1</td>
</tr>
<tr>
<td>pea straw</td>
<td>29:1</td>
</tr>
<tr>
<td>rye cover crop (vegetative)</td>
<td>26:1</td>
</tr>
<tr>
<td>mature alfalfa hay</td>
<td>25:1</td>
</tr>
<tr>
<td><strong>Ideal Microbial Diet</strong></td>
<td><strong>24:1</strong></td>
</tr>
<tr>
<td>rotted barnyard manure</td>
<td>20:1</td>
</tr>
<tr>
<td>legume hay</td>
<td>17:1</td>
</tr>
<tr>
<td>beef manure</td>
<td>17:1</td>
</tr>
<tr>
<td>young alfalfa hay</td>
<td>13:1</td>
</tr>
<tr>
<td>hairy vetch cover crop</td>
<td>11:1</td>
</tr>
<tr>
<td>soil microbes (average)</td>
<td>8:1</td>
</tr>
</tbody>
</table>
Cover crops may Enhance Frost Damage to Orchard or Vineyard

Almond frost damage, UC IPM  Tall & Dense Cover Crop  Low profile Cover Crop
Combat Nematodes

- Sudan grass
- Mustard
- Cahaba white vetch
- Cowpeas

Root knot nematode

5,000 lesion Nematodes in 2012 to 126 in 2016 by using three mustards & a daikon radish cover crop
Rust on Cover Crop may Carry Over to Corn
Cover Crops may Serve as Sources of Inoculum for Diseases in Cash Crops

Vetch

Sclerotinia on vetch
Conclusions

• Identify what you want the cover crop to do?
• Examine crop rotations to identify “windows” where cover crops can fit
• In orchard or vineyard use multispecies cover crops to receive maximum benefit
Thank You

Any questions?