The Feasibility of Cover Crops in Dryland Farming

Abdel Berrada
CSU-AES

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Colorado Plateau/4-Corners Region

- Unique environment
- High elevation
- Finite water resources
- Low & erratic precipitation
- Frequent droughts
- Distance from markets
- Rich cultural history
- Archeological & natural resources
- Resourceful people

Unique environment
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Monthly Precipitation

Precipitation (in)

- Akron (16.6"")
- Yellow Jacket (15.6"")
Dryland crop rotations
- Wheat-Fallow
- Wheat-Bean
- Wheat-Sun/Saff-Fallow

Soil management
- Conventional tillage
- Minimum tillage
# 2011-2013 average crop yield & profit

<table>
<thead>
<tr>
<th>Crop Rotation</th>
<th>Average yield (lb/ac)</th>
<th>Estimated profit ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter Wheat-Fallow</td>
<td>739</td>
<td>$12.99</td>
</tr>
<tr>
<td>Winter Wheat-Sunflower-Fallow</td>
<td>862</td>
<td>$23.53</td>
</tr>
<tr>
<td>Winter Wheat-Safflower-Fallow</td>
<td>827</td>
<td>$18.78</td>
</tr>
<tr>
<td>Winter Wheat-Opp. Crop-Sunflower-Fallow</td>
<td>736</td>
<td>$9.75</td>
</tr>
<tr>
<td>Winter Wheat-Dry Bean-Sunflower-Fallow</td>
<td>777</td>
<td>$3.71</td>
</tr>
<tr>
<td>Winter Wheat-Dry Bean-Dry Bean-Fallow</td>
<td>643</td>
<td>($13.92)</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>758</strong></td>
<td><strong>$7.55</strong></td>
</tr>
</tbody>
</table>
Wheat yield in Dolores Co.

Winter wheat yield (bu/ac)

- 2012
- 2014
Dry bean yield in Dolores Co.

Dry bean yield (lb/ac)

2012 2014
Challenges

- Short Growing season
- Low & variable precipitation/Droughts
- Soil erosion
- Low crop yields
- Distance from markets
- Transportation costs

Opportunities/Solutions

- Conserve soil & water
- Increase level of inputs
- Enhance resource use efficiency
- Grow high cash crops (e.g., organic)
- Diversify & intensify crop production
- Supplemental irrigation!
- Value-added products
Bow & Arrow
Ute Mountain Ute Tribe

Brand
Since 1962

Native Grown  Non GMO  Naturally Gluten Free

Whole Grain Blue Corn Meal

NET WT. 24OZ. (0.68KG)
Sustainable ecosystems!

- Permanent pasture + grazing
- No-Till/Conservation tillage
- Cover crops! Organic farming
  - Improve soil health & quality
  - Reduce soil erosion
  - Suppress weeds
The Feasibility of Cover Crops in Dryland Cropping Systems in SW Colorado and SE Utah

Abdel Berrada (PI)
Determine if & how cover crops can enhance the sustainability of dryland farming in SW Colorado & SE Utah.
Cover crops are grown to provide agroecosystem “benefits” but not harvested.

Forage crops are grown for “feed” that is either hayed or grazed.

Forage crops can be managed for residue cover.
Objectives

- **Agronomic feasibility**: quantify the effects of CCs on soil moisture, soil fertility & quality, weed control, and cash crop.

- **Economic viability**: determine which cover cropping strategies are profitable.

- **Education & Outreach**: share project findings & promote soil health.
Materials & Methods

✓ Three yr. project started in Summer of 2015

✓ Total of ten field trials representing two crop rotations (W-F, W-SA-F) and three management practices (CT & NT, Conventional & Organic crop production)

✓ Nine summer/fall-planted cover crop mixes and six spring-planted cover crop mixes (CCM) have been tested on farmers’ field and at the SWCRC.

✓ Number of species in the mix: 3 to 10
Cover Crops Selection Criteria

- On-farm trials: Collaborating farmer & NRCS select the CCM, in coordination with CSU-SWCRC.
  - Objectives sought (N fix., biomass production, weed control, etc.)
  - Seed availability
  - Seed cost
- Tools: Green Cover Seeds SMARTMIX, local knowledge, experience
✓ Soil water content & infiltration rate
✓ Traditional soil test analysis
✓ Haney soil health test
✓ Soil microbial community (PLFA)
PLANT MEASUREMENTS

✓ Canopy & ground cover (line-transect method)
✓ Plant biomass
✓ Cash crop yield and quality
✓ OTHER: Costs & returns
### CCM (seeding rate)

<table>
<thead>
<tr>
<th>Plot</th>
<th>Mix</th>
<th>YSC, Hairy Vetch, Winter Pea, Winter Rye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plot 103, Mix 2:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plot 102, Mix 1:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plot 101, Mix 3:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Plant Biomass (lbs DM/acre)

<table>
<thead>
<tr>
<th>CCM (seeding rate)</th>
<th>Plant Biomass (lbs DM/acre)</th>
<th>Line-transect (%)</th>
<th>Canopy Cover</th>
<th>Cover Crops</th>
<th>Volunteer Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCM1 (29 #/A)</td>
<td>4067</td>
<td>89</td>
<td>54</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>CCM2 (35#/A)</td>
<td>4337</td>
<td>89</td>
<td>61</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>CCM3 (28#/A)</td>
<td>5033</td>
<td>89</td>
<td>67</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>CV (%)</td>
<td>25</td>
<td>11</td>
<td>28</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Pr &gt; F</td>
<td>0.6</td>
<td>1.1</td>
<td>0.4</td>
<td>0.08</td>
<td></td>
</tr>
</tbody>
</table>
### BN – Oct. 29, 2015

**Winter Peas-25%, Yellow sweet clover-5%, Berseem Clover-10%, Teff-5%, Sorghum-Sudangrass-10%, Proso Millet-10%, Nitro Radish-5%, Purple Top Turnip-5%, Sunflower-5%, Buckwheat-20% @ 20 lbs/ac**

### BSW – Early June 2016

<table>
<thead>
<tr>
<th>BN Sampling period</th>
<th>Plant DM (lbs/ac)</th>
<th>Canopy Cover (%)</th>
<th>Cover Crop Canopy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall’15</td>
<td>966</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>Spring’16</td>
<td>1527</td>
<td>75</td>
<td>67</td>
</tr>
</tbody>
</table>

Pea-26%, Oat-32%, Barley-32%, Rapeseed-3%, Safflower-3%, Flax-5% @ 15 lbs/ac
Cover Crops: Balansa Clover, Crimson Clover, Ryegrass, Tillage Radish @ 15 lbs/ac

Fallow (VW)

Cover Crops: SSG, Barley, Dry Bean, Oat, Corn, Peas (2), Sunflower @ 34 lbs/ac

50 lbs DM /ac

230 lbs DM /ac
## Soil & Yield Data @ SWCRC#1

<table>
<thead>
<tr>
<th>Treatment</th>
<th>September 2016</th>
<th>July 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-3 ft. Soil moisture (%, g/g)</td>
<td>NO(_3)-N (lbs/ac)</td>
</tr>
<tr>
<td>CCM</td>
<td>12.5</td>
<td>36.3</td>
</tr>
<tr>
<td>Fallow</td>
<td>17.8</td>
<td>62.3</td>
</tr>
<tr>
<td>CV (%)</td>
<td>16.9</td>
<td>11.3</td>
</tr>
<tr>
<td>Pr &gt; F</td>
<td>0.03</td>
<td>0.00</td>
</tr>
</tbody>
</table>
## Soil (9/16) & Yield Data (7/17) @ SB

<table>
<thead>
<tr>
<th>CCM vs. Fallow</th>
<th>BN % Soil moisture* (0-2 ft)</th>
<th>BESW % Soil moisture* (0-2 ft)</th>
<th>BN NO3-N (lbs/ac)</th>
<th>BESW NO3-N (lbs/ac)</th>
<th>BN Wheat (bu/ac)</th>
<th>BESW Wheat (bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCM</td>
<td>9.2</td>
<td>9.3</td>
<td>19.8</td>
<td>23.8</td>
<td>26.2</td>
<td>25.2</td>
</tr>
<tr>
<td>Fallow</td>
<td>14.0</td>
<td>12.8</td>
<td>36.6</td>
<td>42.0</td>
<td>32.4 NS</td>
<td>32.5</td>
</tr>
</tbody>
</table>

*by weight
<table>
<thead>
<tr>
<th>CCM planting date</th>
<th>Plant Biomass (lbs DM/ac)</th>
<th>Contribution (% of DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cereals</td>
<td>Legumes</td>
</tr>
<tr>
<td>August 2016</td>
<td>3438$</td>
<td>0</td>
</tr>
<tr>
<td>April 2017</td>
<td>713</td>
<td>50</td>
</tr>
</tbody>
</table>

$Significant at $\alpha=0.0001$
## Cover Crop Mixes at SWCRC#2 -- August 2016

<table>
<thead>
<tr>
<th>CCM (lbs/ac)</th>
<th>Cover Crop Species (% by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CCM1 (25)</strong></td>
<td>Winter Pea (67%), Berseem Clover (4%), Yellow Sweet Clover (1%), Sorghum-Sudangrass (11%), Proso millet (8%), Teff (4%), Nitro Radish (2%), Purple Top Turnip (1%), Sunflower (2%)</td>
</tr>
<tr>
<td><strong>CCM2 (33)</strong></td>
<td>Winter Pea (85%), Flax (10%), Nitro Radish (3%), Rapeseed (1%), Impact Forage Collards (1%)</td>
</tr>
<tr>
<td><strong>CCM3 (43)</strong></td>
<td>Winter Pea (66%), Winter Triticale (31%), Rapeseed (2%), Purple Top Turnip (1%)</td>
</tr>
<tr>
<td><strong>CCM4 (35)</strong></td>
<td>Winter Pea (54%), Yellow Sweet Clover (4%), Winter Triticale (38%), Rapeseed (2%), Nitro Radish (2%)</td>
</tr>
<tr>
<td><strong>CCM5 (38)</strong></td>
<td>Winter Pea (50%), Hairy Vetch (8%), Winter Triticale (35%), Sorghum-Sudan (5%), Nitro Radish (2%)</td>
</tr>
</tbody>
</table>
# Cover Crop Mixes at SWCRC#2 -- April 2017

<table>
<thead>
<tr>
<th>CCM (lbs/ac)</th>
<th>Cover Crop Species (% by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CCM6 (24)</strong></td>
<td>Hairy vetch (14%), spring pea (62%), oat (16%), rapeseed (1%), flax (2%), safflower (4%)</td>
</tr>
<tr>
<td><strong>CCM7 (10)</strong></td>
<td>Balansa clover (40%), crimson clover (20%), annual ryegrass (30%), EcoTiller radish (10%)</td>
</tr>
<tr>
<td><strong>CCM8 (22)</strong></td>
<td>Crimson clover (2%), spring pea (67%), spring barley (25%), Nitro radish (7%)</td>
</tr>
</tbody>
</table>
# Soil Data @ SWCRC#2 in September, 2017

<table>
<thead>
<tr>
<th>Treatment</th>
<th>0-3 ft. Soil Moisture (%, g/g)</th>
<th>NO₃-N (lbs/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug’16 CCM -- CT</td>
<td>11.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Aug’16 CCM -- NT</td>
<td>11.8</td>
<td>14.2</td>
</tr>
<tr>
<td>April’17 CCM -- CT</td>
<td>14.6</td>
<td>17.5</td>
</tr>
<tr>
<td>April’17 CCM -- NT</td>
<td>14.3</td>
<td>17.8</td>
</tr>
<tr>
<td>CT Fallow</td>
<td>16.9</td>
<td>30.0</td>
</tr>
<tr>
<td>NT Fallow</td>
<td>16.6</td>
<td>31.3</td>
</tr>
<tr>
<td>CV (%)</td>
<td>14.8</td>
<td>10.9</td>
</tr>
<tr>
<td>Pr &gt; F</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Preliminary Conclusions

2 yrs of data [2015-2016 (17.5”), 2016-2017 (12.6”)]

3 trials with a complete crop rotation
Unique environment & No prior research data

More data: infiltration rates, PLFA, etc.
How Much Biomass to Increase SOM By 1%?

ASSUMPTIONS

0-3 inch soil depth - 1,000,000 lbs of soil

10% of residue becomes OM, rest is mineralized

ANSWER

100,000 lbs or 50 tons of residue
Too early to draw conclusions BUT the results to date are not in favor of cover crops in dryland farming in SW Colorado & SE Utah

- Cover crops depleted soil moisture and N.
  - Apply N fertilizer?

- Cover crops depressed wheat yield.

- Longer term: Increased SOM, infiltration, biological activity…

- Impacts on soil erosion & weed control (CC vs NT)
• Plant biomass: Fall planting > Spring planting
• Number of species in the mix
  – Species adaptation (pea, winter cereals, brassicas, SSG!)
  – Management (planting & termination dates, seeding depth & rate, legume seed inoculation, etc.)
  – Seed cost
• Cover crops study in the Central Great Plains
• John Holman et al, March 18, 2016, Four States Ag Expo, Cortez, CO.
• Cover crops **USE** water

• Cover crops **CAN** be profitable **IF** hayed or grazed

  ➢ Irrigation makes this easier to accomplish

• Reducing fallow increases **RISK** of crop failure in semi-arid dryland production
Thank you!

http://drylandcovercrops.agsci.colostate.edu/