Use of Cover Crops for Revegetation After Energy Development in Northern Mixed Grass Prairie

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Goals of this project

• To improve revegetation success with an overall reduction of associated costs

• Promote soil vitality with a diversity of cover crops that promote topsoil development and increase water infiltration (reducing runoff)

• Preemptively out-space and reduce the establishment of noxious weeds

• More effectively promote the establishment of native grass species and bolster communities of pollinators and other beneficial insects
Why reclaim?

8/15/2013

9/28/2016
North Dakota Study Site
Revegetation seed mix

western wheatgrass, green needlegrass, slender wheatgrass, blue grama, sideoats grama, little bluestem and prairie junegrass
Erosion happens!
Revegetation often occurs on structureless soils
How cover crops build soil health

- carbon feeds microbes
- exudates build aggregates
- roots make pores

Roots build soils
Using cover crops for revegetation

2015

2016
Cover crop cocktail:
oat, phacelia, flax, radish, turnip, field pea, soybean, sunflower, blanketflower, millet
Questions to answer in cover crop study

• Do cover crops grow at harsh reclamation sites?
• Do cover crops reduce perennial grass establishment?
• Do cover crops reduce weeds?
• Do cover crops reduce erosion?
• Do cover crops build soil aggregates?
Interpreting Indicators of Rangeland Health

<table>
<thead>
<tr>
<th>Rangeland Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil &amp; Site Stability</td>
</tr>
</tbody>
</table>

Ecological Foundation
<table>
<thead>
<tr>
<th>Indicator no.</th>
<th>Indicator</th>
<th>Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rills</td>
<td>SSS, HF</td>
</tr>
<tr>
<td>2</td>
<td>Water flow patterns</td>
<td>SSS, HF</td>
</tr>
<tr>
<td>3</td>
<td>Pedestals and/or terracettes</td>
<td>SSS, HF</td>
</tr>
<tr>
<td>4</td>
<td>Bare ground (%)</td>
<td>SSS, HF, LCC</td>
</tr>
<tr>
<td>5</td>
<td>Gullies</td>
<td>SSS, HF</td>
</tr>
<tr>
<td>6</td>
<td>Wind-scoured, blowouts and/or deposition areas</td>
<td>SSS</td>
</tr>
<tr>
<td>7</td>
<td>Litter movement</td>
<td>SSS</td>
</tr>
<tr>
<td>8</td>
<td>Soil surface resistance to erosion</td>
<td>SSS, HF, BI</td>
</tr>
<tr>
<td>9</td>
<td>Soil surface loss or degradation</td>
<td>SSS, HF, BI</td>
</tr>
<tr>
<td>10</td>
<td>Plant community composition and distribution relative to infiltration and runoff</td>
<td>HF</td>
</tr>
<tr>
<td>11</td>
<td>Compaction layer</td>
<td>SSS, HF, BI</td>
</tr>
<tr>
<td>12</td>
<td>Functional/structural groups</td>
<td>BI</td>
</tr>
<tr>
<td>13</td>
<td>Plant mortality/decadence</td>
<td>BI, LCC</td>
</tr>
<tr>
<td>14</td>
<td>Litter amount</td>
<td>HF, BI</td>
</tr>
<tr>
<td>15</td>
<td>Annual production</td>
<td>BI, LCC</td>
</tr>
<tr>
<td>16</td>
<td>Invasive plants</td>
<td>BI</td>
</tr>
<tr>
<td>17</td>
<td>Reproductive capability of perennial plants</td>
<td>BI</td>
</tr>
</tbody>
</table>
Results
Do cover crops grow at harsh reclamation sites?

2014
Oat: some persistence to 2015
20-40% frequency

2015
Phacelia, Sunflower, soybean,
radish, turnip, blanketflower, flax,
field pea, oat, millet
all established at all sites
Oats 100% frequency
Plants respond strongly to salts in soil
Do cover crops reduce perennial grass establishment?

<table>
<thead>
<tr>
<th>Year</th>
<th>No Oat Plants/m²</th>
<th>Oat Plants/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>28 (±7)</td>
<td>30 (±6)</td>
</tr>
<tr>
<td>2015</td>
<td>21 (±7) Oat only</td>
<td>17 (±7) CCC</td>
</tr>
</tbody>
</table>

Cover crops do not compete with desirable perennial grasses!
Weeds Respond to Increased Fertility

• Weeds increased with increased fertility
• Increased weeds drove a decrease in biotic integrity
• Plots with oats rated better than those without oats.
Range health results

Soil & Site Stability
- Oats: Moderate
- CCC: Extreme to Total

Biotic Integrity
- Oats: Slight to Moderate
- CCC: Extreme to Total

Hydrologic Function
- Oats: Moderate
- CCC: Extreme to Total
Questions to answer in cover crop study

• Do cover crops grow at harsh reclamation sites? YES
• Do cover crops reduce perennial grass establishment? NO
• Do cover crops reduce weeds? YES (Oat cover crop)
• Do cover crops reduce erosion? NOT IN FIRST YEAR
• Do cover crops build soil aggregates? CANT TELL YET
Year 2 of sampling – Unanswered questions

- Do cover crops grow at harsh reclamation sites? YES
- Do cover crops reduce perennial grass establishment? NO
- Do cover crops reduce weeds? (Oat cover crop)
- Do cover crops reduce erosion?
- Do cover crops build soil aggregates?

Not enough time has passed
Do cover crops reduce erosion?

• Based on indicators of rangeland health, there was an increase in signs of erosion between 2015 and 2016.

• Oats appeared to have largest slowdown effect on erosion.

• Difference were not large enough to change rangeland health rating category.
Do cover crops build soil aggregates?

• There has been an increase from 3.4 to 4.3 (scale of 1-6) in field aggregate stability values between 2015 and 2016 with no difference in treatments.

• Increases in soil aggregate stability correlated with:
  • high initial soil OM ($r^2=5.1$; $P=0.009$)
  • litter cover ($r^2=0.40$; $P=0.027$)
  • plant cover ($r^2=0.55$; $P=0.006$)
What have we learned?

• Soil chemistry among reclamation sites within the same ecological site varied widely.

• When prairie soils contain a concentrated, buried salt layer, this layer should either be left intact or removed during the construction phase prior to reclamation.

• In ungrazed interim oilfield reclamations, soil chemistry had an effect on plant establishment.
What have we learned?

• Adding an annual cover crop to the perennial grass seed mix had no effect on perennial grass establishment and a positive effect on rangeland health.

• Positive effect of oats on invasives.

• IIRH method was effective for evaluating reclamation success and communicating results.
Future direction

We will test if the long-term benefits of cover crops in agricultural systems transfer to restoration, but cover crops that establish at low densities due to stressful soil conditions may only have small effects in reclamations. Especially in these already water-limited growing conditions of the northern Great Plains.
Acknowledgements

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Thank you

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Seed costs

western wheatgrass, green needlegrass, slender wheatgrass, blue grama, sideoats grama, little bluestem

$100/acre

Oat

$3.40/acre

CCC

$7/acre