Nothing can replace preparation, hard work and learning from failures. Just don’t try and make all the mistakes yourself.

Dan Forgey
Cronin Farms
Gettysburg, SD
104 year old farm
Monty and Mike Cronin

Third generation on the farm
Our farm family. Leopold Award winners 2016
Average Annual Precipitation

South Dakota

Copyright 2000 by Spatial Climate Analysis Service, Oregon State University

Legend (in inches):
- Under 16
- 16 to 18
- 18 to 20
- 20 to 22
- 22 to 24
- 24 to 26
- 26 to 28
- 28 to 30
- 30 to 32
- 32 to 34
- Above 34

For information on the PRISM modeling system, visit the SCAS web site at http://www.ocs.orst.edu/prism

This is a map of annual precipitation averaged over the period 1961-1990. Station observations were collected from the NOAA Cooperative and USDA-NRCS SnoTel networks, plus other state and local networks. The PRISM modeling system was used to create the gridded estimates from which this map was made. The size of each grid pixel is approximately 4x4 km. Support was provided by the NRCS Water and Climate Center.

The latest PRISM digital data sets created by the SCAS can be obtained from the Climate Source at http://www.climatesource.com
Our Farm 2017

9,600 Acres Farm Ground
600 Acres Under Pivot

We have been 100% No-Till since 1993.
We love heavy residue which we feel is the driving force to success.
8,500 Grass Which Is On The Missouri River Breaks

June 2016

850 Cow Calf Herd (we background the calves)
Father and son you can not put a value on this!
Three generation making lasting legacy
Farming in the 70’s and 80’s
teach us. We already knew how to raise 35 bushel wheat and 50 bushel corn.

Our cover crops were Wild Buckwheat and Kochia weed.

### Crop Rotation:

- **Spring or Winter Wheat**
- **Black Fallow**
- **Corn or Sunflowers**
After wheat harvest we would use sweeps working fall stubble.

We finally had to buy Noble Blades to get through the Buckwheat.

We considered ourselves good farmers.
Not saying they did not know what they were doing!

When it started to blow there was nothing they could do.
Farming in central South Dakota’s in the 80’s

Ever time the wind blew there was soil in the air. We just hoped it was not ours.

Looking back we had no idea how to farm.

But we still thought we were good farmers.
Yield Goals Bushels / Acre

- Corn: 70
- Spring Wheat: 35
- Winter Wheat: 50
- Sunflowers: 1850 lb’s
I feel we should do everything we can to make this a better world.
The focus is on being proactive about preventing problems from happening rather than constantly reacting to the latest problem that occurs.

Dr. Dwayne Beck
Dakota Lakes Research Farm
SDSU
We have been 100% low disturbance no till for 24 years.
**We Share Our Commodity Cart To Help With Cost**

<table>
<thead>
<tr>
<th>March 15 - April 20</th>
<th>April 20 - June 15</th>
<th>June 15 - July 1</th>
<th>Aug 15 - Oct 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Wheat</td>
<td>Corn</td>
<td>Hay Millets</td>
<td>Cover Crops</td>
</tr>
<tr>
<td>Field Peas</td>
<td>Soybeans</td>
<td>Sudan Grass</td>
<td>Winter Wheat</td>
</tr>
<tr>
<td>Lentils</td>
<td>Sunflowers</td>
<td>Teff Grass</td>
<td></td>
</tr>
<tr>
<td>Flax</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**1895 Drill**

**1770 CCS**
We have no excuse. We have the tools and the knowledge to stop this.

Central South Dakota Spring 2014
Corn requires 9 inches of moisture for vegetative growth, and adds 10 bushels of yield for each additional inch above the vegetative requirement.

Yield goal 140 bushel
23 inches of moisture

Wheat uses 5.5 inches of moisture devoted to vegetative growth and each additional inch of moisture will add 5 bushels of yield.

Yield goal 75 bushel
20.5 inches of moisture
Crops we will raise in 2017

1. Spring Wheat
2. Winter Wheat
3. Corn
4. Sunflowers
5. Soybeans
6. Field Peas
7. Red Lentils (grain-seed)
8. Indianhead Lentils (seed)
9. Flax (grain-seed)
10. Willow Creek WW (seed-forage)
11. Forage Peas (seed-forage)
12. Oats (seed-grain)
13. Teff Grass (forage)
14. Forage Barley (seed)
15. German Millet + Piper Sudan grass

73% high residue crops
27% low residue crops
2017 Rotations

1. Forage Sorghum – Corn – Sunflowers - SW – WW – Cover Crop - Corn
2. Corn – Soybeans – Soybeans – SW – WW
3. Field Peas – Corn – Sunflowers – SW
4. WW – Corn – Field Peas – Cover Crop – Corn-Oats
5. Corn – Soybeans – SW – Corn – Sunflowers – Teff grass
6. WW – Soybeans – Soybeans – Corn – Oats
7. WW – German Millet – Corn – Soybeans – Forage Barley
8. Sunflowers – SW – WW – Field Peas - Corn
9. Sunflowers - SW – WW – Cover Crop - Corn – Soybeans
10. Corn – Sunflowers – SW – WW – Cover Crop
12. Field Peas – WW – Corn
13. SW – Oats (Forage) – Alfalfa - Alfalfa
Letting Rotations Work For You

1. Feed the soil food web to promote soil health and gain OM
2. Help with weed control without the use of chemicals
3. Allows you to use different chemicals to stop resistance
4. Help manage our fertility by planting legume crops and taking N credits on past legume crops
5. Manage your residue
Do we need to worry about resistance weeds?

Kochia

Palmer Amaranth
A good crop rotation makes a good chemical rotation.

We are very concerned with resistance to herbicide. We might be doing everything to stop this but what is your neighbor doing.
Sampling Zoned Field For VRA

- 2005 Landsat
- 2007 Landsat
- VRA Map
- 2009 Yield Map
- RTK Elevation
Letting earth worms tell you your soil health

…it may be doubted if there are any other animals which have played such an important part in the history of the world as these lowly organized creatures."

Charles Darwin (1809-1882)
Earthworms burrows enhance water infiltration.

Earthworms tunneling can increase the rate of water entry into the ground 4 to 10 times higher than fields that lack worm tunnels.

During droughts these tunnels allow for deep plant root penetration into subsoil regions of higher moisture content in addition to organic matter.
**Earthworms:** Earthworm burrows enhance water infiltration and soil aeration. Earthworm tunneling can increase the rate of water entry into the ground 4 to 10 times higher than fields that lack worm tunnels (4). This reduces water runoff, recharges groundwater, and helps store more soil water for dry spells. Vertical earthworm burrows pipe air deeper into the soil, stimulating microbial nutrient cycling at those deeper levels. Tillage done by earthworms can replace some expensive tillage work done by machinery.

Worms eat dead plant material left on top of the soil and redistribute the organic matter and nutrients throughout the topsoil layer. Nutrient-rich organic compounds line the tunnels that may remain in place for years if not disturbed. During droughts these tunnels allow for deep plant root penetration into subsoil regions of higher moisture content. In addition to organic matter, worms also consume soil and soil microbes as they move through the soil. The soil clusters they expel from their digestive tracts is known as a worm cast or casing. Each worm cast is separate from other casts and ranges in size from that of a mustard seed to a sorghum seed depending on the size of the worm. The soluble nutrient content of worm casts is considerably higher than those of the original soil (see Table 2). A good population of earthworms can process 20,000 pounds of topsoil per year, with turnover rates as high as 200 tons per acre having been reported in some exceptional cases (5).

Earthworms also secrete a plant growth stimulant. Reported increases in plant growth due to earthworm activity may be attributed to this substance, not just to improved soil quality.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Worm casts</th>
<th>Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>171,000</td>
<td>78,500</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>10,720</td>
<td>7000</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>280</td>
<td>40</td>
</tr>
<tr>
<td>Potassium</td>
<td>900</td>
<td>140</td>
</tr>
</tbody>
</table>

*From Graff, O. 1971 (6) Soil had 4% organic matter.*
To recognize that a soil can be healthy. One has only to think of the soil as a living entity. It breathes, it transports and transforms nutrients, it interacts with the environment, and it can even purify itself and grow over time.
How we handle our corn biomass

We do not bale it
When you graze corn stalks you do not lose residue you just cycle it faster.
unlock your farm’s potential
dig a little
learn a lot
Dig in and smell

Healthy soil has a sweet and earthy aroma. This is the scent of geosmin, a byproduct of soil microbes called actinomycetes. These microbes decompose the tough plant and animal residues in and on the soil and bring nitrogen from the air into the soil to feed plants.

An unhealthy, out-of-balance soil smells sour or metallic, or like kitchen cleanser.

Dig in and feel

Healthy soil is easy to dig into. It is soft, moist, and crumbly, and allows plants to grow their roots more freely and unimpeded. This crumbly or granular structure is ideal because porous, healthy soil holds water for plants to use when they need it. Its increased water-holding capacity reduces runoff that can cause flooding, and increases the availability of water to plants during droughts.

An unhealthy, poorly functioning soil feels dry, crusty, and cloddy and does not crumble readily when pulled apart.
The value of a tile spade. You can tell when you have heathy soil.
Food Security (Sustainability)

It’s all about (mostly) “C” management!
What Mother Nature Has Been Doing For Years
True soil conservation is more related to plant management than soil management because plants provide carbon from the atmosphere to the soil.
Carbon is a key ingredient in soil organic matter (57% by weight).

Plants produce organic compounds by using sunlight energy and combining carbon dioxide from the atmosphere with water from the soil.

Soil organic matter is created by cycling of these organic compounds in plants, animals and microorganisms into the soil.
“A nation that destroys its soil, destroys itself.”
Franklin D. Roosevelt, 1937

Organic Matter composition under prairie

- 45-50% passive OM
- 30-35% slow OM
- About 10% active OM
- About 10% plant residues
80 to 90% passive OM
Less than 10% slow OM
Less than 2% active OM

“To forget how to tend the soil, is to forget ourselves” Mahatma Gandhi
Improving organic matter on our farm

Grass for 60 years sampled fall 2011 5.1% OM

Average land on our farm 2001 2.8% OM

Average land on our farm 2015 4.3% OM
Benefits of Organic Matter

1. Nutrient Supply
   Each percent of OM release 20 to 30 lbs. of N
   4 to 6 lbs. phosphorus
   2 to 3 lbs. sulfur
2. Water Holding Capacity

Organic Matter acts like a sponge. It will hold up to 90% of its weight in water.

3. Soil Structure Aggregation

Organic matter causes soil to form aggregates which helps with water infiltration.

4. Erosion Prevent

Increasing soil organic matter from 1 to 3 percent can reduce erosion by 20 to 30 percent because of water infiltration.
The Message

A great deal of the carbon once stored in the soil is now stored in the atmosphere.

We desperately need to return this carbon back to the soil as humus.
# Table 2: Value of Soil Organic Matter

Assumptions: 2,000,000 pounds soil in top 6 inches

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>1% organic matter = 20,000# 50% Carbon, C:N ratio = 10:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen:</td>
<td>1000# * $0.50/#N = $500</td>
</tr>
<tr>
<td>Phosphorus:</td>
<td>100# * $.70/#P = $70</td>
</tr>
<tr>
<td>Potassium:</td>
<td>100# * $0.40/#K = $40</td>
</tr>
<tr>
<td>Sulfur:</td>
<td>100# * $0.50/#S = $50</td>
</tr>
<tr>
<td>Carbon:</td>
<td>10,000# or 5 ton * $4/Ton = $20</td>
</tr>
<tr>
<td>Value of 1% SOM Nutrients/Acre</td>
<td>= $680</td>
</tr>
<tr>
<td>Relative Ratio of Nutrients:</td>
<td>100 Carbon/10 Nitrogen/ 1 Phosphorus/1 Potassium/1 Sulfur</td>
</tr>
</tbody>
</table>
First cover crop planted 2006
Canola – Indian Head Lentils
We received 13.7 inch's rain in 2006

2007 corn yield map
Yield 145 bushel

19.5 inch's moisture 2007
Cover crops and C:N ratio

- Small grains have high C:N ratio
- Mature, older crops have high C:N ratio
- Legumes have low C:N ratio
- Succulent, young crops have low C:N ratio
Heifers on full season covers November 15
Rotations on our pivots

- Corn
- Soybean
- Teff Grass
- Oats
- Cover Crop
We have to do our part to protect this resource.
Grazing cover crop
Weaning on covers

Field Peas
Warm season cover
10 way mix planted July 22
Pivot planted to field peas harvest for grain
Planted to covers and used for weaned calves.
Pivot planted to corn 2017
2016 Spring Wheat Projections

Production Cost $256

Estimated Yield 70 bushel
Estimated Price $4.75

Gross $332

Net/acre $76 (spring wheat)
Buckwheat
Flax
Okra
BMR Sorghum
BMR Corn
Dwarf BMR Oats
Forage Peas
Lentils
Cow Peas
Rape
Kale
Turnips

Inoculant

C/N Ratio 32/1

Crude protein 16%

Forms arbuscular mycorrhizal association

Enhance soil P

Benefits arbuscular mycorrhizal

Full season graze 2016-2017
Planting full season cover crop into Teff stubble
Mycorrhizal Fungi

Assists with P uptake from the soil.

Moves P from the non-legume plant to the legume plant.

Moves N from the legume plant to the non-legume plant.

The Nature and Property of Soils, Brady and Weil
Planted July 10
Strips in cover crop with no nitrogen
September 12 biomass
Time for second biomass sample

11/28/16
8,237 biomass = 906 lbs. protein or 144 lbs. N

<table>
<thead>
<tr>
<th></th>
<th>Aug. 14</th>
<th>Nov. 28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three Way</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRY Biomass</td>
<td>9,558</td>
<td>7,758</td>
</tr>
<tr>
<td>RFV</td>
<td>83</td>
<td>75</td>
</tr>
<tr>
<td>RFQ</td>
<td>118</td>
<td>102</td>
</tr>
<tr>
<td>Protein</td>
<td>8.8%</td>
<td>7.3%</td>
</tr>
<tr>
<td>C/N Ratio</td>
<td>31/1</td>
<td>39/1</td>
</tr>
<tr>
<td>12 Way With N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRY Biomass</td>
<td>7,120</td>
<td>8,237</td>
</tr>
<tr>
<td>RFV</td>
<td>97</td>
<td>88</td>
</tr>
<tr>
<td>RFQ</td>
<td>119</td>
<td>131</td>
</tr>
<tr>
<td>Protein</td>
<td>8.8%</td>
<td>11.0%</td>
</tr>
<tr>
<td>C/N Ratio</td>
<td>31/1</td>
<td>25/1</td>
</tr>
<tr>
<td>12 Way No N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRY Biomass</td>
<td>7,620</td>
<td>4,898</td>
</tr>
<tr>
<td>RFV</td>
<td>108</td>
<td>85</td>
</tr>
<tr>
<td>RFQ</td>
<td>140</td>
<td>107</td>
</tr>
<tr>
<td>Protein</td>
<td>8.3%</td>
<td>7.3%</td>
</tr>
<tr>
<td>C/N Ratio</td>
<td>32/1</td>
<td>38/1</td>
</tr>
<tr>
<td>Nutrient Type</td>
<td>Analysis As Received</td>
<td>Analysis Dry Basis</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Moisture, %</td>
<td>60.14</td>
<td>0.00</td>
</tr>
<tr>
<td>Dry Matter, %</td>
<td>39.86</td>
<td>100.00</td>
</tr>
<tr>
<td>Biomass Weight, g</td>
<td>1945.1</td>
<td></td>
</tr>
<tr>
<td>PROTEIN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Crude Protein, %</td>
<td>4.4</td>
<td>11.0</td>
</tr>
<tr>
<td>FIBERS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acid Detergent Fiber, %</td>
<td>14.8</td>
<td>37.1</td>
</tr>
<tr>
<td>Neutral Detergent Fiber, %</td>
<td>25.3</td>
<td>63.5</td>
</tr>
<tr>
<td>NDFD (digestibility) 48 hr, % of NDF</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>IVTDMD (in vitro true digestibility) 48 hr, %</td>
<td>31.2</td>
<td>78.2</td>
</tr>
<tr>
<td>ENERGIES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TDN Est., %</td>
<td>24.0</td>
<td>60.3</td>
</tr>
<tr>
<td>Net Energy Lact, MCal/lb</td>
<td>0.2459</td>
<td>0.6169</td>
</tr>
<tr>
<td>Net Energy Maint, MCal/lb</td>
<td>0.2391</td>
<td>0.5997</td>
</tr>
<tr>
<td>Net Energy Gain, MCal/lb</td>
<td>0.1352</td>
<td>0.3390</td>
</tr>
<tr>
<td>QUALITY VALUE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative Feed Value</td>
<td></td>
<td>88</td>
</tr>
<tr>
<td>Relative Forage Quality</td>
<td></td>
<td>131</td>
</tr>
</tbody>
</table>
Yield biomass/acre | Graze% | Lbs.to graze
---|---|---
8,237 lbs. | 66% | 5,430

156 acres 847,300 lbs.

Cattle to graze 675 * 30 lbs. feed/day

20,250 total lbs. feed/day

40 days grazing
Cover crop production cost $147/acre

156 acres * $147 = $22,932 total cost

650 cows 46 days graze

$.75 cost/day

11% protein
$1.65 cost/day at 20\textdegree C temp

Cost /day with feed wagon $1.65
Cover crop cost / day $0.75
Saving/day $0.90

$585 saving / day

Net $172/acre
December 22 cattle grazing
**Table 1. Voluntary feed intake of beef cattle in different thermal environments. (Adapted from NRC, 1981)**

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Intake relative to published values (NRC, 1974)</th>
</tr>
</thead>
<tbody>
<tr>
<td>78 to 60°F</td>
<td>Published values in Nutrient Requirements of Beef Cattle</td>
</tr>
<tr>
<td>60 to 40°F</td>
<td>Intake stimulated 2 to 5%</td>
</tr>
<tr>
<td>40 to 22°F</td>
<td>Intake stimulated 3 to 8%</td>
</tr>
<tr>
<td>22 to 5°F</td>
<td>Intake stimulated 5 to 10%</td>
</tr>
<tr>
<td>&lt;5°F</td>
<td>Intake stimulated 8 to 25% - intake during extreme cold or blizzards may vary greatly. Intake of high-roughage feeds may be limited by bulk.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Herd Cows</th>
<th>24*Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lbs feed</td>
<td>Cost/lb</td>
</tr>
<tr>
<td>Silage</td>
<td>18,900</td>
<td>$0.011</td>
</tr>
<tr>
<td>Hay</td>
<td>6,000</td>
<td>$0.063</td>
</tr>
<tr>
<td>Corn</td>
<td>3,300</td>
<td>$0.048</td>
</tr>
<tr>
<td>peas</td>
<td>900</td>
<td>$0.108</td>
</tr>
<tr>
<td>Feed labor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29,100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loads</td>
<td>3</td>
<td>650</td>
</tr>
<tr>
<td>Labor/load</td>
<td>$75.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Herd cow</th>
<th>DM needs</th>
<th>-3*</th>
<th>1200 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lbs of feed</td>
<td>Cost/lb</td>
<td>Feed Cost</td>
</tr>
<tr>
<td>Siage</td>
<td>24,868.42</td>
<td>$0.011</td>
<td>66%</td>
</tr>
<tr>
<td>Hay</td>
<td>7,894.74</td>
<td>$0.063</td>
<td>12%</td>
</tr>
<tr>
<td>Corn</td>
<td>4,342.11</td>
<td>$0.048</td>
<td>12%</td>
</tr>
<tr>
<td>Peas</td>
<td>1,184.21</td>
<td>$0.108</td>
<td>12%</td>
</tr>
<tr>
<td>Labor</td>
<td>1,184.21</td>
<td>$200.00</td>
<td>12%</td>
</tr>
<tr>
<td>Total feed</td>
<td>38,289.47</td>
<td>DM</td>
<td>20,266</td>
</tr>
</tbody>
</table>

650 Cattle

31.18 DM/head
¼ feeding with wagon  8# DM cost $298/ day

3/4 feeding cover crop 22# DM $806/day

$892* 36 days =$32,116  (cover crop feed value) $22,900  (production cost)
$59 return/acre from cover crop graze

“We cannot change the cards we are dealt, just how we play the hand.”  
Randall Pausch
We have been feeding 150 deer. This will not be as bad on a normal winter. We hope!!! We feel we lost one paddock to the deer that would be 31 acres or 7 days grazing.
Herd cows bale grazing late January.
You can tell your soil health by
1. Looking - it will have great texture
2. Touching - it crumbles like moist chocolate cake
3. Smelling – it will have same smell as freshly dug potatoes
Yield Goals Bushels / Acre

- **Corn**: 2011-2016 - 155 bushels, 1996-2001 - 70 bushels
- **Spring Wheat**: 2011-2016 - 75 bushels, 1996-2001 - 35 bushels
- **Winter Wheat**: 2011-2016 - 85 bushels, 1996-2001 - 50 bushels
- **Sunflowers**: 2900 lbs., 2011-2016 - 110 bushels, 1996-2001 - 80 bushels
No-Till
Diversified Rotation
Cover Crops
Cattle
= Soil Health
Nothing can stop the man with the right mental attitude from achieving his goal; nothing on earth can help the man with the wrong mental attitude. — Thomas Jefferson (1743-1826)
Making It A Better World

Think Soil Health

Thank You For Your Time