Climate Smart Precision Agriculture

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Early 1900s
- Cover about ~ 3 acres/day (~1.5 ha)
- Harvesting about ~50bu or 1.3 tons of corn

100 yrs later
- Cover over 300 acres in ~150ha/day (8hrs)
- Harvest over 1100 tons

http://fatknowledge.blogspot.com/2008/06/us-corn-consumption.html

Digital Yield Map

Pixels = Average?

Mean: 182.5 bu/A

<172.5 bu/A

24% Under-fertilized

172.5 bu/A

8%

>192.5 bu/A

40%

Over-fertilized

HABER-BOSCH PROCESS

Nitrogen

- Responsible for half of today's world food
- Without it, 30-40% of population would not be alive

Process fixing N in the air into ammonia

One of the greatest inventions of the 20th century

Responsible for half of today's world food

Without it, 30-40% of population would not be alive
Agriculture represents the largest anthropogenic source of Nitrous oxide (N₂O) emissions

1 N₂O = 298 CO₂

Sources: EPA, 2013; IPCC 2007, CAIT 2.0

- Human sewage (3%)
- Atmospheric deposition (9%)
- Biomass burning (10%)
- Agriculture (67%)
- Fossil Fuel combustion and industrial processes (10%)

Global NPK fertilizer consumption

25% increase in 10 years (from 2008 levels)

Recent declaration by FAO senior plant production and protection specialist Caterina Batello

Source: FAOStats
Closer look to the US N fertilizer consumption

\[ N \text{ fertilizer use (1960 to 1980)} \]
\[ y = 438x + 2319 \]

\[ N \text{ fertilizer use (1981 to 2011)} \]
\[ y = 72x + 9991 \]

\[ N \text{ fertilizer use (1994 to 2011)} \]
\[ y = 13x + 11179 \]

For farmers to practice CSA, mandates enhancement of NUE

Precision agriculture

For farmers to practice CSA, mandates enhancement of NUE

Long-term research at Colorado State University since 1997

Site-specific management zones is an effective tool for CSA
Delineating management zones…

The three data layers
- Aerial Imagery
- Topography
- Farmer’s experience

are stacked as GIS layers to delineate the zone

Traits such as dark color, low-lying topography, and historic high yields were designated as a zone of potentially high productivity or high zone.

Macro-variability

Micro-variability

~60 lb/a
~180 lb/a
~160 lb/a

NDVI
0.78
0.4
0.63

N Rate (kg ha-1) = (135.3 × (NDVIRef / NDVITarget)^2) – (134.8 × (NDVIRef / NDVITarget)) + 1
Modeling N₂O emissions

Adapted from a presentation by Dr. Dennis Ojima

PSA BD
KSat
FC
WP
Min. T
Max. T

Crop
Fertilizer
H₂O
Tillage/Harvest

DAYCENT model

Plant Production
SOM changes
Trace Gas Fluxes

Difference in N₂O emission (kg/ha/y)
0
0.7
5
10
2010 2011 2012

Reductions in N₂O with precision N mgmt.

-54%
-55%
-50%

What does this means for Colorado?

1.1 Million ha of Corn (USDA NASS 2015)

Uniform application: 5.75 kg N₂O/ha/y
Precision N application: 3.25 kg N₂O/ha/y
Difference: 2.50 kg N₂O/ha/y
2,750 Mt N₂O/year
1.1 Million ha of Corn (USDA NASS 2015)

What does this mean for Colorado?

N₂O emissions

Impact at the US level  N₂O emissions

36.7 Million ha of Corn (USDA NASS 2015)

"USDA and its partners are moving forward to reduce net emissions and enhance carbon sequestration by over 120 million metric tons of CO₂ equivalent per year [...] by 2025."

"This reduction is equivalent of taking 25 million cars off the road [...] per yr."

5,780,444 - 1 input - 1 crop - 1 mgmt year
alternative management practices could substantially mitigate agricultural GHG fluxes, ranging from a 34% reduction with a 25% adoption rate to as much as complete elimination with possible net sequestration of C when a greater proportion of farmers adopt new agricultural practices.

Potential for reductions in N₂O emissions around the world

Thank you

Climate Smart Precision Agriculture
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