Challenges in Accounting for Variability and Developing Variable Rate Prescriptions

Jeff Schoenau PAg

Dept. of Soil Science

University of Saskatchewan
College of Agriculture and Bioresources

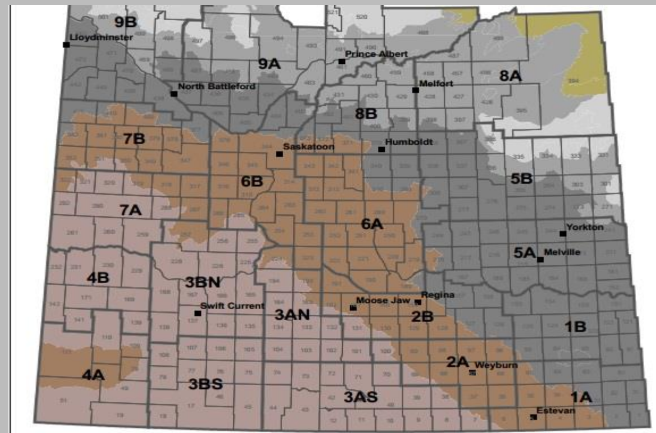
Developing a Good Variable Rate Prescription:

A Soil Scientist's Perspective

- ✓ Understanding Variability in Soils
- ✓ Formulating a VR Fertilization Plan: Approaches, Requirements, Challenges

Scales of Soil Variability

Regional



Kilometers

Farm & Field

Macro

Meters

Micro

Centimeters

For farm and field, it can all seem **rather random** at first glance!

The goal

Converting random variation into systematic variability: variability we understand!

1) Soil properties, crop yields are different in different places for a reason (s)

2) Group according to source and nature of variation

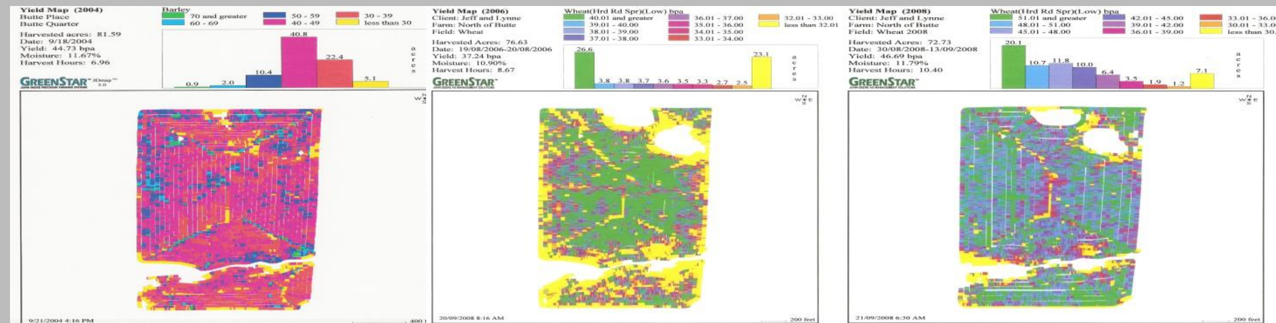
3) Creation of separate management units or zones within the field.

Developing / Delineating Management Zones

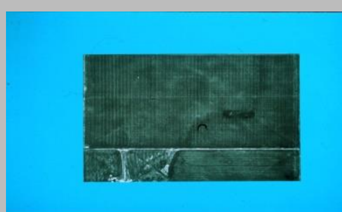
Many Approaches (SMA Variable Rate Treatments Fact Sheet)

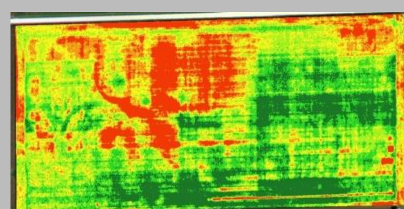
- Yield maps

  Protein maps



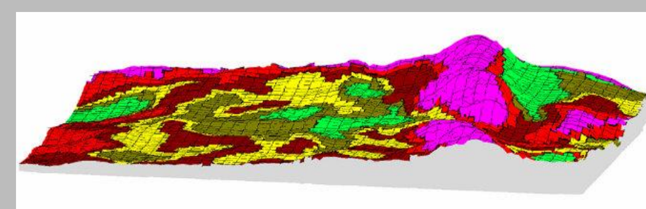
- Aerial/Satellite Imagery





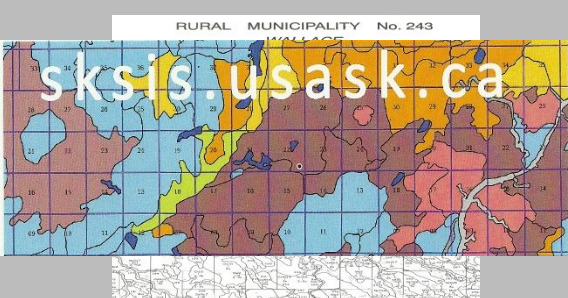
www.planthealthimaging.com

Topography



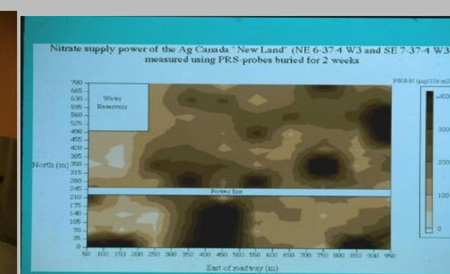
www.farmersedge.ca

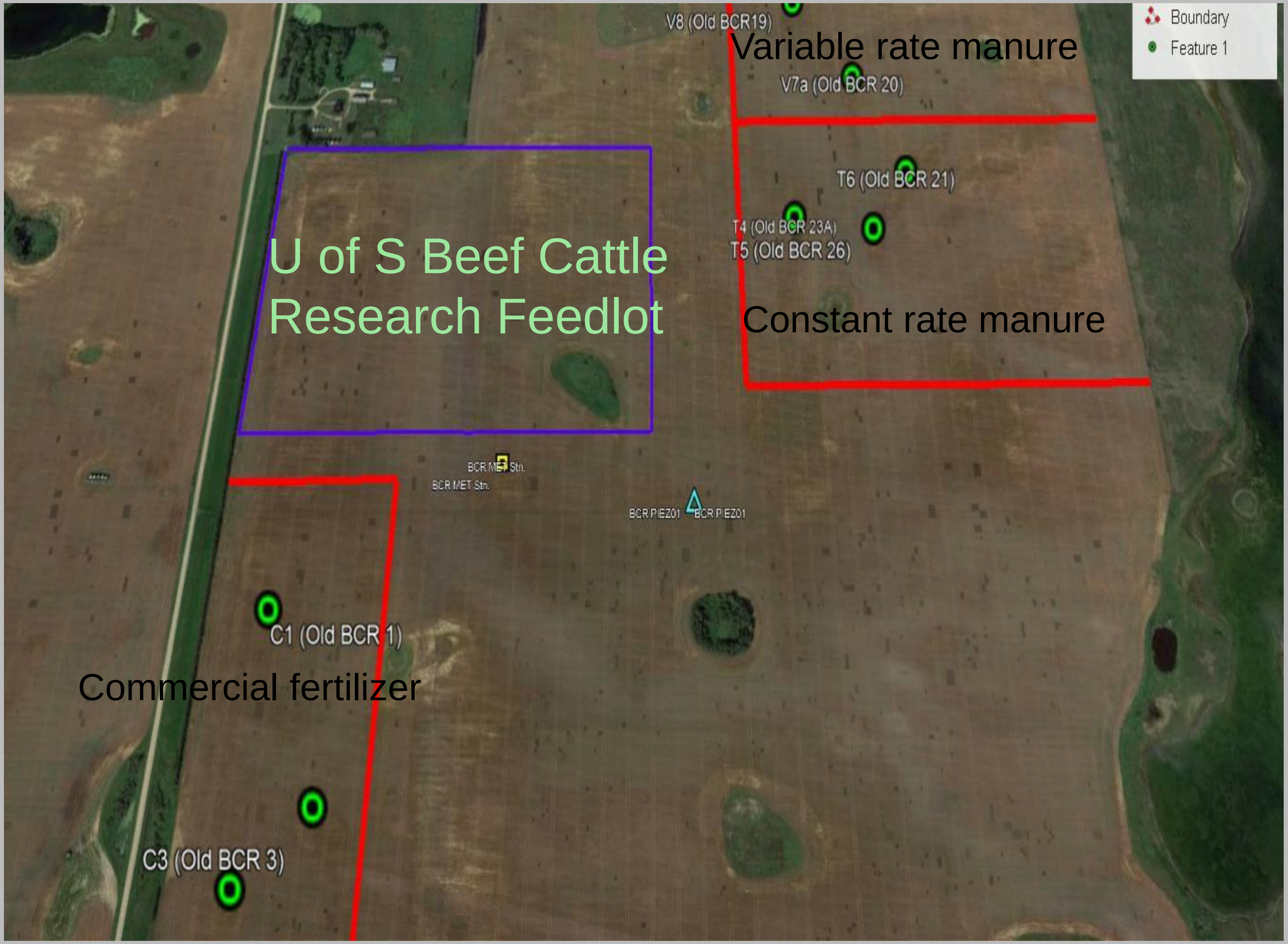
- Digitized soil maps, EC (Veris, EM38)



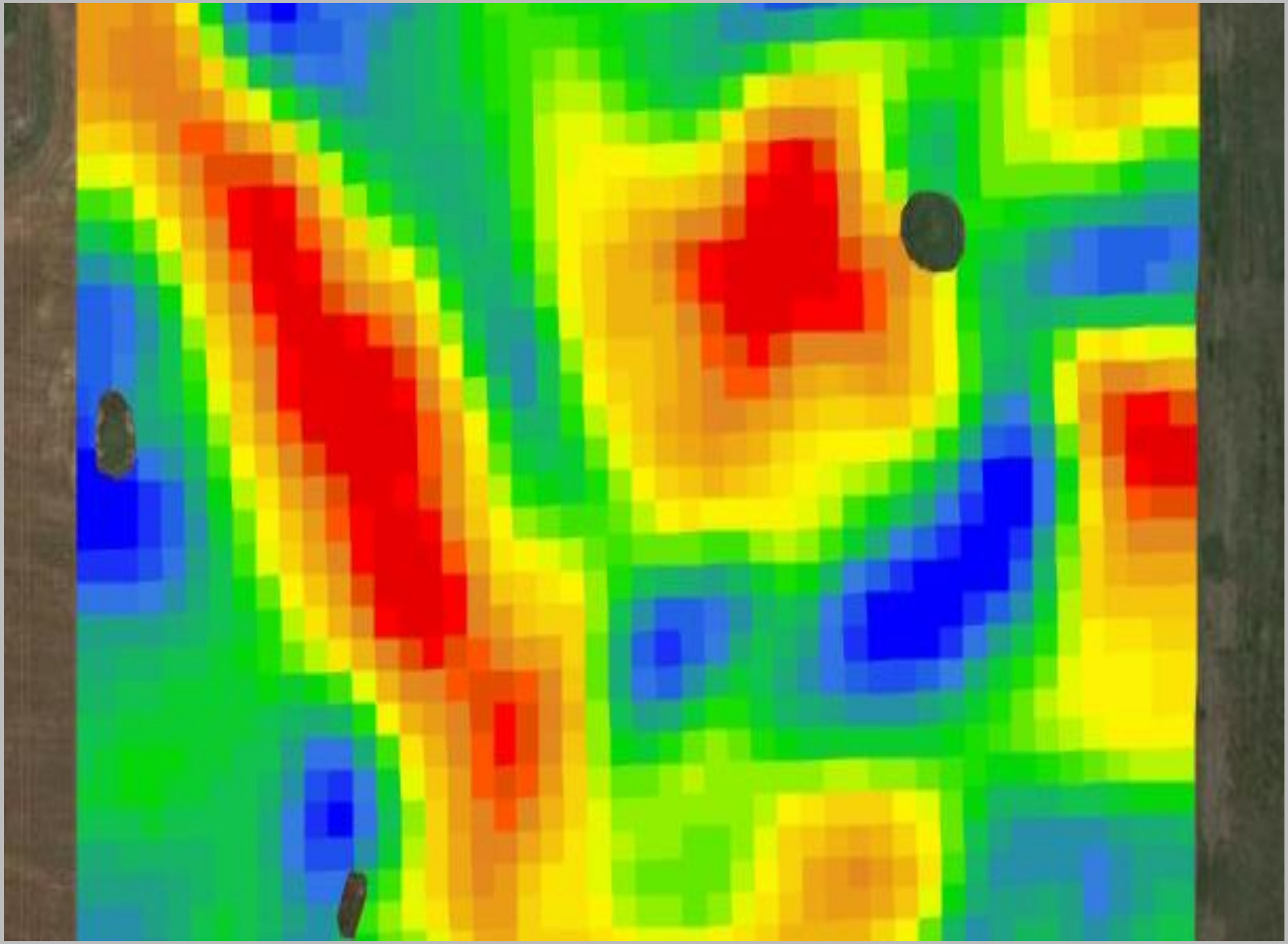
www.veris.com

Soil & plant sampling, testing





Boundary
Feature 1
V8 (Old BCR19)
Variable rate manure
V7a (Old BCR 20)
T6 (Old BCR 21)
T4 (Old BCR 23A)
T5 (Old BCR 26)
U of S Beef Cattle Research Feedlot
Constant rate manure
BCR MET Stn.
BCR MET Stn.
BCR PIEZ01
BCR PIEZ01
C1 (Old BCR 1)
Commercial fertilizer
C3 (Old BCR 3)



NDVI Map of NE 21-34-3-Wof 3rd at BCRTU courtesy Echelon™

Sources of Variation in Soil Nutrient Availability Across Fields:

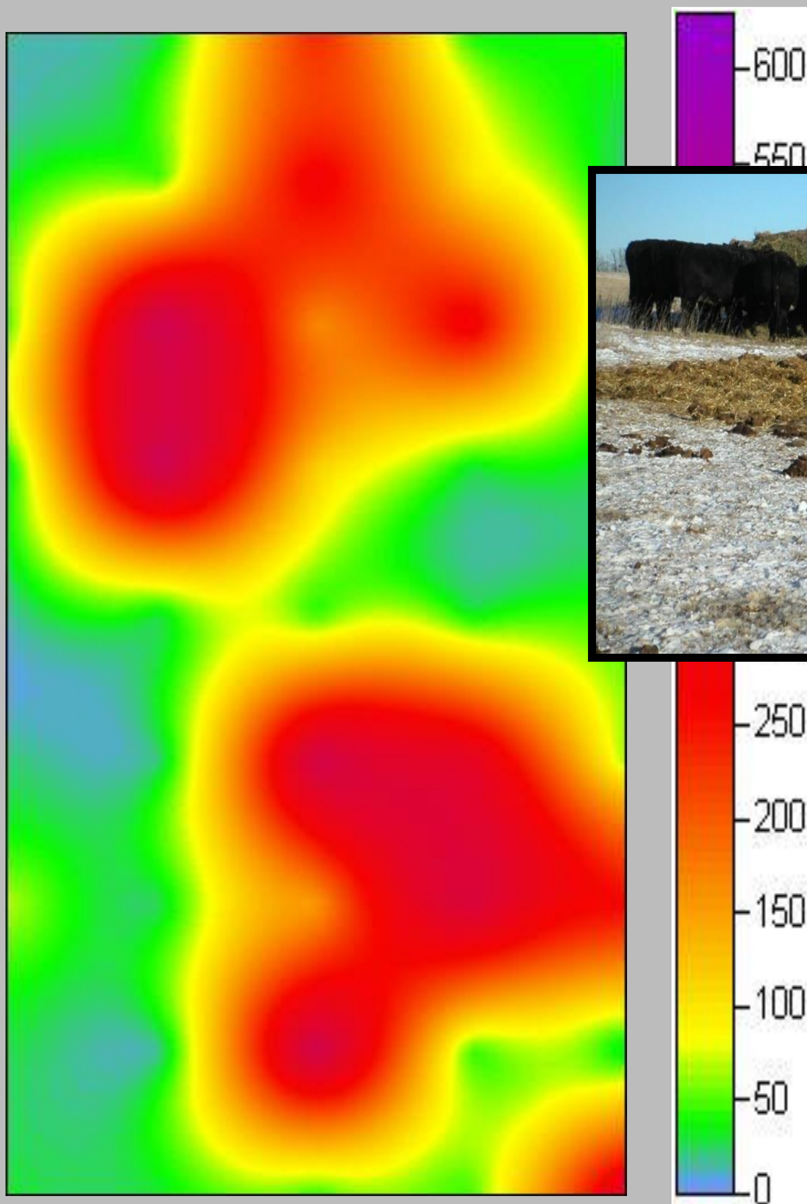
1)Topography

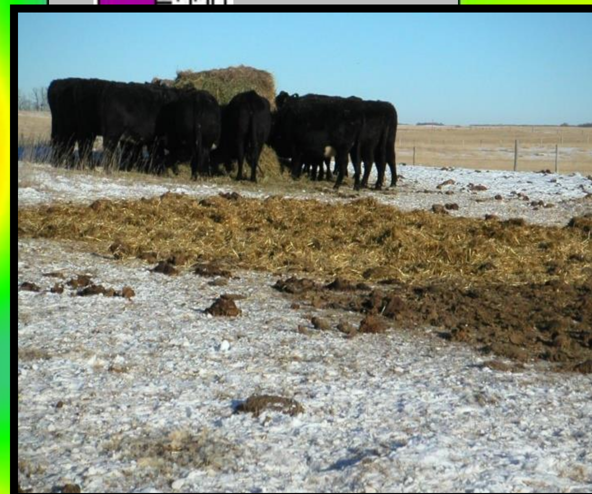
2)Past Management

3) Parent Material

Soil Test N

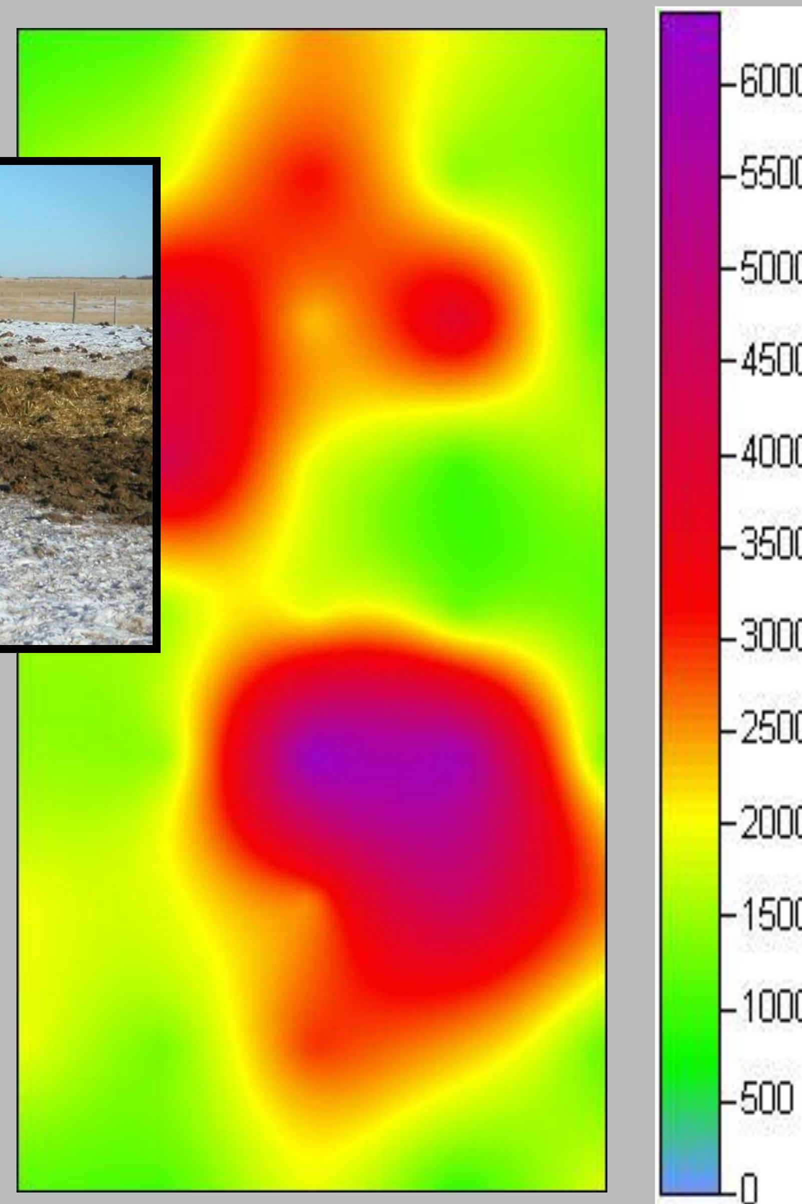
(0-6” depth, lb N/acre)





Soil Test K

(0-6” depth, lb K/acre)



Microscale variability (variation in available nutrient over just a few cm) in soils can be huge!

(B. Weiseth MSc project fall 2014)

	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	13.4	12.8	9.8	11.2	17.4
4 cm	5.7	5.9	4.3	4.1	4.6
7 cm	1.4	1.5	1.6	1.4	1.7
10 cm	1.4	1.3	1.5	1.4	1.8

Unfertilized Control

Soil Test P Values in Fall after Harvest

	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	5.3	8.5	20.7	12.8	9.6
4 cm	3.4	6.5	13.0	9.2	5.6
7 cm	1.6	2.1	2.0	3.0	2.2
10 cm	1.1	1.6	2.4	2.7	2.0

Seed Placed 20 lbs P_2O_5/acre

How to account for micro and macroscale variability in a management unit?

(Hu,Schoenau and Si, 2014. J. Precision Agric.)

- Microscale: sample across seed-rows.

30-60cm width for CV<10%

~30cm for avail P, ~60cm for N

- Macroscale: take lots of samples!

40 to 80 cores for nutrient CV<10%

40 in VR field, 80 in CR

- Variable rate fertilization, direct seeding helps to smooth out, reduce the macroscale variability.

Putting It All Together: *Formulating the Prescription*

- This is the challenging part!
- How to vary rate of application among management units?
- Which gets more, which gets less?
- How much more? How much less (if any)?

Back to the Basics

NEED TO CONSIDER ALL FACTORS THAT INFLUENCE CROP RESPONSE TO ADDED FERTILIZER

Crop response to added fertilizer nutrient at a particular location in the field depends on:

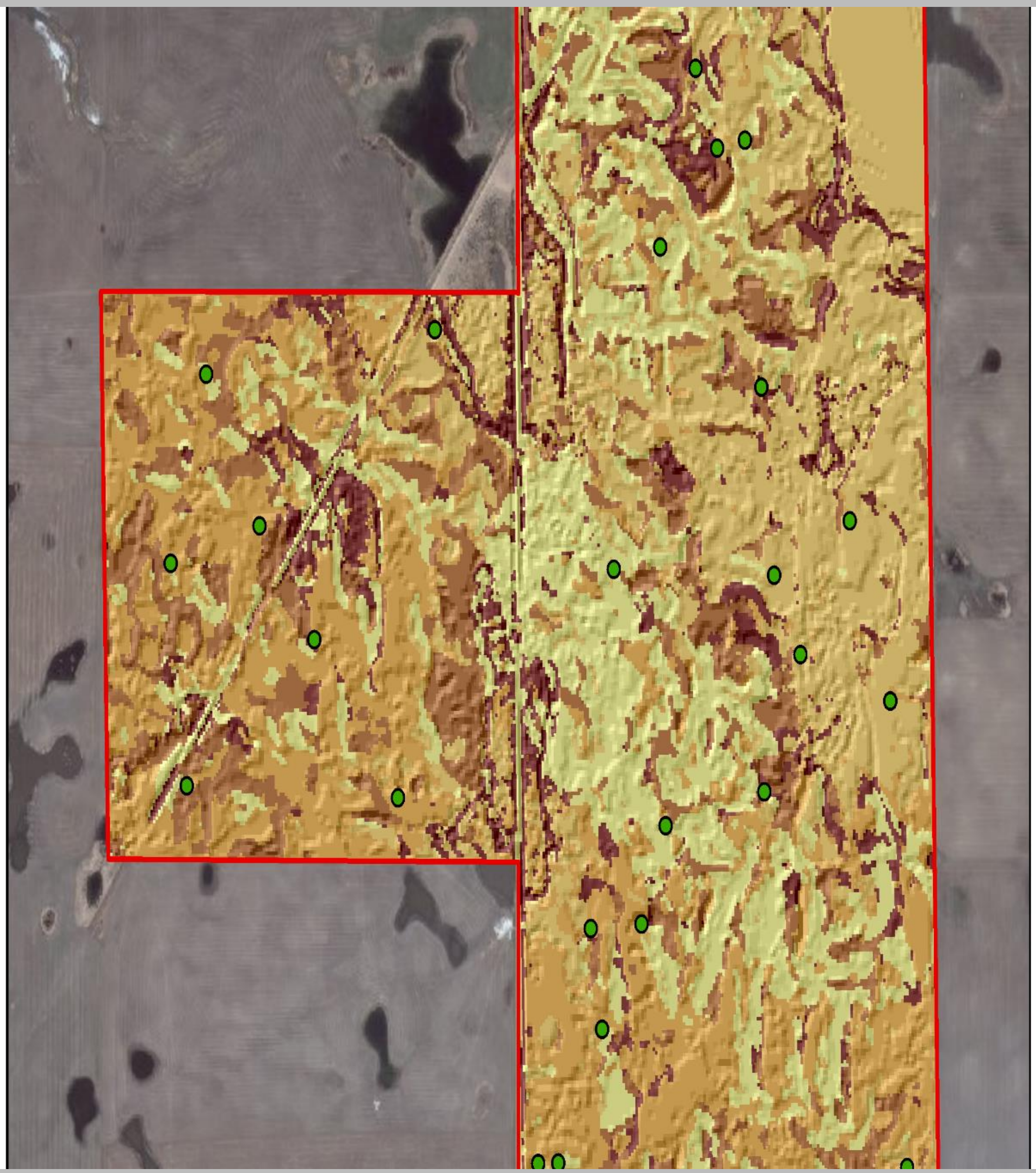
1) <u>Capacity of soil</u> to supply that particular nutrient over growing season, and relative balance of other nutrients.

2) <u>Relative supply of physical factors</u> that act as limitations on crop growth and fertilizer response: water, soil conditions

3) <u>Biological limitations</u> imposed by weeds, disease, insects

NEED GOOD INFORMATION ON ALL THESE FACTORS!

Soil Properties, Crop Yield, Quality: Direct measures, remote sensing



Topsoil thickness = fertility, productivity

The Challenge

<u>As yet unknown variations</u> in soil moisture, weather, pests and their effects on soil capacity, yield potential and fertilizer response are <u>magnified within different regions of the field</u>.

Dry-Normal year: low spots very productive

Wet year: low spots flooded out!

Fertilizing to “normal” conditions often doesn’t mean much in Saskatchewan! More extremes than normal

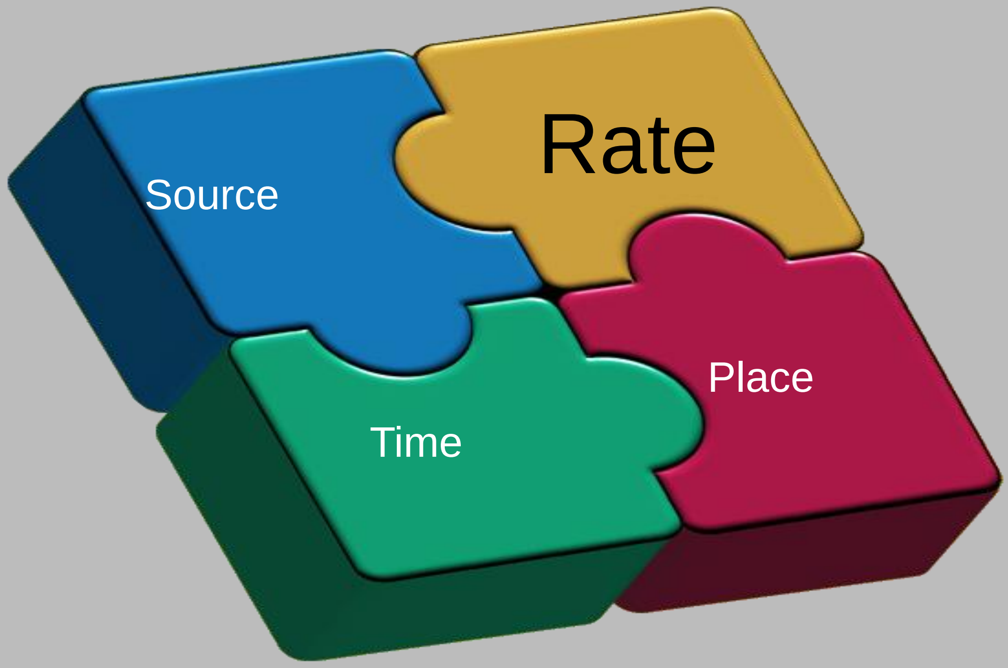
We need good forecasting tools!

http://bestpaperz.com

And record keeping

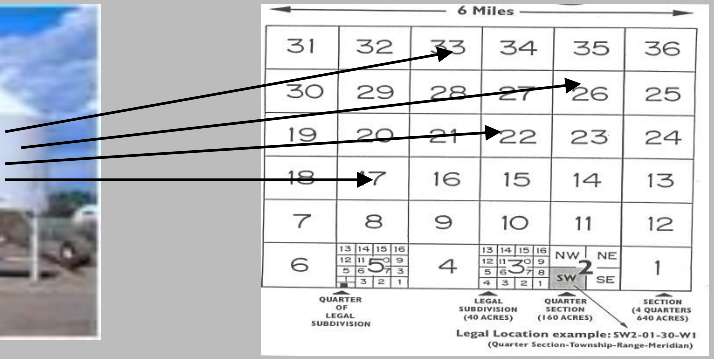
Robust prescriptions are developed with several sources of information, have local knowledge incorporated, are flexible, and are tested, validated.

Nutrient Rates: Where to put more? Where to put less?



N rates have been going up

- Benefits achieved: e.g. record yields in 2013
- Is the allocation of the N among fields on the farm the best that it can be?



Probably not!

Tendency to pick one fertilizer blend, one rate, and apply same rate across all acres for a crop on the farm.

Gains can be made by recognizing differing fertility, production potentials on different fields, adjusting rate accordingly.

- Accounting for the differences in nutrient supplying power **among fields** is the first step in precision nutrient management.

- Soil “building”: e.g. application of manure, P, K, micronutrients to eroded portions **within fields**.

Guidelines for Developing Sound Variable Rate Fertilization Prescriptions

- Assemble management areas based on key soil and crop indicators of productivity, fertilizer response.
- Understand and address all limitations that may exist within and among management zones.
- Recognize that there is no one simple formula, one size does not fit all.
  - Time, patience and effort required to make it work for prairie cropping systems. A single year of evaluation is not enough.

Precision fertilization, variable rate tech will provide benefit

- Going to take some time and effort by everyone to figure it all out!