Can Organic Farms Benefit from Precision Agriculture?

Soils and Crops Conference 2020

Presented by: Sasha Loewen
PhD student Montana State University
Department of Land Resources and Environmental Sciences
Advisor: Bruce Maxwell

Outline

- Research Problem/Question
- Methods & Preliminary Results
  - A Manitoba Example of On Field Precision Experimentation
- Challenges
- Future

Research Problem

- Feeding a growing population while maintaining ecosystem services
- Solutions?
  - Organic Agriculture
    - No synthetic fertilizer, no chemicals
      - Low yield
  - Precision Agriculture
    - Reams of unused data

AGRICULTURE

Sustainable Intensification in Agriculture: Premises and Policies

T. Garnett[1], M.C. Appleby[2], A. Balmford[3], I.J. Bateman[4], T.G. Benton[5], P.Bloomer[6], B. Burlingame[7], M. Dawkins[1], L. Dolan[1], D. Fraser[8], M. Herrero[9], I. Hoffmann[7], P. Smith[10], P.K. Thornton[11], C. Toulmin[12], S.J. Vermeulen[11], H.C.J. Godfray[1*]

nature
International journal of science

Letter | Published: 25 April 2012

Comparing the yields of organic and conventional agriculture

Verena Seufert, Navin Ramankutty & Jonathan A. Foley

The power of agricultural data Science

Joshua D. Woodard[1,*], Bruce J. Sherrick[2], Deborah M. Atwood[3], Robert Blair[4], Greg Fogel[5], Nicholas Goeser[6],
+ See all authors and affiliations

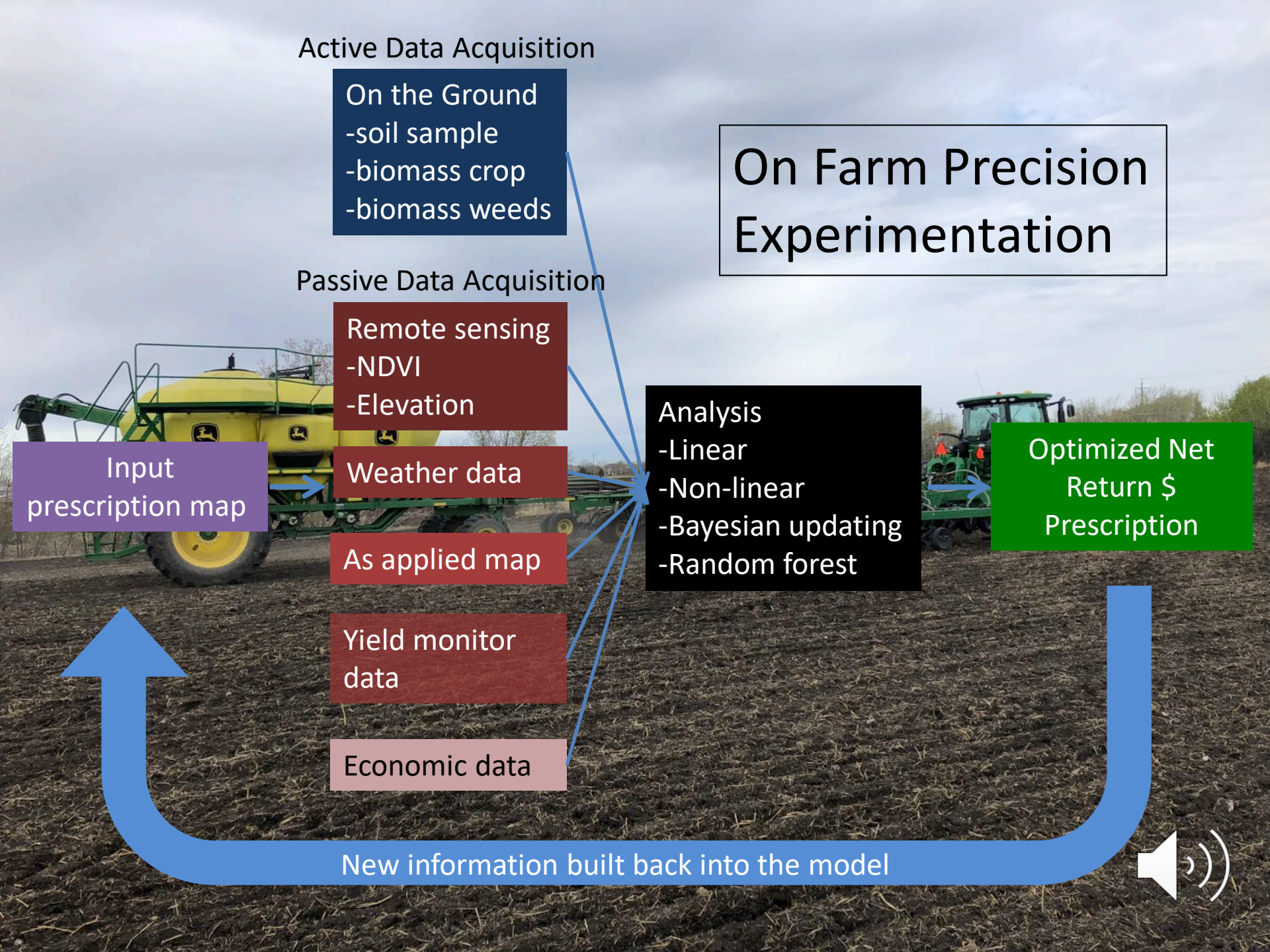
Science 26 Oct 2018:
Vol. 362, Issue 6413, pp. 410-411
DOI: 10.1126/science.aav5002

Solutions for a cultivated planet nature

Jonathan A. Foley[1], Navin Ramankutty[2], Kate A. Brauman[1], Emily S. Cassidy[1], James S. Gerber[1], Matt Johnston[1], Nathaniel D. Mueller[1], Christine O'Connell[1], Deepak K. Ray[1], Paul C. West[1], Christian Balzer[3], Elena M. Benn[4], Stephen R. Carpenter[5], Jason Hill[1,6], Chad Monfreda[7], Stephen Polasky[1,8], Johan Rockström[9], John Sheeh[an], Sie[ert][10], David Tilman[1,11] & David P. M. Zaks[12]

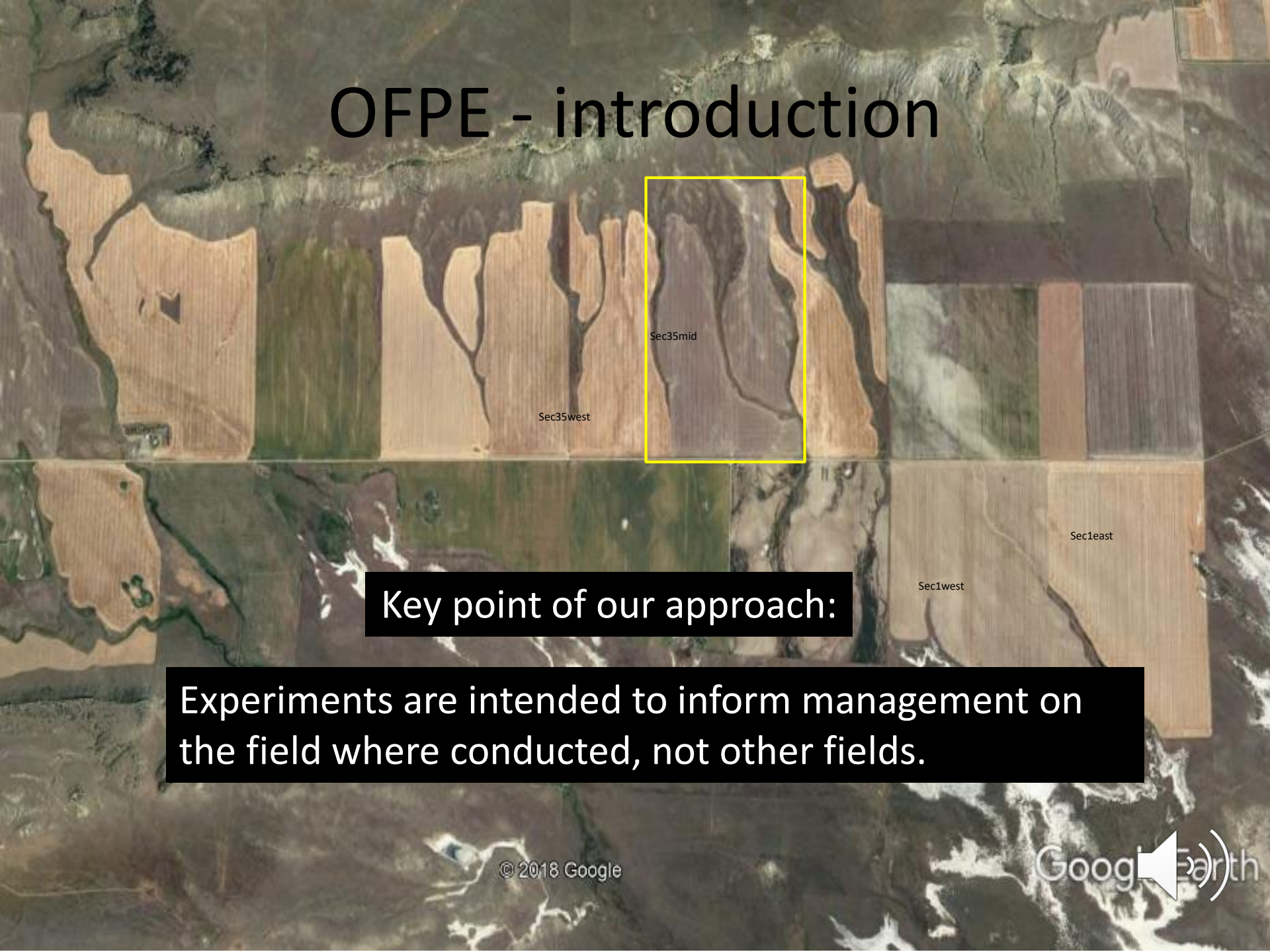
Research Question

- Can we improve yields (and the farmer's bottom line) using PA?
- Apply On Farm Precision Experimentation (OFPE) to answer this question



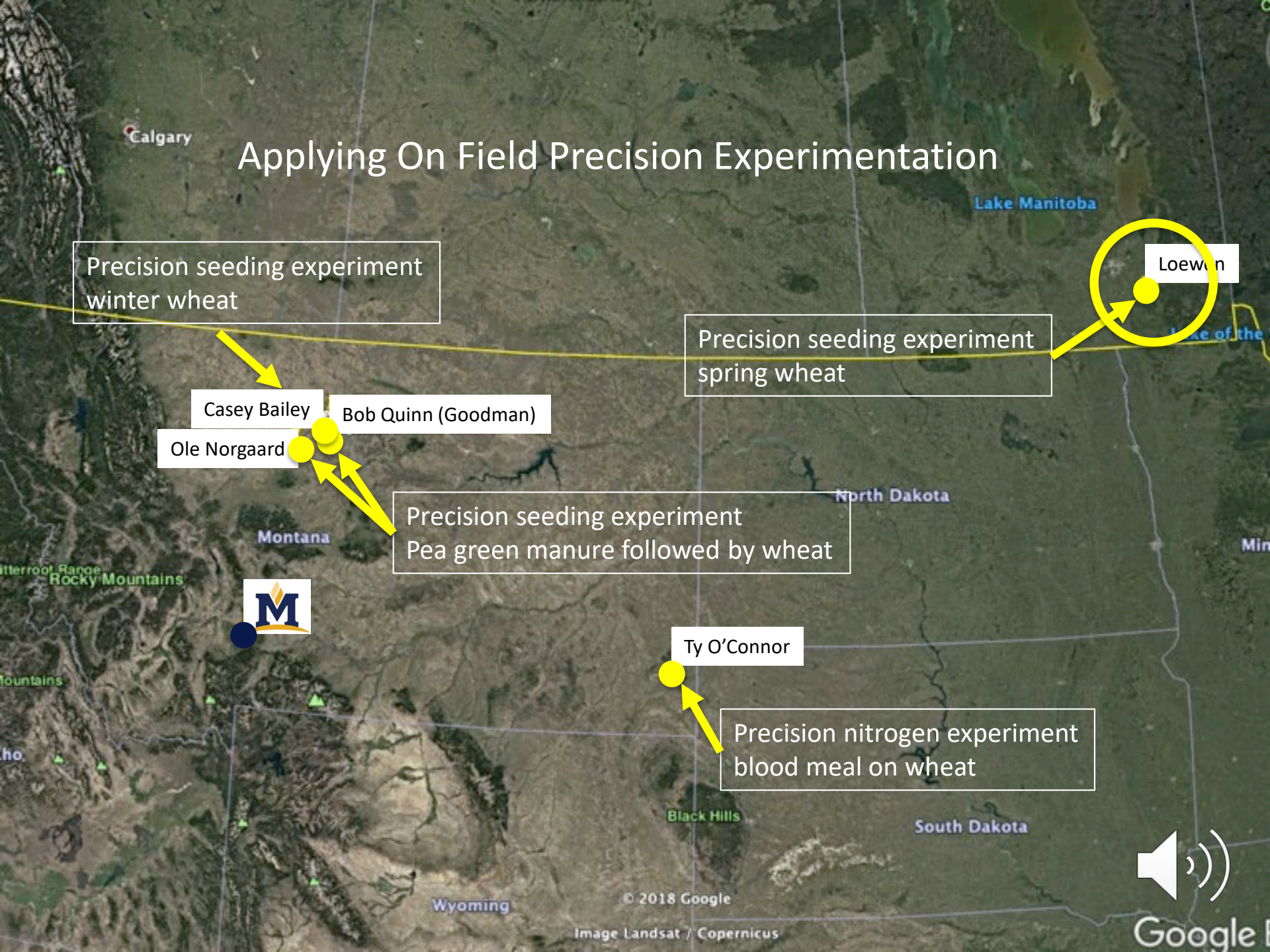
On Farm Precision Experimentation

OFPE - introduction

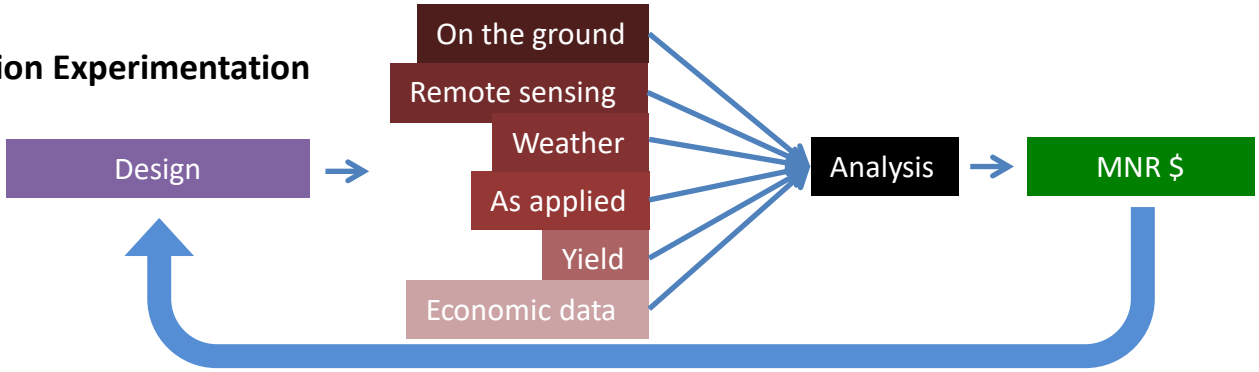


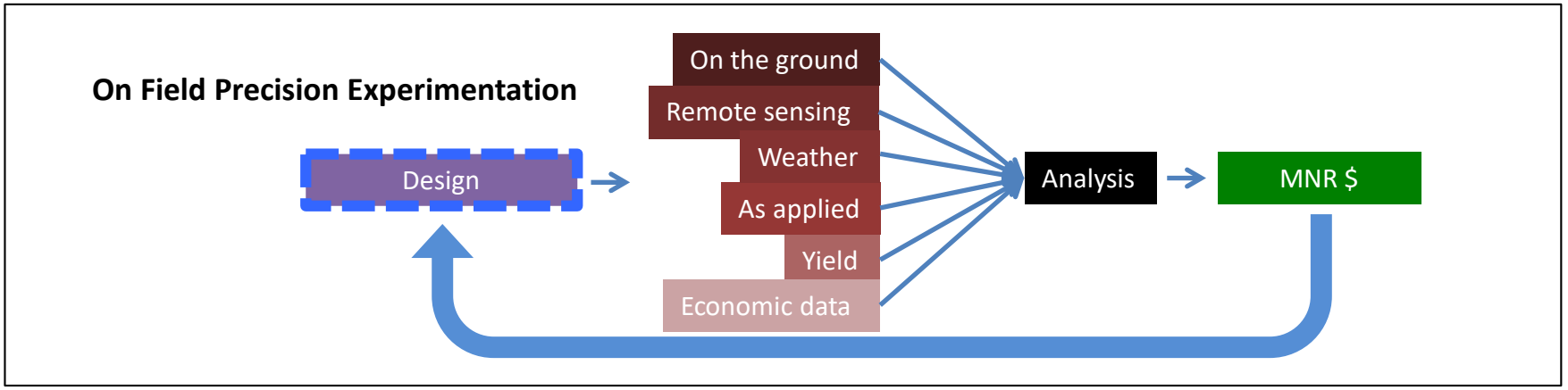
Key point of our approach:

Experiments are intended to inform management on the field where conducted, not other fields.

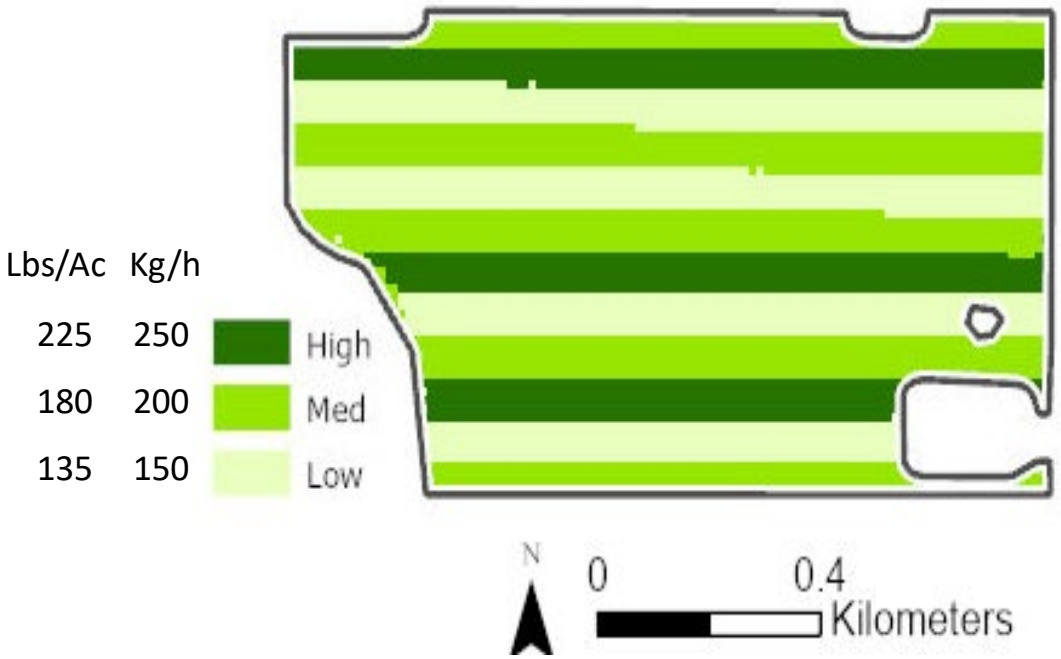

Applying On Field Precision Experimentation
Calgary
Lake Manitoba
Precision seeding experiment
winter wheat
Loewen
Precision seeding experiment
spring wheat
Casey Bailey
Bob Quinn (Goodman)
Ole Norgaard
Precision seeding experiment
Pea green manure followed by wheat
North Dakota
Montana
Rocky Mountains
Ty O'Connor
Precision nitrogen experiment
blood meal on wheat
Black Hills
South Dakota
Wyoming
© 2018 Google
Image Landsat / Copernicus

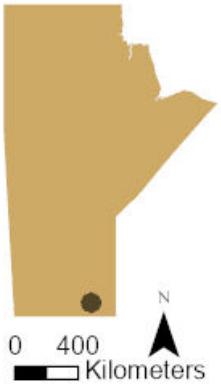
On Field Precision Experimentation





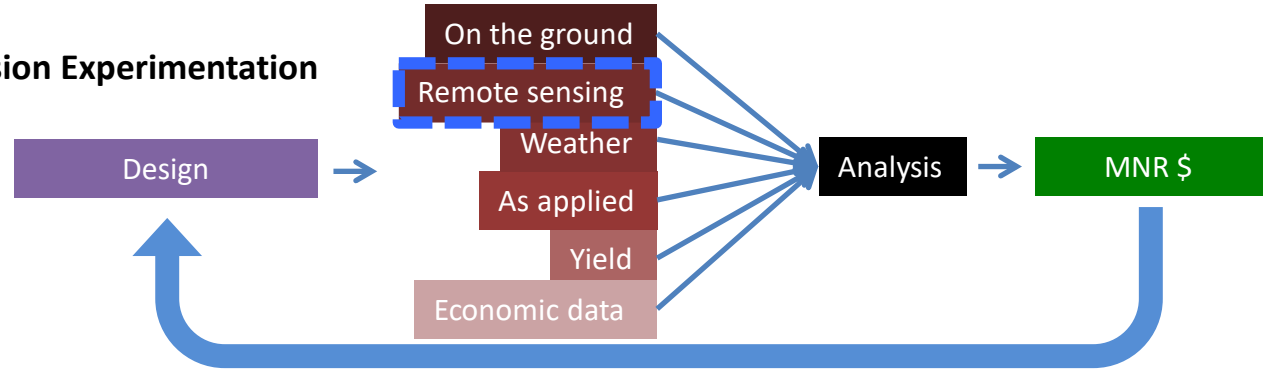
Variable Rate Spring Wheat, May 15 2019



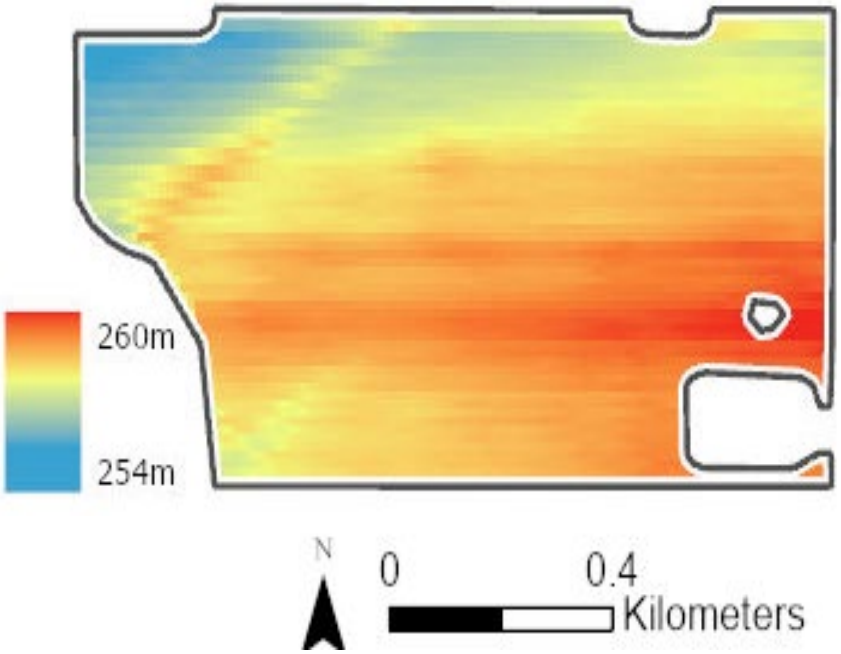


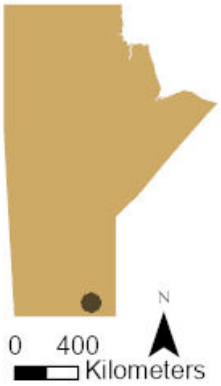
Field size: 71 hectares (175 acres)
Farmer: Sasha Loewen
Location: South East Manitoba

On Field Precision Experimentation



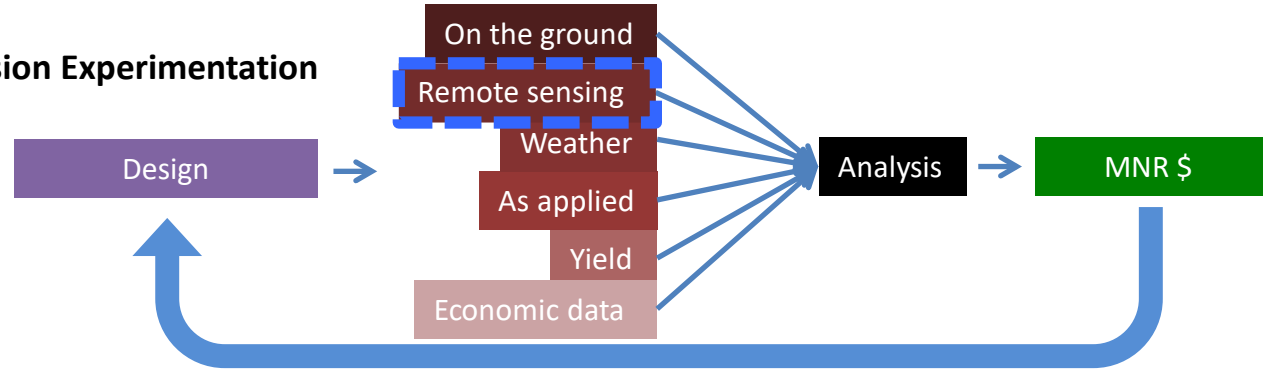
Field elevation levels



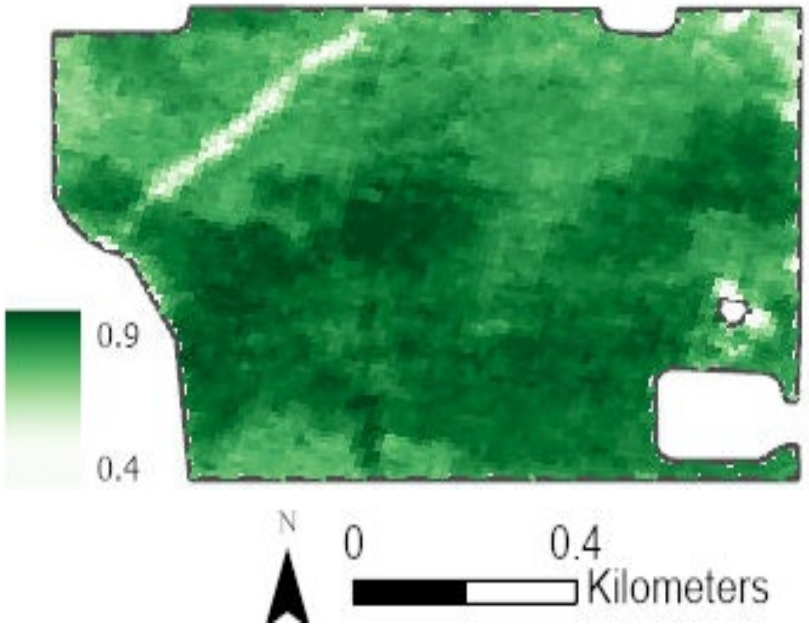


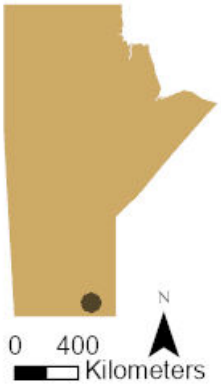
Field size: 71 hectares (175 acres)
Farmer: Sasha Loewen
Location: South East Manitoba

On Field Precision Experimentation



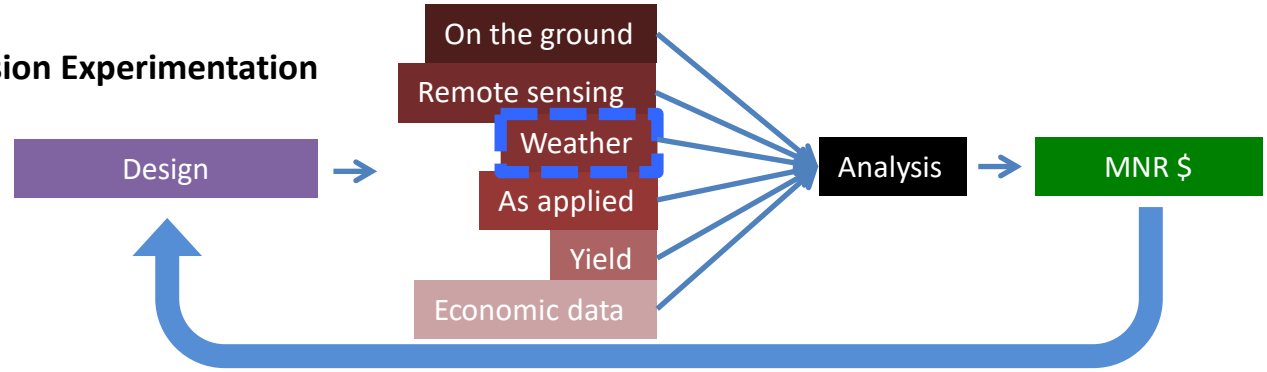
NDVI from Sentinel 8 from oat crop 2017



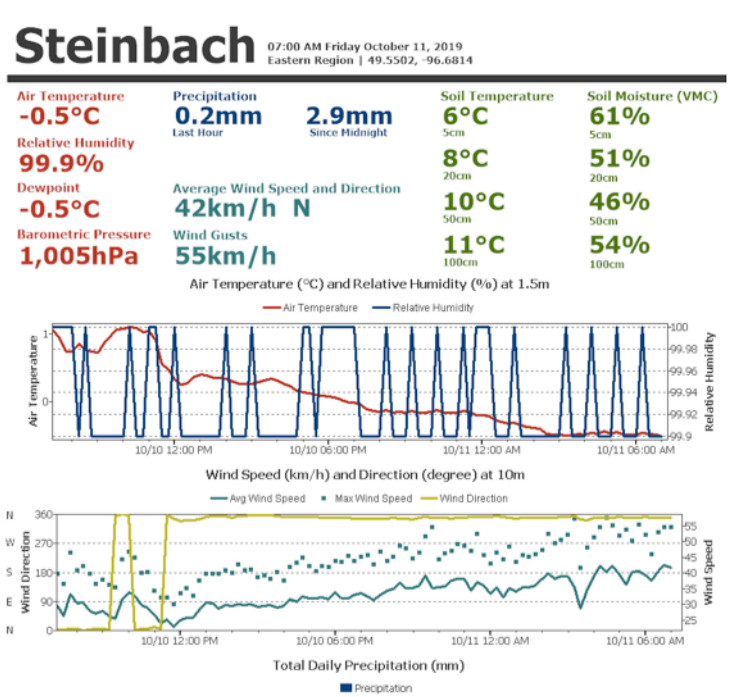


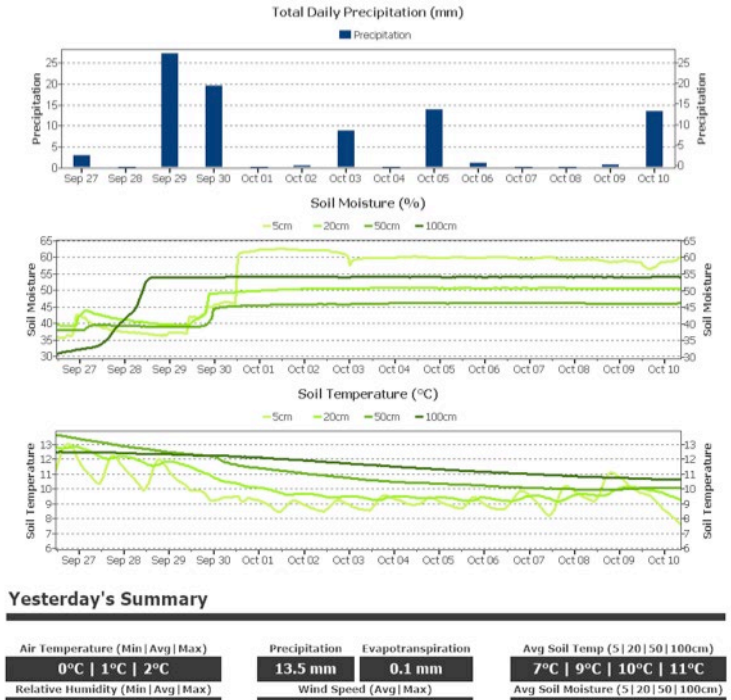
Field size: 71 hectares (175 acres)
Farmer: Sasha Loewen
Location: South East Manitoba

On Field Precision Experimentation

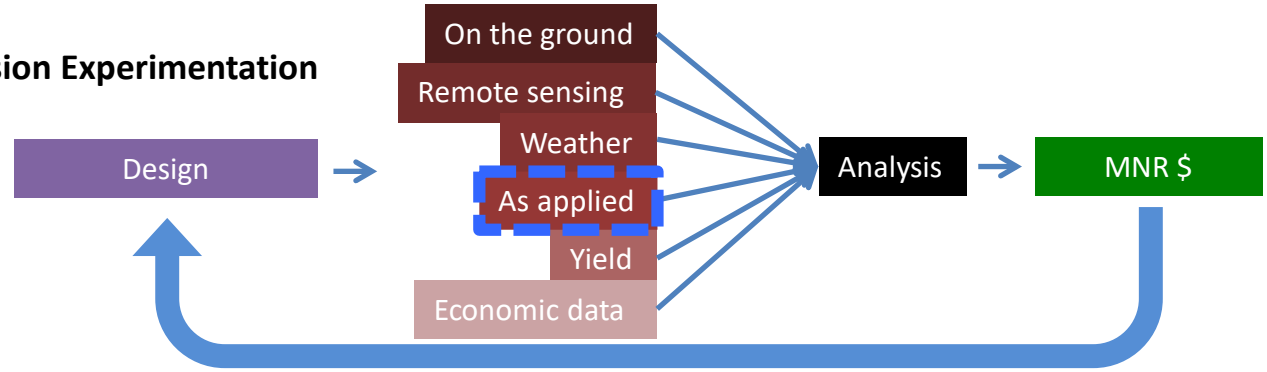


Weather data from nearby weather stations

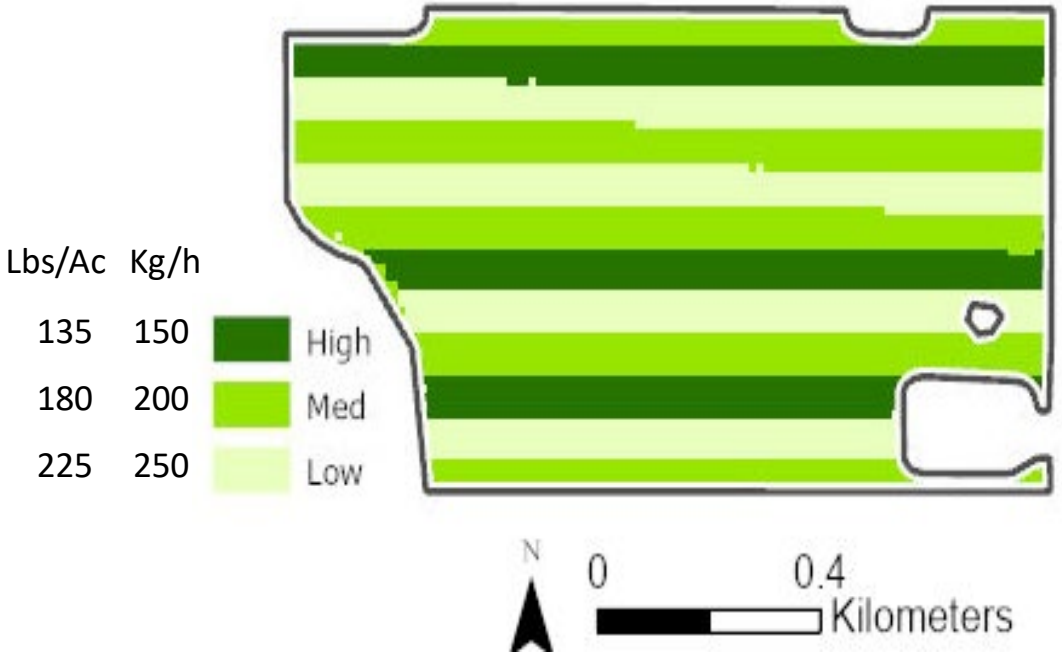


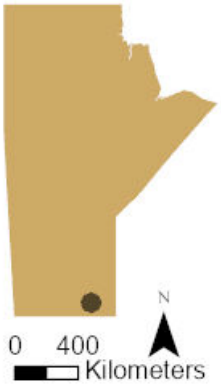


On Field Precision Experimentation

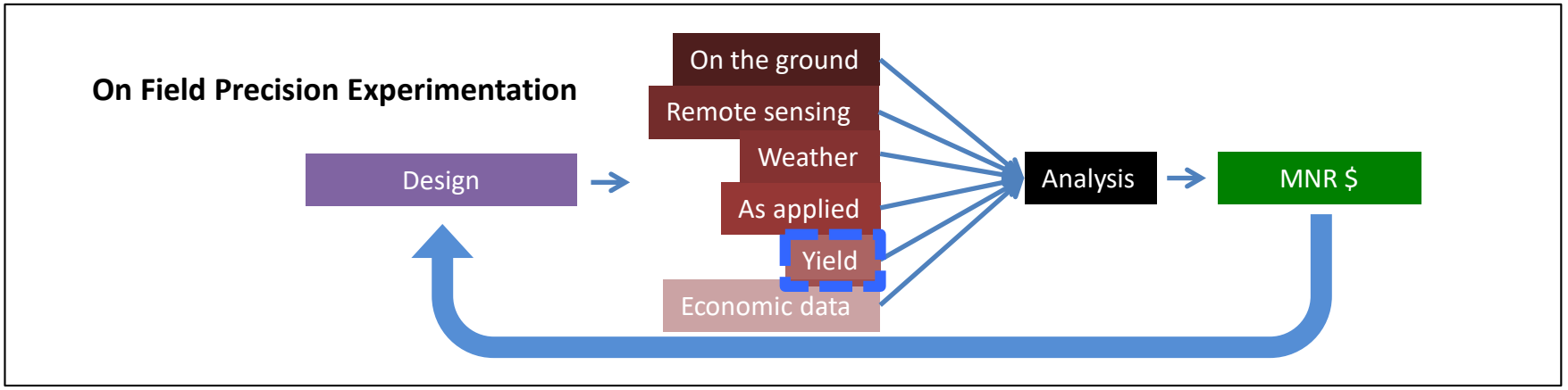


As applied spring wheat seed rates, May 2019

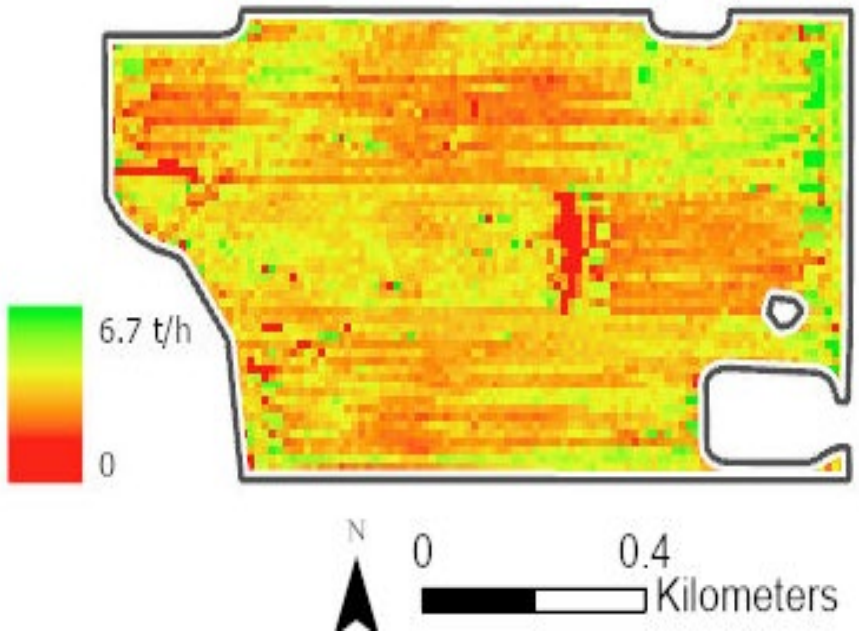


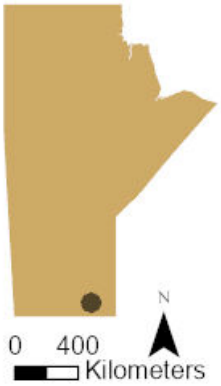


Field size: 71 hectares (175 acres)
Farmer: Sasha Loewen
Location: South East Manitoba

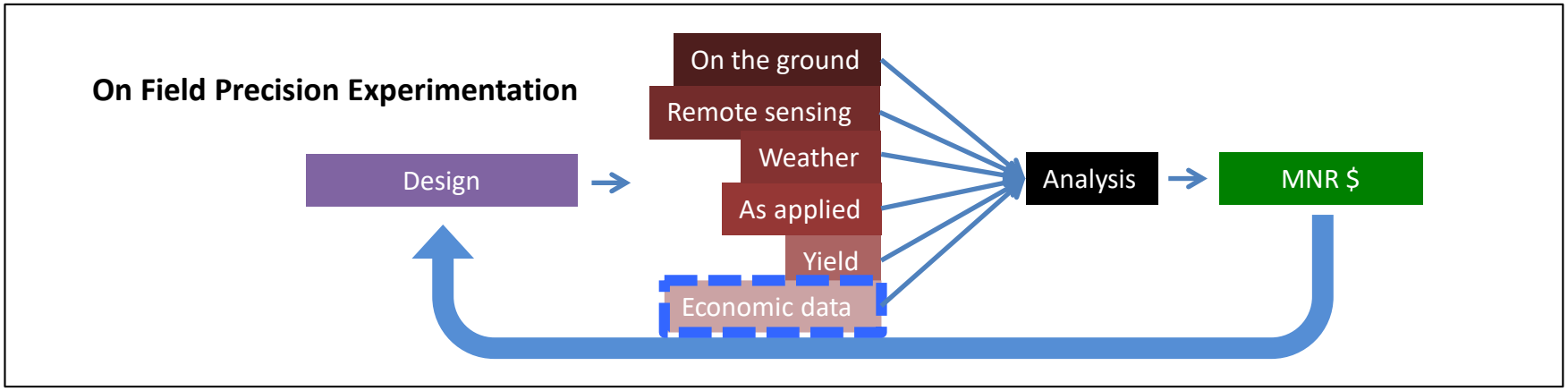


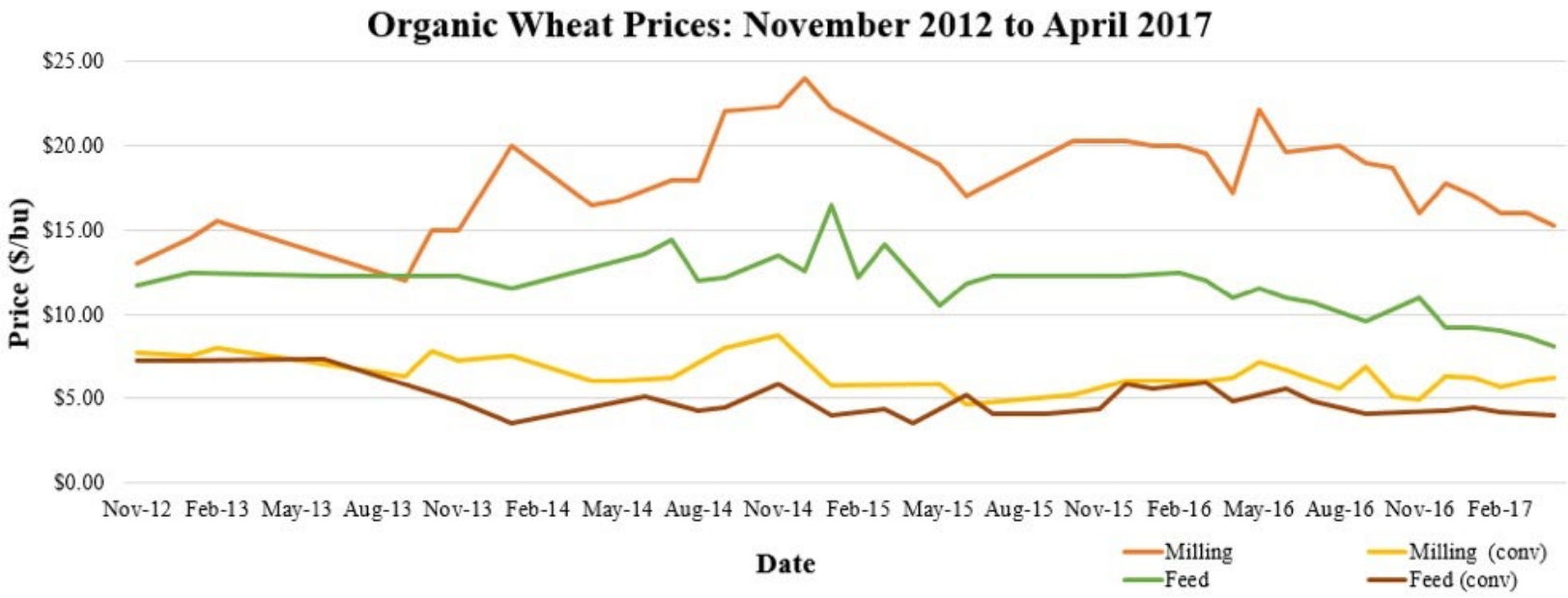
Combine monitor yield results - SE Manitoba field - wheat harvested Aug 15, 2019 field average: 3.01 tonnes/hectare (44.8 bushels/acre)





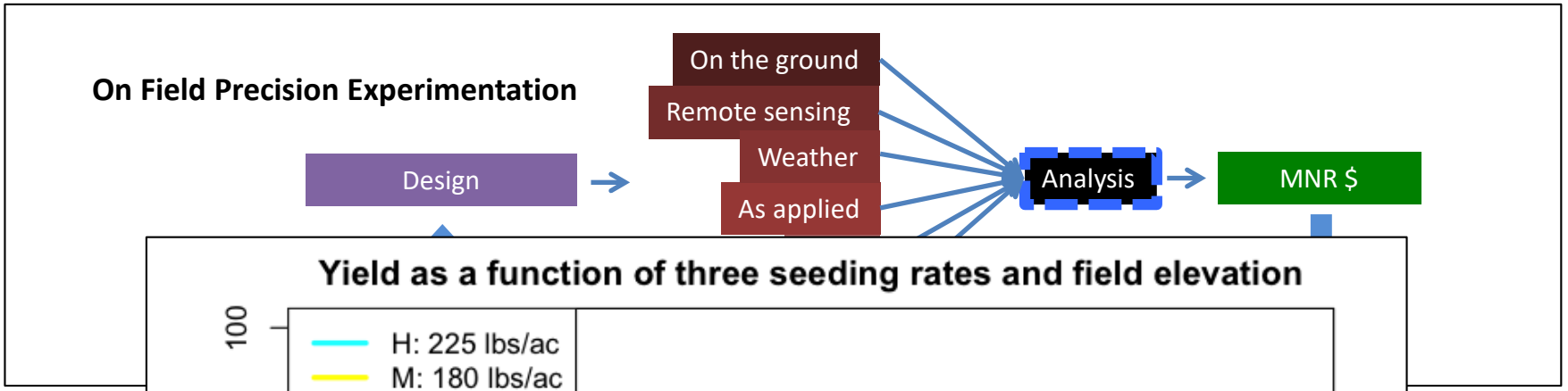
Field size: 71 hectares (175 acres)
Farmer: Sasha Loewen
Location: South East Manitoba

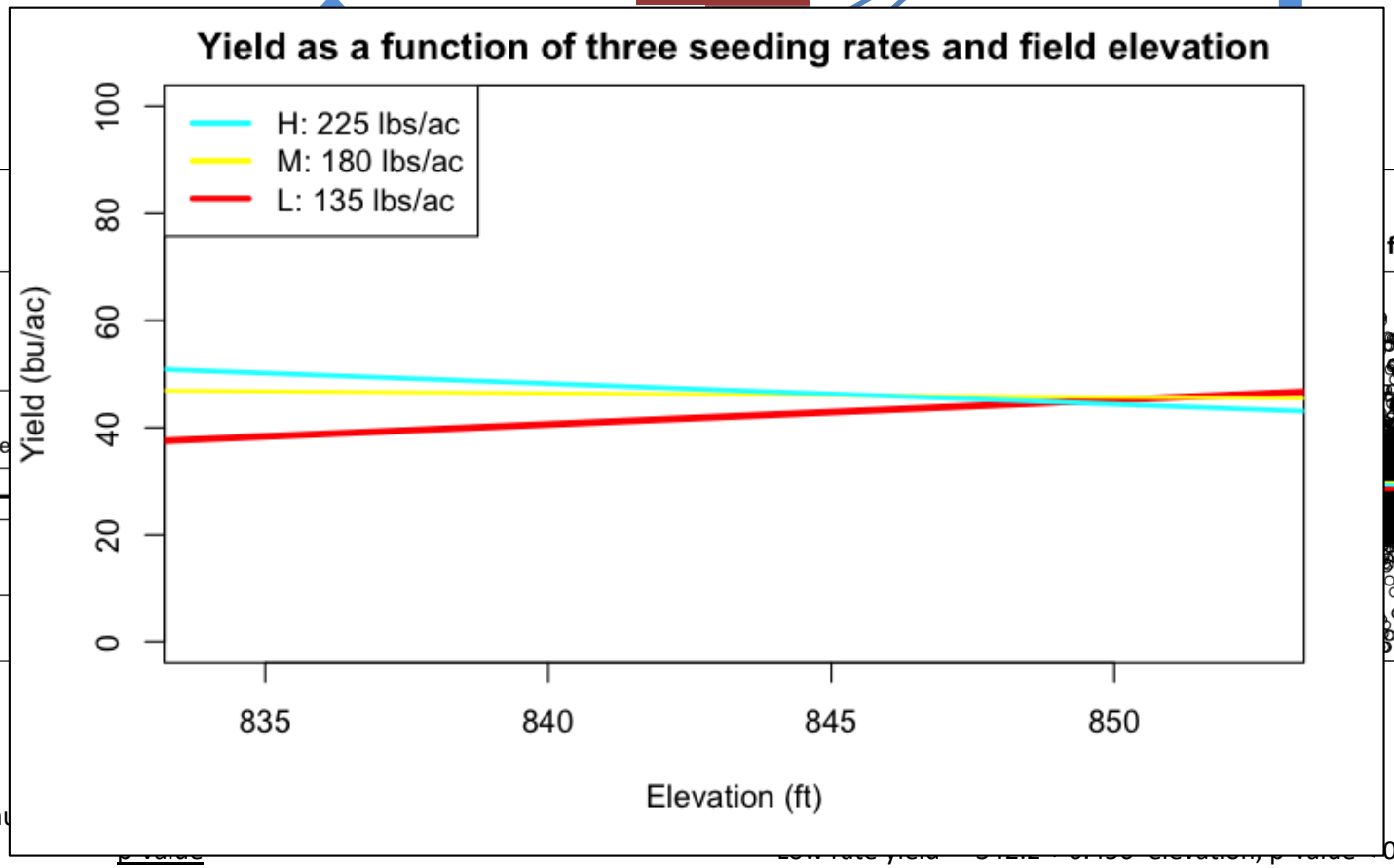




https://organicbiz.ca/organic-grain-price-trends-over-time/

On Field Precision Experimentation





Tukey mu

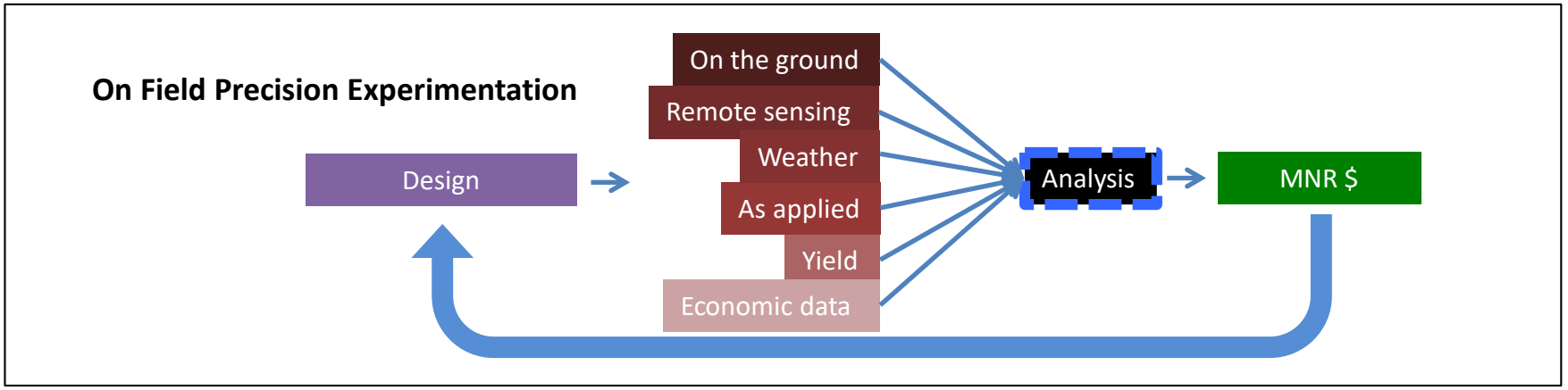
Diff	p-value
med-low	0.0000
high-low	0.0000
high-med	0.0002

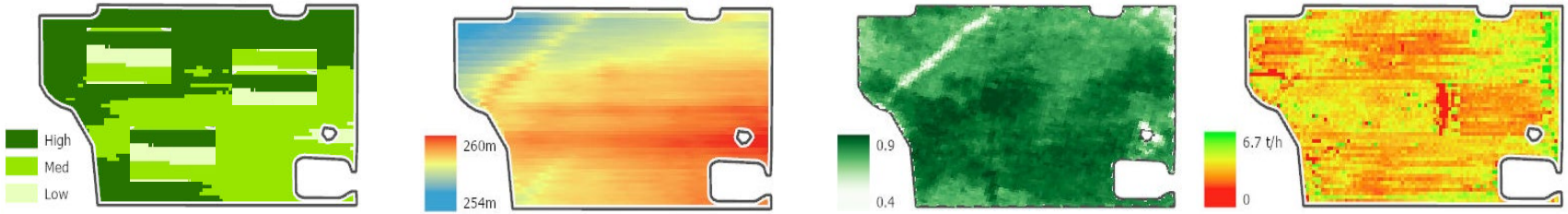
0.0001

Med rate yield = 108.5 – 0.074*elevation, p-value < 0.0001

High rate yield = 374.5 – 0.388*elevation, p-value < 0.0001

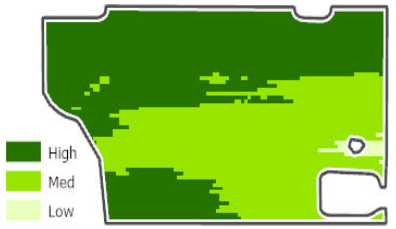
On Field Precision Experimentation



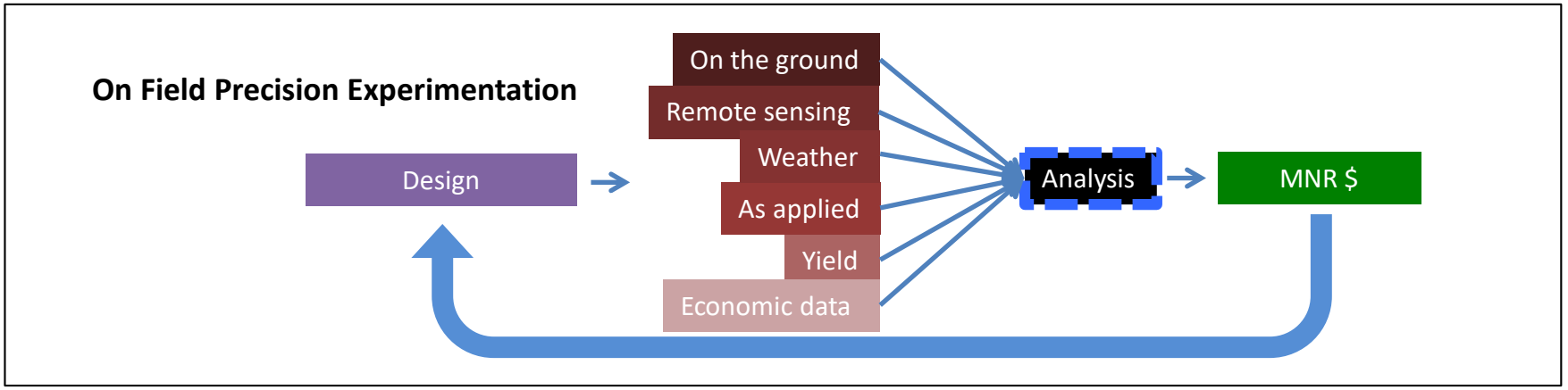


MLR:

Seed Rate * Elevation + NDVI = Yield

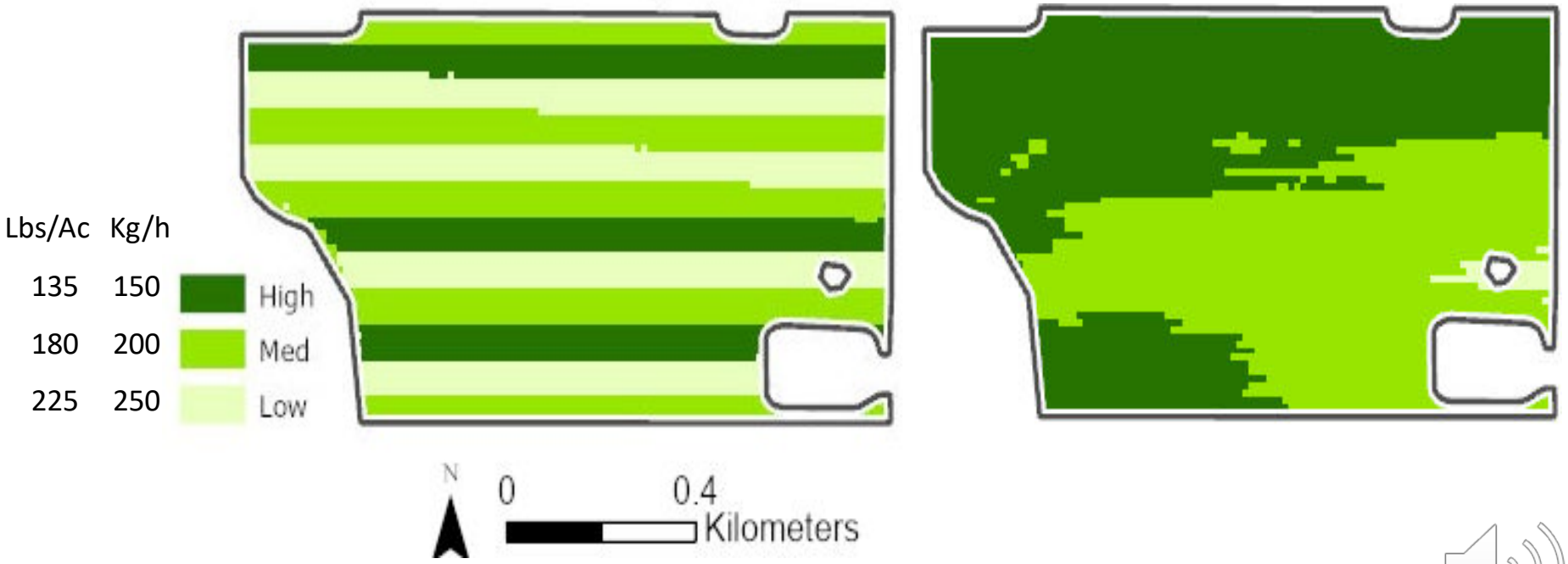


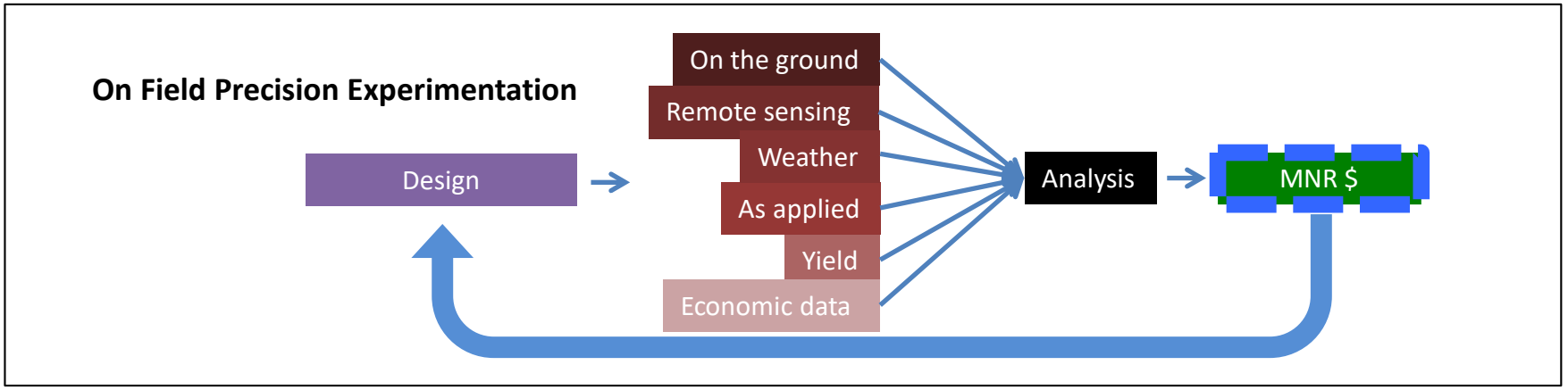
Optimize seeding rate for max net yield

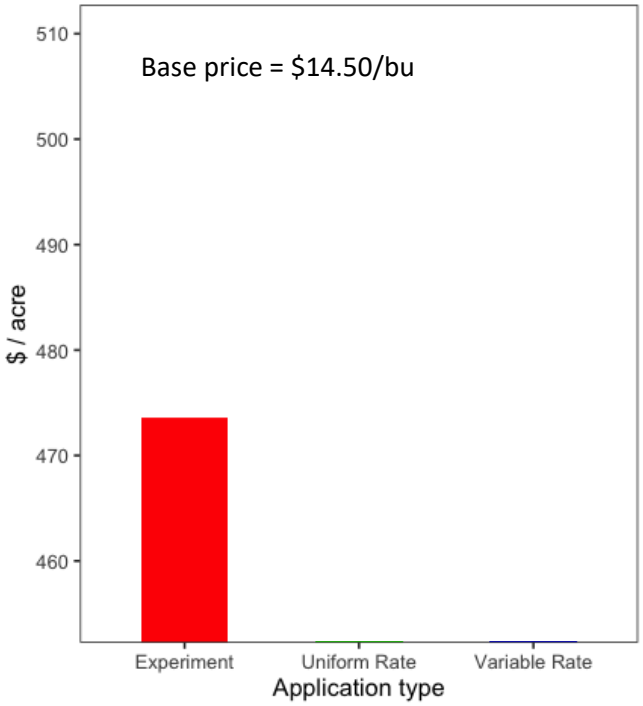


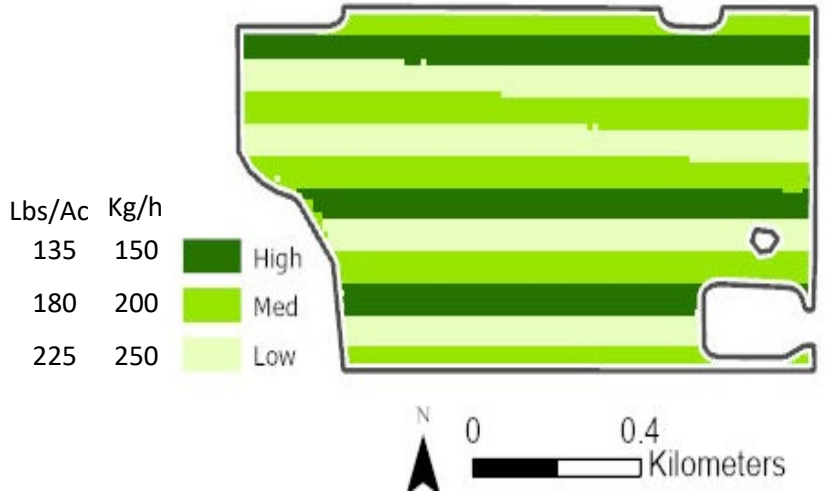
Original Design

New, more complex design

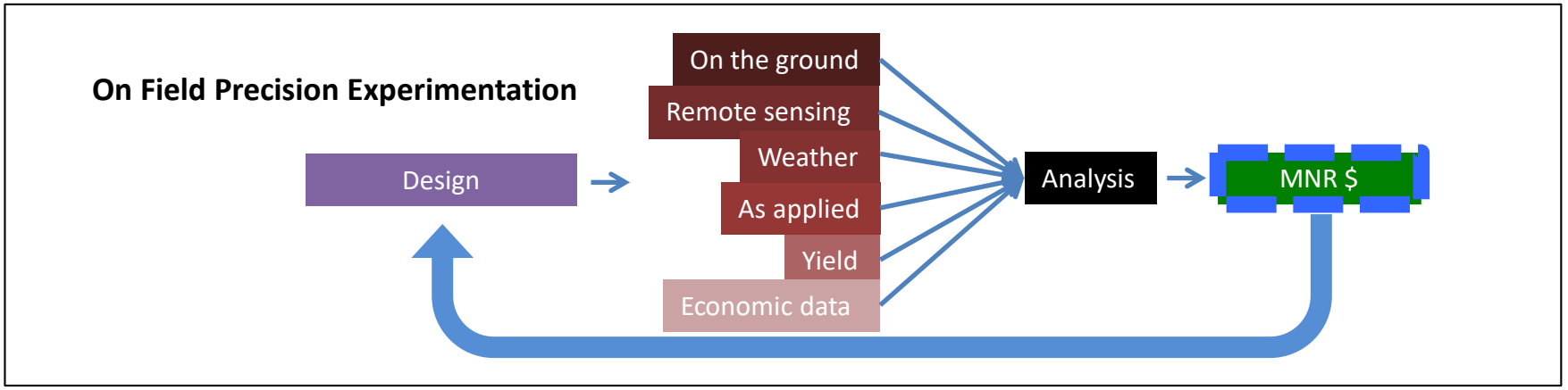


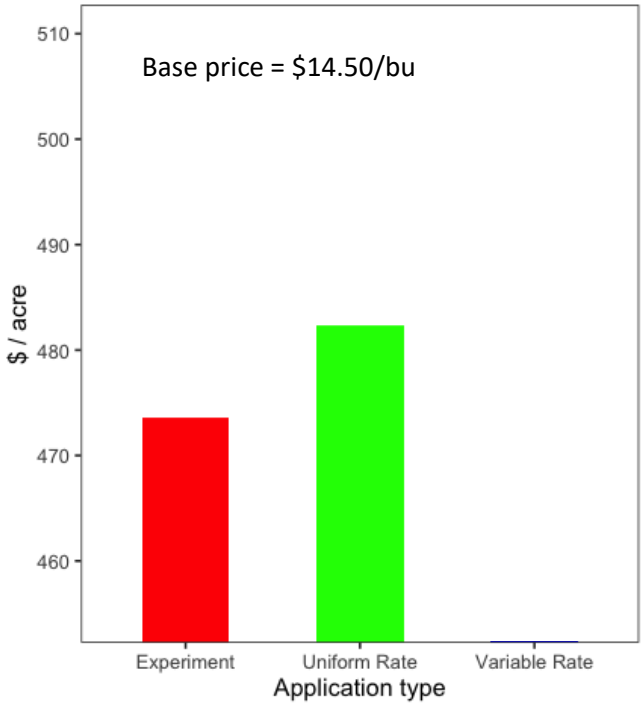


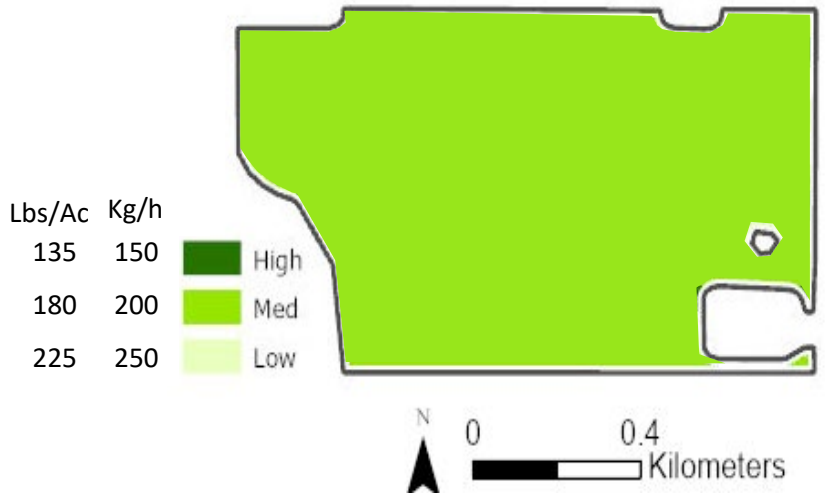




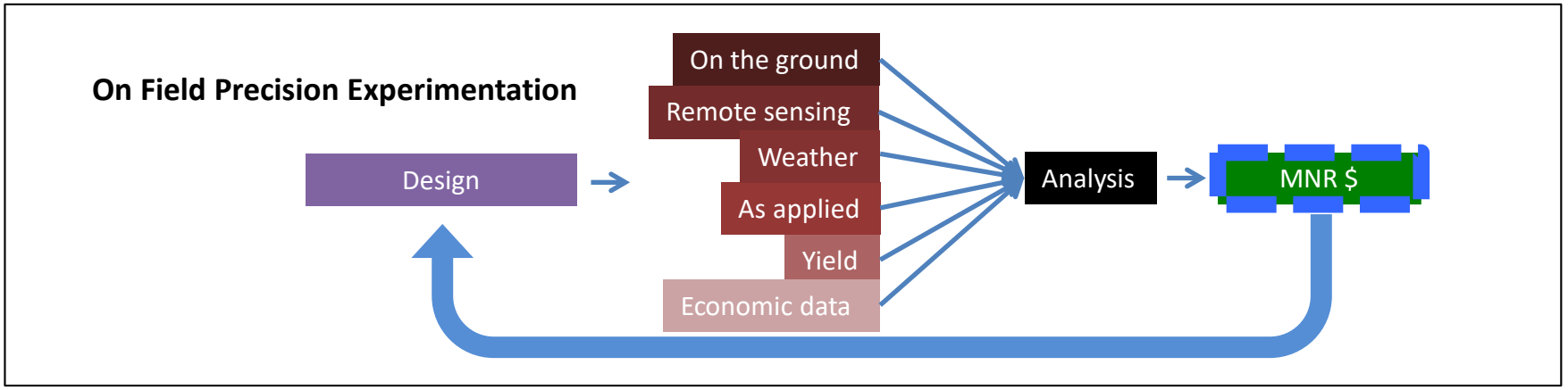
Cost and benefit of OFPE from Manitoba test site in net return per acre

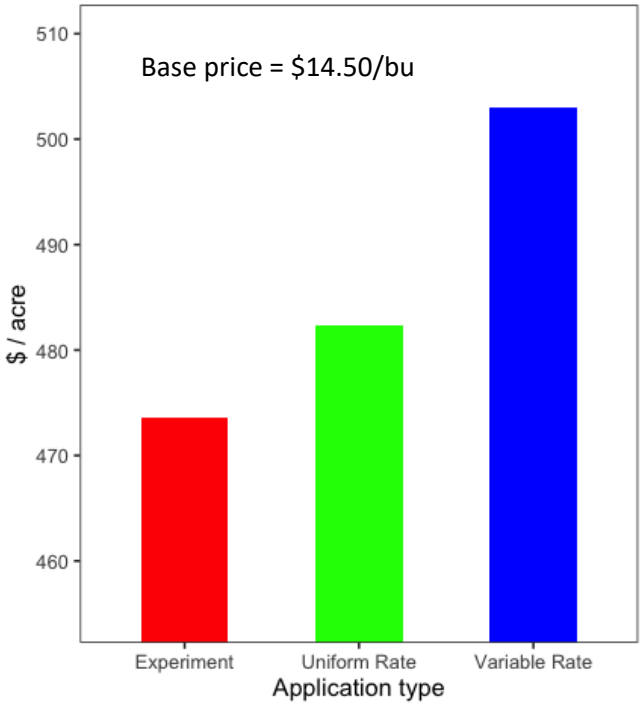


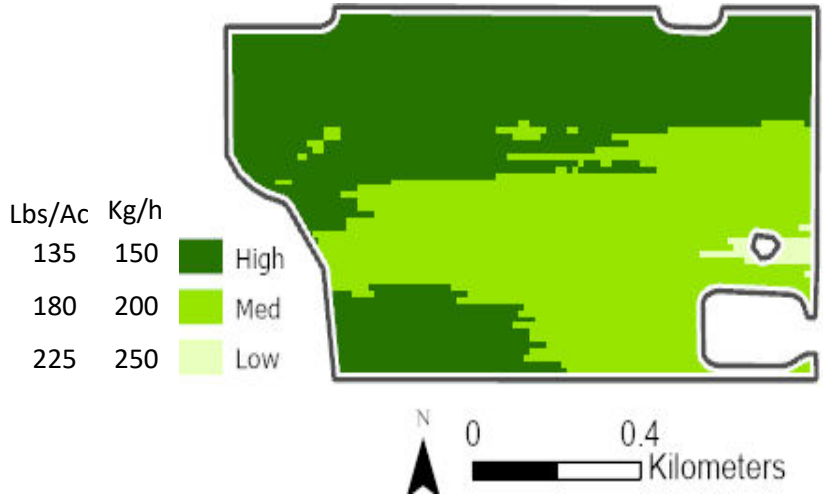




Cost and benefit of OFPE from Manitoba test site in net return per acre







Cost and benefit of OFPE from Manitoba test site in net return per acre

Unique Organic Challenges

- Fertility
  - Green manure plowdowns

Unique Organic Challenges

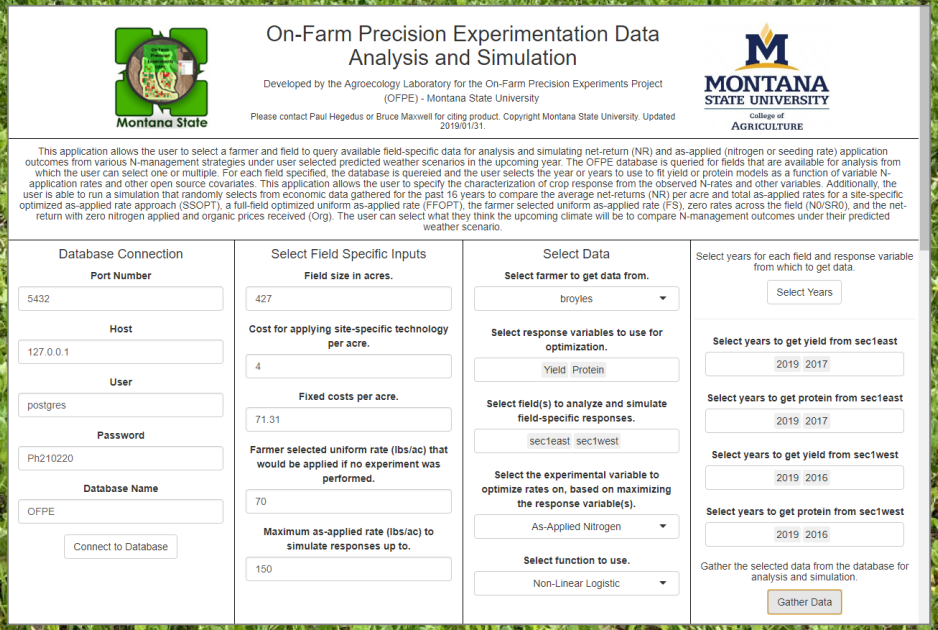
- Fertility
  - Green manure plowdowns
- Weeds
  - Map perennials

Unique Organic Challenges

- Fertility
  - Green manure plowdowns
- Weeds
  - Map perennials
- Organic farmers skeptical of tech
  - Is PA worth it?

Conclusion and Moving Forward

- Other inputs (manure?)
- Integrate satellite data, NDVI, Soil Moisture Active Passive (SMAP), Enhanced Vegetation Index (EVI)
- Develop complete program that can integrate weather, variable prices, to make predictions for ideal seed rates (build from conventional model)

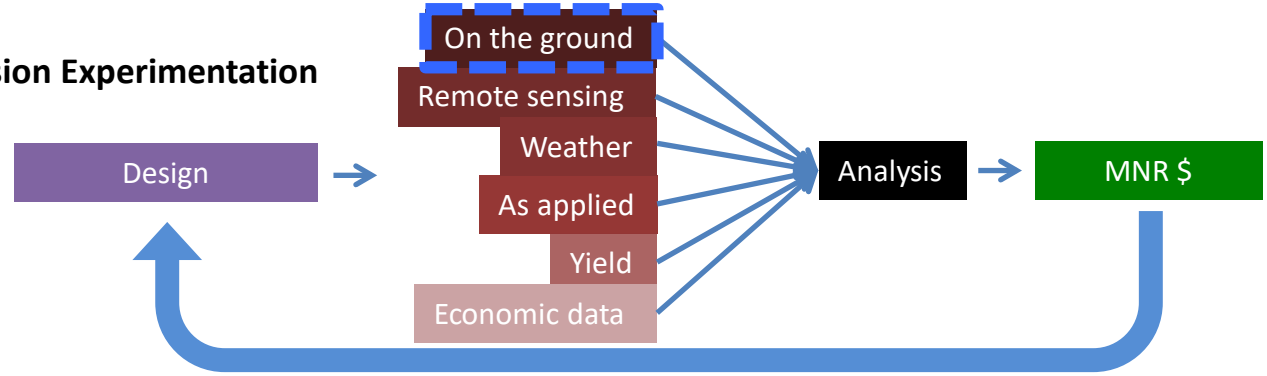


Thank you!

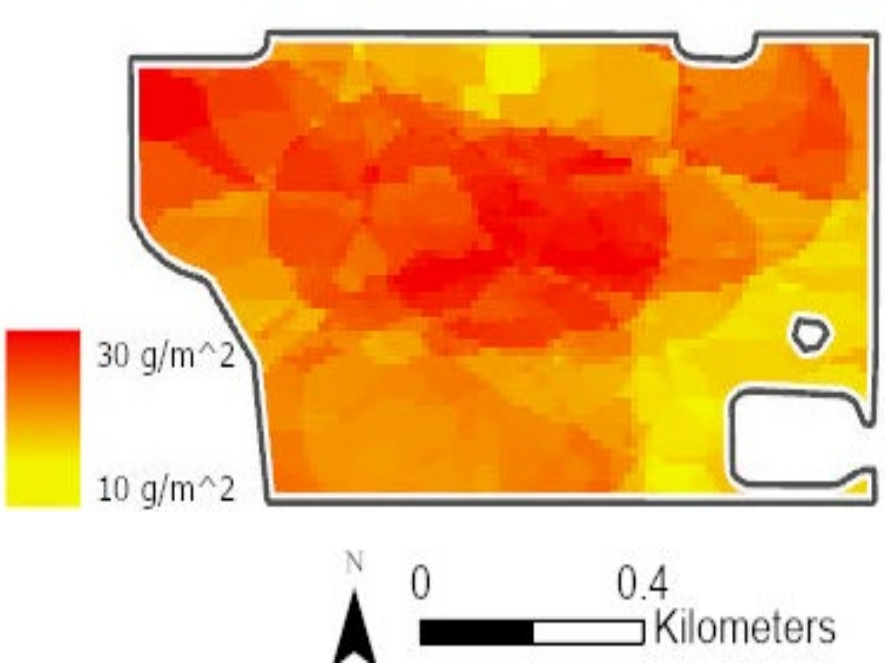
Advisor – Bruce Maxwell
Lab mates – Hannah Duff, Paul Hegedus, Tommy Bass, Braedon Lineman, Lexi Emeny, Madison Boone
Farmers: Bob Quinn, Ole Norgaard, Casey Bailey, Ty OConnor, Roy Loewen
Funding: Western SARE, Montana Acadamy of Sciences

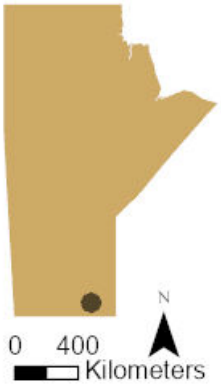
Questions?

On Field Precision Experimentation



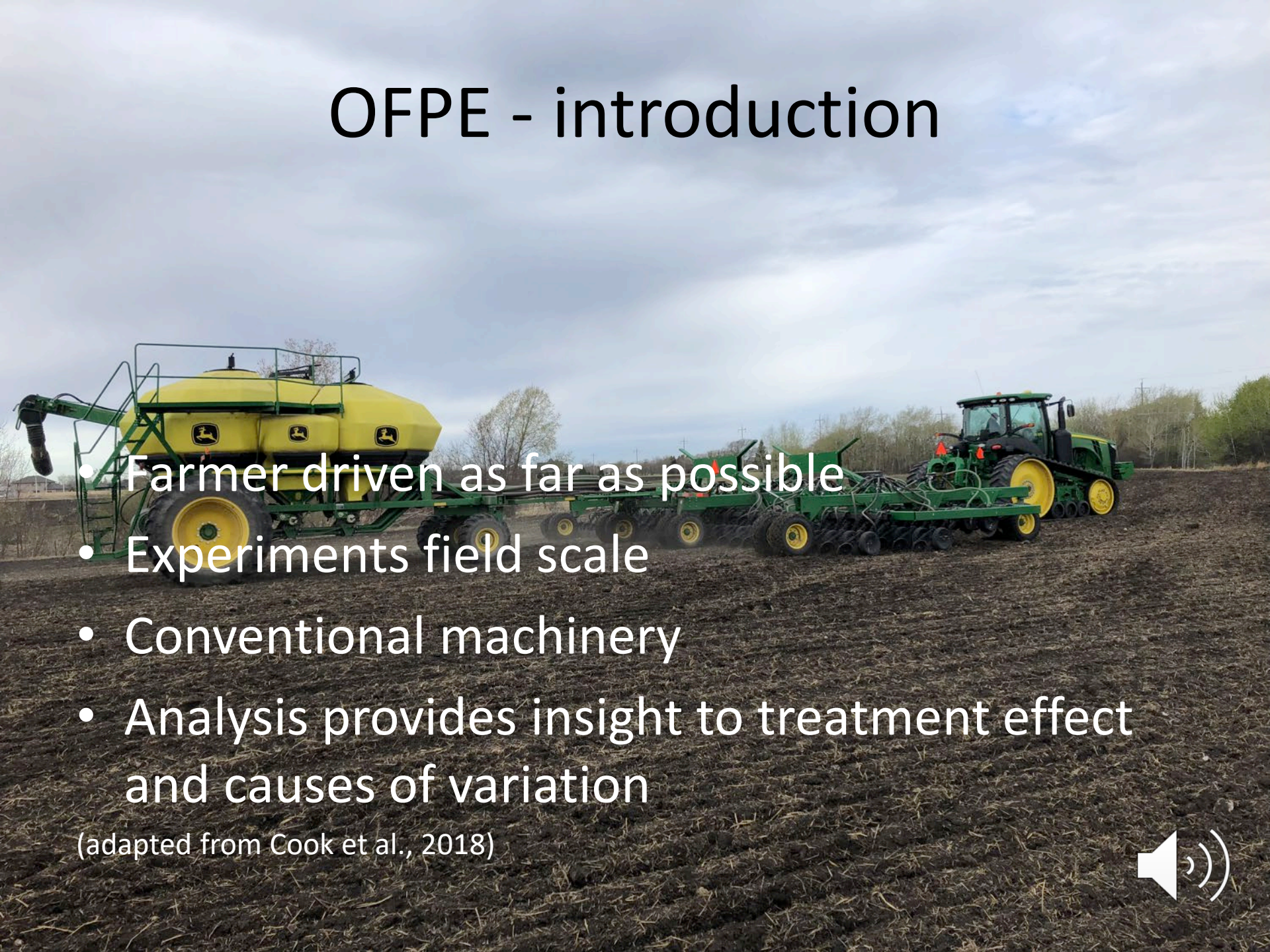
Estimated weed densities, June 15, 2019





Field size: 71 hectares (175 acres)
Farmer: Sasha Loewen
Location: South East Manitoba

OFPE - introduction



- Farmer driven as far as possible
- Experiments field scale
- Conventional machinery
- Analysis provides insight to treatment effect and causes of variation

(adapted from Cook et al., 2018)