Precision Agriculture and Profitability Mapping

Canada First Research Excellence Fund- Food from Thought

C.J. Swanton

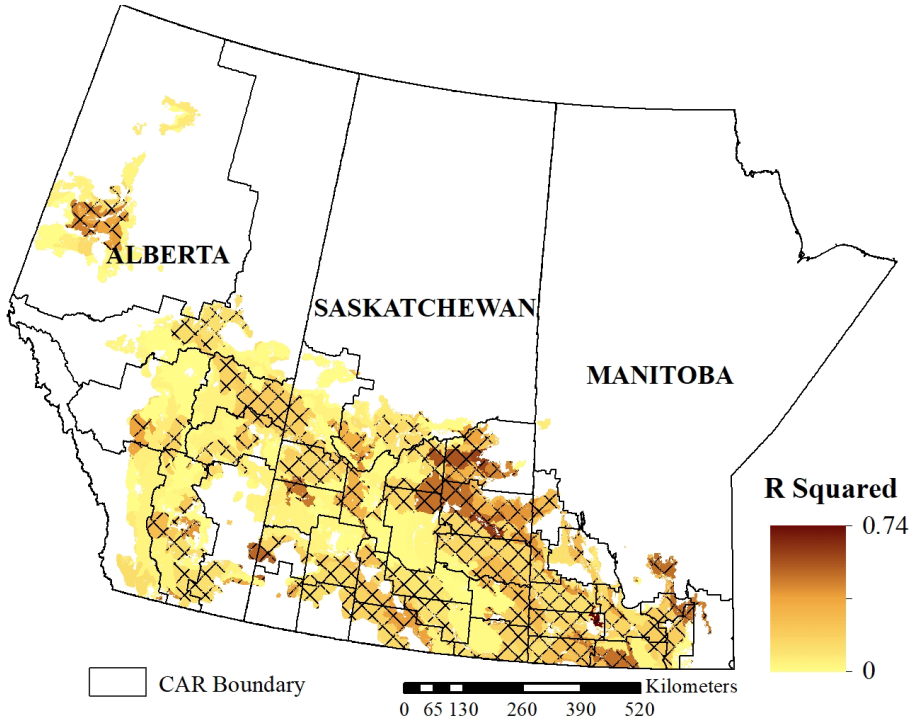
University of Guelph

Key questions ?

- Is the future production system based on crop yield or crop nutritional value?
- How important is diversity at the soil, field and landscape level?
- Will climate change result in greater variability/risk in food production?
- Will instability in food production lead to social instability?

Leveraging Canada's RADARSAT Constellation mission for advances in precision agriculture and precision conservation

A. Berg



Satellite derived estimates of soil moisture were used in Agriculture and Agri-food Canada's crop yield prediction model for canola yield forecasts. Our results show improved yield forecasts if we use soil moisture rather than traditional vegetation indices.

Improved approaches for management zone creation- J. Sulik

1) Efficient N management is important because too much of the N that is applied doesn't go where we intend.

2) It may be possible to accurately map variation in N response during crop development, which would help identify responsive and non-responsive areas within a field.

Profitability Mapping

Precision conservation meets precision agriculture: A case study from southern Ontario. 2018. Agricultural Systems 167: 176-185.

V. Capmourteres, J. Adams, A. Berg, E. Fraser, C.J. Swanton and M. Anand,

- Can precision agriculture enhance profitability and reduce the environmental foot print of agriculture?

Profitability Mapping

Profit mapping is being studied to highlight unproductive agricultural lands at the provincial level to enhance biodiversity conservation.

These lands hold conservation potential via their combination of low profit - high connectivity and biodiversity potential.

Profitability Mapping

Viewed as having long-term outcomes that will improve policy and result in more sustainable management of natural and agricultural lands.

Union of sustainable management of natural and agricultural lands and on farm profitability

Producer decision making is enhanced when yield maps are converted into profit maps.

1. Identification- producers recognise and diagnose problems and opportunities
2. Development – discovery of potential solutions, new strategies
3. Selection – evaluation and choice

Massey et.al. 2008. Agronomy Journal. P52-59.

Profitability mapping can serve as a management tool for farmers that will allow:

- Identification of optimum crop areas
- Optimisation of best management practices
- Provision of ecosystem services at the local scale
- Optimise profitability
- Reduction of risk to management caused by climate change
- Protection of international markets

How stable are our farming systems?

- On farm risk to management has increased significantly because of:
    - **International trade demands- the market is changing**
    - Climate change

International Trade-the sustainable supply chain

- Why would you buy Canadian commodities?
- “Today farmers are being asked to go through sustainability schemes to verify the practices they do on the land are environmentally and socially responsible while being economically viable.“

  M. Buttenham, Ontario Grain Farmer June/July 2017

- How do you maintain accountability and prepare for audits?

International Trade- Ecosystem Protection

“Companies also see sustainability as a way of connecting their consumers to farmers, pulling back the curtain and showing that the farmer is being a good environmental steward.”

M. Buttenham, October 2017, Ontario Grain Farmer

Why should primary producers be interested?

How does Canadian agriculture “grow and protect its brand on the international market?”

How green is your product? What is your carbon footprint?

Your product and pesticide residues?

- On farm risk to management has increased significantly because of:
    - International trade demands- the market is changing
    - **Climate change**

Climate change is now Climate crisis!

What are the issues?

How do you flow “excess energy” through an agroecosystem ?

How do you manage this increased “risk to management” ?

On a field basis what can farmers do to manage on farm risk to management created by climate change?

- Increase organic matter, soil health
- Water control- field drainage, tiling, berms, waterways
- Crop genetics and diverse cropping systems
- Protection of ecosystem services – goods and services provided by the ecosystem processes and utilised by humans

Ecosystems Services

Nutrient flow

Pollinator habitats

Soil formation

Water quality

Food and Fiber

What is the relationship between biodiversity and ecosystem services?

Above and below ground biodiversity is critical to the maintenance of ecosystem services.

On-farm risk to management increases substantially with decreases in ecosystem services.

The earth's biodiversity is declining

- Species invasions
- Species extinctions
- Climate change
- Farming practices

Agro/Ecosystems under stress

Through the loss of biodiversity are we deconstructing our ecosystems under the assumption that these ecosystems have the ability to withstand such pressures without collapsing?

(Kevin McCann, Nature 2000)

Diversity –Stability Hypothesis

- Biodiversity within an ecosystem tends to be correlated positively with plant community and ecosystem stability

- Biodiversity-- species richness, strength of community interactions and functional traits

Diversity –Stability Hypothesis

- Functional diversity (range of species traits) rather than species numbers determines how the ecosystem functions

- Biodiversity is a critical factor influencing the stability of ecosystem services

The questions become:

1. How resilient are our agroecosystems?

   - the ability of a community to return to its original state following a stress or disturbance caused by climate change

2. Is there a threshold level of biodiversity required to protect ecosystem services?

The questions become:

3. How do you flow excess energy caused by climate change through an agroecosystem- at the farm level?

Think of Climate change in terms of Energy

Chisel Plowed Field

Can Precision agriculture contribute to the enhancement of biodiversity?

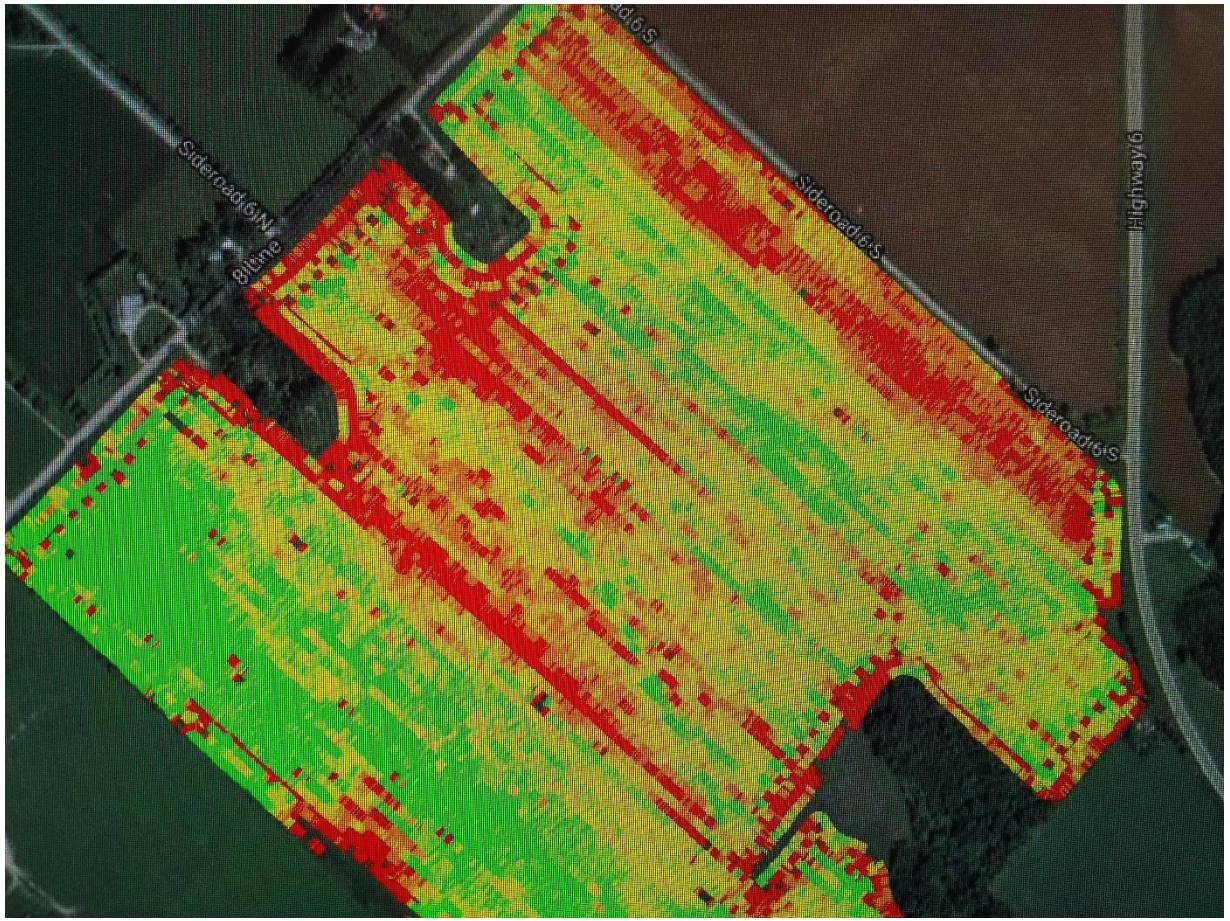
- General perception that ecological and environmental conservation efforts equate into a loss of profit for producers

- Can precision agriculture help to “transition” this perception to “ ecological and environmental conservation will enhance profitability?”

Sustainably Intensify Production

- Hypothesis: If landscape and soil biodiversity are enhanced then agricultural productivity can be intensified while reducing the detrimental effect on ecosystem services.

Yield Maps
Technology that is readily available and understood



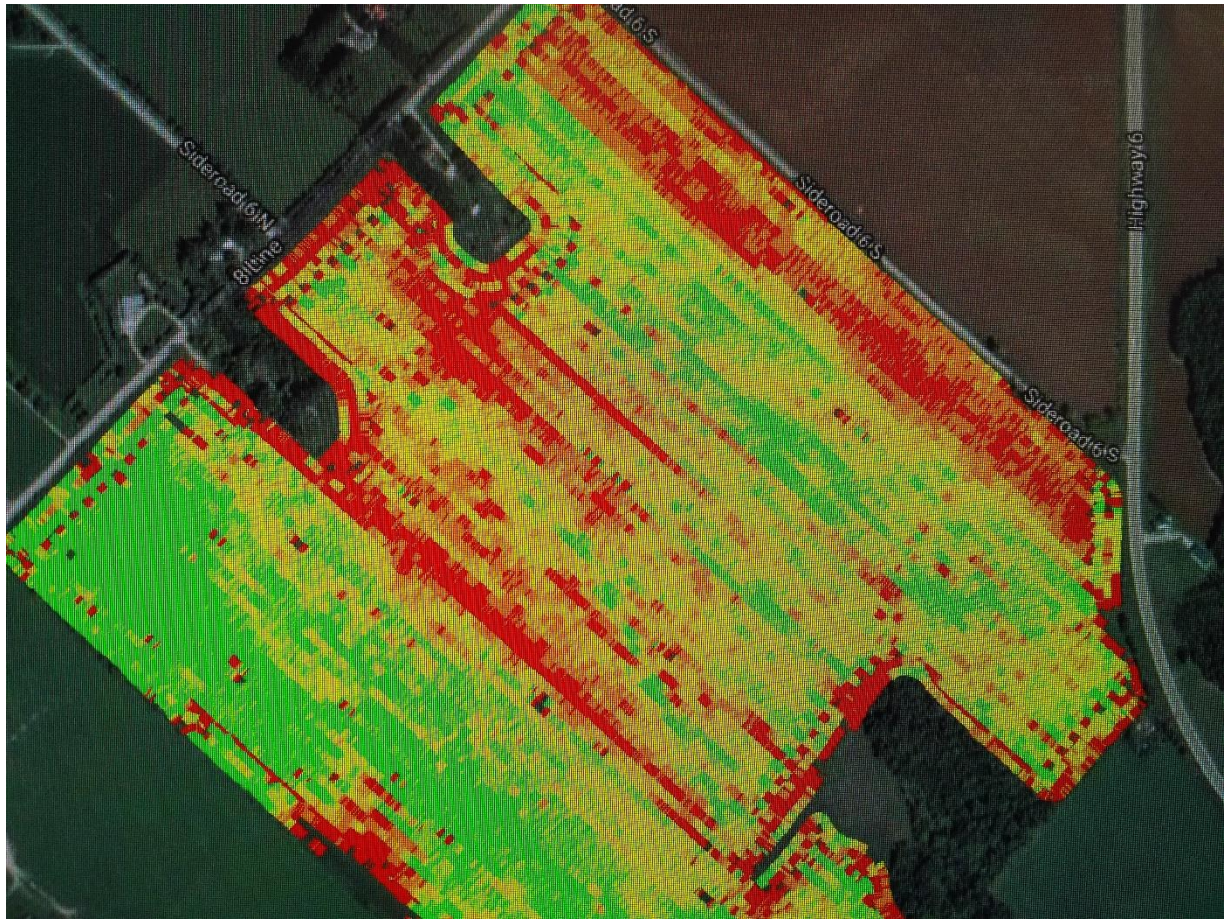
First response

- Are there opportunities to correct or manage low yielding parts of the field?
    - Water management
    - Organic matter, soil type analysis
    - Precision adjusted planting and nutrient applications to compensate for low yields

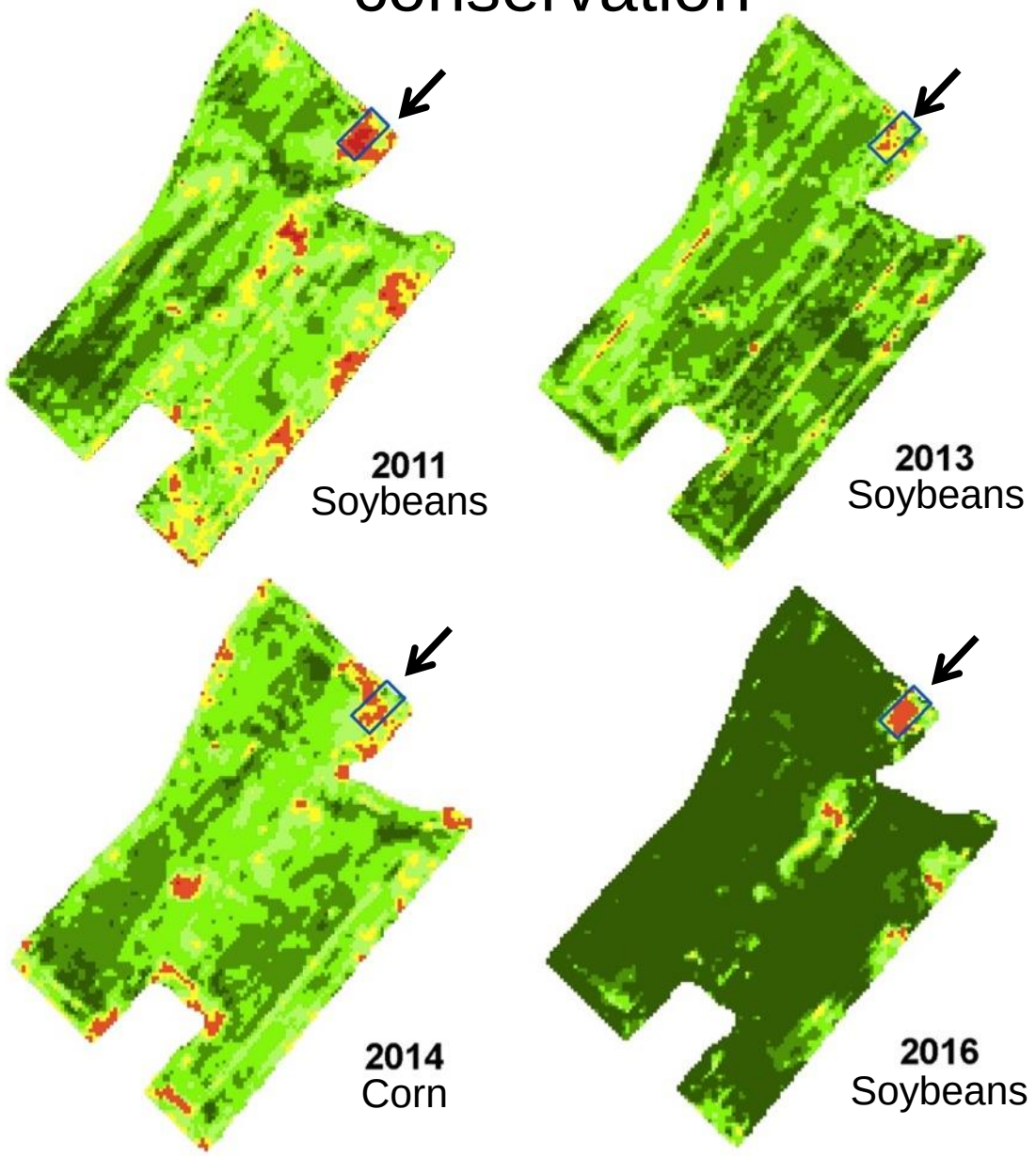
- What if none of these approaches work?

- Can we divert these areas within a field to enhance diversity and conservation while protecting farm profitability

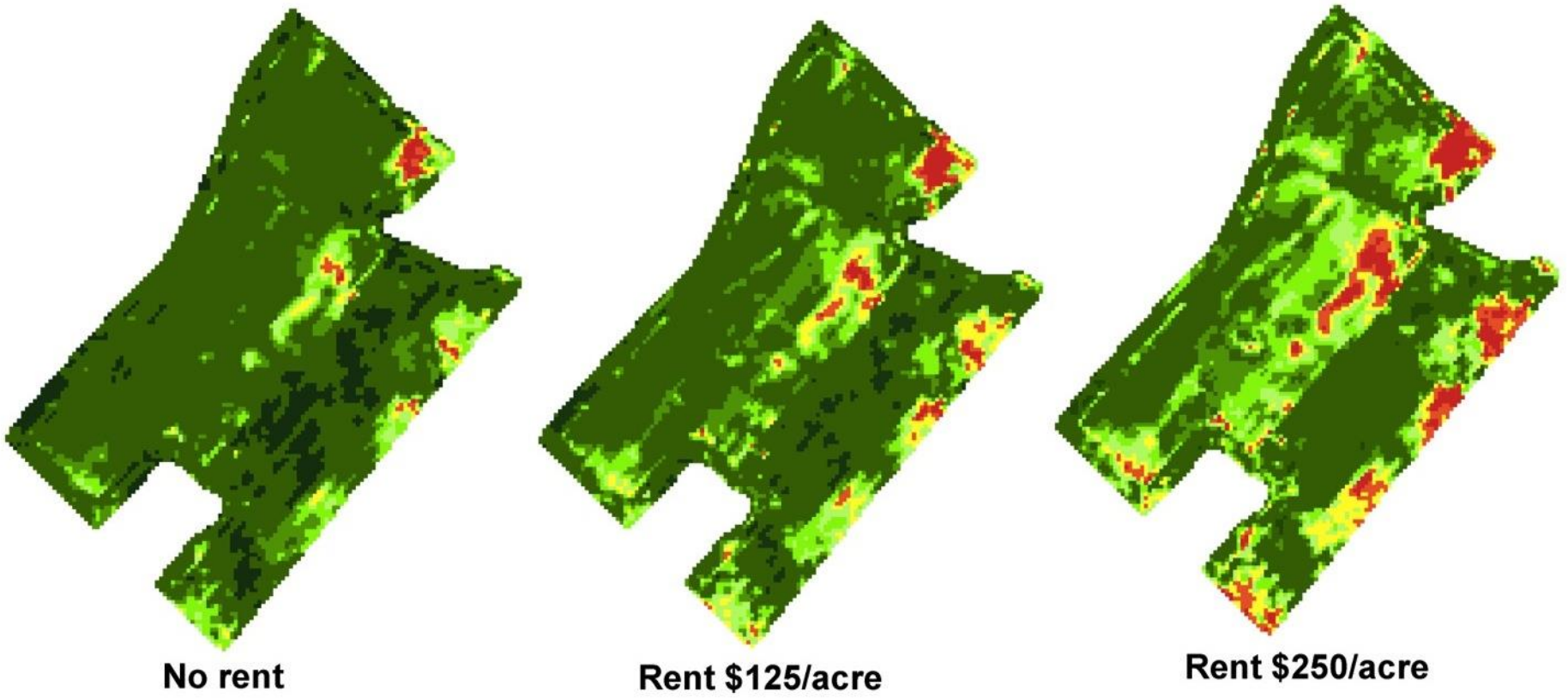
Yield Map transitions to Profitability Map Technology that is readily available but may not be fully understood



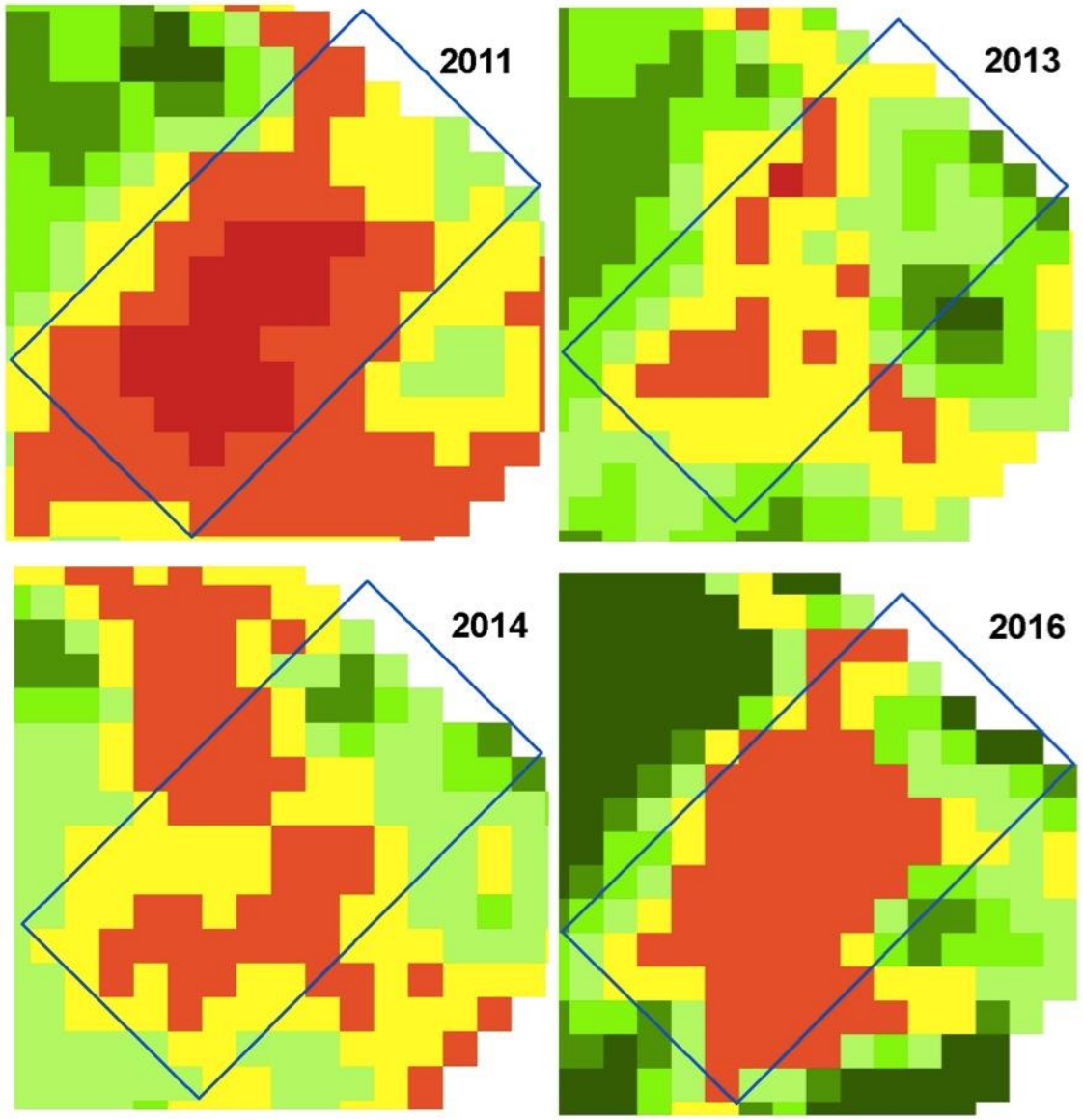
Profit mapping over time to detect potential areas for conservation



Example of 2016 farm profit mapping



Proposed area for conservation (zoomed in!)



Size: 0.6 acres

The average profit of this area, assuming no rent, is $ 27.84/acre

If paying rent, the profit goes down:

- $125 rent: $ -97.16
- $250 rent $ -222.65

Conservation scenarios and costs

Wildflowers

- Est. $800/acre
- $50/acre

Alfalfa: $115.30/acre

Red clover: $25.20/acre

White clover: $42.00/acre

Buckwheat: $50/acre

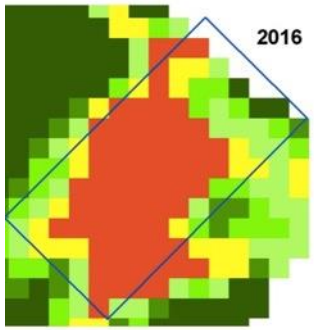
Peas-Oats: $43/acre

Untreated Oats: $36.00/acre

Phacelia tanacetifolia: $110.00/acre

Costs: http://www.generalseedcompany.ca; Images: www.oscseeds.com; http://www.johnnyseeds.com; https://wesco.co.nz; https://www.omcseeds.com

Agricultural profit vs. conservation costs



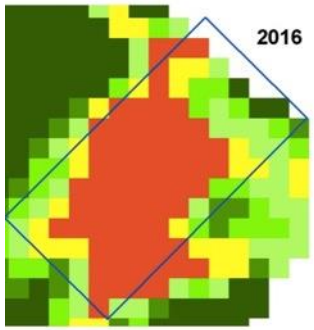
Average profit:

- no rent ……. $ 27.84
- $125 rent…….. $ -97.16
- $250 rent ……. $ -222.65

No rent:

- Two out of four years further ahead to plant economical cover crops

Agricultural profit vs. conservation costs



Average profit:
- no rent ……. $ 27.84
- $125 rent…….. $ -97.16
- $250 rent ……. $ -222.65

With rent:

- If $125/acre rent then conservation with cover crops was more economical 3 out of 4 years

- If $250/acre rent then conservation with cover crops was more economical in all years

How significant is 0.6 acres?

Neighbouring farm= 0.6 acres (57 acres)

Swanton farm = 0.6 acres (106 acre farm)

Total 1.2 acres from 163 acres

In Ontario approximately 6 million acres of land growing corn, soybeans or wheat

Potential conservation set aside as a result of profitability mapping would = 44,171 acres

Barriers to Adoption

- Conservation scenarios are highly field and farm specific
- The land owner value system, rental agreements
- Need for farm organisations and governments to support policies that encourage biodiversity

Profitability mapping can serve as a management tool for farmers that will allow them to

- Identify optimum crop area
- Optimise best management practices
- Provide ecosystem services at the local scale
- Optimise profitability
- Protect international markets
- Reduce risk to management caused by climate change

Profitability Mapping an Important Tool

To enhance:

ecosystem stability through greater diversity

on farm profitability

access to international markets

Thank you