Edge effects and optimal field sizes in Alberta

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Abstract

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1. Introduction

- Preserving SNL around fields is important for agriculture and conservation
  - Ecosystem services
  - Act as reservoirs for beneficial insects
  - Microclimate zones
  - Poorly studied in North America
  - Studies tend to be limited in scope (e.g. only certain organisms/crops) and applicability
- Ecosystem services can influence both the mean and variability of yield in agroecosystems
  - Typically only averages (means) are considered, but higher stability (lower variance) in yield is also valuable
- Field size and field boundaries are directly related to the conservation of SNL in agroecosystems
  - Size examples: wheat study from the UK
  - Boundary examples: flower strip studies, hedgerows
  - In North America, large financial incentives to make fields large and homogeneous, especially with large harvesting and planting equipment
  - Crop edge effects cause low yields at the margins of fields because of late emergence, poor microclimate, and competition with weeds
  - Ecosystem services should decay with distance from edge, so crops at the centre of a large field will not benefit from ecosystem services
  - Therefore, there should be a “goldilocks" field size, where negative edge effects are canceled out by ecosystem services
- Precision yield data holds enormous promise for agronomy
  - Limited because of:
  - Lack of standardized formats
  - Yearly calibration data
  - Clear statistical protocols

2. Methods

2.1. Data collection

- Precision yield data were collected directly from farmers across Alberta
  - Farmers were solicited for yield data through local agronomists, and we received data from a total of X growers across a total of X years
  - Most fields represented only a single year of data, but we did sometimes receive multiple years of data from the same field
  - File formats vary depending on the brand of combine, so we converted data to a standard format (csv) using Ag Leader SMS
  - In total, we analyzed yield data from X field-years of data, containing a total of X million data points
- Yield data was collected in discrete rectangles of the same length as the data interval (distance = speed $\times$ interval, typically 1 second) and the same width as the combine header (5-7 m)
  - We extracted the size of each polygon (m^2), dry yield (tonnes), and the spatial location, and the sequence of collection (1 - end of harvest)
  - Because of the large number of yield rectangles per field (30-800 thousand), we used the centroid of each polygon as its location
  - Seeding and application rates were constant with each field, so we did not consider inputs in our analysis
- Field boundaries were automatically digitized, then manually checked using satellite imagery and classified land cover data
  - Crop boundaries are flexible, and often change from year to year depending on planting and emergence conditions (e.g. flooding during some years)
  - Additionally, seminatural features often change from year to year
    * Ephemeral wetlands are flooded during some years, but consist mainly of grasses during dry years
    * Grass boundaries can change if fields are used for as haying or pasture during crop rotation
  - This makes accurate and consistent classification of field boundaries very difficult

- Because of this, we used the following general categories for field boundaries:

    1. Standard: thin (< 10 m wide) grassy field boundary, often grassy road right-of-ways
    2. Wetland: permanent wetland, whose borders are largely unchanged from year-to-year
    3. Forest/shrub: permanent windbreaks or remnant forests
    4. Grass: larger grassy area (pasture or permanent seminatural grassland)
    5. Other crop: different crop with little or no visible boundary between planted areas
    6. Bare: unplanted (fallow), flooded area, or unpaved roads

2.2. Analysis

- At each field, we fit an additive model of the effect of boundary distance on crop yield while accounting for within-field spatial variation and temporal variation in the combine yield monitor
    - Crop yield varies within a field due to soil conditions, moisture, seeding rates, herbicide application, and previous agricultural practices such as strip farming
    - While sensor calibration can reduce combine-level bias (such as a combine recording consistently higher/lower yields), this does not address sensor drift over time that occurs within fields
    - The yield monitors may record lower yields as sensors accumulate debris during harvest (pers. comm. Trent Clark), leading to changes in accuracy and bias over time
    - Additionally, ground speed is known to be extremely important to yield monitor accuracy (Arslan & Colvin 2002)
    - To address this, we fit the following model:

$$ln(yield) \tag{1}$$

3. Results

Results here

4. Discussion

Discussion here

5. Authors' contributions

Author's contribution

6. Acknowledgements

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References

Arslan, S. & Colvin, T.S. (2002). An evaluation of the response of yield monitors and combines to varying yields. *Precision Agriculture*, 3, 107–122.

Appendix A: Supplementary Material

Supplemental materials here