Variability of Biofuel Feedstock from Agricultural Residues in Alberta

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BACKGROUND

- Alberta produces large amounts of agricultural crops and residues that could provide potential feedstock for producing biofuels, but these amounts vary over time and space.
- Volatility of feedstock supply, because of weather and other factors, could influence the cost of biofuel production (Stephen et al., 2009).
- This study investigates residue yield variability in Alberta as a critical factor of identifying potential biorefinery sites.
- A preliminary risk analysis is conducted for each county, and the results are mapped using GIS.
- Spatial analysis of risk factors may help to identify best locations for potential biorefineries.

Data and Methods

The following data sources for wheat, canola, oats and barley are used in our analysis:

- **Yield**: Agriculture Financial Services Corporation (ANFC 2017)
- **Annual Crop Land Cover**: Agriculture and Agri-Food Canada (AAFC)
- **Conversion Ratio** (straw-to-crop): from the Bio-Resource Management System (BRIMS)

- Residue yield was estimated with straw-to-crop conversion ratios obtained from BRIMS (wheat-1.1, barley-0.8, oats-1.3, and canola-2.2).
- We combine crop residues using the following formula:

$$weighted\ average\ residue\ yield = \sum_{crop} \%_{crop} \times Y_{crop} \times R_{crop}$$

Where $\%_{crop}$ is the percentage of total land seeded to a given crop, Y_{crop} is the average crop yield and R_{crop} is the straw-to-crop conversion ratio.

- Averages and standard deviations of the weighted residue yields were calculated the for each county. The standard deviations were normalized relative to means using coefficients of variation (CV = Standard Deviation/Mean).

RESULTS

Aggregated Crop Results:

- Mean residue yields vary from 820 to 2038 kg/acre (Figure 1).
- CVs of residue yields vary from 9.9% to 57.2% (Figure 2).
- Counties with high residue yields and low CVs tend to be clustered in the east central part of the province around Edmonton.

Sources of Variations within the Aggregate Results:

- The differences in crop yield variation (Figure 3).
- Differences in land cover changes over time and across counties (Figure 4).

Figure 1: Mean of Weighted Average Residue Yield

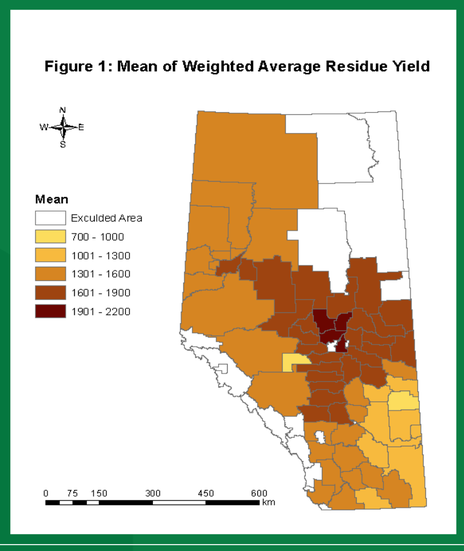


Figure 2: Agricultural Residue Yield Variability

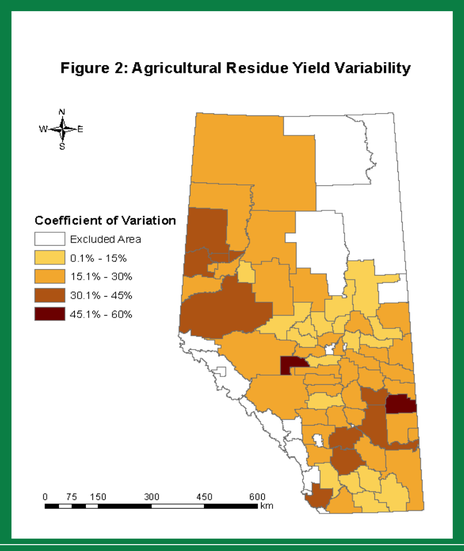


Figure 3: Variation of Mean Residue Yield (kg/acre) for 2009-2016 over 66 counties

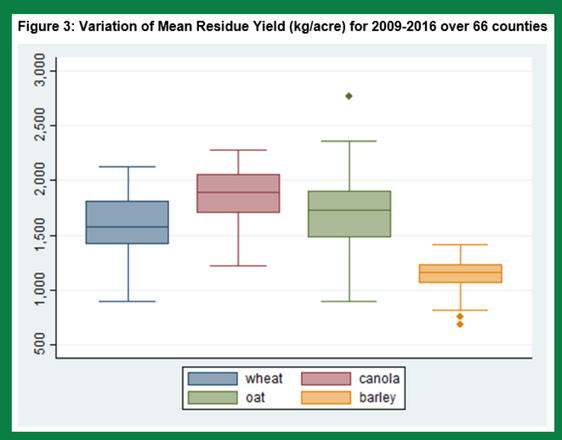
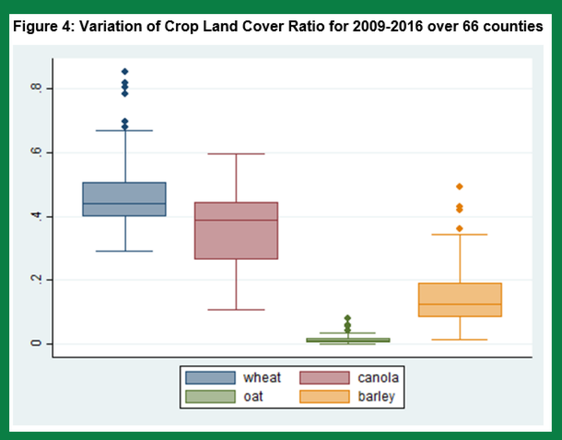


Figure 4: Variation of Crop Land Cover Ratio for 2009-2016 over 66 counties



IMPLICATIONS

- Results indicate that biofeedstock availability varies substantially across years, counties, and crops in Alberta.
- Yield variability seems to be primarily associated with weather but is also influenced by differences in yield variability between crops and percentages of cropping area over time.
- Methods of managing agricultural residue supply variability will need to be developed before biorefineries are seen as viable investments.

FUTURE DIRECTIONS

- Further economic dimensions to investigate include price variability in crops and potential portfolios of feedstocks to make biorefinery investments more viable.

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PARTNERS

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FES PROJECT OVERVIEW

T01-P02 Investment Decisions and Policy Analysis

- This project will inform investment decisions and policy development by integrating economic modelling – designed for decision making under uncertainty – into the biomass energy supply chains.

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