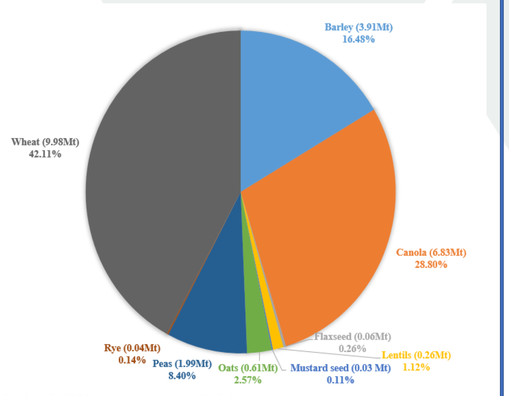
Potential Ethanol Biorefinery Sites in Alberta Based on Agricultural Residues

Yanan Zheng, Claire Doll, Grant Hauer, Martin Luckert*, and Feng Qiu [1]

BACKGROUND

- Alberta produces large quantities of agricultural crops and residues that could be used as feedstock for an emerging bioenergy industry (Figure 1) (Statistics Canada, 2018).
- The sustainable biomass supply and other economic features (e.g., the plant's road network accessibility) are key considerations in selecting potential biorefinery sites (Thomas et al., 2013).
  - A number of previous studies have investigated potential biorefinery sites (e.g., Argo et al., 2013; Eksioglu et al., 2009; Gonzales and Searcy, 2017; Sultana and Kumar, 2012;)
  - We build on the previous work and conduct a GIS-based analysis in Alberta at a high spatial resolution (i.e. 9.7km × 9.7km, the township level) and with residues from four major crops (barley, canola, oats, and wheat).

Figure 1. Major Crops in Alberta, 2017.



Unit: Million tonnes (Mt)

AIMS AND OBJECTIVES

- Examine the spatial distribution of available feedstocks and some economic considerations, with the aim of identifying possible future biorefinery sites.
- Some economic considerations:
  - Road network accessibility (Sahoo et al., 2016)
  - Supply radius (Gonzales and Searcy, 2017)
  - Economies of scale for residue processing (Muth et al., 2013)
  - Workforce availability (Zhang et al., 2011)

DATA AND METHODS

- **Data**: 2015 township level crop residue data (including barley, canola, oats, and wheat) from the Bio-Resource Management System (BRIMS).
- **Conceptual Framework**

Available Biomass
- **Crop production**
- **Crop residue** (straw-to-crop ratio: barley-0.8, canola-2.2, oats-1.1, wheat-1.1)[1]
- **Soil conservation needs** (20% left on the field)[2]

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Accessible Biomass & Suitable Sites for Biorefineries
- **Road network accessibility** (1km away from road)
- **Supply Radius** (80km and 40km)
- **Economies of scale for residue processing** (1.8-3.3 Mt/year)
- **Workforce availability** (counties or nearby counties that are within the supply radius having populations of 1,000 or greater)

1 Bailet-Stamler et al. (2007); 2 Stumborg et al. (1996)

RESULTS

- Total available biomass from barley, canola, oats, and wheat in Alberta is approximately 22.4 million tonnes (Mt), with canola straw making up the largest share (45.2%).
- Applying an 80-kilometer supply radius, 4 plants could be built in Alberta assuming a plant capacity of 1.8 Mt/year (Table 1). Figure 2 maps the spatial distribution of biomass and the locations of possible future biorefineries.
- The 4 possible future plants are found within the counties of Beaver, Kneehill, Vulcan, and Sturgeon (Table 2). If all plants were built, they would process 67% of total available biomass in Alberta.
- When the accessible biomass for a possible site exceeds 3.3 Mt, another site could be possibly built nearby to process the surplus.
- When the supply radius is reduced to 40 kilometers, there are 2 sites that could be built with enough biomass supply (i.e., greater than 1.8 Mt/year). They would be sited in the counties of Flagstaff and Kneehill.

Figure 2. Spatial Distribution of Feedstocks and Location of Possible Future Biorefinery Sites.

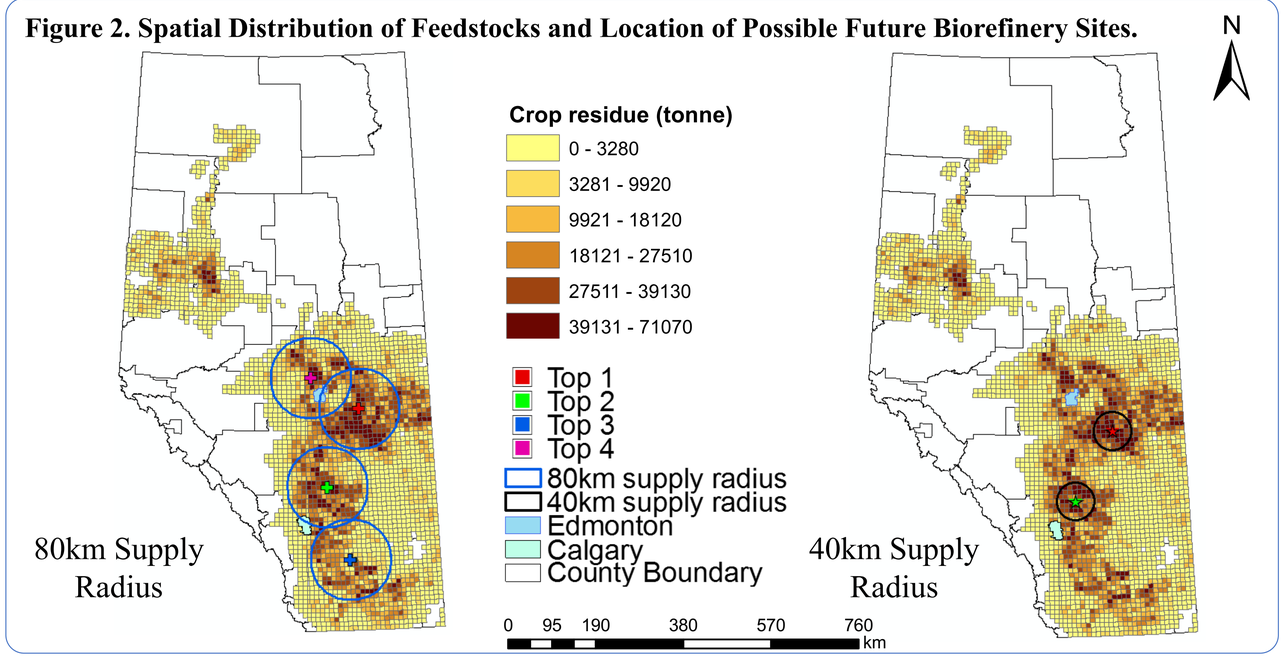

Table 1. Accessible Crop Residues for Potential Biorefinery Sites.

	80km Supply Radius				40km Supply Radius	
	Top 1	Top 2	Top 3	Top 4	Top 1	Top 2
Wheat	1.939	1.439	1.176	0.824	0.769	0.632
Barley	0.424	0.884	0.520	0.221	0.188	0.362
Oats	0.107	0.029	0.010	0.081	0.031	0.007
Canola	2.730	1.784	0.815	1.279	1.029	0.765
Other	0.023	0.018	0.316	0.009	0.014	0.011
Total	**5.2**	**4.2**	**2.8**	**2.4**	**2.0**	**1.8**

Unit: Million tonnes (Mt)

Table 2. Locations of Possible Future Biorefinery Sites.

	80km Supply Radius		40km Supply Radius	
	County	Location	County	Location
Top 1	Beaver	W	Flagstaff	NW
Top 2	Kneehill	NW	Kneehill	SW
Top 3	Vulcan	SE		
Top 4	Sturgeon	NW		

IMPLICATIONS

- Applying an 80-kilometer supply radius, our study found sites for 4 plants that could be possibility built in Alberta assuming a plant capacity of 1.8 Mt/year.
- Our research provides a staring point for investigating economic viability of biorefineries and may inform future site selections.

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.

PARTNERS

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[1]Department of Resource Economics and Environmental Sociology, 515 General Service Building, University of Alberta, Edmonton, AB, T6G 2H1

*Principal investigator. Email: mluckert@ualberta.ca

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