Lifecycle Analysis Canola Biodiesel

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Agenda

- Lifecycle Assessment
- GHGenius
- Canola Biodiesel
- Canadian Canola Biodiesel Strengths

Life Cycle Assessment

- Life Cycle Assessment (LCA) is a technique for assessing the potential environmental aspects associated with a product (or service), by:
  - ***compiling*** an inventory of relevant inputs and outputs,
  - ***evaluating*** the potential environmental impacts associated with those inputs and outputs, and
  - ***interpreting*** the results of the inventory and impact phases in relation to the objectives of the study.
  - Source: US EPA

What is LCA?

- LCA is a cradle to-grave approach for assessing industrial systems
- Begins with gathering the raw materials from the the earth and ends when the materials are returned to the earth
- Evaluates all of the stages as if they are interdependent
- Provides a comprehensive view of all environmental impacts and allows a more accurate assessment of environmental trade-offs

Benefits Of LCA

- Helps decision makers select options that provide the lowest environmental impact
  - This is used with other information such as cost and performance to select a product or process
- Companies can claim one product is better than another on the basis of LCA
- LCA inventory process helps to narrow in on the area where the biggest reductions in environmental emissions can be made
- Can be used to reduce production costs

Limitations of LCA

- Can be time and resource intensive
  - Availability and accuracy of data can influence the results
- Most LCA’s won’t determine which product works the best or is the most cost effective
- LCA’s need to be used as one component of the decision making process assessing the trade-offs with cost and performance

Life Cycle Assessment Principles

- The ISO 14040 standard for Life Cycle Assessment has seven principles:
  1. Life Cycle Perspective
  2. Environmental Focus
  3. Relative Approach and Functional Unit
  4. Iterative Approach
  5. Transparency
  6. Comprehensiveness
  7. Priority of Scientific Approach

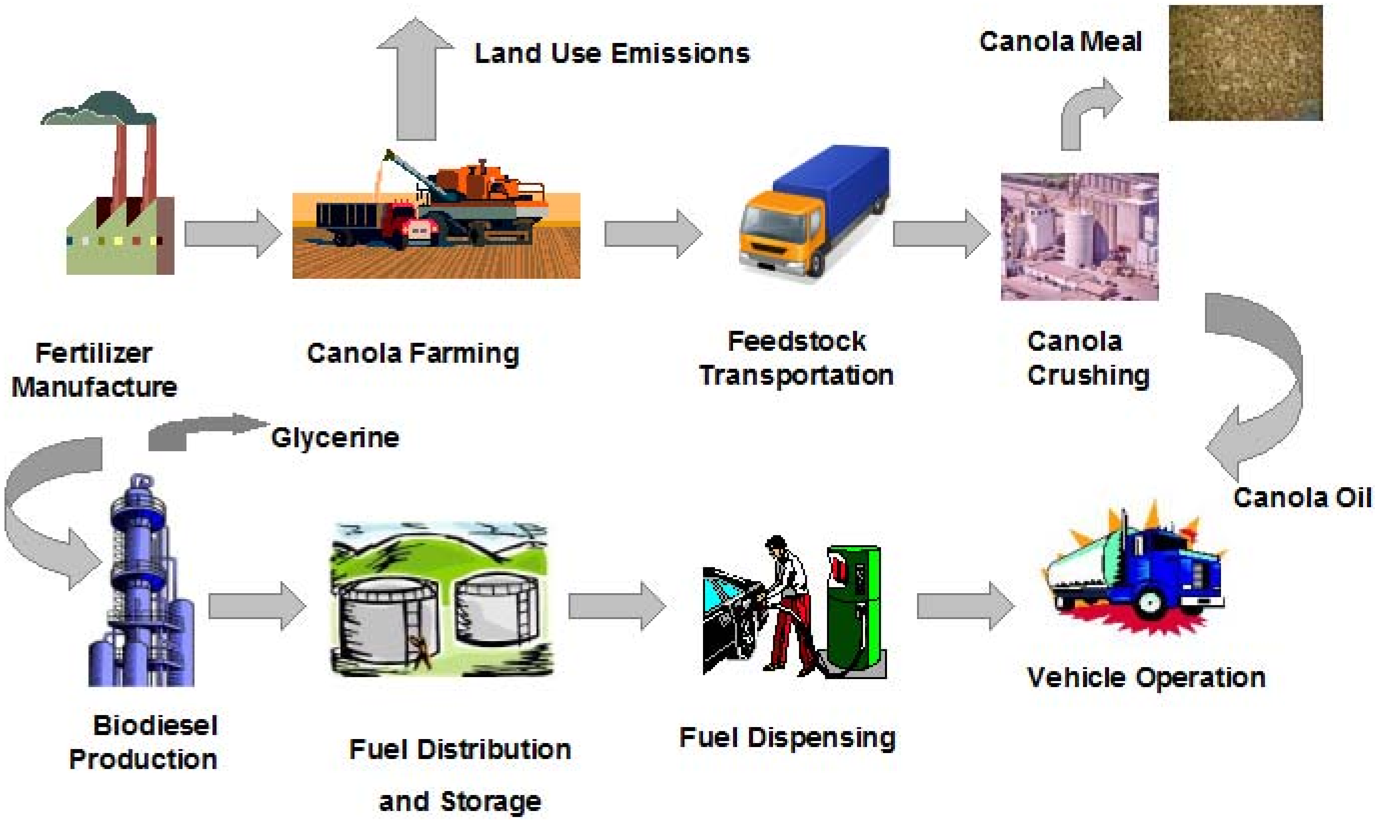
GHGenius Background

- Based on a Lotus 123 spreadsheet model developed by Dr. Mark Delucchi, University of California, Davis in the late 1980's for estimating transportation emissions
- In 1999, Levelton Engineering was asked by NRCan to use the model for the Transportation Table of the National Climate Change Process
- Since 1999 the model, now called GHGENIUS, has been used for studies for Agriculture and Agri-Food Canada, Natural Resources Canada, a number of the Provinces and some industries
- Many new pathways have been added so that there are now over 200 transportation fuel pathways in the model. Much more Canadian specific data in the model
- An Excel version is now available with an updated guide

Why GHGENIUS?

- Follows an accepted LCA process
- Transportation specific but covers most energy sources and many materials manufacturing processes and land use changes
- Best Canadian database available
- Good American database
  - Allows comparison of Canadian and US applications of the same process
  - There are some significant differences in the industrial infrastructure between the countries
- Has some economic tools incorporated

Canola Biodiesel



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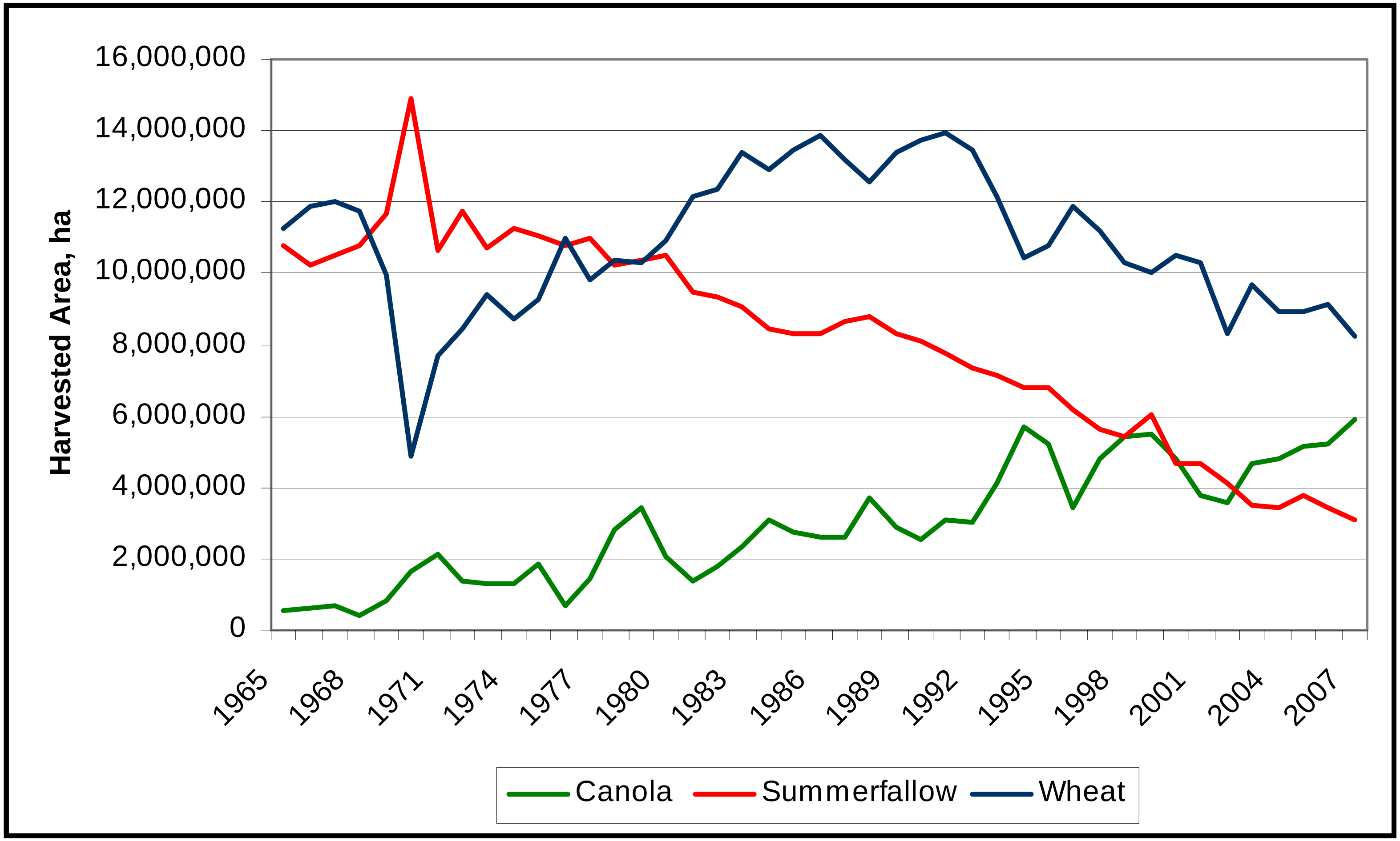
Land Use



Harvested Area, ha
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
Canola
Summerfallow
Wheat

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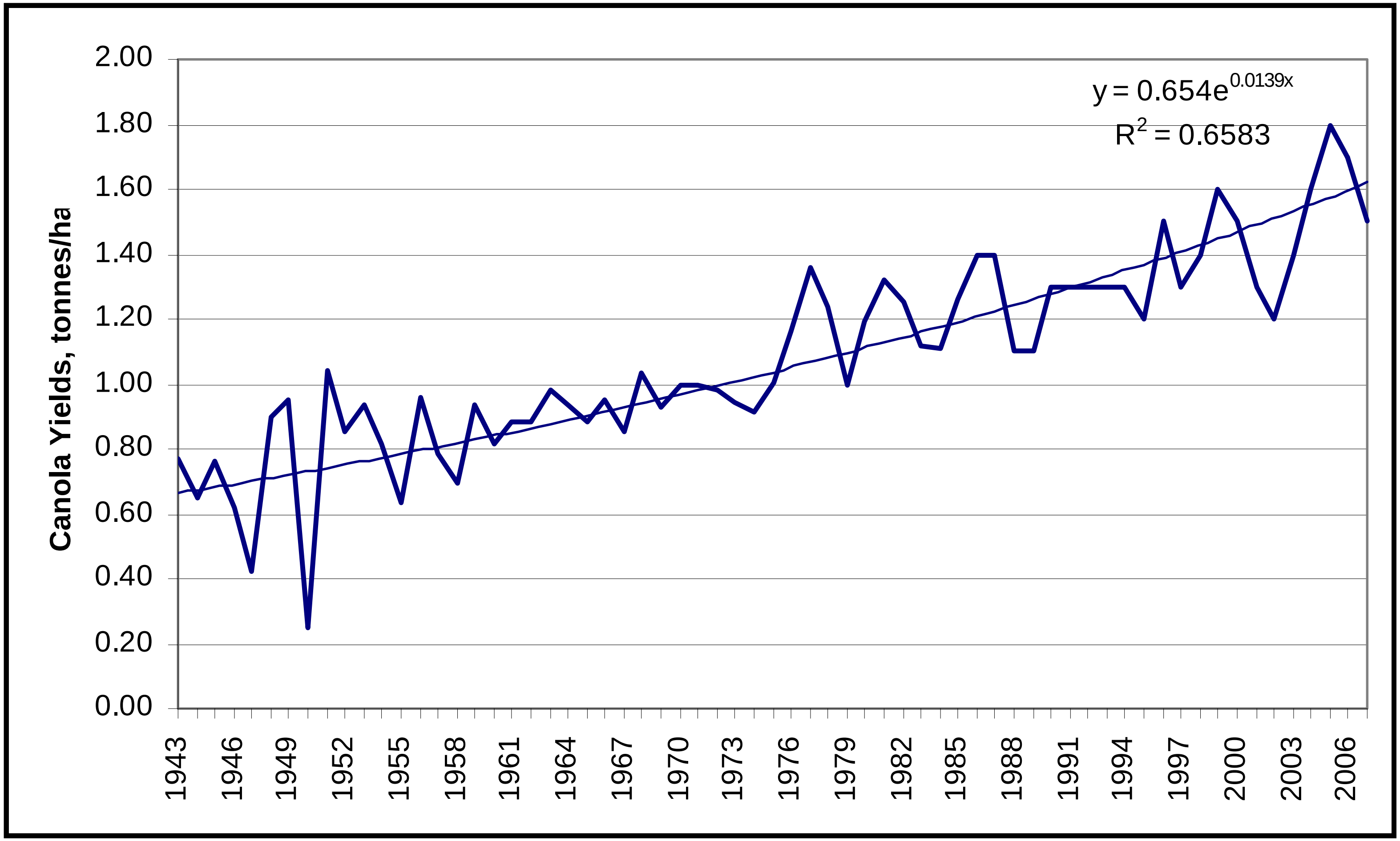
Canola Yield



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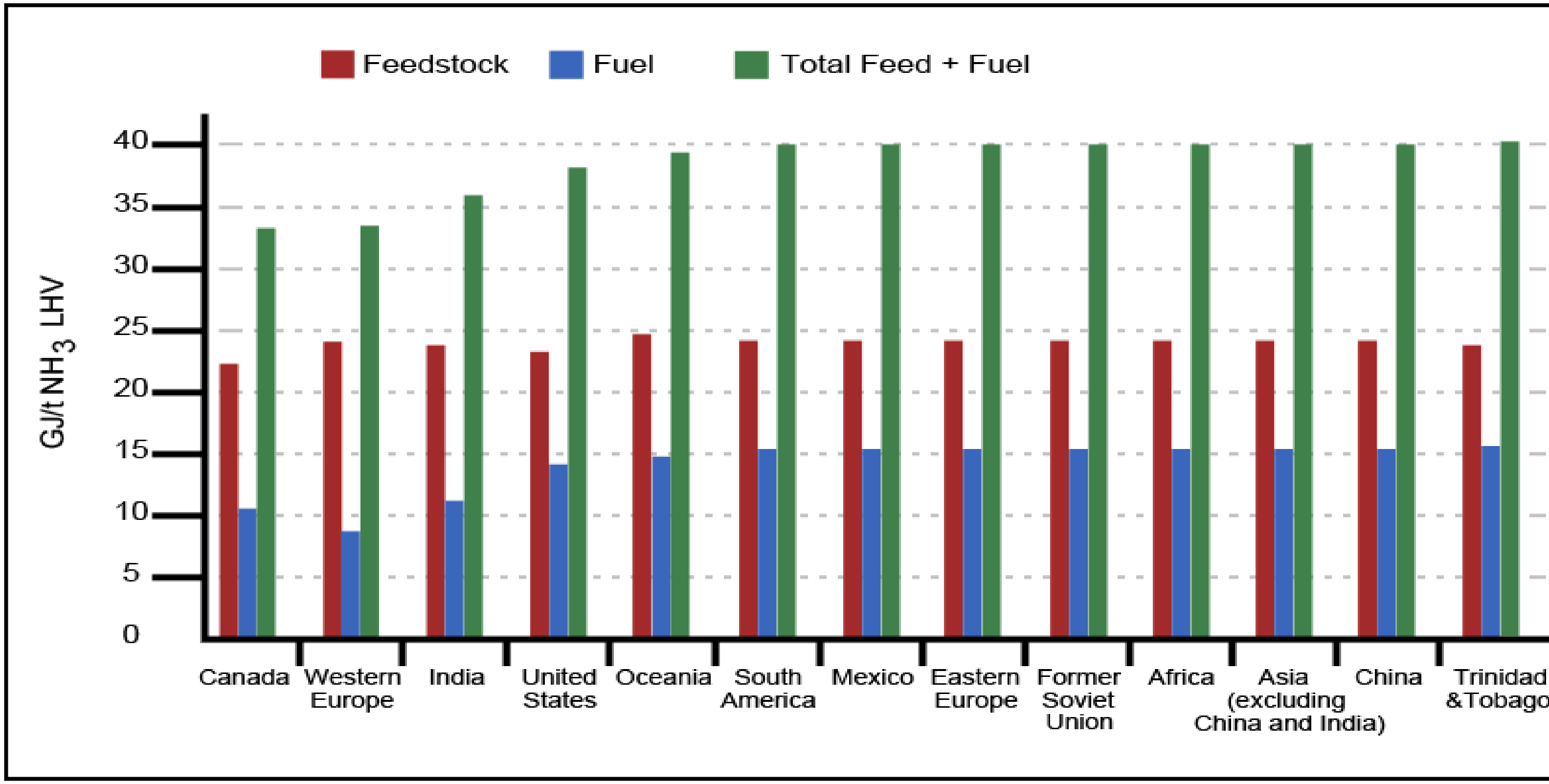
Nitrogen Fertilizer Use

- European rapeseed producers use ~50% ammonium nitrate fertilizer which has about twice the embedded GHG emissions of ammonia or urea.

	Nitrogen Content	1,000 tonnes	Nitrogen in fertilizer	% by Nitrogen
Ammonia	0.82	479	393	27.9%
Urea	0.46	1,664	765	54.3%
Ammonium Nitrate	0.34	0	0	0.0%
Ammonium Sulphate	0.20	507	101	7.2%
UAN	0.28	532	149	10.6%
Total		3,182	1,409	100.0%

Efficient Fertilizer Manufacturing



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Low N_2O Emissions

	Minimum	Maximum	Average
	Kg N_2O-N/kgN applied		
Atlantic	0.0128	0.0168	0.0161
Quebec	0.0147	0.0167	0.0160
Ontario	0.0098	0.0166	0.0139
Manitoba	0.0065	0.0142	0.0105
Saskatchewan	0.0021	0.0101	0.0067
Alberta	0.0045	0.0099	0.0075
BC	0.0047	0.0113	0.0081
Canada	0.0076	0.0120	0.0100
Canada East	0.0128	0.0168	0.0161
Canada Central	0.0117	0.0166	0.0147
Canada West	0.0037	0.0106	0.0076

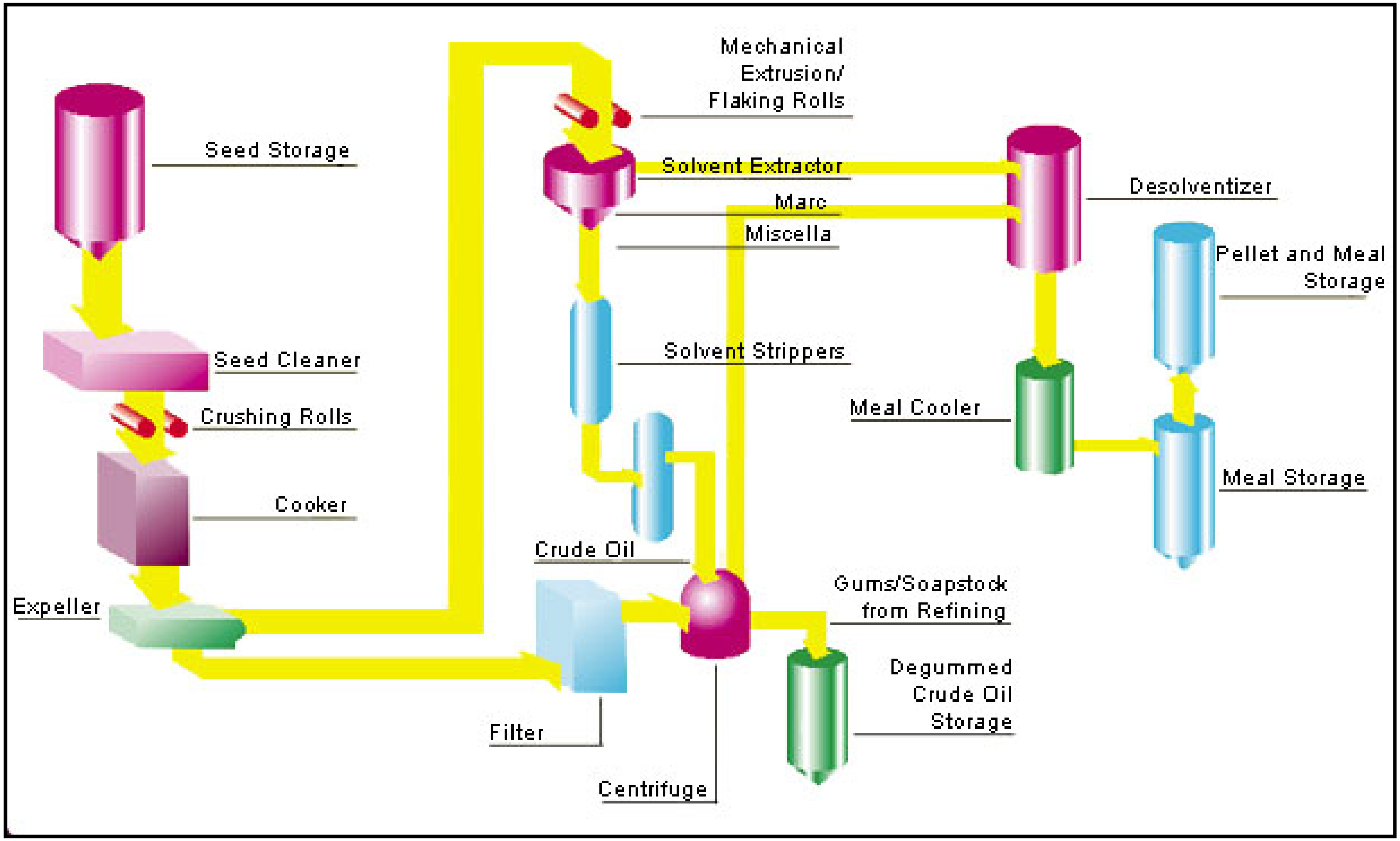
Leading Tillage Practices

	Seeded Area	Full Tillage	Conservation Tillage	No Tillage
	hectares			
Manitoba	3,890,618	1,689,335	1,371,380	829,903
Saskatchewan	13,348,192	2,443,085	2,876,161	8,028,946
Alberta	7,578,201	1,877,391	2,098,535	3,622,274
Total	24,817,011	6,009,811	6,346,076	12,481,123
% of seeded acres		24.2	25.6	50.3

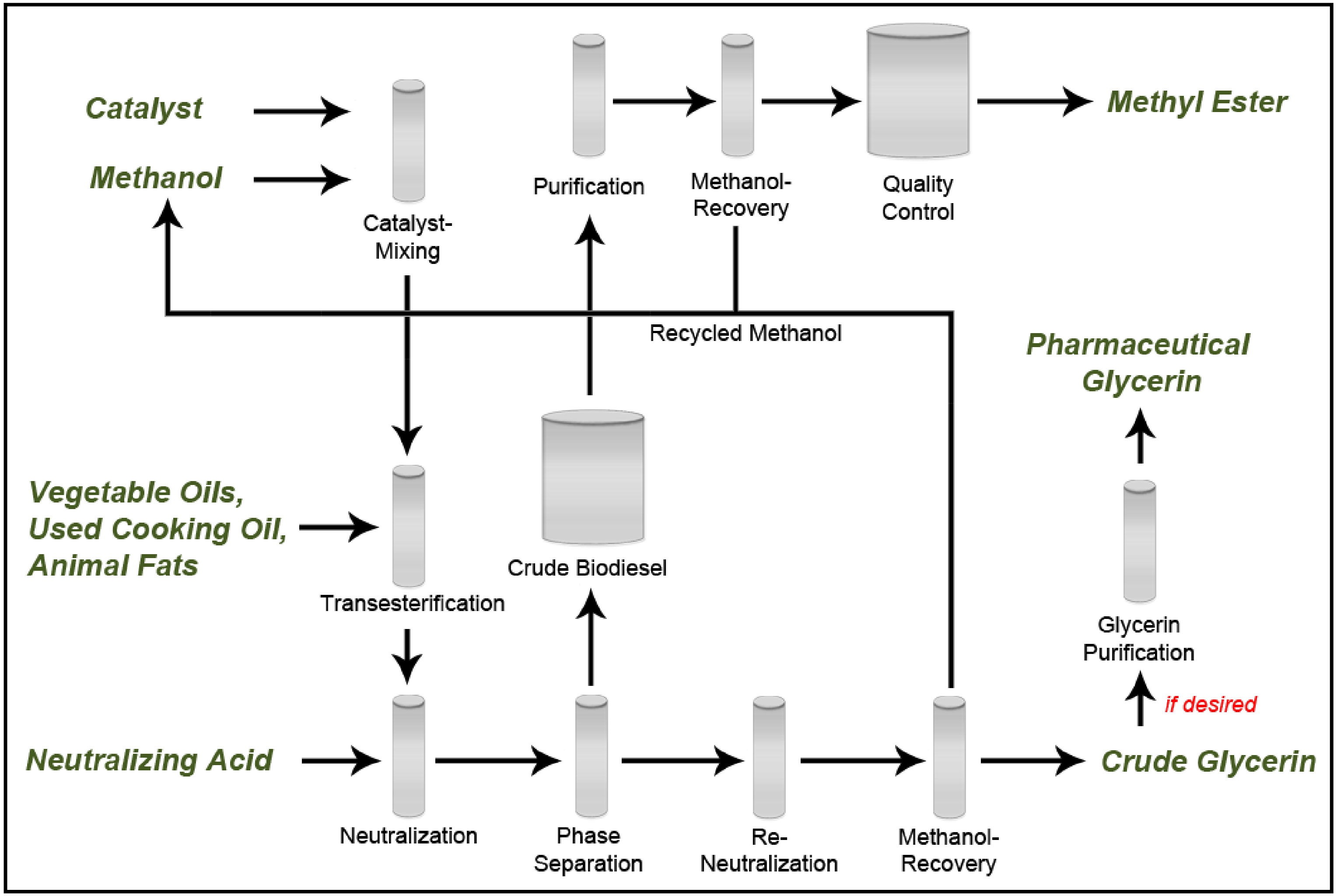
Building Soil Carbon

	Atlantic	Central	Parkland	Semi-arid Prairies	West
	kg C/ha/year				
Intensive till to no-till	60	100	140	100	50
Intensive till to reduced till	50	40	50	40	0
Reduced till to no till	0	60	70	50	40
Decrease fallow	300	300	300	300	300
Increase perennial	770	740	550	560	460

Canola Crushing



Biodiesel Manufacturing



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Energy Balance

Fuel	Hwy diesel	Biodiesel
Feedstock	Crude oil	Canola
	Joules consumed/Joule Delivered	
Fuel dispensing	0.0024	0.0027
Fuel distribution, storage	0.0069	0.0153
Fuel production	0.1168	0.1363
Feedstock transmission	0.0117	0.0126
Feedstock recovery	0.1182	0.0722
Ag. chemical manufacture	0.0000	0.1643
Co-product credits	-0.0011	-0.1779
Total	**0.2549**	**0.2255**
Net Energy Ratio (J delivered/J consumed)	**3.9231**	**4.4345**

Upstream GHG Emissions

Fuel	Hwy diesel	Biodiesel
Feedstock	Oil	Canola
	g CO_2eq/GJ (HHV)	
Fuel dispensing	114	131
Fuel distribution and storage	476	1,187
Fuel production	8,432	7,231
Feedstock transmission	905	976
Feedstock recovery	8,626	6,276
Land-use changes, cultivation	266	6,321
Fertilizer manufacture	0	10,116
Gas leaks and flares	1,855	0
CO_2, H_2S removed from NG	0	0
Emissions displaced	-230	-27,172
Total	20,444	5,065

Lifecycle GHG Emissions

General fuel	Petrol diesel	Biodiesel
Fuel specification	0.0015% S	Canola B100
Feedstock	Crude oil	Canola
	g CO_2eq/km	
Vehicle operation	1,078.3	1,108.3
C in end-use fuel from CO_2 in air	0.0	-1,081.7
Net Vehicle Operation	1,078.3	26.7
Fuel dispensing	1.8	2.0
Fuel storage and distribution	7.3	18.2
Fuel production	129.4	111.0
Feedstock transport	13.9	15.0
Feedstock recovery	132.4	96.4
Land-use changes, cultivation	4.1	97.1
Fertilizer manufacture	0.0	155.3
Gas leaks and flares	28.5	0.0
CO_2, H_2S removed from NG	0.0	0.0
Emissions displaced by co-products	-3.5	-417.2
Sub total (fuel cycle)	1,392.0	104.4
% changes (fuel cycle)	--	-92.5
Vehicle assembly and transport	*5.5*	*5.5*
Materials in vehicles	*31.3*	*31.3*
Grand total	1,428.7	141.2
% changes (grand total)	--	-90.1

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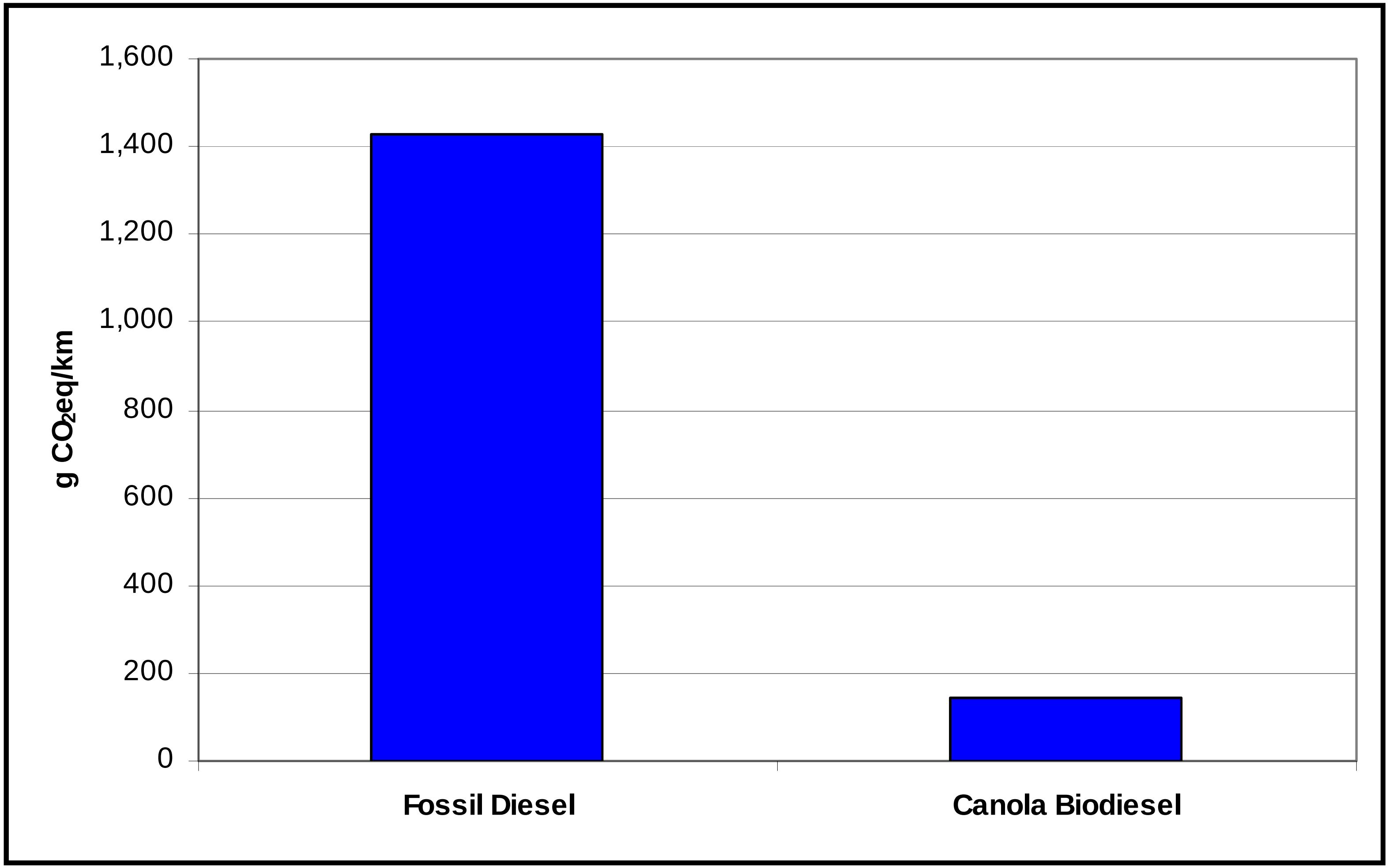
Lifecycle GHG Emissions



Canadian Canola Biodiesel Advantages

- The energy efficient production methods employed by Canadian producers, including high adoption rates of no till and conservation tillage practices.
- The use of ammonium type fertilizers rather than nitrate fertilizers, with their lower GHG emissions profile.
- Low N_2O emissions in the primary canola production areas due to the low annual precipitation.
- The production on alkaline soils and thus avoiding the need for soil pH adjustment through the addition of lime.

Questions

and

Discussion

Thank You