Land Use Change: New Insights

Presented to:

ISCC North America Committee Meeting

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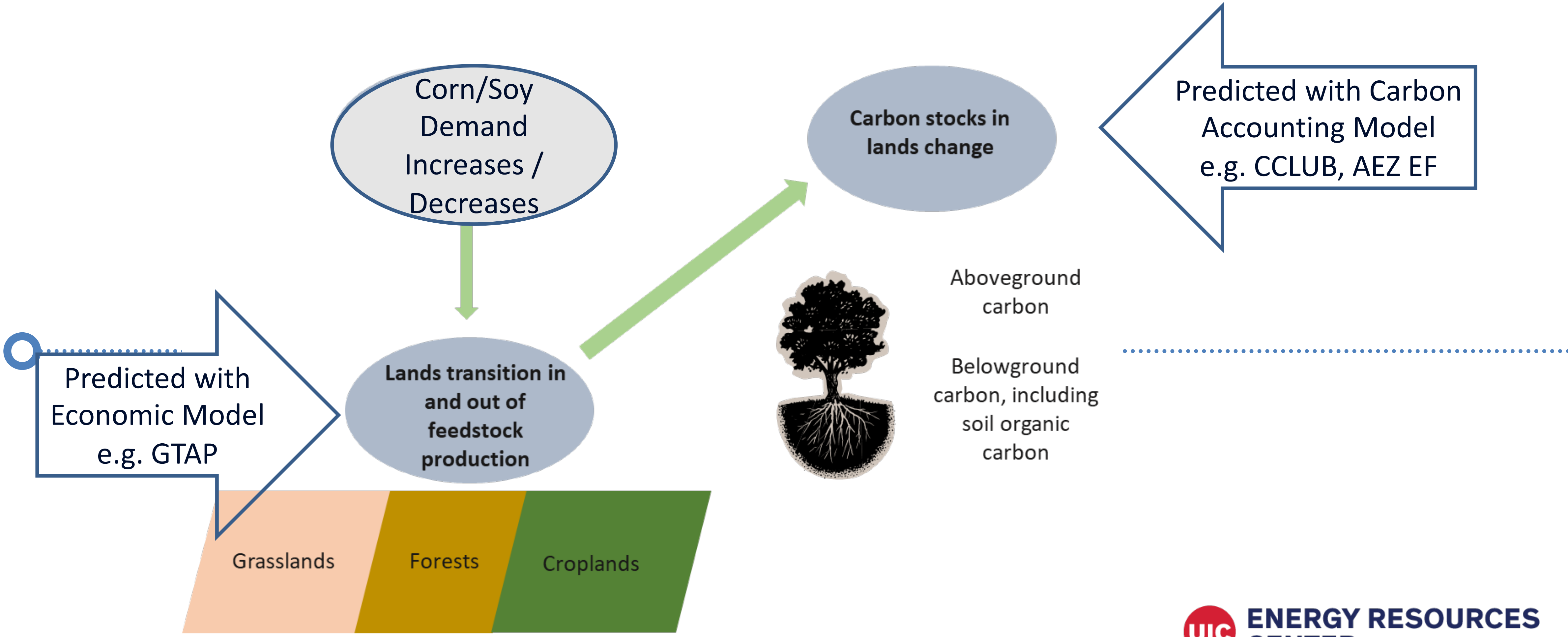
Overview

- Introduction to induced land use change modeling (iLUC)
- iLUC under ICAO CORSIA
- Sensitivity of CORSIA iLUC values
- New research insights into iLUC
- Low iLUC risk SAF
  - Unused lands
  - Yield improvements (winter canola)

Indirect Land Use Change

Induced Land Use Change (iLUC) Modeling & Carbon Accounting

Combine economic models with carbon accounting models



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Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

- Core LCA + iLUC
- Use CORSIA calculated default value or calculate and certify specific pathway
- No iLUC if feedstocks are grown on “Low iLUC Risk Lands”

ICAO document

CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels

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Table 2. CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels produc with the Hydroprocessed Esters and Fatty Acids (HEFA) Fuel Conversion Process

Region	Fuel Feedstock	Pathway Specifications	Core LCA Value	ILUC LCA Value	LS_f (gCO_2e/MJ)
Global	Tallow		22.5	0.0	22.5
Global	Used cooking oil		13.9		13.9
Global	Palm fatty acid distillate		20.7		20.7
Global	Corn oil	Oil from dry mill ethanol plant	17.2		17.2
USA	Soybean oil		40.4	24.5	64.9
Brazil	Soybean oil		40.4	27.0	67.4
Global	Soybean oil		40.4	25.8	66.2
EU	Rapeseed oil		47.4	24.1	71.5
Global	Rapeseed oil		47.4	26.0	73.4
Malaysia & Indonesia	Palm oil	At the oil extraction step, at least 85% of the biogas released from the Palm Oil Mill Effluent (POME) treated in anaerobic ponds is captured and oxidized.	37.4	39.1	76.5
Malaysia & Indonesia	Palm oil	At the oil extraction step, less than 85% of the biogas released from the Palm Oil Mill Effluent (POME) treated in anaerobic ponds is captured and oxidized.	60.0	39.1	99.1
Brazil	Brassica carinata oil	Feedstock is grown as a secondary crop that avoids other crops displacement	34.4	-20.4	14.0
USA	Brassica carinata oil	Feedstock is grown as a secondary crop that avoids other crops displacement	34.4	-21.4	13.0
Global	Brassica carinata oil	Feedstock is grown as a secondary crop that avoids other crops displacement	34.4	-12.7	21.7
Global	Camelina oil	Feedstock is grown as a secondary crop that avoids other crops displacement	42.0	-13.4	28.6

Table 3. CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels produced with the Alcohol (isobutanol) to jet (ATJ) Fuel Conversion Process

Region	Fuel Feedstock	Pathway Specifications	Core LCA Value	ILUC LCA Value	LS_f (gCO_2e/MJ)
Global	Agricultural residues	Residue removal does not necessitate additional nutrient replacement on the primary crop.	29.3	0.0	29.3
Global	Forestry residues		23.8		23.8
Brazil	Sugarcane	Standalone or integrated conversion design	24.0	7.3	31.3
Global	Sugarcane	Standalone or integrated conversion design	24.0	9.1	33.1
USA	Corn grain	Standalone or integrated conversion design	55.8	22.1	77.9
Global	Corn grain	Standalone or integrated conversion design	55.8	29.7	85.5
USA	Miscanthus (herbaceous energy crops)		43.4	-54.1	-10.7
EU	Miscanthus (herbaceous energy crops)		43.4	-31.0	12.4
Global	Miscanthus (herbaceous energy crops)		43.4	-23.6	19.8
USA	Switchgrass (herbaceous energy crops)		43.4	-14.5	28.9
Global	Switchgrass (herbaceous energy crops)		43.4	5.4	48.8

Table 1. CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels produced with the Fischer-Tropsch Fuel Conversion Process

Region	Fuel Feedstock	Pathway Specifications	Core LCA Value	ILUC LCA Value	LS_f (gCO_2e/MJ)
Global	Agricultural residues	Residue removal does not necessitate additional nutrient replacement on the primary crop	7.7	0.0	7.7
Global	Forestry residues		8.3		8.3
Global	Municipal solid waste (MSW), 0% non-biogenic carbon (NBC)		5.2		5.2

Sensitivity of CORSIA iLUC Values

"Biofuels induced land use change emissions: The role of implemented emissions factors in assessing terrestrial carbon fluxes"

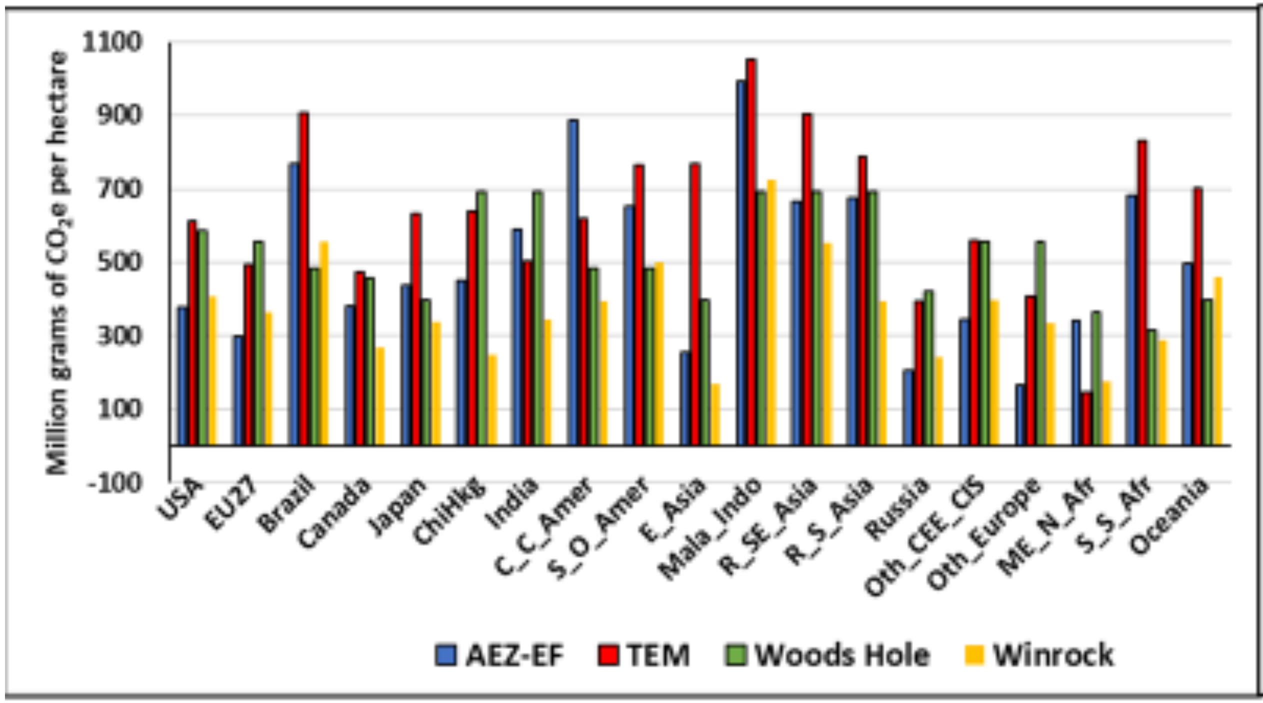
https://ageconsearch.umn.edu/record/322289/files/23039.pdf

Research Goals

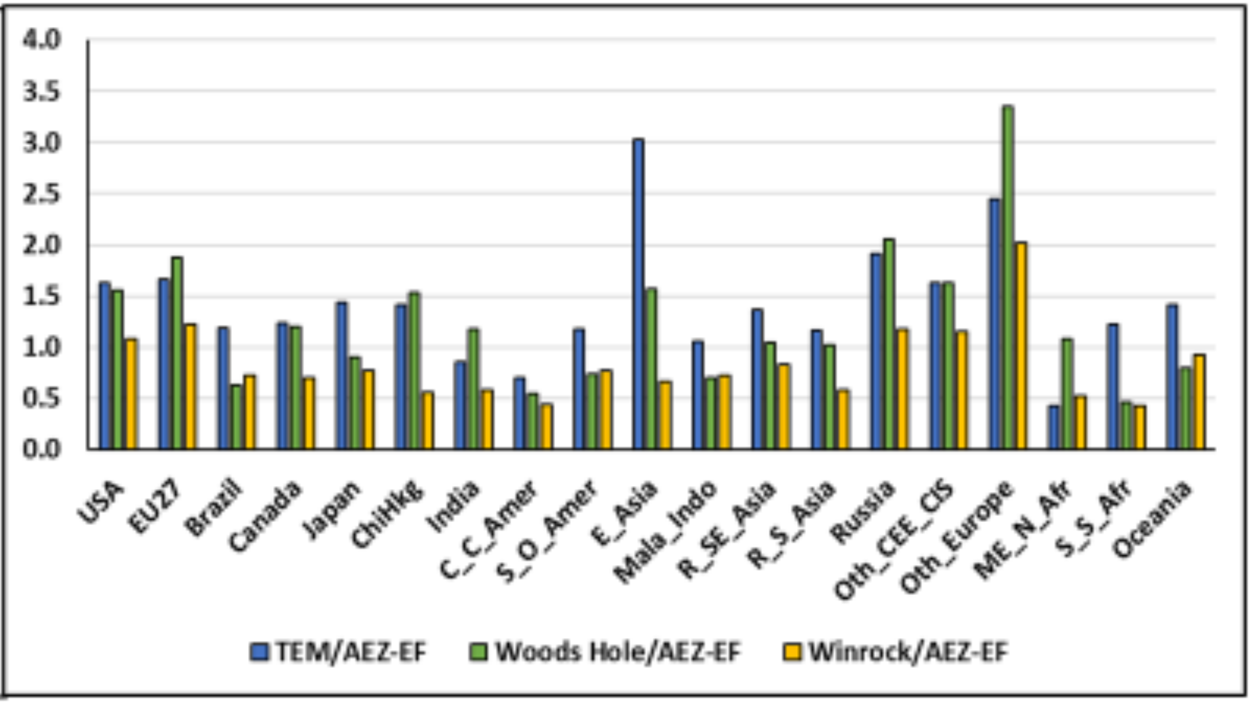
- This research aims at:
  - Highlighting uncertainties in data on land use emission factors,
  - Collecting and review the existing data sources including TEM; Woods Hole, Winrock International, and IPCC and other sources to determine their prose and cons.
- To compare two carbon accounting models (AEZ-EF and CCLUB) that have been developed to covert GTAP-BIO results to ILUC values:
  - AEZ-EF has been developed by Plevin et al. (2014) and adopted by CARB
  - CCLUB has been adopted by Argonne National Laboratory and used in combination with the GREET model.
- To evaluate ILUC values for various Sustainable Aviation Fuels (SAF) using both the AEZ-EF and CCLUB accounting models and in combination with the projections on land use changes obtained from the GTAP-BIO model.

Comparison (1)
Forest to cropland emissions factors by GTAP-BIO regions and data source

Absolut emissions per hectare



Emissions relative to AEZ-EF



These figures show major differences across data sources

Comparison of ILUC Values

Work in Progress

Estimated ILUC values for various SAF pathways using different emissions accounting models for 25- and 30-years amortization time periods (gCO_2 e/MJ)

Pathways	CORSIA values 25 years			25 years		30 years	
	GTAP-BIO	GLOBIOM	Default Value	GTAP-BIO with AEZ-EF	GTAP-BIO with CCLUB	GTAP-BIO with AEZ-EF	GTAP-BIO with CCLUB
US Corn ATJ	22.5	21.7	22.1	22.5	14.4	18.7	12.0
US Corn ETJ	24.9	25.3	25.1	24.9	15.6	20.8	13.0
US Soy oil HEFA	20.0	50.4	24.5	20.0	15.0	16.6	12.5

"Biofuels induced land use change emissions: The role of implemented emissions factors in assessing terrestrial carbon fluxes." By: Farzad Taheripour, Steffen Mueller, Isaac Emery, Omid Karami, Ehsanreza Sajedinia, 25th Annual Conference on Global Economic Analysis Accelerating Economic Transformation, Diversification and Job Creation; June 8-10, 2022: Virtual

New iLUC Relevant Research

New Research in Publication Process

- iLUC has a big impact on life cycle modeling of biofuels
- Currently, several models assess carbon stock changes (AEZ-EF, GREET-CCLUB, Globiom, IPCC, others) from biofuels production and their results differ widely, primarily driven by differing carbon stock factors assigned to land on the margin.
- These lands include marginal lands, fallow land, unused land, cropland-pasture land, and others (collective referred to as land on the margin for the purpose of this document).
- However, assigning the impact from these transitional land type conversions on carbon stock changes via carbon accounting models have been subject to substantial debate in the literature.

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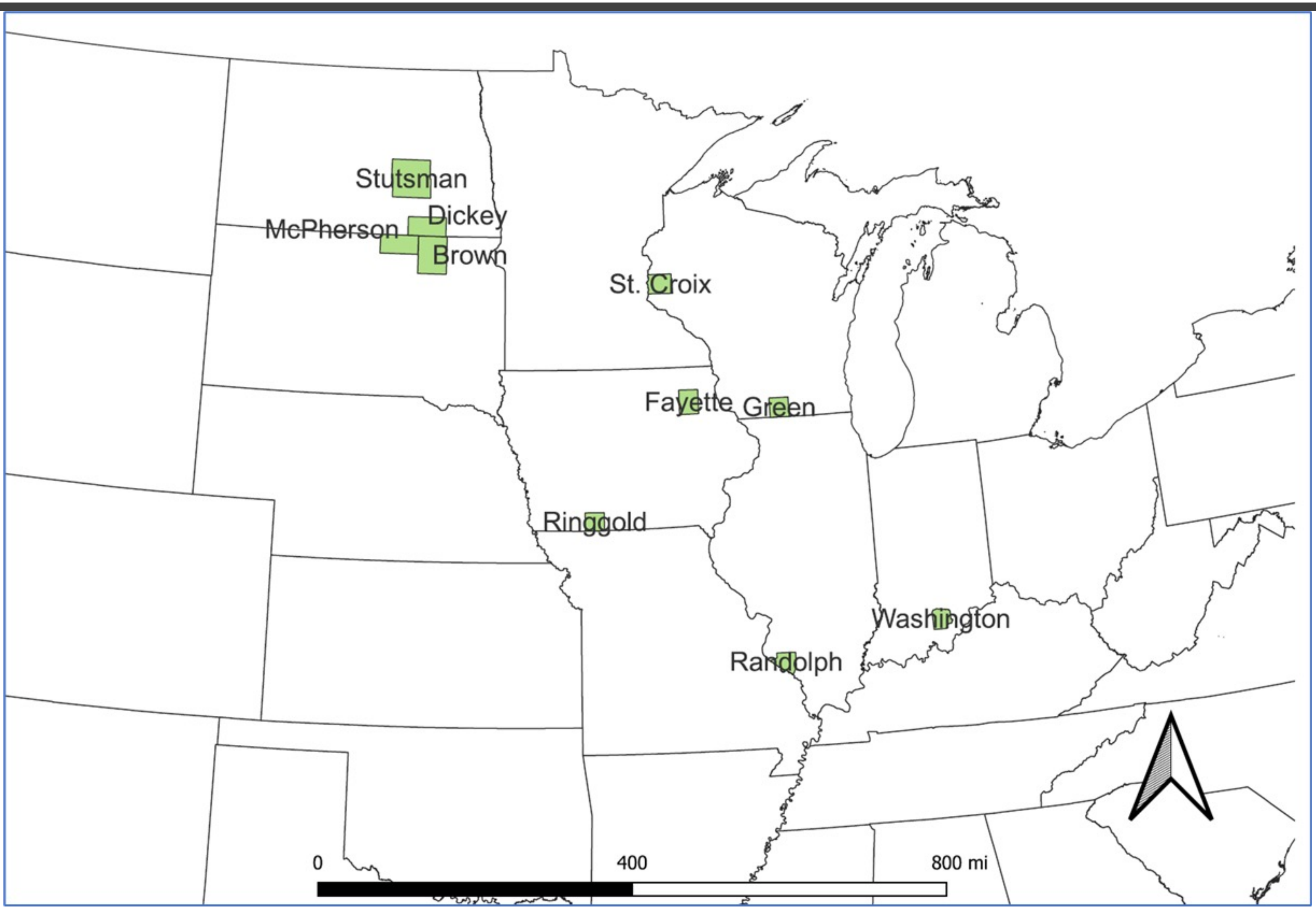
New Research in Publication Process

Aims to increase the understanding of transitional land that changes between crop and non-crop uses

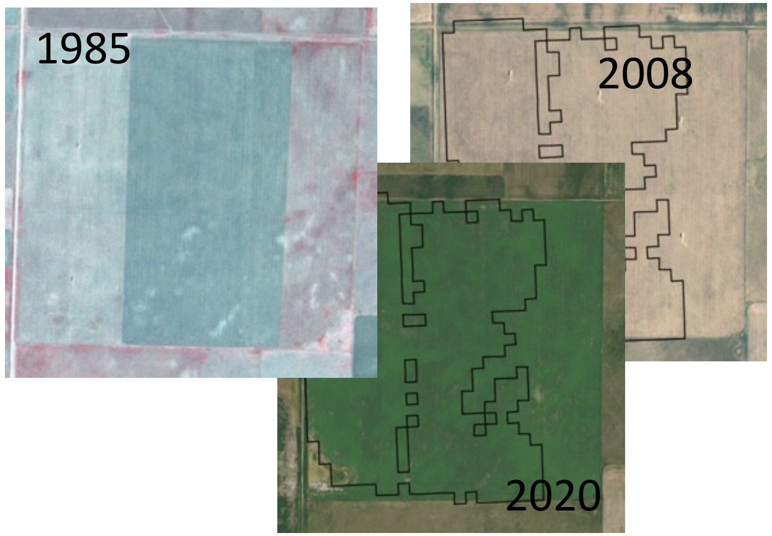
Methodologically, the analysis is based on

a) identifying the land use patterns of 1000 parcels from 1985 to 2021 (re-analysis of Lark parcels) with a combination of several remote sensing tools
b) in depth grower interviews to understand the drivers for land use change, and
c) an assessment of the carbon implications resulting from the identified land use patterns comparing SALUS to GREET CCLUB

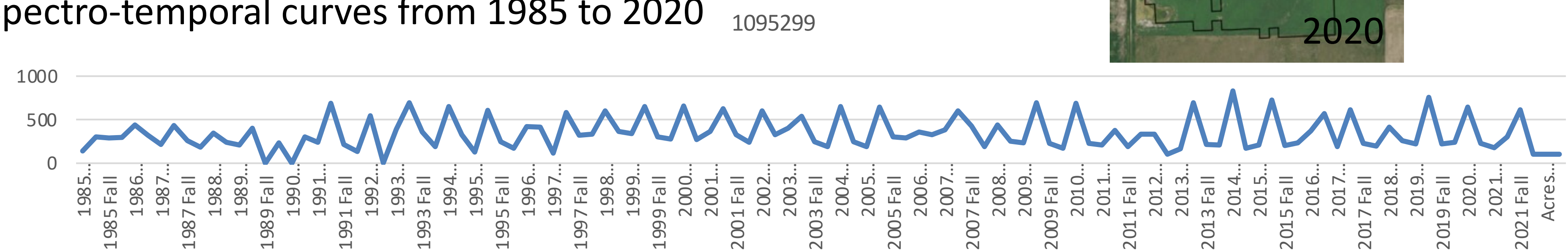


Three Checks on Land Use from 1985 to 2020 For 100 Points in Each County

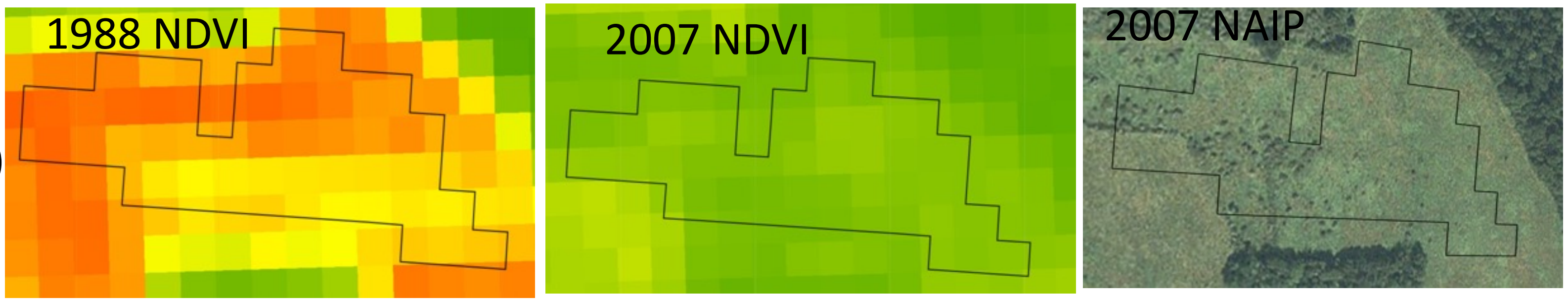
1. Review USDA aerial images from 1985 to determine if in agriculture.
   Review USDA aerial images from 2003 to 2020 to determine if in agriculture.



2. Review LandTrendr Landsat Spectro-temporal curves from 1985 to 2020 to determine if agriculture



3. Review Landsat Vegetation Index for June (brown=residue/bare soil, green is vegetation)



Low LUC Risk SAF

Yield Increase Approach (Source: ISCC CORSIA Guidance for LOW LUC Risk Certification

"The yield increase approach applies to any situation where feedstock producers are able to increase the amount of available feedstock out of a fixed area of land (i.e. without expanding the surface of the land). An increase in the harvested feedstock may be the result of the following options (non-exhaustive) and shall be documented and described in the low LUC risk report:

- An improvement in agricultural practices (practices that increase yields through means such as increased organic matter content, reduced soil compaction/erosion, decreased pests, etc.);
- Intercropping (i.e. the combination of two or more crops that grow simultaneously, for example as hedges or through an agroforestry system);
- Sequential cropping (i.e. the combination of two or more crops that grow at different periods of the year);
- Improvements in post-harvest losses (i.e. losses that occur at cultivation and transport up to but not including the first conversion unit in the supply chain), including also:
- Mechanical improvements (e.g. using machinery that reduces inputs to enhance output or reduce losses, includes also sowing, precision farming, the introduction of a new harvest machine or new/ faster truck ensuring lower post-harvest losses)
- Non-mechanical inputs (e.g. the introduction of new seed technologies that save chemical and non-chemical inputs or improve crop resistance against climate change and drought)"

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Low LUC Requirements under CORSIA

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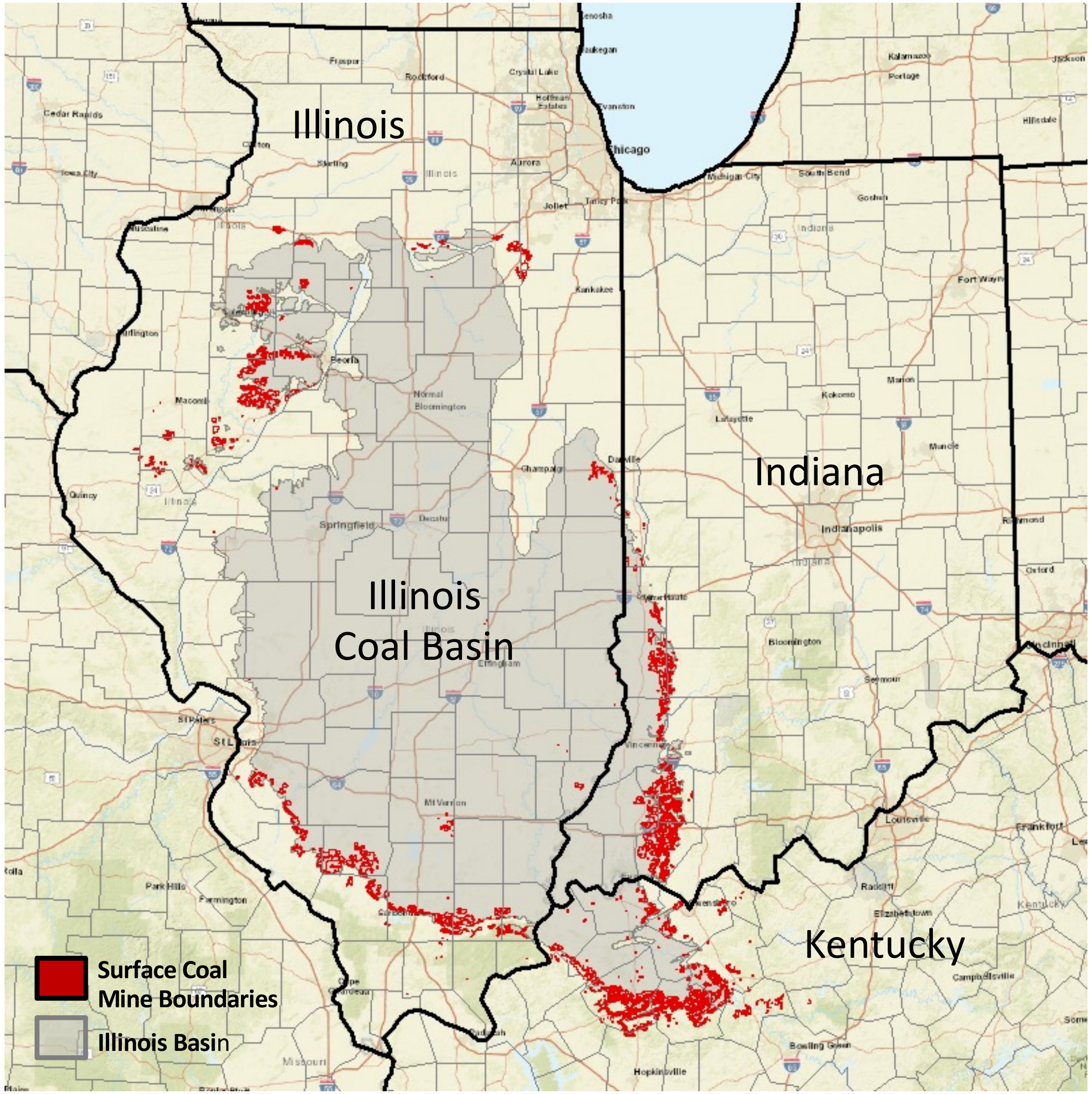
November 16, 2021

Results from Illinois Coal Basin Mapping Analysis



Technical Evaluation Study with ISCC to qualify reclaimed coal lands under "Low iLUC Risk Lands"

Total area of surface mines in the Illinois Basin is approximately 250,000 hectares.

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Winter Canola

CORSIA Default LCA Values

Note: negative iLUC for several cover crops due to co-products

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	Global	Used cooking oil	13.9		13.9
	Global	Palm fatty acid distillate	20.7		20.7
	Global	Corn oil (from dry mill ethanol plant)	17.2		17.2
	USA	Soybean oil	40.4	24.5	64.9
	Brazil	Soybean oil	40.4	27.0	67.4
	EU	Rapeseed oil	47.4	24.1	71.5
	Malaysia & Indonesia	Palm oil – closed pond	37.4	39.1	76.5
	Malaysia & Indonesia	Palm oil – open pond	60.0	39.1	99.1
	Brazil	Brassica carinata (grown as a secondary crop that avoids other crops displacement)	34.4	-20.4	14.0
	USA	Brassica carinata (grown as a secondary crop that avoids other crops displacement)	34.4	-21.4	13.0

Low LUC Risk under CORSIA


CORSIA

ISCC
International Sustainability
& Carbon Certification

ISCC CORSIA

GUIDANCE FOR LOW LUC RISK CERTIFICATION

Two approaches for Low LUC Risk Feedstock Production

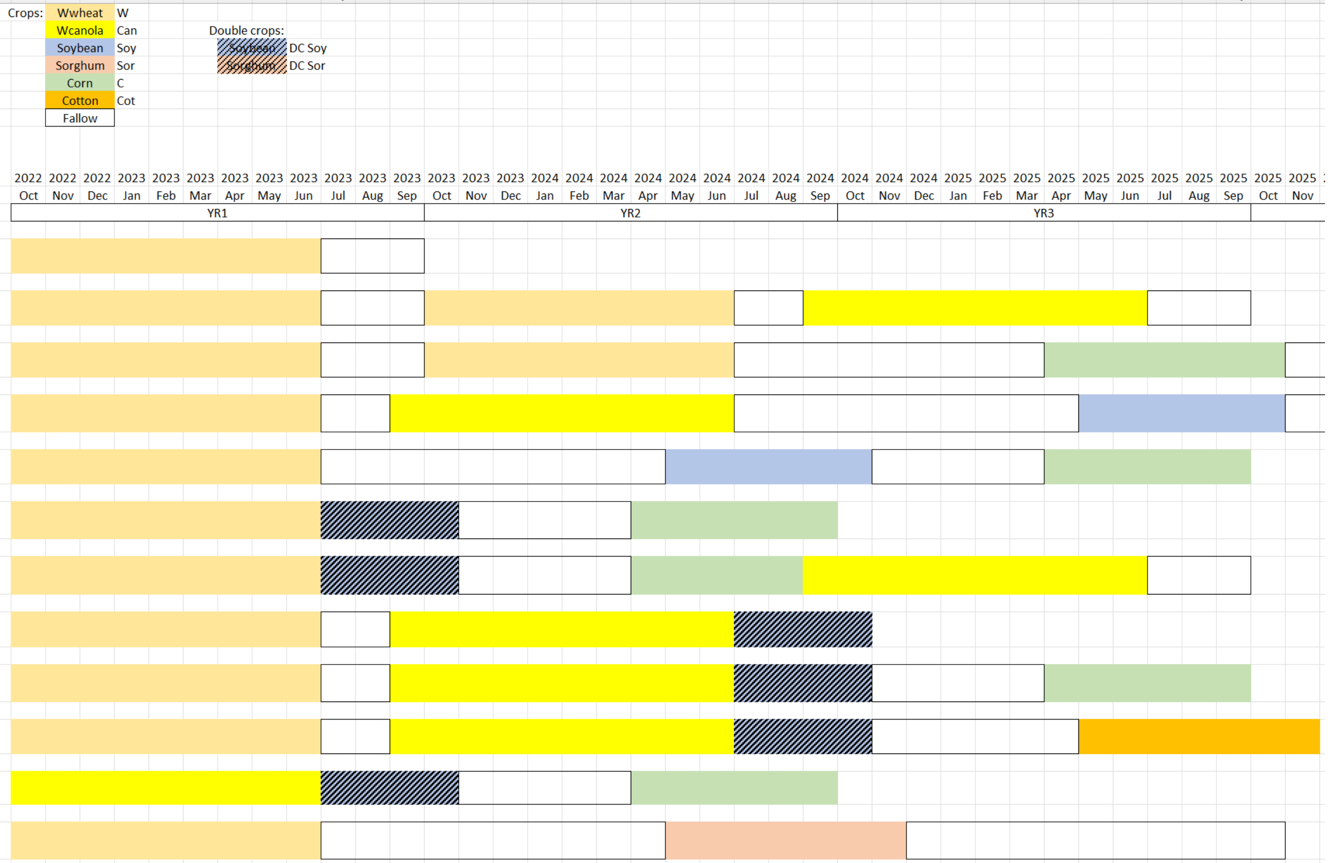
- Yield Increase Approach
- Unused Land Approach

More Efficient Land Use Considerations with Winter Canola

Wheat, DC-Soy, Corn, W-Canola. The rotations are quick following, diverse and over a 3 year period leave the land only 8 months unused vs. the standard wheat rotation which leaves the land for 9 months unused.

M. Stamm, K. Roozeboom, J. Holman
Kansas State University

Rotation	Rotation Type	Area	Crop Harvests	Rotation length, Yr	Crops/Yr
A1	Traditional continuous wheat SC KS, OK	SC KS, OK	1	1	1
A2	Replace wheat with canola every third year	SC KS, OK	3	3	1
B1	Traditional W-W-C/Sor-Soy, no double crops	Central KS, SC KS, N OK	4	4	1
B2	W-Can-C/Sor-Soy	Central KS, SC KS, N OK	4	4	1
B3	Traditional W-Soy-C	Central KS	3	3	1
C1	Traditional W-DC Soy-C	Central KS, SC KS, N OK	3	2	1.5
C2	W-DC Soy-C-Can	Central KS, SC KS, N OK	4	3	1.3
C3	W-Can-DC Soy	Central KS, SC KS, N OK	3	3	1
C4	W-Can-DC Soy-C/Sor	Central KS, SC KS, N OK	4	3	1.3
C5	W-Can-DC Soy-Cot	SC KS, OK	4	4	1
D1	Can-DC Soy-C	SE KS	3	2	1.5
E1	Traditional W-Sor-Fallow	Western KS	2	3	0.67



Average Yield Increase of Wheat Following Canola: 14.5%

Crop Economics, Production & Management

Continuous Winter Wheat Versus a Winter Canola–Winter Wheat Rotation

Joshua A. Bushong, Andrew P. Griffith, Thomas F. Peeper, and Francis M. Epplin*

ABSTRACT

Difficult to control winter annual grasses that have been used to produce forage, especially Italian ryegrass (*Lolium multiflorum* Lam.) and feral rye (*Secale cereale* L.), have invaded Oklahoma fields traditionally used to produce continuous winter wheat (*Triticum aestivum* L.). This study was conducted to determine whether a winter canola (*Brassica napus* L.)–winter wheat crop rotation could compete economically with continuous winter wheat. The effects of seven herbicide treatments for continuous wheat and 24 herbicide treatments for the canola–wheat rotations were analyzed during a rotation cycle at four Oklahoma locations. Enterprise budgets were prepared to enable economic comparisons across production systems and treatments. Wheat yields in the second year of the canola–wheat rotations were significantly ($P < 0.05$) greater than wheat yields in the second year of continuous wheat across all four locations (10, 11, 15, and 22%). Based on the historical relationship between wheat and canola prices, and a wheat price of US\$0.21 kg^{-1} and a canola price of US\$0.40 kg^{-1}, for the three sites for which net returns could be pooled across herbicide treatments, net returns from the canola–wheat rotation (US\$197, US\$123, and US\$24 ha^{-1} yr^{-1}) were significantly ($P < 0.05$) greater than net returns from continuous wheat (–US\$46, –US\$118, and –US\$48 $ha^{-1}yr^{-1}$). Based on historical price relationships and the yields produced in the trials, a winter canola–winter wheat crop rotation may improve net returns relative to continuous winter wheat for Oklahoma fields infested with Italian ryegrass and feral rye.

Questions ???