HIGH-LINOLEIC ACID SOYBEAN OIL: PROMISING NEW FEEDSTOCK FOR COATINGS, PAINTS AND OTHER PRODUCTS

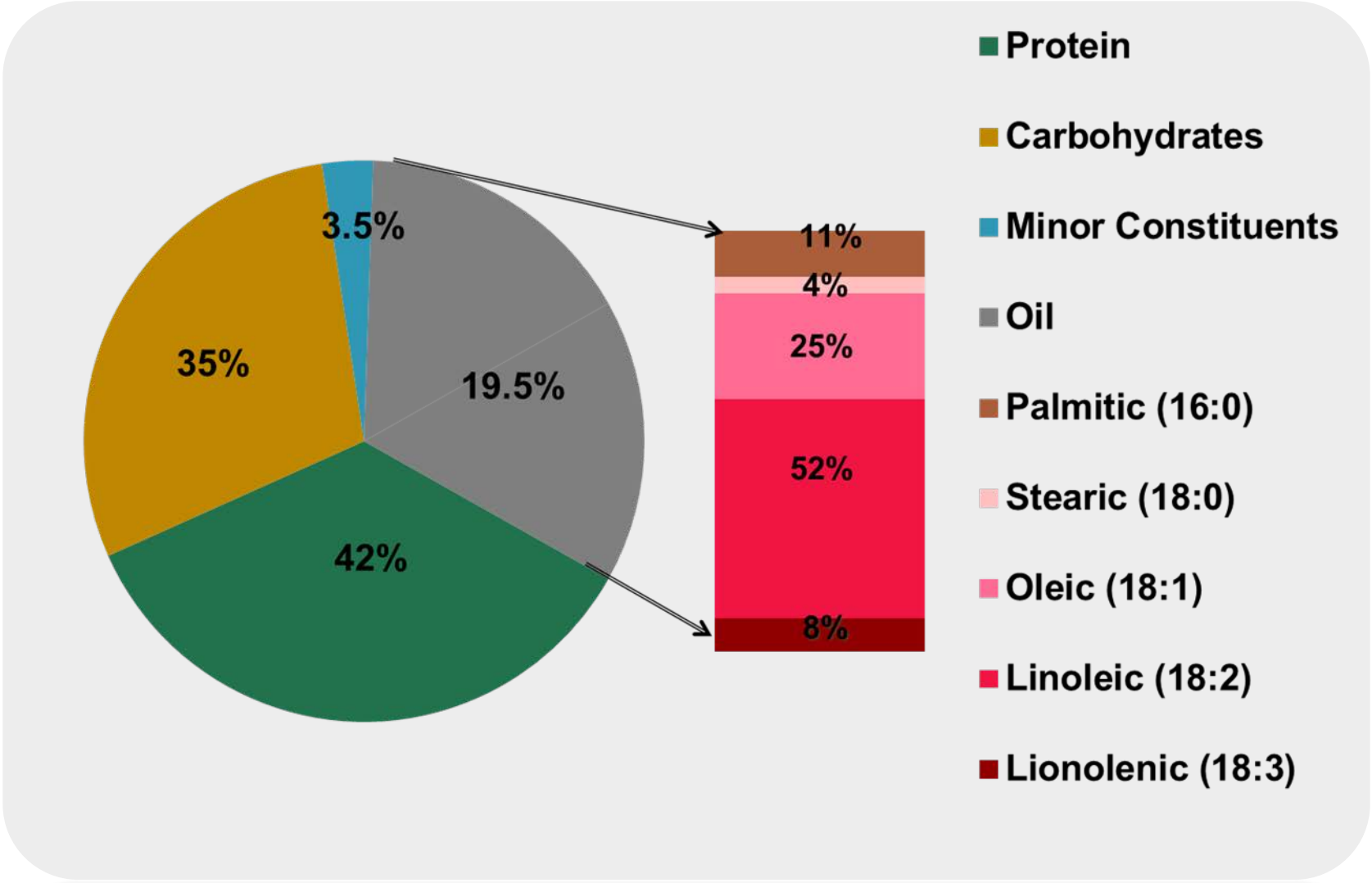
Istvan Rajcan and Robert Roe
University of Guelph and Oilseed Innovation Partners







Soybean Seed Components



Soybean Seed Qualities



Nutraceuticals

- Health effects
- Isoflavones, tocopherol, saponin



Oil

- High quality (fatty acid profile)



Protein

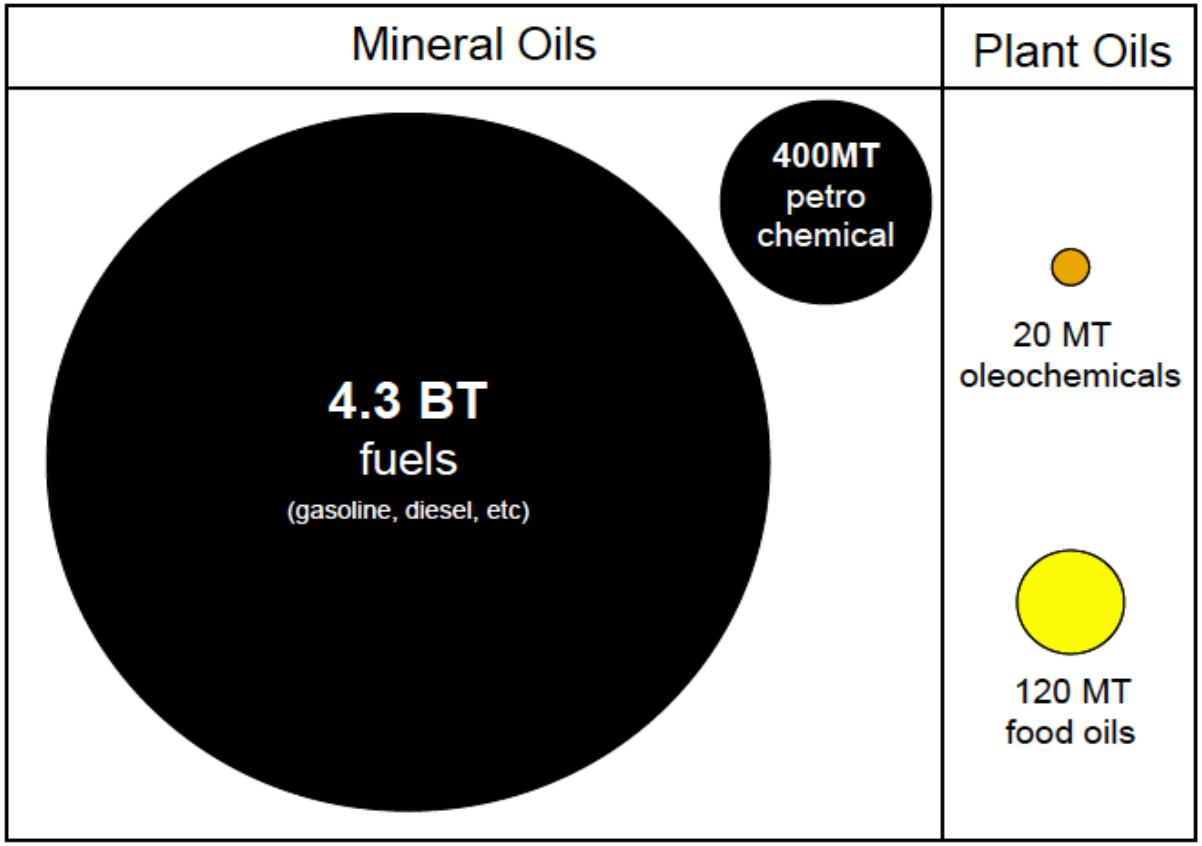
- ALL essential amino acids

…Many products (>300)



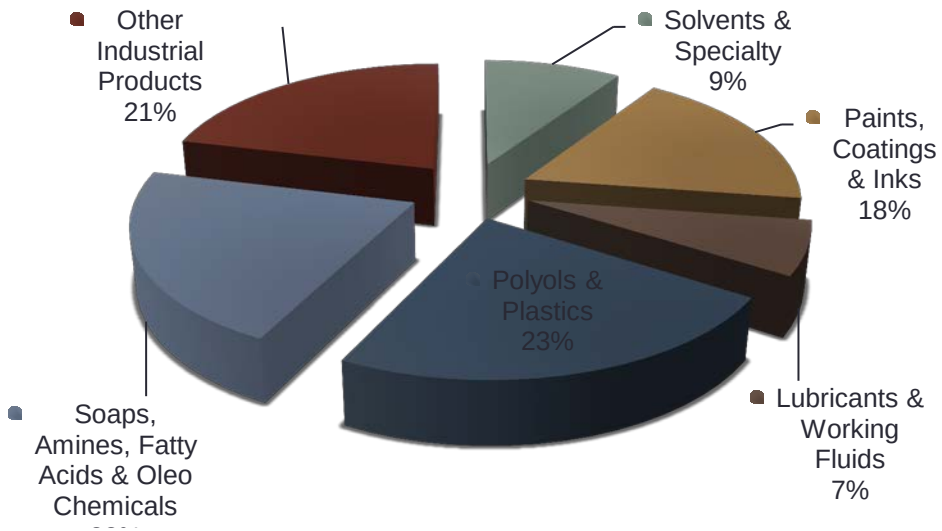
INDUSTRIAL USES OF SOYBEAN OIL

Global Consumption of Oils



US Soybean Industrial Use (excluding biodiesel)

0.68 M Tonnes , 7.9 % of total (8.6 M) soybean oil used



Industrial Categories	M tonnes
Solvents & Specialty	0.06
Paints, Coatings & Inks	0.12
Lubricants & Working Fluids	0.05
Polyols & Plastics	0.16
Soaps, Amines, Fatty Acids & Oleo Chem	0.15
Other Industrial Products	0.14
Total	**0.68**

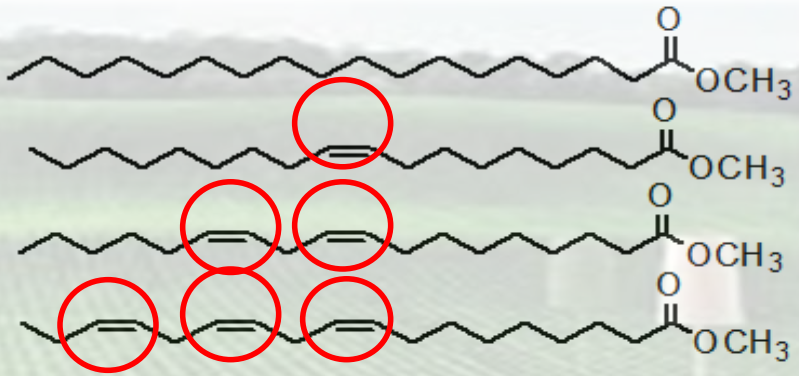
Soybean Oil Functionality

Double Bonds are the Key

Provide reaction sites
Foundation for chemical Intermediates

Hydrophobic nature increase water resistance
Double bonds - Crosslinking
- Film Hardness
- Durability
- Impact resistance

Derivatizations of the fatty acids
- Alcohol functionality
- Epoxy functionality
- Dimer Fatty Acids
- Dimer Fatty Alcohols





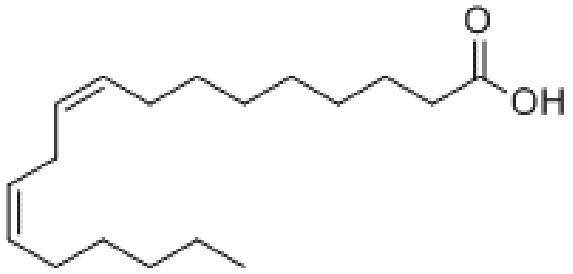
HIGH LINOLEIC (18:2) SOYBEAN OIL (HLSO) FOR INDUSTRIAL USES

High Linoleic Soy

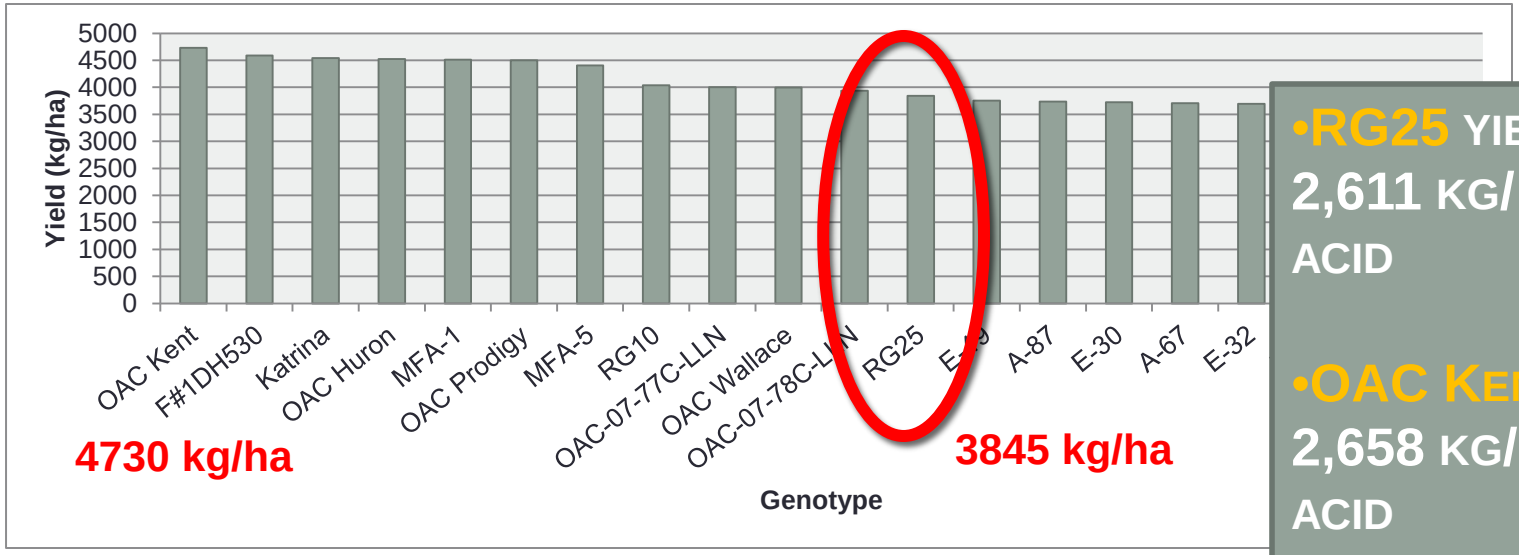
- A non-GMO variety developed at the **University of Guelph**
- Commercial investigation of the industrial utility of the variety has been lead by ***Oilseed Innovation Partners***, formerly Soy 2020
- Laboratory evaluations of leading applications coordinated by ***The Material Solution LLC*** in Columbus, Ohio

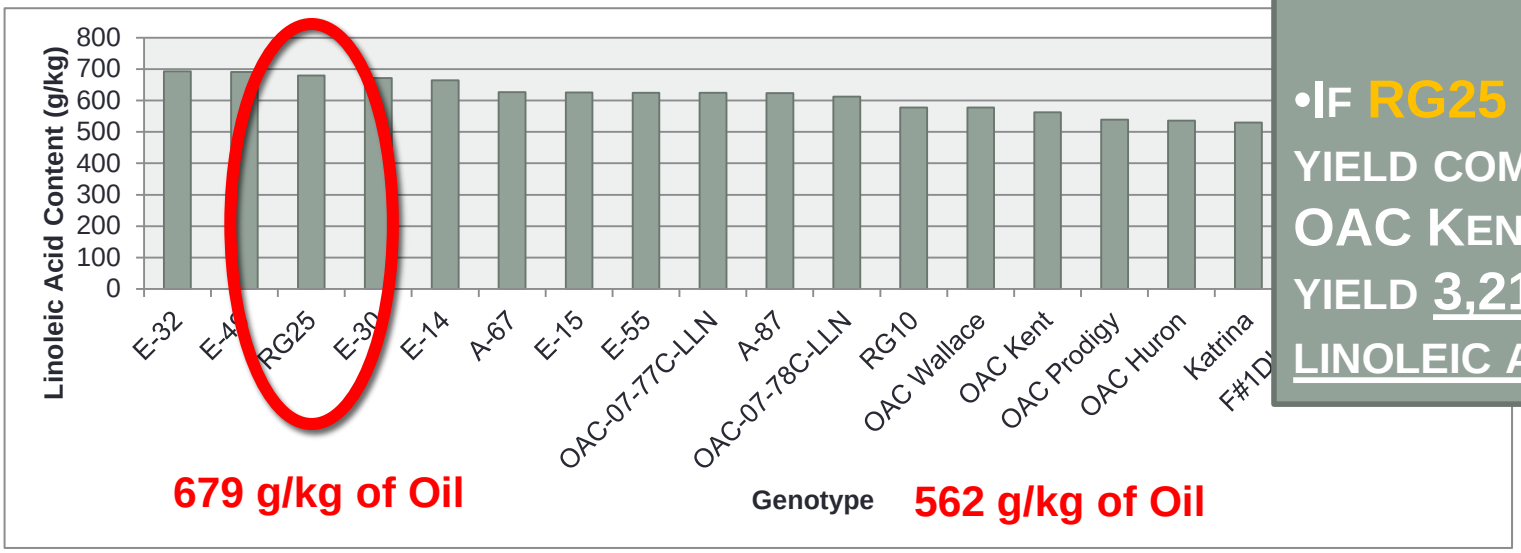
Linoleic Acid

- A polyunsatured omega-6 (18:2) fatty acid
- An essential fatty acid found in many plant oils
- Useful in industry because of the reactivity of the double bonds leading to many functionalized products



High Linolenic (18:2) Soybean Background





- **RG25** yields 2,611 kg/ ha linoleic acid
- **OAC Kent** yields 2,658 kg/ha linoleic acid
- If **RG25** had the seed yield comparable to OAC Kent it would yield 3,212 kg/ha linoleic acid

HLSO variety for industrial uses

OAC 13-55C-HL has the highest reported 18:2 concentration at ***69%***

Derived from the cross:

OAC Wallace x RG25

RG25 is the high linoleic soybean parent developed by EMS mutagenesis

OAC Wallace is the high yielding soybean variety

High Linoleic (18:2) Oil for Industry

Composition	Name	Formula	MW	Soybean Oil					Beef Tallow	Canola
				Commodity Soy Oil	DuPont Plenish	Monsanto Vistive Gold	HOSO Average	High linoleic soybean		
C16:0	Palmitic Acid	$C_{16}H_{32}O_2$	256.4	11.0%	7.0%	3.0%	5.0%	3.8%	27.0%	4.0%
C18:0	Stearic Acid	$C_{18}H_{36}O_2$	284.5	4.0%	4.0%	3.0%	3.5%	2.4%	19.0%	3.0%
C18:1	Oleic Acid	$C_{18}H_{34}O_2$	282.5	23.0%	76.0%	75.0%	75.5%	19.0%	50.0%	65.0%
C18:2	Linoleic Acid	$C_{18}H_{32}O_2$	280.5	54.0%	10.0%	15.0%	12.5%	69.3%	3.0%	19.0%
C18:3	Linolenic Acid	$C_{18}H_{30}O_2$	278.4	8.0%	3.0%	4.0%	3.5%	5.4%	1.0%	9.0%
Total				***100.0%***	*100.0%*	*100.0%*	***100.0%***	***100.0%***	***100.0%***	***100.0%***
Double Bond Content				1.6	1.1	1.2	1.1	1.7	0.6	1.3
Double Bond per cent increase over Commodity Soy Oil				**0%**	**-32%**	**-25%**	**-28%**	**12%**	**-62%**	**-16%**

In 2015, we produced ~100 kg of seed of high linoleic line OAC 13-55C-HL

Contains 69% linoleic acid, C18:2

Producing 5 tonnes this year

Testing it as feedstock in coatings, polyol, paints, plastics

Market Assessment

- Oilseed Innovation Partners (OIL) commissioned a market study for HLSO from OmniTech International
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- OmniTech is the primary technical consultant to the United Soy Board
- Focus was on industrial uses of HLSO

The Industrial Opportunity for High Linoleic Soybean Oil (HLSO)

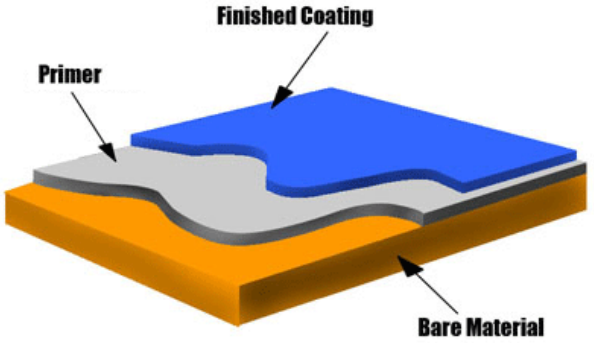
- Coatings
  - Increased functionality, faster drying time
  - Alkyd Coatings
    - Displace commodity soybean oil
    - Potential ranges between 10~50%
- Safflower and Sunflower oils
  - Moving towards High Oleic Fractions
- Linseed Oil opportunities
  - Properties of HLSO may be similar (needed verification)
- Capitalize on Sustainability trends
  - Increased focus on biobased raw materials

Summary of Market Study (OmniTech)

- HLSO offers an attractive FA profile
  - Less saturates (~6.3% vs. 14%)
  - Higher double bond intensity
  - Lower 18:3
- Volume potential
  - 18 to 81 M lbs. per year
- Non-GMO is not a driver for industrial markets
  - Could be grown even in Europe
- Where HLSO falls on pricing will dictate its usage
  - Price versus performance still a key in most markets

HLSO for Alkyd Coating

- Higher Iodine number would lead to faster drying
  - SBO 130
  - **HLSO 146**
  - Linseed 175



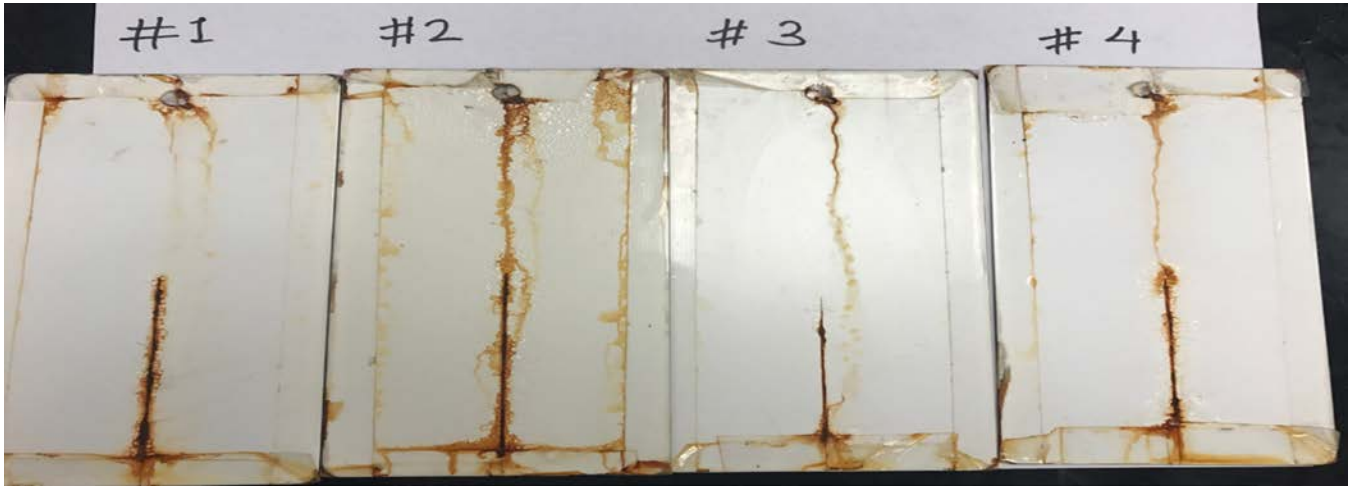
- Lower 18:3 - better colour stability
  - SBO 8%
  - **HLSO 5%**
  - Linseed 54%

Alkyd Resin Conclusions

- HLSO in an alkyd resin formulation compared to SBO, Linseed, and Sunflower oil has:
  - Lighter color
  - Faster drying
  - Higher hardness

Corrosion Improvement

Corrosion Testing				
	#1 Soybean Oil	#2 Linseed oil	***#3 HLSO***	#4 Sunflower oil
HOURS	96 Hrs	96 Hrs	***96 Hrs***	96 Hrs
CREEPAGE	1/32"	1/32"	***1/64"***	1/8"
FIELD BLISTERS	None	#6-8 on panel	***None***	Few #8
OTHER	Med #8 on scribe	#8 med, #6 few on scribe	***None on scribe***	3/16" on scribe, #6/#8



HIGH LINOLEIC SOYBEAN OIL BUSINESS UPDATE



Performance data (HLSO – / alkyd paint characterization) presented to industry at key conferences. *American Coatings Show / AOCS Annual / Bio World Congress*

Major alkyd coatings companies are intrigued and have ordered samples for
in-house testing.

OIP's cost vs. price models indicate a competitive position for HLSO versus linseed and sunflower oils.

HIGH LINOLEIC SOYBEAN OIL BUSINESS UPDATE



OIP estimates the opportunity:

- 16,000 tonnes of oil (from 60,000 acres) with a potential for growth.
- Potential premium benefit to Ontario growers at $4.5 M.
- Processors will realize additional margin from both a premium for the oil and the non gmo meal. (annual gross revenue estimate of > $50 M)

Anticipate a demand for large samples of HLSO for demonstration in 2019 and 2020.

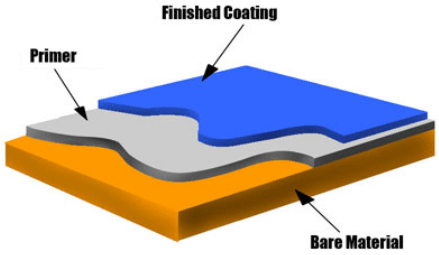
Five acres of the HLSO variety grown in Ontario by Curtis Seeds

Target of approximately 5 tonnes of the high linoleic soybeans is expected to yield at least 600 kgs of fully refined oil

HLSO Summary

- HLSO is a new vegetable oil with a unique FA profile useful for many industrial applications
  - Alkyd resins and paints
  - Epoxides
  - Polyols
- Sample requests should be addressed to Rob Roe Oilseed Innovation Partners:
- rroe@oipartners.ca







Acknowledgements

- OPC Polymers
- OmniTech International
- Richard Heggs , The Material Solution LLC









Thank you

