

ABIC 2010

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Outline

- Feed stocks and Plant Bio-technology
- Camelina as an Industrial Platform Crop
- Developing an alternative source of Castor
- ABIP Industrial Oil Seed Network



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At Linnaeus we want to change...



the way industrial chemistry is done.



Linnaeus Mission:
We want to do chemistry in Oil Seeds
Modern Philosopher's Stone

- Light and water to make valuable feed stocks
- Increase use of oilseeds as petroleum substitutes
- Increase oilseed values for farmers...beyond fuel
- Reduce environmental impacts of petroleum
- Decrease dependence on petroleum
- Support early adopters of bio-products
- Assist Government with rational policy development
- Test case for Regulatory Agencies



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Plant Bio-technology Overview



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Potential of Plant Oil Diversity

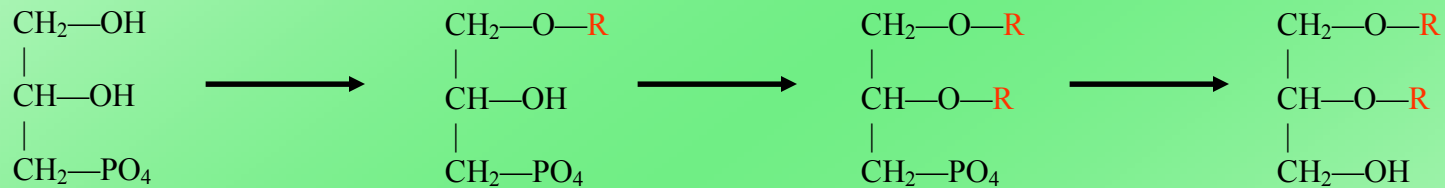
- The Tropics contain great bio-diversity
- Tropical plants have long been a source of our most valued medicines – *why not industrial feed stocks?*
- These plants produce THOUSANDS of valuable industrial oils BUT they lack agronomics
- Linnaeus is developing germ plasm and applications
- Availability drives applications



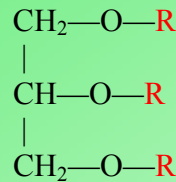
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TAG Assembly (Simple Version)

- TAG is synthesized by the sequential addition of fatty acids to a glycerol “backbone”. Expression levels and packaging key.



TAG



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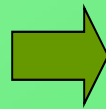
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Hydroxy Fatty Acid (HFA) Technology

Hydroxylase Gene



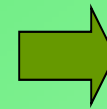
Ricinus communis
(Castor)



Expression in Model



Arabidopsis thaliana



Expression in Camelina



Advantages of (GM) Approach

Conventional Approach

Conventional Oils

Canola, Soybean,
Corn

Goals

- High oleic
- Low saturates
- Low poly-unsaturates
- Limited profiles

Industrial Oils

Lesquerella
(Castor) Vernonia

Goals

- Agronomics
- Infrastructure
- Limited regions

GM Approach

Combine Conventional and Industrial Oils

High oleic oils,
Castor

Goals

- Higher functionality
- High oleic
- Low polyunsaturates
- Multiple crops



Relevance to Industry

- New genes will be cloned and engineered
- Patents will control new materials
- Competitive advantages will be conferred
- Regulations evolving
- Plants can produce large volumes at low cost



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Camelina Agronomic Advantages

- A low input *non-food crop*
- Uses conventional farm machinery (no additional cost for the growers)
- Early maturing crop (10 days earlier than canola)
- Drought tolerant
- Few insect problems
- Genetic potential untapped
- Offers growers another rotational, value-added crop



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Linnaeus Camelina Program

- Access to one of the largest collections of Camelina germplasm
- Largest Field trials ongoing in Canada
 - Canadian Food Inspection Agency (CFIA) approval for camelina
 - Confined field trials of HFA camelina underway
 - Agronomic trials to develop best management practices
- M2 population, targets include:
 - Specific oil profiles
 - Herbicide tolerant camelina
 - Disease resistant varieties



Castor Case Study



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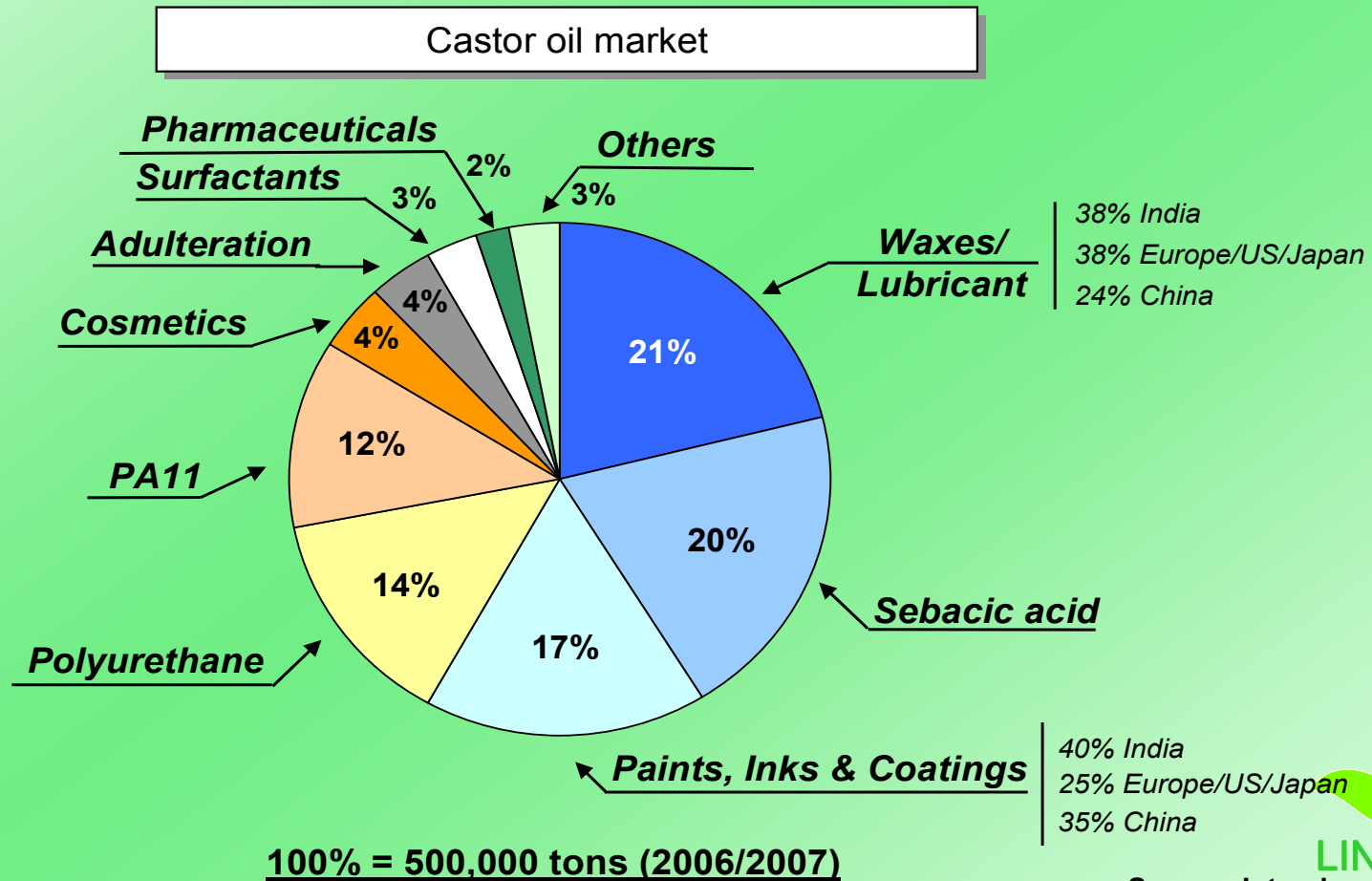
Castor as GM Trait

- Over 1,000 patented industrial applications
- Industrial chemistry established since 1900's
- Recognized oxidative stability and lubricity
- US Strategic stockpile up to '70's
- Only commercial source of HFA
- Largest user seeks alternative source

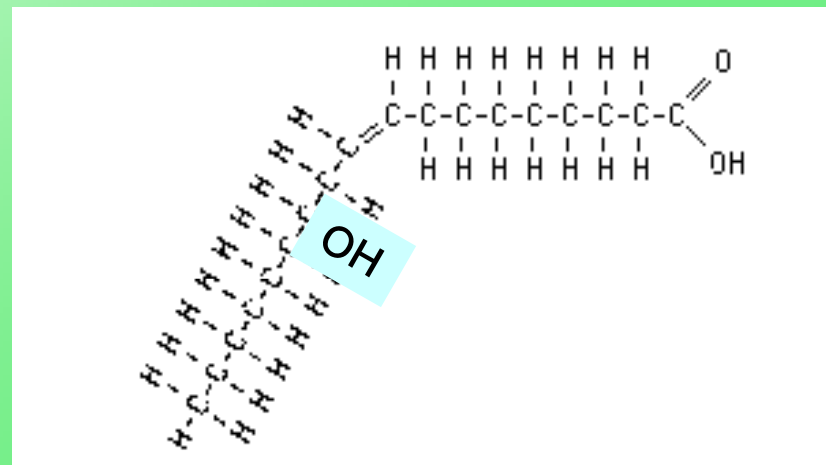


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Castor Oil Applications



Ricinoleic Acid



Ricinoleic acid: a reactive fatty acid capable of numerous oleochemical conversions

Rilsan® Production Chain



Crude Oil -> Naphtha



Butadiene



Lauryl Lactame



Polymerization & Compounding



Rilsan® PA12



Castor oil



Methyl Ricinoleate



Amino 11 Undecanoic Acid



Polymerization & Compounding



Rilsan® PA11



What about the economics?

- Castor represents the only large scale supply of HFA

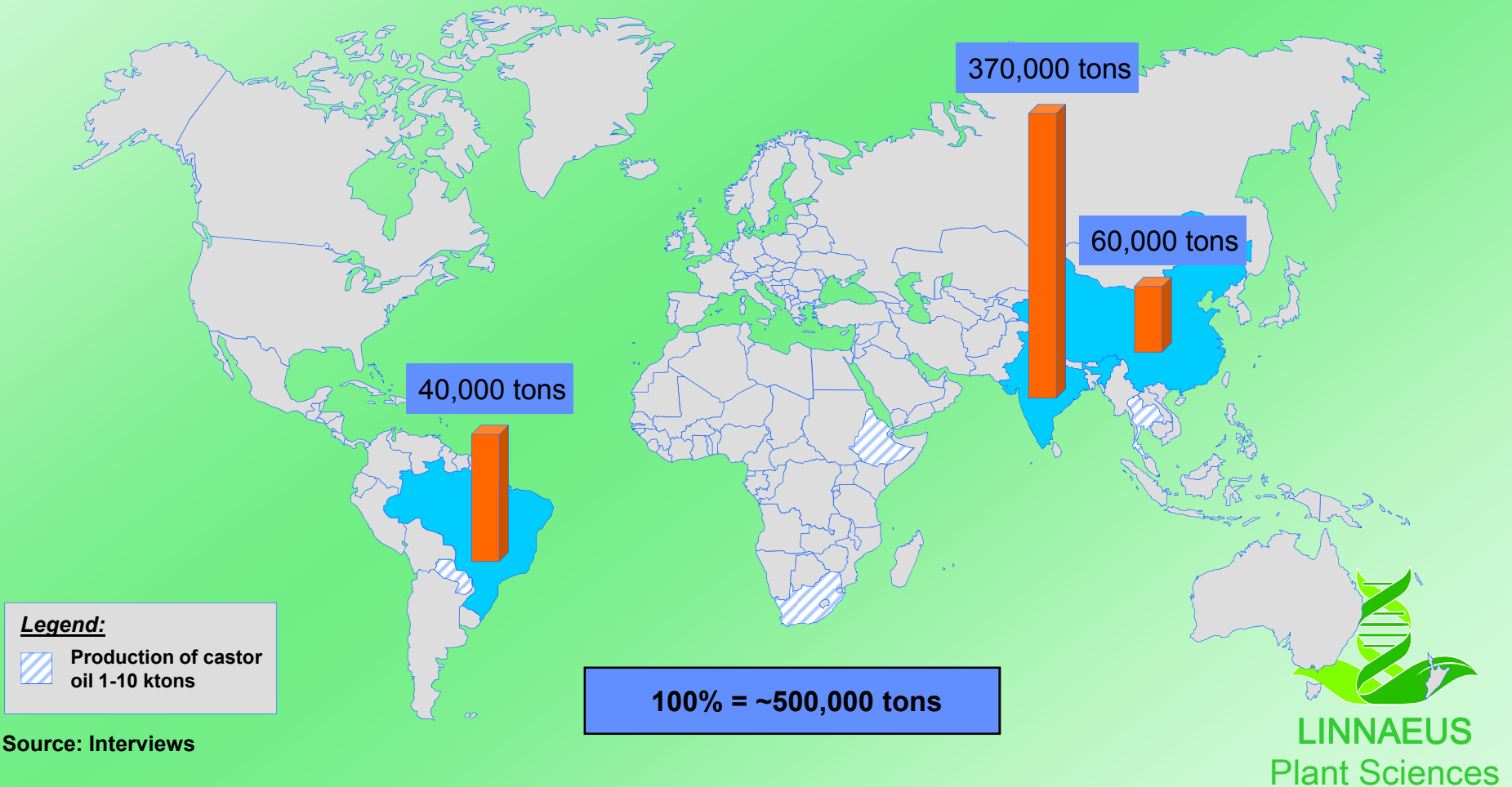


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→ The world production of castor oil is around 500,000 tons, India being the leader with 370,000 tons.

World production of castor oil

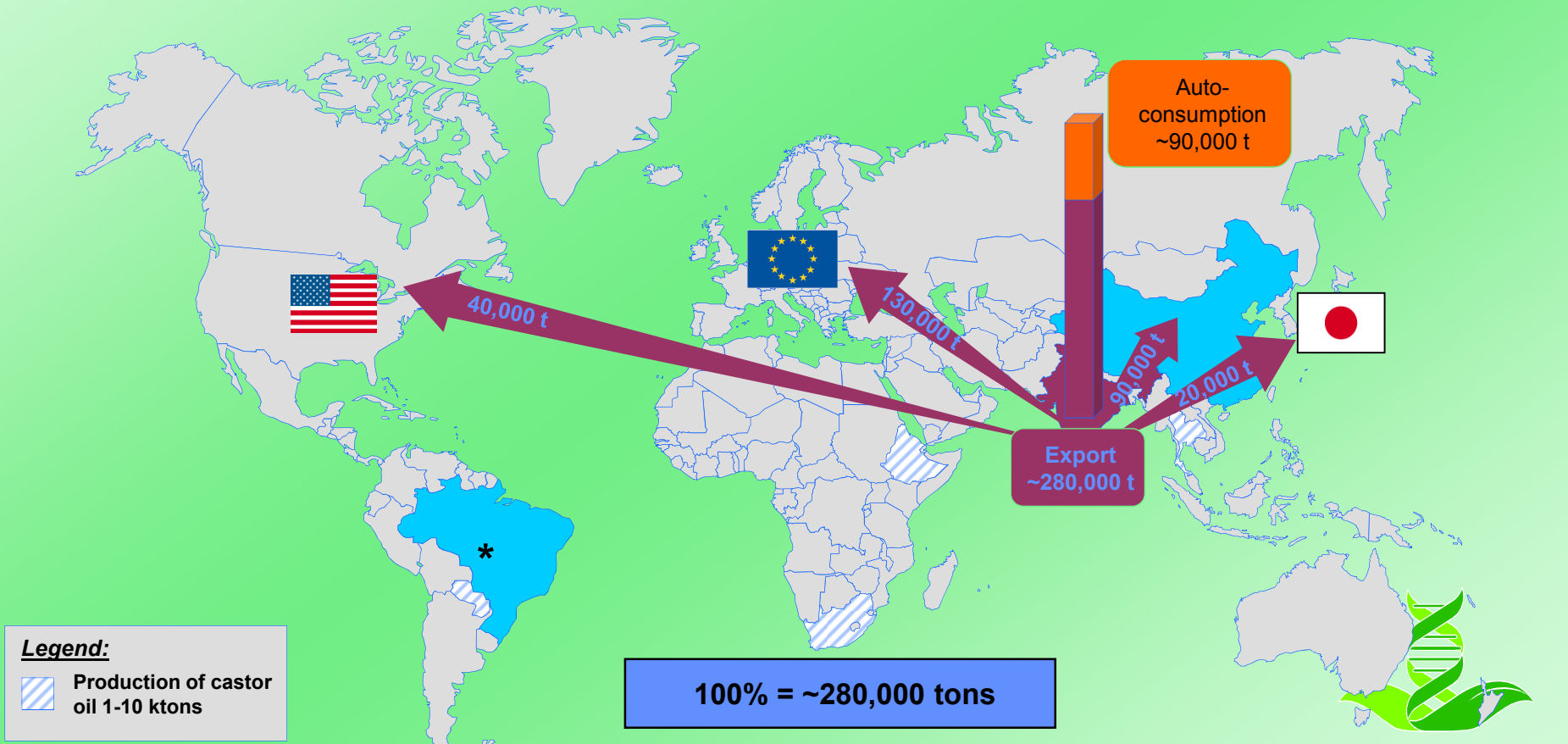
World production of castor oil - 2006/ 2007



→ Most of the Indian production is exported, with Europe and China being the principal consumers of castor oil.

Exportation of castor oil

Export of castor oil - 2006/2007



Source: Interviews

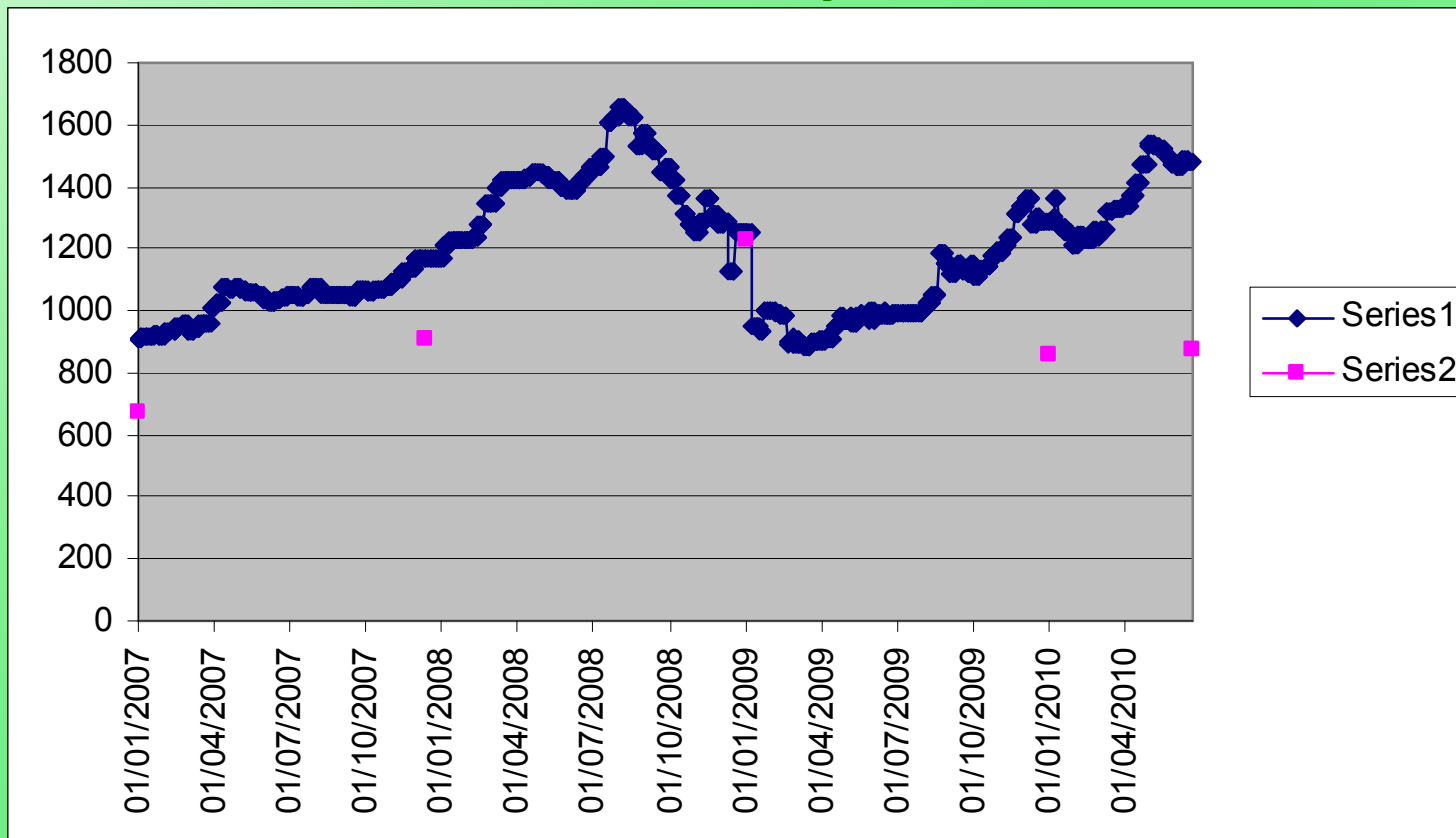
*Brazil auto-consumes 10,000 tons and makes derivatives with 30,000 tons

Castor Oil fob Mumbai US \$/mt 01/01/07-06/21/10

Canola as annual average

\$1191 US vs \$1001cdn

NOTE volatility and fob site



Challenges to Future Castor Supply

- India is largest supplier crops – they seek value added markets.
- China is increasing its consumption. Auto production represents major new demand
- Arkema has spent 20 years trying to increase Castor production including development of germ plasm to give farmers but little success
- Brazil – a large exporter is using more domestic production for bio-diesel
- Largest user requires 50kt. Almost 30% of total exports in some years



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Camelina Advantages

- Gets out of the Food/Fuel debate
- Secure supply - Produced in North America
- Steadily improving agronomics
- Low transportation costs
- Carbon Credits will increase margins
- Low input and *marginal land* production possible
- Growing demand for bio-based renewable products



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Camelina Advantages

- Yield is getting comparable to canola and will improve
- Nitrogen usage about 1/3 canola
- Oil at 40%
- Meal market needs development but nutritionally promising
- At 20% HFA about 500k acres could satisfy current US market.
- 16 million acres of canola will be planted in Canada this year.
- Given connection to canola should be able to hedge.



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Industrial Bioproducts Initiative Program



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ABIP Background

“The Agricultural Bioproducts Innovation Program (ABIP) is a five-year, \$145 million program aimed at supporting the establishment, further development and operation of bioproducts research networks, thereby promoting research, development, *technology transfer and commercialization* activity in agricultural bioproducts in Canada”



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ABIP Process

- Process began 3 years ago
- Over 90 Networks applied
- After intensive peer review 9 Networks were selected
- The Industrial Oil Seed Network (IOSN) lead by Linnaeus was the first to be signed. \$3 million in funding
- Helped position us for today's announcement with DuPont



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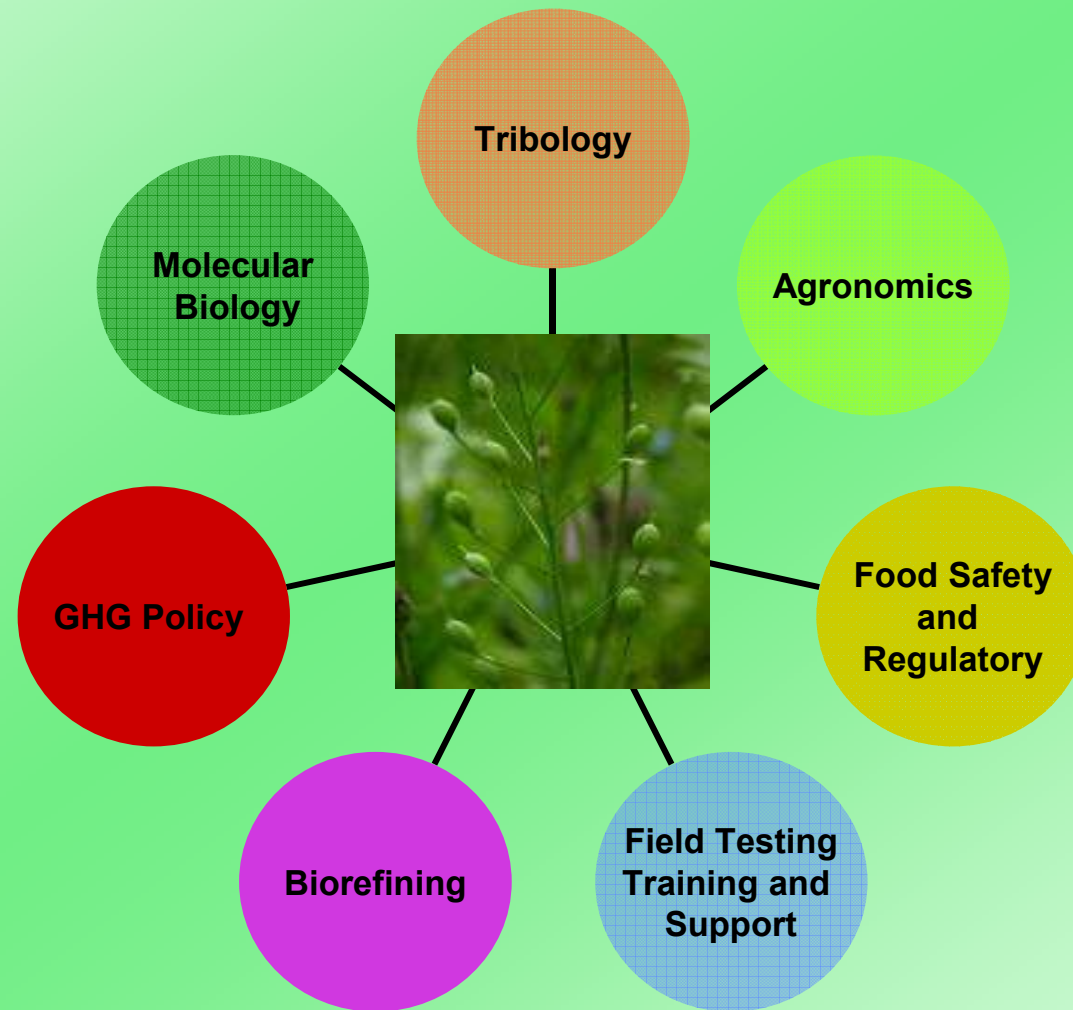
Central Themes

- Determine engineered oilseed profiles best suited for industrial applications
- Test, verify and quantify bio-based fluid performance in the field
- Help users over the “Petroleum bias”
- Develop policy background for rational incentives
- Support regulatory process



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IOSN Areas of Expertise



Eco-pactor Pilot Project

now beginning

- 2 – site pre-pilot testing near completion
- 6 TCHC compactor pilot sites now being brought up to Eco-pactor specifications
- General rollout could commence no later than April 2010



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Smart Earth

Smart Earth Bio-based Hydraulic Fluid ISO 32

Smart Earth Bio-based Hydraulic Fluid ISO 46

Smart Earth Bio-based Hydraulic Fluid ISO 68

Smart Earth Bio-based Dielectric Hydraulic Fluid ISO 22

Smart Earth Bio-based Dielectric Hydraulic Fluid ISO 32

Smart Earth Bio-based Dielectric Hydraulic Fluid ISO 46

Smart Earth Bio-based Dielectric Hydraulic Fluid ISO 68

Smart Earth Bio-based E.P. Gear Oil ISO 46

Smart Earth Bio-based E.P. Gear Oil ISO 68

Smart Earth Bio-based E.P. Gear Oil ISO 100

Smart Earth Bio-based E.P. Gear Oil ISO 150

Smart Earth Bio-based E.P. Gear Oil ISO 220

Smart Earth Bio-based E.P. Gear Oil ISO 320

Smart Earth Bio-based E.P. Gear Oil ISO 460

Smart Earth Bio-based High Performance Motor Oil

Smart Earth Bio-based High Temp 180 Grease #2

Bio-based home lubricants

non-toxic, bio-degradable, non-flammable, non-staining



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R&D Summary

- Drive technology towards products
- Work with the regulatory system
- Quantify benefits
- *Show it can be done*
- Help Government form rational policy



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Sept. 13th Announcement Linnaeus and DuPont Technology License

- Develop industrial oil seed platform
- Commercially exploit Linnaeus/DuPont HFA IP
- Obtain proof-of-concept for several DuPont industrial oil traits in Camelina
- Assess possible applications for DuPont oil profiles and related chemistries; support with sample preparations



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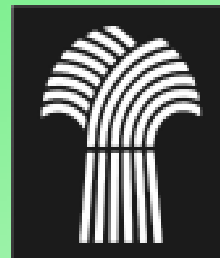
Thanks for your support...

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Saskatchewan
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