

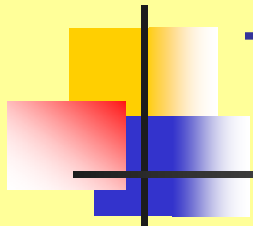


# Biorefining: New Demand / New Landscape



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# This Presentation

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- Drivers for Change
- Changing AgriFood Landscape
- Feedstocks for Biorefining
- Business Case Issues
- Strategic Framework



## If We Need:

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- 4X in top line revenue
- 3X in energy output
- 2X in contribution margin
- 0.5X in energy inputs

What do we need for -  
Next Generation Feedstocks?



# Drivers for Change

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- China & India – powerhouse demand
- Energy
  - Supply & security – US & EU & others
  - The cost factor – crude petroleum
- Climate Change
  - Air quality
  - Global warming
- Alternative Platforms Needed – Energy, Chemicals & Polymers
  - New bio-based feedstocks
  - New processes & chemistry
  - New product applications
- For Canada, its all about -
  - Staying in the game
  - Competitiveness
  - Skilled workers
  - Rebuilding the Rural & Industrial Economies

# Energy & Climate Change

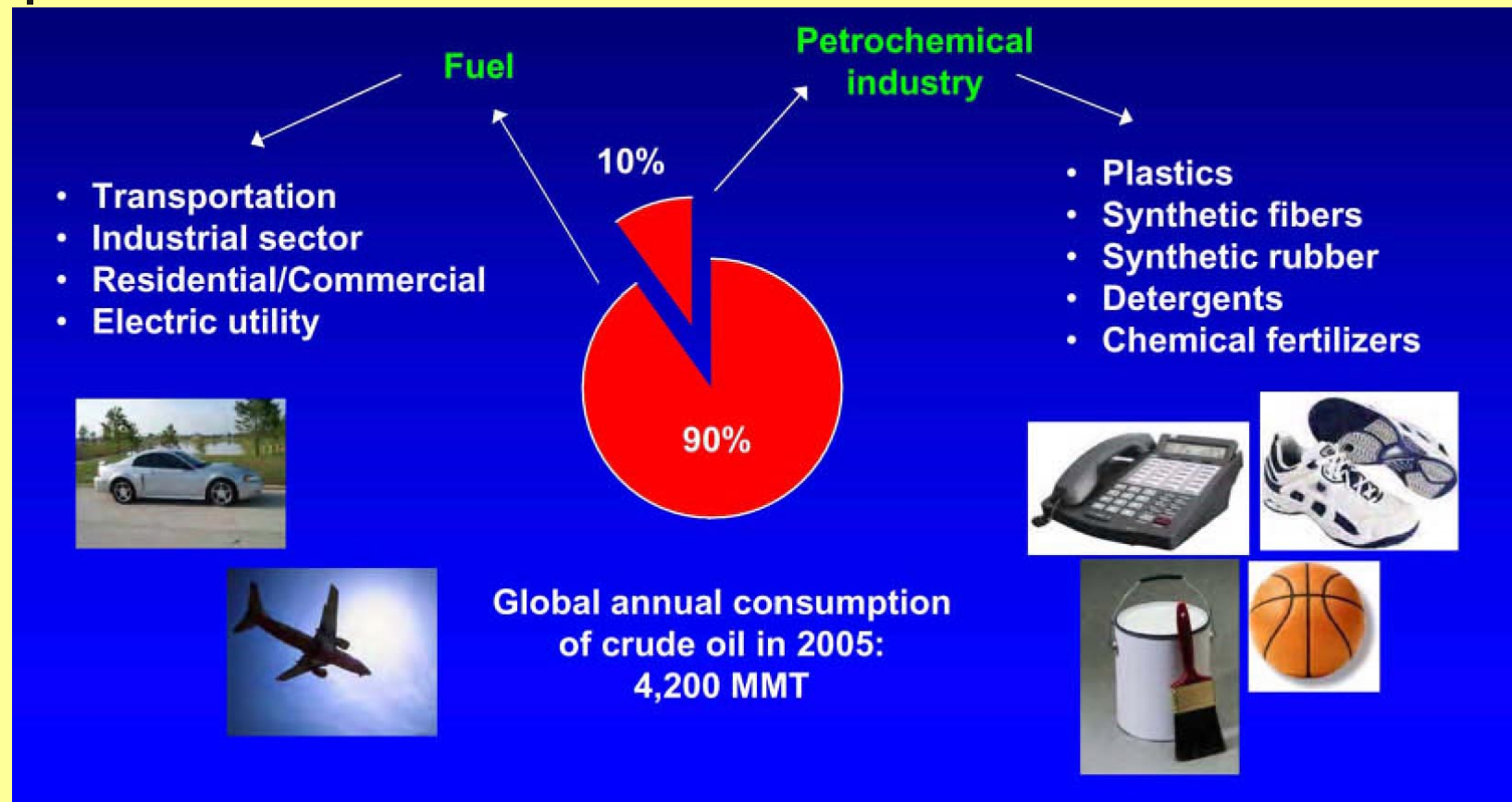
## *Adding to the AgriFood Landscape*

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- Fundamental new demand for crops and biomass
  - Concerns about food *versus / and* energy
  - Concerns about sustainability of land and ecosystems
- Not enough supply at the right price & place
  - Need quantum change in local yields & competitiveness
  - Need quantum move to sustainable technologies
  - Both call for strategic investments in discovery R&D, technology transfer, commercialization & market development
- New role for agriculture
  - New social contract with society
  - New business arrangements between energy, agriculture, forestry and manufacturing
- Opportunity for entrepreneurs & investors
  - Energy production and distribution
  - Specialty bio-based chemicals & materials

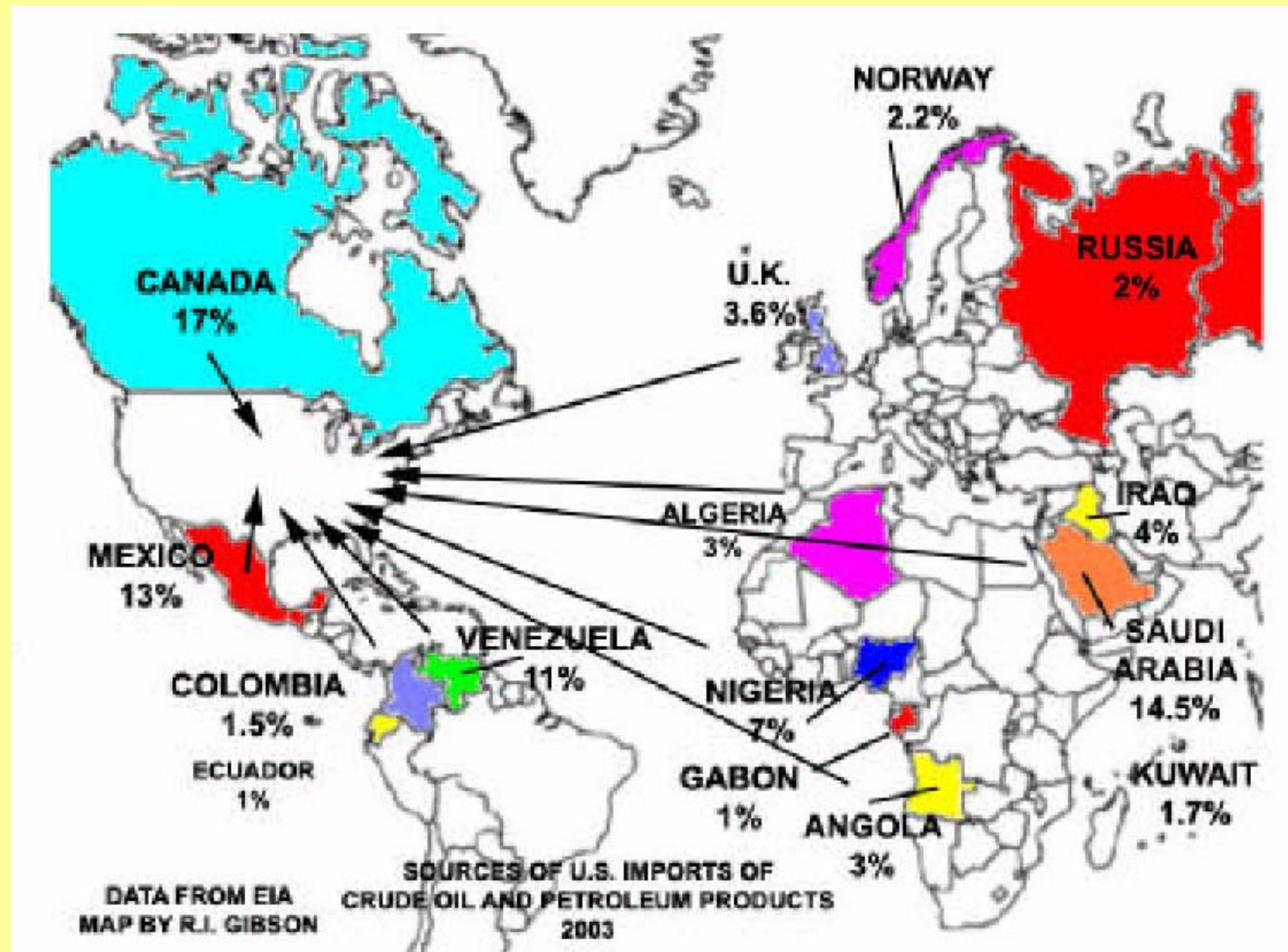
# Fossil Fuels

*Underpin the global economy*

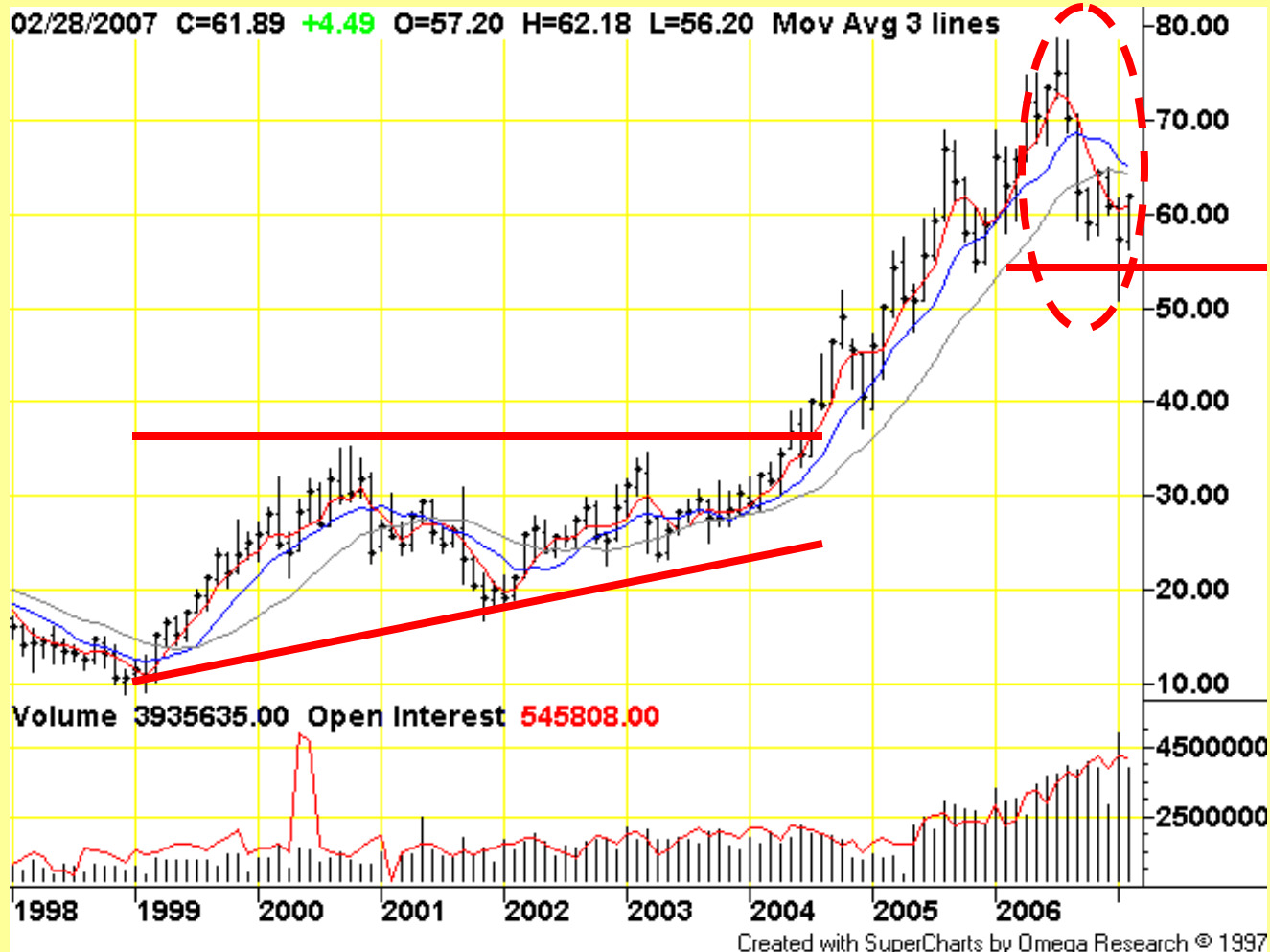


# US Sources

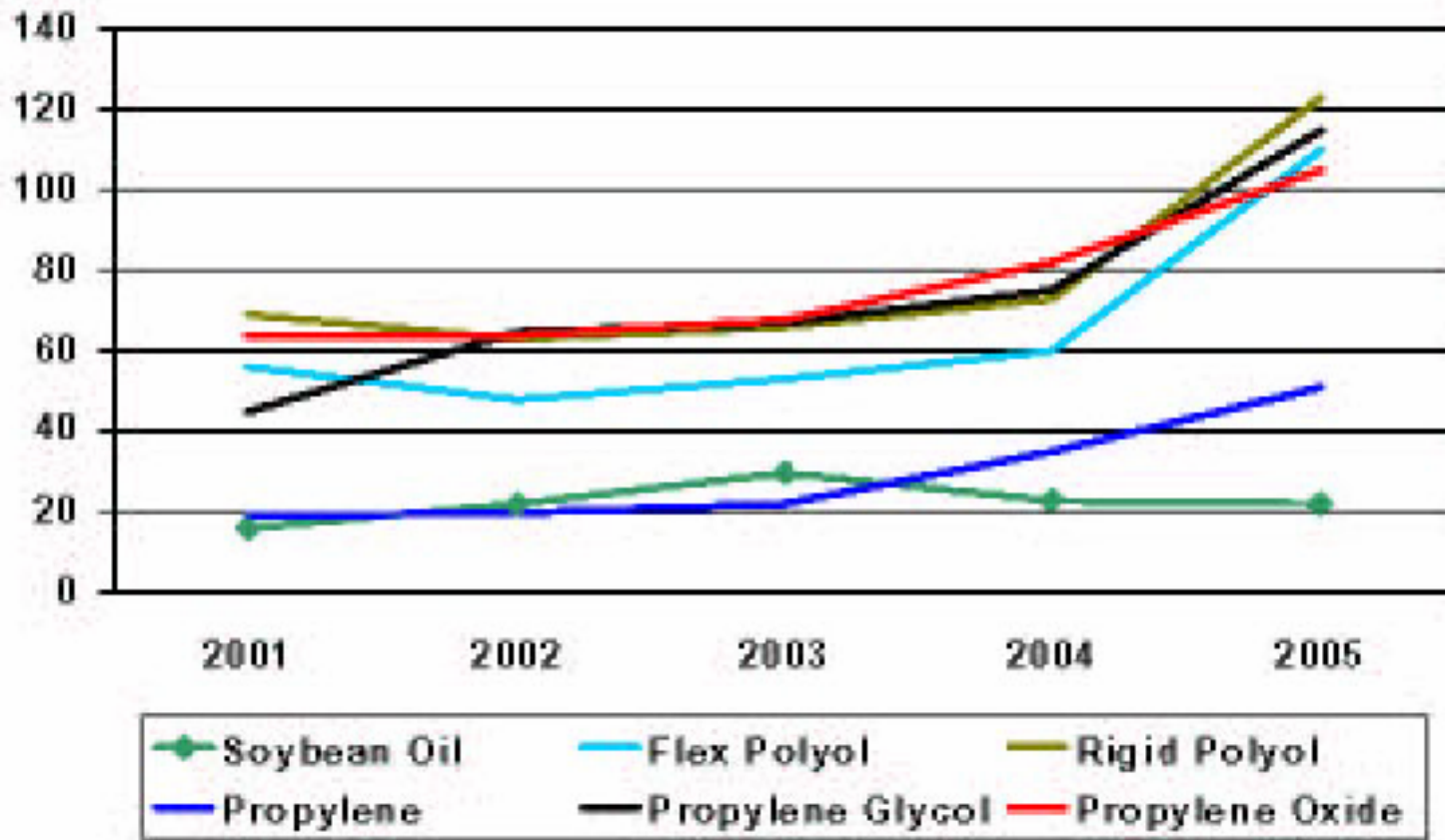
## *Crude Oil & Petroleum Products*



# Brent Crude Petroleum



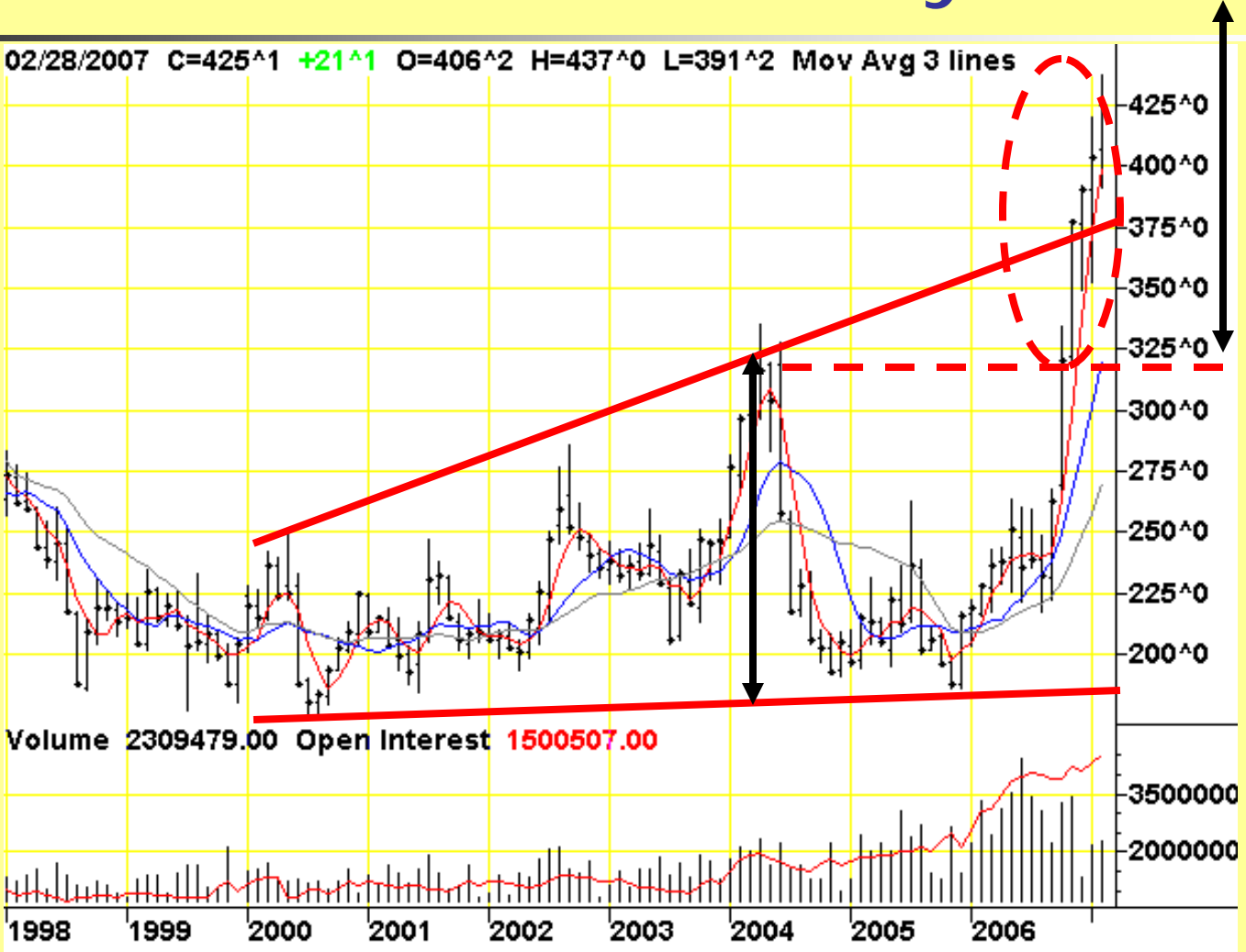
# Polyol & Intermediate Prices



# CBOT Corn - monthly

-500^0

02/28/2007 C=425^1 +21^1 O=406^2 H=437^0 L=391^2 Mov Avg 3 lines



Created with SuperCharts by Omega Research © 1997



# Biorefining ....

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- Do we look to the US and EU for direction?
  - US adopted corn & soy as engines for growth
  - US industry now global players in both
- Business models for Canada?
  - What's the same?
  - What's different?
  - What's possible?
- Opportunity – A Growth Industry for Canada
  - Have food and feed manufacturing
  - Have some biogas and combined heat & power
  - Have recent investments in ethanol, more planned
  - Governments & industry positioning for biodiesel
  - 5% renewable fuel standard coming
  - Capital markets showing interest

# Product Drivers

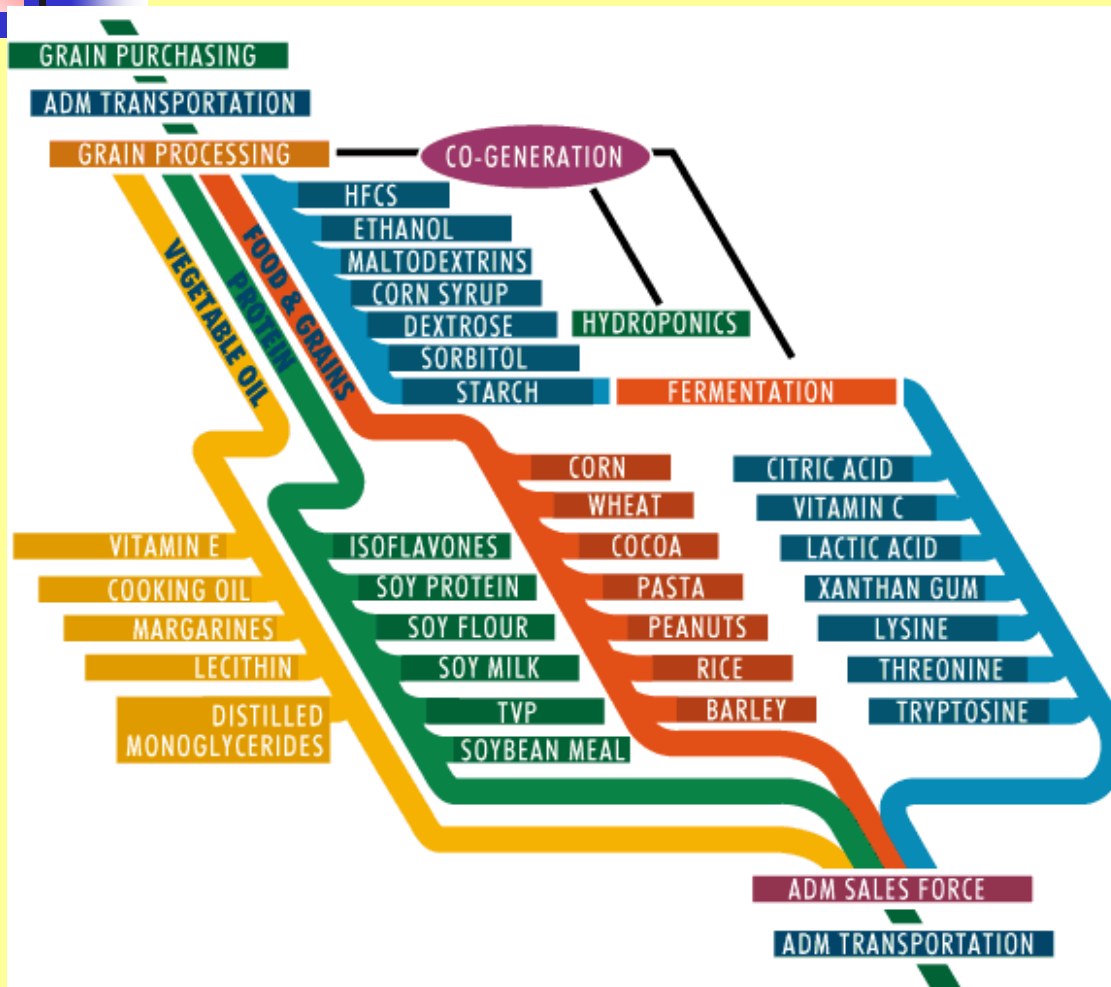
*Food Feed Energy Biomaterials Biopharma*

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- Refining of Grains, Oilseeds & Fibre Crops
  - Major constituents
    - Starch, oil, protein, cellulose, hemi-cellulose, lignin
  - Domestic feedstock opportunities
    - Oilseed, cereals, perennials and forestry waste
  - Export feedstock opportunities
    - As grains, oilseeds and primary biorefinery products
- Domestic Fuel Categories
  - Diesel Pool – National, W. Can. & E. Can.
  - Gasoline Pool – National, W. Can. & E. Can
- Competitive Factors
  - Food, feed, energy and materials demand
  - Ethanol versus biodiesel in domestic market
  - Imported ethanol and biodiesel

# Biorefining

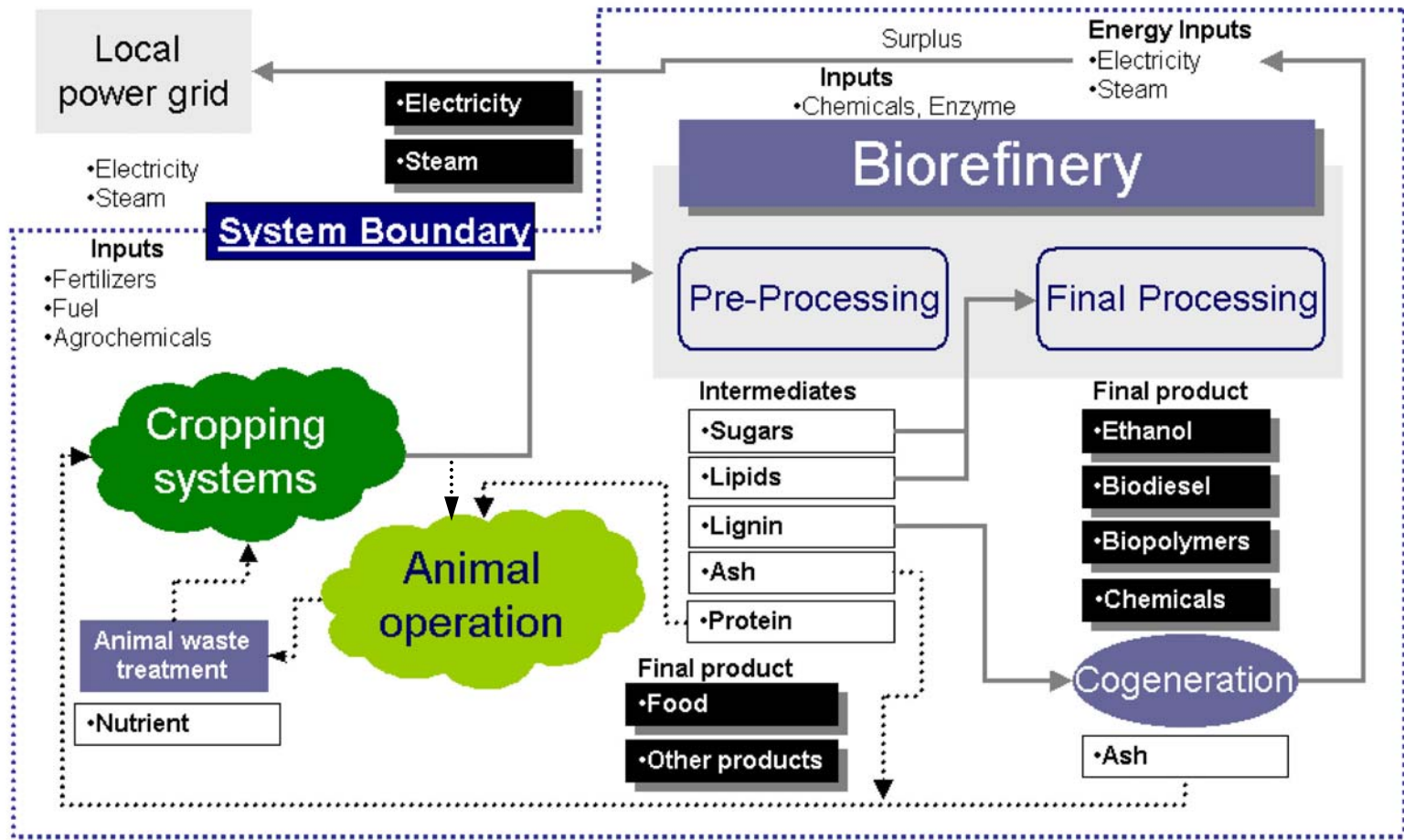
## *Many Products & Channels*



- Feedstock cost mission critical
- Total material utilization imperative
- By-product credits strengthens competitiveness
- Cost reducing synergies with over the fence feeds & services
- New chemistries lead to an expanded range of base chemicals, intermediates & bioproducts

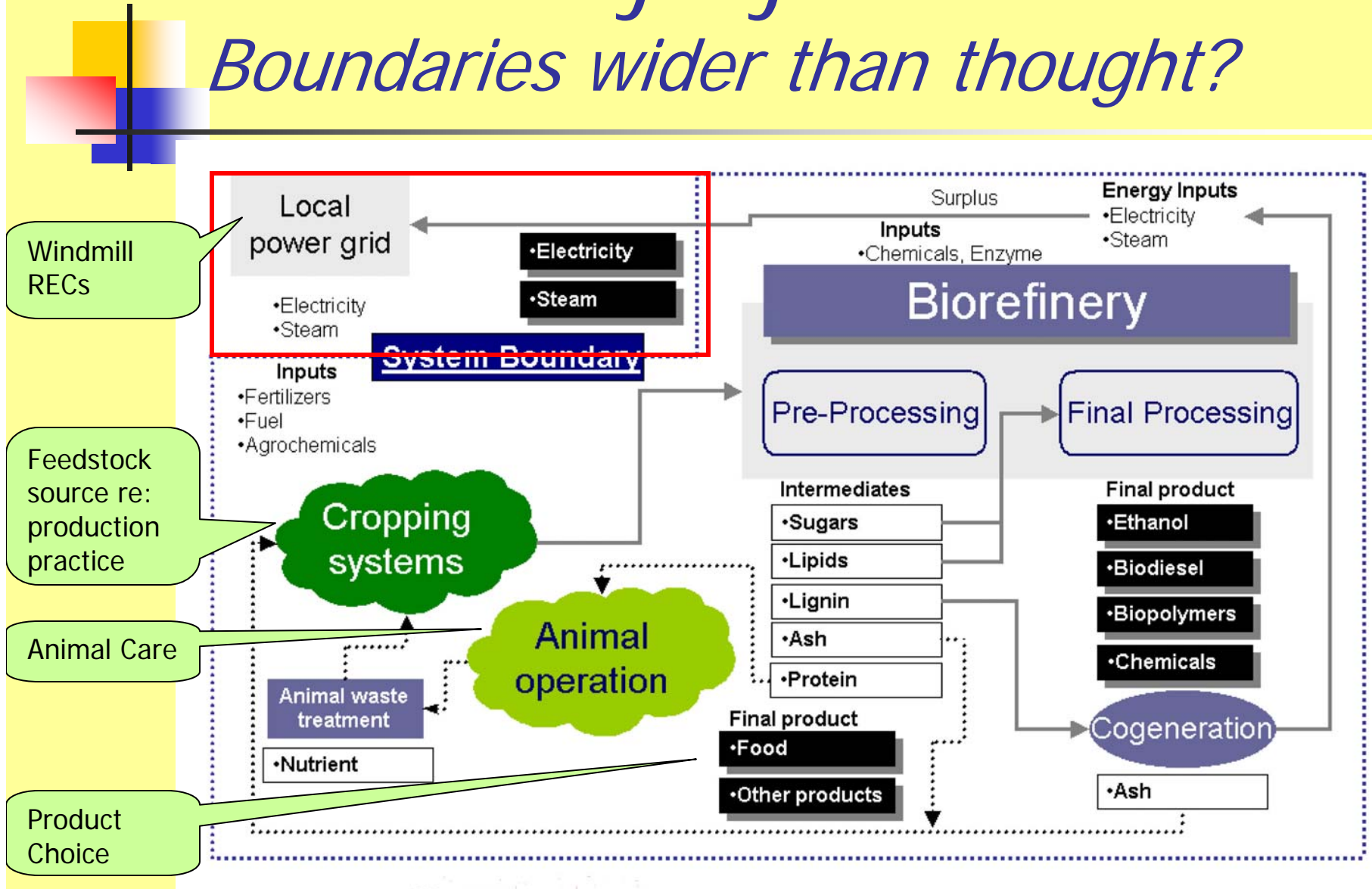
# Biorefinery Systems Model

## *Economics & Life Cycle*

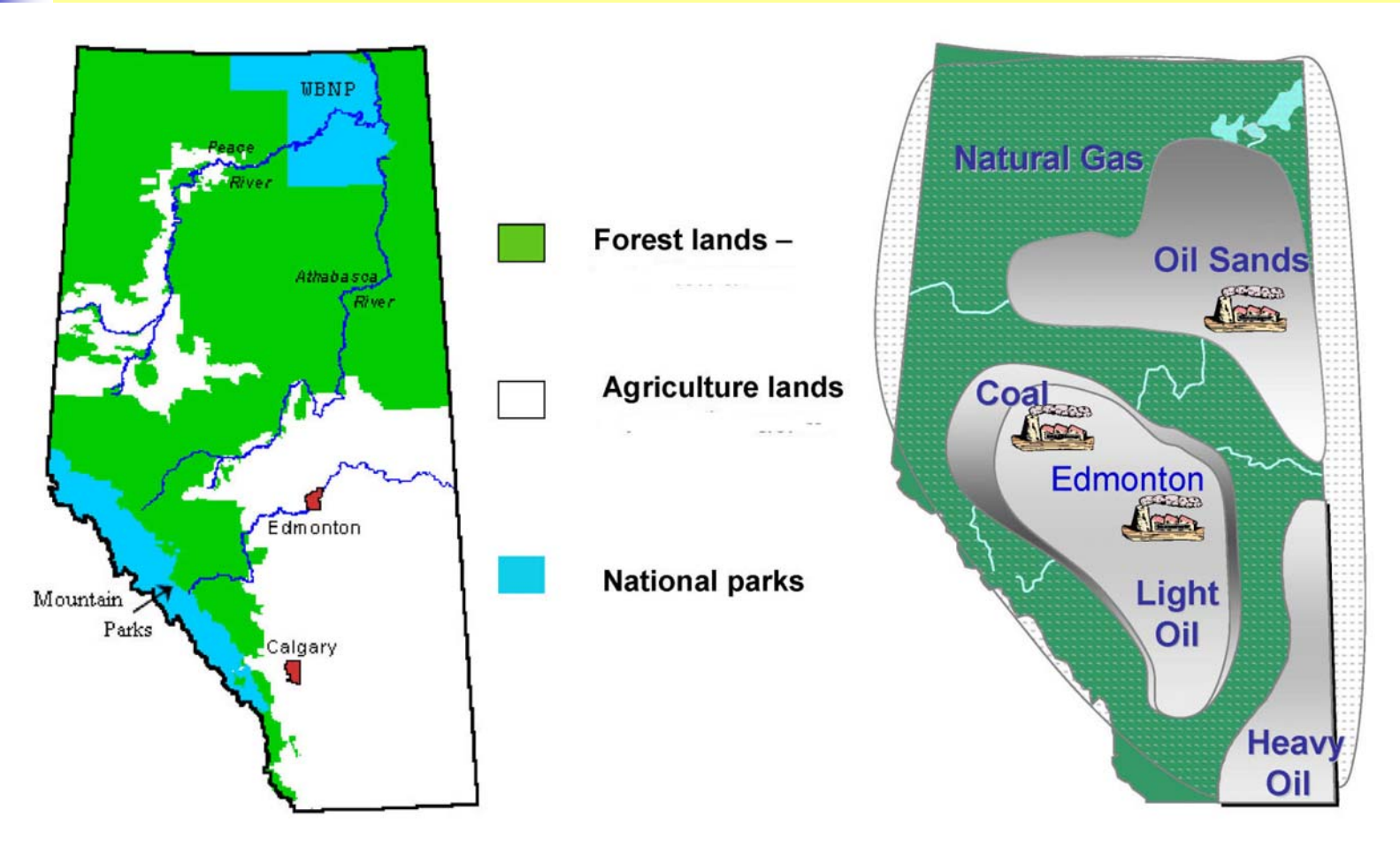


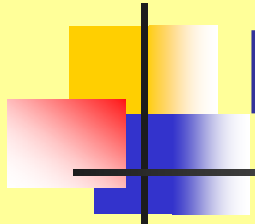
# Biorefinery Systems Model

## *Boundaries wider than thought?*



# Alberta's Natural Capital





# Feedstocks for Biorefining

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## Starch, Sugar & Oil

Corn	Wheat
Soybean	Barley
Palm	Triticale
Sugar cane	Canola

## Cellulose / Hemicellulose

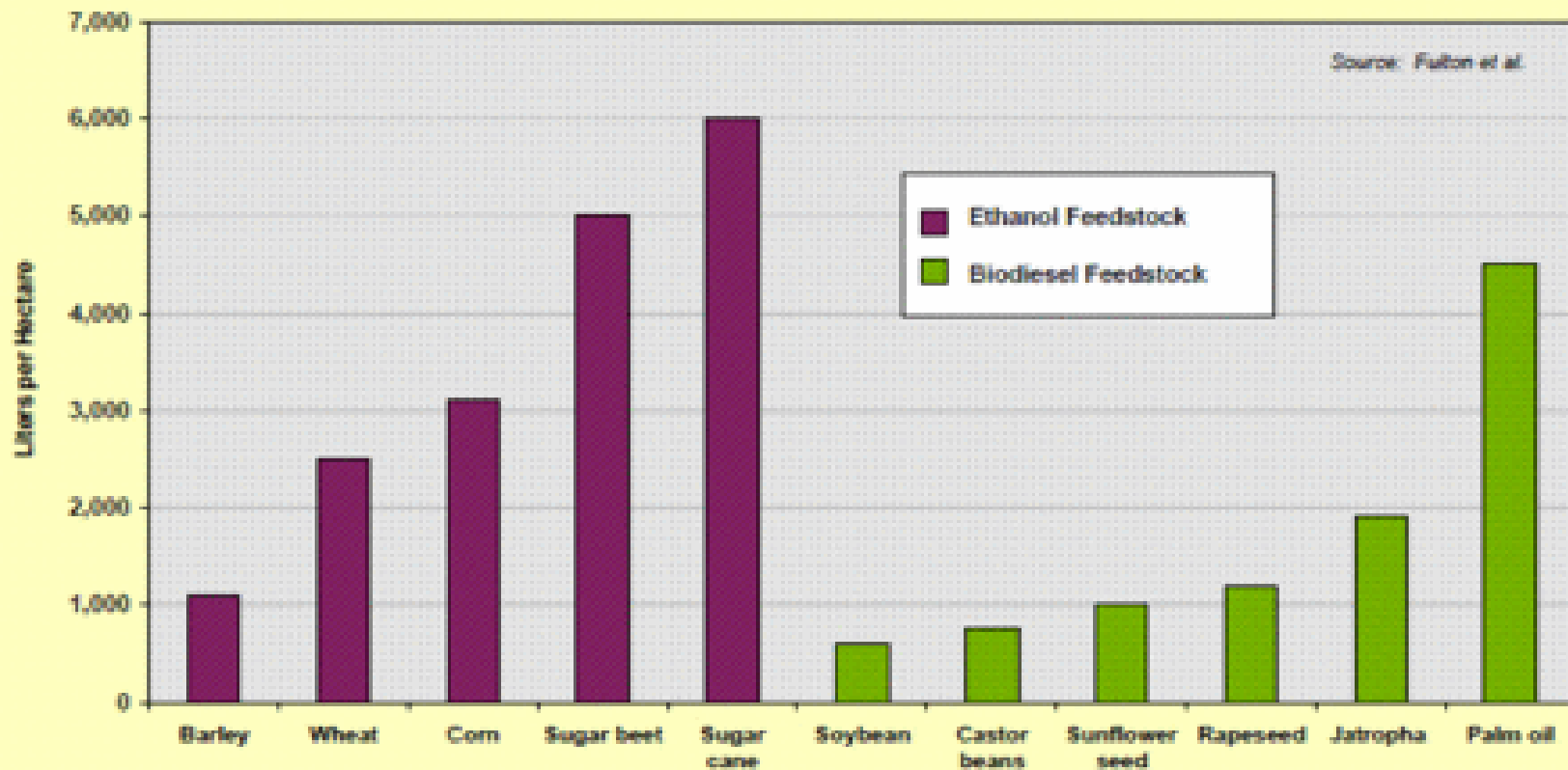
Hybrid Poplar	Grasses
Forest residue	Hemp
Sawdust	Cereal straw
Yard waste	

## Livestock and Food Processing Wastes

Manure  
Cheese whey  
Corn syrup  
Milling byproducts

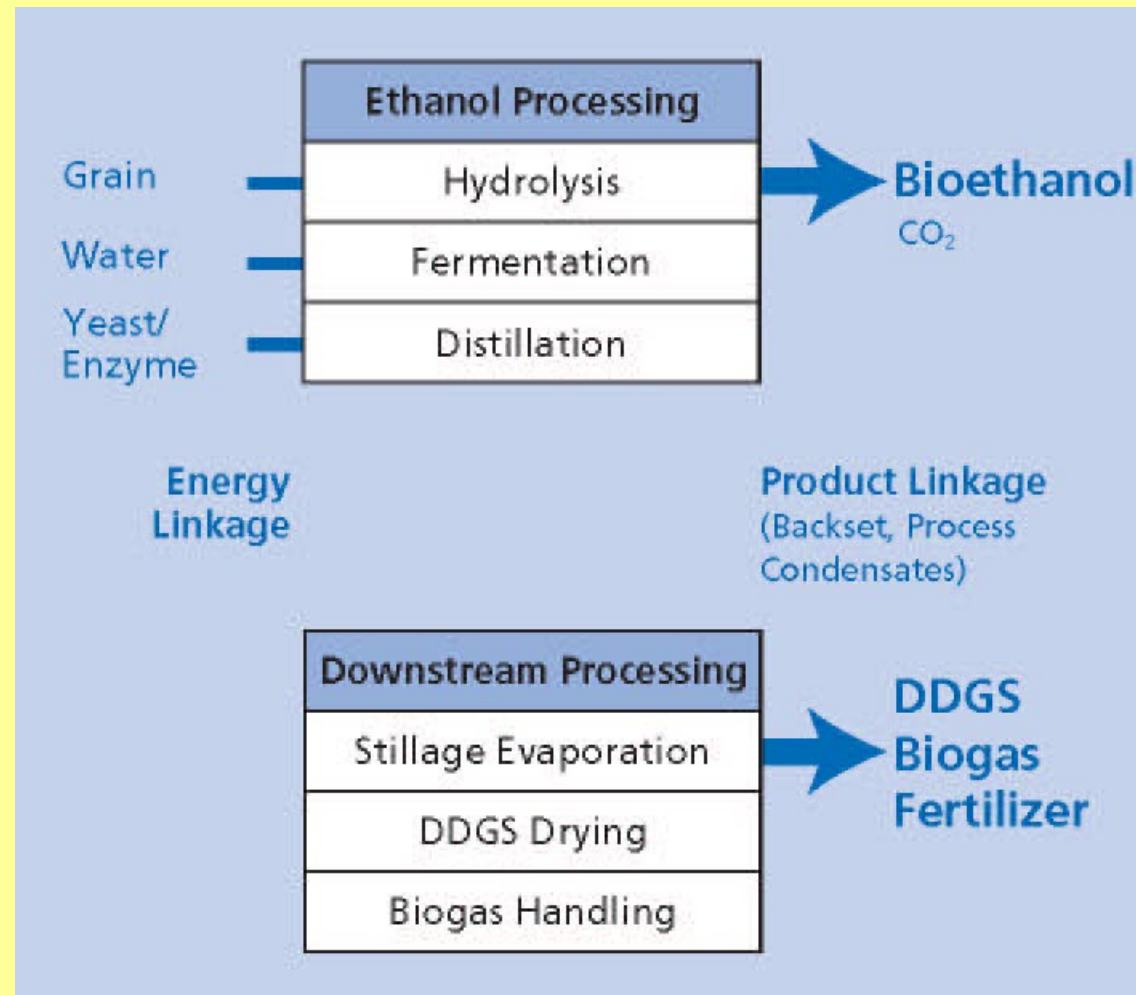
Animal fats & used frying oils  
Food processing wastes  
Fruit processing wastes  
Biorefinery wastes

# Biofuel Yields by Feedstock



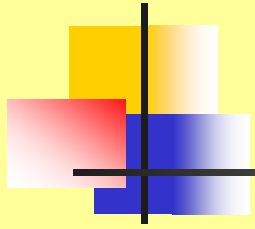
# Ethanol Platform

## *Mature Technology?*



# Ethanol Platform

*Many innovations possible*

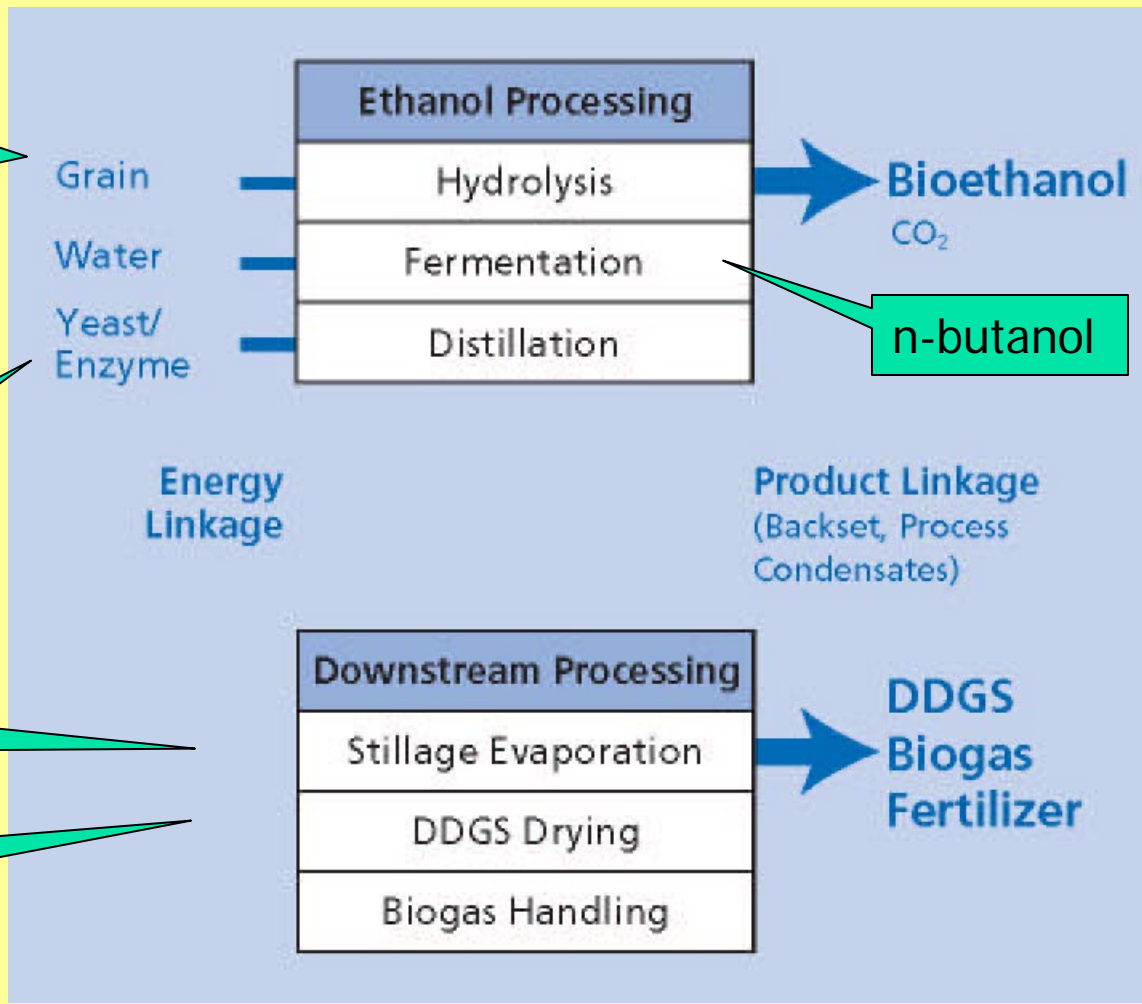


Grain yield  
Starch in grain  
Straw yield  
Cell wall  
Fractionation

Sugar Yield  
Conversion rate

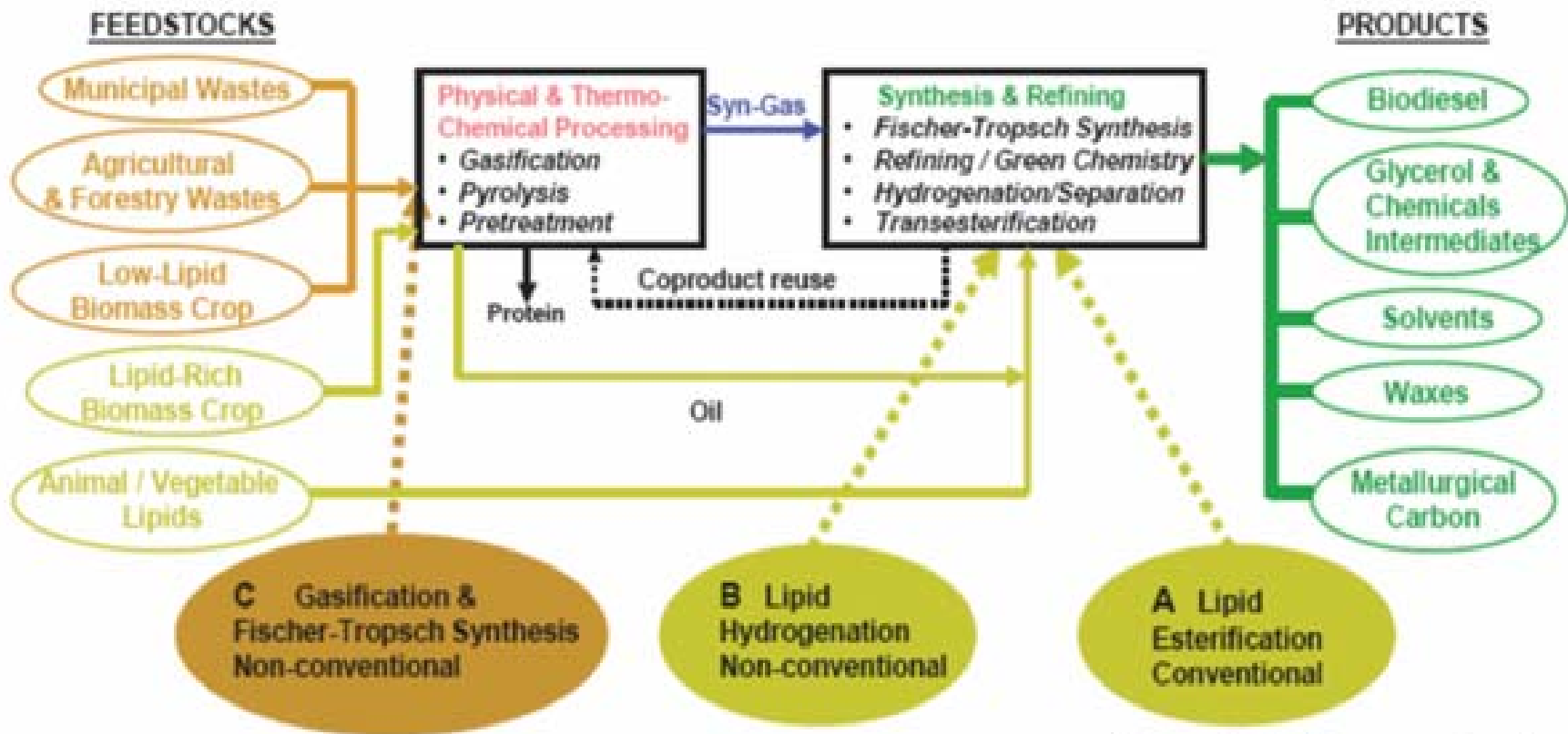
Ethanol / water  
separation

Protein value  
Residue value



# Pathways to Biodiesel

*Many innovations possible*



Source: Natural Resources Canada

# Biomass to Energy

*Many innovations possible*

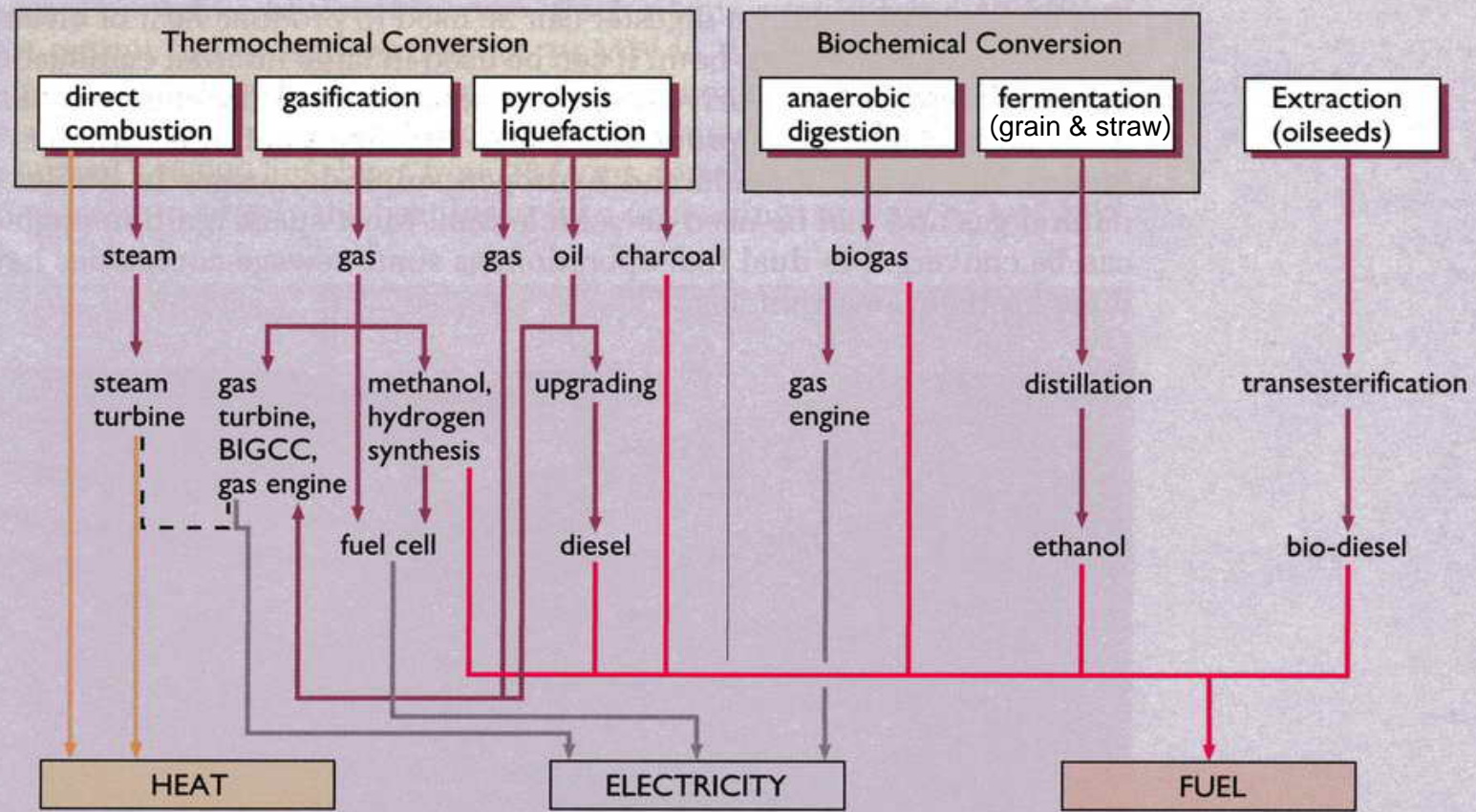
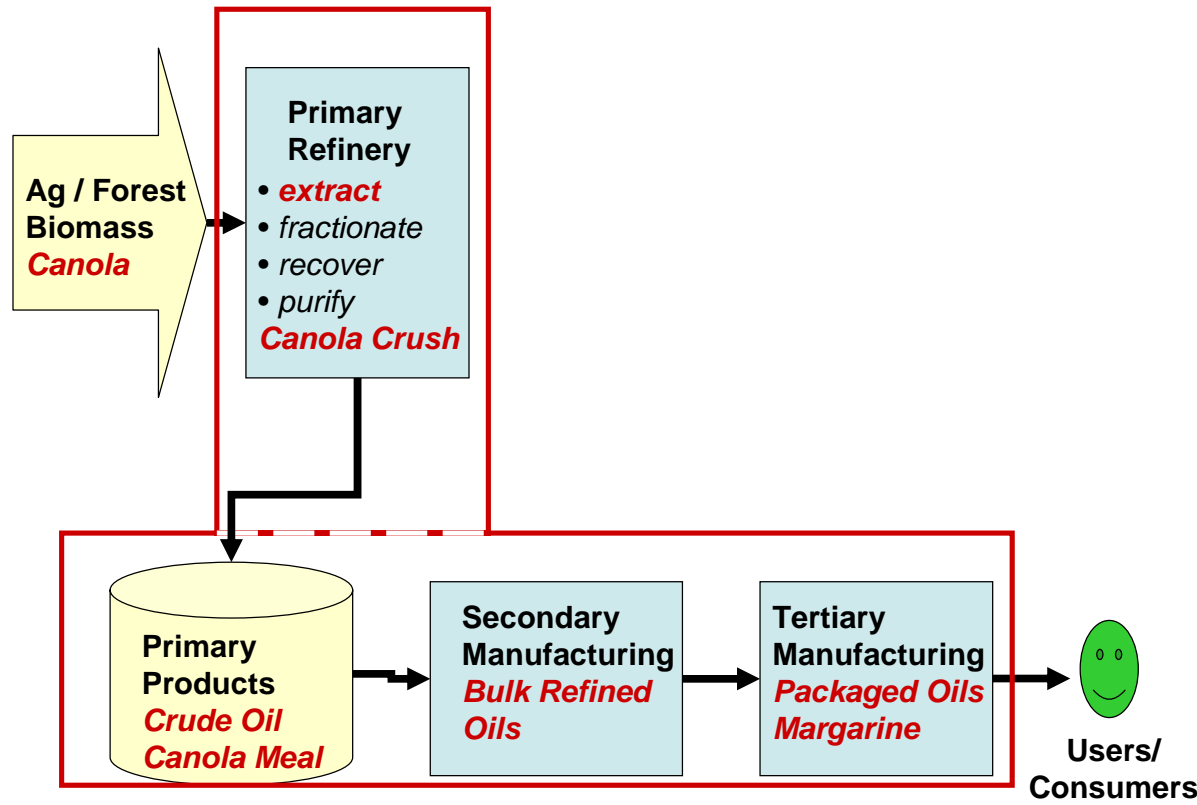


Figure 4.13 Main bioenergy conversion routes

# Canola Processing

## *Integrated, Consolidated & Partnered*



### Canadian Oilseed Processors

Bunge Foods

Cargill

ADM

Canbra

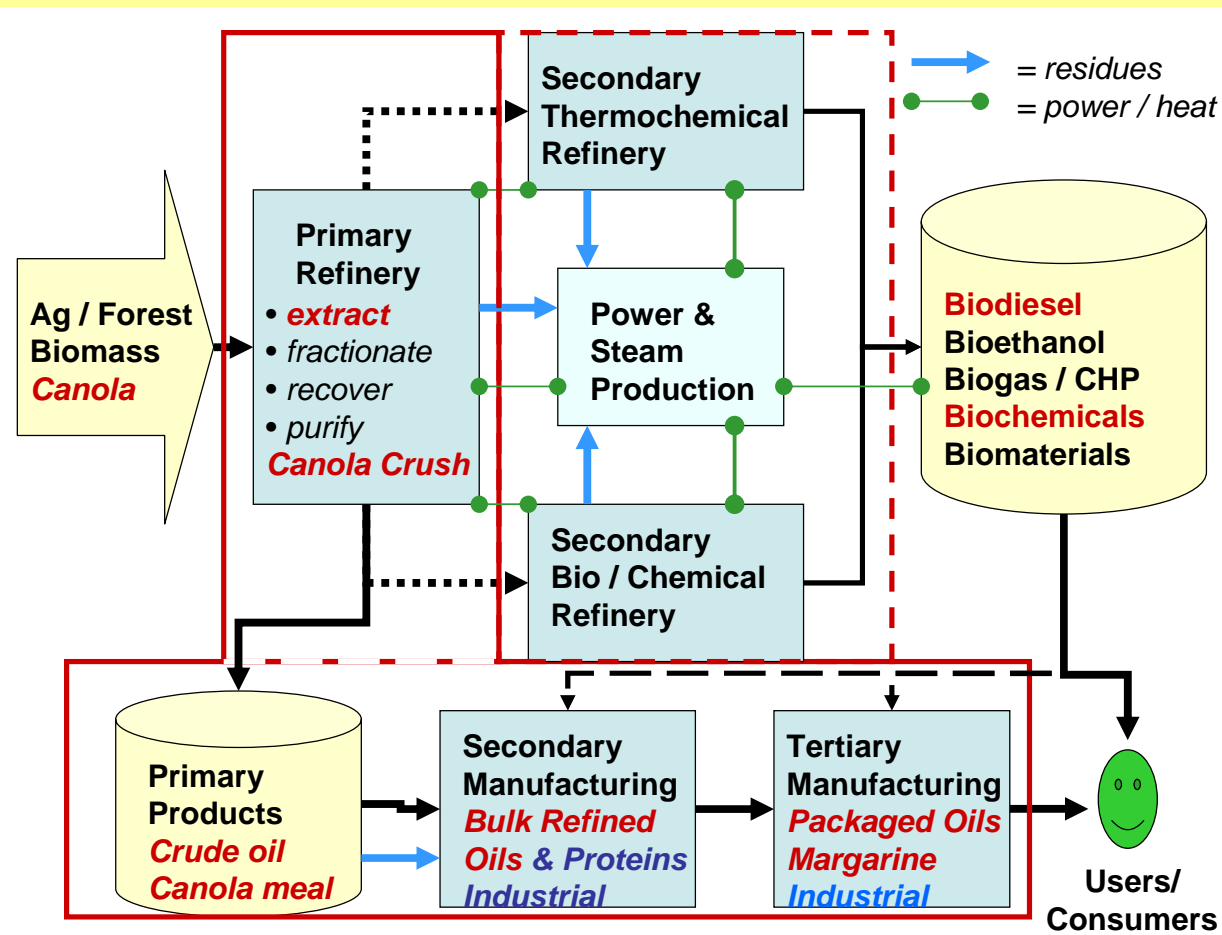
Associated Proteins

Dreyfus  
(announced)

Dominion  
(announced)

# Canola Biorefining

## *Synergy & Diversified Products*



*Efficient co-production of:*

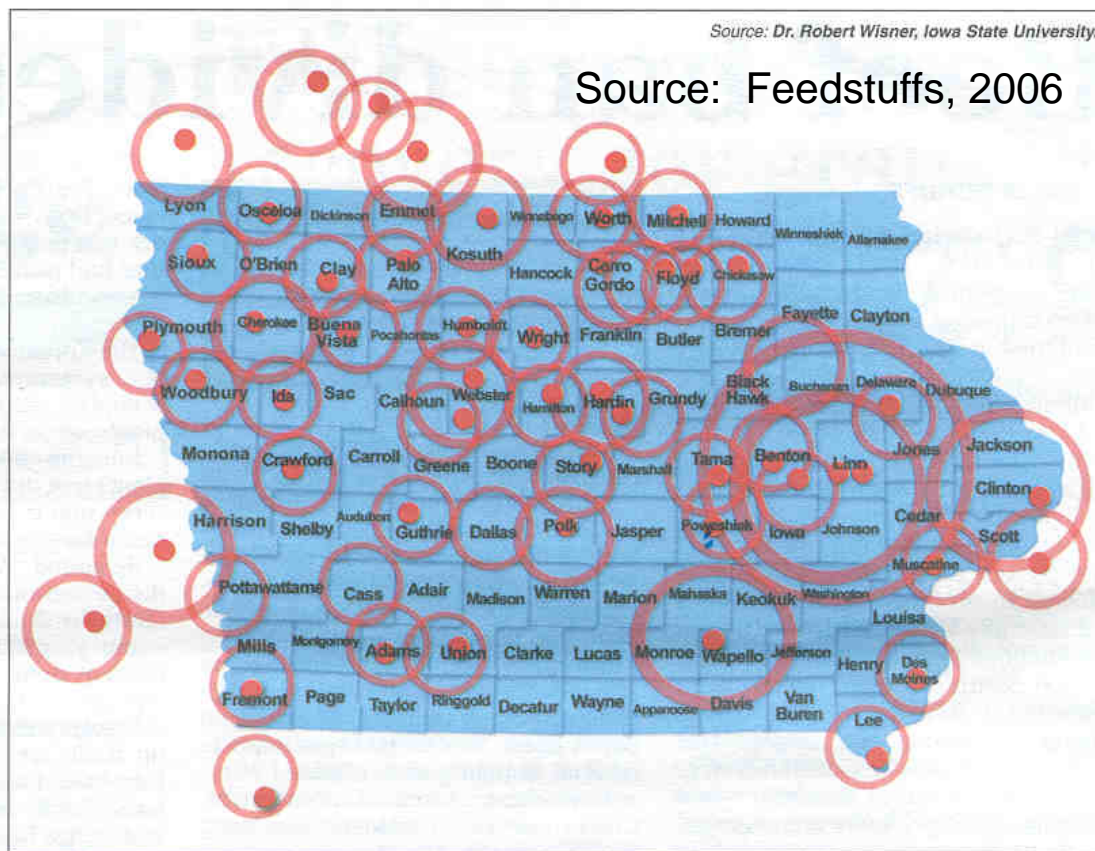
- *Food oils & proteins*
- *Biodiesel*
- *Base chemicals*
- *Intermediates*
- *Bio-based materials*
- *Power & heat*

# The World Has Changed

## *For Feeders in Iowa .... & Alberta?*

Source: Dr. Robert Wisner, Iowa State University.

Source: Feedstuffs, 2006



**CORN DRAW:** Ethanol production in Iowa this year will draw 1.1 billion bushels of Iowa corn away from animal feeding, exports and other purposes into fuel. The Figure shows actual and planned ethanol plants in the state and the areas from which they will pull corn.

# Corn Dried Distillers Grain with Solubles (DDGS)



- Useful mid-protein feedstuff
- Increased supply with ethanol
- Quality is extremely variable
- US ethanol industry working to improve corn DDGS quality
- Triticale and Wheat DDGS superior to Corn DDGS

# Biorefining

## *Business Case Issues*

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- Its All About Manufacturing and Selling Products
  - Product revenue = volume x price
  - Feedstock cost *versus* petroleum
  - Economies of scale
  - Conversion costs
  - Synergies from co-location – important for competitiveness
  - Competitiveness – in new policy environment
  - Return on investment
- Byproducts
  - Utilization – livestock feeds & / or bio-gas/bio-oil
  - Revenue contribution makes the difference between the go & no go investment decision
- Feedstocks
  - Many types of bio-feedstocks
  - Must narrow focus

# Biorefinery

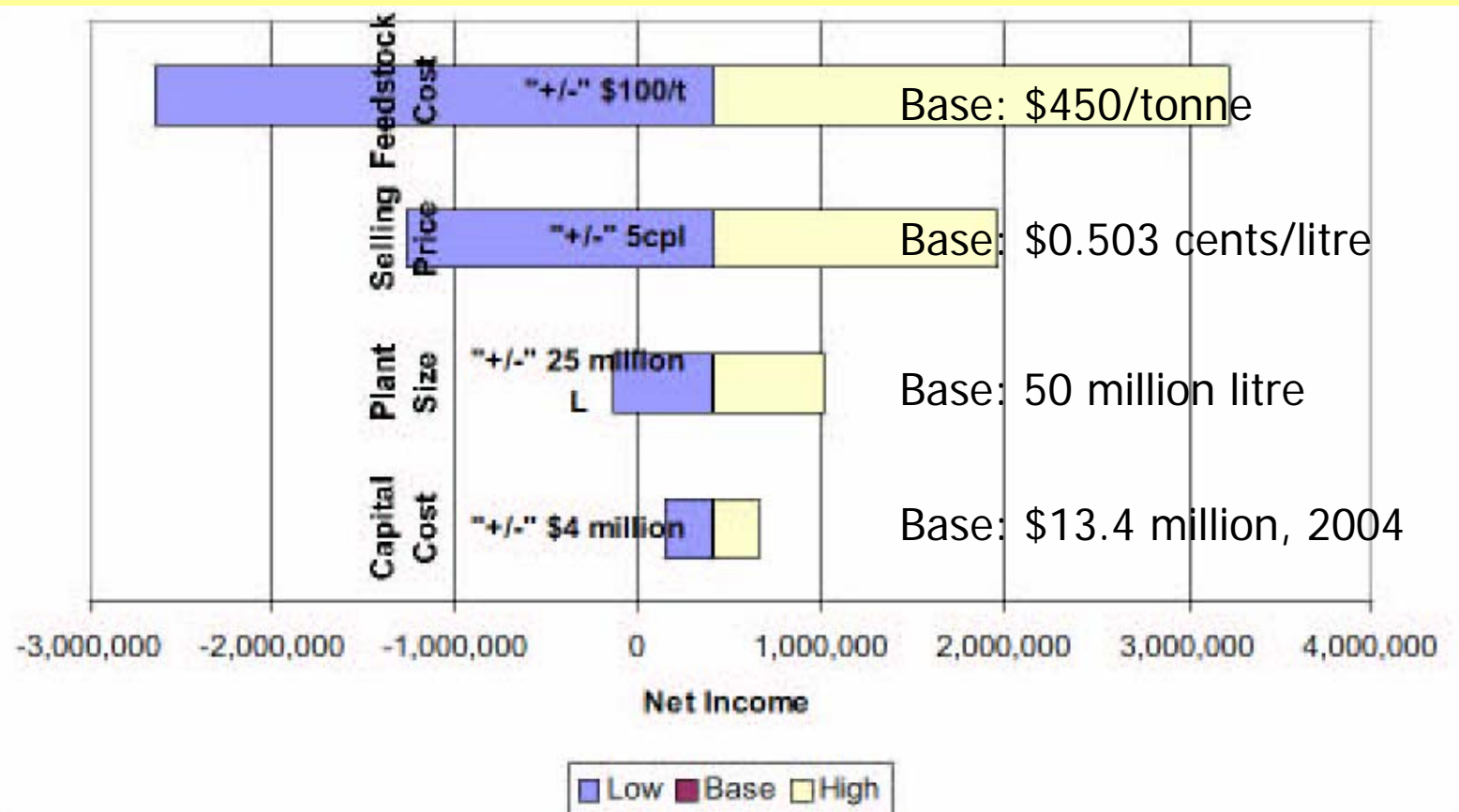
## *Business Case Issues*

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- Policy & Public Investment
  - Mission critical
  - Responds to social, industry and political agendas
  - Various public statements & initiatives
  - Federal & provincial cooperation
- Contributors to Government Strategy
  - Return to political capital
  - Cost & benefit to national accounts
  - Environmental solutions

# Price Sensitivity

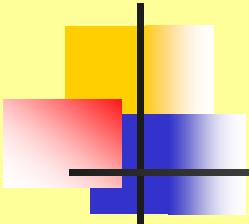
## *Animal Fat Biodiesel Plant*



Source: NRCan, 2004. Economic, Financial, Social Analysis and Public Policy for Biodiesel

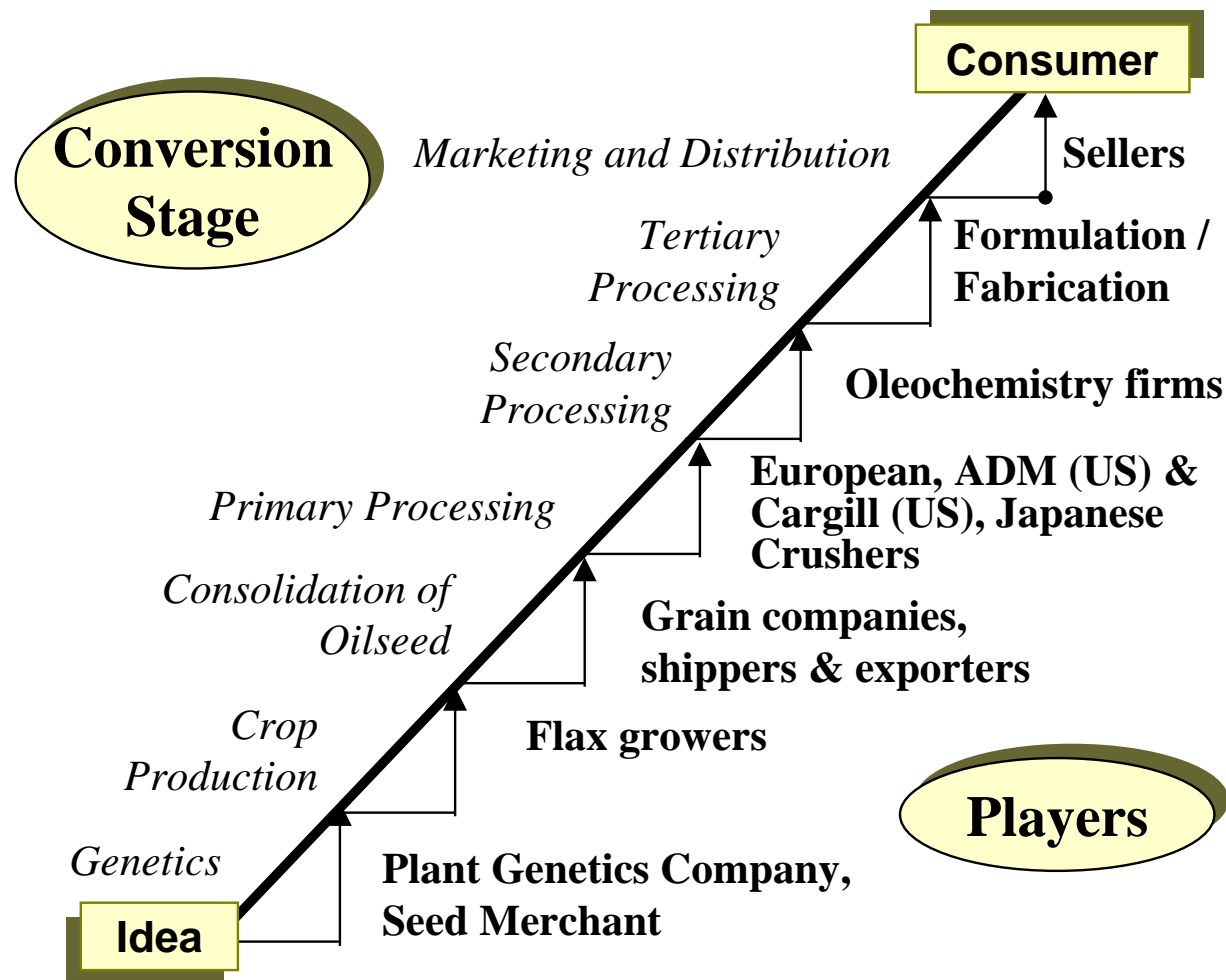
# Crop Platforms

*Many to choose from ....*



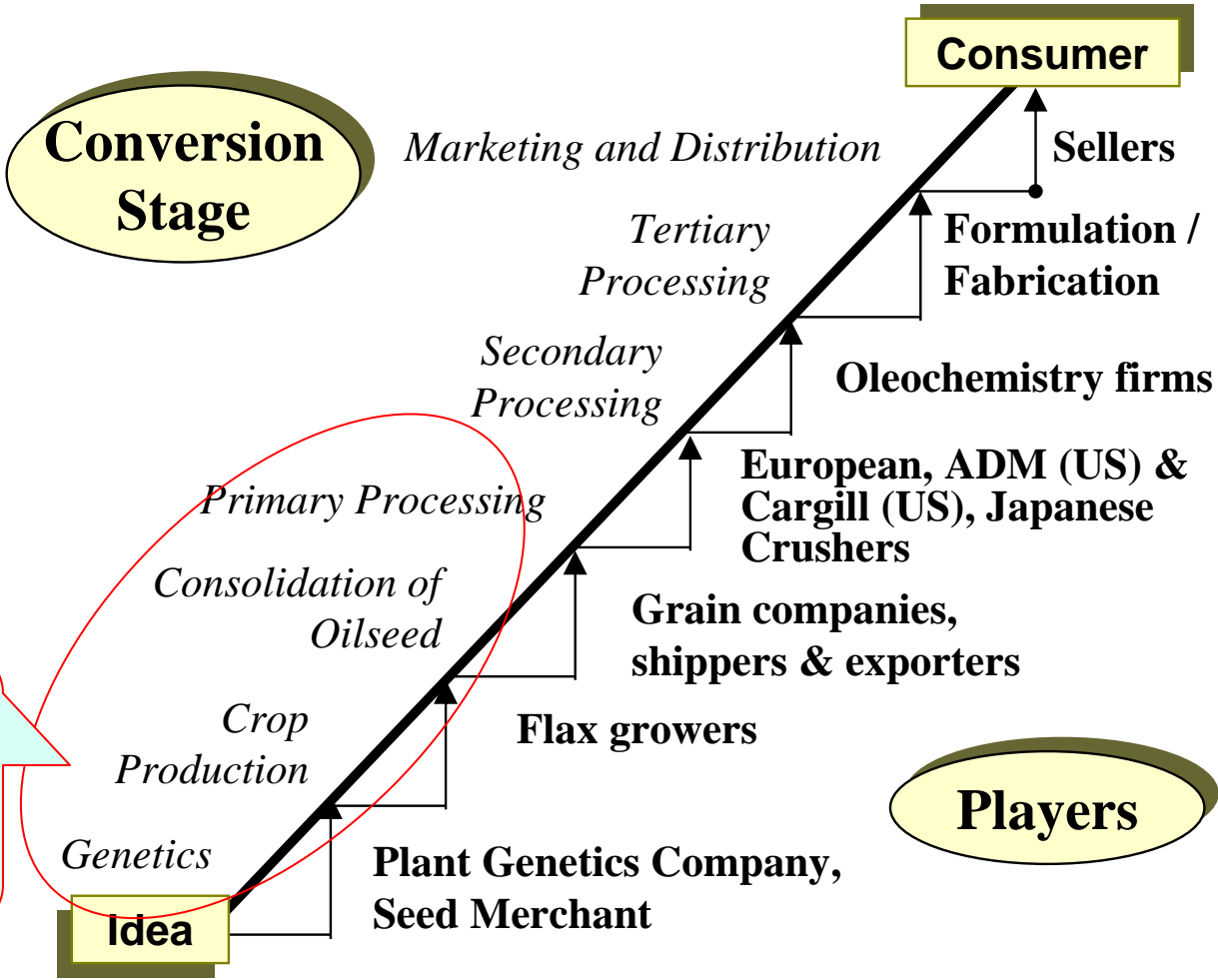
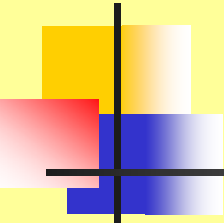
# Flax Biorefining Chain

## *Linking the Players*



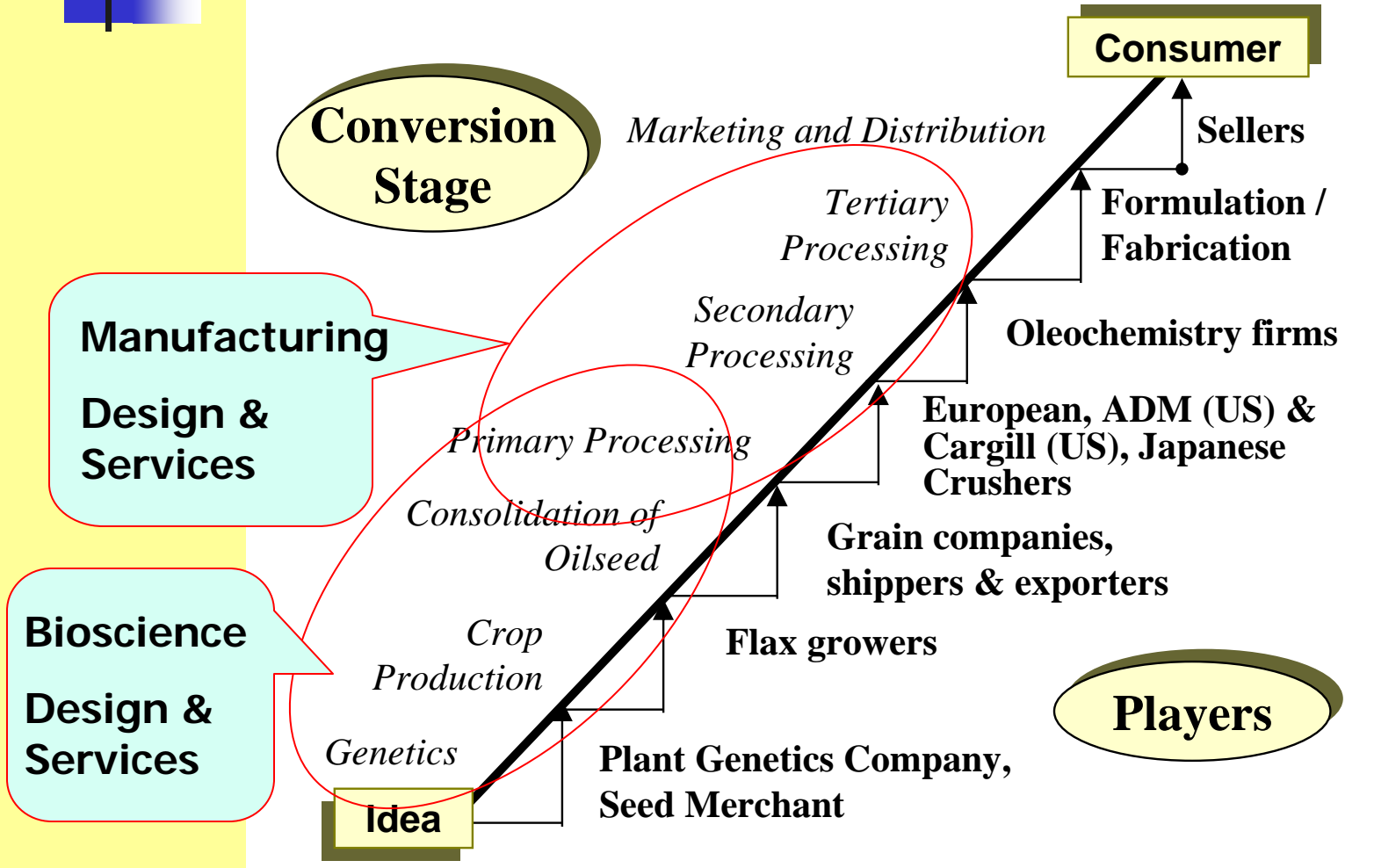
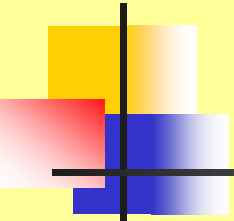
# Flax Biorefining Chain

## *Linking the Players*



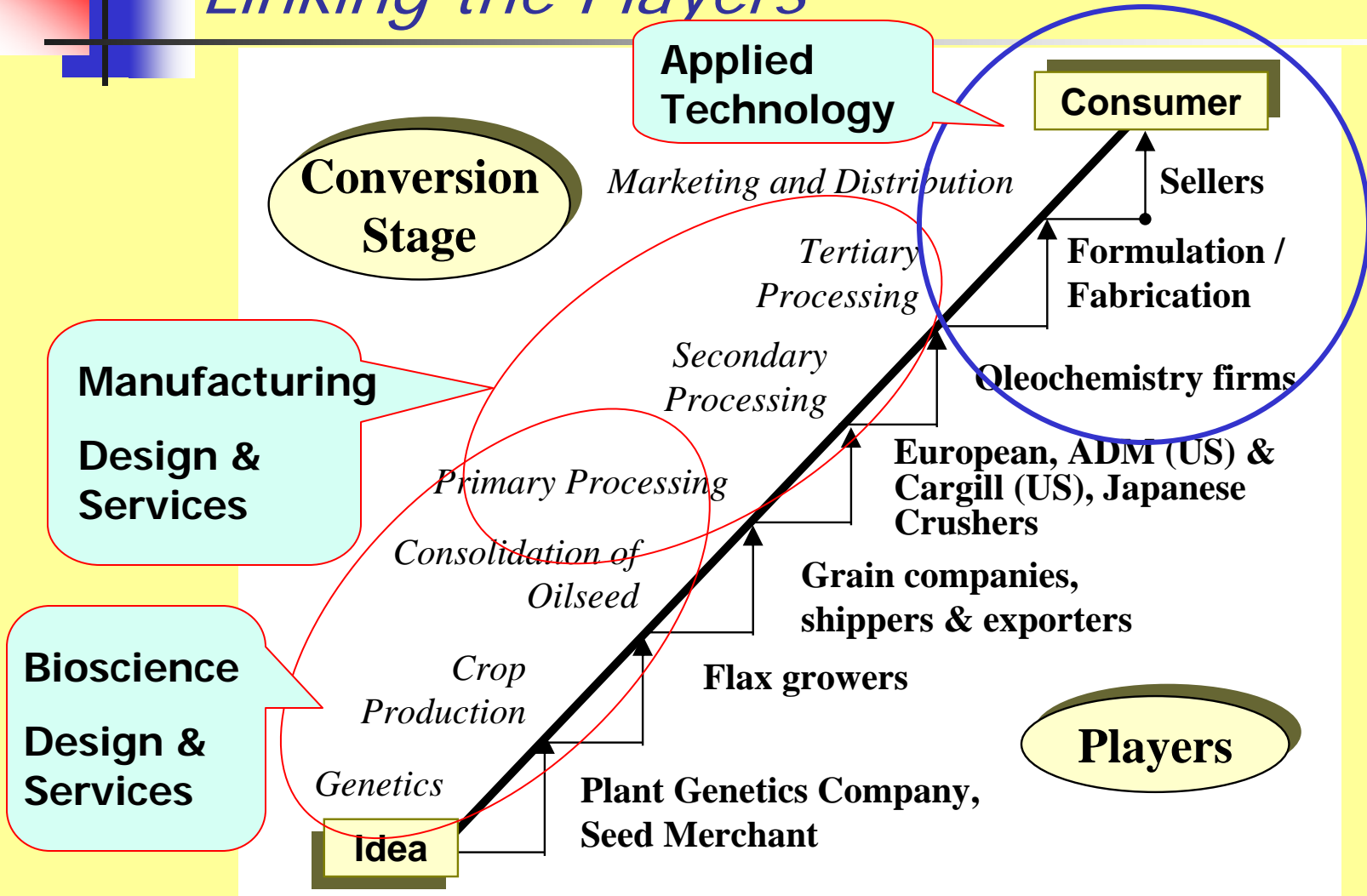
# Flax Biorefining Chain

## *Linking the Players*



# Flax Biorefining Chain

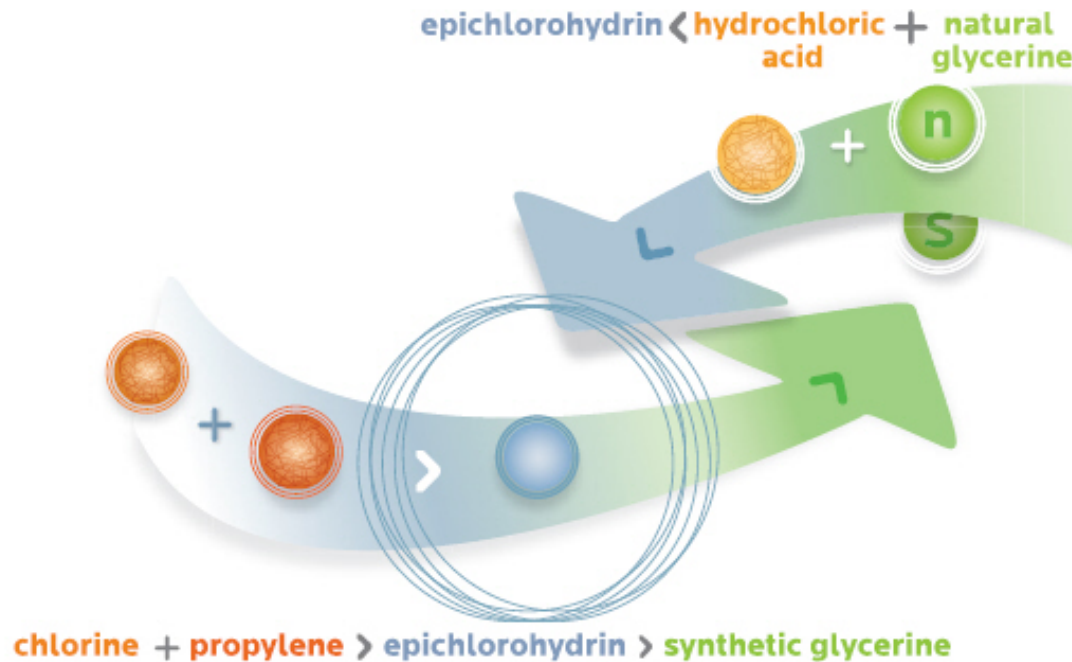
## *Linking the Players*



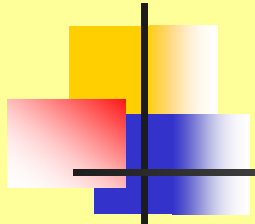
# Reversing the Chemistry

## *Glycerol - new base chemical*

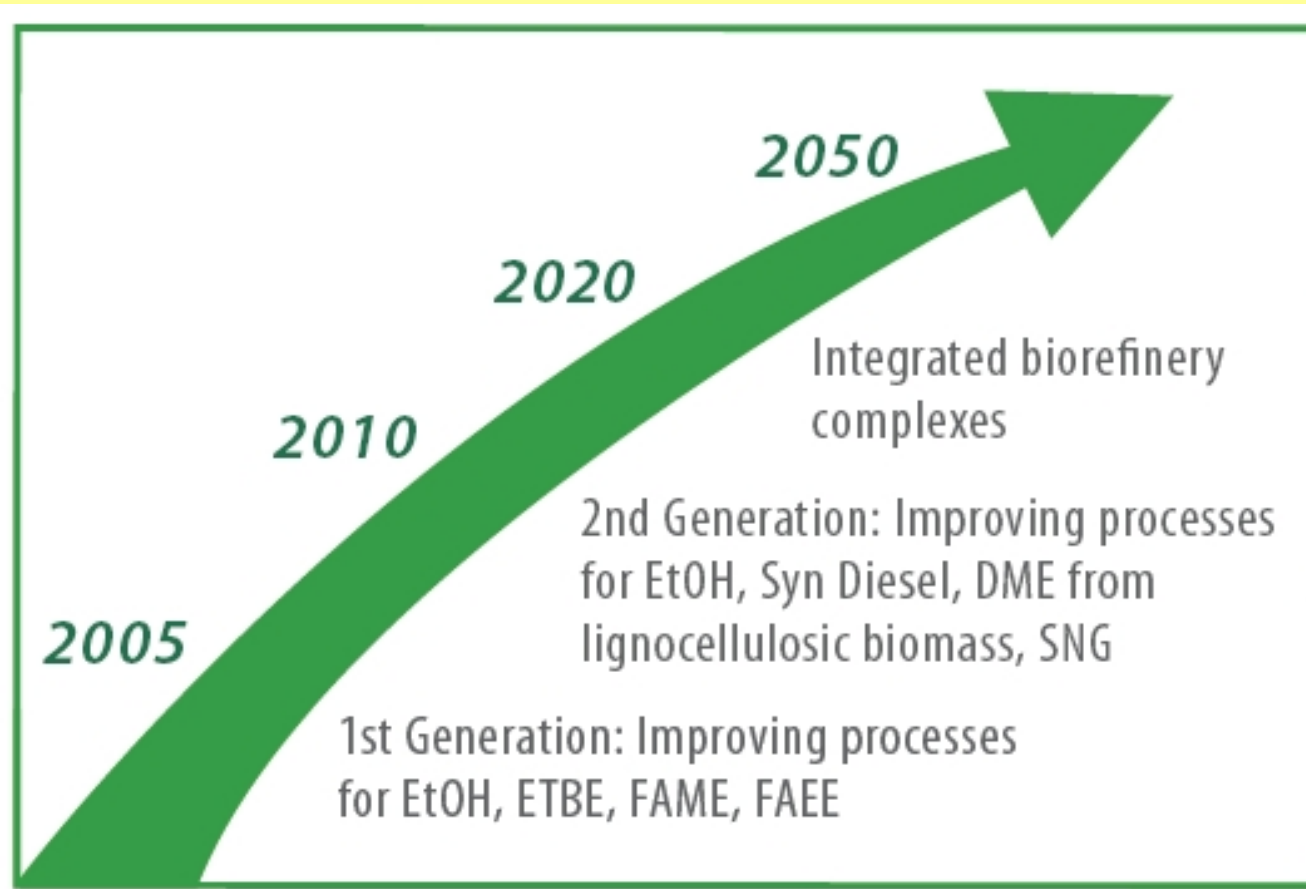
Epicerol™, from product to raw material



Source: Solvay, 2007

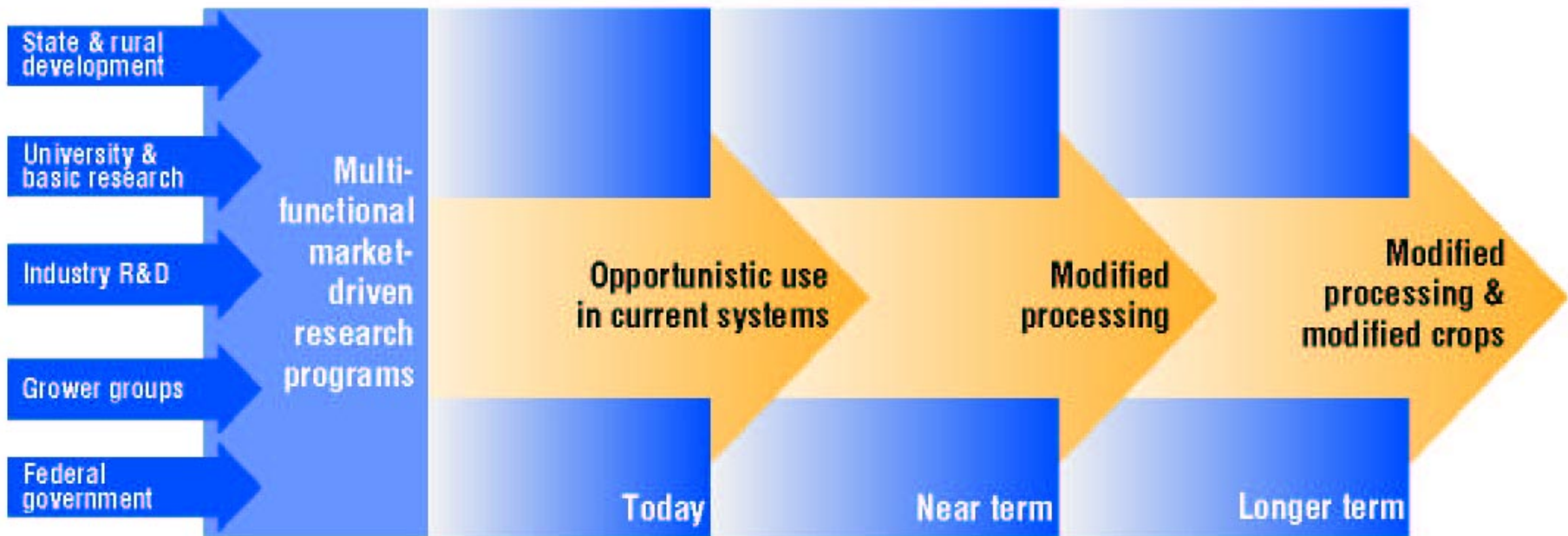


# Biorefining Trajectory



# Feedstock Trajectory

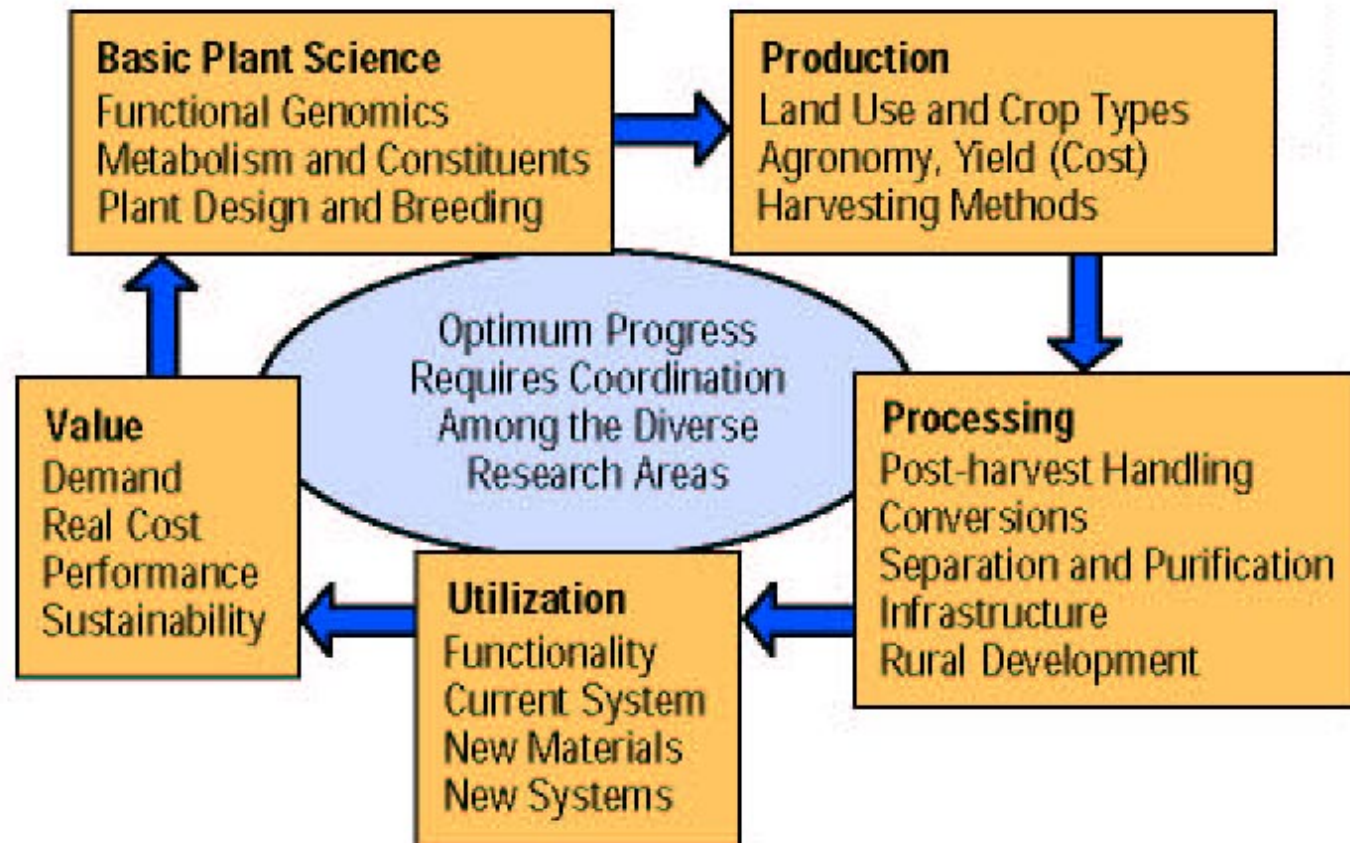
## *Vision & Timelines*



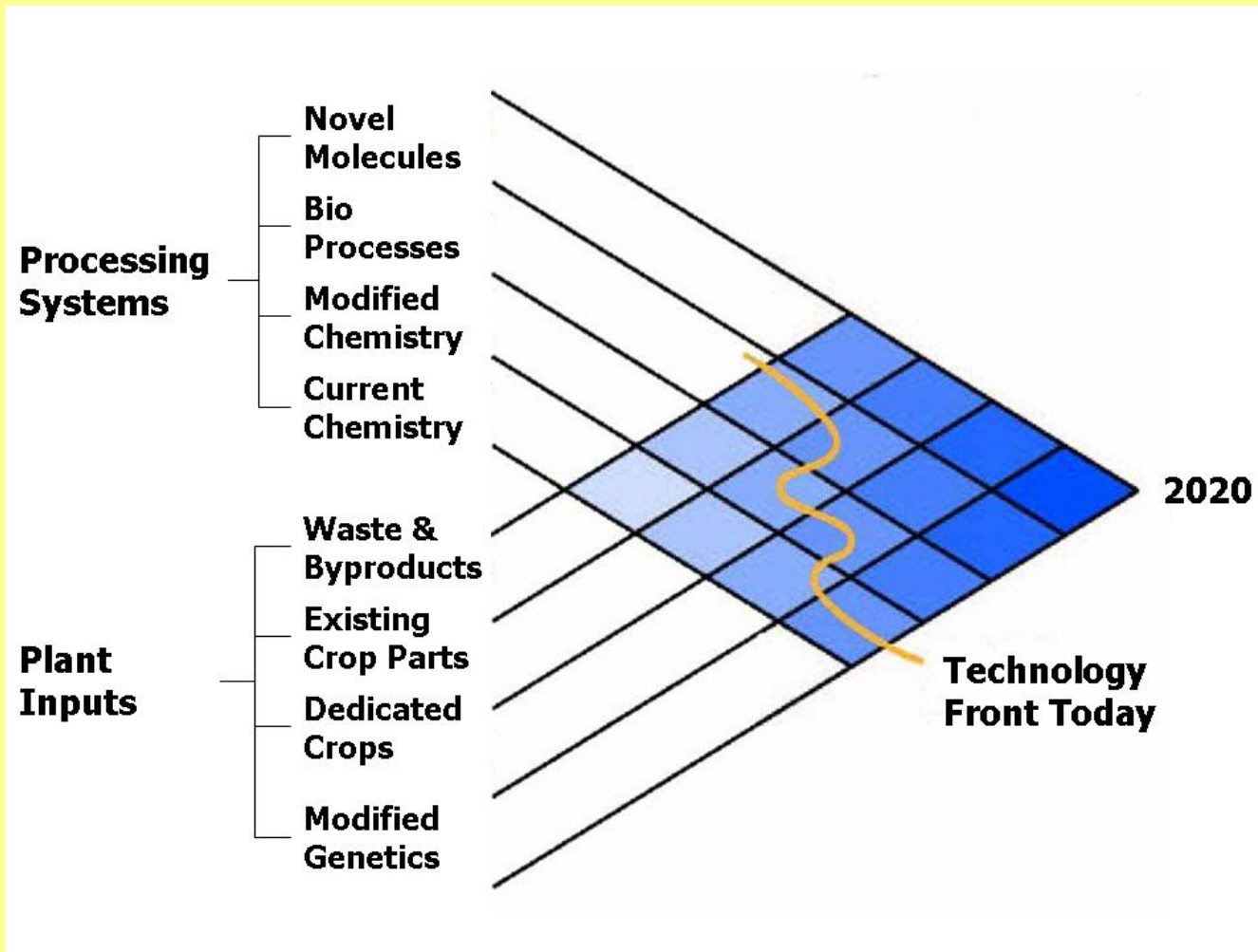
Source: Adapted from Plant / Crop-Based Renewable Resources, US DOE, 1998

# Strategy for Investment

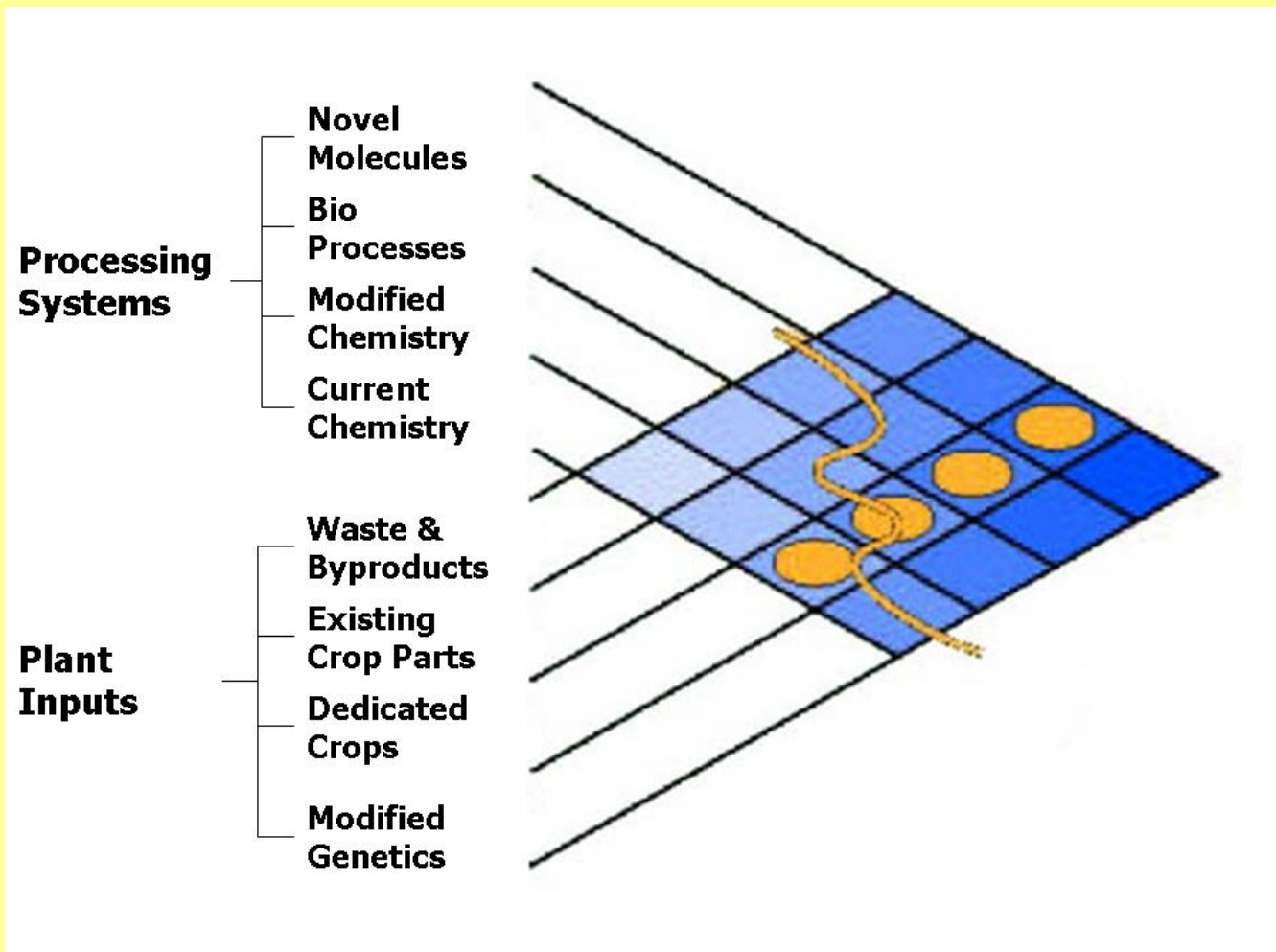
## *Simultaneous Discovery*



# Technology Front Today

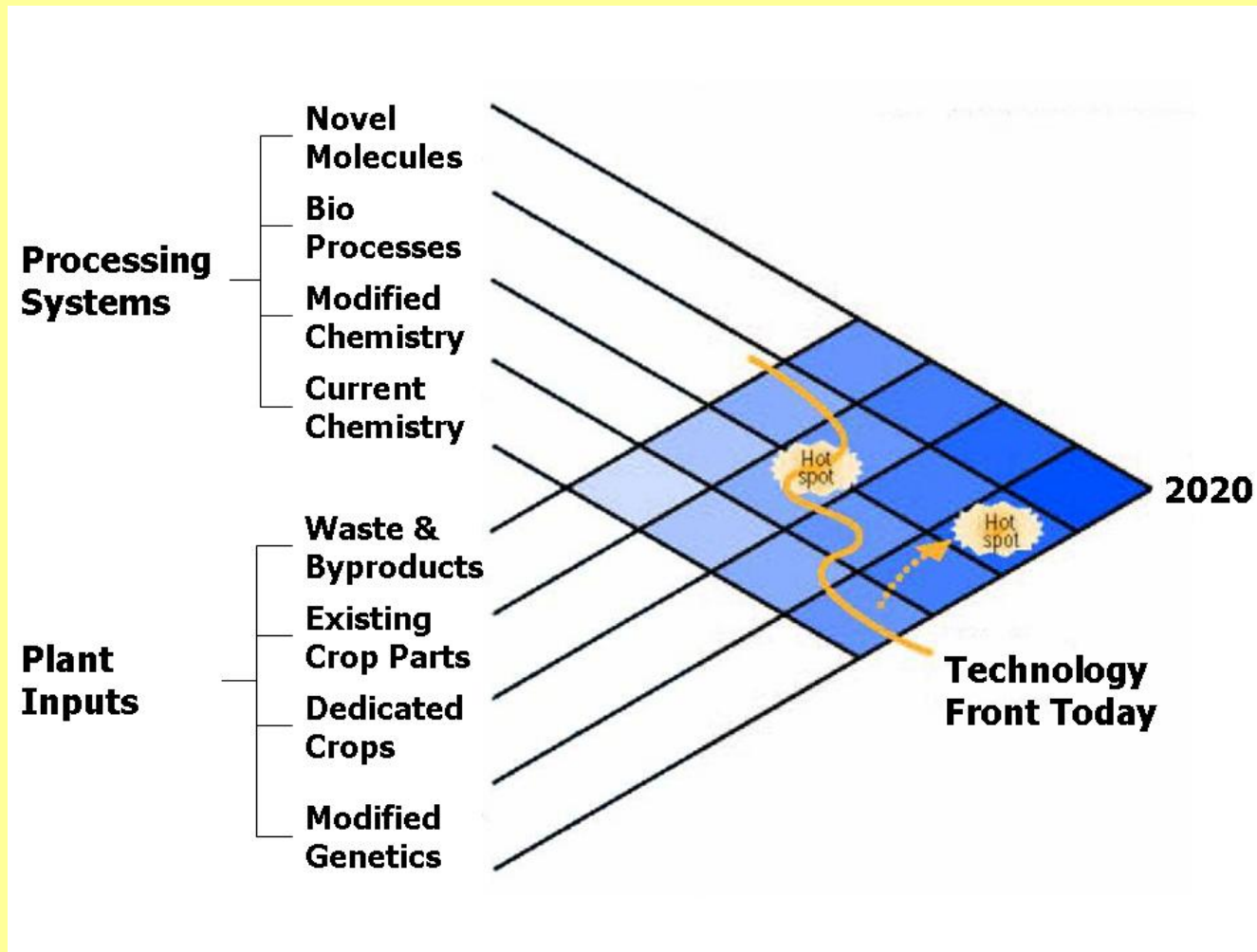


# Dedicated Industrial Crops



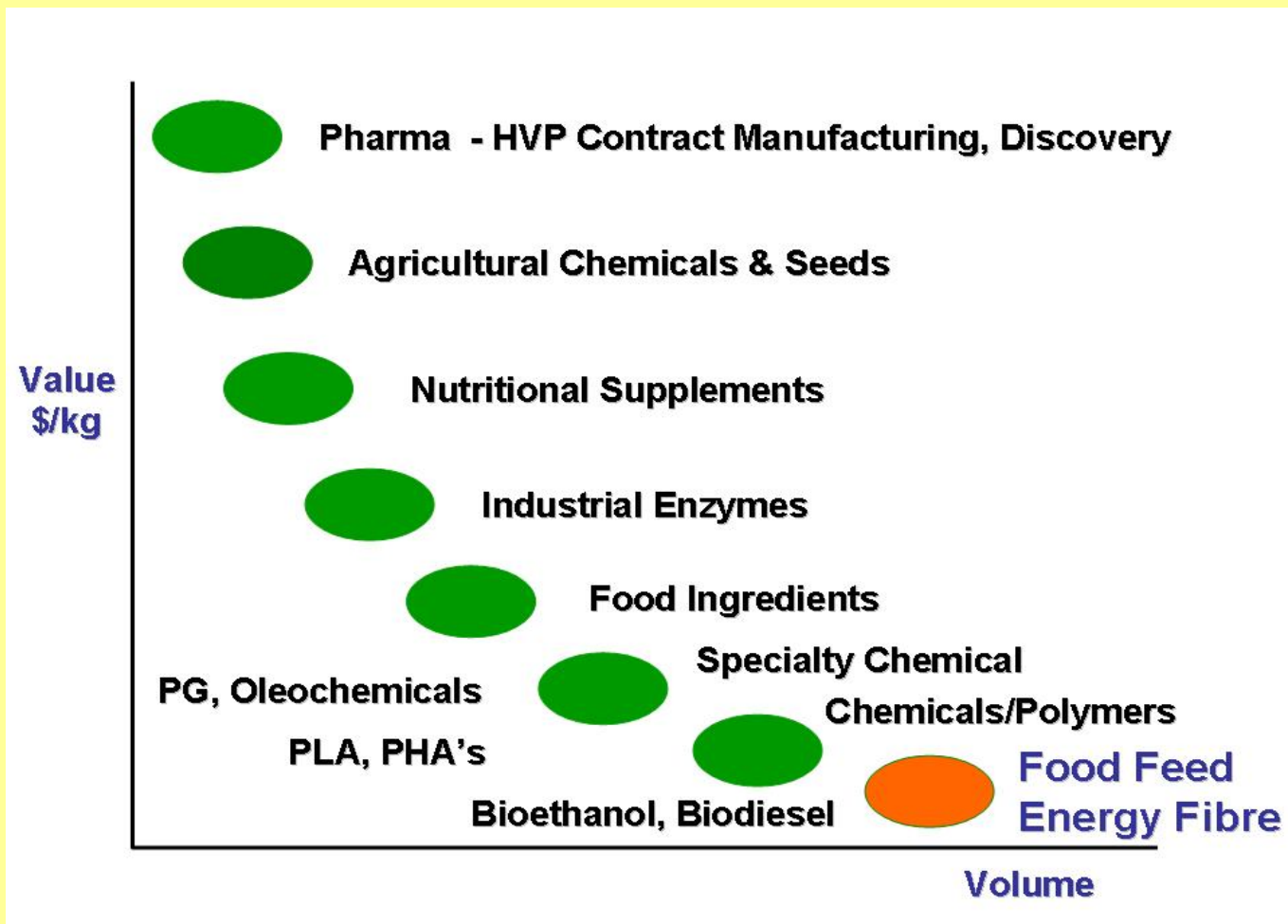
# Hot Spots

## *Today & Tomorrow*

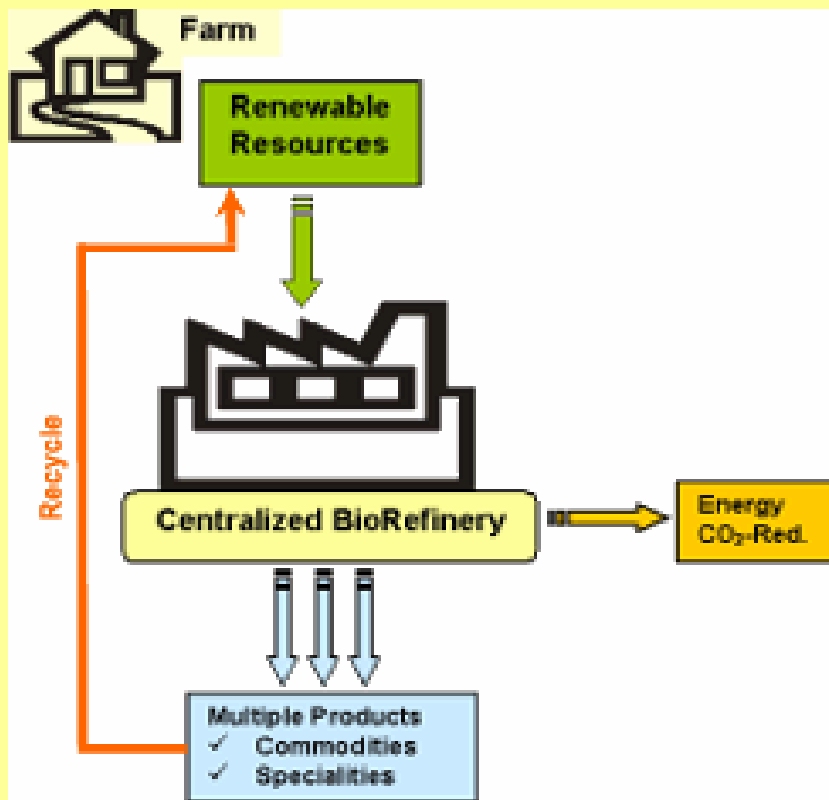


# Next Generation Products

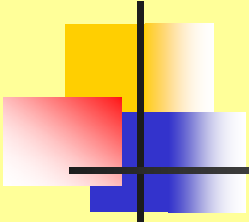
*from Renewable Feedstocks*



# So, ...what will it take?



- Solid Drivers
- 3-4 Crop Focuses
- Foresight – future growth
  - New products
  - New processes
  - New genetics
- Confidence re: hot spots!!
- Investment – now & long term
- Public Support
- Entrepreneurs
- Action



## Thank you for your attention.

If you have questions or ideas to discuss,  
please don't hesitate to contact:

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