

Fuel ethanol

- Checkered past
- Political football
- Parallel with GM crops with regard to public perception uncanny!

BioEthanol – the Facts

- Benefits of Bioethanol
 - Provides new income source for growers
 - Renewable, clean and green resource
 - Greenhouse gas benefits
 - Replacement for toxic additives
 - Suitable for virtually all vehicles
- However the Reality!
 - Using current technology, Bioethanol not cost competitive with petrochemical-based fuels
 - but at > US\$ 70 per barrel?

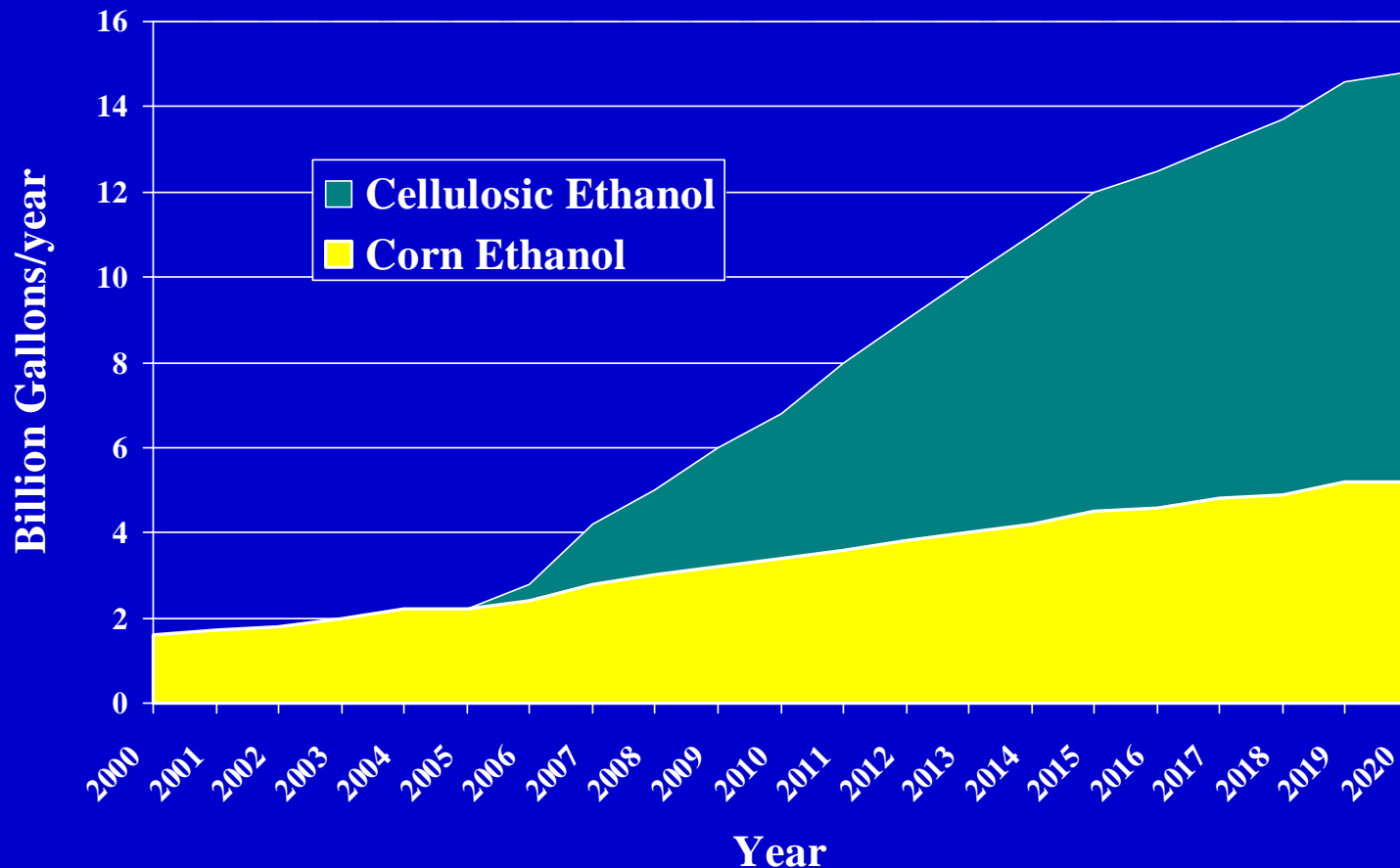
Processing Just 30% of Corn Stover has the following impact:



- Adds 20 to 35 billion liters of ethanol for fuels with no increased land use
- Increases direct farm income \$2.3 billion from feedstock sale of 30% of total
- Improves soil quality (no till farming)
- Mitigates GHGs by more than 60- 97 M metric tons C/year, 12% - 20% Kyoto Commitment

Lignocellulosic Potential

Projected Ethanol Usage - 2020



Forecast Demand in Australia

- Govt mandate - by 2010 biofuels (ethanol, biodiesel) will contribute at least 350 ML to the total fuel supply.
- If increased adoption of E10 blend total annual requirement for fuel ethanol in Australia by 2016 is projected to increase to **~4 BL (Billion Litres)**.
- Requires a **50-fold** increase over current production levels (~70 ML per year).
- This forecast is consistent with the current US experience from 10 in 1996 to 20 BL in 2005 and is forecast to reach 60-80 BL in 2012.
- Where is the feedstock coming from?????
- There is only one source of renewable carbon large enough to meet the demand!

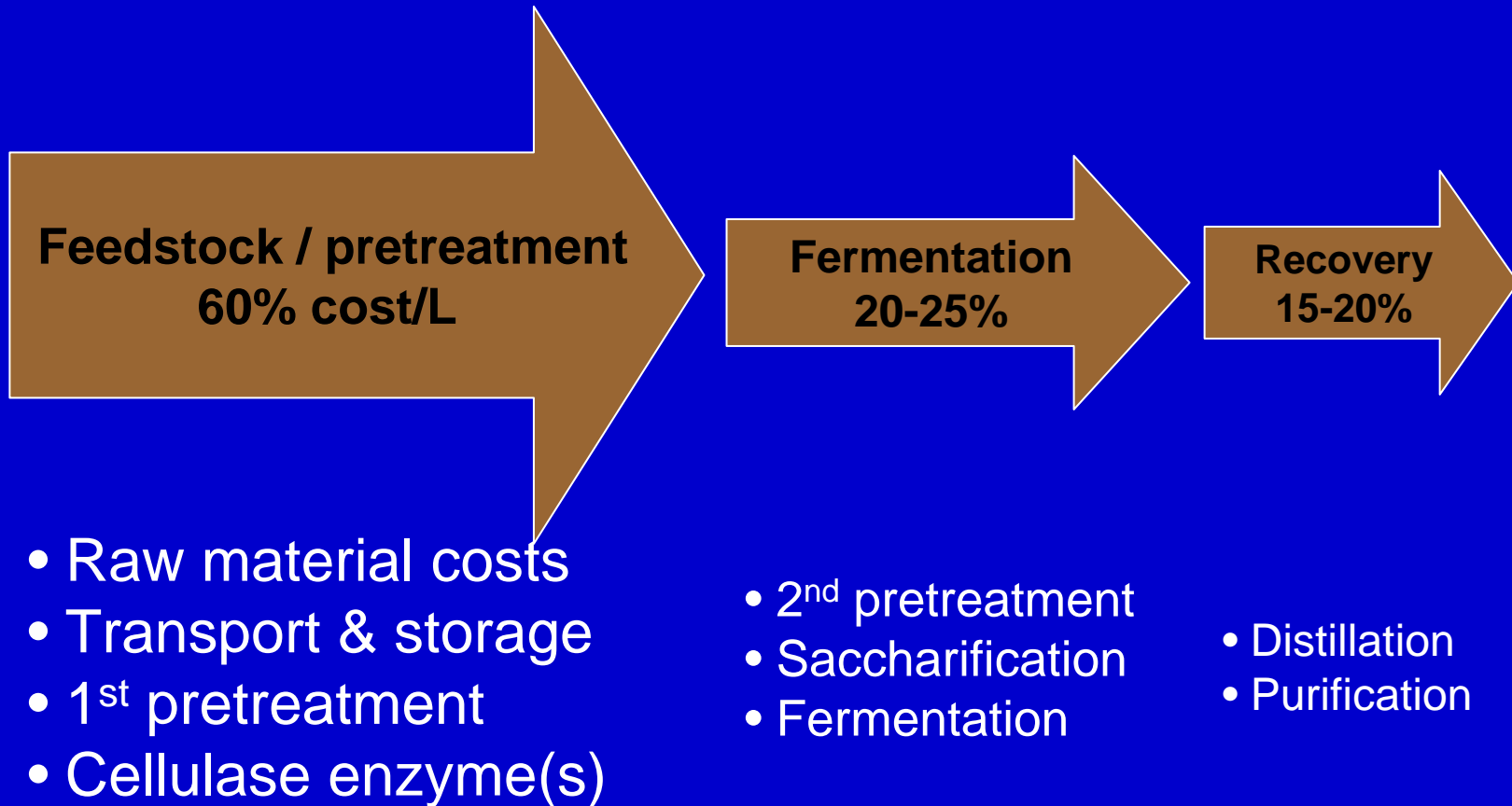
Another fact!- Feedstock Limitations to a Viable Ethanol Industry

- Current ethanol production relies solely on grain/starch or sugar as the fermentation feedstock.
- However, reliance on grain/starch and sugar as feedstocks is unsustainable
- Feedstock production costs and competing demand
 - animal feed and food.

Estimated Availability of Nonwood Fibers (million dry metric tons)

<u>Agricultural Residue</u>	<u>U.S.</u>	<u>World</u>
Wheat Straw	76.0	600.0
Rice Straw	3.0	195.0
Seed Flax Straw	0.5	2.0
Corn Stover	250.0	550.0
Cotton Stems	4.6	68.0
Sorghum Stems	28.0	252.0
Sugar Cane Bagasse	4.4	102.2

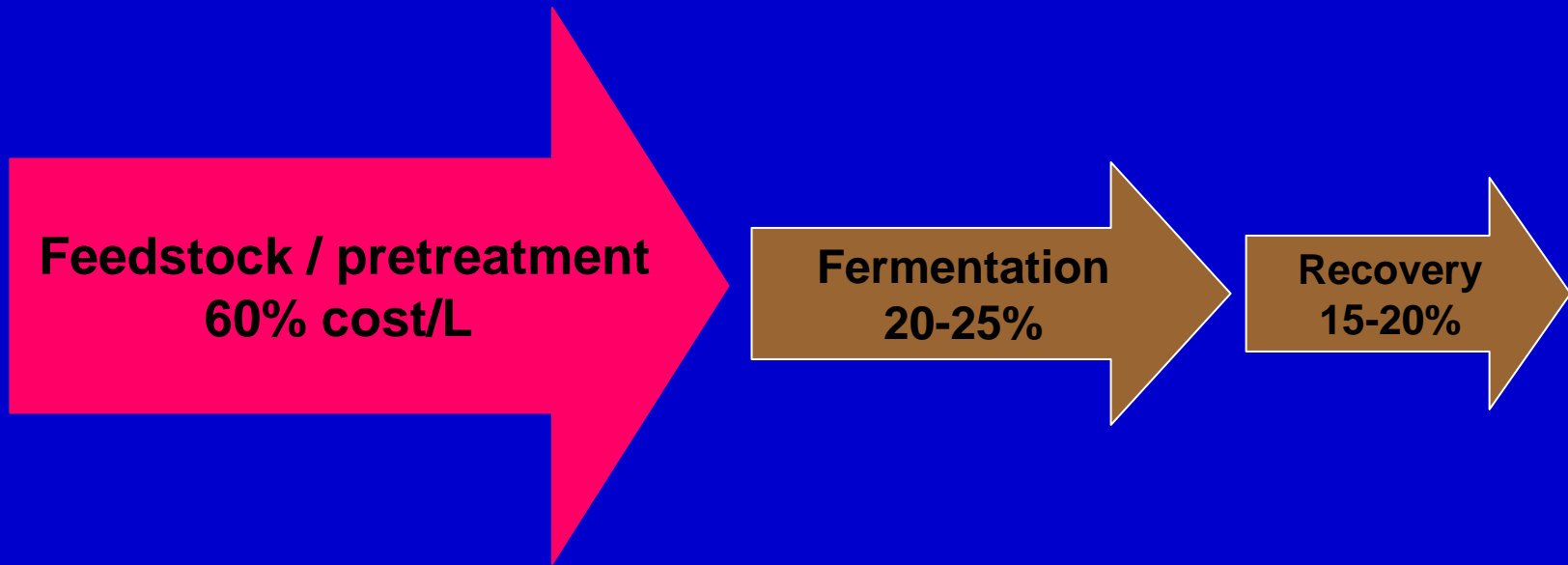
Production Costs – Lignocellulosic Ethanol



The Technical Challenge

- Ligno-cellulosic biomasses are non-starch polysaccharides that constitute plant cell wall materials
- Efficient ligno-cellulose degrading enzymes are currently not commercially available.
- When they are developed these enzymes will increase the cost of ethanol production by at least 30%.
- A secondary consideration is the need for very large scale fermentation to produce the necessary ligno-cellulose degrading enzymes.

BCT Technology Impacts



- Raw material costs
- Transport & storage
- 1st pretreatment
- Cellulase enzyme(s)

- 2nd pretreatment
- Saccharification
- Fermentation

- Distillation
- Purification

Rationale for Use of Crop Residues

- The only large-scale and sustainable feedstock is lignocellulose derived from crop residues, especially from grain crops such as wheat, barley and sorghum.
- Worldwide, the availability of ligno-cellulosic crop residues (wheat, maize, rice, barley and sorghum) approaches 1.5 B tonne/yr.
- Assuming a 500 L ethanol/tonne of feedstock output, conversion of 25% of this available feedstock could provide about 1900 BL/year worldwide.
- Australia could generate ~40 M tonne of crop residue feedstock/yr from wheat and barley that could eventually produce upwards of 20 BL of ethanol annually. Note E10 requires 4 BL.

Benefits to Australia

- Revenue source for Australia's cereal growers/farmers from a large agricultural post-harvest waste stream.
- Lessen Australia's dependence on fossil fuels.
- New industry potential, technology innovation for large-scale bioprocessing
- Rural job creation - regional plants.
- Assist in decreasing the \$7 billion dollar chemical deficit that Australia currently faces.
- A cleaner, healthier environment
- More efficient use of waste biomass.

It is a long way into the future, but:

- Clear consumer and environmental benefits
- If we don't someone else will
- It is GM for a major food crop
 - The last bastion for the opponents.
- It will require "Co- harvesting" with food grain
- We don't really have a choice this time around!