

Fuel For Thought

Assessing California's Biofuel Future



By Kyle Hubbard



Ethanol and California

- Background

- 1990 amendment to the 1970 Clean Air Act required oxygenate to conform to pollution standards
- 1999 Phase out of MTBE with complete transition to ethanol by 2003



Ethanol and California

- Background

- April 2006: Governor Schwarzenegger established Executive Order S-06-06 mandating 20% of ethanol consumed in CA be produced within the state by 2010
- Targets extended to 40% by 2020 and 75% by 2050



Benefits of Biofuels

- Reduced Green House Gas Emissions
- Reduced Dependence on Oil
- Agricultural Sector Support



California Fuel Consumption Gasoline and Ethanol

- Gasoline

- 15.9 Billion Gallons in 2006
- 11% of US supply

- Ethanol

- 900 Million Gallons in 2006
- 37 Million Gallons produced in CA
- 863 Million Gallons imported from Midwest

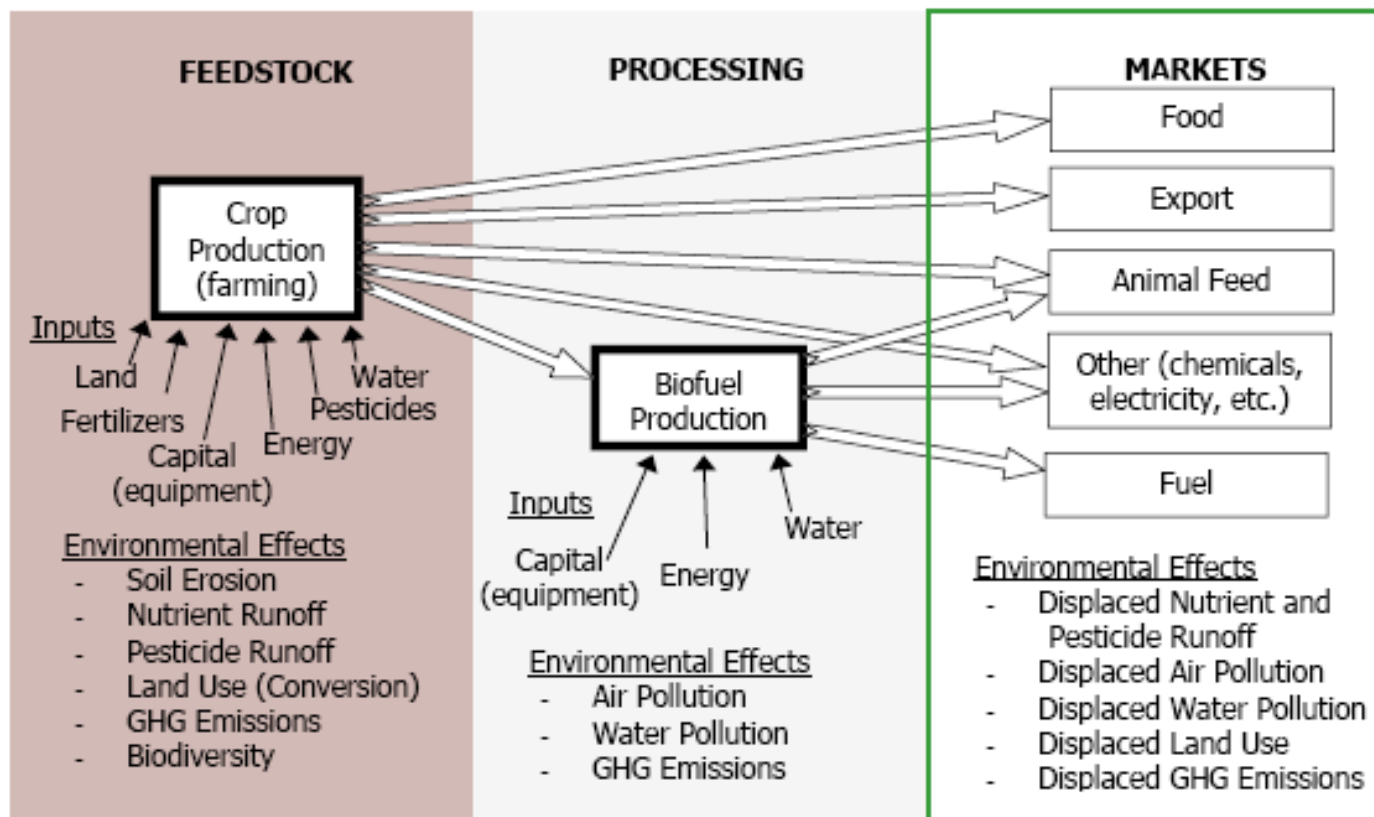


Resources Required for Ethanol Production

- Crops
- Land
- Thermal Energy
- Fertilizer, Pesticides, and Water
- Infrastructure
 - Transportation of biomass
 - Refinery infrastructure
 - Biofuel distribution

Ethanol Life Cycle Impact

Figure 1: General Biofuel Pathway with Inputs and Environmental Impacts (simplified)





Feedstock Options for Ethanol

- Grains
 - Corn, Barley, Wheat, Milo
- Sugars
 - Sugar Cane, Sweet Sorghum
- Short rotation woody crops
 - Switchgrass, Poplar, Willow
- Perennial Grasses (LIHD)
 - Native species
- Agricultural Wastes
 - Wood, fruit, and vegetable byproducts, paper pulp, consumer recycling



Feedstocks and Technology for California

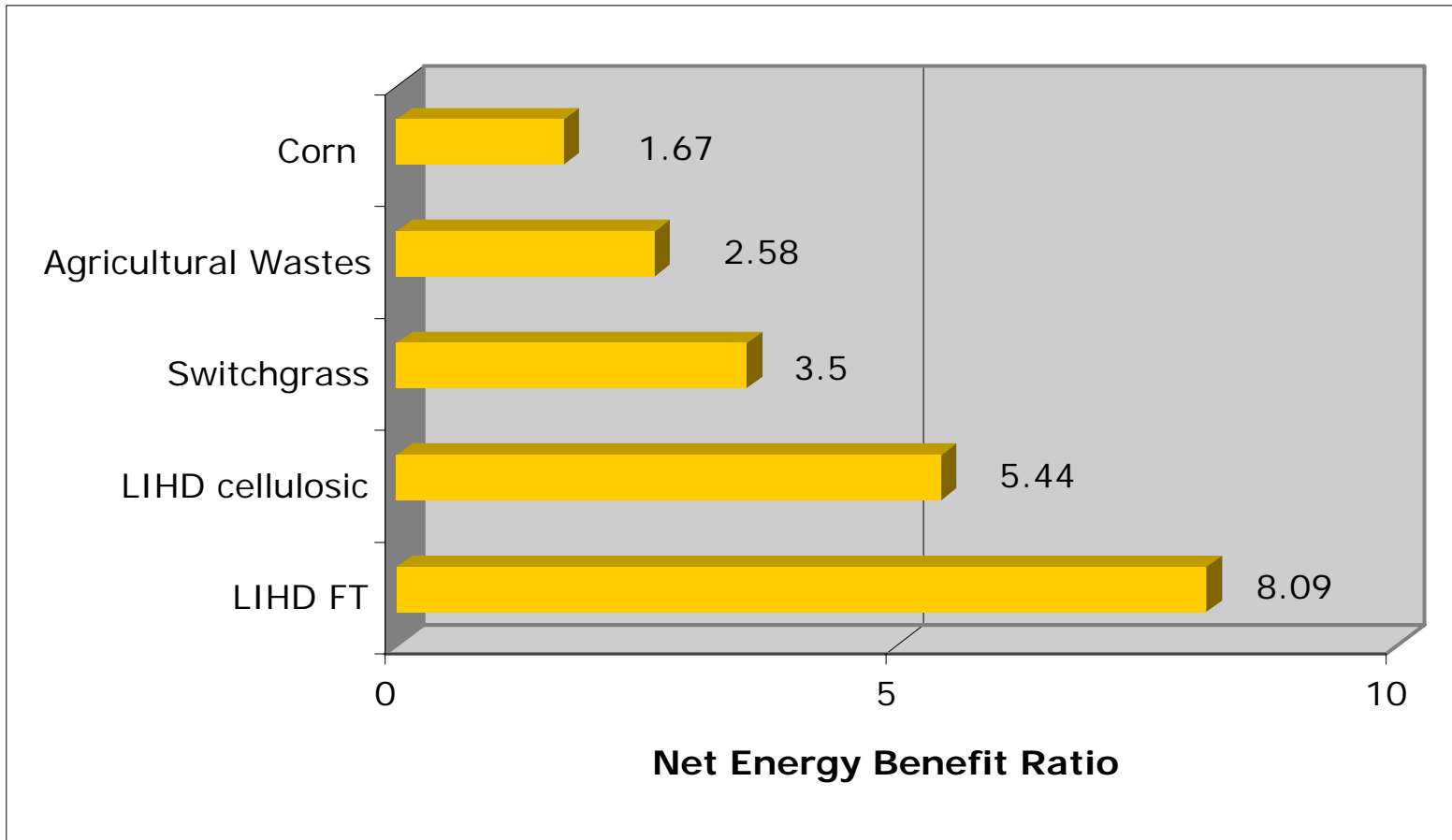
- Corn
 - Grain Fermentation
- Switchgrass
 - Cellulosic
- Perennial Grasses (LIHD)
 - Cellulosic and Fischer-Tropsch
- Agricultural Wastes
 - Cellulosic



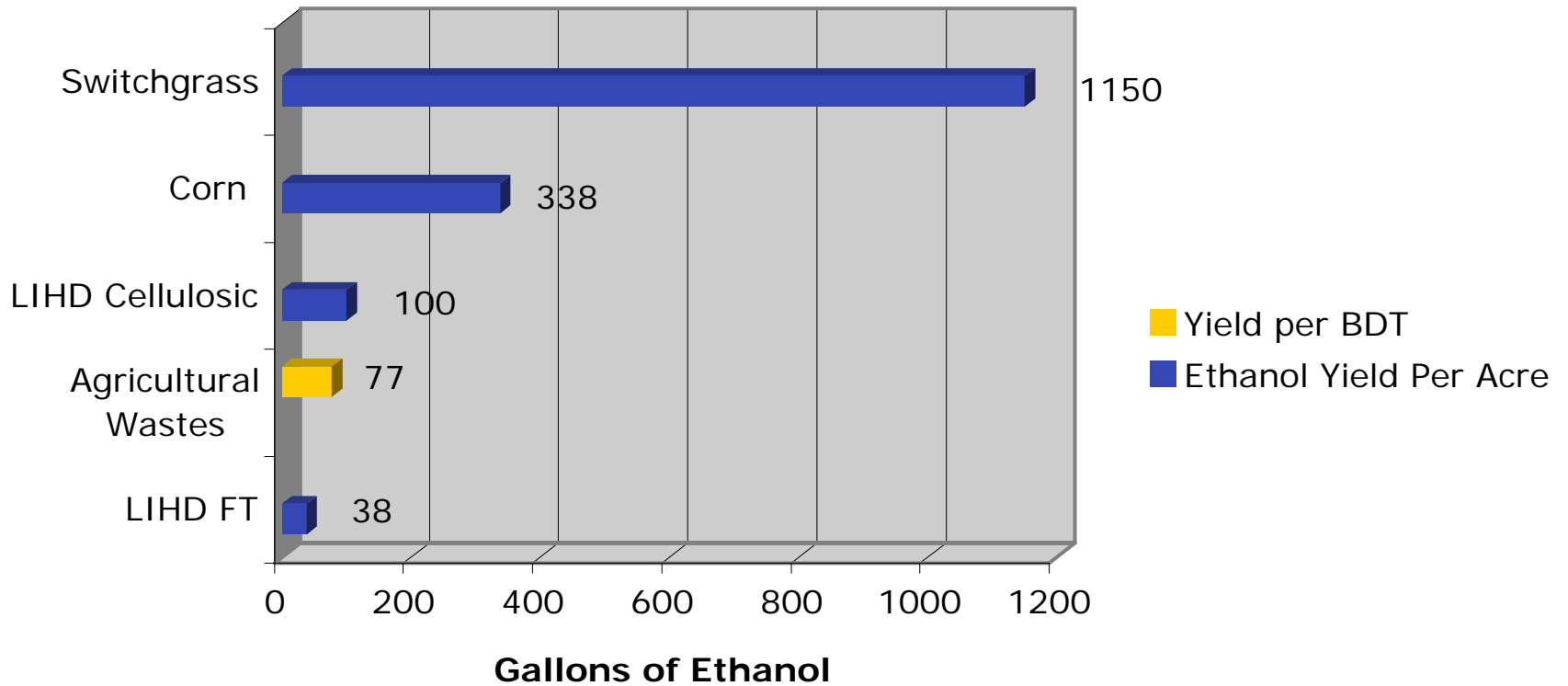
Net Energy Benefit

- This is the ratio of energy output to input
 - $NEB = (\text{Output} / \text{Input})$

Net Energy Benefit



Ethanol Yield

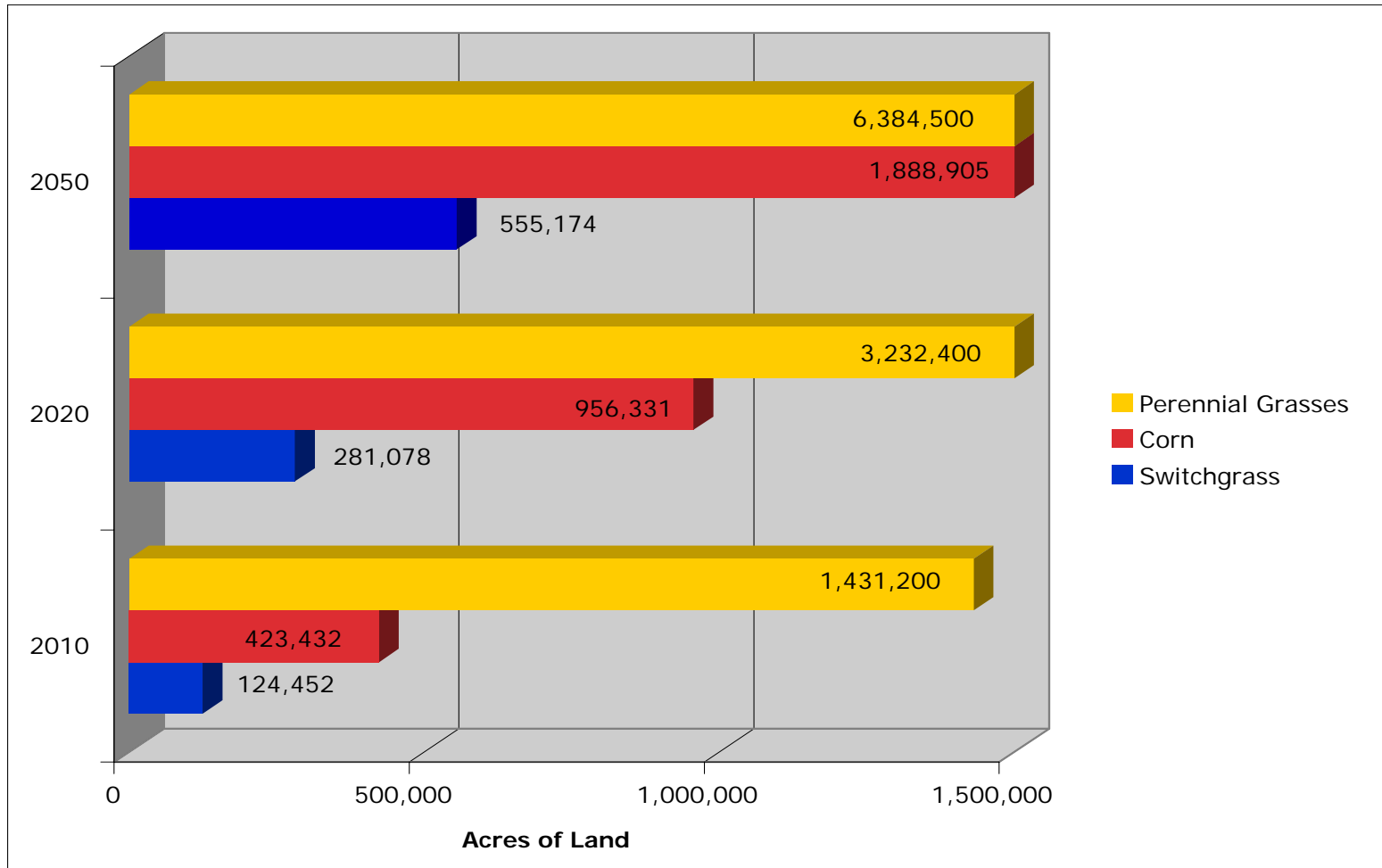




CA Production Requirements

- Current Production
 - 37 Million Gallons
- 20% by 2010
 - 143 Million Gallons
- 40% by 2020
 - 323 Million Gallons
- 75% by 2050
 - 638 Million Gallons

Land Requirements





Agricultural Wastes

- Projected to produce 200 million gallons per year without impacting current agricultural land use



Land Resources

- 11 Million acres of cropland at maximum capacity
 - 1 Million acres idle / degraded land
 - Used for Perennial Grasses?
 - 2 Million acres forage crops (hay / alfalfa)
 - Used for Switchgrass or other cellulosic source
- Agricultural waste contribution



Summary

- Future Agricultural Landscape?
- One scenario
 - Use Ag wastes
 - LIHD on degraded lands
 - Cellulosic feedstocks
- Impacts on Food Prices?



Thank You

