

# Feedstocks for Biodiesel Production

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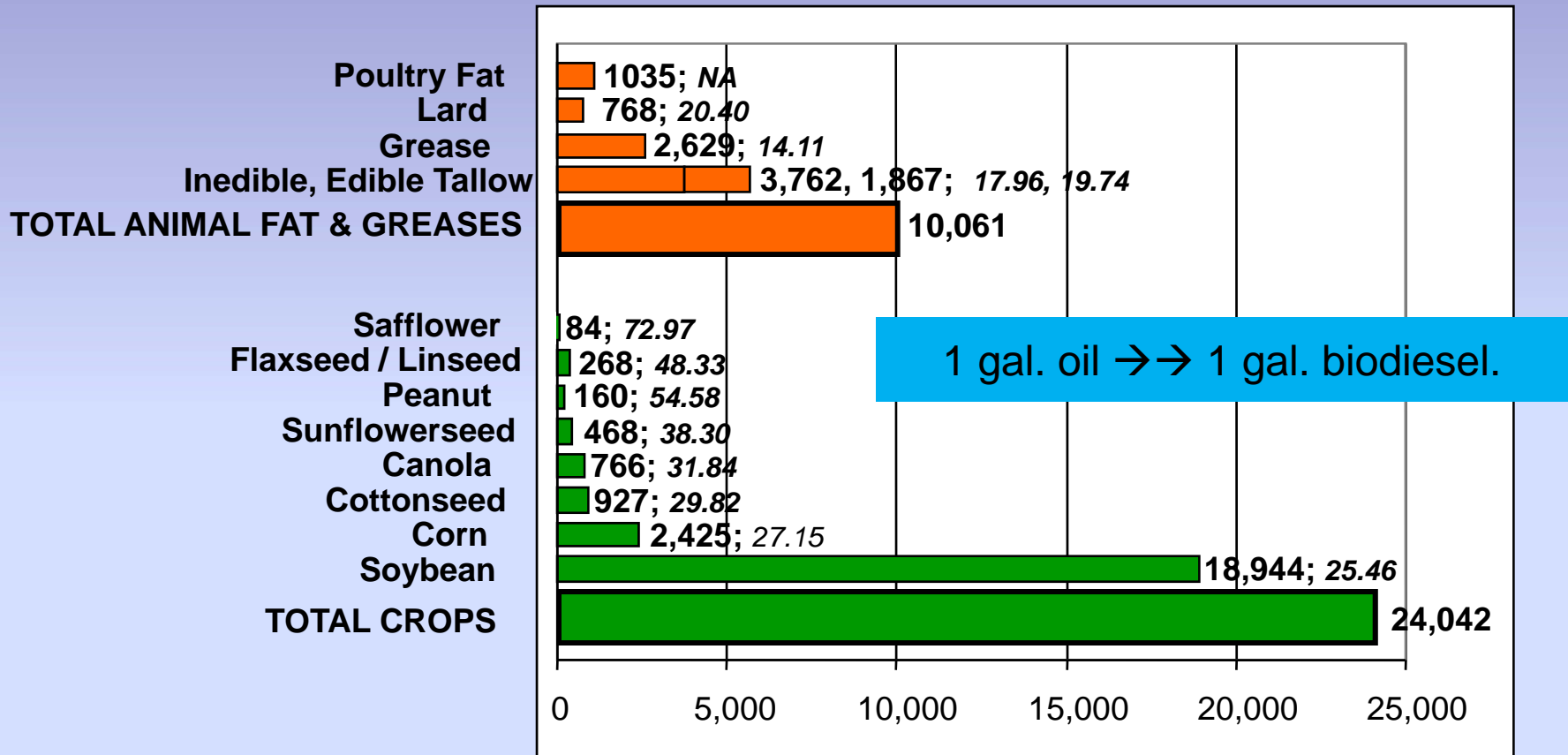
# Biodiesel Feedstocks: Theory

- Any living thing OK: Fat is nature's energy and carbon currency; everything has it.
- Camelina                      Seashore mallow
- Trap grease                 Black soldier fly
- Castor oil                     Coffee grounds
- Fish oil                        Chinese tallow tree
- Sewage                        Mustard
- Palm                             Jatropha
- Soapstocks                  Soybean
- **The fuel future will be of distributed sources**

# Biodiesel Feedstocks: Present Reality

## U.S. PRODUCTION OF FATS AND OILS

Millions of pounds (3-year average, 2003-2005) and price (US¢/pound)



# New Feedstock Reality Check

- Agronomic: yield, quality, disease resist., vigor
  - A sustainability matter: Lacks the efficiencies of 'double cropping', 'virtual acres'
- Infrastructural
  - Micro-
  - Macro-
- Economic
  - Lipid cost: as cheap as possible
  - Value of byproduct meal: as great as possible

# Why look to improvements in current crops?

A microstructural barrier:

2007 Case IH 2052 Combine Head

Used, Lisbon, ND

\$42,000

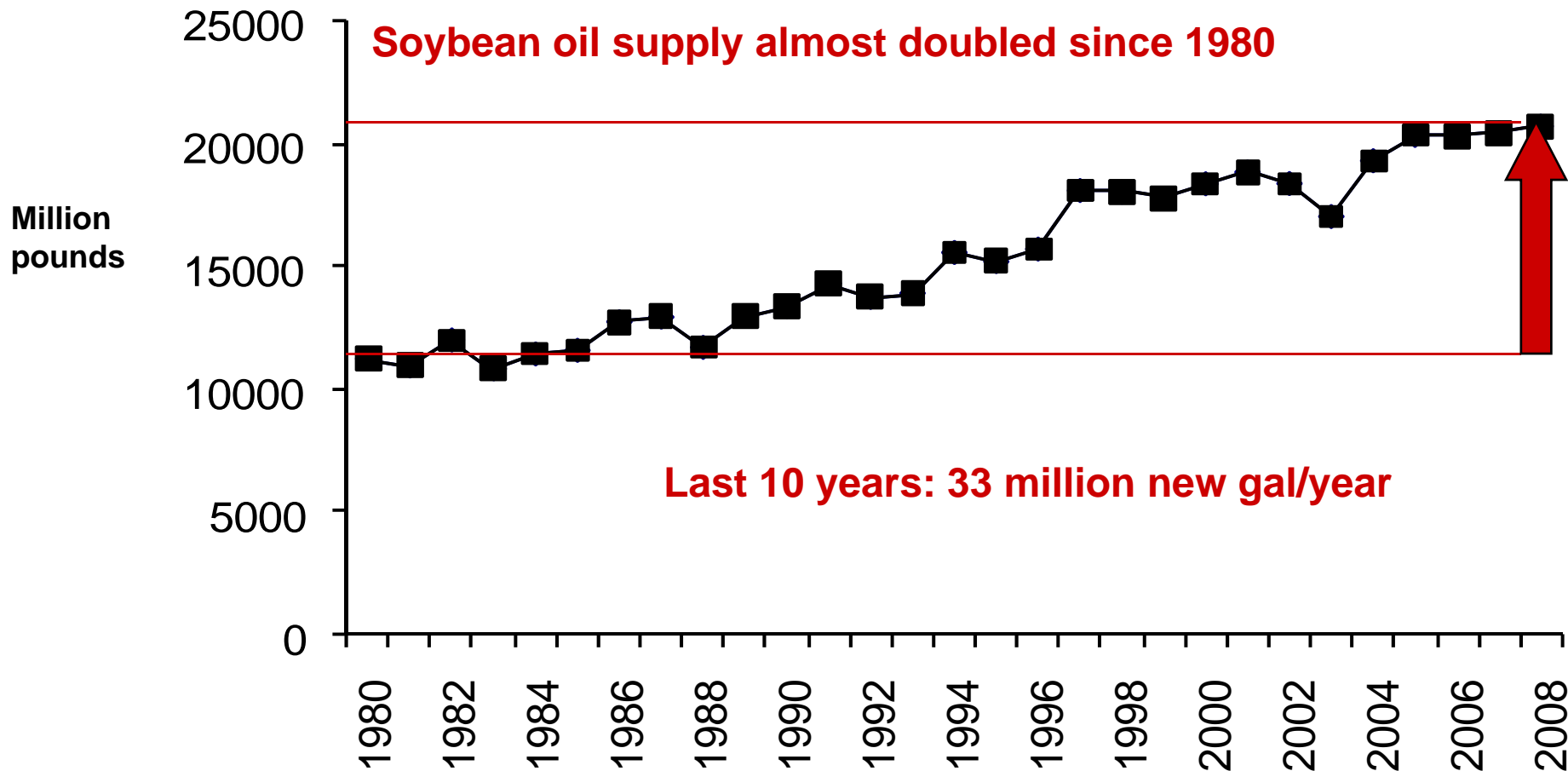


# 2007 Case IH 2577 Combine

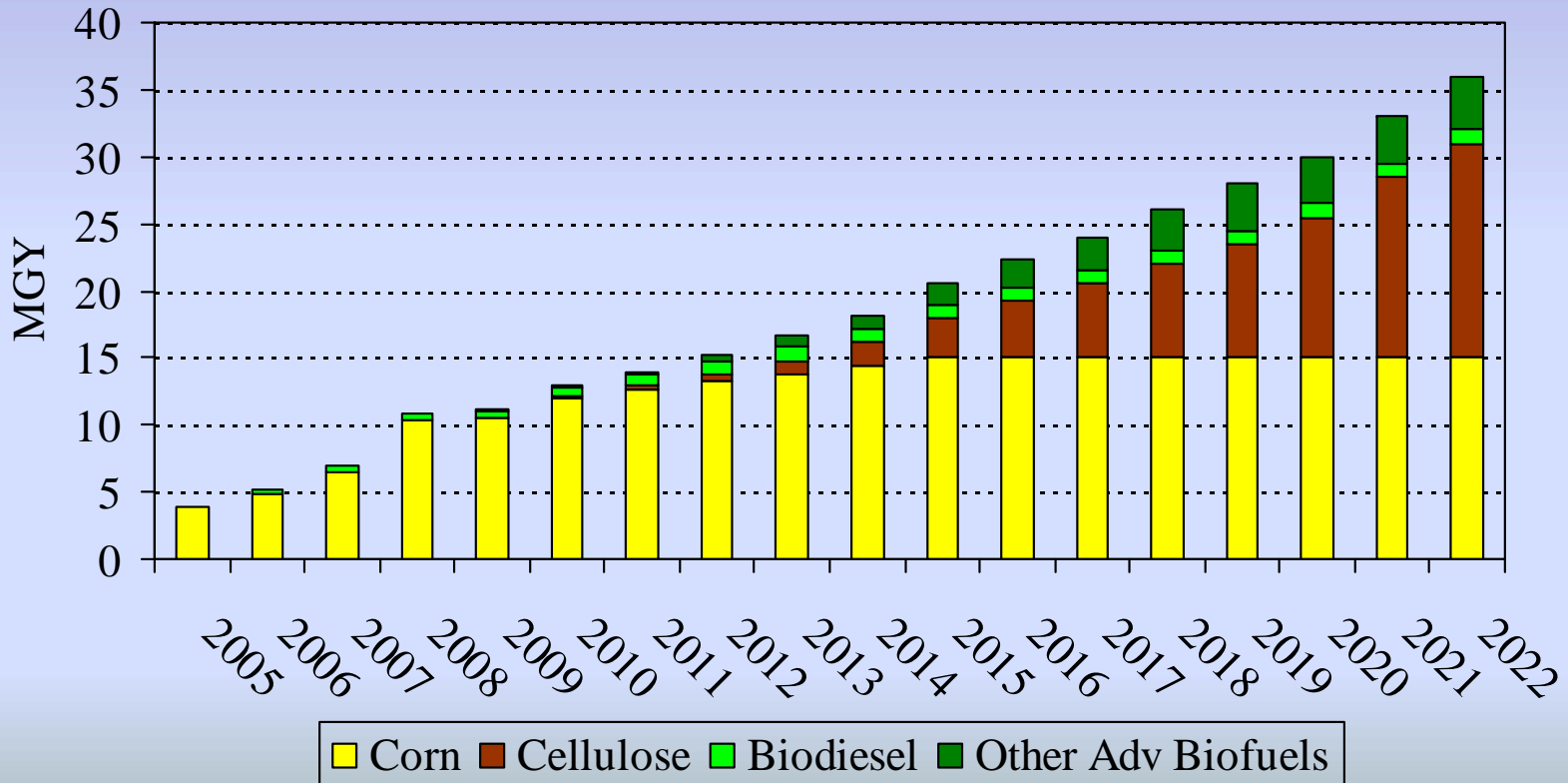
Used: ~ \$190,000



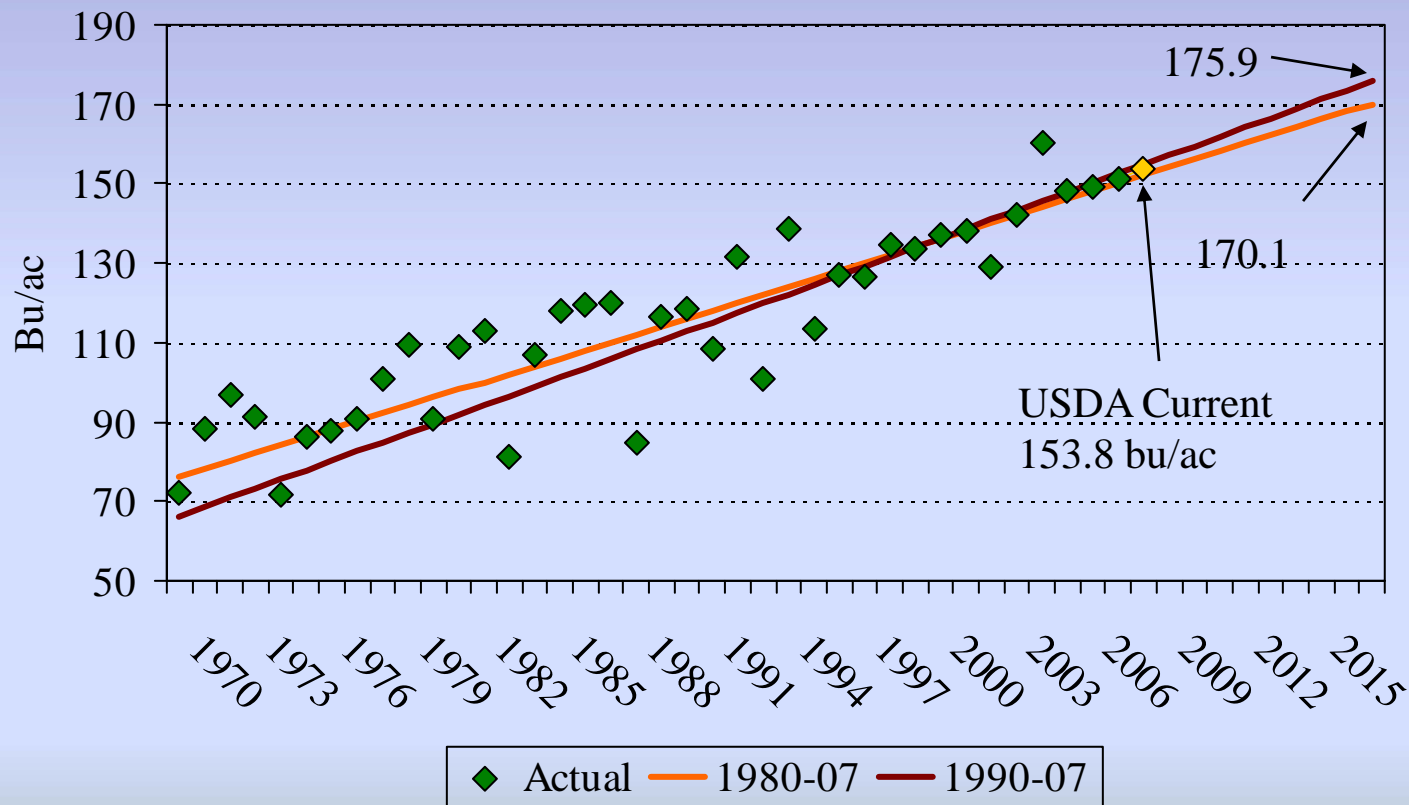
# Soybean Production and Oil Supplies are Increasing



# Forecast Biofuel Growth Under the Renewable Fuel Standard of 2007 (36 bil gal @ 2022)



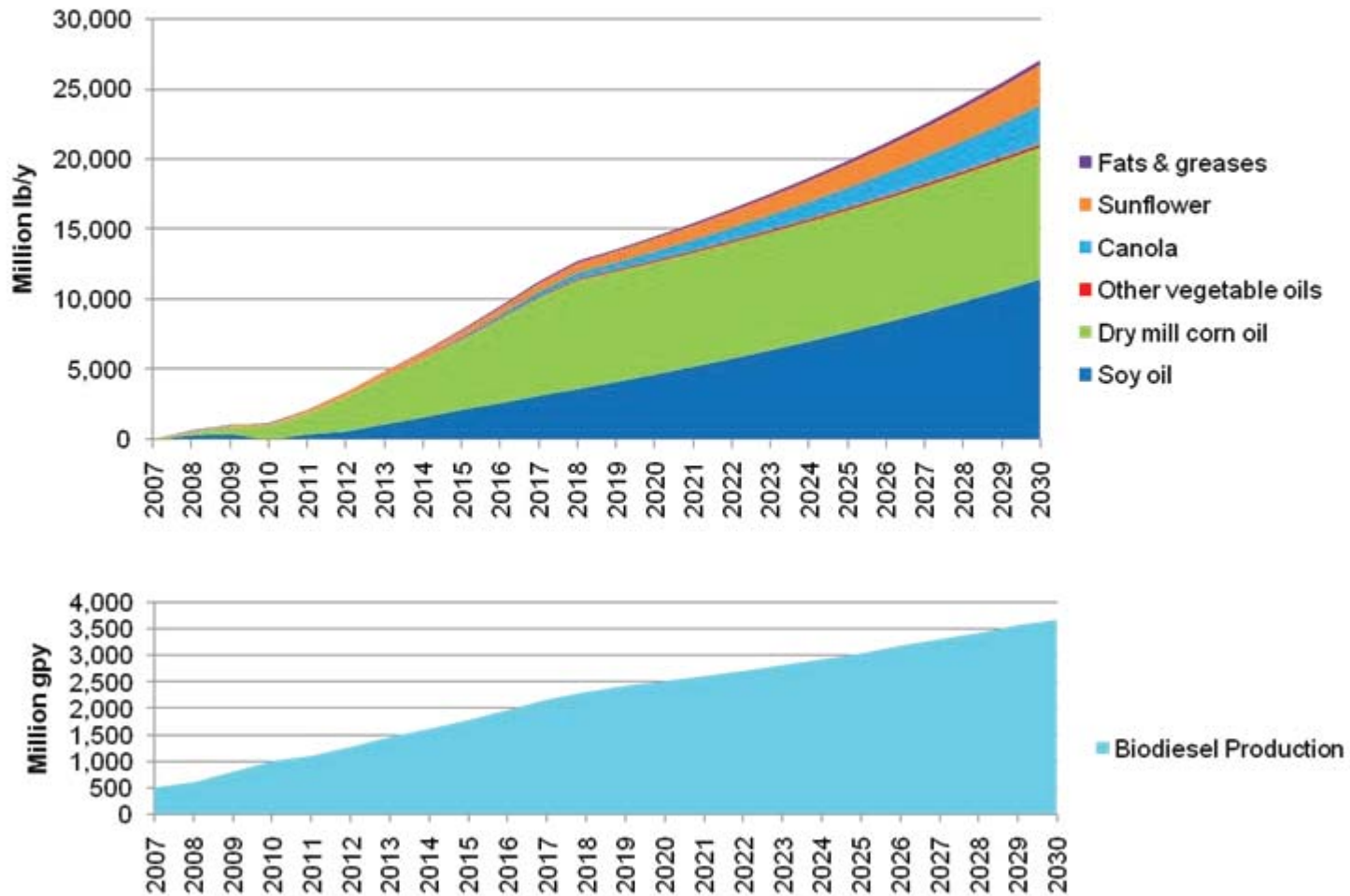
# Corn yields are increasing, raising the effective acres in cultivation with no increase in land use



# Potential alternative biodiesel feedstocks

- **New soy oil: 33 M gal / ann.**
- **Corn oil from ethanol production (just beginning)**
  - A bushel of corn is 3-4% oil; assuming a 75% retention rate this provides 1.5 lbs of oil per bushel.
  - 13 BG of dry mill ethanol by 2015 (4.6 bil bu corn) could provide 6.9 B lb of oil equivalent to 924 M gal biodiesel.
- **Yellow grease (already in use)**
  - 9.4 lb/cap = 2.8 B lbs = 380 M gal biodiesel
- **Brown grease (almost just beginning)**
  - 13 lb/cap = 3.9 B lbs = 525 M gal biodiesel
- **Other edible oils and fats**
- **Other inedible oils: More palm    Jatropha?    Algae?**

# Aggressive Case: New oil



# Palm Oil



- Available presently
- A decent fuel feedstock?
  - Fuel via conventional technology
  - Pro: Abundant, productive
  - Con: Food
- How much will there be? 9.4 billion gal (380 gal/acre) and increasing by 2.5 – 5 X/acre, plus new plantings
- What will it cost? A few cents more or less than soy per gallon



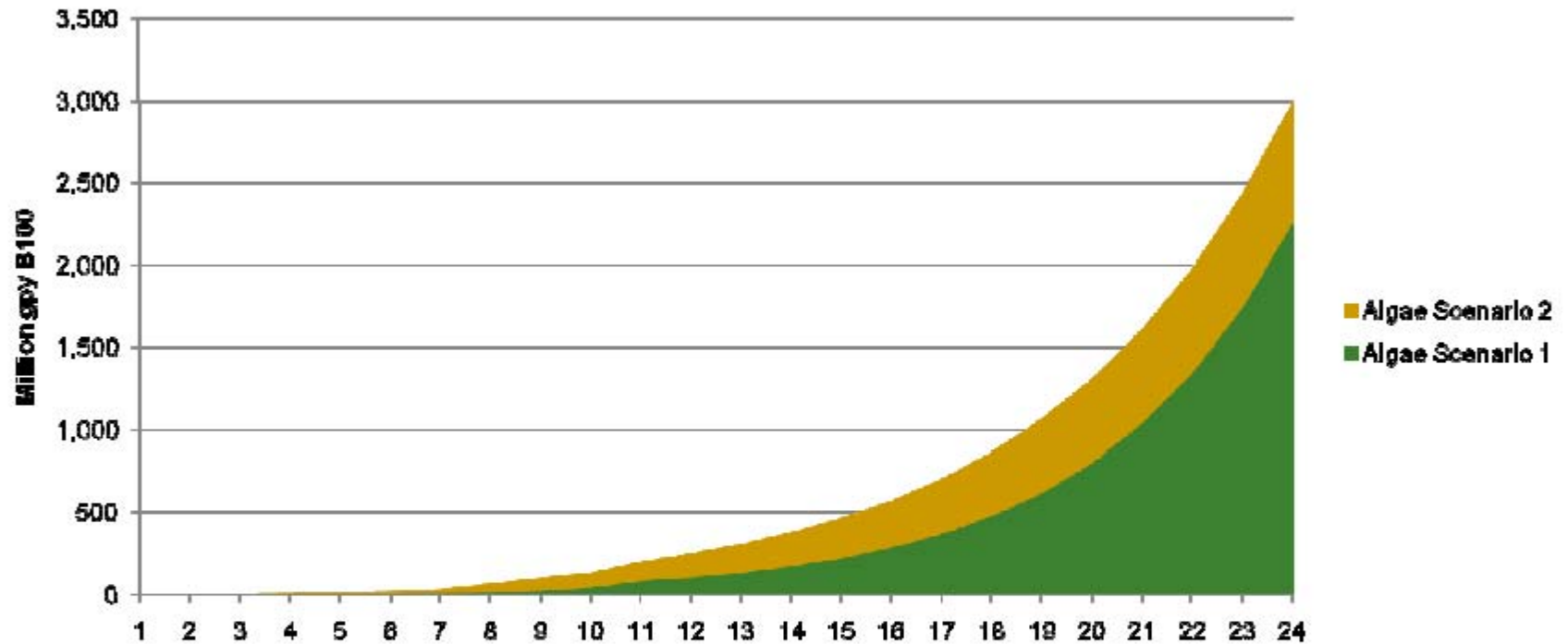
# Algae Implications

5000-15000 gal/acre. All fuel needs on 6% of cultivated land

- 🔥 Algae production costs at current scales
  - 🌱 \$2,000-\$4,000/ dry ton (\$800-1,600/ton 40% solid paste +) (\$2-\$4/ lb oil)
- 🔥 Need low cost algae production
  - 🌱 Wide range of technical improvements
  - 🌱 Economies of scale
  - 🌱 Greenhouse gas credits
- 🔥 Need improved algae processing technologies, lower costs
- 🔥 Time to commercialization (e.g., PROFITABLE)
  - 🌱 Today: New entrants, bottom of learning curve
  - 🌱 In 2 years: Made lots of mistakes, reinvented the wheel
  - 🌱 In 5 years: Got a consistent system going, know where cost structure is
  - 🌱 In 7 years: Economies of scale expanding, R&D targeted
  - 🌱 In 10 years: Some firms actually making money



# Algae Scenarios



- 💧 Scenarios for “what if” only
- 💧 Shows there is a rationale for investment

