The Original Green - How Agriculture is Fueling the Green Economy

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The Original Green - How Agriculture is Fueling the Green Economy

Is agriculture contributing enough?

Are you?

Maybe Not!!!


Thank you for your attention!
Any questions?

Agriculture in the Green Economy

- Bioenergy
- Renewable energy
- Energy conservation

- Opportunities and constraints

Some Issues to Consider

- National security
- Environmental quality
- Limited supply
- Increasing demand

A World Problem!

Peak Oil (M. King Hubbert, 1956)

Liquid Transportation Fuel

A World Problem!

When oil demand outstrips faltering supply it creates a clash between energy haves and have nots.

(Matthew R. Simmons, Chairman Simmons & Company International)

Renewable Energy

- **Massachusetts is now the second-leading clean-energy state in the U.S.**

Massachusetts Clean Energy Center (MassCEC).

Energy cost of running to the Store

- Car gets 20 mpg travels 6 miles R/T.
- Purchase: 1 doz. Eggs, ½ gal. Milk, & Bread.
- Outcome: 9,374 Cal. Gas for 2,102 Cal. Food.

- Unaccounted Energy: embodied energy in store, car, refrigeration, distribution, preparation, and waste.

Solar Renewable Energy

Why Biofuels?

- Fossil fuels take thousands of years to recycle carbon.
- Carbon from crops (switchgrass and corn) recycled in just one year, from wood a few years more.

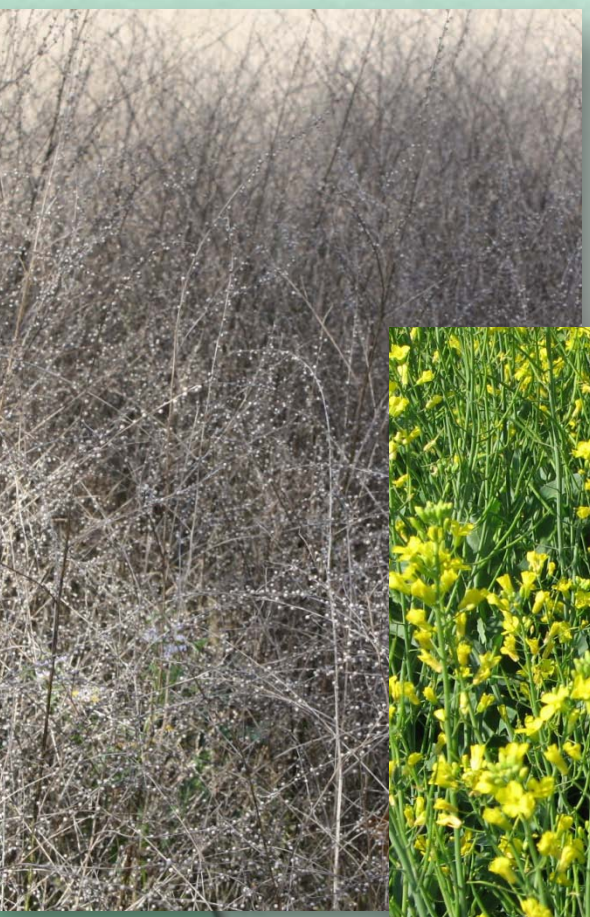
Biofuel/Bioenergy Crops

- **Biomass**
  - Solid fuels (wood, grass pellets, corn grain)
  - Alcohol based fuels (grains, cellulosic)
  - Gasified fuels (cellulosic)
- **Biodiesel**
  - Crop oils (oilseed crops)

Farm Based Biofuels

Oilseed Crops

Crambe



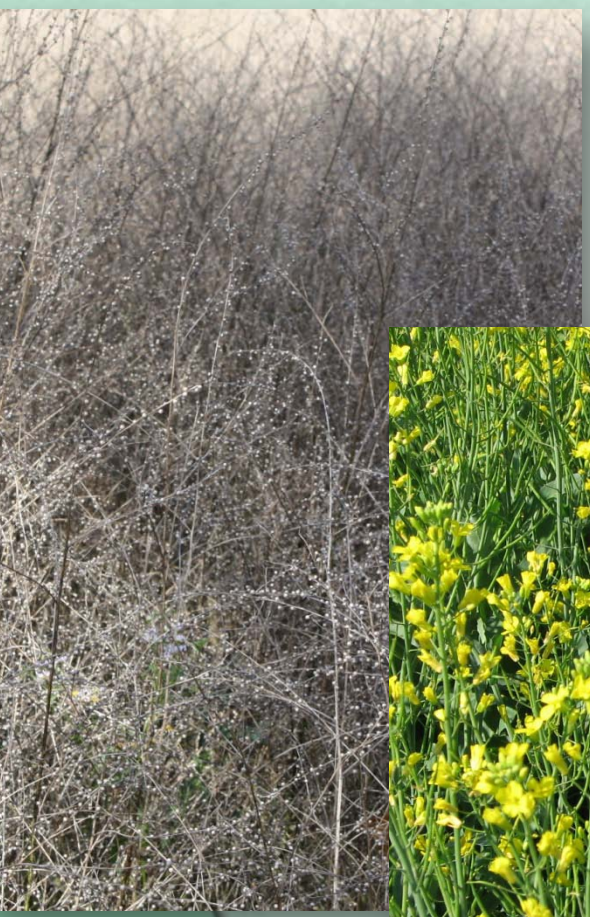
Oilseed Rape/Canola

Sunflower

Soybean

Farm Based Biofuels
Annual Yields – 1-3 t/ac

Crambe



Oilseed Rape/Canola

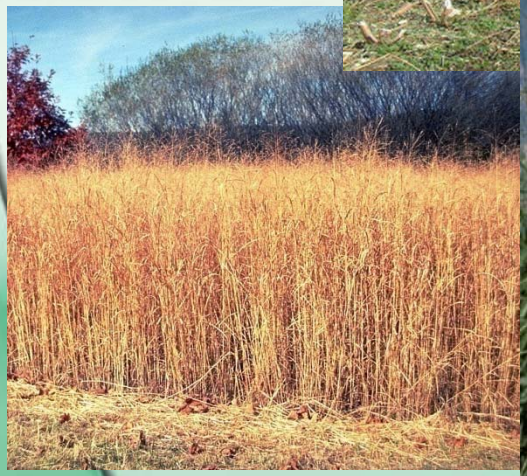
Sunflower

Soybean

Cellulosic Biomass

Willow
Poplar

Corn
Stover
3 t/ac



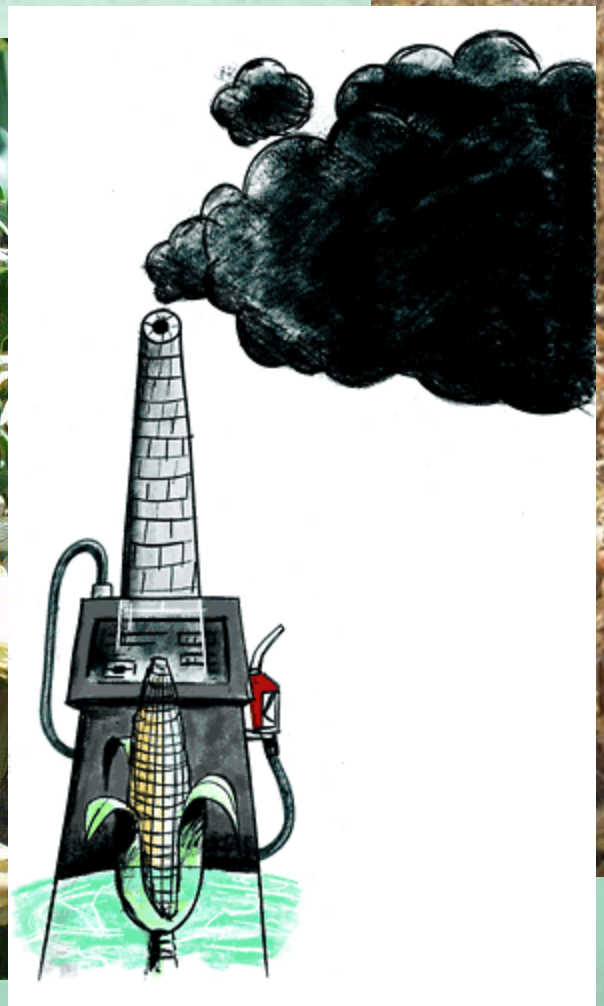
Switchgrass 5-9 t/ac

Miscanthus giganteus - 26.5 t/ac observed Univ. of Illinois

Biofuel Energy: - alternative crops on abandoned and non-productive land

Ethanol from Corn and Crop Residues

- Is this sustainable?



Corn Stover

Ethanol Feedstocks

- Corn grain – 92 gal/ton; ~ 400 gal/ac
- Cellulosic – 90 gal/ton

  corn stover ~ 270 gal/ac

Ethanol Feedstocks

- Corn grain – 92 gal/ton; ~ 400 gal/ac
- Cellulosic – 90 gal/ton

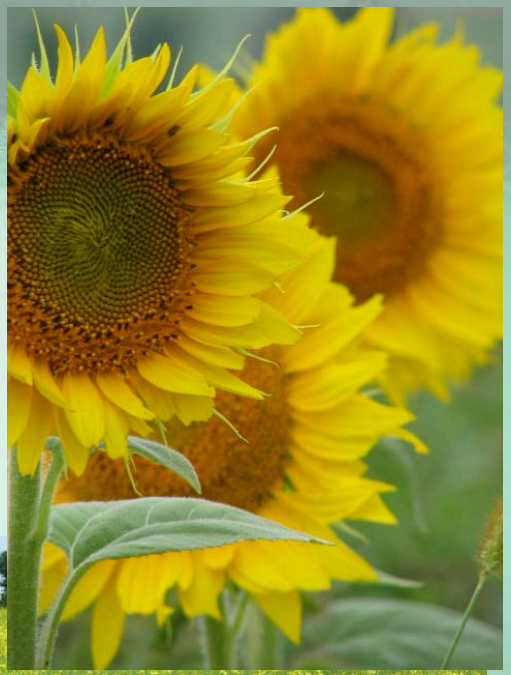
  corn stover ~ 270 gal/ac

  switchgrass ~ 400 gal/ac

Both processes not very efficient.

Oilseed Crops

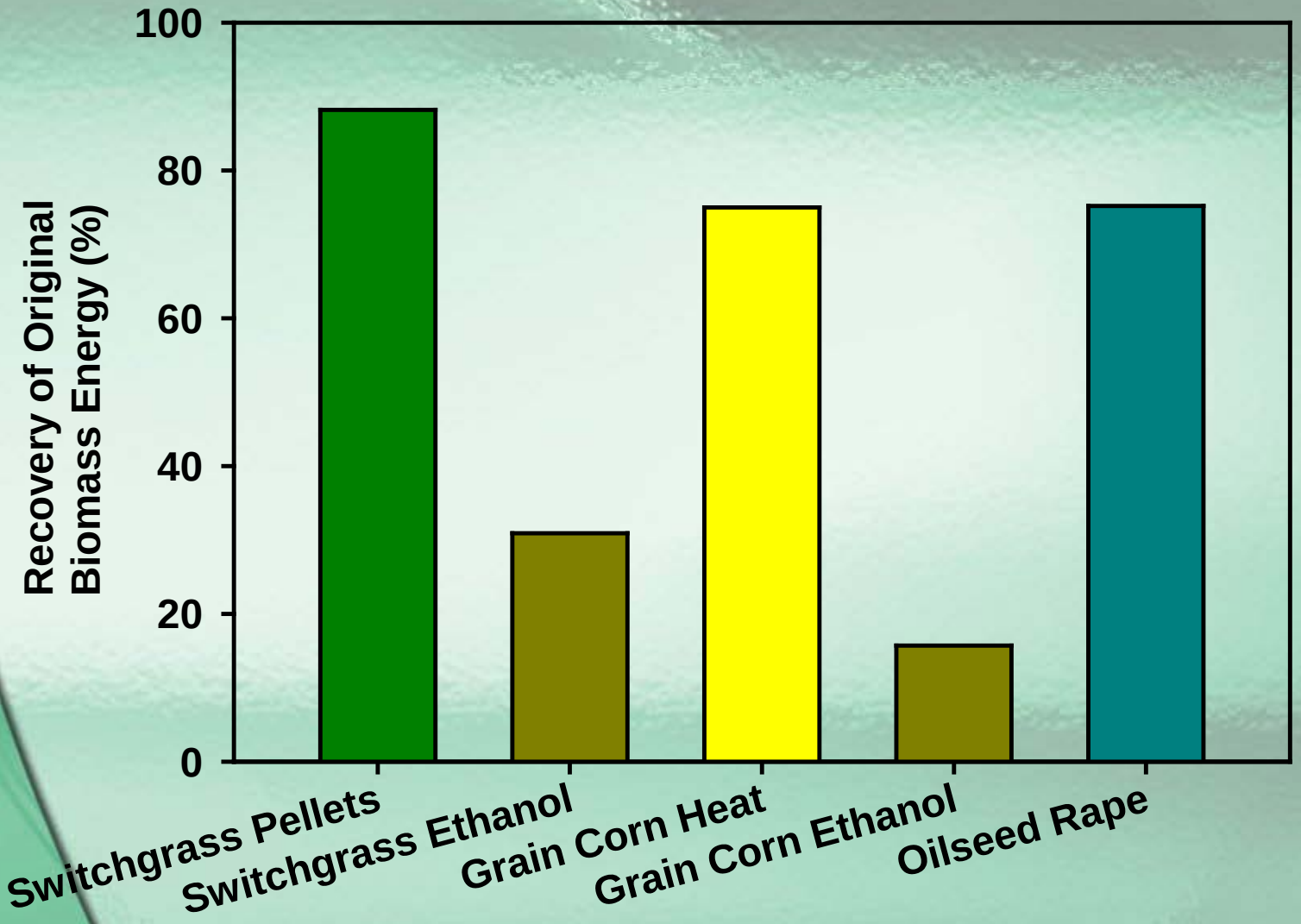
Crop	US gal oil/ac
Sunflowers (30)	102
Oilseed rape (45) (related to crambe)	150
Soybean (18)	75



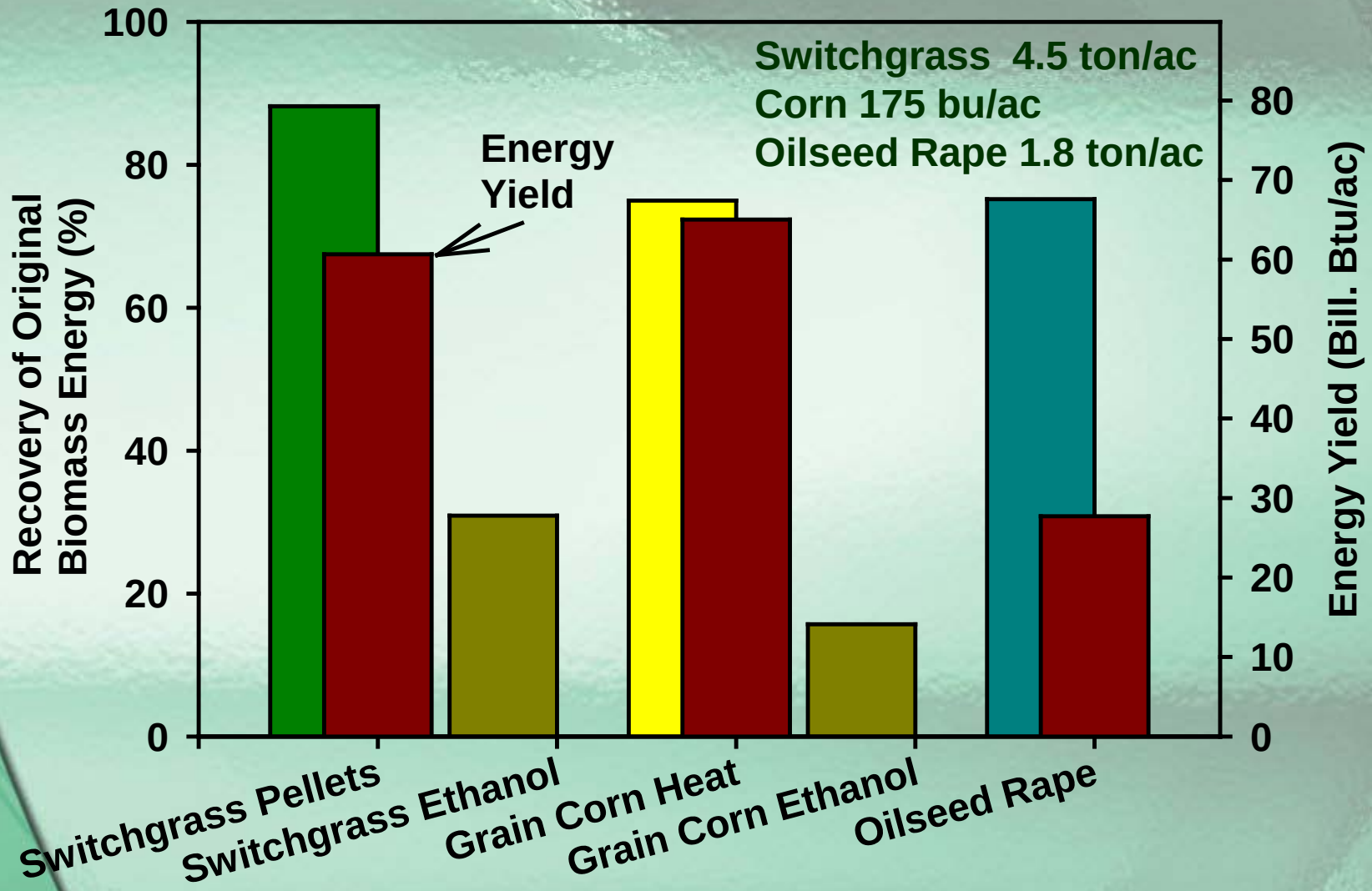
Constraints: combines, oilseed press, technology

http://journeytoforever.org/biodiesel_yield.html

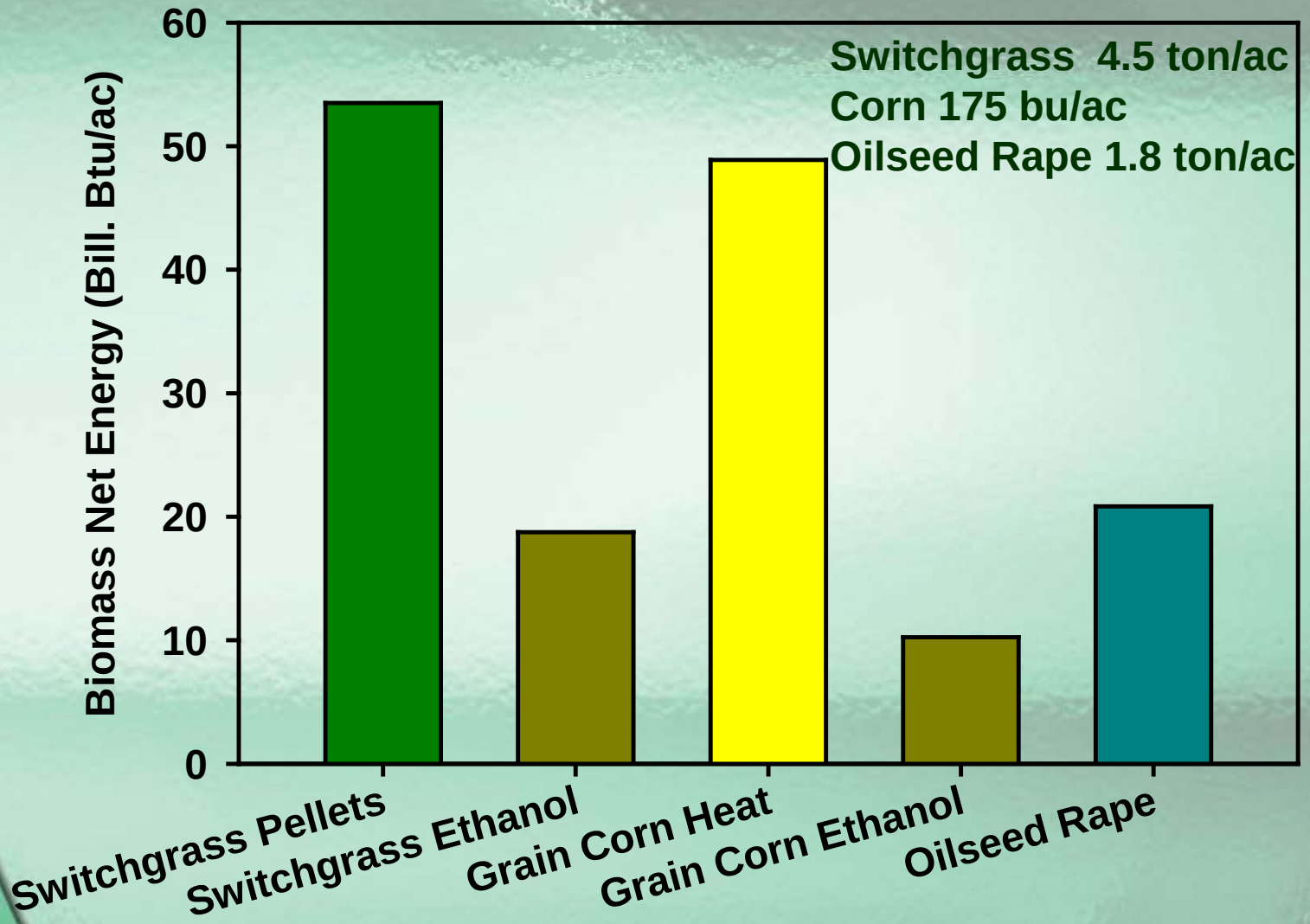
Efficiency of Biofuel Crops



Eff. & Yield of Biofuel Crops



Net Energy Yield of Biofuels



Cellulosic Biomass

Why switchgrass?

Switchgrass

- Low maintenance


PLANTS Database
Switchgrass Native Zone
Forestburg
Sunburst
Dacotah
WI-Eco
NE 28
Pathfinder
Cavel
-in-
Rock
Shawnee
Shelter
Carthage
Blackwell
Alamo
SPM
DC
HI
PR
VI
PAVI2

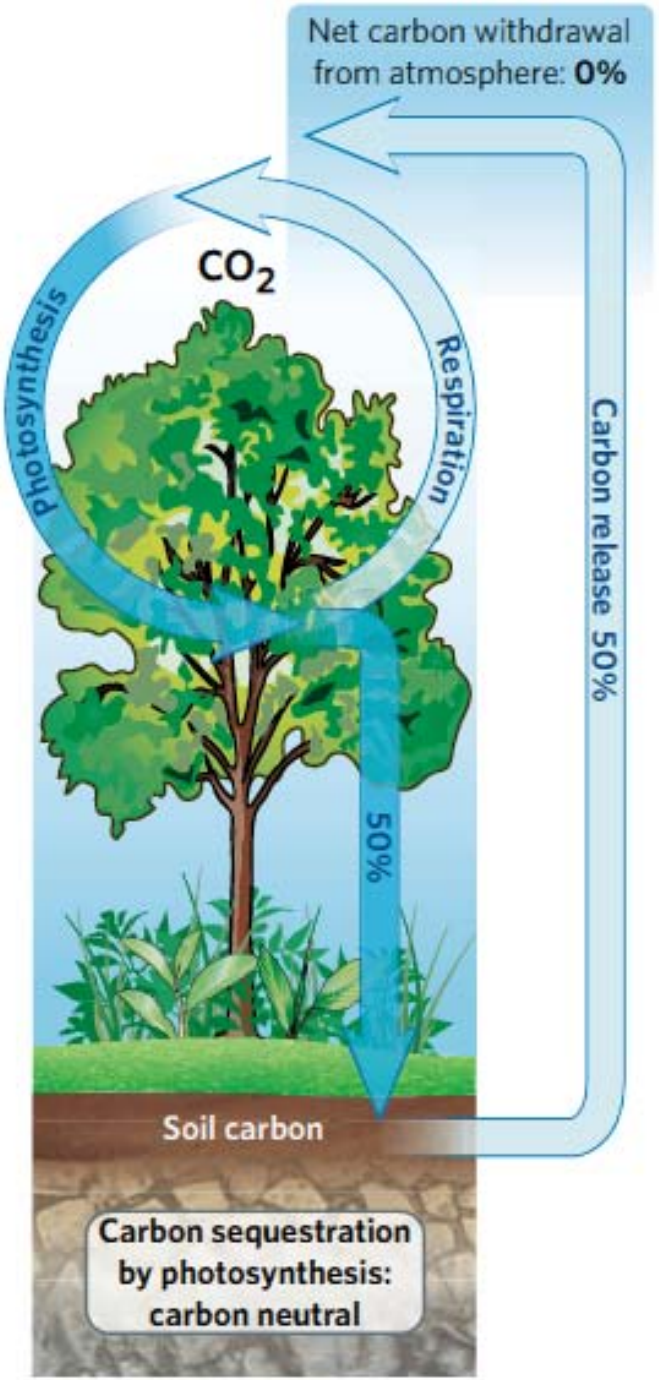
Farm Forests

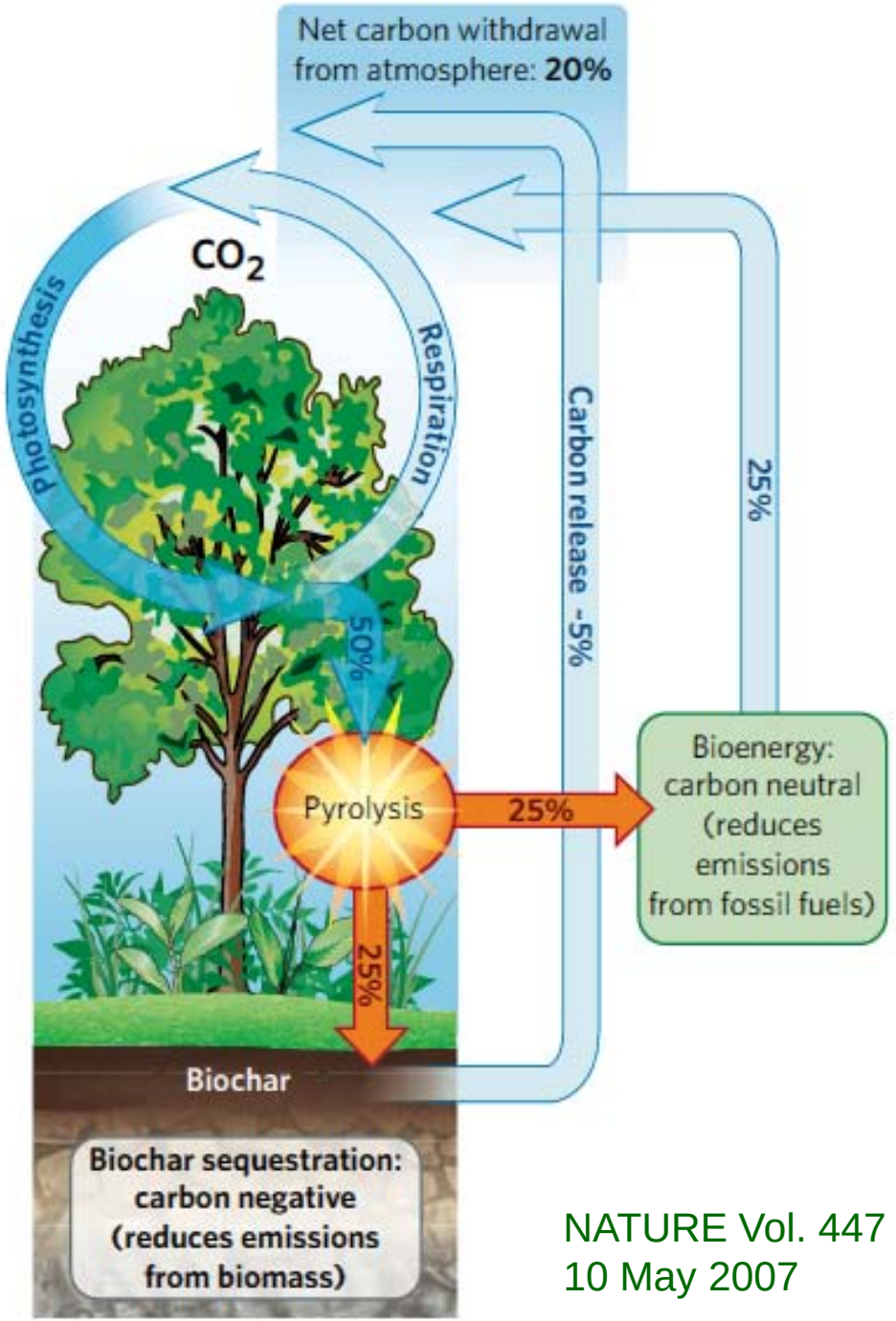
- Grow naturally
- On-farm and community heat
- Local and regional biomass
- Environmental considerations

Need to Invest in Appropriate Technologies

Thermochemical

- Gasification / Fast Pyrolysis
- Wide variety of feedstocks
- Scalable - low capital cost & relatively small footprint





NATURE Vol. 447
10 May 2007

Green Energy in Agriculture

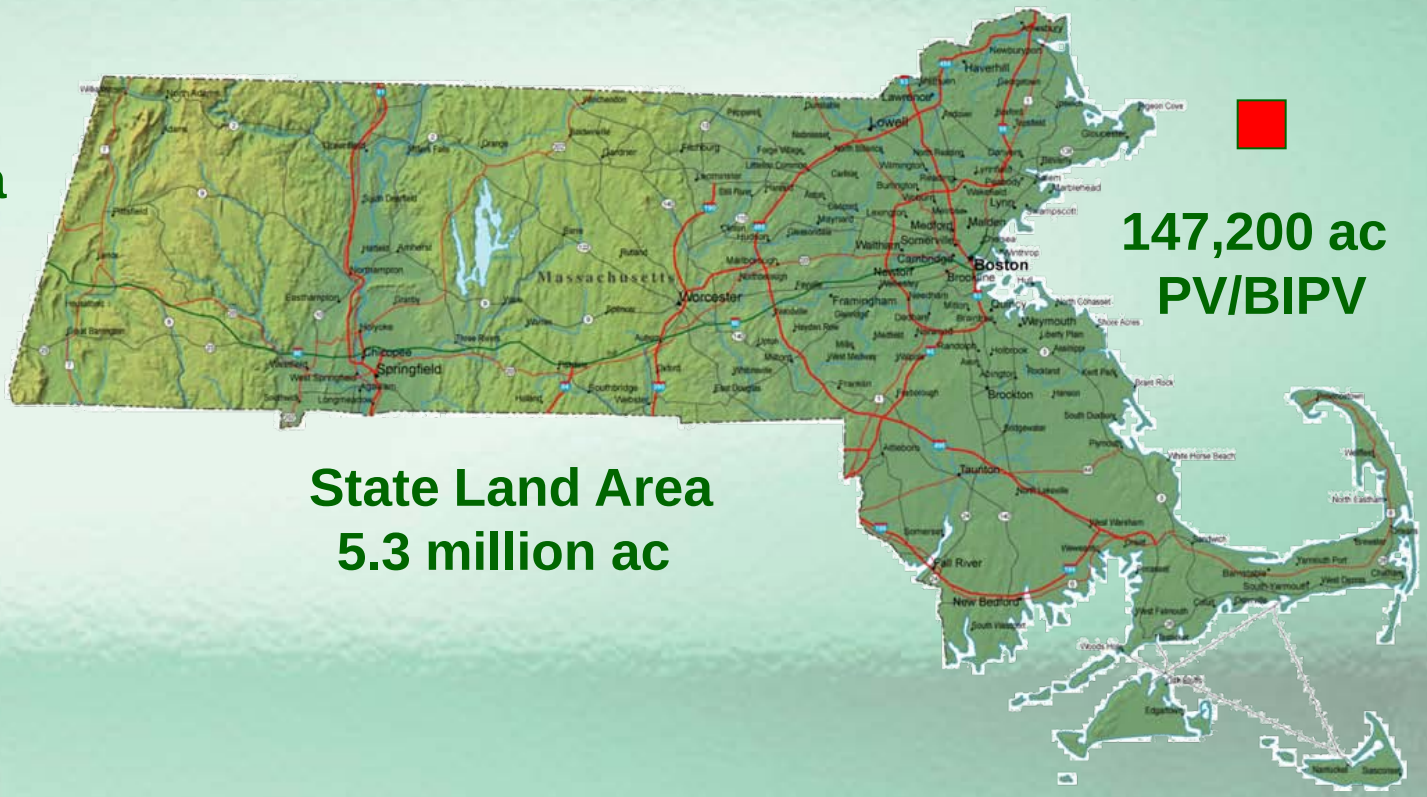
1. Efficient processing technology.
2. Sustainable feedstock production and distribution systems.
3. Adequate profits along the value chain.

Renewable Energy

LAND AREA REQUIREMENTS
Electricity Consumption in MA = 53 million MWh
Total US Consumption = 3,150 million MWh

1.1 million ac
wind farm area
(class 4 wind)

147,200 ac
PV/BIPV

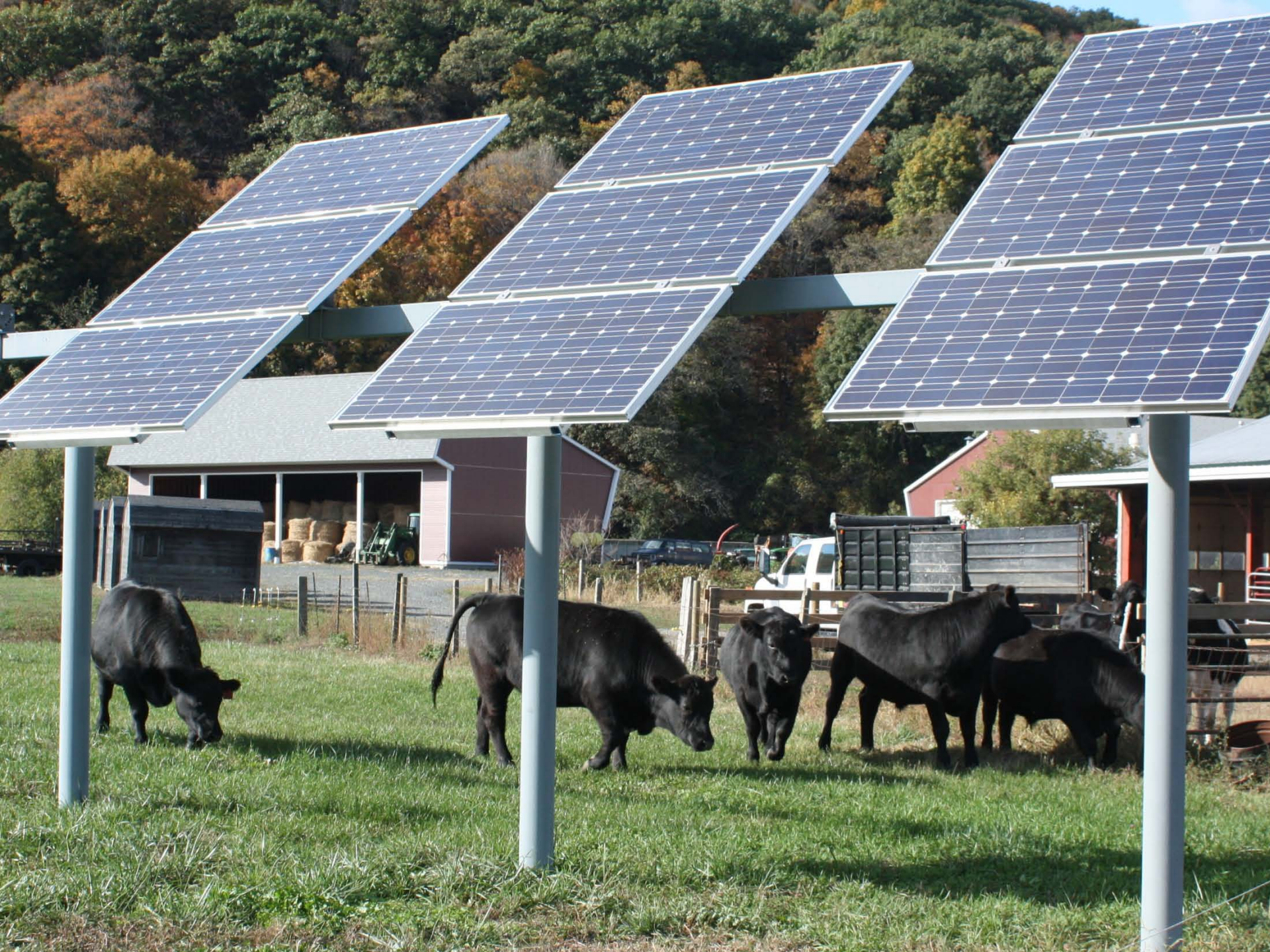


State Land Area
5.3 million ac

6.5 million ac
willow plantations

Adapted from:
Keoleian, UMich.
Lewis, UWaterloo

On-Farm Solar Options



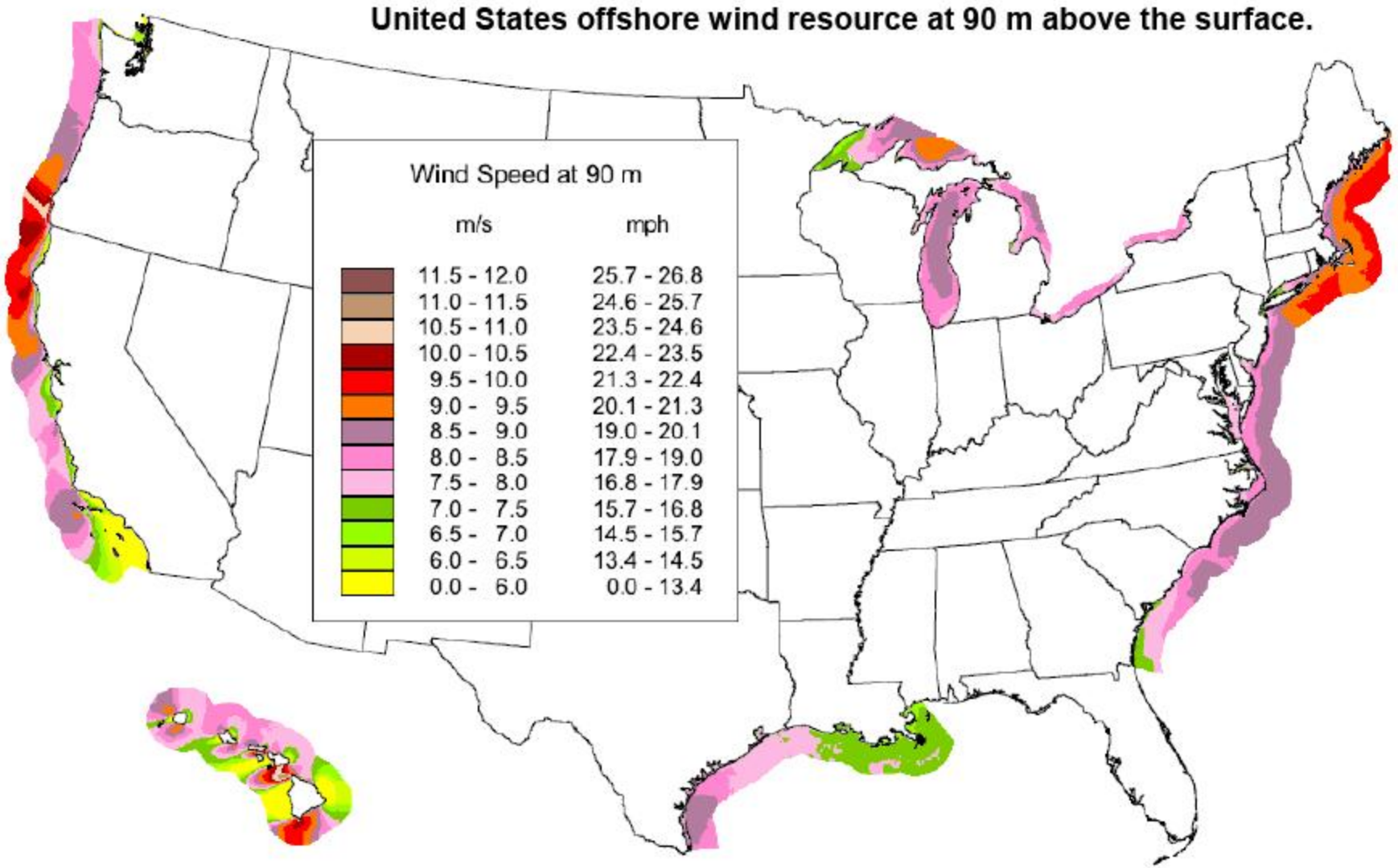
Wind Power

- By 2020, wind could provide 12% of world electricity supplies. (European Wind Energy Assoc.)
- Denmark - 20% of electricity needs.
- U.S. only ~0.5%, potential for 10%.

Wind Power

- 'Non-firm' or 'intermittent' generation cited as a detriment.
- Capacity factor used of 30-35%.
- Is wind variability a major threat?
- Up to 10% of country's electricity can come from intermittent energy sources.
- Major States - Great Plains (top 10 states)

Off-Shore Wind Power



Renewable Energy
Costs & Incentives - Moving Targets

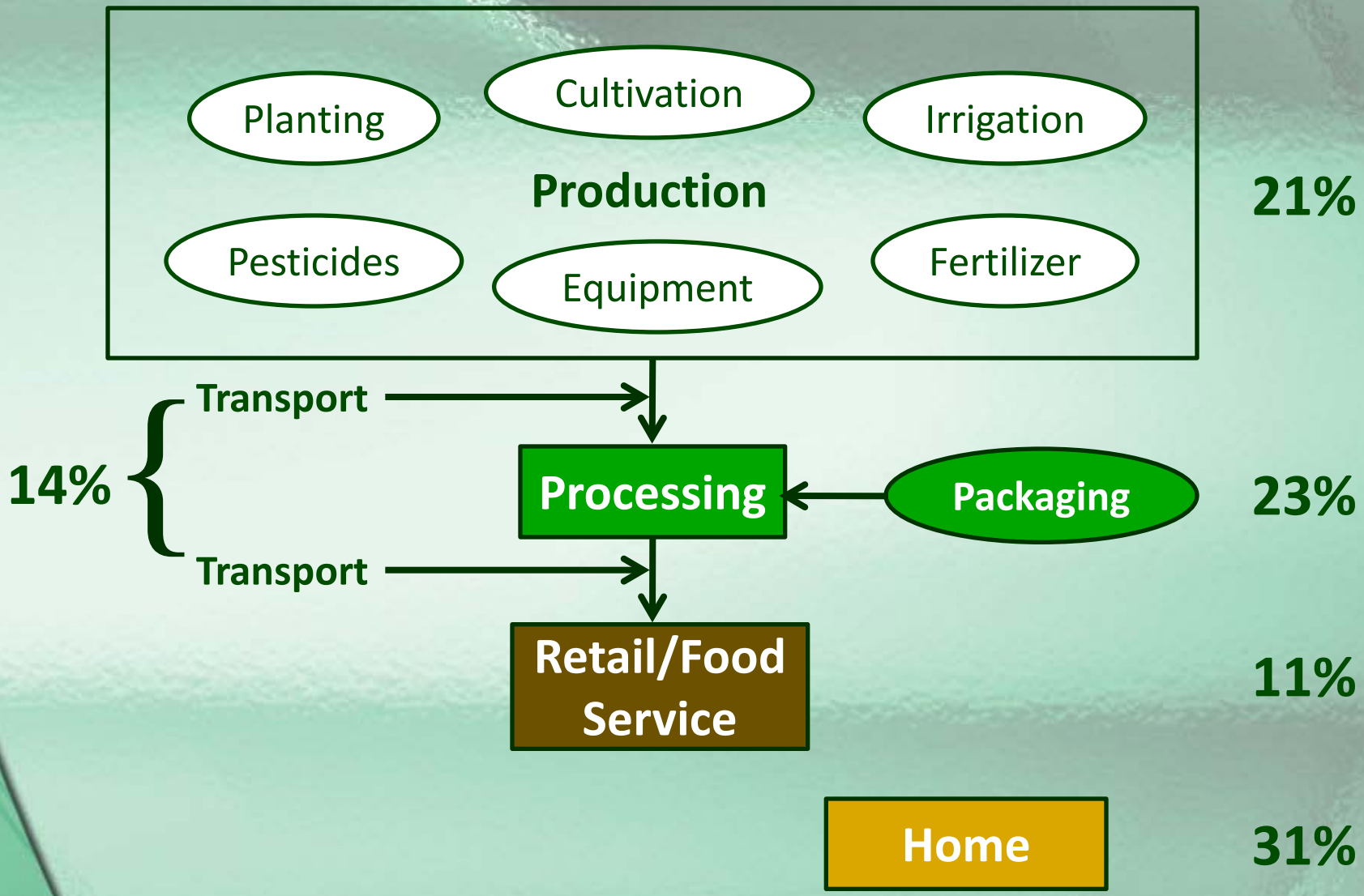
Cost

Capital Cost 100 kW system @ $7 / Watt = $700,000
Less PTC¶ Incentive = $210.000
Carrying Cost = loan for portion not funded by incentives
Loan @ market rate for balance: cost for
$490,000 @ 5.25, 10 years = $63,088/yr

Funding §

State: Solar Renewable Energy Certif. (SRECs).
$250 - $500 per kW annually (10 yrs) = $25K to $50K
Electric Savings: $0.17 to $0.34/kWh/yr = $17K to $34K
Funds for loan payment $42,000 to $84,000
Net cost/benefit -$21,088 to +$20,912

Food System Energy Use



Source: Heller and Keoleian

Where We Use Energy in Crop Production

34% Direct fuel use

28% Fertilizer (mostly N)

7% Irrigation

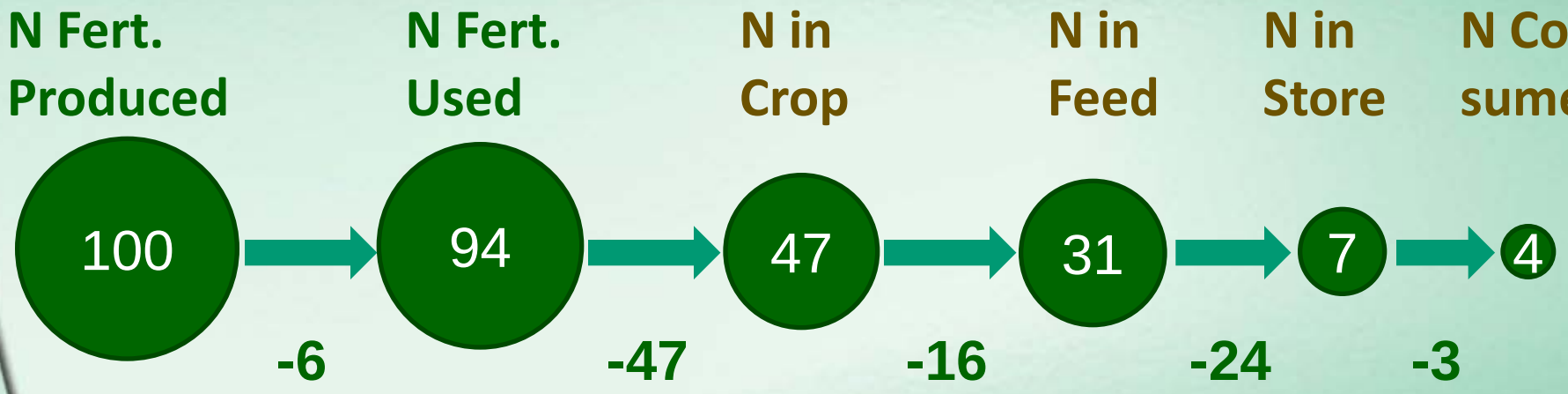
31% Other (grain drying, facilities operation)

Reducing Farm Fuel Usage

- Reduce tillage, combine operations.
- Lower forage production cost, use pasture, haylage?
- Reduce fuel used in buildings (heat), recycle (burn) waste oil, use biofuels.
- Use bio-diesel alternatives.

Pasture Intensification: for lower energy input into feed for dairy and livestock

Fossil Fueled Nitrogen

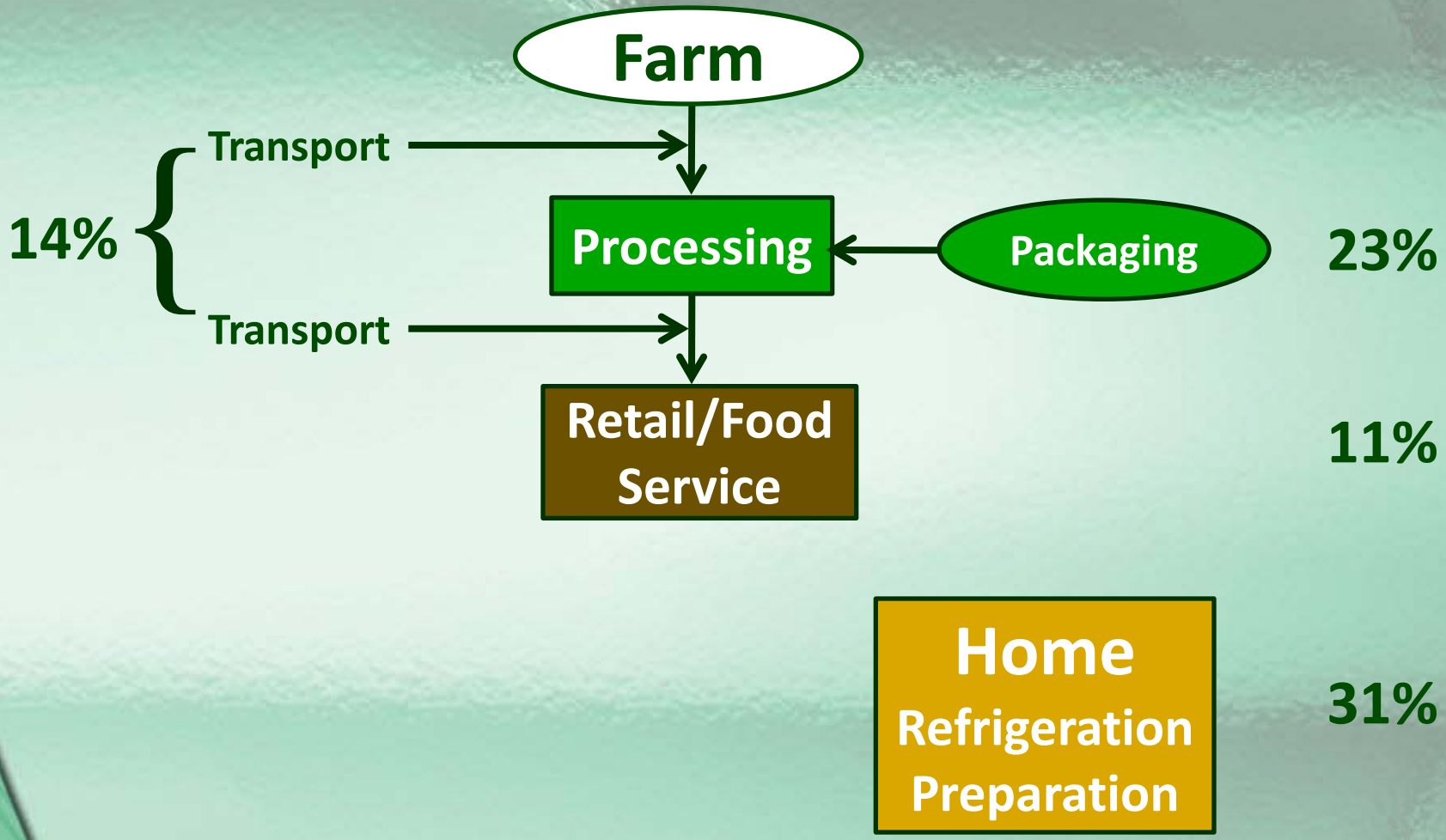


Only 4% of Haber-Bosch N in fertilizer produced and used in animal production enters the consumers mouth.

Fertility Conservation

- Change process of N fertilizer production.
- Control soil erosion, use cover crops, reduce tillage or use no-till.
- Proper timing, rates and incorporation of manure.

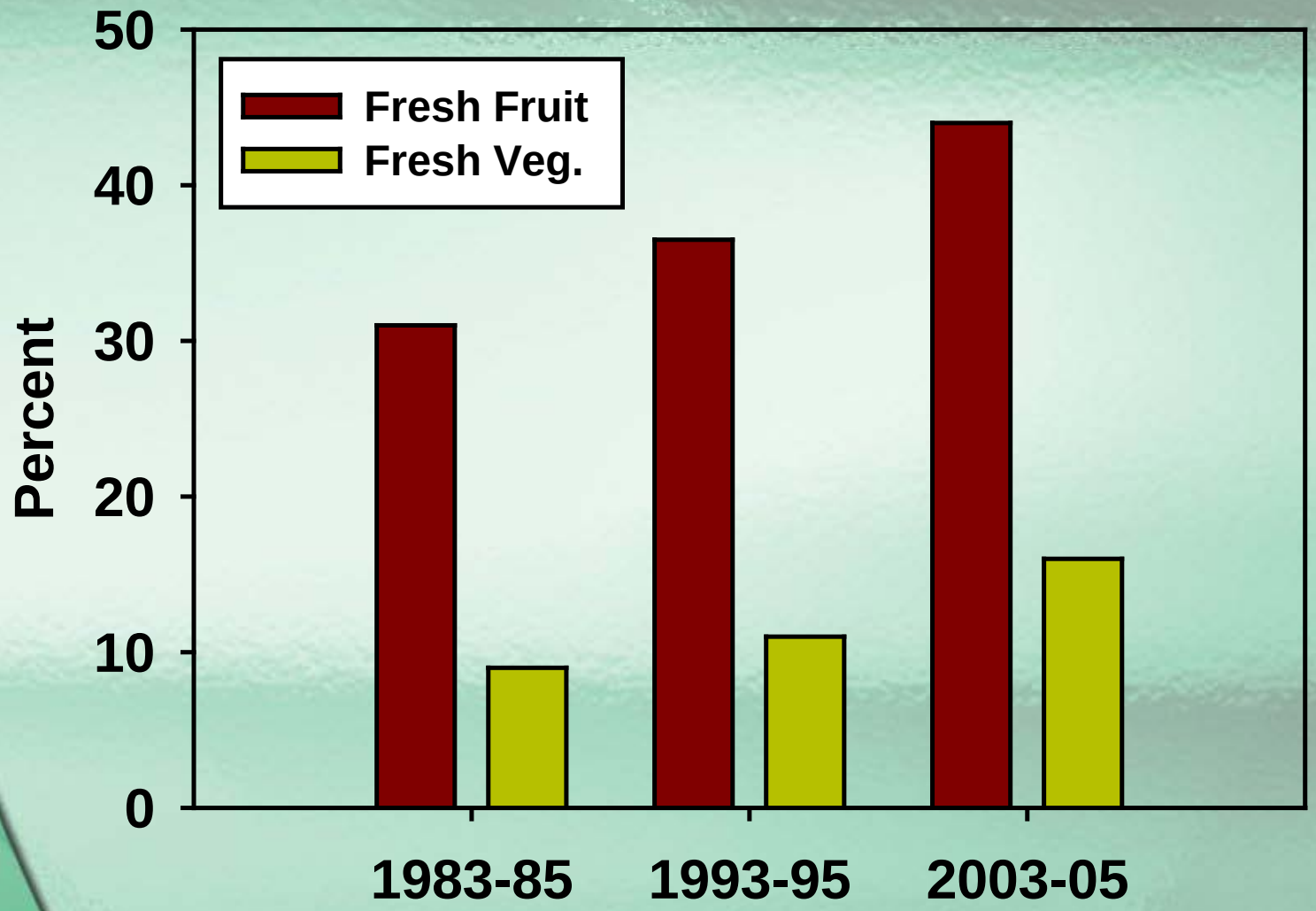
Off-Farm Food Energy Use - 79%



In 2001 the US imported:

- 68% of our fish and shellfish
- 27% of confectionary products
- 21% of fruits, juices, and nuts
- 16% of vegetable oils
- 9% of red meat

U.S. Imported Fresh Fruit and Vegetables



Source: USDA Econ. Res. Serv.

It is not the food we grow, it is more the food we do not grow!

Can we grow more food locally?

Food Miles

- Distance food travels from where it is grown to where it is consumed.
- Estimates range 1,500 to 2,500 miles.
- Food miles have increased much in recent years.

Food Miles vs. Buy Local Economic Opportunity

- Peaches grown in Spain.
- Shipped to Thailand for processing.
- Shipped to U.S. for distribution.
- Arrive in Massachusetts store for purchase.

Total Food Miles: >14,000

A Crude Oil Meal

- Bowl of oatmeal porridge: 4oz crude oil.
- Serving of red raspberries: 1oz crude oil.
- Butter, milk and salt: 1oz crude oil.
- Cup of java: 2oz crude oil.

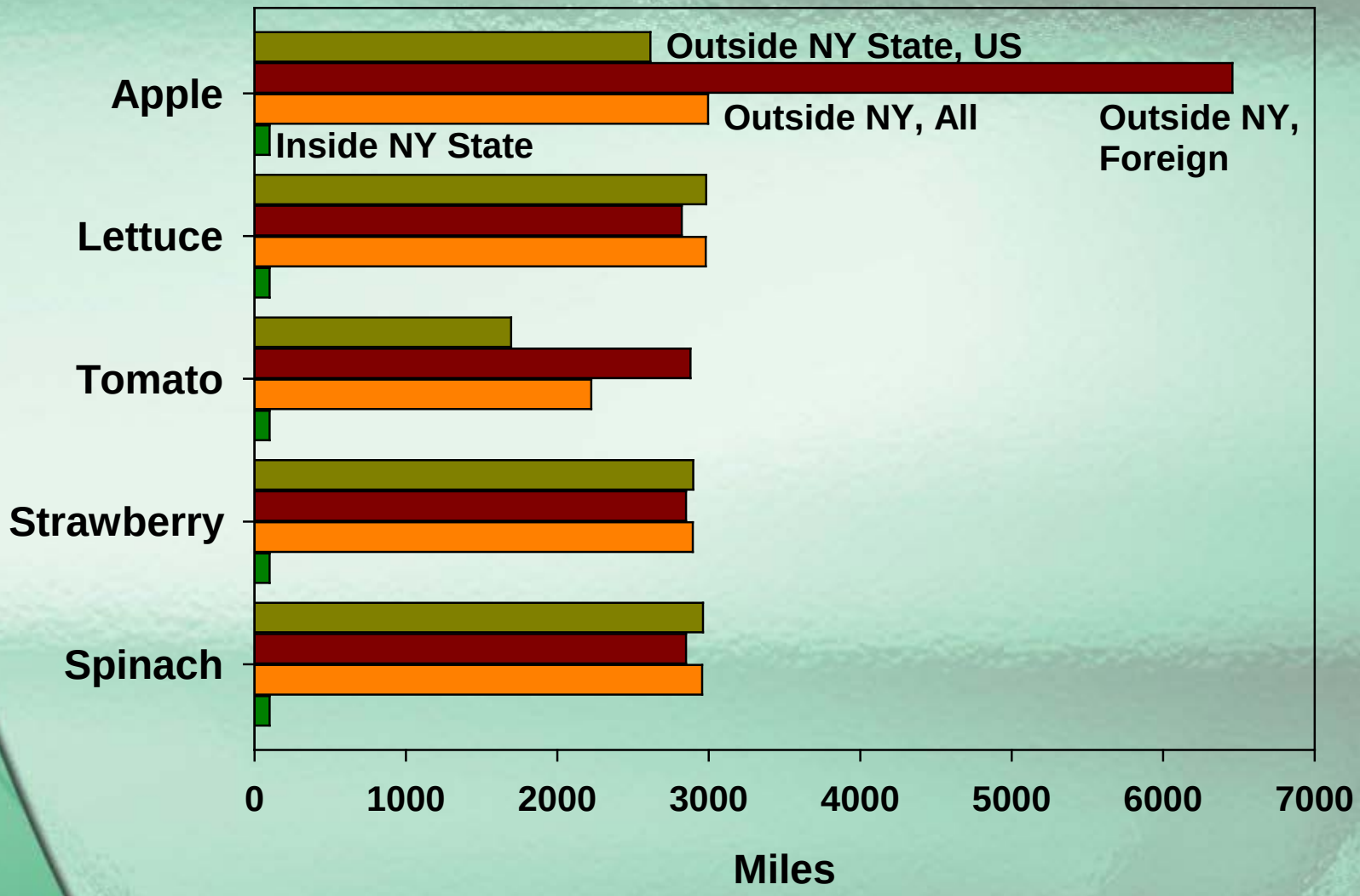
Chilean

Energy in one week's worth of breakfast for one person: More than 2qts of crude oil.

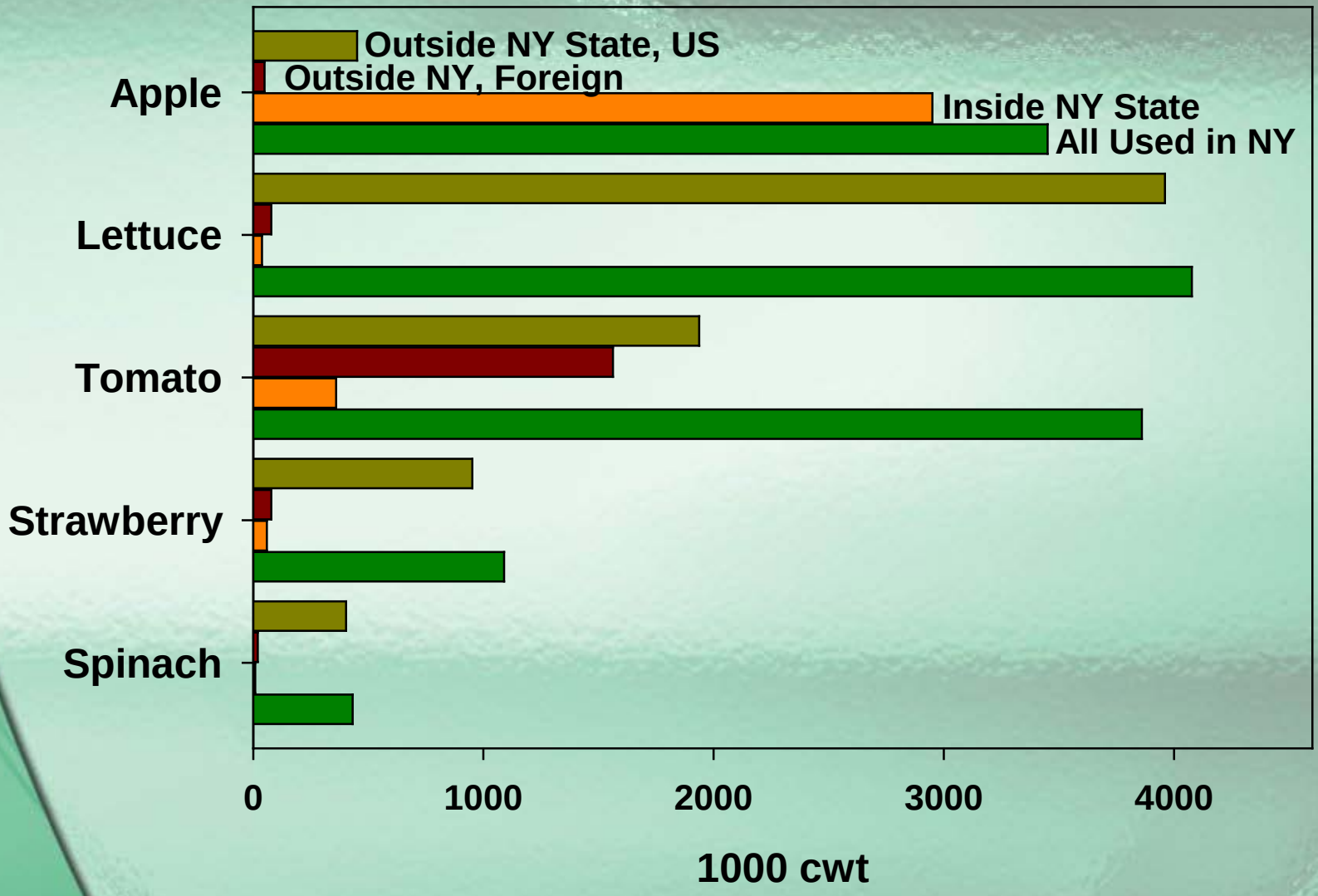
Chad Heeter, *San Francisco Chronicle*

Av. Distance Shipped

Produce Consumed in New York

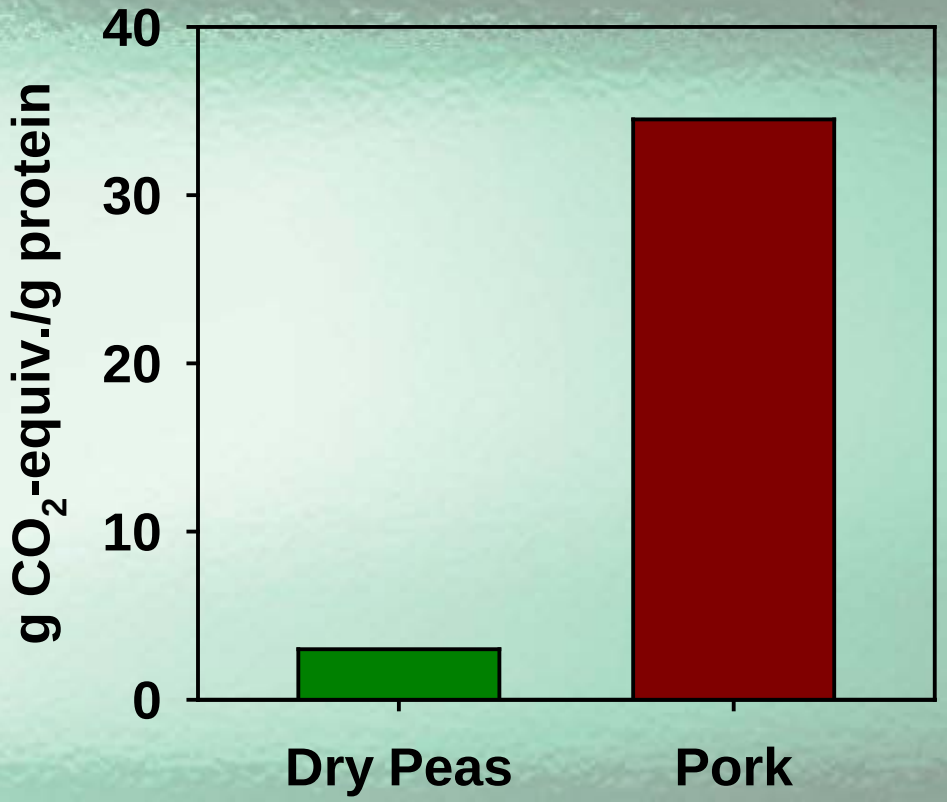


Is Local Field Production Enough?

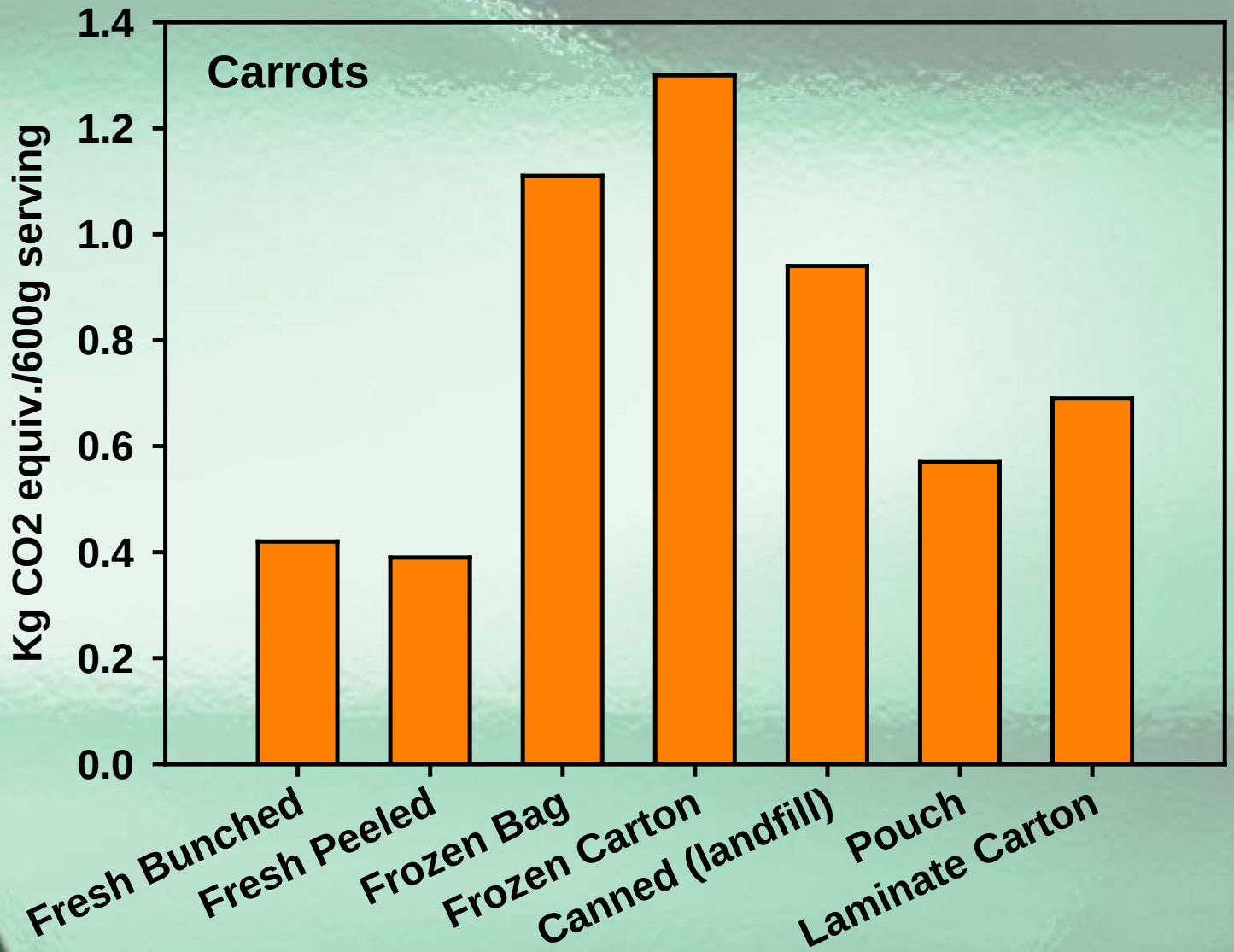


Livestock

- Meat and dairy: 50% of all food-related emissions of CH_4, N_2O, and CO_2.
- Animal-based protein foods 2-100 times more energy intensive than plant-based.
- Plants <1 GJ in/GJ out
- Animals >8 GJ in/GJ out

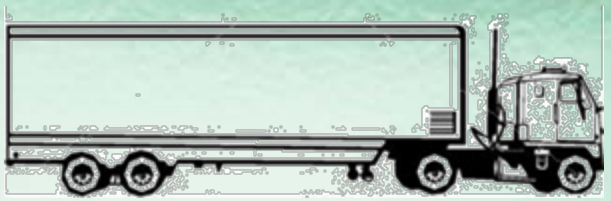


Processing & Transport of Crops



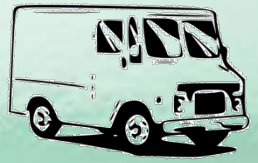
Impact of Food Transport
CO_2 Emissions and Miles Traveled

Conventional System



Regional System

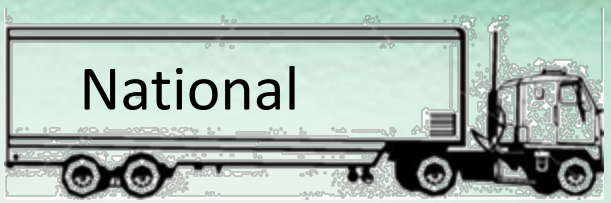
Local System



CSA/farmers markets, institutional markets

CO_2 Emissions and Miles Traveled

368,000 gal/yr
8,400,000 CO_2 lbs/yr



44,000 gal/yr
993,000 CO_2 lbs/yr

88,000 gal/yr
1,730,000 CO_2 lbs/yr

Agriculture in the Green Economy

Energy Crops:

- Heat (grass pellets, corn grain)
- Biodiesel (oilseed crops)

Renewable Energy:

- Photovoltaic dual land use

Energy Conservation:

- More local food
- Less processed food

Thank you

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