

Agricultural Outlook Forum 2011

Promoting Sustainable Agriculture through Regional Food Sheds

# Energy Usage in Regional Food Production

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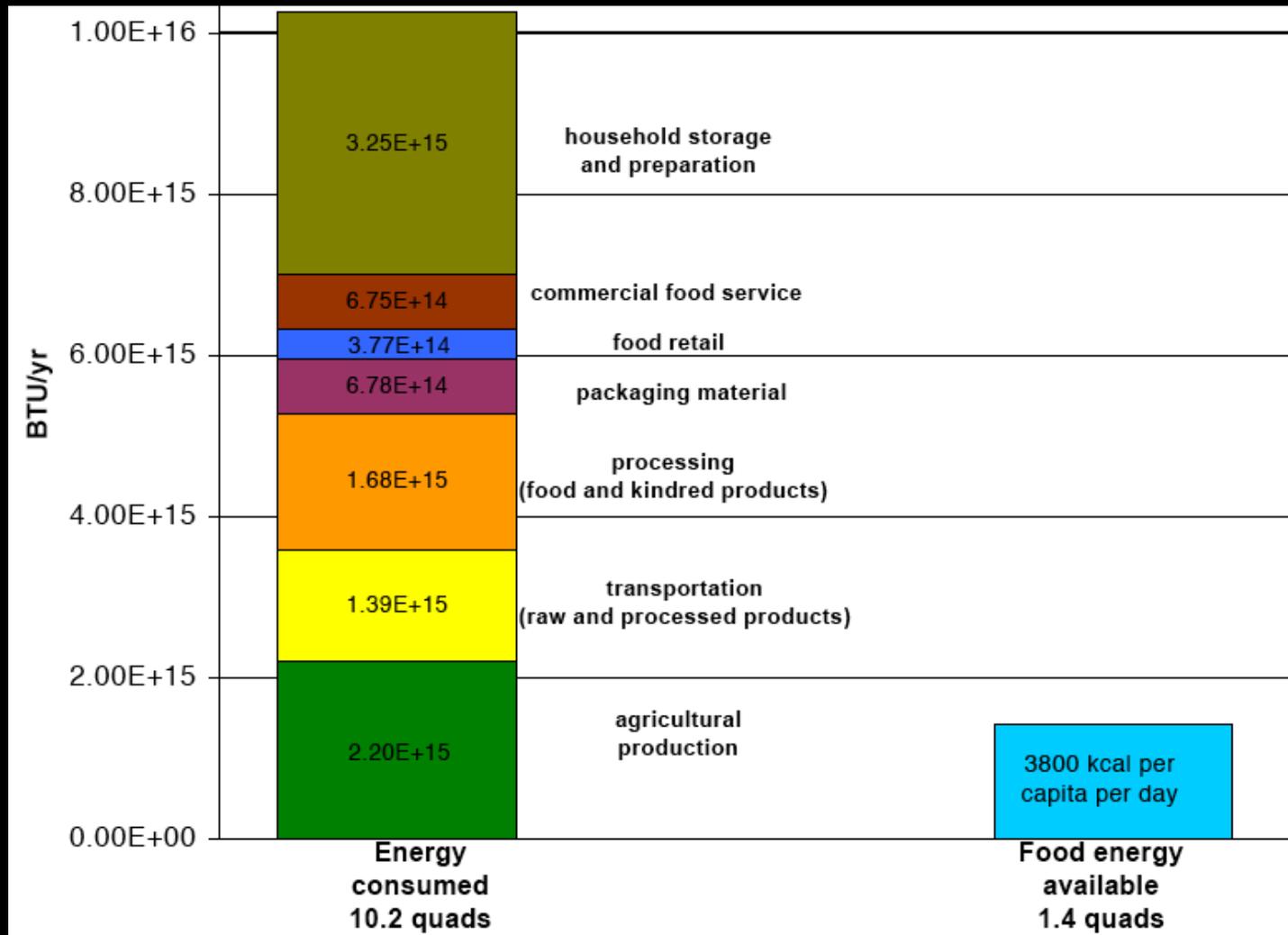
**Department of the Geophysical Sciences and the**

**Environment, Agriculture, and Food Working Group**

**The University of Chicago**

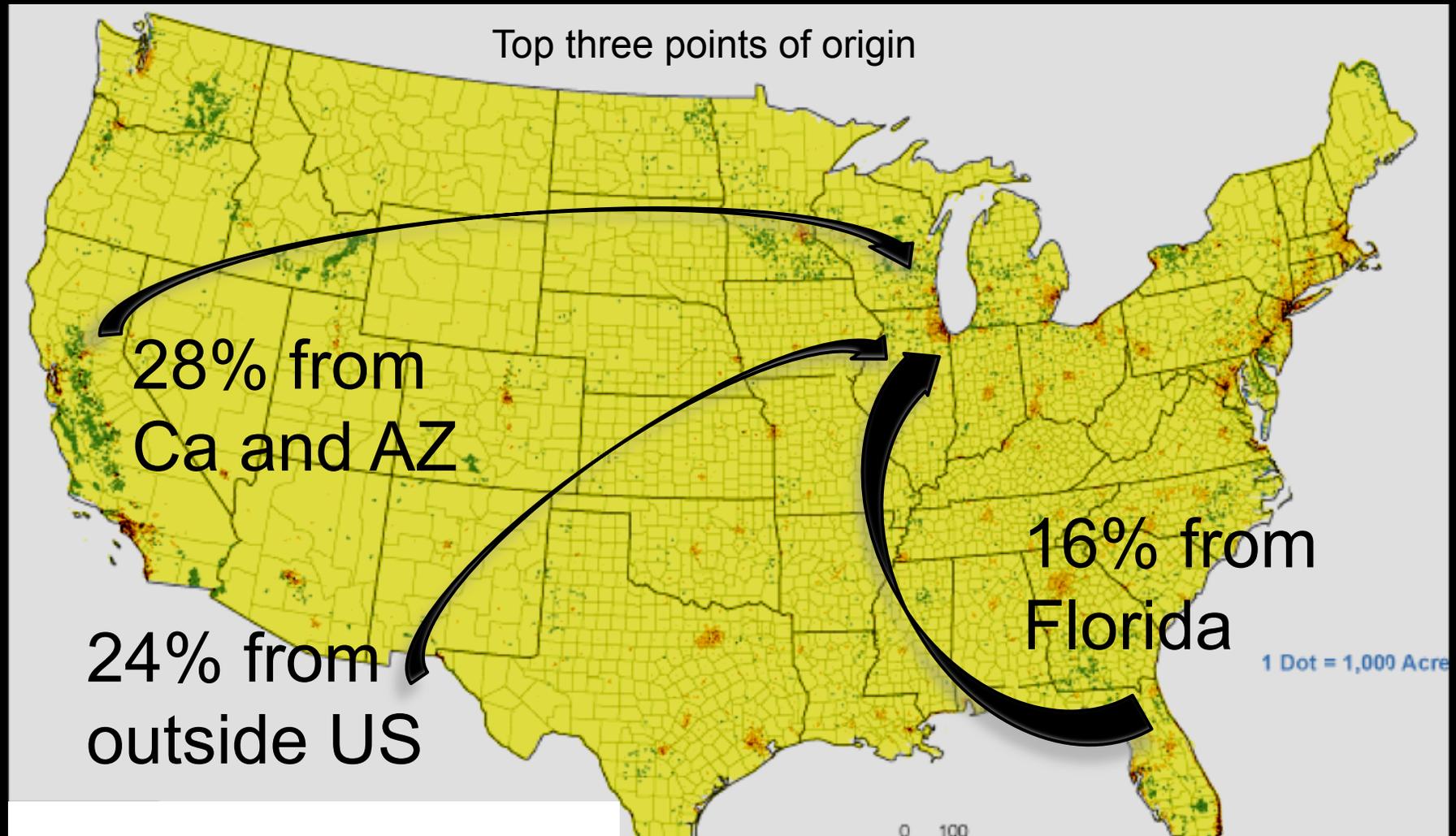


# Energy Use in the Food System



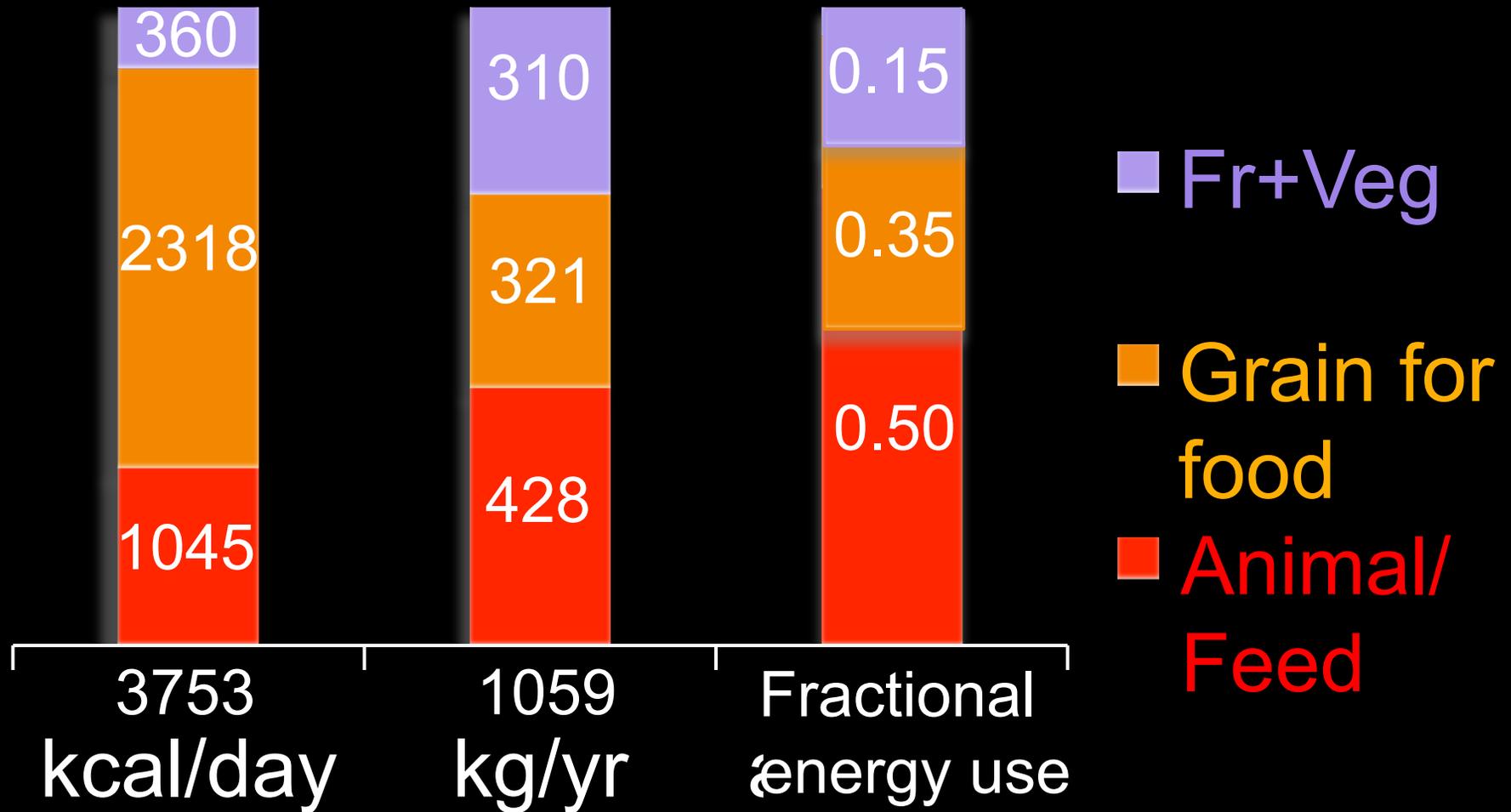
Heller and Keoleian, Report No. CSS00-04 of the Center for Sustainable Systems, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI

# Transportation: distance and mode from producer to consumer



- Calculations by N. Bamberger and J. Archer, summer High School interns (U of Chicago, 2009); Based on food movement data, AMS USDA

# Consumption pattern: Per Capita Mean American Diet



Calculated from USDA and FAOSTAT data; Energy after Mattew and Weber 2008

The goal:

Evaluate efficiency and potential  
of a regional food system

**The Tools:**

**Whole farm analysis**

**Foodshed mapping**

**Life cycle system analysis**

# Previous work has focused on single crops

**INPUTS:**

**TABLE 11.1**

**Energy Inputs in Apple Production in the Eastern United States**

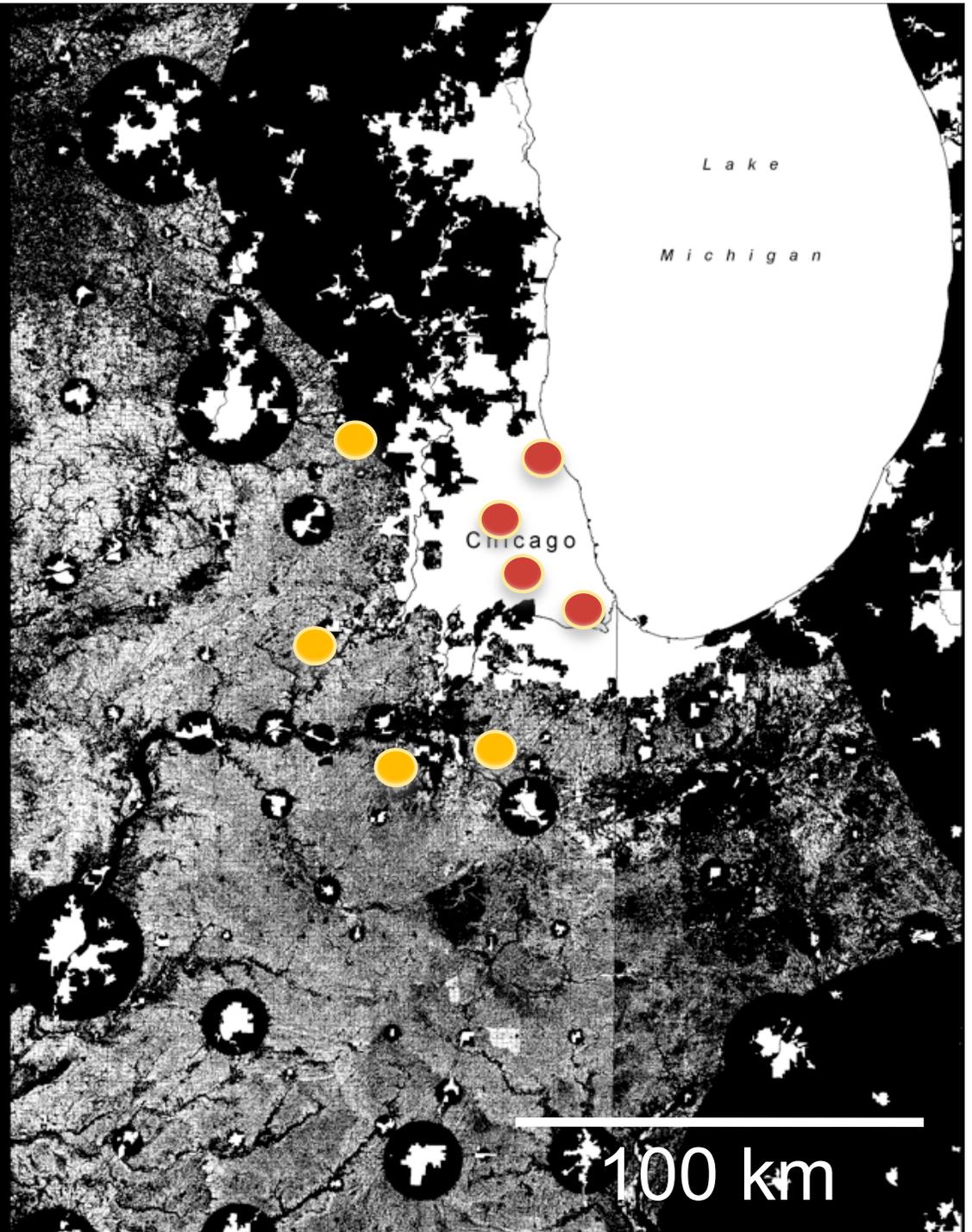
	Quantity/ha	kcal/ha
<i>Inputs</i>		
Labor	385 h	17,150,000
Machinery	88 kg	1,408,000
Diesel	483 L	5,506,000
Gasoline	1346 L	13,406,000
Nitrogen	45 kg	837,000
Phosphorus	114 kg	472,000
Potassium	114 kg	372,000
Insecticides	47 kg	4,700,000
Herbicides	6 kg	600,000
Fungicides	49 kg	4,900,000
Electricity	66 kWh	57,000
Transportation	2974 kg	787,000
Total		50,195,000

**OUTPUTS:**

Pimentel and Pimental, 1996;2007

# Local yields, small farms

- 4 rural farms,  
2-20 acres
- 4 urban farms
- Highly diversified  
in produce  
(40-300 varieties)
- “Sustainable”  
practices



# Our approach: Whole Farm study

## Full “input/output” analysis for energy

### INPUTS:

- (1) “Direct” on-farm energy use
- (2) “Indirect” energy: material inputs
- (3) Labor

### OUTPUTS:

Itemized production



# Output analysis: Calculating yields from diversified, sustainable farms

$$\text{Equivalent land use} = \sum_{i=1}^N \frac{\text{Mass of item } i, \text{ kg yr}^{-1}}{\text{Conventional Yield, kg acre}^{-1} \text{ yr}^{-1}}$$

$$\text{Relative land use} = \frac{\text{Equivalent land use}}{\text{Actual production area}}$$

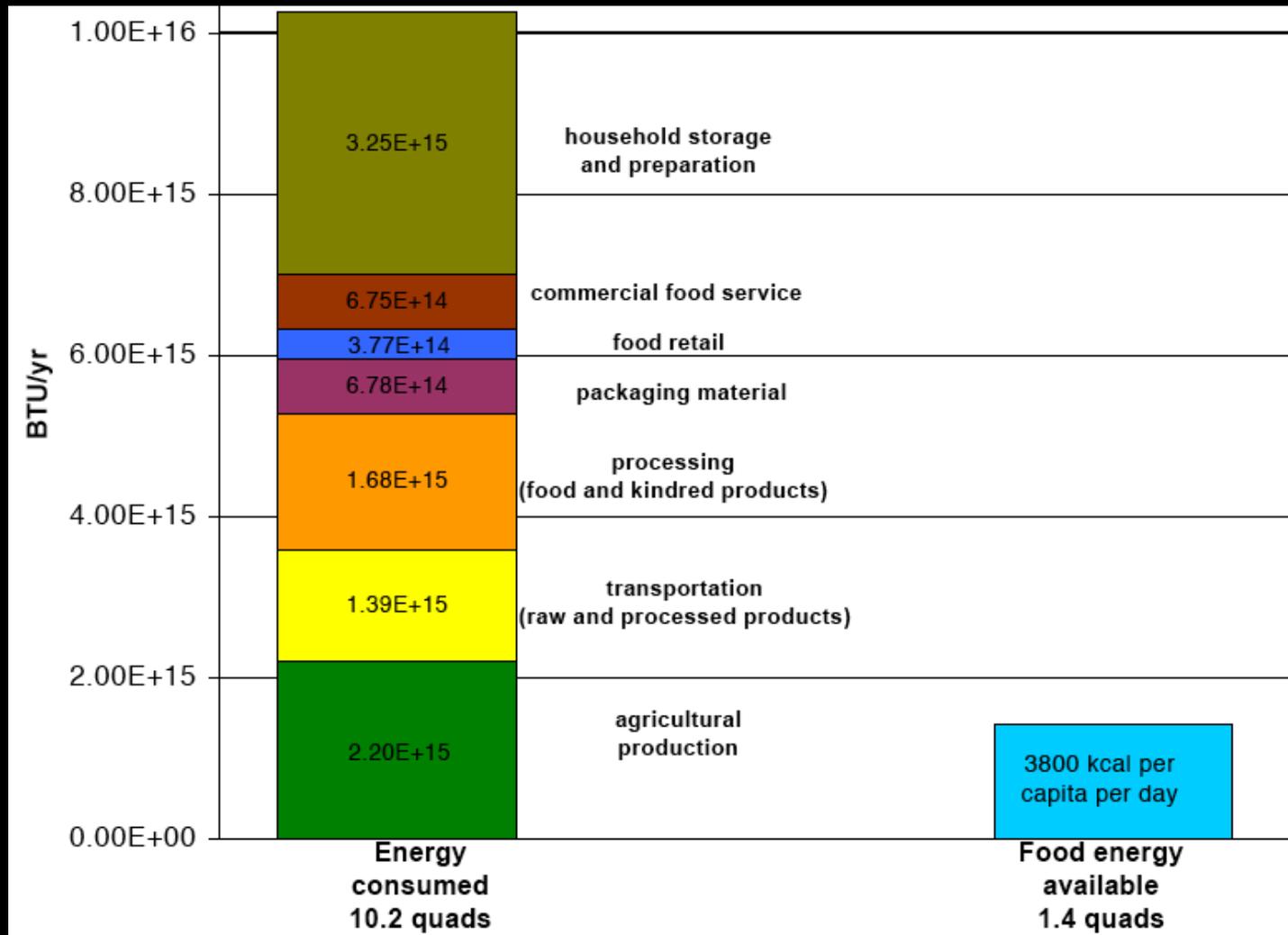
Relative Land Use > 1, diverse farms use more land

Relative Land Use < 1, divers farms use less land

# Input –Output analysis: Preliminary results small, diversified vs conventional ag

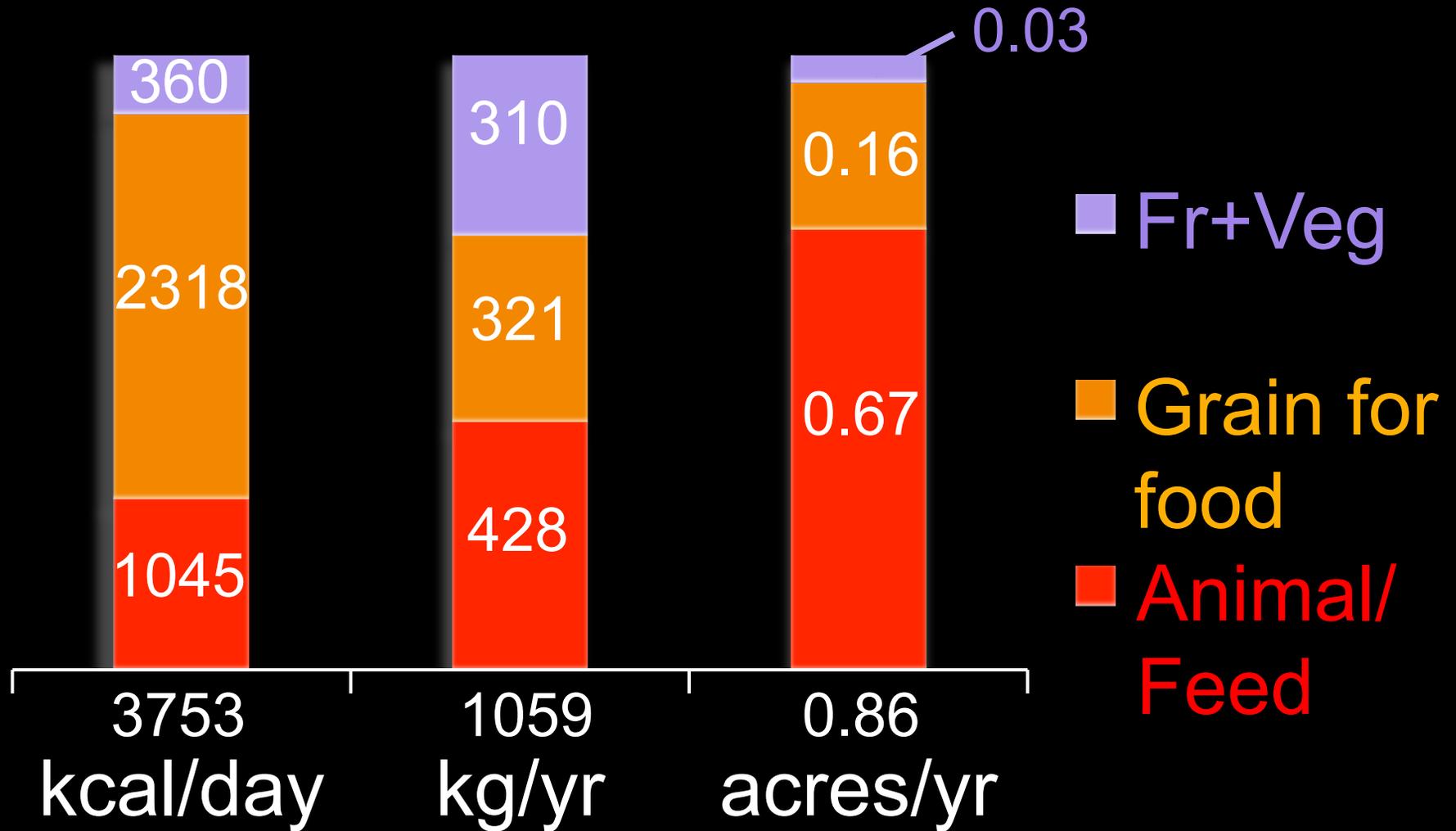
- **Urban Farms:**
  - Land use: 0.5 to 1 acre per acre of conventional
  - Direct energy use: 5 – 15% of conventional
  - Indirect energy use: 25 – 50% of conventional
- **Rural Farms:**
  - Land use: 1.1 -1.8 acre per acre of conventional
  - Direct energy use: 30 – 95% of conventional
  - Indirect energy use: 25 – 70% of conventional

# Energy Use in the Food System



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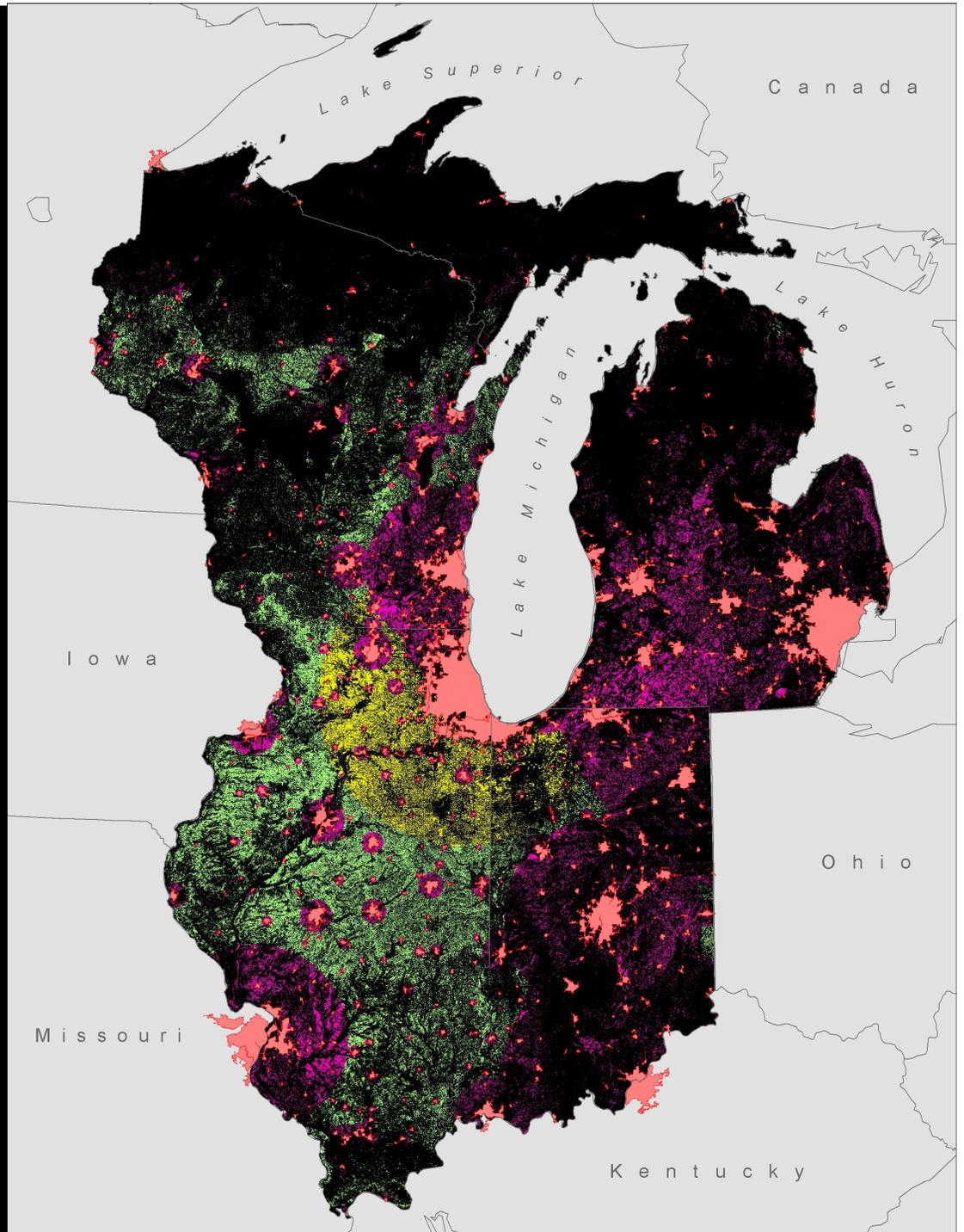
# Per Capita Mean American Diet



Calculated from USDA and FAOSTAT data; Land from Martin et al and Eshel et al. 2010

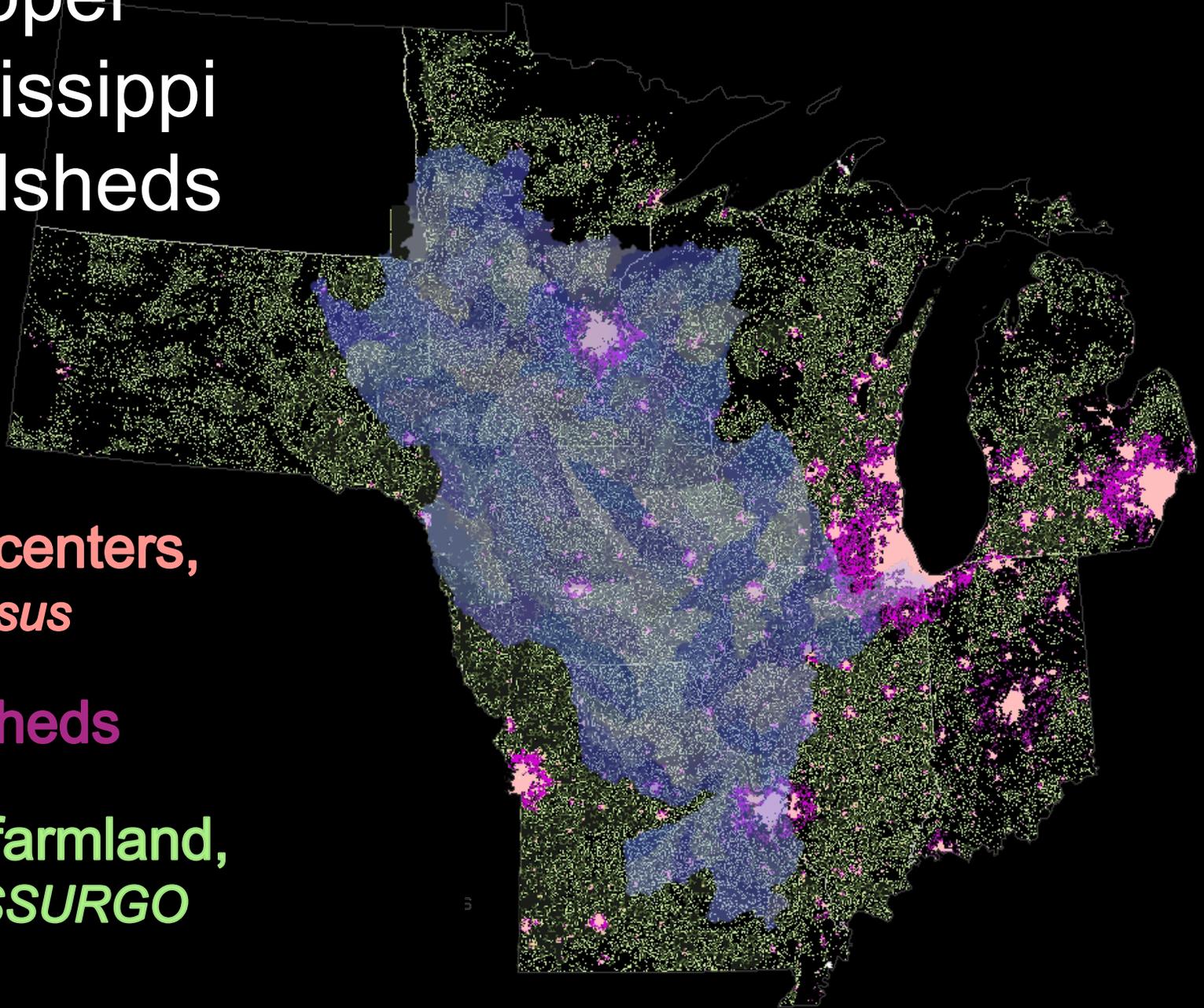
# Foodsheds, small to large

- **Chicago Foodshed**
- **Urban centers, US Census**
- **Prime farmland, USDA/SSURGO**
- **Secondary foodsheds**

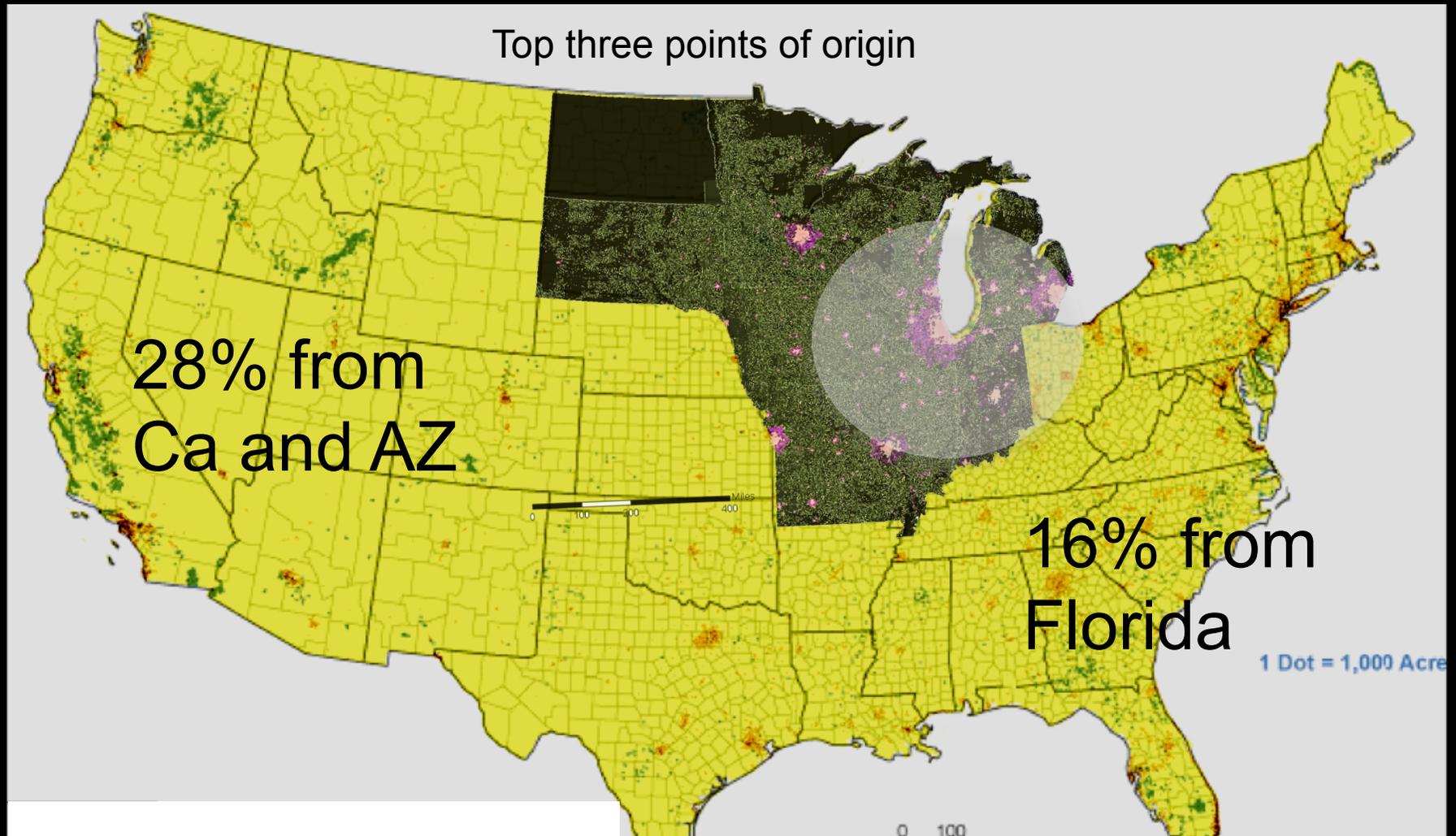


# Upper Mississippi Foodsheds

- Urban centers,  
*US Census*
- Foodsheds
- Prime farmland,  
*USDA/SSURGO*

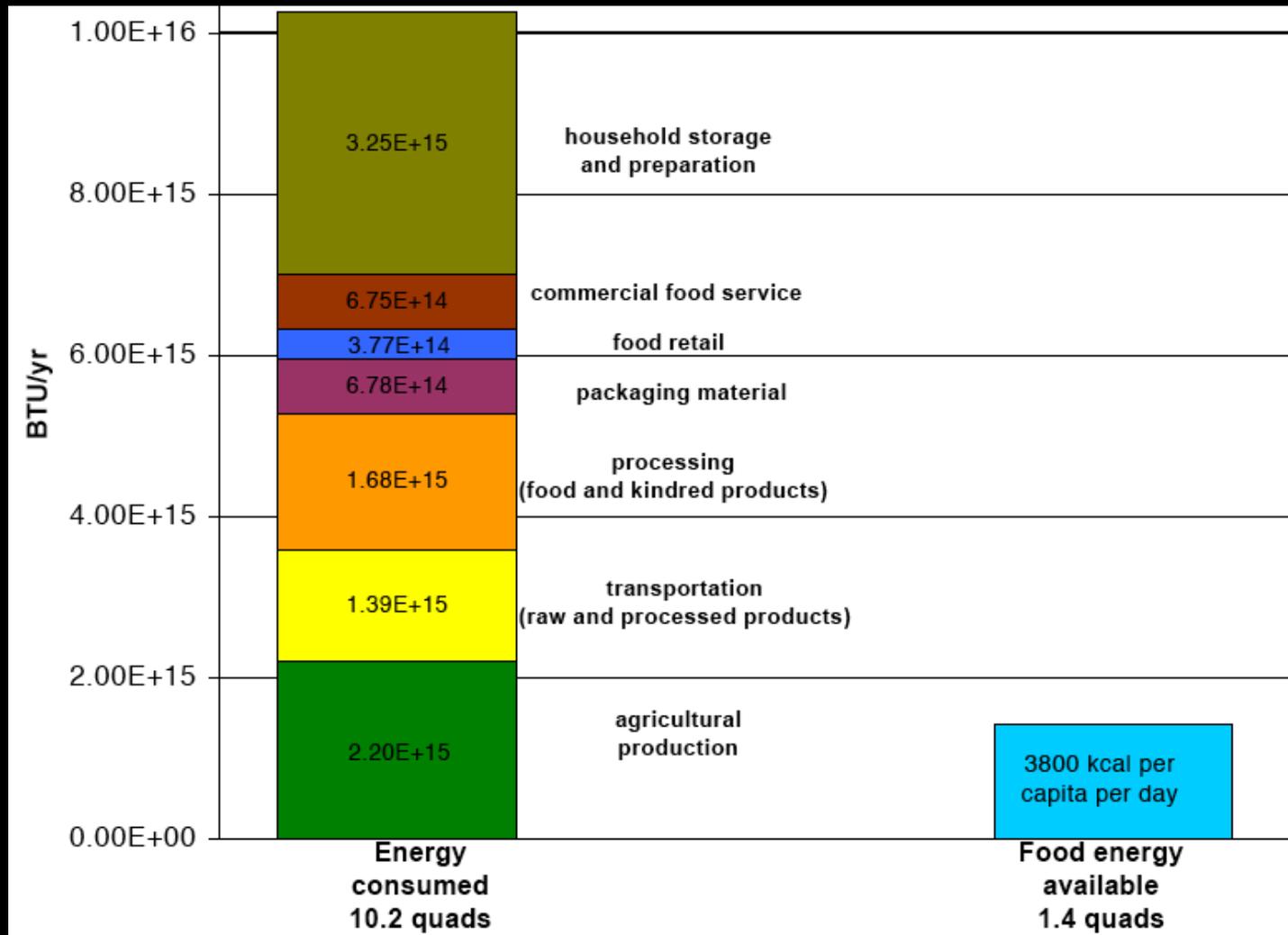


# Transportation: Distance and Load



- Calculations by N. Bamberger and J. Archer, summer High School interns (U of Chicago, 2009); Based on food movement data, AMS USDA

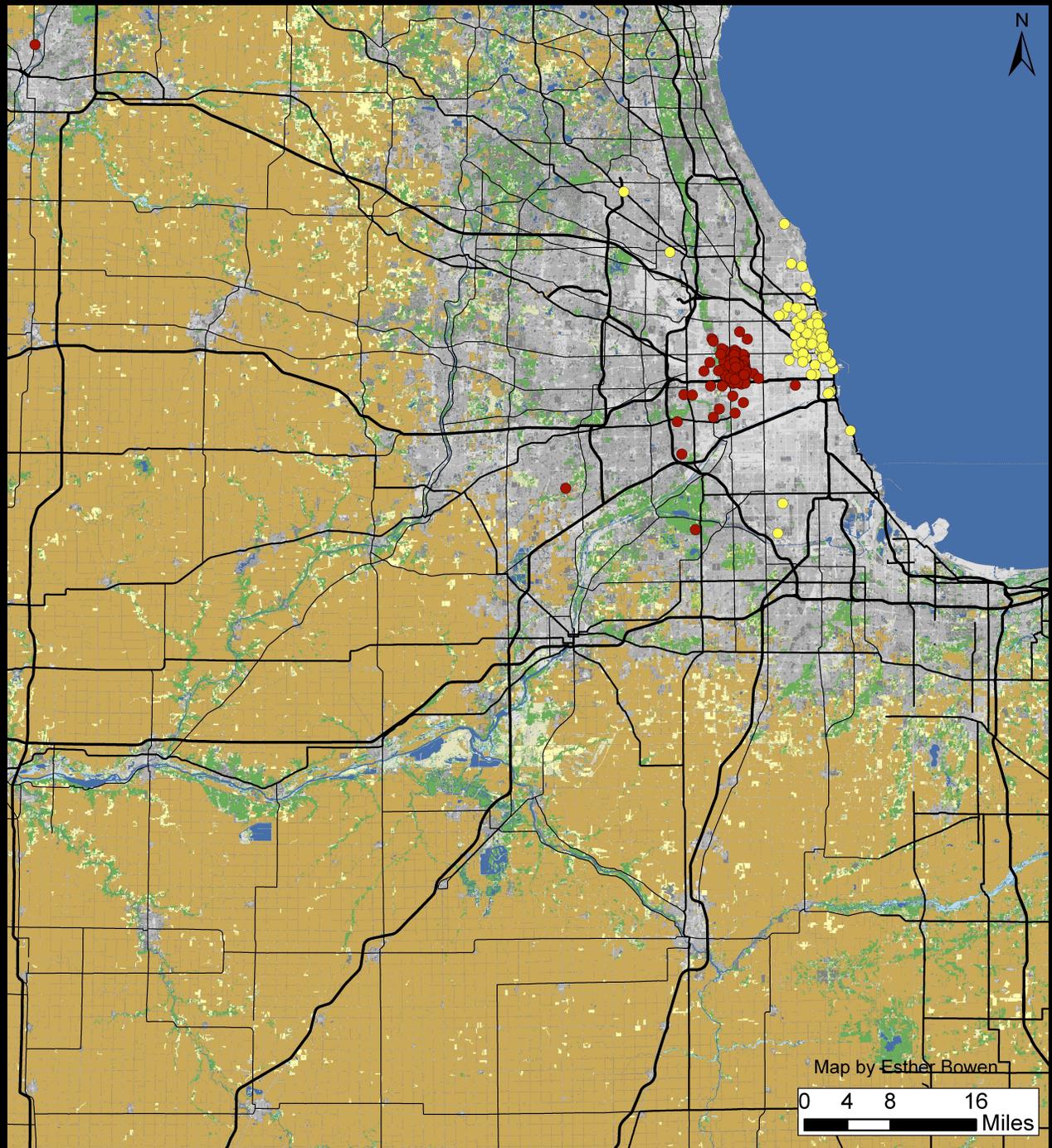
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# Farmers' Market Survey Data

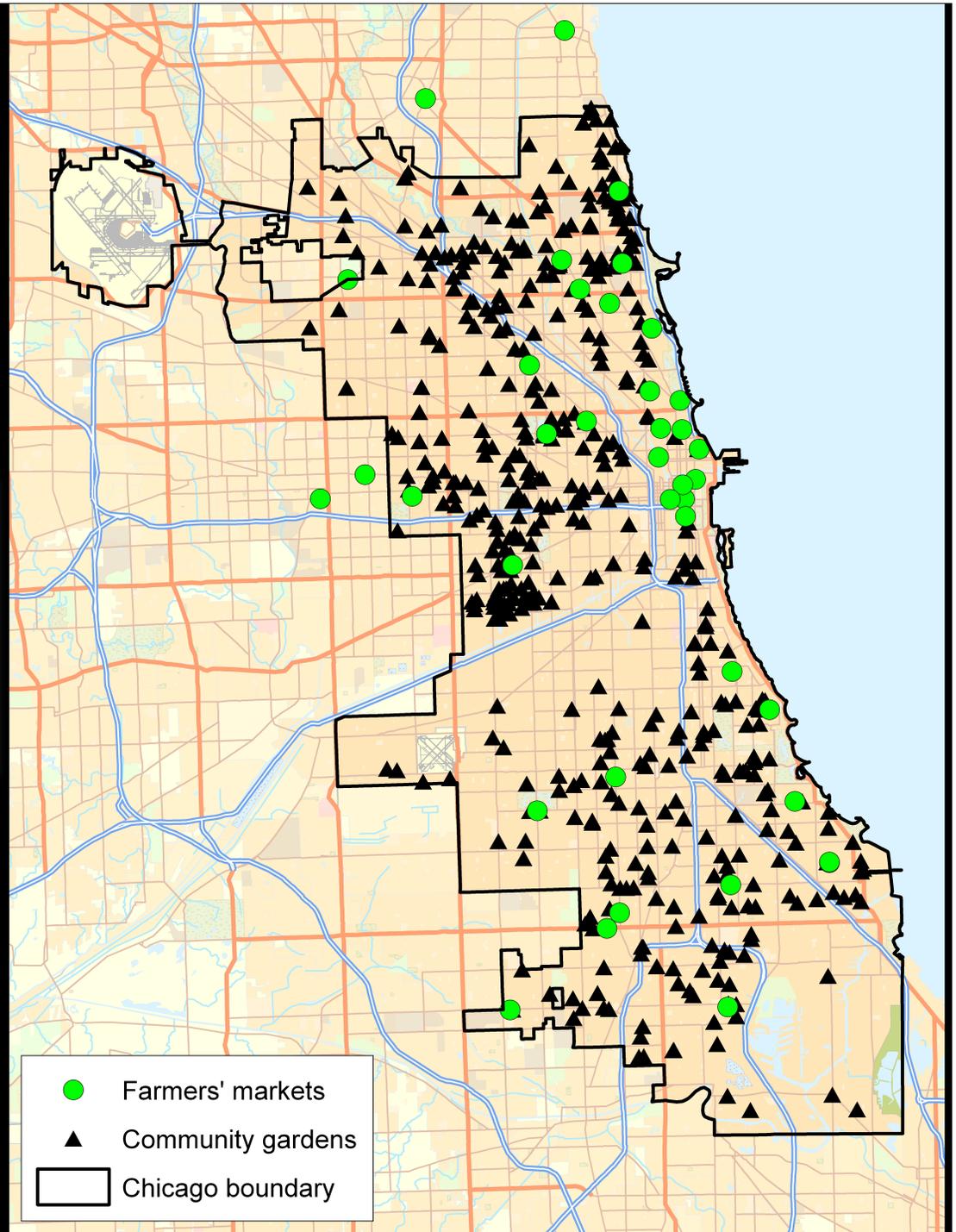
Less than 2 miles  
80% walk or bike



# Distribution: Fresh from the farm

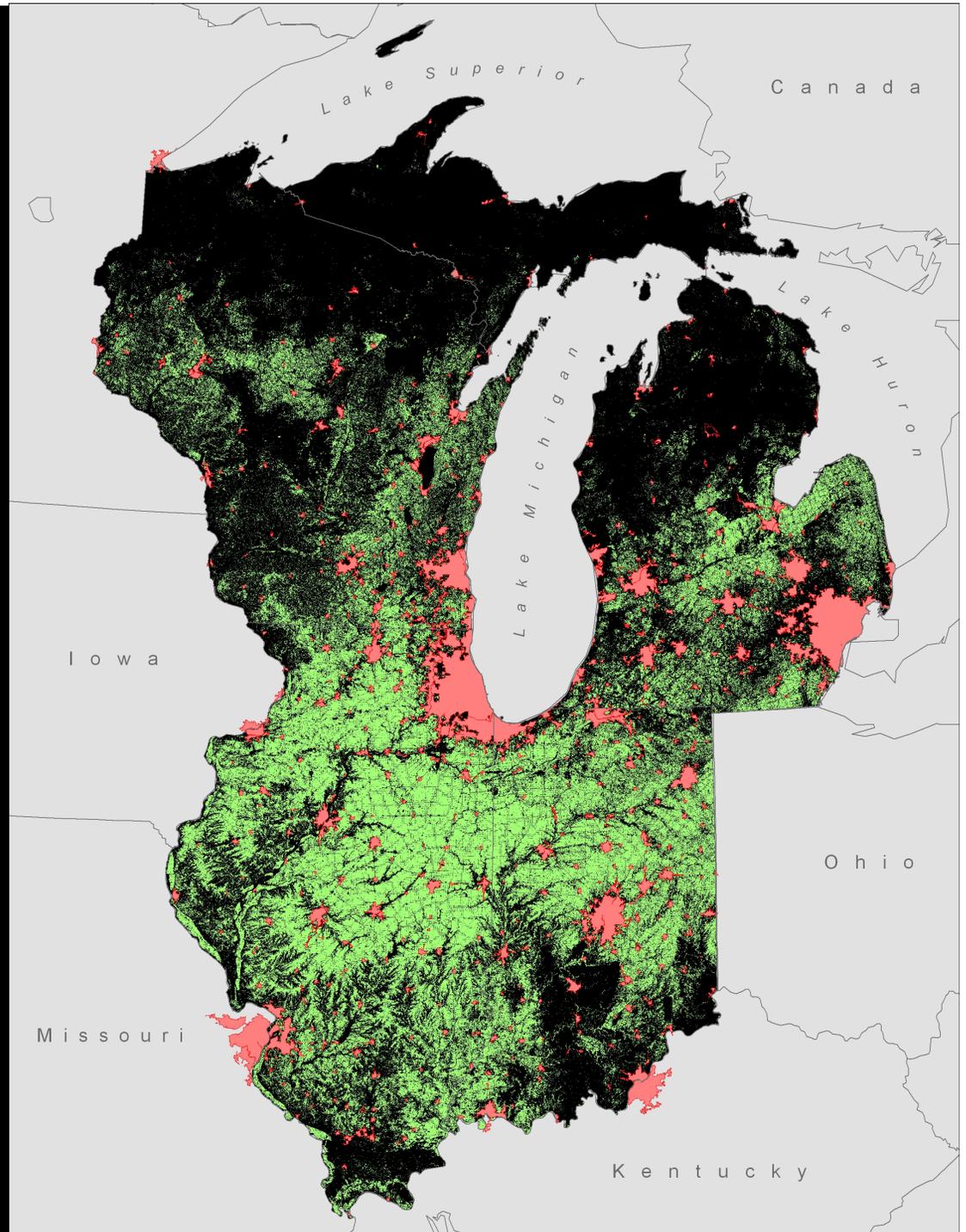
• **Farmers' Markets**

▲ **Community  
Gardens**



# Cultivated Land surrounding Chicago

- **Urban centers,  
US Census  
(Chicago = 8.3E6)**
- **42.5E6 acres  
USDA/SSURGO**



# Increasing the data collection (2011)

- (1) Adding nine farms in three regions of the US**
- (2) Adding self reporting farms in midwest**
- (3) Monitoring water use on two farms**
- (4) Additional economic data**

# Challenge: Comparing “apples to apples”

- (1) **Categories of inputs**
- (2) **“Stages” of the Life Cycle**
  - **production/post harvest**
  - **marketing**
  - **delivery**
  - **waste**

**TABLE 11.1**  
**Energy Inputs in Appl**

*Inputs*

Labor

Machinery

Diesel

Gasoline

Nitrogen

Phosphorus

Potassium

Insecticides

Herbicides

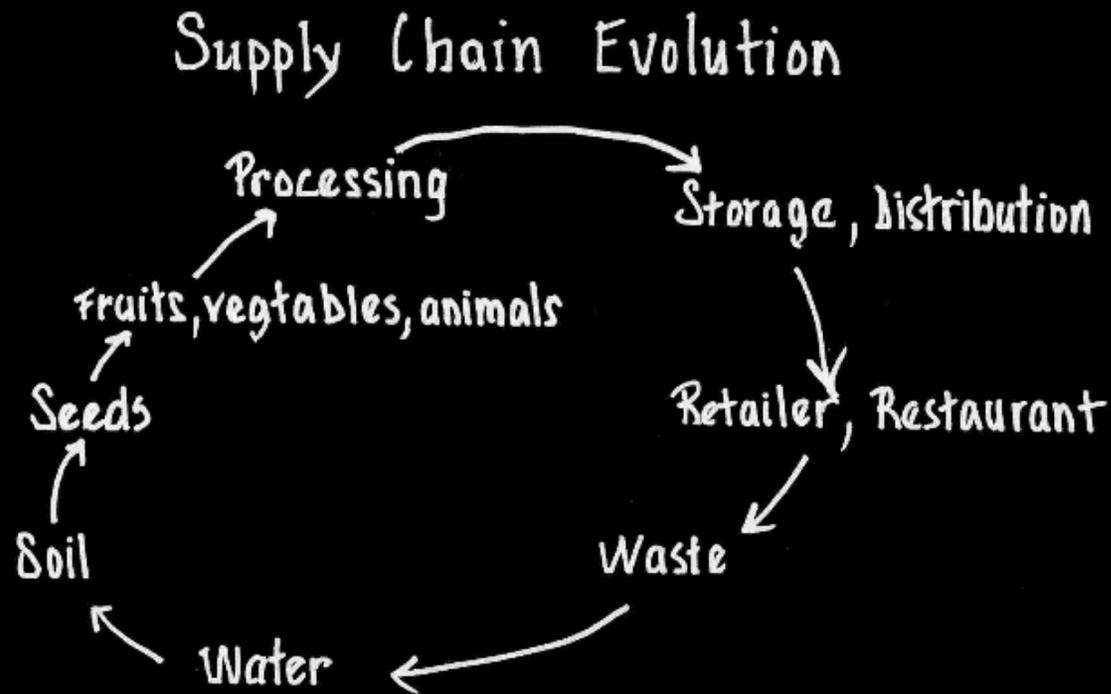
Fungicides

Electricity

Transportation

Total

# Energy Use in the Food System



Richard Schneider, formerly of Sysco, Ag Forum 2010 speaker

# Acknowledgments

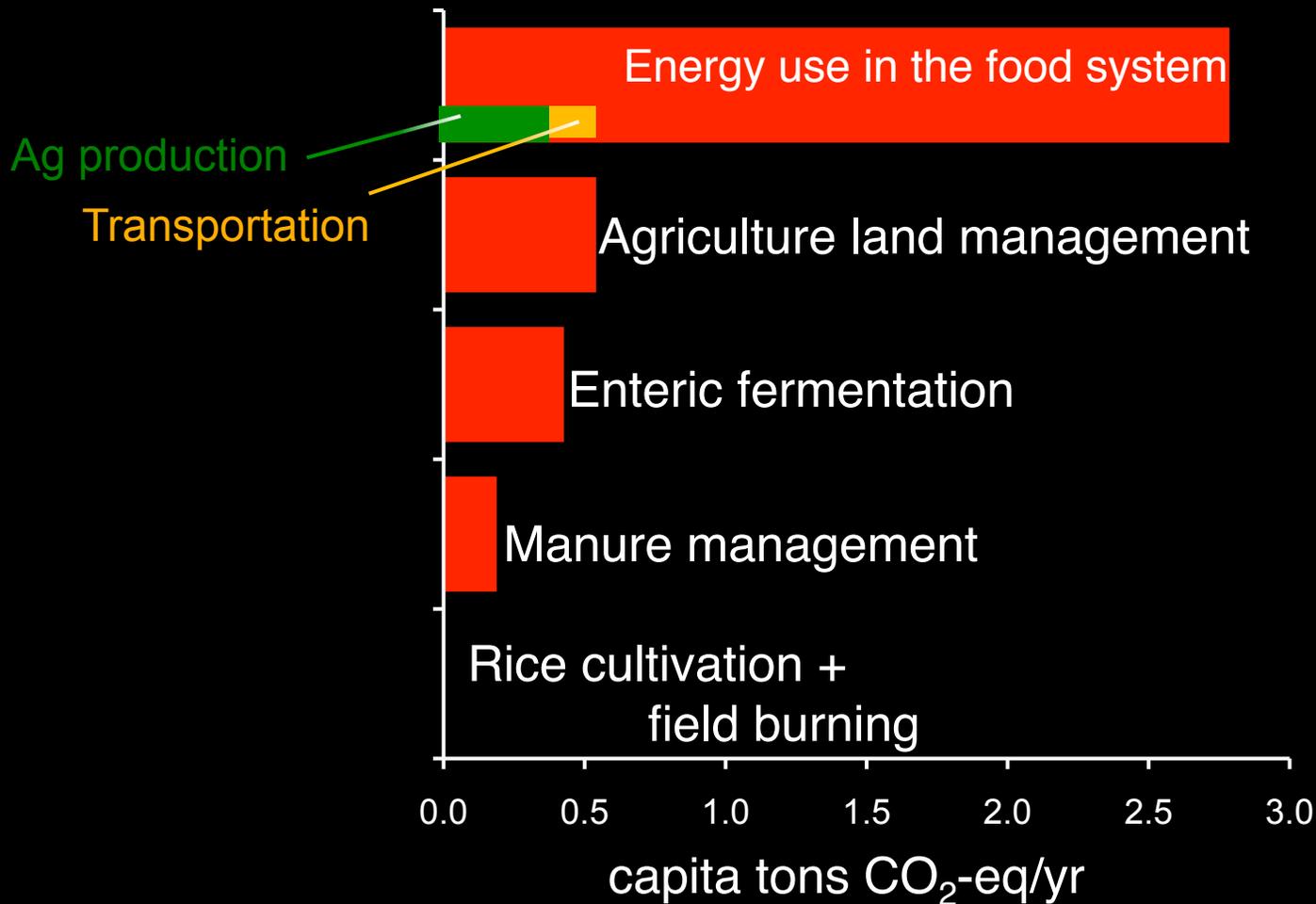


Interns supported by The College and the Program in the Global Environment at The University of Chicago and the Energy Initiative

New partners In 2010:  
Bon Appétit Management Foundation  
Farm to School



# Greenhouse gas emissions associated with the US food system



- Energy use from USDA, 2010; Emissions data from EPA, 2009; import/exptort, FAO 2008

# Land requirements for US diet

$$= \frac{\text{Acres for fruit + veg}}{\text{US Population}}$$

$$= \frac{\text{Acres for food grain}}{\text{US Population}}$$

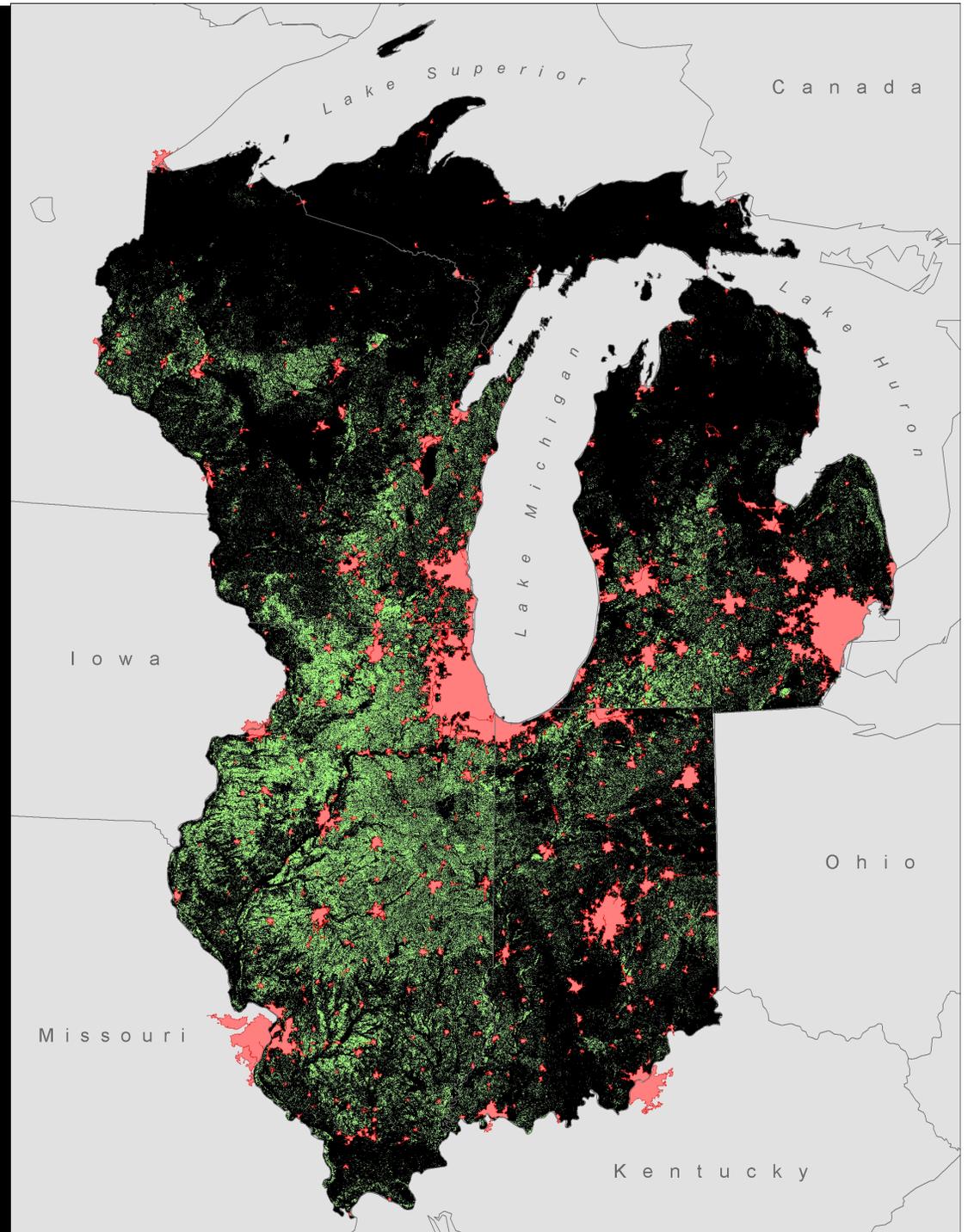
$$= \frac{\text{Acres for feed grain}}{\text{US Population}}$$

Data from USDA food availability, USDA grain yearbook, and FAOSTAT

crop	needed 10 <sup>3</sup> feed acre-eq.
corn	33,365
hay	62,241
soybean	23,461
wheat	16,128
sorghum	1,488
barley	1,173
oats	2,222
<b>total</b>	<b>140,077</b>
<b>weighted mean</b>	

# Population and land resources

- **Urban centers,**  
*US Census*
- **Prime farmland,**  
*USDA/SSURGO*



# Ultimate destination of farm fresh produce

## Sandhill Organics CSA and Market Distribution

