Energy Efficiency, Food Miles and Fuel Usage in Food Transport

CTRE Transportation Scholars Seminar
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Leopold Center for Sustainable Agriculture

- Created in 1987 (Iowa Groundwater Protection Act)
- State funded (Iowa general revenue fund and tax on N fertilizer and pesticides)
- Averaging 1.2 million per year in funded projects
- Focus on 3 initiative areas since 2001:
  - Marketing and Food Systems
  - Policy
  - Ecology

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Interest and demand for locally grown food products increases….

- From 1994 to 2004…111 percent increase in number of farmers markets
- 50 CSAs in 1990, more than 1,000 today
- Increase in independent restaurants serving local food products
- Increase in larger food service companies sourcing local products (SYSCO, Bon Appetit`)

Why the interest in local?

- Freshness, taste, quality
- Knowing the food story
- Supporting farmers
- Supporting the local economy
- Consumer connection back to the land

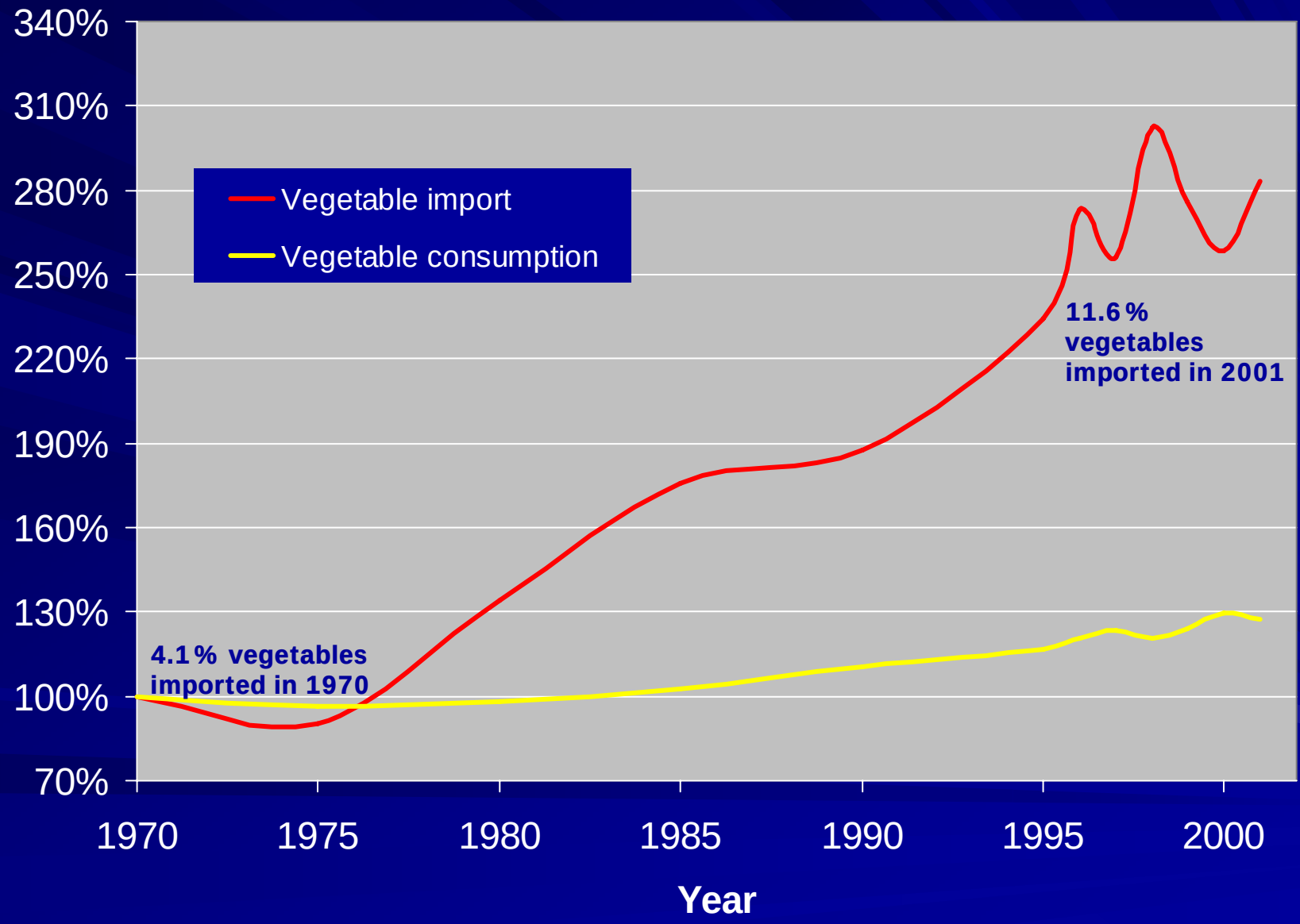
Energy Use in the Food System

- Food systems account for 16-17 percent of total U.S. energy consumption*
- Transportation accounts for 11 percent of energy use within the food system*
- In the UK, agricultural/food production accounts for 28% of goods transported on UK roads, imposing external costs of 2.35 billion pounds per year**

* Hendrickson, John, "Energy Use in the Food System: A Summary of Existing Research and Analysis" 1996.

**From "Farm costs and food miles: An assessment of the full cost of the UK weekly food basket (Jules Pretty et. al., *Food Policy* 30 (2005) 1-19).

U.S. total vegetable imports and per capita consumption trends relative to 1970 base year



Data from USDA Economic Research Service

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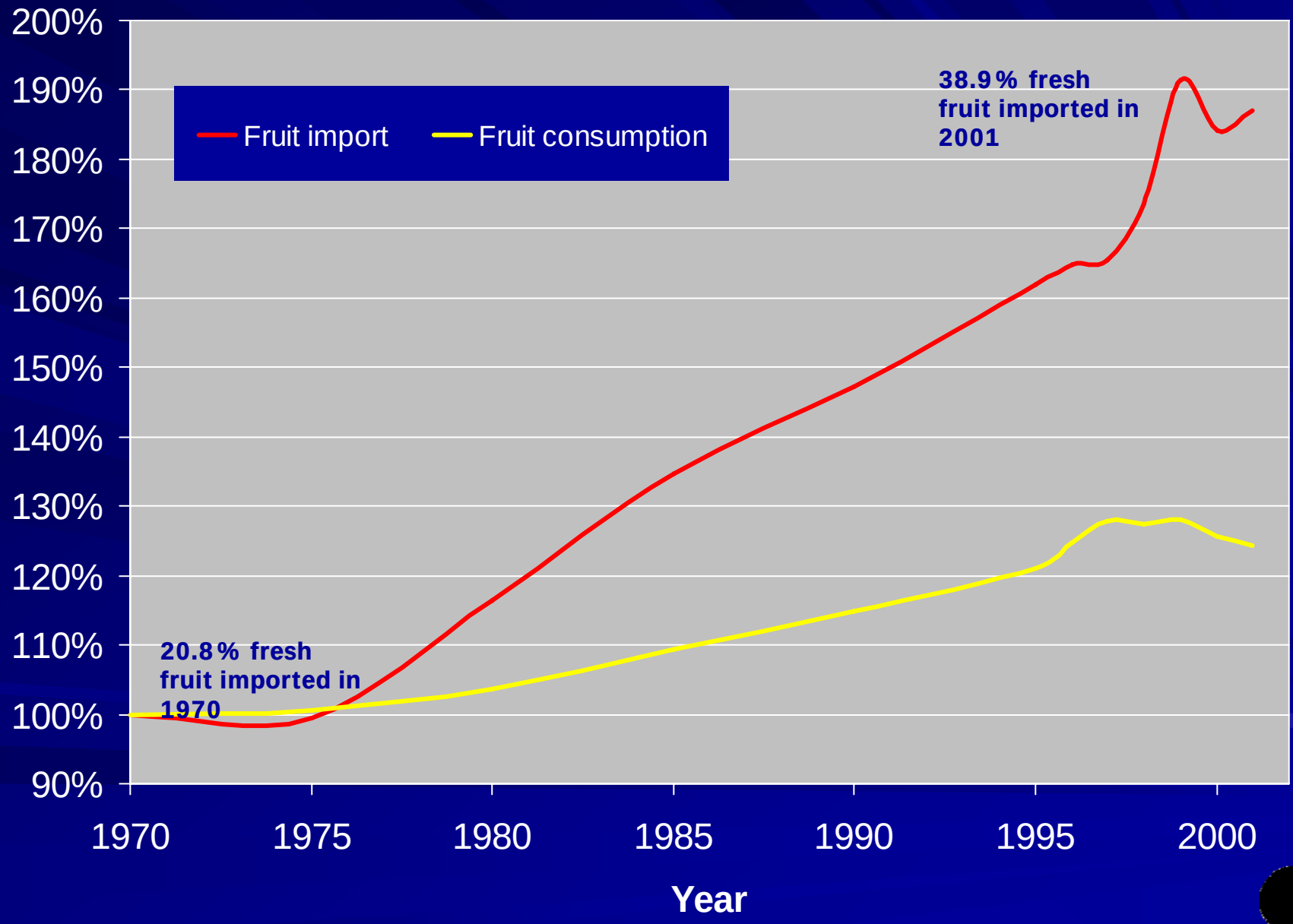
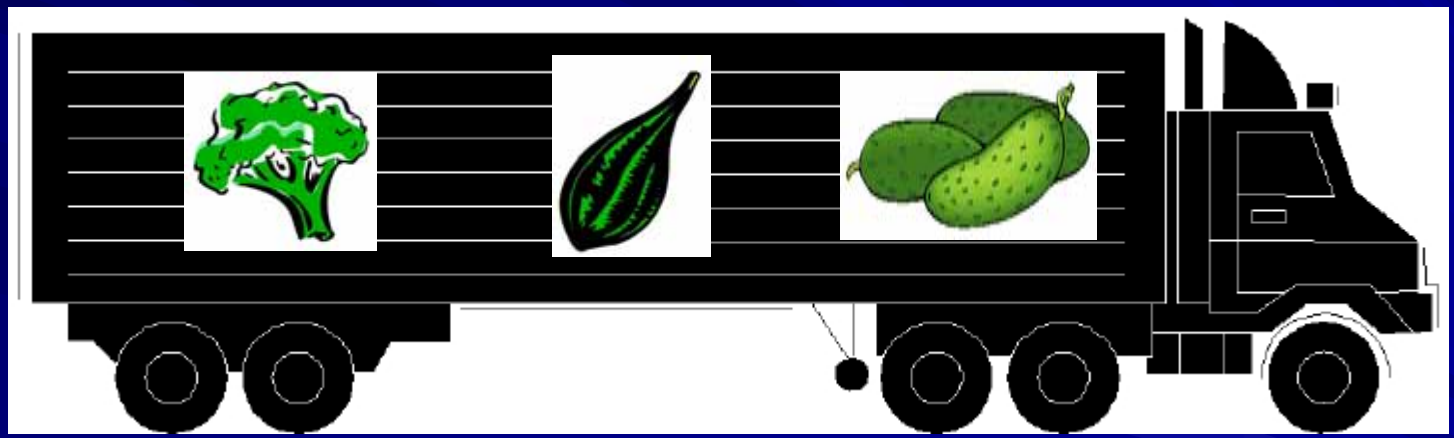
U.S. total fresh fruit imports and per capita consumption trends relative to 1970 base year



Data from USDA Economic Research Service

In California more than 485,000 truckloads of fresh fruits and vegetables travel 100 to 3,100 miles to reach their destinations*



*Hagen, J.W., D. Minami, B. Mason, and W. Dunton. 1999. “California’s Produce trucking Industry: Characteristics and Important Issues”

What are “food miles?”

- Distance food travels from where it is grown/raised to where it is purchased (consumer or end-user)
- 1969 DOE study – 1,346 miles
- 1980 estimation (UW) for produce – 1,500 miles
- Food miles in industrial nations have increased significantly in last 50 years

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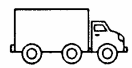
Weighted Average Source Distances (WASD) for Fresh Produce - Chicago Terminal Market

	1981	1989	1998
Truck WASD – continental U.S. (miles)	1,245 miles	1,424 miles	1,518 miles
Arrivals by truck – overall (% of total)	49.6%	68.6%	86.9%
Arrivals by rail – overall (% of total)	50.4%	31.4%	13.1%
Foreign arrivals (% of total)	12.5%	16.4%	21.5%

Average distance by truck to Chicago Terminal Market*

(Continental U.S. only)

		# States supplying this item	% Total from Mexico
Grapes	2,143 miles	1	7
Broccoli	2,095 miles	3	3
Asparagus	1,671 miles	5	37
Apples	1,555 miles	8	0
Sweet Corn	813 miles	16	7
Squash	781 miles	12	43
Pumpkins	233 miles	5	0



Each truck represents about 500 miles of distance traveled

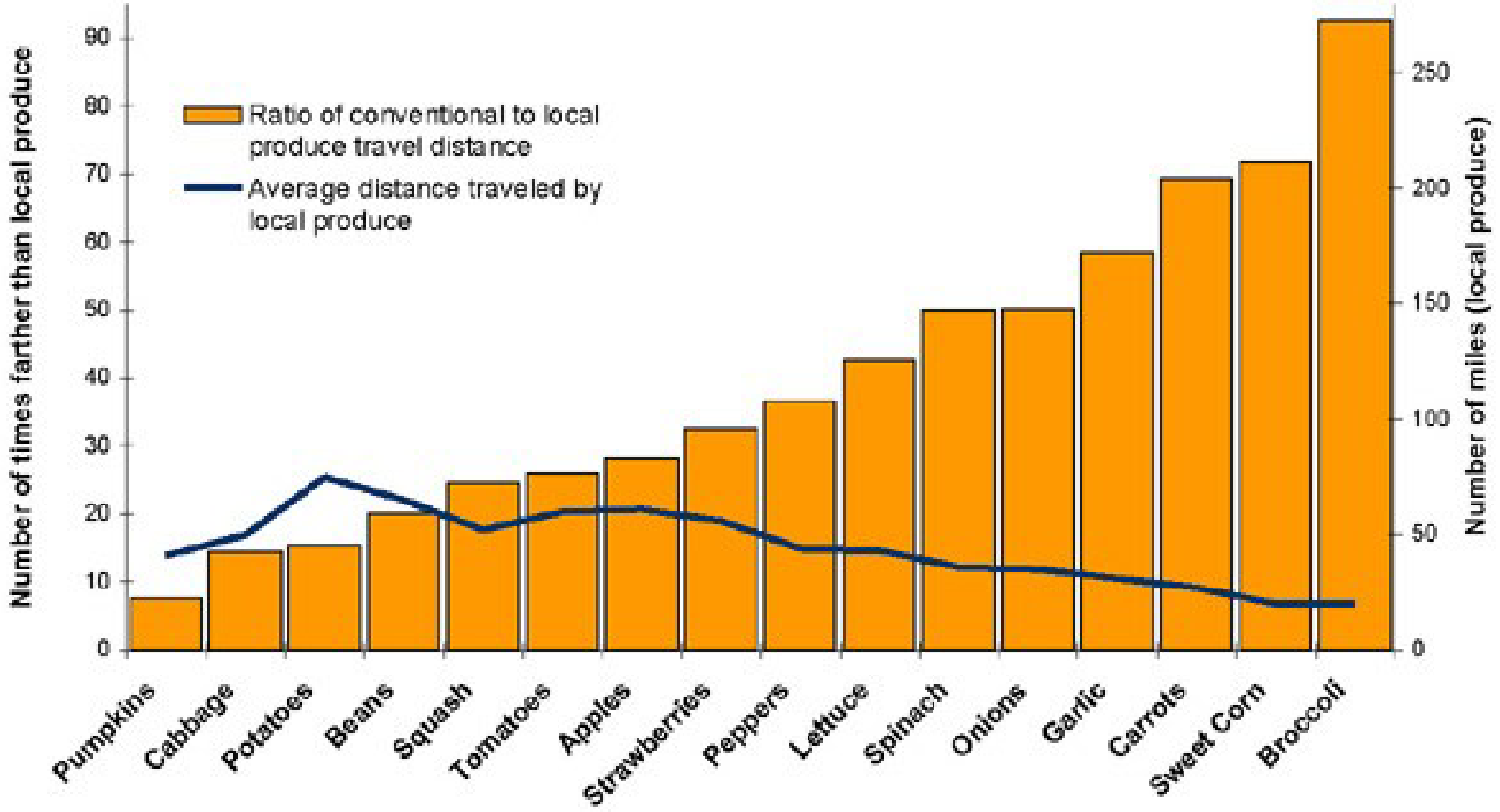
Weighted average source distances calculated from USDA AMS arrival data -1998 Chicago Terminal Market. Estimations do not include distance from terminal market to point of retail sale

Tonnage and distance traveled by food in the UK (1978-1999)

	Quantity (millions of tonnes)	Average distance (kilometers)
1978	287	82
1983	264	89
1988	302	100
1993	300	119
1998	346	123
1999	333	125

DETR, 1999. Transport of Goods by Road 1998, Dept. of the Environment Transport And the Regions. HMSO, London.

How much farther does conventional produce travel?



Source: Leopold Center for Sustainable Agriculture, 2003

Local produce data from 2001 Practical Farmers of Iowa "All Iowa" meals. Conventional data extrapolated from 1998 USDA AMS produce arrival data for Chicago and St. Louis

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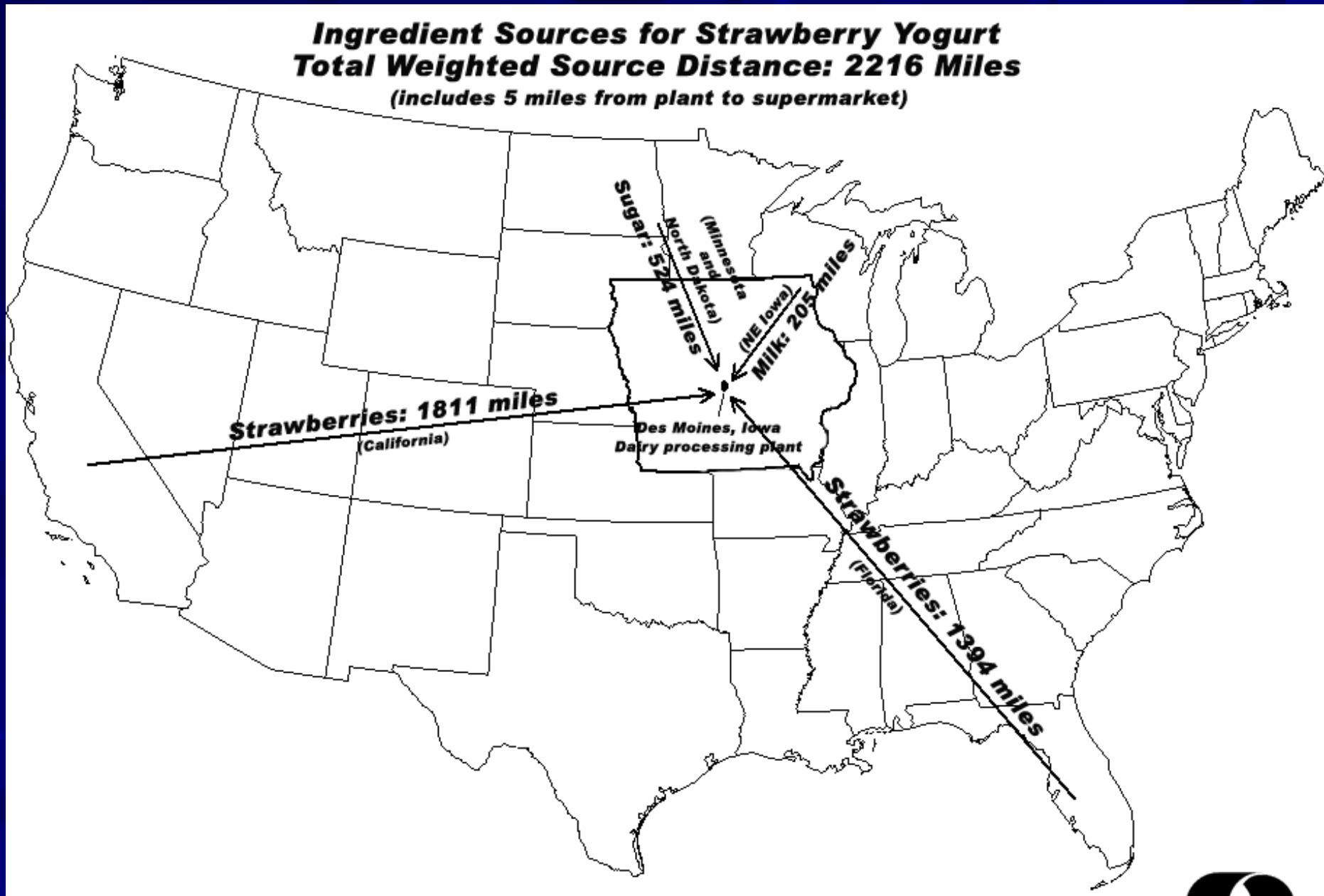
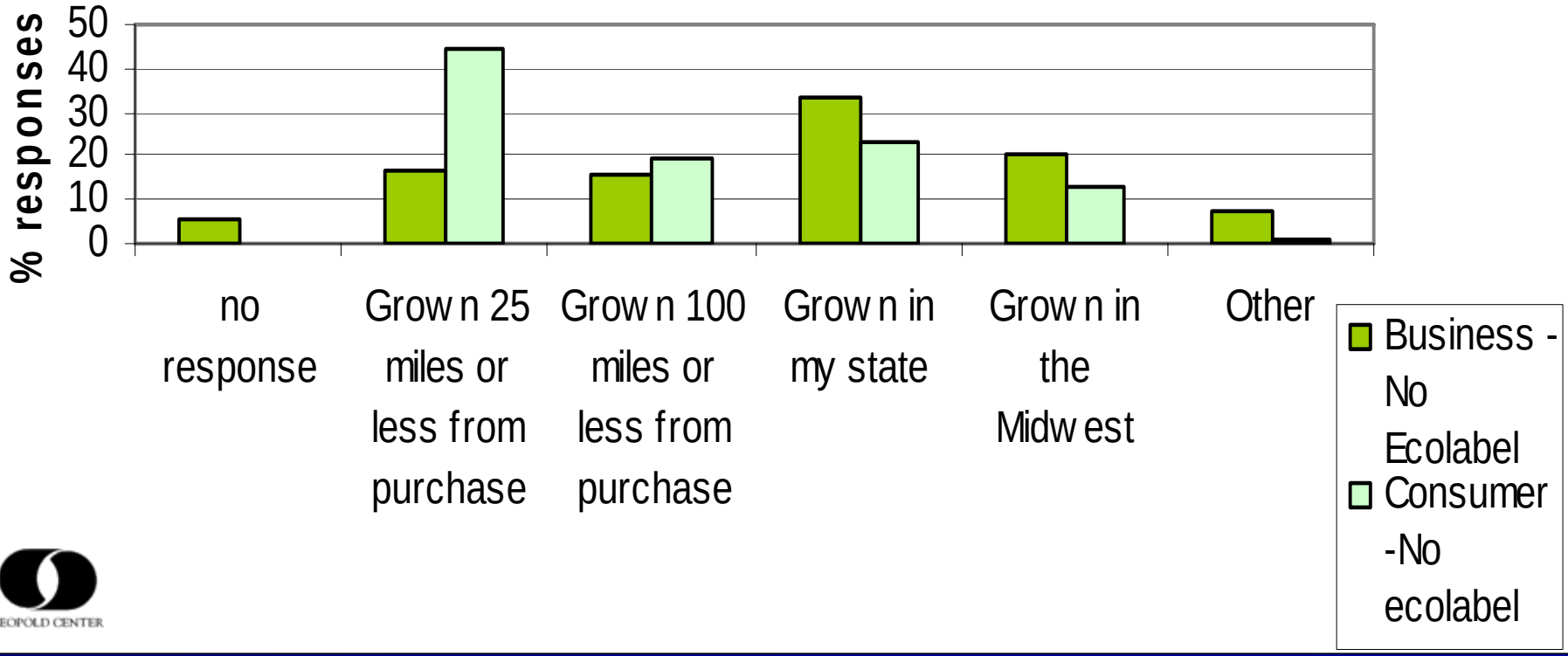

Ingredient Sources for Strawberry Yogurt
Total Weighted Source Distance: 2216 Miles
(includes 5 miles from plant to supermarket)
Sugar: 524 miles
(Minnesota and North Dakota)
(NE Iowa)
Milk: 205 miles
Strawberries: 1811 miles
(California)
Des Moines, Iowa
Dairy processing plant
Strawberries: 1394 miles
(Florida)

Ecolabel Value Assessment – Phase I

What do you consider "local" when making a food purchase or carrying a food product through your store or business?



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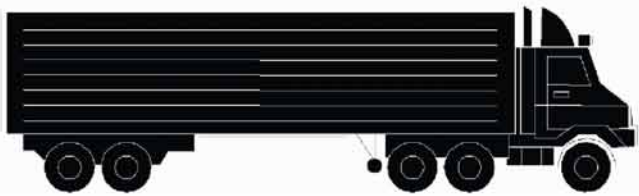
Environmental impact of food transportation

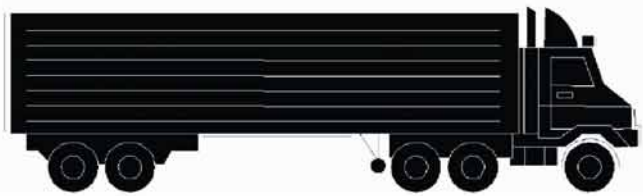
Estimating fuel usage, CO_2 emissions and miles traveled

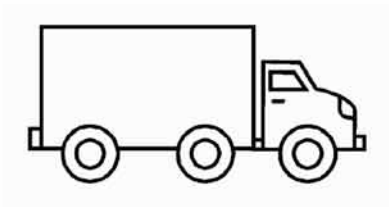
Three food (produce) distribution systems

- **Conventional system** — integrated retail/wholesale national system using semitrailer trucks



- **Iowa-based regional system** — based on existing regional distribution system using semitrailer and midsized trucks





- **Local system** — CSA/farmers markets and institutional markets using light trucks

Estimated fuel consumption, CO2 emissions, and distance traveled for three truck-based food transport systems.

Food transport system	Fuel Consumption (gal/year)	Co2 Emissions (lbs./year)	Distance traveled (miles)
National semitrailer	368,000	8,400,000	2,245,000
Regional midsize truck	44,000	993,000	370,000
Local small truck (institutional)	88,000	1,730,000	1,518,000

From: Food, Fuel, and Freeways – Leopold Center, 2001. Each system was to transport 10% of per capita consumption of fresh produce to feed Iowa

Food miles & CO_2 emissions in Japan

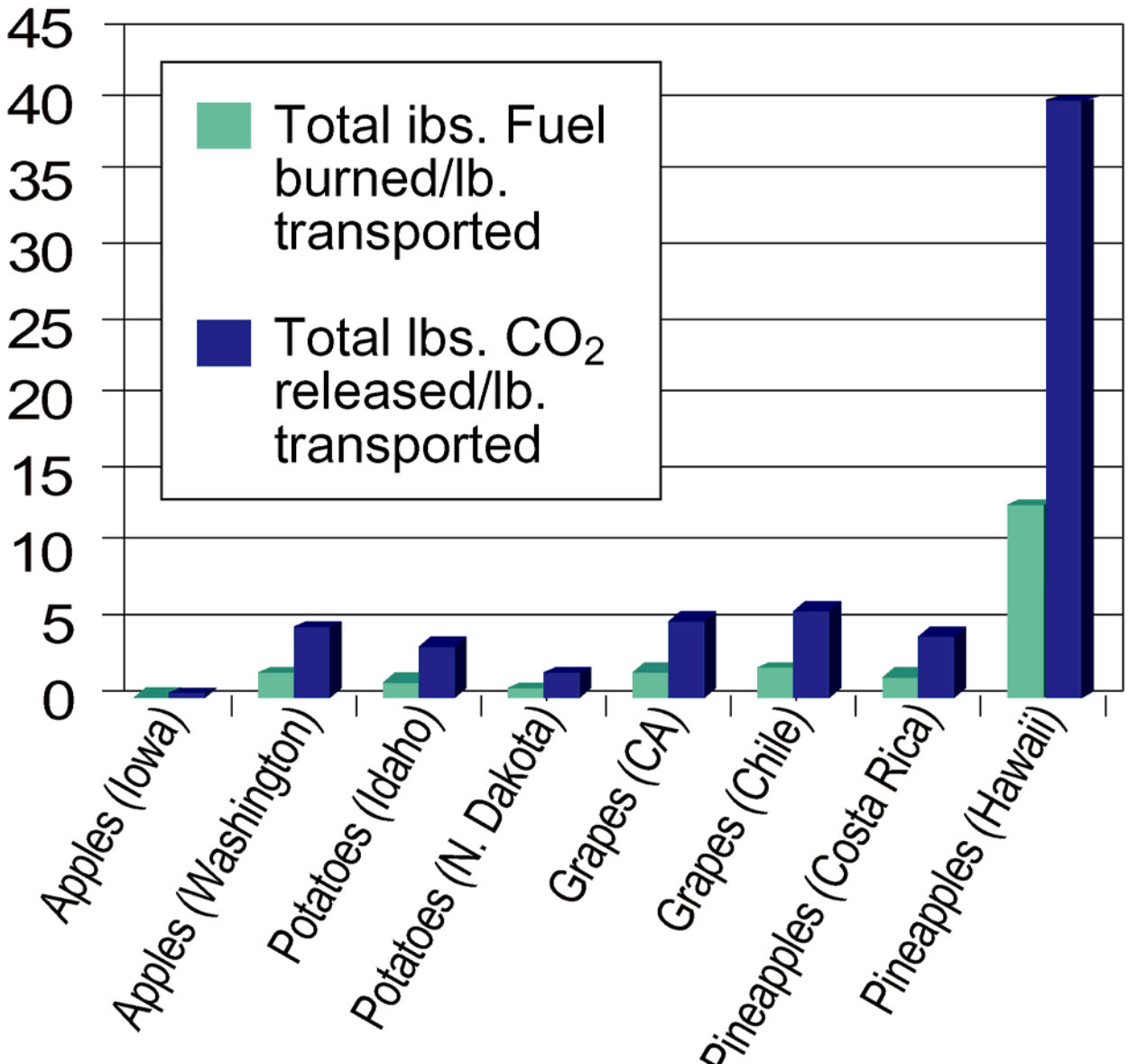
- CO_2 emission levels from transportation sector in Japan is rising rapidly: 21% increase between 1990-1998, and 40% by 2010.
- Transportation of agricultural products is largely responsible : total distance traveled thru Japan's food imports is 500 billion t-km.
- Significance of local markets such as Teikei for minimizing environmental adverse effects from transportation needs to be verified.

From "CO2 Emissions from Transportation of Fresh Vegetables: Comparison among Local, National and International Markets" *Yoko Taniguchi et. al*

Mode of transportation makes a big difference in fuel usage

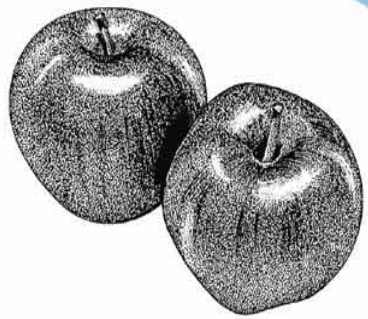
- Air transport
- Truck (road transport)
- Rail
- Water

Comparison of fuel usage and CO_2 emissions to transport selected produce items to Des Moines, Iowa supermarket



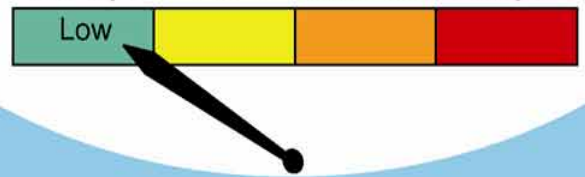
Food miles ecolabel
Point of purchase: supermarket
in Des Moines, Iowa

Apples



Source: Iowa
Food miles (farm-to-store distance): 60 miles
Transported by:

Transport Environmental Impact



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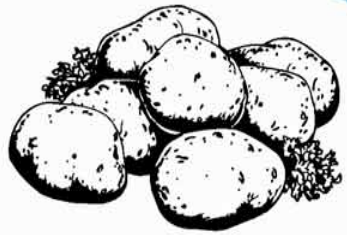
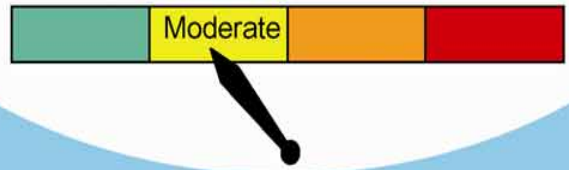
Food miles ecolabel
Point of purchase: supermarket
in Des Moines, Iowa

Potatoes



Source: North Dakota
Food miles (farm-to-store distance): 558 miles
Transported by:

Transport Environmental Impact



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Food miles ecolabel
Point of purchase: supermarket in Des Moines, Iowa

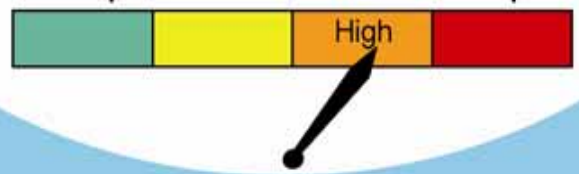
Table grapes

Source: Chile

Food miles (farm-to-store distance): 7268 miles

Transported by:

Transport Environmental Impact



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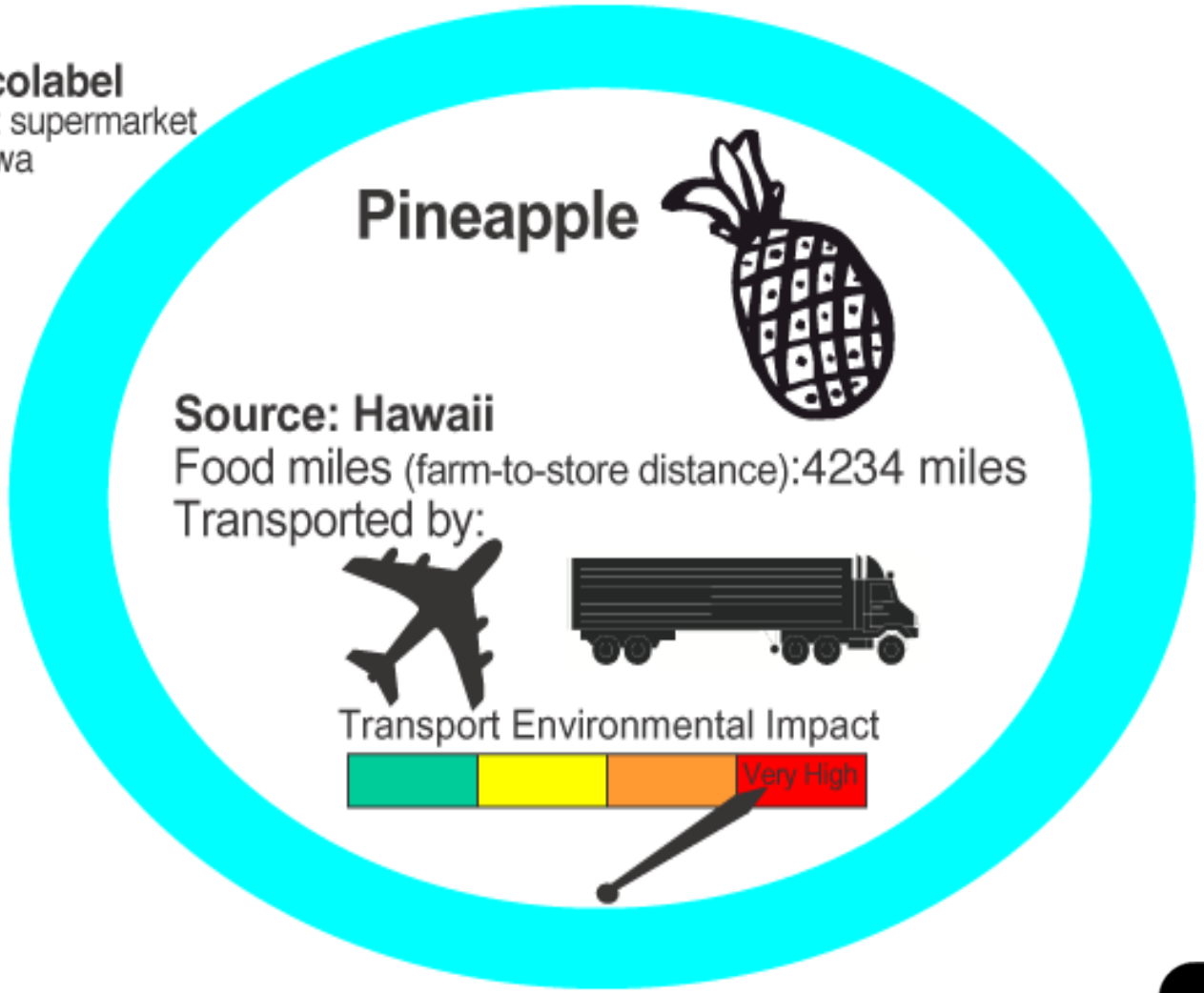
Food miles ecolabel
Point of purchase: supermarket
in Des Moines, Iowa



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Limitations in using food miles

- Higher food miles for certain foods don't always translate into higher energy use
- Local foods grown in greenhouses might use more energy than foods grown in open fields and transported across U.S.
- Need to apply Life Cycle Analysis to agricultural products

Summary

- Food miles offer a simple metaphor to contrast food systems (local vs. global)
- Developing or redeveloping a local or regional food system may help reduce fuel use and greenhouse gas emissions (food transport)
- Mode of transport plays a key role in total fuel usage and greenhouse gas emissions
- Need to apply LCA to agricultural products

Iowa Produce Market Potential Calculator

- Uses national per capita consumption data
- USDA Ag Census and other production data
- Compares “supply and demand”
- Makes assumptions that markets are local and regional (these assumptions don’t work for California, Texas, Florida for many of their produce items).

Iowa Produce Market Potential Calculator

- A market discovery tool for farmers
- A transportation/logistics tool for farmers, distributors, retailers
- An economic impact tool for local food groups

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Iowa Produce Market Potential Calculator

Demand for

Apples

Pounds

Per Year

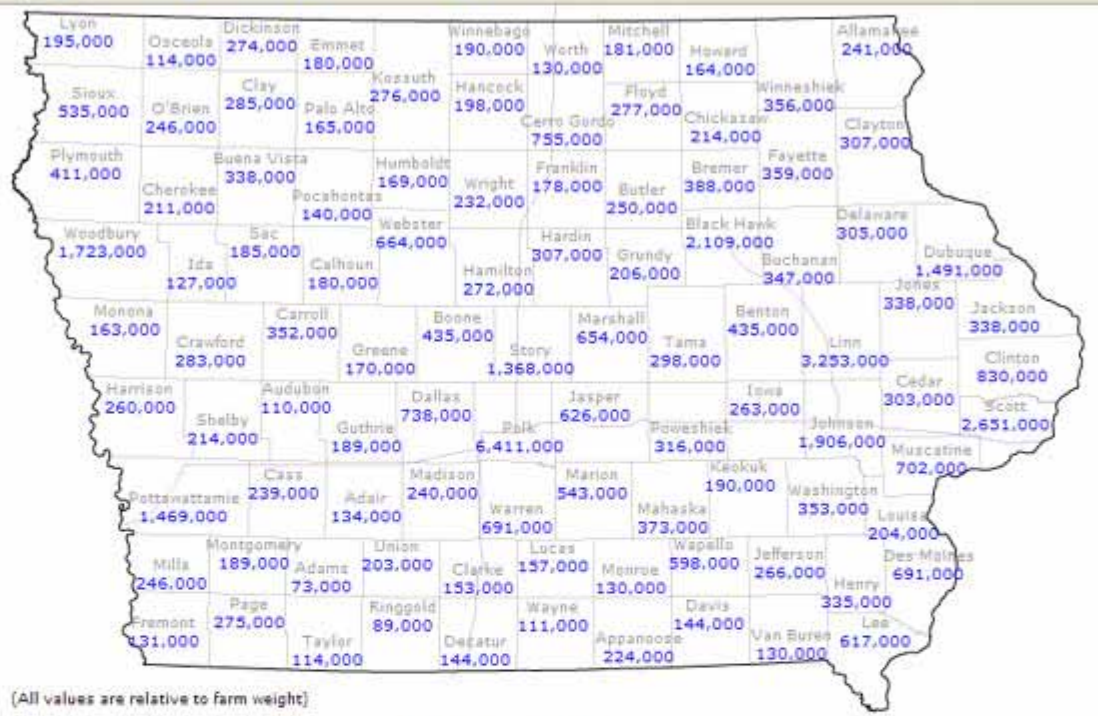
Target market share: 100 %

Iowa yield: 100 %

Iowa acreage: 100 %

Calculate Reset

IOWA STATE UNIVERSITY



(All values are relative to farm weight)

State Data

Demand: Apples
Pounds per Year

State Total: 48,937,000

Per Capita: 16.7

Target Market Share: 100%

Adjusted Iowa Yield: 7,237

National Yield: 21,800

Ratio: 33%

County Data

Demand: Apples

County	Pounds per Year
Adair	133,534
Adams	73,100
Allamakee	240,752
Appanoose	223,985
Audubon	109,767
Benton	434,803
Black Hawk	2,108,897
Boone	435,236
Bremer	388,386
Buchanan	347,402

County	Pounds per Year
Jefferson	265,735
Johnson	1,905,962
Jones	338,019
Keokuk	190,018
Kossuth	276,485
Lee	616,654
Linn	3,253,004
Louisa	203,535
Lucas	157,334
Lyon	194,551

Done

Scenario

- Twenty-five percent of 37 selected fruits and vegetables consumed in the state over a calendar year are grown by Iowa farmers
- *Apples, Apricots, Asparagus, Beans (Snap),Blackberries, Blueberries, Broccoli, Cabbage, Cantaloupes, Carrots, Cauliflower, Cherries, Cucumbers, Eggplant, Garlic, Grapes, Greens/Collards, Lettuce (Head), Lettuce (Leaf), Nectarines, Okra, Onions, Peaches, Pears, Peppers (Bell), Plums, Potatoes (Fresh), Potatoes (Sweet), Pumpkins, Radishes, Raspberries, Spinach, Squash, Strawberries, Sweet Corn, Tomatoes, Watermelons*

Assumptions

- Increased production in fruits and vegetables will reduce corn and soybean production
- All new fruit and vegetable sales would be farmer to consumer (direct-market) sales
- Existing food store retail sales (actually retail margins) will be reduced by an amount proportionate to coincide with the new direct market sales
- All of the production to meet this goal of 25 percent is for in-state consumption

Baseline Values

Scenario 1			
	Fruits	Vegetables	Total
Farm Pounds	31,903,024	154,976,807	186,879,831
Farm Acres	4,881	10,508	15,389
Farm Receipts	8,921,120	28,149,128	37,070,249
Retail Pounds	26,450,359	126,047,947	152,498,306
Gross Retail Receipts	31,217,012	105,322,688	136,539,699
Retail Margin Offset	(8,584,678)	(28,963,738)	(37,548,416)
Corn Offset	(785,053)	(1,690,176)	(2,475,228)
Soybean Offset	(486,896)	(1,048,260)	(1,535,155)
Direct Marketing Output	22,295,891	77,173,559	99,469,451

Modeling Data Inputs

- Farm Pounds
- Farm Receipts
- Farm Acres
- Retail Pounds
- Retail Receipts
- Corn and soybean offsets

Modeling Foundations

- *Iowa Produce Market Potential Calculator*

- *IMPLAN*, as modified for this assessment.

  IMPLAN is an I-O model that tracks the purchases and sales of “goods” between industries, businesses, and final consumers

- Census of Agriculture

Some definitions in the model

- Total output – gross sales
- Labor income – wages/salaries, cash-like benefits, as well as returns to labor and management
- Jobs – number of positions in a sector
- Direct – initial set of expenditures or production changes
- Indirect –value of supplies and services purchases by “Direct” industry
- Induced – workers in the “Direct” industry take their labor incomes and convert them into household-level purchases
- Multiplier – Quotient of the total economic values divided by the direct values

Fruit and Vegetable Farming	Direct	Indirect	Induced	Total	Total Multiplier
Total Industrial Output	37,070,248	9,007,737	9,515,237	55,593,224	1.50
Labor Income	9,629,401	3,319,123	3,056,805	16,005,329	1.66
Jobs	190.1	123.7	119.9	433.7	2.28

Grain and Soybean Offset	Direct	Indirect	Induced	Total	Total Multiplier
Total Industrial Output	(4,010,383)	(1,261,203)	(1,134,362)	(6,405,948)	1.60
Labor Income	(1,107,308)	(406,059)	(364,417)	(1,877,784)	1.70
Jobs	(41.8)	(14.3)	(14.3)	(70.5)	1.69

Direct Marketing	Direct	Indirect	Induced	Total	Total Multiplier
Total Industrial Output	99,469,448	25,760,500	42,646,762	167,876,710	1.69
Labor Income	49,492,352	8,566,843	13,700,431	71,759,627	1.45
Jobs	2,341.7	255.4	537.5	3,134.7	1.34

Retail Offset	Direct	Indirect	Induced	Total	Total Multiplier
Total Industrial Output	(37,548,416)	(5,848,227)	(13,716,190)	(57,112,831)	1.52
Labor Income	(17,431,646)	(2,049,468)	(4,406,414)	(23,887,528)	1.37
Jobs	(933.9)	(65.3)	(172.9)	(1,172.1)	1.26

Total Economic Effects	Direct	Indirect	Induced	Total
Total Industrial Output (Sales)	94,980,897	27,658,807	37,311,447	159,951,155
Labor Income	40,582,799	9,430,439	11,986,405	61,999,644
Jobs	1,556.1	299.5	470.2	2,325.8

Total Economic Effects Accounting for All Existing Statewide Production	Direct	Indirect	Induced	Total
Total Industrial Output	83,090,335	24,192,384	32,615,679	139,898,402
Labor Income	35,467,985	8,250,353	10,477,877	54,196,216
Jobs	1,358.4	262.1	411.0	2,031.5

Cautions

- Outputs (findings) are only as good as our inputs (data)
- IMPLAN and other input-output models make certain assumptions about the economy that may not totally apply to local/regional food enterprises
- This is a scenario – the gap from current production levels to the scenario would require a significant investment in technical and financial resources
- Assumes that retail food stores and the traditional sources of production (California, Texas) would allow this to happen

For more information

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