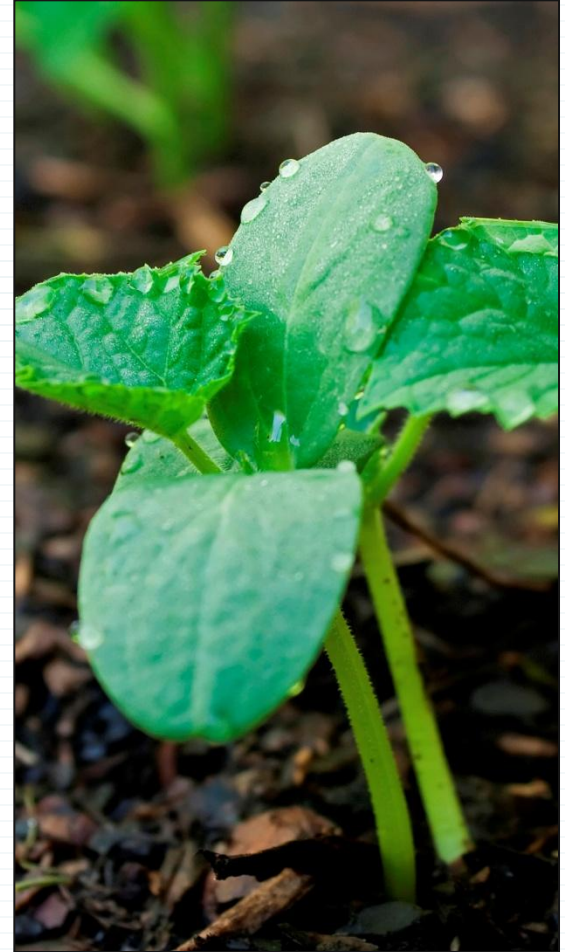
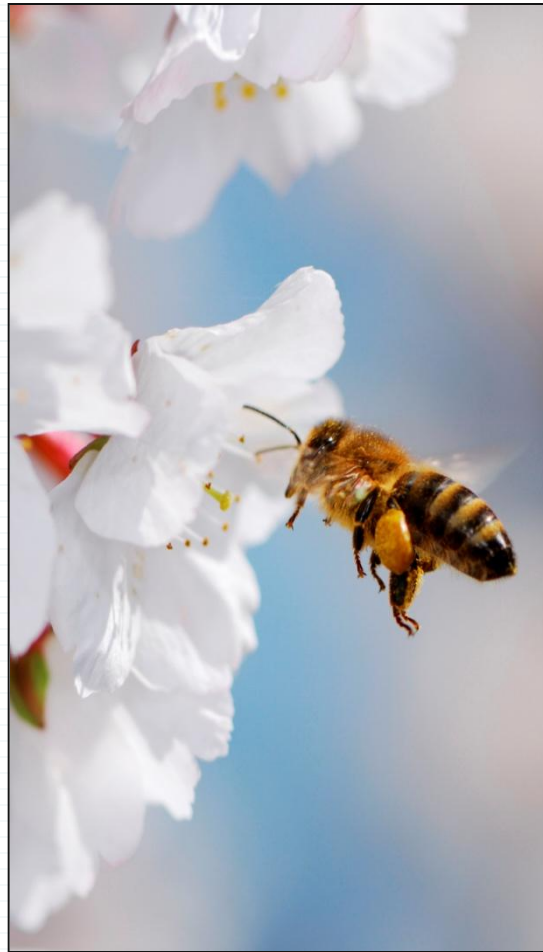


AGRICULTURE AND ECOSYSTEMS | *SLIDES*



Images copyright.



Overview

- **Food, agriculture and ecosystems**
- **Problems in agriculture**
- **Organic agriculture**
- **Sustainable agriculture**
- **Think-pair-share**

Essential questions

- Where does our food come from? How is our food supply dependent on ecosystems?
- How do current agricultural practices affect public health, social justice, the environment and the economy?
- What can be done to address the current problems facing agriculture?
- How does an industrial approach to agriculture compare with organic and sustainable approaches?
- If the prevailing practices in agriculture continue, what kind of food system can we expect in the future? What kind of agriculture *should* we strive toward, and how will we get there?



Overview

- **Food, agriculture and ecosystems**

Problems in agriculture

Organic agriculture

Sustainable agriculture

Think-pair-share

Food, agriculture and ecosystems

Soil

- Foundation of farm ecosystems
- Foundation of food supply
- Sustains plants by providing:
 - Water
 - Nutrients
 - Root support

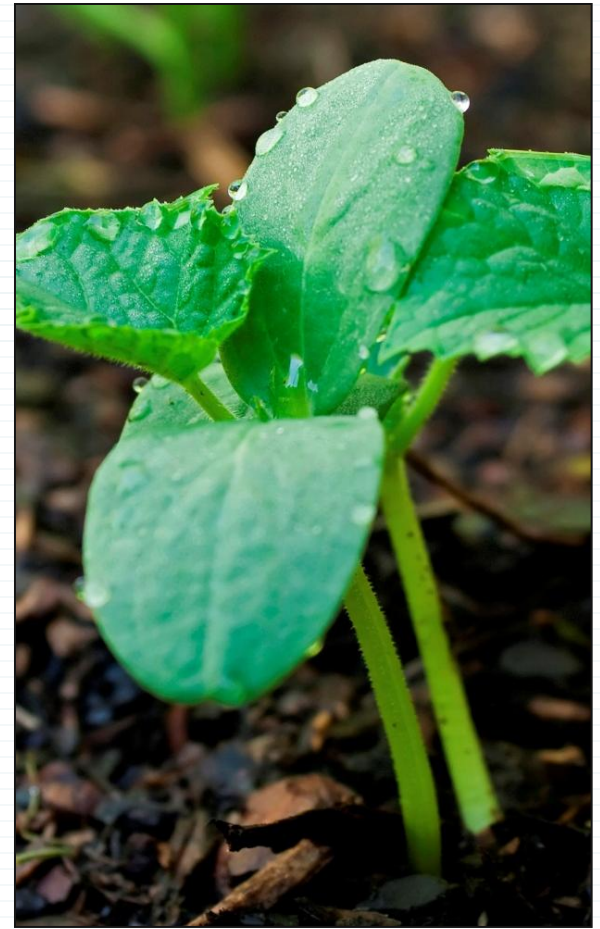
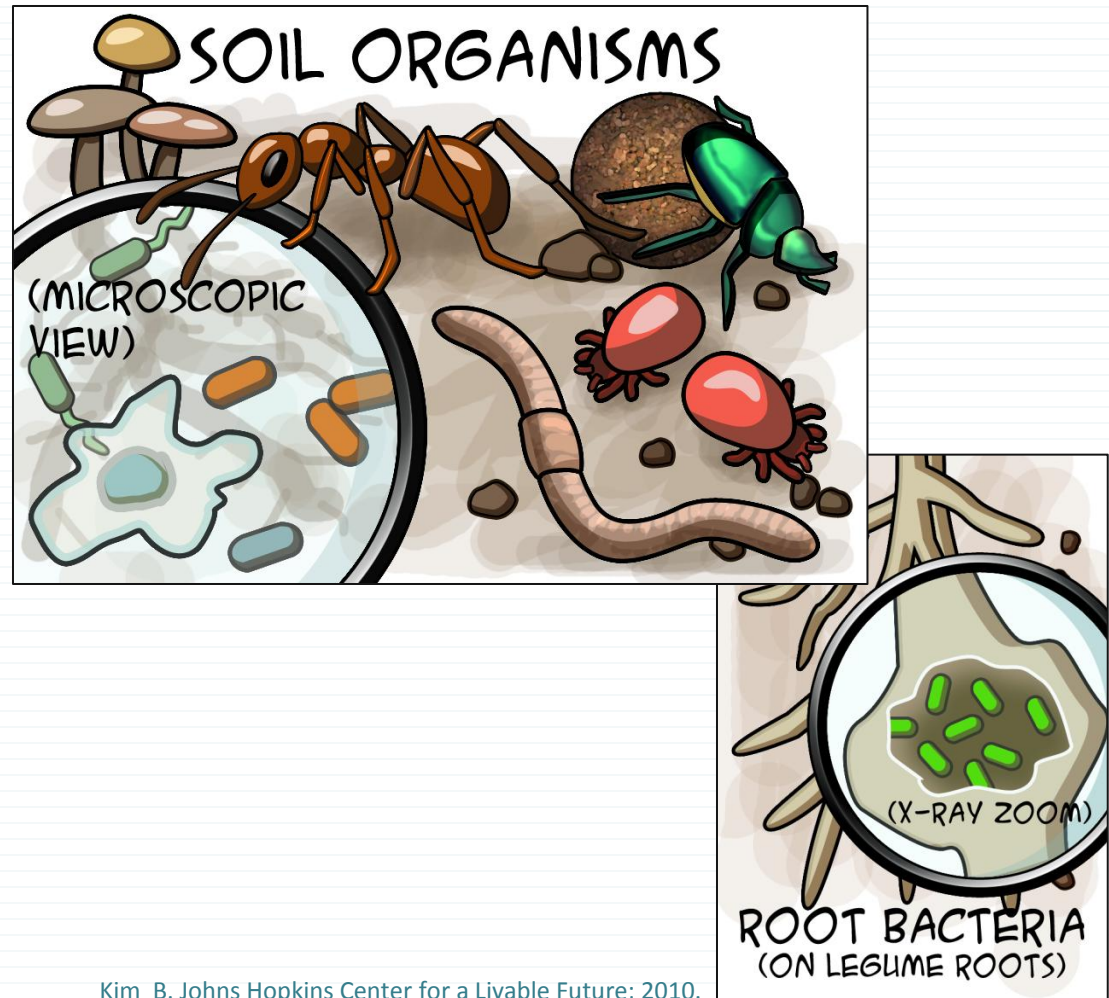


Image copyright.

Food, agriculture and ecosystems

Soil organisms

- Bacteria
- Arthropods
- Earthworms
- Fungi
- Nematodes
- Protozoa
- Mammals
- Etc.

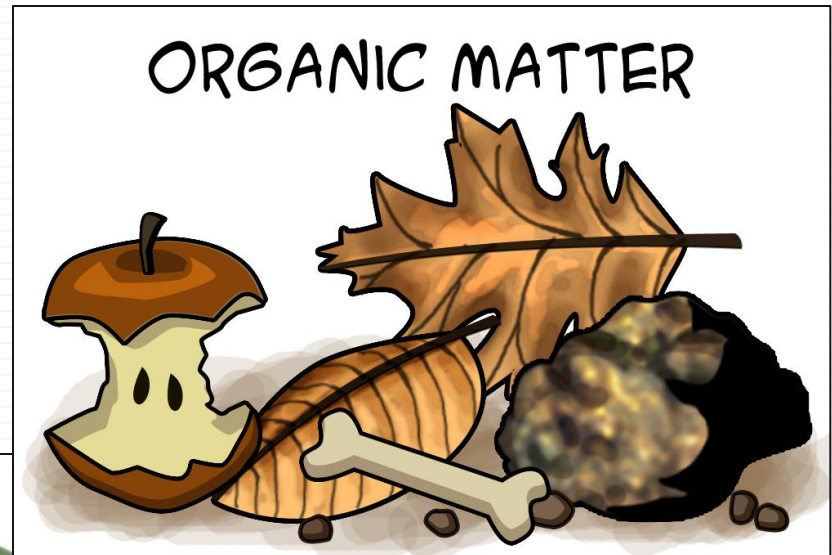


Kim B. Johns Hopkins Center for a Livable Future; 2010.

Food, agriculture and ecosystems

Soil organic matter

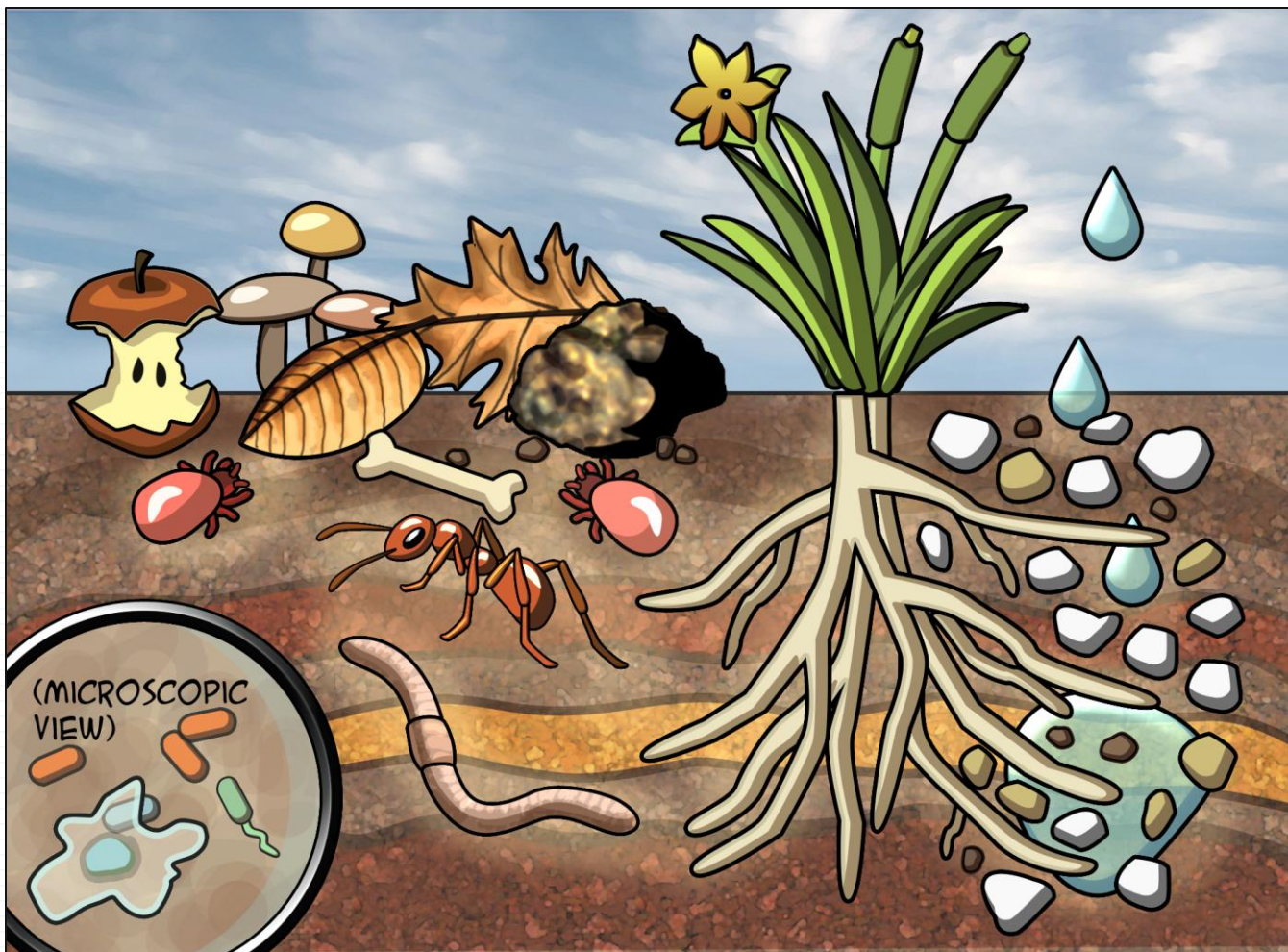
- Decaying leaves
- Dead organisms
- Animal manure
- Food waste
- Etc.



Top: Kim B. Johns Hopkins Center for a Livable Future; 2010. Other images copyright.

Food, agriculture and ecosystems

Soil food web



Kim B. Johns Hopkins Center for a Livable Future; 2010.

Food, agriculture and ecosystems

Climate



U.S. Global Change Research Program. www.globalchange.gov.

Food, agriculture and ecosystems

Fresh water



Image copyright.

Food, agriculture and ecosystems

Irrigation

- Irrigation, salinization led to decline of Sumer
- 67% U.S. Freshwater use for irrigation



Image copyright.

Wild Biodiversity

- Pollinators responsible for 35% of the global food supply



Image copyright.

Food, agriculture and ecosystems

Domestic Biodiversity

- Variety of plant, animal species grown and raised for food



Socially Responsible Agriculture Project. *Vegetables at a Farmers Market*. 2009. www.sraproject.org.

Food, agriculture and ecosystems

Consequences of mismanagement

- Dust Bowl: soil erosion across midwestern U.S.



USDA. *Buried machinery in barn lot in Dallas, South Dakota, United States during the Dust Bowl. 1936.* Available at Wikimedia Commons. Public domain.



Overview

Food, agriculture and ecosystems

- **Problems in agriculture**

Organic agriculture

Sustainable agriculture

Think-pair-share

Problems in agriculture

Fertilizers and aquatic ecosystems

- Nutrient runoff promotes algal blooms, dead zones

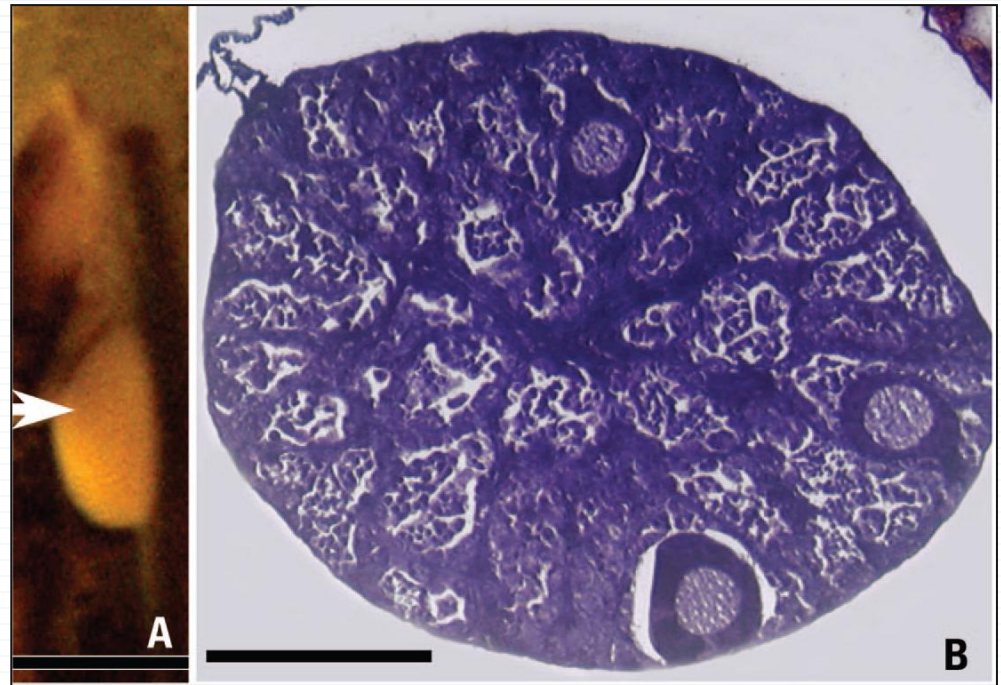


Left: U.S. Fish & Wildlife Service. digitalmedia.fws.gov/.
Right: Images copyright.

Problems in agriculture

Pesticides and ecosystems

- Deformities, sex reversals in amphibians
- Declining pollinator populations
- Compromised immune systems in dolphins, seals, whales



Hayes et al. *Atrazine-induced hermaphroditism at 0.1 ppb in American Leopard Frogs (*Rana pipiens*): Laboratory and field evidence.* 2009.

Problems in agriculture

The treadmill effect

- Continually need to apply more chemicals to achieve desired effect

Synthetic fertilizers



Chemical pesticides

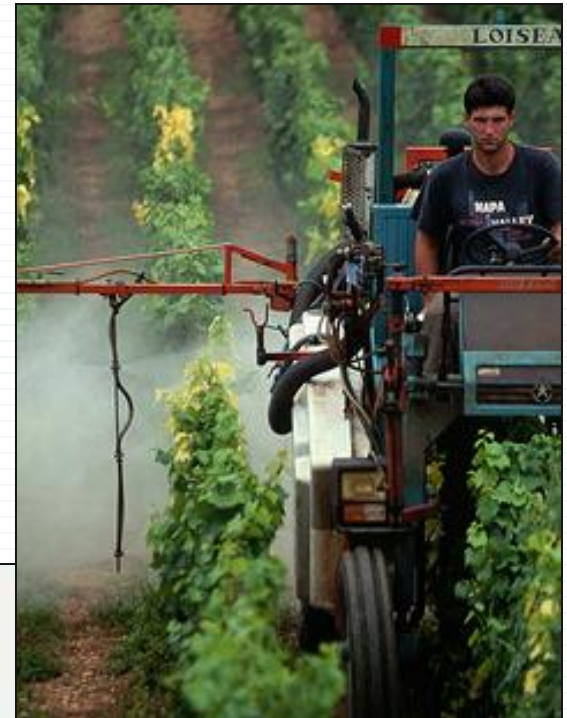


Ammonia plant: Image copyright. Chemical pesticides: O'Rear C. *Spraying Pesticide in California*. USDA. Available at Wikimedia Commons. Public domain.

Problems in agriculture

Agricultural chemicals and health

- Cancers
- Reproductive harms
- Endocrine disruption
- Nervous system impacts
- Acute poisonings
- Death



Top: Tpmartins. *Tractor spraying pesticides*. 2009.
Available at Flickr Commons. Public Domain.
Bottom: Beseler C. *Environmental Health News*.
Used with permission from the photographer.

Problems in agriculture

Wild biodiversity loss: Insecticides



- Impacts to pollinators, predators of pests



Left: O'Rear C. *Spraying Pesticide in California*. USDA. Available at Wikimedia Commons. Public domain. Other images copyright.

Problems in agriculture

Wild biodiversity loss: Monocultures

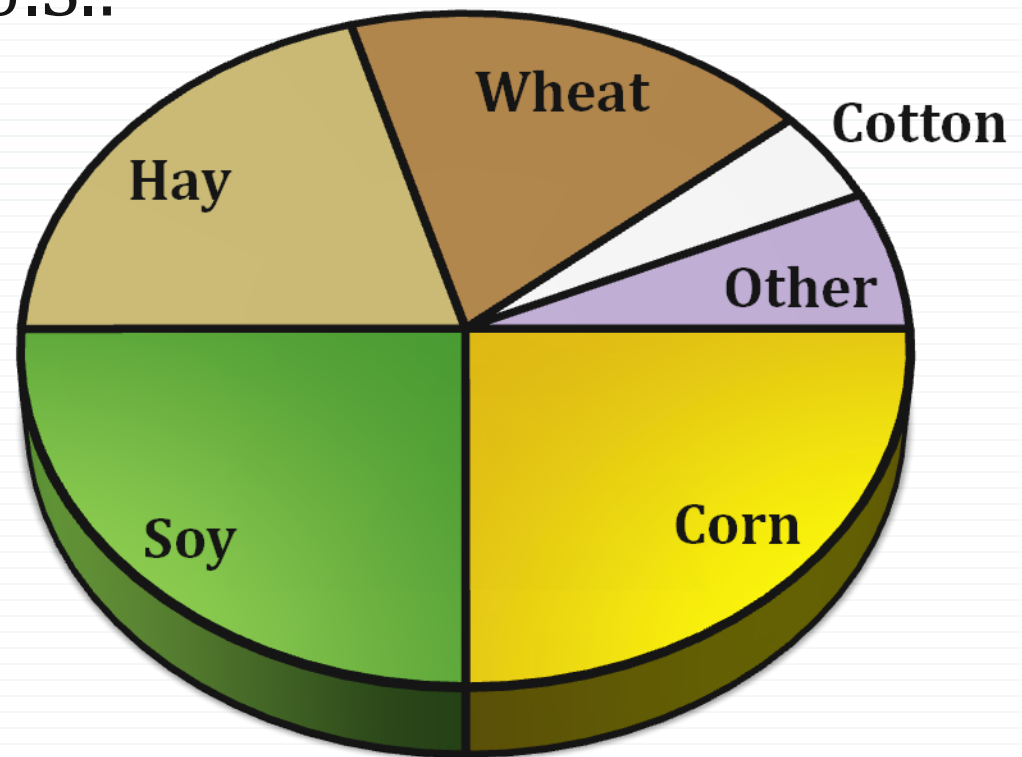


Image copyright.

Problems in agriculture

Domestic biodiversity loss

- Acres of harvested crop land in the U.S.:

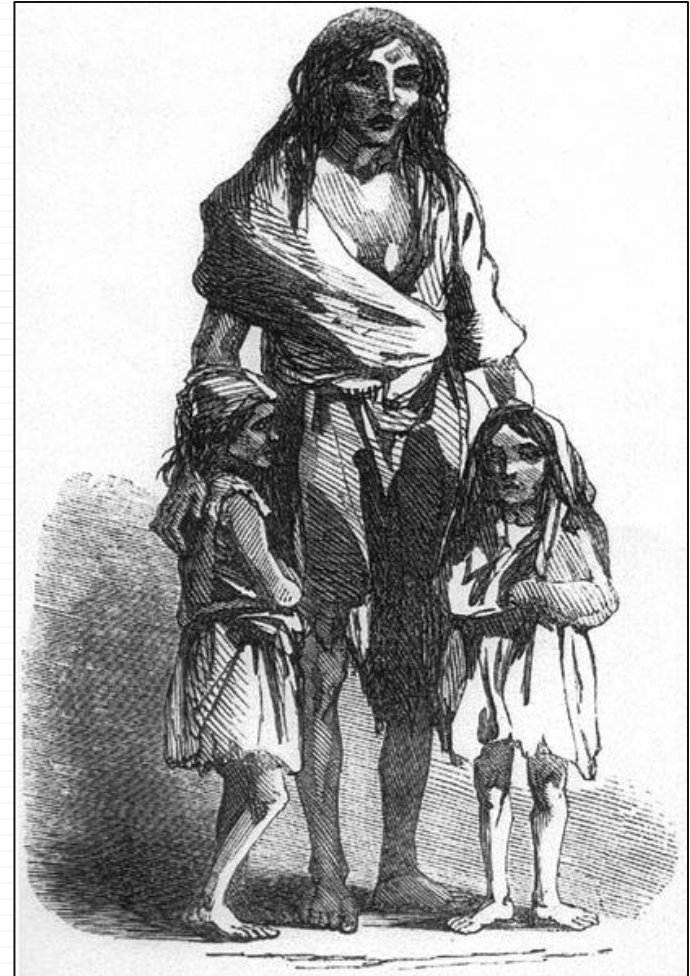


Adapted from: U.S. EPA. *Major Crops Grown in the United States*. 2000. www.epa.gov/agriculture/ag101/cropmajor.html.

Problems in agriculture

Domestic biodiversity and food security

- Irish Potato Famine
- Mid 1800s
- Million people die of famine
- Not enough genetic variation in potato crop

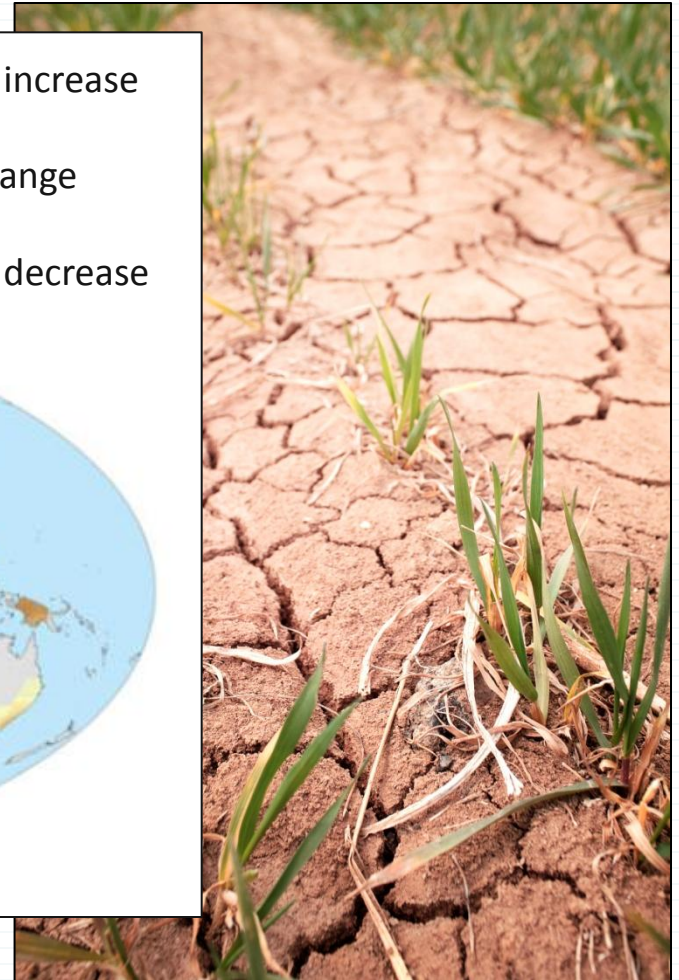
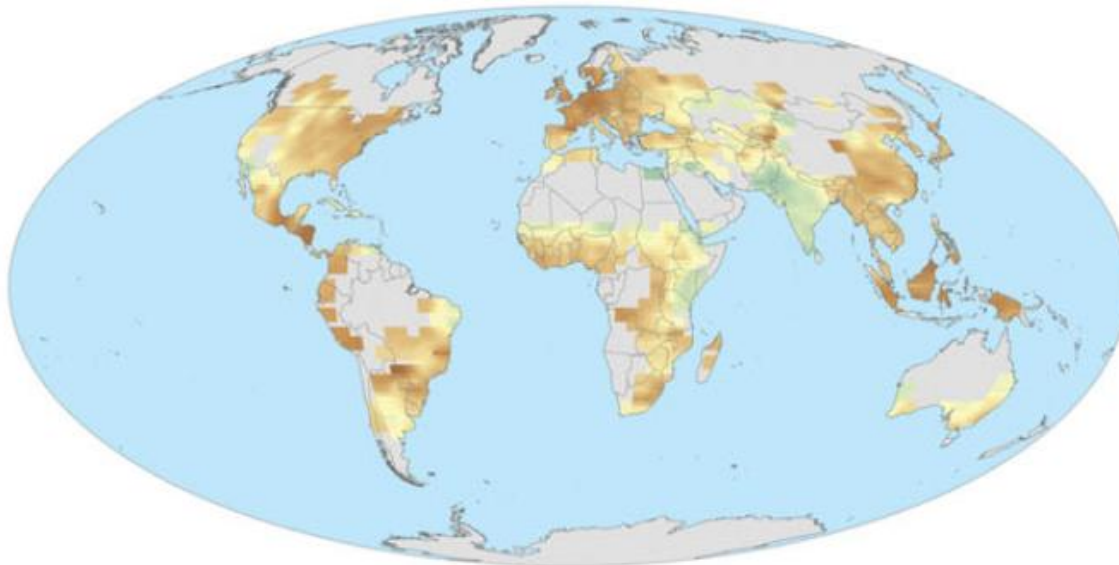
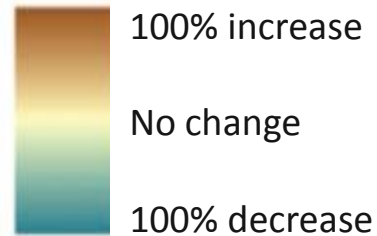


Illustrated London News. *Bridget O'Donnel and children*. December 22, 1849. Public domain.

Problems in agriculture

Climate change

Cropland in 2050:
Percent change in time spent
under drought conditions,
relative to 2000.

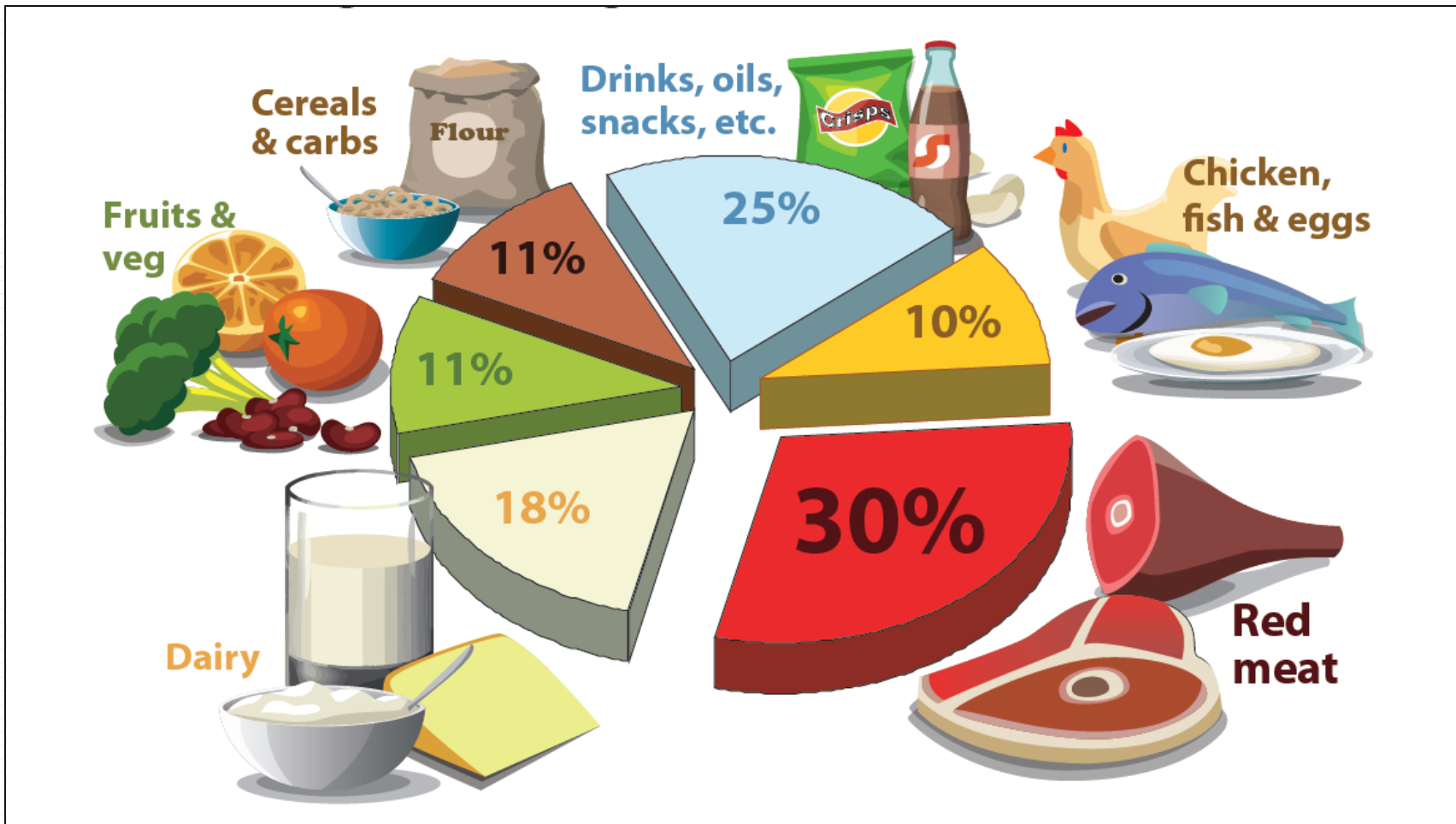


Adapted from Gornall J, Betts R, Burke E, et al. Implications of climate change for agricultural productivity in the early twenty-first century. *Philosophical Transactions of the Royal Society B: Biological Sciences*. 2010;365(1554):2973-2989 .

Wheat crop during drought. Image copyright.

Problems in agriculture

Sources of GHG emissions

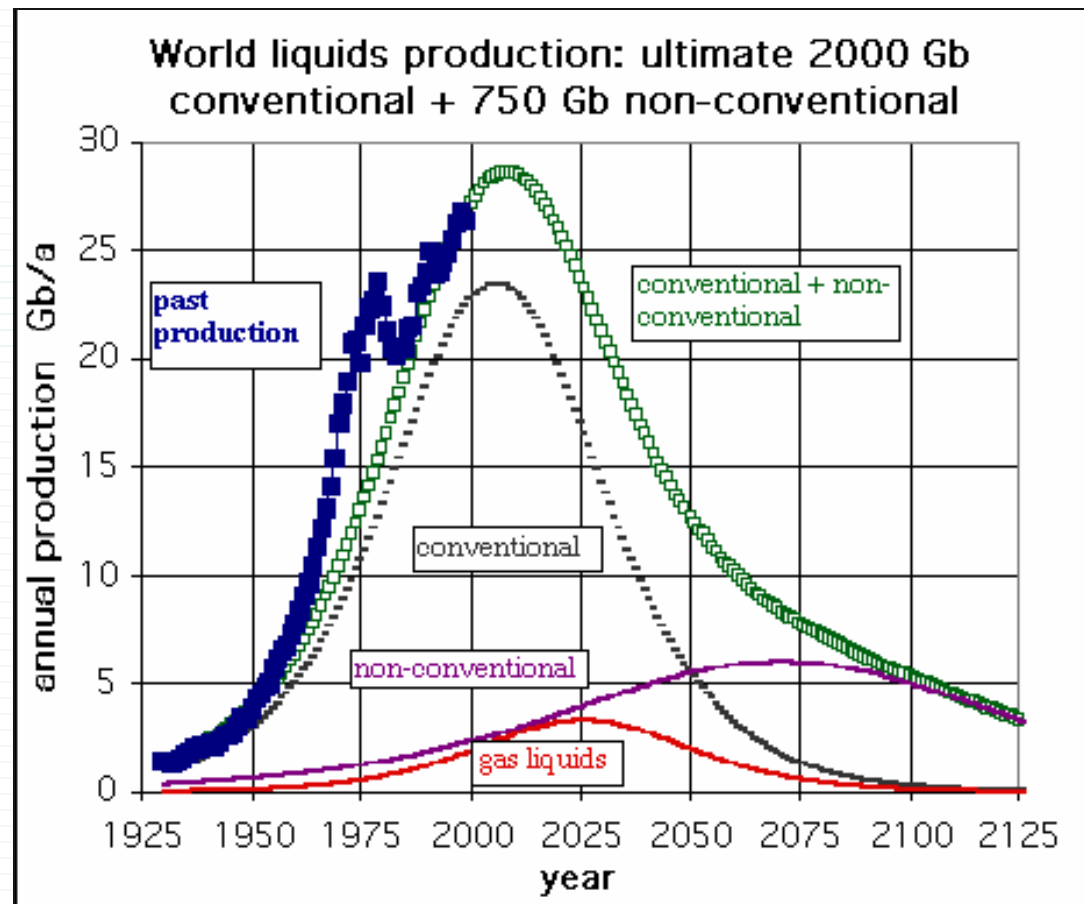


Kim B. Johns Hopkins Center for a Livable Future; 2010. Adapted from Weber C L, Matthews HS. *Food-Miles and the Relative Climate Impacts of Food Choices in the United States. Environmental Science & Technology.* 2008;42 (10), 3508-3513.

Problems in agriculture

Resource depletion

- Fertile soil
- Groundwater
- Fossil fuels
- Phosphate
- Forests
- Etc.



U.S. Department of Energy. www.fossil.energy.gov/programs/reserves/npr/publications/npr_strategic_significancev1.pdf.

Problems in agriculture

Loss of farmland

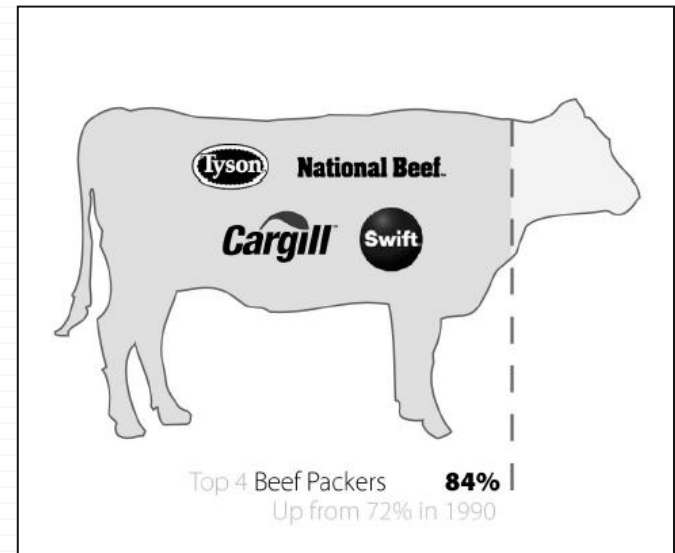
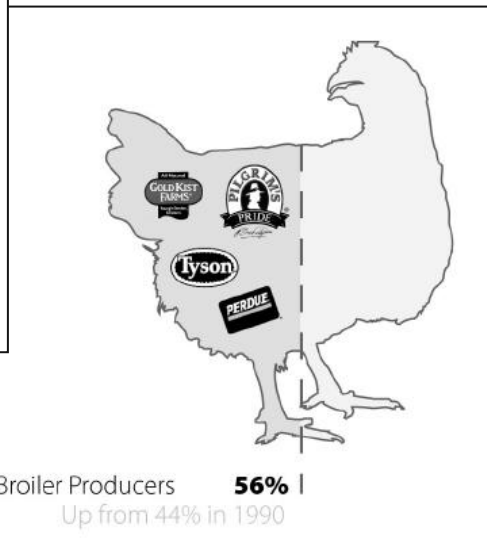
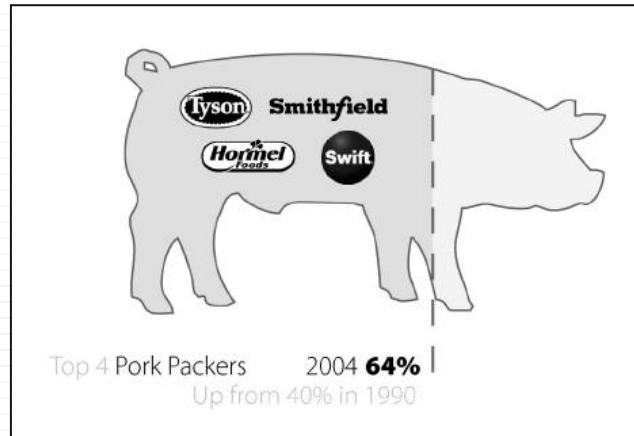
- Two acres per minute paved for developments



Image copyright.

Problems in agriculture

Loss of farmer equity



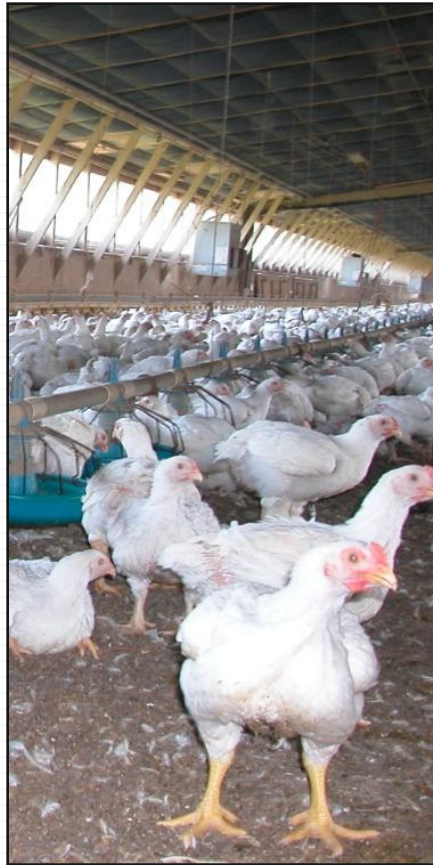
Anna Lappé and theCoup.org.
GRUB Graphics; 2004.
www.eatgrub.org.
Used with permission.

Data from Hendrickson, Heffernan.
Concentration of Agricultural Markets,
University of Missouri; 2005.

Problems in agriculture

Industrial food animal production

Health, social, environmental, animal welfare concerns



Dairy cattle: Image copyright. Poultry: Socially Responsible Agriculture Project. www.sraproject.org.
Hogs: USDA. 2004. Manure sprayer: USDA NRCS photo gallery.

Problems in agriculture

Addressing these problems

- Will require collaborate efforts on the part of:
 - Farmers
 - Industries
 - Consumers
 - Policymakers
 - Other participants in the food system



Overview

Food, agriculture and ecosystems

Problems in agriculture

- **Organic agriculture**

Sustainable agriculture

Think-pair-share

Organic agriculture

USDA definition

- Not allowed in crop production:
 - ❑ Petroleum-based fertilizers
 - ❑ Synthetic pesticides
 - ❑ Sewage sludge
 - ❑ Genetic engineering
- Not allowed in animals:
 - ❑ Hormones
 - ❑ Other growth promoting drugs



Organic agriculture

Benefits

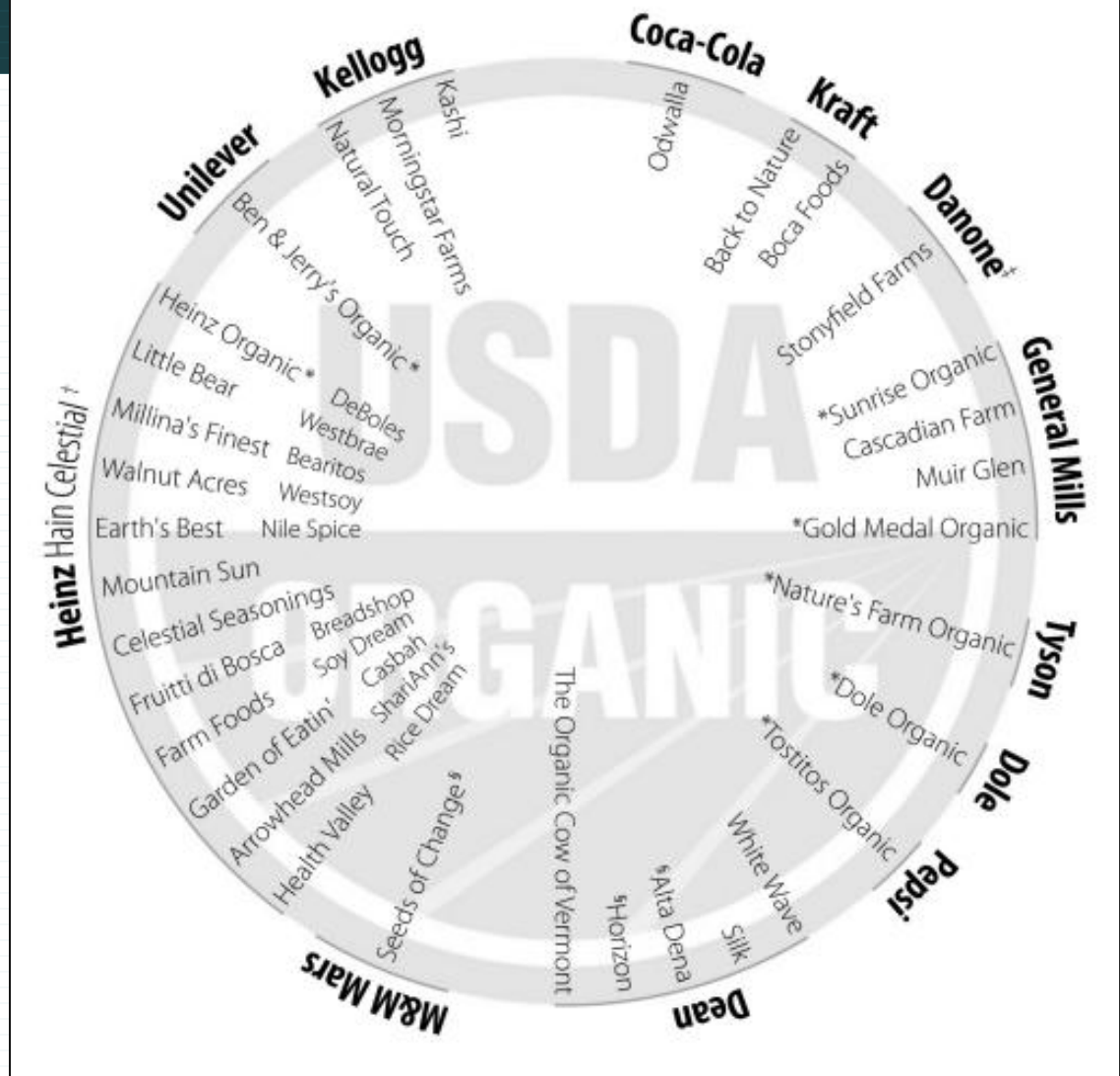
- Reduced chemical contamination of air, water, soil
- Reduced pesticide residues in food
- Fewer occupational health risks
- Etc.

Criticisms

- Originally proposed standards in 1990s would have allowed:
 - Irradiation
 - Sewage sludge
 - Genetically engineered crops
- Generated unprecedented public outcry

Organic agriculture Industry structure

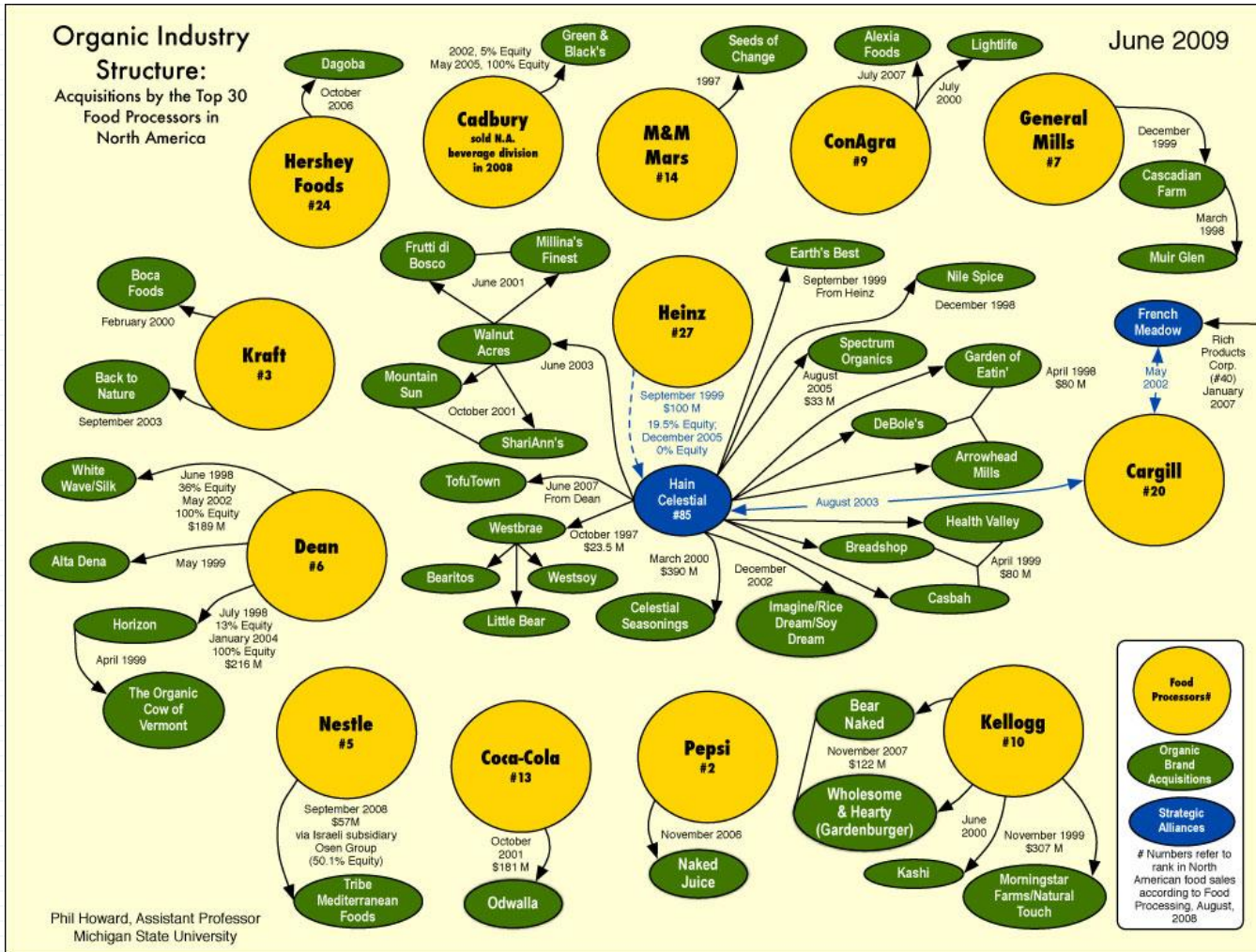
Organic Brands Acquired and introduced by major corporations 1999-2004



Anna Lappé and theCoup.org.
GRUB Graphics; 2004.
www.eatgrub.org
Used with permission.

Data from Howard P. Center for Agroecology
and Sustainable Food Systems, University of
California, Santa Cruz; 2004.

Organic agriculture Industry structure



Howard P.
Michigan State University; 2009.
www.msu.edu/~howardp/organicindustry.html

In defense of “big organic”

- “Business is the most powerful force in the planet; it got us into this mess and is the only force strong enough to get us out.”
- “Most environmental problems exist because businesses have not made solving them a priority.”



Overview

Food, agriculture and ecosystems

Problems in agriculture

Organic agriculture

- **Sustainable agriculture**

Think-pair-share

Definition

- “Meeting the needs of the present... without compromising the ability of future generations to meet their needs.”
- “To maintain, keep in existence, keep going.”
- No universal prescription
 - Every farm is unique
 - Conditions continually changing

Sustainable agriculture

Themes

- Ecologically sound
- Economically viable
- Socially just



Girl with beets: Urban Tilth. Used with permission.
Other images copyright.

Sustainable agriculture

Protecting long-term interests

- Minimizing soil erosion
- Building soil fertility
- Conserving fresh water
- Protecting water quality
- Protecting biodiversity
- Etc.

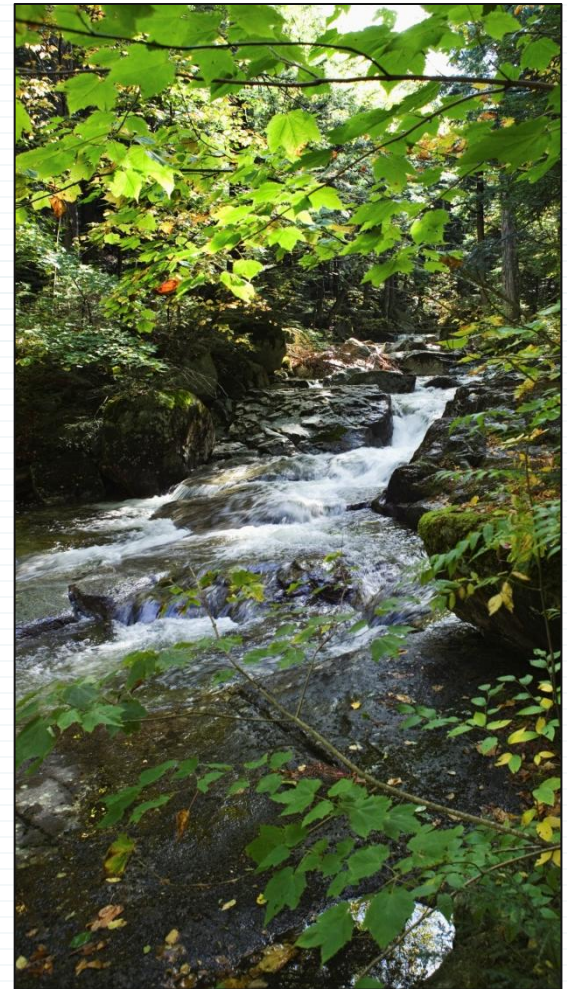
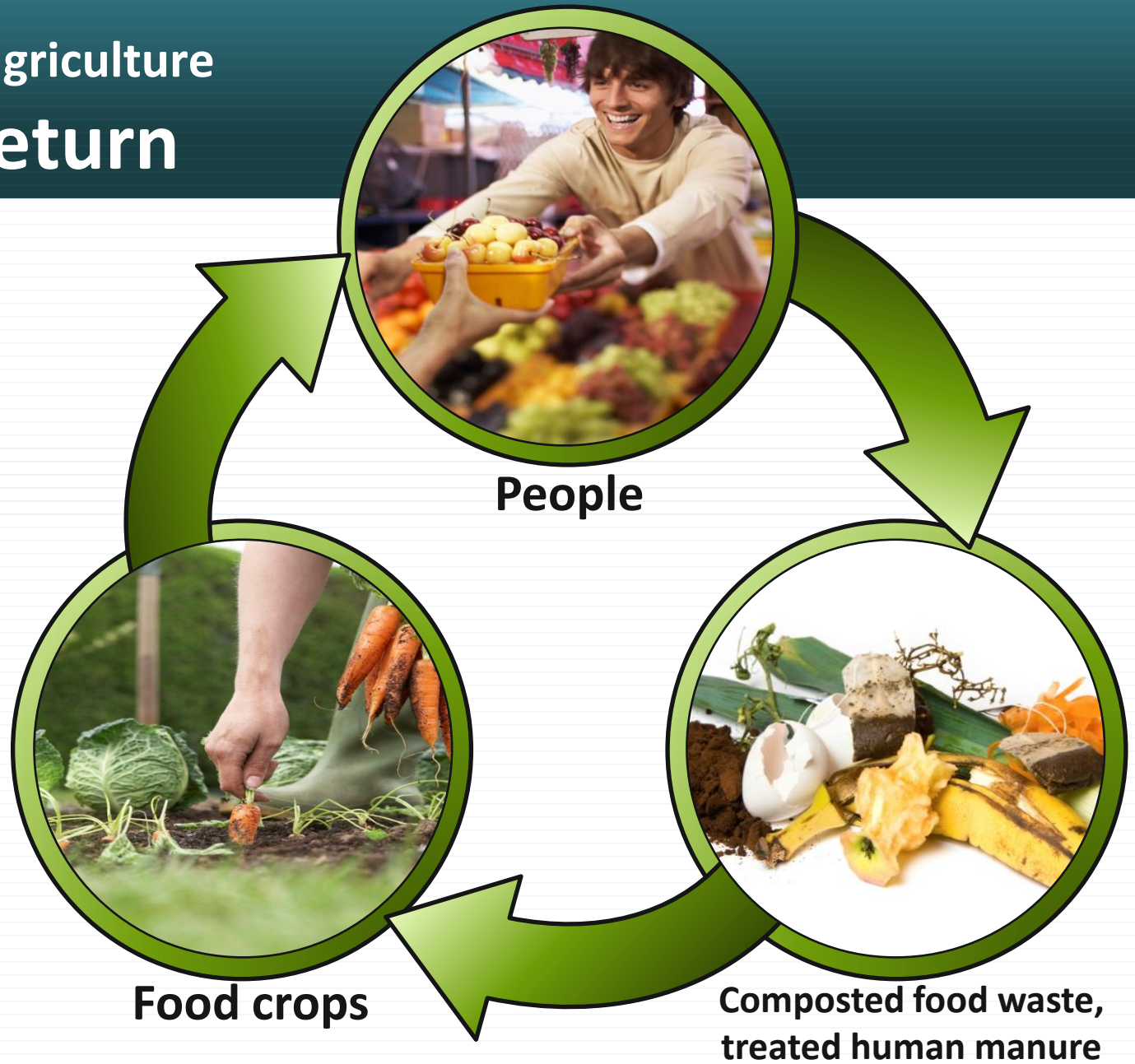


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Sustainable agriculture

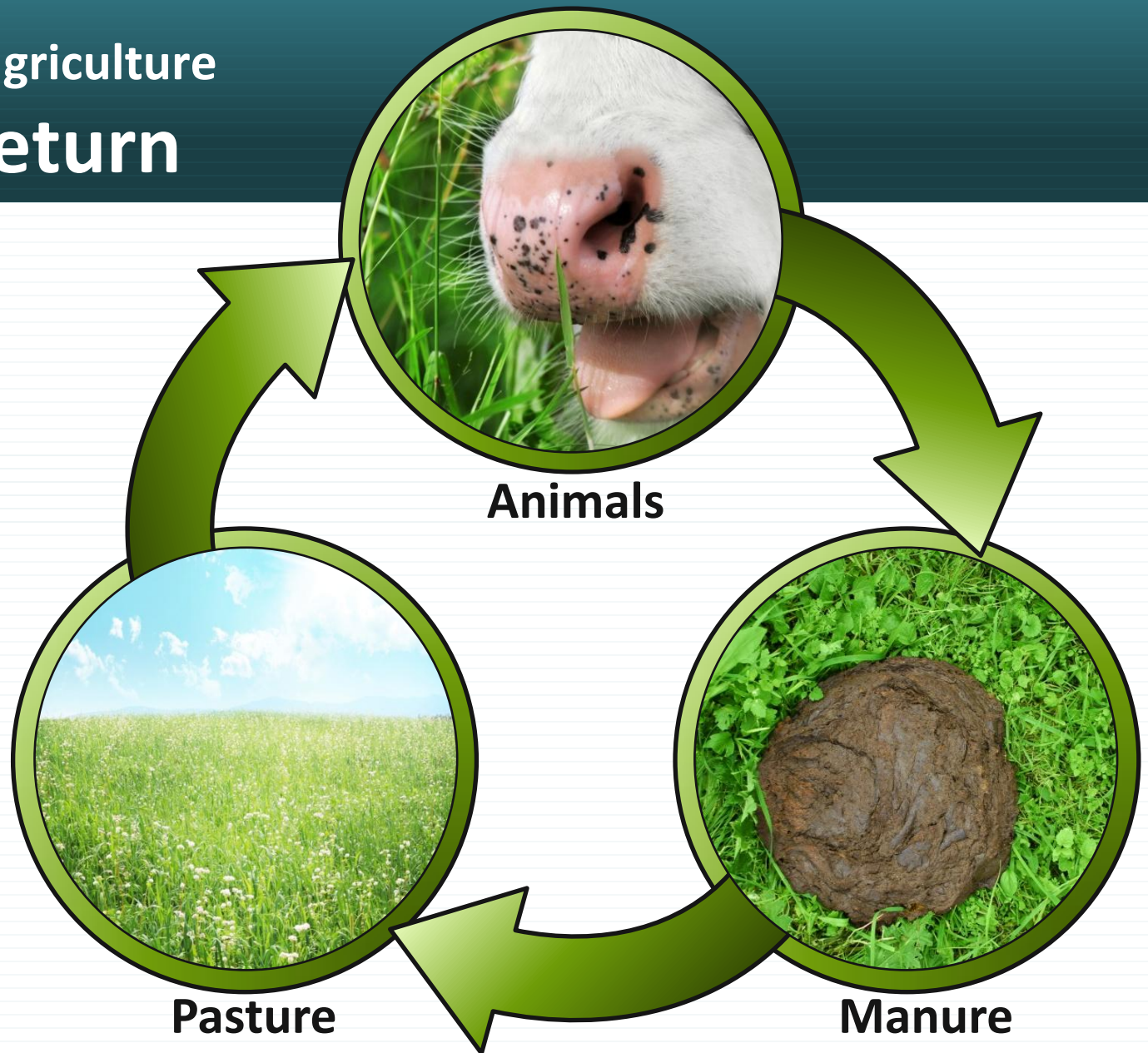
Law of return



All images copyright.

Sustainable agriculture

Law of return

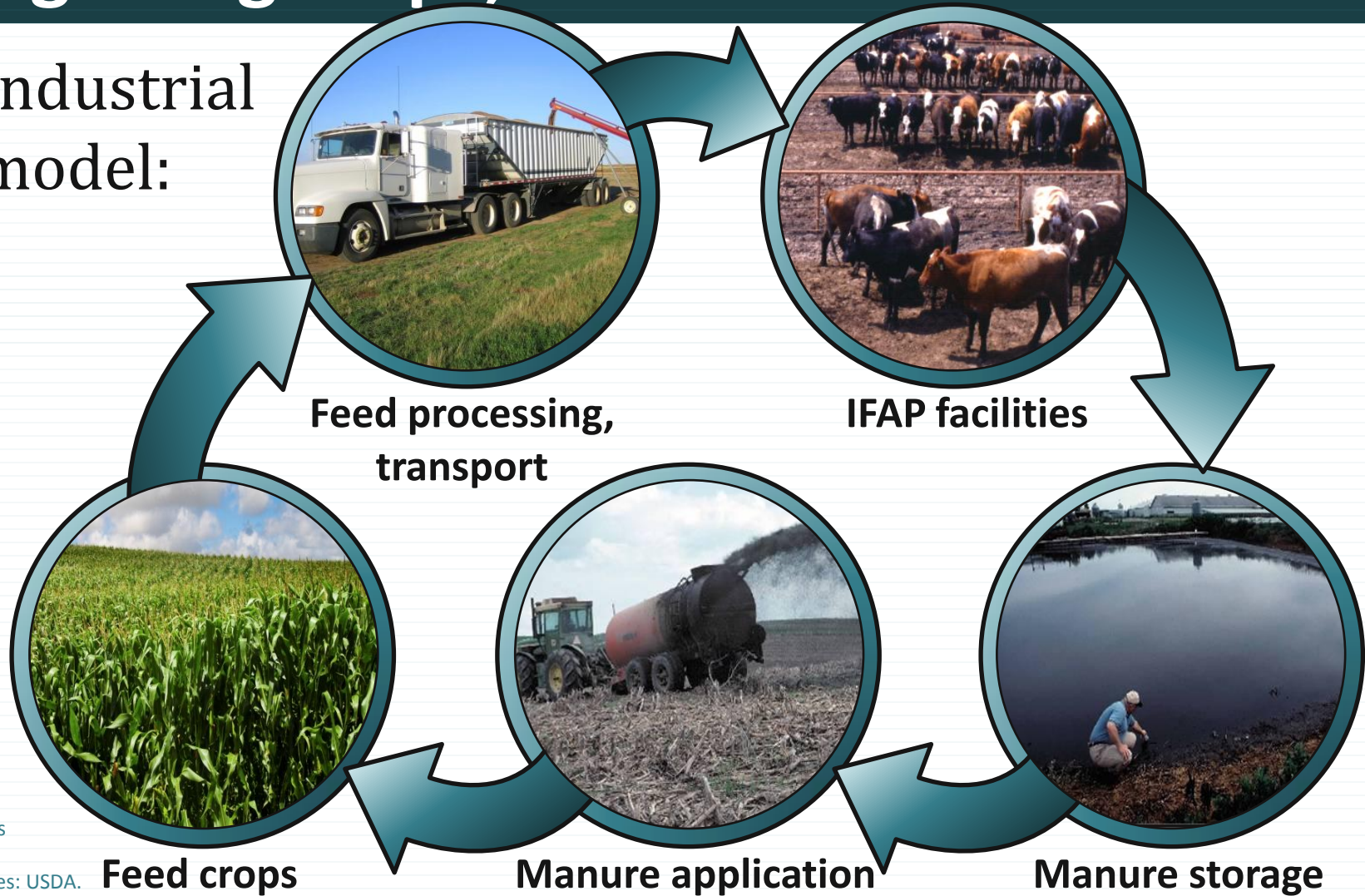


All images copyright.

Sustainable agriculture

Integrating crops, livestock

- Industrial model:



Feed images
copyright.
Other images: USDA.

Sustainable agriculture

Leveraging natural processes

- Using plants and animals to:
 - Control pests
 - Enhance soil fertility
 - Promote crop growth
 - Etc.

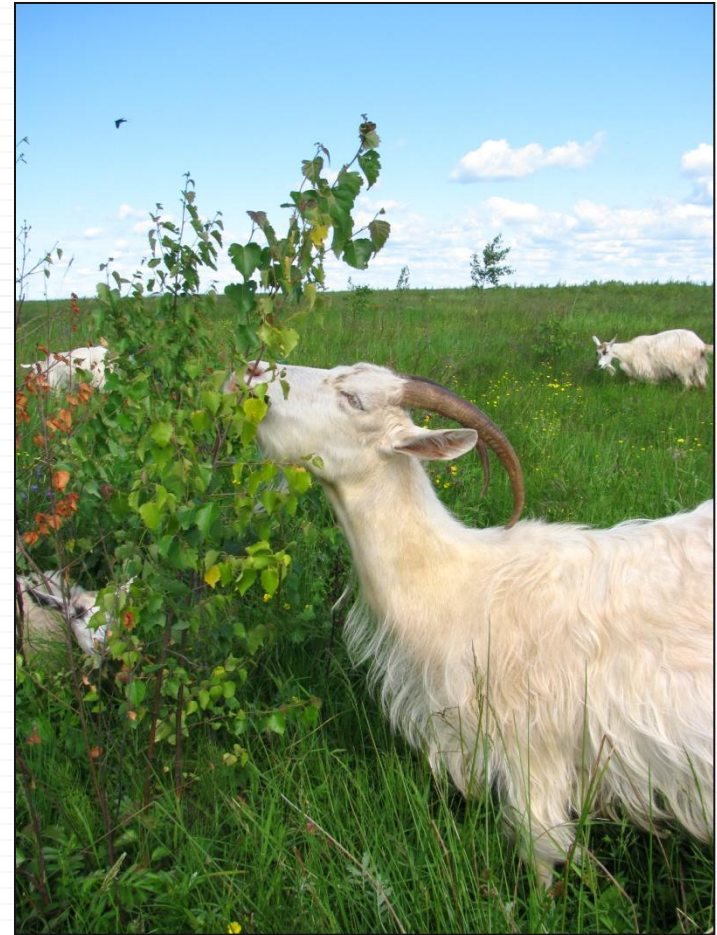


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Sustainable agriculture

Informed by current knowledge

- Not a throwback to earlier times
- Neither shuns nor embraces technology

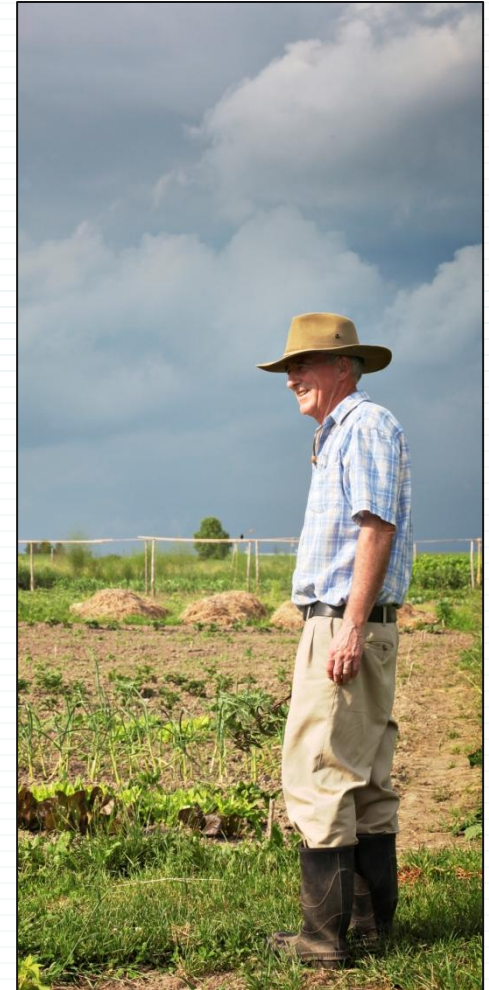
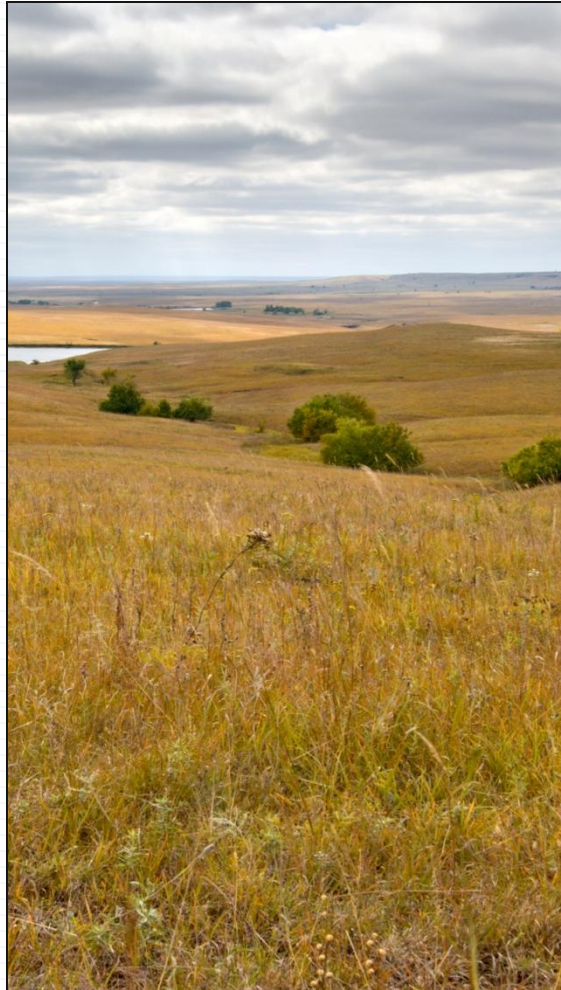


Greb P. USDA Agricultural Research Service Image Gallery. www.ars.usda.gov.

Sustainable agriculture

Becoming native to places

- Understanding their unique qualities



Images copyright.



Overview

Food, agriculture and ecosystems

Problems in agriculture

Organic agriculture

Sustainable agriculture

- **Think-pair-share**

Think – pair – share



“The whole problem of health, in soil, plant, animal and man is one great subject.”

- *Sir Albert Howard*



“Eating is an agricultural act.”

- *Wendell Berry*

Shetterly R. *Wendell Berry*. 2003. www.americanswhotellthetruth.org. Used with permission from the artist.