**The Relationship between Agriculture and Animals**

Pillar 3 C. Explain why farmers consider how their actions affect animals (Grades 4th – 8th)

|  |
| --- |
| **Website**: <https://www.cias.wisc.edu/curriculum/modIII/index.htm>**Hands On**: video: <https://www.youtube.com/watch?v=z9SMYQpk148> |

Activity: **Animals in the Food System**

Digital Activity: Resource for digital learning supplements: <http://www.agfoundation.org/on-the-farm/learn-about-beef>

**Section A: Animals in the Food System**

* [Projected Outcomes](https://www.cias.wisc.edu/curriculum-new/module-iii-section-a/#proj_outcomes)
* [Background / Lessons](https://www.cias.wisc.edu/curriculum-new/module-iii-section-a/#backless)
	+ [Where ‘s the beef from?](https://www.cias.wisc.edu/curriculum-new/module-iii-section-a/#wheresbeef)
	+ [Food safety and processing](https://www.cias.wisc.edu/curriculum-new/module-iii-section-a/#foodsafe)
	+ [How necessary are animal products?](https://www.cias.wisc.edu/curriculum-new/module-iii-section-a/#doweanimal)
	+ [Critiques of animal agriculture](https://www.cias.wisc.edu/curriculum-new/module-iii-section-a/#critiques)
	+ [Conclusion](https://www.cias.wisc.edu/curriculum-new/module-iii-section-a/#conclusion)
* [Activities](https://www.cias.wisc.edu/curriculum-new/module-iii-section-a-activities/)
* [Career Pathway content standards](https://www.cias.wisc.edu/curriculum-new/module-iii-section-a/#standards)

**Projected outcomes:**

1. Students will become aware of the intermediate stages between growing the animal and buying animal products at the grocery store.
2. Students will examine the role of animal products in nutrition.
3. Students will know about critiques of animal agriculture

**Background /Lessons:**

**Introduction**

Wisconsin is the Dairy State and Iowa is the leading producer of pork in the nation. Most of our crops go to feed livestock: dairy cows, pigs, beef cattle, chickens, sheep, and turkeys, as well as less well-known food animals such as fish, goats, elk, etc. Animal products are the cornerstones of our agricultural economy. This section will get students thinking about how animal products fit into our food system.

The section also introduces students to some criticisms of livestock production. Some people have criticized animal agriculture as environmentally damaging and wasteful. Some animal rights activists have even dismissed all animal agriculture as cruel and unnecessary. On the other side, some defenders of animal agriculture have dismissed any criticisms as ridiculous. Most practitioners of sustainable agriculture in the Midwest find themselves right between the two extremes. They recognize that animal production has sometimes had negative impacts, but they also see that it plays an important role in food systems and agroecosystems around the world. Sustainable animal production systems such as managed grazing can benefit the environment, enhance farm profits, and make the most efficient use of natural resources.

**Where’s the beef from?**

* Livestock products are part of a global commodity system
* Wisconsin, the dairy state, imports both fluid milk and milk solids
* Iowa is a net exporter and leading processor of beef and pork, but that does not necessarily mean the beef and pork you buy in the store or get in a restaurant was raised and/or processed in state.

**Food safety and processing**

* Livestock products pose special food safety and processing challenges
* In the US, with the exception of farm eggs, most of the livestock products the consumer buys have been processed (when is the last time you saw a live, or even an unplucked chicken for sale in the market?). Even eggs are washed, checked, graded, and packed, but that is far less processing than meat and dairy products must go through.
* This processing is subject to strict regulation
* Food safety is still a concern. Preventing bacterial food-borne illness such as salmonella, listeria, and campylobacter is generally recognized as a priority. However, there is debate about the significance of other concerns for food safety, such as mad cow disease and the human health impacts of antibiotics and growth hormones used in meat and dairy production. In addition, there is some disagreement on what practices, regulations, and structures will best promote safety, and who should be responsible.
* This regulation and processing adds a layer of complexity to direct marketing of animal products.
* See Section E “Regulation and Handling of Animal Products” for more information and activities on food safety and processing.

**How necessary are animal products?**

* The importance of animal products in our diet has been the subject of much debate.
* It is possible for humans over the age of 1 to 2 years to survive without deliberately eating any animal products (and before that age the only animal product babies need is human breast milk or a close substitute)
* Different cultures have different amounts and types of animal products in their diets, and people in those cultures often seem to be physiologically adapted to their traditional diets.
* Although many people in the world eat little or no red meat, animal products (including fish, yogurt, cheese, reptiles or even insects) are part of virtually all traditional diets.
* Humans are omnivores – we can get by on widely differing diets, and we still don’t know quite what is the best diet, or if there even is such a thing. What is more, the best diet will vary depending on a person’s age, gender, activity, personal history, and genetics.
* As recently as 2000, most nutritionists thought that too much consumption of animal products was an important contributor to obesity and heart disease. Some recent health studies have thrown that thinking into question, and in very short order meat and dairy products have become the centerpiece of trendy low-carb diets. The very fast re-embracing of a meat-heavy diet probably is more a reflection of US dietary culture than a result of clear scientific advances in the understanding of human nutrition.
* Animals are intertwined with agro ecosystems and food systems in many ways: they turn plants humans cannot eat into food we can, they can help with pest control, nutrient cycling, and waste management, and they can store agricultural surpluses.

[Activity 2: Pyramid Presumptions](https://www.cias.wisc.edu/curriculum-new/module-iii-section-a-activities/#act2)

**Critiques of Animal Agriculture**

Some people hold that eating meat or even eating any animal products is environmentally and socially unsustainable, for the following reasons:

* Grain-fed meat is an inefficient way to produce agricultural nutrients, and the longer lived and larger the meat animal, typically the less efficient it is. According to Farm Bureau statistics it takes 10 lbs of corn to produce 1 lb of beef and 2 lbs of corn to produce 1 lb of chicken. This means that there is less food available for poor people to eat. If everyone ate a vegetarian diet, there would be plenty of food to go around, and we could afford to return some agricultural land to a natural state.
* Animal products require more energy for processing and storage than most grains.
* Livestock production is responsible for a large amount of greenhouse gas emissions, which contribute to climate change. A 2008 United Nations study estimated that worldwide livestock accounts for 18% of total human-caused greenhouse gas emissions.
* Animal production typically uses a lot of water, which is a particular problem in arid livestock production areas such as the high plains and California . It takes 145 gallons of water to produce enough flour for one loaf of bread, compared to 1,849 gallons used to produce 3 1/2 ounces of beef. (This is why ecological footprint calculators ask about how much meat you consume [http://www.earthday.net/footprint/index.asp](http://www.earthday.net/footprint/index.asp%22%20%5Ct%20%22_blank) )
* In addition, processing of meat is highly concentrated, leading to concerns about corporate control of this market. For example in 2006 the four top beef packing firms processed 83% of the beef sold in the US and the top four pork packers (which include three of the same names as the top 4 beef packers) processed 66% of the pork ([http://nfu.org/issues/economic-policy/resources/heffernan-report](http://nfu.org/issues/economic-policy/resources/heffernan-report%22%20%5Ct%20%22_blank)).
* Moreover, many of these same companies produce feed and other livestock inputs and are increasingly involved in some phase of actually raising the animals, either through contracts with farmers or direct ownership. The growing corporate control of meat production has been associated with falling wages and benefits for workers and increased use of both legal and illegal immigrant labor in livestock production and processing.

[Activity 3: The Meatix](https://www.cias.wisc.edu/curriculum-new/module-iii-section-a-activities/#act3)

**Conclusion**

Animal products are the cornerstones of Iowa and Wisconsin ‘s agricultural economy. However, many people have raised questions about the environmental impact, nutritional benefits and morality of animal agriculture. On the other hand, some farmers are working hard to ensure that their systems of raising livestock do not cause the problems pointed out by critics of animal agriculture. In fact, integrating animals into the agro-ecosystem can bring major environmental benefits. The case studies presented in this curriculum will introduce your students to a few examples of sustainable livestock systems.

**Section B: Real People, Real Farms: Case studies of animal agriculture**

* [Projected Outcomes](https://www.cias.wisc.edu/curriculum-new/module-iii-section-b/#proj_outcomes)
* [Activities](https://www.cias.wisc.edu/curriculum-new/module-iii-section-b-activities/)
* [Career Pathway content standards](https://www.cias.wisc.edu/curriculum-new/module-iii-section-b/#standards)

**Projected outcomes:**

1. Students will learn about examples of sustainable animal production both in-state and around the country and the world.
2. Students will be able to apply the concepts taught in the module to real situations.

Tom Frantzen’s system for producing pigs on pasture and in hoophouses is profiled in Hogs Your Way . A range of other pork production systems are described in the same publication.

Rick Adamski and Valerie Dantoin’s pasture-based dairy farm has been written up several times over the years. In 2005 these Wisconsin farmers received an Honorary Recognition award from the UW-Madison College of Agricultural and Life Sciences for their leadership in Wisconsin agriculture. Read how their operation has evolved over time.
[1995 Case study](https://www.cias.wisc.edu/curriculum-new/files/mod-iii/secb/1995_adamski_case_study.doc)
[2002 Grant write-up](https://www.cias.wisc.edu/curriculum-new/files/mod-iii/secb/2002_Adamski_case_study.doc)
[2004 Article](https://www.cias.wisc.edu/curriculum-new/files/mod-iii/secb/2004_Graze_article.doc)

Don Adams and Nan Bonfils worked with a consultant to create marketing materials for their natural beef. [Marketing case study.](https://www.cias.wisc.edu/curriculum-new/files/mod-iii/secb/Full_Circle_Case_Study.pdf%22%20%5Ct%20%22_blank)

[Poultry Your Way](http://www.cias.wisc.edu/pdf/poultryway.pdf%22%20%5Ct%20%22_blank) contains a number of case studies of poultry production in the upper Midwest. See [“Ducks That Don’t Quack”](https://www.cias.wisc.edu/curriculum-new/files/mod-iii/secb/Muscovy_Duck.pdf%22%20%5Ct%20%22_blank) for an example of a sizable alternative enterprise started by two Minnesota high school students. [“Returning Chickens to the Range”](https://www.cias.wisc.edu/curriculum-new/files/mod-iii/secb/Pasture_and_Market.pdf%22%20%5Ct%20%22_blank) profiles the Milladore, Wisconsin farm of Mike and Debra Hansen.

[Dairy Your Way](http://www.cias.wisc.edu/archives/2006/05/23/publication_profiles_business_options_for_dairy_producers/index.php%22%20%5Ct%20%22_blank) contains descriptions and case studies of different dairy production systems in the upper Midwest. [“Seasonal Calving”](https://www.cias.wisc.edu/curriculum-new/files/mod-iii/secb/Seasonal_calving.pdf%22%20%5Ct%20%22_blank) describes how Dan and Ruth Vosberg have combined grazing and more conventional practices to make their dairy farm work for them.

Other livestock production profiles can be found in the [SARE](http://www.sare.org/%22%20%5Ct%20%22_blank) book [The New American Farmer](http://www.sare.org/newfarmer/%22%20%5Ct%20%22_blank) and includes Greg and Lei Gunthorp in Indiana, Tom Larson in Nebraska, and Bob Wackernagel in Michigan. For **national examples,** see David and Cynthia Major, Vermont (sheep dairy), Tom Trantham, South Carolina (dairy grazing of standing crops), Rosa Shareef, Mississippi (pastured poultry, goats, and sheep); Frank Bohman, Utah (rangeland restoration), and Mark Frasier, Colorado (range management).

Other profiles can be found at [The New Farm.](http://www.newfarm.org/archive/1000_stories/1000stories_archive.shtml%22%20%5Ct%20%22_blank) About half of the profiles feature livestock operations, including [organic egg production at New Century Farm in Wisconsin](http://www.newfarm.org/depts/talking_shop/0303/umoc.shtml%22%20%5Ct%20%22_blank) and [meat goat production in Iowa.](http://www.newfarm.org/features/0704/meatgoat/index.shtml%22%20%5Ct%20%22_blank)

[Activity 1 Evaluating sustainability](https://www.cias.wisc.edu/curriculum-new/module-iii-section-b-activities/#act1)

**Section C: Animals in the agro-ecosystem**

* [Projected Outcomes](https://www.cias.wisc.edu/curriculum-new/module-iii-section-c/#proj_outcomes)
* [Background / Lessons](https://www.cias.wisc.edu/curriculum-new/module-iii-section-c/#backless)
	+ [Introduction](https://www.cias.wisc.edu/curriculum-new/module-iii-section-c/#intro)
	+ [Ecological question 1: What are the nutrient flows in the system?](https://www.cias.wisc.edu/curriculum-new/module-iii-section-c/#ecoq1)
	+ [Ecological question 2: What are the sources and sinks of pollutants in the system?](https://www.cias.wisc.edu/curriculum-new/module-iii-section-c/#ecoq2)
	+ [Ecological question 3: What are the interactions of living organisms in the system?](https://www.cias.wisc.edu/curriculum-new/module-iii-section-c/#ecoq3)
	+ [Ecological question 4: What are the energy flows in the system?](https://www.cias.wisc.edu/curriculum-new/module-iii-section-c/#ecoq4)
	+ [Conclusion](https://www.cias.wisc.edu/curriculum-new/module-iii-section-c/#conclusion)
* [Activities](https://www.cias.wisc.edu/curriculum-new/module-iii-section-c-activities/)
* Presentation
* [Career Pathway content standards](https://www.cias.wisc.edu/curriculum-new/module-iii-section-c/#standards)

**Projected outcomes:**

Students will learn how to apply ecological analysis to animal production systems.

**Background /Lessons:**

**Introduction**

“Mother earth never attempts to farm without live stock…”
Sir Albert Howard, An Agricultural Testament, Oxford University Press, 1940, p. 4.

Animal agriculture can have very negative ecosystem impacts, or it can bring ecosystem benefits. In general, when animals are raised in large confinement systems and fed grain, their production uses more energy and causes more pollution than the production of field crops. When animals are raised in small groups primarily on pasture, their production uses less energy and tends to cause less pollution than field crop production. However, good management is the key in all cases. Well-managed confinement systems can minimize environmental damage, and poorly managed grazing can cause serious environmental problems.

In sustainable agriculture the goal is to take advantage of ecosystem processes by designing an agricultural system that works with them.

As we look at the agroecology of animal production, we should keep four questions in mind:

* Where do key nutrients come from?
* What are the sources and sinks of pollutants in this system?
* How do the living organisms in the system interact?
* What are the energy flows?

**Ecological question 1: What are the nutrient flows in the system?**

In a sustainable system they will be recycled on-site or generated in a renewable fashion.

When livestock feed is obtained from off the farm, it is extremely difficult to close nutrient cycles, especially for phosphorus, potassium, and carbon. These nutrients are being exported from the farms producing the feed, and they accumulate on the livestock farms in the form of manure, creating nutrient imbalances in both locations.

When the livestock feed comes from the same farm or from farms within a few miles, the nutrient cycles for these major nutrients can be nearly closed, because it is cost-effective to return the nutrients in the manure to the fields where the feed is grown. Nutrient losses from export of the nutrients contained in the animals are minor compared to the nutrient value of the manure. Moreover, good manure management can minimize leaching and runoff of nutrients in manure.

Water is not typically thought of as a nutrient, but when livestock feed is grown using irrigation, that disrupts the natural hydrological cycle, which can have far-ranging ecological impacts. Much of the forage and grain fed to beef produced in the west is grown using irrigation. Some of this irrigation water is pumped from aquifers at unsustainable rates. Some is diverted from river systems, altering aquatic communities and reducing the water available for other uses. For example about 85% of the water taken from the Colorado River in California, Arizona, and Nevada is used for agricultural purposes. Long before the Colorado River reaches its historic outlet to the ocean in Mexico, it has completely dried up. Some of the water withdrawn goes to fruit and vegetable production, but livestock production is also a major water user (see [http://www.cpluhna.nau.edu/Change/waterdevelopment6.htm](http://www.cpluhna.nau.edu/Change/waterdevelopment6.htm%22%20%5Ct%20%22_blank)).

In Iowa and Wisconsin production of livestock feed and forage generally does not require irrigation. In both these states, the withdrawal of irrigation water from streams and rivers is regulated to protect aquatic life. However, even in this area the potential exists for local conflicts over agricultural water use.

[Activity 1: Water and Numbers](https://www.cias.wisc.edu/curriculum-new/module-iii-section-c-activities/#act1)

**Sustainable nutrient management practices:**

* Managed grazing allows animals to consume plant nutrients right where they are produced, and return most of those nutrients to the pasture soil in the form of manure (without additional capital, labor, and energy costs for storage and spreading).
* Mixed species pastures contain legumes that support nitrogen-fixing bacteria, reducing or eliminating the need for N inputs from off-site.
* Year-round ground cover on well-managed pastures tends to retain soil nutrients on-site.
* Many high-quality forage crops are legumes that support nitrogen-fixing bacteria.
* Proper manure management minimizes nutrient runoff, leaching, and volatilization as well as unpleasant odors. It also returns nutrients to the fields where they are needed for optimum plant growth. See [Nutrient Management Fast Facts](http://ipcm.wisc.edu/download/pubsNM/NutrientManagementFastFacts.pdf%22%20%5Ct%20%22_blank) for a brief overview of plant nutrients in different types of manure. Many more in-depth publications about manure management are available at at [http://ipcm.wisc.edu/downloads/nutrient-managment/](http://ipcm.wisc.edu/downloads/nutrient-managment/%22%20%5Ct%20%22_blank), including [When and Where to Apply Manure.](http://ipcm.wisc.edu/download/pubsNM/WhereWhenToApplyManure.PNG%22%20%5Ct%20%22_blank)
* Composting is a form of manure management that stabilizes nutrients and can also reduce weed seed viability and disease pressure.
* Deep bedded systems absorb nutrient-rich urine as well as manure solids and lend themselves to composting.

**Ecological question 2: What are the sources and sinks of pollutants in the system?**

A sustainable system will minimize the amount of pollutants.

In livestock production systems, animal waste or manure is usually the largest potential source of pollution. Other pollution sources from livestock production can include erosion from poorly managed grazing, improper disposal of dead animals, improper disposal of milkroom waste, and dust and odors from CAFOs (Confined Animal Feeding Operations).

Since most field crops in Wisconsin and Iowa are used for animal feed, the pollution that may result from field crop production, including erosion and runoff and leaching of fertilizers and pesticides, can be viewed as an indirect result of livestock production.

Manure is a valuable farm resource if it is properly managed. All too often, though, manure is a major agricultural pollutant. For example, the Iowa Department of Natural Resources attributes more than a quarter of the fish kills in the state to animal waste ([http://www.igsb.uiowa.edu/gsbpubs/pdf/WFS-2008-05.pdf](http://www.igsb.uiowa.edu/gsbpubs/pdf/WFS-2008-05.pdf%22%20%5Ct%20%22_blank) and [http://programs.iowadnr.gov/fishkill/default.aspx](http://programs.iowadnr.gov/fishkill/default.aspx%22%20%5Ct%20%22_blank)). In addition to harming aquatic life, microorganisms from livestock manure can threaten human health if they get into the water supply. (See [http://www.dnr.state.wi.us/runoff/ag/waterquality.htm](http://www.dnr.state.wi.us/runoff/ag/waterquality.htm%22%20%5Ct%20%22_blank)) As discussed above, when livestock is raised or finished far from where their feed is grown, it is usually not economical for the farmer to apply the manure only as needed for optimum crop growth.

**Sustainable practices to minimize pollution**

* Livestock production should be sited close enough to the area of feed production for the return of manure to those fields to be profitable.
* Grazing should be managed to prevent soil erosion and degradation of stream and river banks. Both rotational grazing and traditional extensive grazing can minimize pollution, if well-managed.
* Manure must be stored, handled, and applied in such a way that it will not leach or run off and contaminate surface or ground water. Deep bedding and composting are manure management practices used by many sustainable livestock producers. [Manure Storage](http://www.extension.iastate.edu/Publications/PM1518K.pdf%22%20%5Ct%20%22_blank), [The Art and Science of Composting.](http://www.cias.wisc.edu/wp-content/uploads/2008/07/artofcompost.pdf%22%20%5Ct%20%22_blank)

**Ecological question 3: What are the interactions of living organisms in the system?**

Typically, sustainable agro-ecosystems will try to work with species interactions and will favor species diversity.

Grazing systems are based on direct species interactions. When livestock is raised in confinement, natural ecological interactions are interrupted. Feed crops are raised in a monoculture, then harvested, transported, stored, and fed to livestock held in areas where all other living species except human workers are excluded as much as possible. The species interactions on pastures can bring additional challenges such as loss to predators and exposure to parasites. However, they also bring ecosystem services, such as nutrient cycling, pest management, and efficient capture and storage of solar energy.

Rotationally managed pastures can provide habitat for wildlife and native prairie plants (see [Grassland birds: Fostering habitats using rotational grazing](http://learningstore.uwex.edu/pdf/A3715.pdf%22%20%5Ct%20%22_blank)).

Another issue to consider is the genetic diversity of the farm animals themselves. For thousands of years, localized selection of traits in farm animals led to a proliferation of regional breeds. For example, in England, a country smaller than the state of Wisconsin, there are more than 25 breeds of sheep, most developed in and named for an area no bigger than a US county. These breeds varied widely in their adaptations and the characteristics of their meat and wool. (For a listing of recognized sheep breeds worldwide, see the left panel at [http://www.ansi.okstate.edu/breeds/sheep/](http://www.ansi.okstate.edu/breeds/sheep/%22%20%5Ct%20%22_blank)). Modern commodity livestock production and processing emphasizes uniformity and a few traits such as leanness and efficiency of growth. This emphasis has led to having one or two breeds dominate production agriculture for our entire country and beyond. Perhaps the most extreme example is the domestic turkey. All turkey meat raised by large commercial growers in the US is from one breed, the Broad-breasted White. This turkey has been bred to put on weight fast, to have white feathers that leave the skin a uniform creamy color, and to grow a large amount of breast meat. In fact the breasts of mature birds are so large that these animals cannot mate naturally. Recently, some specialty producers have begun to grow and market some of the more than 20 other American breeds with different size and flavor characteristics and better abilities to fend for themselves. See [http://www.feathersite.com/Poultry/Turkeys/BRKTurkey.html](http://www.feathersite.com/Poultry/Turkeys/BRKTurkey.html%22%20%5Ct%20%22_blank), [http://www.newholland.com/na/News/nhn/NovDec01/V47No8\_1.htm](http://www.newholland.com/na/News/nhn/NovDec01/V47No8_1.htm%22%20%5Ct%20%22_blank). For all our farm animals, older and uncommon breeds offer an important reservoir of genetic traits, from disease resistance and adaptation to a variety of climates to variations in flavor and other traits of interest to the consumer or farmer. Organizations such as the American Livestock Breeds Conservancy are now working to preserve rare breeds of farm animals in our country. (See [http://www.albc-usa.org/](http://www.albc-usa.org/%22%20%5Ct%20%22_blank)).

Manure management can have a significant effect on soil organisms. Raw manure contains pathogens that can threaten human health until they are broken down or consumed by benign organisms. The nutrients and organic matter in manure can benefit soil life. Compost contains a variety of generally beneficial soil organisms, though the predominant organisms will vary, depending on the materials and process used.

What are the impacts on other organisms of feed production? For example, in aquaculture systems high-value carnivorous fish such as trout and salmon are often fed fish meal. Production of this fish meal may damage marine ecosystems. At the other end of the process, pollution from livestock production, such as sedimentation and nutrient runoff, can damage aquatic ecosystems.

In some cases the livestock may transmit disease or may escape and displace native species. For example, farm animals such as pigs, goats, dogs, and cats have contributed to the extinction of many flightless birds on islands in the Pacific Ocean. In Wisconsin there is debate about whether deer farms may have introduced Chronic Wasting Disease to the state.

**Sustainable practices include:**

* Grazing on multi-species pasture ([http://clean-water.uwex.edu/pubs/pasture/pasturereport.pdf](http://clean-water.uwex.edu/pubs/pasture/pasturereport.pdf%22%20%5Ct%20%22_blank)).
* Managing grazing and haying to encourage nesting success for grassland birds such as meadowlarks, grasshopper sparrows, and bobolinks (see [Grassland birds: Fostering habitats using rotational grazing](http://learningstore.uwex.edu/pdf/A3715.pdf%22%20%5Ct%20%22_blank)).
* Grazing different livestock species together or in sequence.
* Use of traditional breeds adapted to the climate and to outdoor conditions.
* Providing shade and/or shelterbelts.
* Management of water access to protect streams and prevent erosion (see [Grazing streamside pastures](http://learningstore.uwex.edu/pdf/A3699.pdf%22%20%5Ct%20%22_blank)).

**Ecological question 4: What are the energy flows in the system?**

Sustainable agro-ecosystems rely more on solar energy than on fossil fuels. Sustainable systems minimize energy waste.

In general, grazing systems maximize use of solar energy and minimize use of fossil fuels. Unlike in confinement animal production systems, no fossil fuels are used to harvest, dry, or transport the feed to the grazing animals when forage growth is good. Also, energy use for extracting, transporting, and applying fertilizer to well-managed pastures is minimal. Confinement systems such as hoophouses that rely on natural ventilation and on deep bedding for manure management require less energy for both construction and operation than fully confined systems with mechanical ventilation and liquid manure management systems. On the other hand, manure from confinement systems can be used to generate electricity (see [http://www.mnproject.org/e-biogas.html](http://www.mnproject.org/e-biogas.html%22%20%5Ct%20%22_blank)), though it is not clear whether the energy recovered compensates for the extra energy required for the confinement system. According to the Wisconsin Integrated Cropping Systems Trial, the energy efficiency of rotational grazing systems is about twice that of forage-based cropping systems and about four times that for row crop production. (See [http://www.cias.wisc.edu/wicst/pubs/energy.htm](http://www.cias.wisc.edu/wicst/pubs/energy.htm%22%20%5Ct%20%22_blank), [http://www.cias.wisc.edu/wicst/pubs/images/energy/table3.html](http://www.cias.wisc.edu/wicst/pubs/images/energy/table3.html%22%20%5Ct%20%22_blank).)

**Sustainable energy management practices:**

* Rotational grazing
* Grazing of standing crops
* Stockpiling of winter forage on pastures minimizes energy used for manure spreading
* Design buildings to eliminate or minimize reliance on mechanical ventilation, heating, and cooling
* If animals are in confinement, consider generating electricity from manure
* Install and maintain energy efficient systems for major energy users such as refrigeration of milk (see [http://learningstore.uwex.edu/Energy-Conservation-C29.aspx](http://learningstore.uwex.edu/Energy-Conservation-C29.aspx%22%20%5Ct%20%22_blank)).

More than half of the energy in our food system is used not on the farm, but in transportation, processing, storage and packaging, and home cooking.

**Sustainable practices for the consumer:**

* Buy local foods, when possible
* Avoid excess packaging
* Use energy-efficient appliances and techniques when possible
* Use renewable energy sources, if possible (solar and wind power)
* Consider eating lower on the food chain or sticking to grass-fed meat and dairy products (most of the food energy contained in grain is used by livestock to sustain their own life and only a small amount is stored as meat. Thus it takes 4 lbs of corn to produce 1 lb of pork and 7 to 10 lbs of corn to produce 1 lb of beef).

**Conclusion**

Poorly managed animal agriculture can have extremely negative impacts on the environment and can be very wasteful of natural resources. However, animals play critical roles in natural eco-systems, and animal agriculture that mimics and builds on natural systems can be far less damaging to the environment than even well-managed cropping systems that try to function without animals.

In the last twenty years or so, ideas about grazing have changed considerably, as the use of lightweight electric fencing allowed much more flexible and detailed management of livestock on pasture. There is still much to be learned about managed or rotational grazing, but it is the foundation of livestock management on many sustainable farms.