



Introduction to the Animal Sciences

- Please do not write on These
- Return Them in good condition
* Write your answers on a separate sheet of paper!

Key Terms

Agriculture	Ethology
Animal behavior	Farmer
Animal breeding	Genetic code
Animal health	Genetics
Animal science	Green revolution
Applied ethology	Heredity
Biofuel	Hunter-gatherer
Biométry	Livestock revolution
Biotechnology	Meat
Civilization	Meat science
Culture	Nutrient density
Dairy product science	Nutrition
Diet	Omnivore
Domestic animals	Physiology
Draft animal	Renewable resources
Essential amino acids	

Learning Objectives

After you have studied this chapter, you should be able to:

- Define *animal science* and all of its component parts.
- Describe how, why, and when domestication occurred.
- Give an overview of the distribution of agricultural animals worldwide.
- Explain to a nonagriculturist the contributions of domestic animals to humankind and state why domestic animals are so important to life as we know it.
- Describe the worldwide livestock revolution and its implications.

INTRODUCTION

Animals. We live with them, worship them, consume them, admire them, fear them, love them, care for them, and depend on them. They are part of our sustenance, our sociology, and our day-to-day lives. Because they are so important to us, we also study them and apply what we learn to improve their lives and enhance their roles in our lives. The branch of science that deals with domestic animals is **animal science**, which is the topic of this book.

Much of our use for animals revolves around their contributions to our food supply. Food comes from the land. To coax a more stable food supply from the land, humans developed a complicated resource management system called **agriculture**. In agriculture, domestic plants and animals are kept to produce for humankind's needs. Humans have practiced agriculture for thousands of years and, either directly or indirectly, every person on the planet depends on agriculture for his or her daily food (Figure I-1). Because this is true, it is also ultimately true that all of humankind's other occupations are tied to agriculture. This is especially the case in the world's developed countries. In fact, the

Animal science The combination of disciplines that together comprise the study of domestic animals.

Agriculture The combination of science and art used to cultivate and grow crops and livestock and process the products.



Figure 1-1

Bolivian farmers cultivating potatoes on old Incan terraces. They use the same tools as those used by their ancestors. (FAO photo 22399/Roberto Faidutti. Used with permission by the Food and Agriculture Organization of the United Nations.)



Domestic animals Those species that have been brought under human control and that have adapted to life with humans.

Culture In this context, culture refers to the set of occupational activities, economic structures, beliefs/values, social forms, and material traits that define our actions and activities.

Hunter-gatherer Hunter-gatherer peoples support their needs by hunting game, fishing, and gathering edible and medicinal plants.

Farmer Anyone who practices agriculture by managing and cultivating livestock and/or crops.

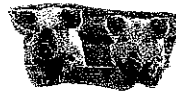
Civilization In modern context this refers to what

entire urban industrial complex of the developed world is sustained only because of food surpluses generated by agriculturists. Humans have found many other uses for **domestic animals** in such areas as sports, recreation, manufacturing, religion, and as companions. Add these uses to food production and we discover that animals are at the core of virtually all of our lives, whether or not we are aware of it. Because agriculture and its animals are integral to our existence, they have become a dominating part of our **culture**, our influence on the landscape, and, either directly or indirectly, our day-to-day activities.

Exactly when the individual animal species were domesticated is unknown. DNA sequencing technology suggests that the dog may have been domesticated from the wolf as long as 135,000 years ago, but archaeological evidence suggests that the dog was domesticated about 14,000 years ago (12000 B.C.). The earliest domestic food species (as most Westerners currently define it) was the sheep (somewhere around 8000 B.C.), followed by goats, pigs, and cattle (6500 B.C.), llamas (5500 B.C.), horses (3500 B.C.), donkeys (4000 B.C.), reindeer (3000 B.C.), and chickens (6000 B.C.).

Humans did not plan their dependence on the animals they tamed and then domesticated. **Hunter-gatherers** (who first domesticated animals) used the meat, bones, and skins just as they had done before domestication. The only difference after domestication was convenience. The additional uses (milk, clothing, power, war, sport, and prestige) came later. This happened after people had lived in the company of animals for a long time in a more sedentary lifestyle.

Humans had hunted and consumed animals for 2 million years before domesticating them. The behavioral change required for hunters and gatherers to become **farmers** was a major cultural revolution and a major step toward what we call **civilization**.



ANIMAL SCIENCE SPECIALTIES

Animal science is simply the collective study of domestic animals. This includes every aspect, from conception to death, behavior to management, physiology to nutrition, and reproduction to product distribution. Animal science represents an accumulation of knowledge that began with observations of those hunter-gatherers who began the process of domestication long ago. As animal scientists have learned more and more about animals, the accumulated wealth of information has become too large for anyone to comprehend completely. Out of necessity, its study is divided into disciplines, or specialties, as a means of creating manageable pieces. These specialties may be broken down several ways, but the following categories illustrate the point:

- **Genetics** is the science of **heredity** and the variation of inherited characteristics. **Animal breeding** is the use of **biometry** and genetics to improve farm animal production. Genetics is an expanding field due largely to steady progress in deciphering the **genetic code**.
- **Nutrition** is the study of how organisms take in and use food/feed for body needs. Whether or not animals develop their genetic potential depends on their environment. The most important environmental factor is feed. Nutrition is the science that combines feeds with feeding management to bring about the economical production of livestock and/or health and long life to animal companions.
- **Physiology** is the study of the mechanisms of life from the single biochemical reactions in cells to the coordinated total of specialized cells that constitute a living animal. Because physiology is complex, we usually break down the study to the workings of physiological systems. Examples include reproductive physiology, renal physiology, and exercise physiology.
- **Animal health** is the study of how diseases, parasites; and environmental factors affect productivity and animal welfare. Disease is defined as any state other than a state of health. Once animals were domesticated, diseases and parasites began taking their toll.
- **Ethology** is the study of the biology of animal behavior. The specific study of behavior in domestic animals is **applied ethology**. This discipline developed along with the livestock industry's increased dependence on confinement rearing systems, which provide greater control over animals, reduce labor and feed costs, and help maximize genetic potential. They also present problems associated with behavior. Applied ethology includes many aspects of animal behavior, including animal welfare assessment, optimizing production, behavioral control, behavioral disorders, and behavioral genetics.
- **Meat science** deals with the handling, distribution, and marketing of finished meat products. **Meat** is defined as the edible flesh of animals that is used for food. Meat by-products are all of the products other than the carcass meat, some of which are edible and some of which are not.
- **Dairy product science** deals with the collection, handling, and marketing of milk in its many forms to the consuming public.
- **Biotechnology** involves technological applications of biology. This discipline has received new attention in animal science because of recombinant DNA technology and its many promises. Each of the other disciplines of animal science has benefited from biotechnology and will continue to do so at an ever-increasing rate.

Certainly, tremendous overlap occurs in these areas, and separations are made for our convenience. However, this convenience can also be a hindrance. By breaking the discipline of animal science down into smaller units, we have made it easier to learn but harder to grasp—we know the pieces of the puzzle better, but it is harder to put the pieces together. Always remember that it is the combination of the specialties that constitutes the whole discipline of animal science.

Genetics The science of heredity and the variation of inherited characteristics.

Heredity The transmission of genetic characteristics from parent to offspring.

Animal breeding The use of biometry and genetics to improve farm animal production.

Biometry The application of statistics to topics in biology.

Genetic code The set of rules by which information encoded in genetic material (DNA or RNA sequences) is translated into proteins (amino acid sequences) by living cells.

Nutrition The study of nutrients and how the body uses them.

Physiology The study of the physical and chemical processes of an animal or any of the body systems or cells of the animal.

Animal health The study and practice of maintaining animals as near to a constant state of health as is possible and feasible.

Ethology The study of animals in their natural surroundings.

Applied ethology The study of behavior in domestic animals.

Meat science The science of handling, distributing, and marketing meat and meat products.

Meat The flesh of animals used for food.

Dairy product science The science of providing milk and milk products as food.

Biotechnology A collective set of tools and applications of living organisms, or parts of organisms, to make or modify products, improve plants or animals, or develop microorganisms for specific uses.



ANIMAL DISTRIBUTION

There are approximately 4.5 billion large farm animals and 19.8 billion poultry distributed throughout the world (Table 1-1). The number of large farm animals has been increasing at an average rate of about 1% annually for three decades. During that time there have been shifts in the size of individual species populations

Table 1-1
AGRICULTURAL ANIMAL NUMBERS IN THE WORLD

	World Total	South America and the Caribbean	North and Central America	Oceania	Africa	Europe	Asia
Large Farm Animals							
Cattle (head) ¹	1,356,712,486	341,385,050	156,386,372	38,550,319	262,284,948	127,771,556	430,334,240
Sheep (head)	1,089,122,420	76,031,729	14,876,215	122,810,949	284,537,622	135,847,109	455,018,796
Pigs (head)	929,513,715	60,059,612	98,215,858	5,541,593	25,417,889	194,116,935	546,161,826
Goats (head)	839,855,010	25,600,260	11,991,274	972,755	284,846,006	17,951,905	498,492,809
Buffalo (head)	178,089,540	1,146,981		205	4,355,016	281,734	172,305,604
Horses (head)	58,851,371	16,347,025	17,201,053	416,357	4,445,260	6,364,559	14,077,117
Asses (head)	42,866,652	3,863,139	3,364,805	9,000	17,863,831	641,837	17,124,039
Camels (head)	24,369,291				20,635,089	7,143	3,727,058
Mules (head)	11,608,620	2,845,522	3,506,051		1,048,768	223,282	3,984,997
Other camelids (head) ²	6,835,086	6,835,086					
Total	4,537,824,189	527,279,318	305,541,629	168,301,178	905,434,429	483,206,061	2,141,226,488
Rabbits and Rodents³							
Rabbits (1,000 head)	1,213,705	282,547	4,240		80,849	326,593	519,475
Other rodents (1,000 head)	67,500	67,500					
Poultry							
Chickens (1,000 head)	17,859,361	2,133,904	2,851,506	127,091	1,395,400	1,931,296	9,420,164
Ducks (1,000 head)	1,094,067	7,949	16,497	1,197	16,815	56,298	995,310
Geese & guinea fowl (1,000 Head)	342,168	398	300	78	12,362	21,730	307,300
Turkeys (1,000 head)	473,499	52,063	278,474	111,902	15,857	111,902	13,343
Total (1,000 head)	19,769,096	2,194,315	3,146,778	130,227	1,440,434	2,121,226	10,736,117
Insects							
Beehives (number)	64,750,626	5,520,872	5,098,466	699,079	16,167,361	16,174,450	21,090,398
Silkworm cocoons (MT)	422,510	8,097			170	1,246	413,000

Source: FAO, 2011.

¹Includes yaks.

²Includes both llamas and alpacas.

³Producing animals slaughtered.

⁴Primarily guinea pigs.



Table 1-2
CONTRIBUTIONS OF ANIMALS TO HUMAN SOCIETIES

Food

Eggs

Meat

Milk

Blood

Fat

Edible slaughter by-products

Body Coverings

Wool

Leather, pelts, hides

Hair, fur, feathers

Work

Draft and other labor

Transportation

Body Wastes

Fuel

Fertilizer

Construction material

Animal feed

Other Uses

Income

Storage of capital

Storage of food

Biomedical research models

Contributions to the economy

Buffer for fluctuating grain supplies

Soil fertility enhancement

Prestige

Religion and other cultural needs

Slaughter by-products

Recreation and sport

Pest and weed control

Companionship and service

Pet foods and treats

Conservation

Source: McDowell, 1991, and Turman, 1986.

and their worldwide distribution. Poultry numbers have increased more rapidly at an average rate of over 5% annually. Until very recently, greater than two-thirds of the large farm animals were found in developing countries, but they produced only about a third each of the meat, milk, and wool produced in the world. Reasons for the low productivity include environmental stresses, disease challenges, lack of access to technology, and different objectives of livestock production. However, the world agricultural order is undergoing profound changes, which are causing a greater percentage of the world's livestock to be found in the developing world. In addition, the productivity of the livestock in the developing world is improving dramatically.

Agricultural animals have made a major contribution to the welfare of human societies for millennia by providing a variety of products and services, as shown in Table 1-2. They are a **renewable resource**, and they use another renewable resource—plants—to produce these products and services.

CONTRIBUTIONS OF ANIMALS TO HUMANITY

A detailed look at animal use comes later in this book. This section briefly surveys some of the many contributions of livestock and other animals to humans.

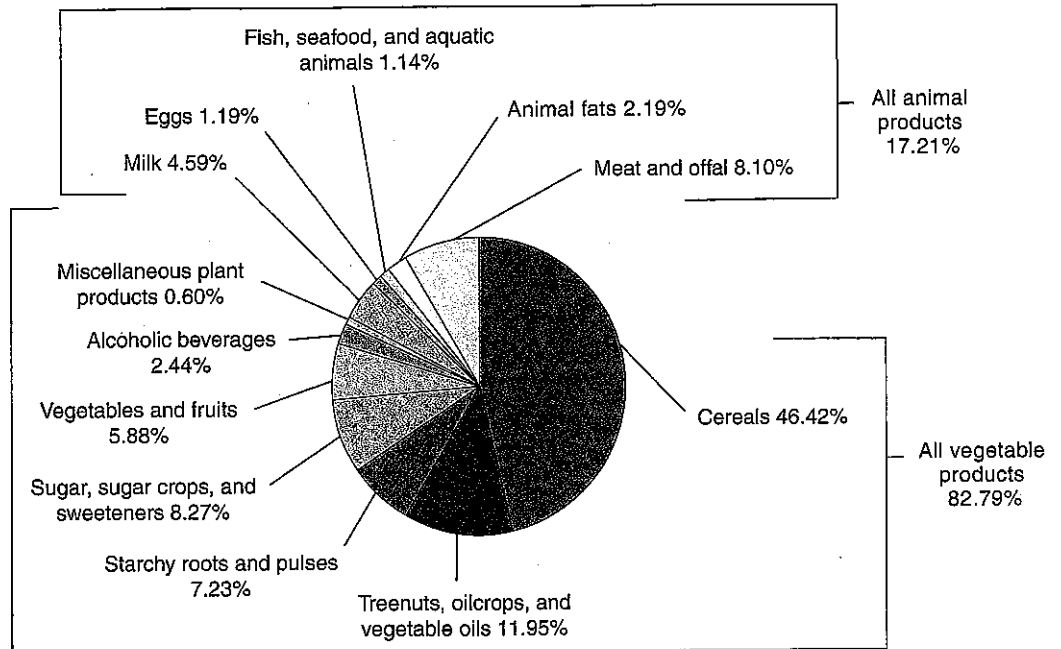
Food Source

Humans are **omnivores**, consuming both plant- and animal-based foods. Figure 1-2 shows the contributions of different food sources to the world food supply. Although food is the most important contribution of agricultural animals to humans, plants

Renewable resources

Those resources that can be replaced or produced by natural ecological cycles or management systems.

Omnivore An animal that eats both animal- and plant-based feeds.

**Figure 1-2**

Contributions of food sources to human energy (calorie) consumption.

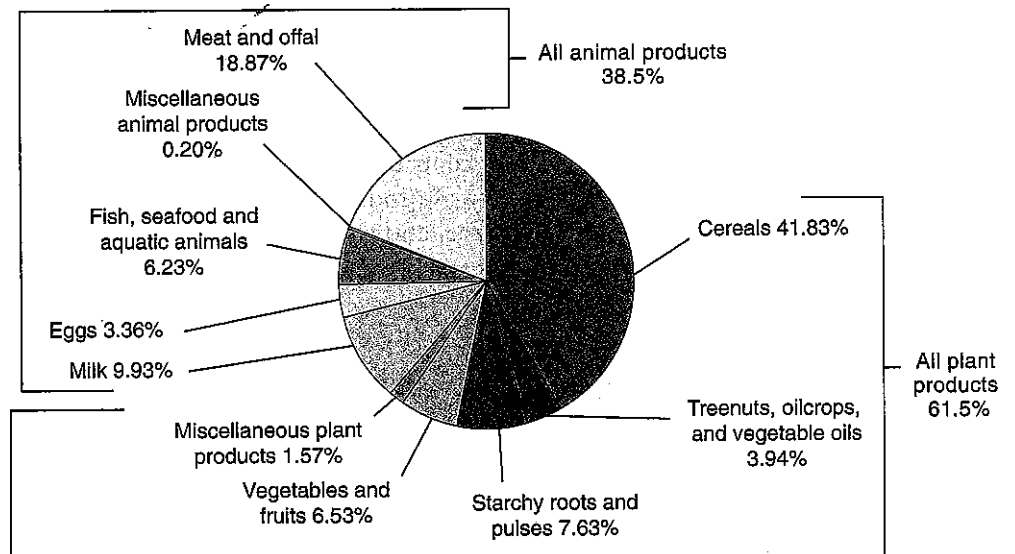
(Source: FAO, 2011a.)

supply a greater total quantity of food. Plants supply 82.8% of the total food energy consumed by the world's people, primarily because such a high percentage of the human diet in the developing countries is of plant origin. Animal products supply the remaining 17.2%. In developed countries, animals contribute a greater percentage of the total food energy. In the United States, for instance, they provide 27%. Animals are a more important source of protein than they are of calories (Figure 1-3), supplying 38.5% of the protein consumed in the world. Of the animal protein sources, meat provides approximately 49.5%, milk provides approximately 25.8%, fish supplies approximately 16%, and eggs supply 8.7%. Developed countries obtain a greater percentage of their total protein from animal products. The United States, for example, gets approximately 64% of its protein from animal products. Table 1-3 shows a more

Figure 1-3

Contributions of food sources to human protein consumption.

(Source: FAO, 2010a.)



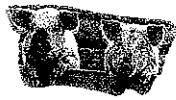
**Table 1-3
PERCENTAGE CONTRIBUTION OF FOOD GROUPING TO VARIOUS NUTRIENTS IN THE U.S. FOOD SUPPLY**

Nutrient	Meat,		Dairy (excl. butter)	Eggs	Total Animal	Vegetables	Legumes, Nuts, Soy		Fruits	Fats and Oils	Sugars and Sweeteners	Misc ¹
	Poultry, Fish											
Energy	14		9	1	24	4	3	24	3	24	17	1
Protein	41		19	4	64	5	6	22	1	0	0	2
Total Fat	21		11	2	34	0	4	2	1	58	0	1
SFAs ²	24		22	2	48	0	2	2	0	47	0	1
MUFAs ²	22		7	2	31	0	4	1	1	62	0	1
PUFAs ²	12		2	1	15	1	6	4	1	73	0	0
Cholesterol	45		14	35	94	0	0	0	0	5	0	0
Vitamin A	23		20	5	48	32	0	6	3	9	0	0
Vitamin E	4		2	2	8	6	6	4	3	74	0	0
Vitamin C	2		1	0	3	47	0	5	43	0	0	0
Thiamin	18		5	1	24	8	5	60	3	0	0	0
Riboflavin	17		27	6	50	5	2	39	0	0	1	1
Niacin	37		1	0	38	9	4	44	2	0	0	2
Vitamin B ₆	38		6	2	46	21	4	19	7	0	0	0
Folate	4		3	3	10	11	10	61	6	0	0	1
Vitamin B ₁₂	70		24	6	100	0	0	0	0	0	0	0
Calcium	4		70	2	76	7	4	5	3	0	1	2
Phosphorus	25		31	4	60	7	6	20	2	0	0	4
Magnesium	13		13	1	27	13	14	24	6	0	1	14
Iron	15		2	3	20	9	7	51	2	0	1	6
Zinc	37		17	3	57	6	6	26	1	0	0	4
Copper	21		3	2	26	11	19	21	5	0	2	16

Source: USDA, 2010.

¹Coffee, tea, chocolate-liquor equivalent of cocoa beans, spices, and fortification of foods not assigned to a specific group.

²SFAs = saturated fatty acids; MUFAe = monounsaturated fatty acids; PUFAs = polyunsaturated fatty acids.



Nutrient density A measurement of the nutrients provided in a food compared to the calories it contains.

Diet The total of the foods and water being consumed by an individual or group.

Essential amino acids

Those amino acids required by the body that must be consumed in the diet.

Undernourished Receiving inadequate nourishment for proper health and growth.

complete picture of the contribution of various foods to the U.S. food supply. Meat, eggs, and dairy products are important food sources because they are **nutrient dense**. This means they have many nutrients compared to their calories, and the nutrients are digestible and readily available. High-quality protein and biologically available levels of vitamins and minerals, as well as a significant amount of energy, are supplied to the **diet** by animal foods.

Animal foods are generally preferred over plant foods by human populations, and the vast majority of the world's population routinely chooses food produced from animals in its diet. A country's living standards can be gauged by the proportion of its food supply that consists of animal foods. Time and again, people have demonstrated that increasing animal-derived foods in their diet is one of the first things they will do when their income increases. Not only are animal foods palatable and delicious, they are also the most nutritionally complete foods. They are an important source of vitamins and minerals, and the protein in animal foods is more likely than are plant proteins to include the **essential amino acids** in the correct proportions.

Absolute food quantity and amount of animal products are more available to some of the world's peoples than to others. Approximately 27% of the calories in the average diet in North America is from animal products compared to 7.4% for the average African. There is also a tremendous difference in food distribution to the world's peoples. The average African eats only 66% of the daily calories eaten by the average North American. Globally, over 1 billion people are **undernourished**.

Most people include meat and dairy products in their diets whenever they can. Exceptions are almost always because of religious prohibitions (prohibitions against beef consumption by Hindus, for example) or because of prohibitive costs. The world's meat (excluding fish) is predominantly supplied by pigs, cattle, and poultry with lesser amounts from sheep, goats, buffalo, and horses. Several other species provide a significant amount of meat to the people of various geographic regions. Most milk comes from cows, but buffalo, goats, and sheep provide significant amounts of milk, and most domestic hooved animals are milked somewhere in the world.

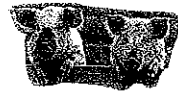
Other Uses

In addition to food, other animal products are also of great importance to humans, who have used wool, hair and other fibers, feathers, and hides for millennia for clothing and other uses (Figure 1-4). Manure from animals is a valuable by-product used for fertilizer and other applications (Figure 1-5).

Figure 1-4

Hides are a slaughter by-product that humans have used since long before domestication. (Photo courtesy of Adele M. Kupchik.)



**Figure 1-5**

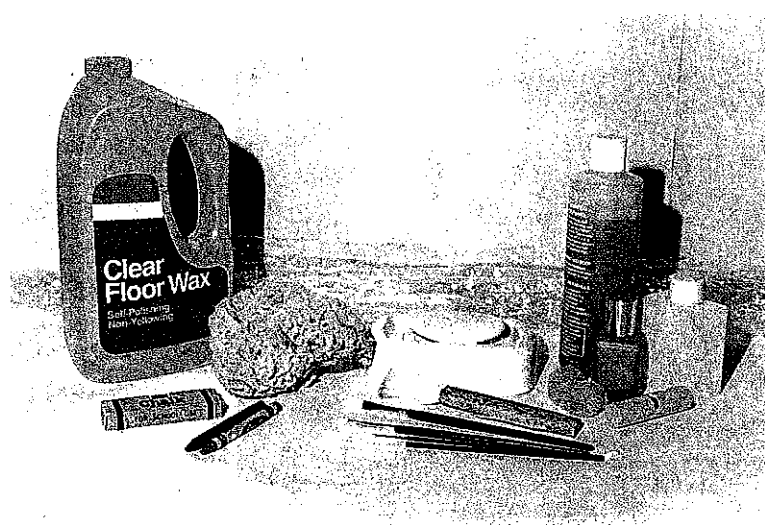
Liquid manure from a hog-feeding operation in Iowa is being pumped onto cropland with a "honey wagon." (Photo by Tim McCabe. Courtesy of USDA Natural Resources Conservation Service.)

Slaughter by-products are the source of a large number of industrial and consumer products. Some examples include pharmaceuticals, insecticides, crayons, cosmetics, plastics, cellophane, glass, water filters, plywood adhesive, soap, gelatin, air filters, and animal feed (Figure 1-6).

Draft animals are vitally important to many Asian, African, and Latin American countries. Oxen plow fields; water buffalo work in rice paddies; yaks, donkeys, and camels still trudge over ancient trade routes; and dogs still pull sleds (Figure 1-7). Much of the world's food production in less developed regions is dependent on draft animals, as is transportation of goods to and from markets. Tasks such as carrying water and fuel are significant contributions of draft animals. As much as 80% of the nonhuman power of subsistence agriculture is provided by draft animals.

Animals are used as models for humans in biomedical research. Thirty years have been added to the average American life span since 1900. In addition, the quality of life for people afflicted with chronic diseases has been improved dramatically. Medical research depends on the use of animals as models. It will continue to do so

Draft animal An animal whose major purpose is to perform work that involves hauling or pulling. An ox or horse pulling a plow or wagon is a draft animal.

**Figure 1-6**

Slaughter by-products are used in the manufacture of a variety of industrial and consumer products. (Photo courtesy of Adèle M. Kupchik.)

**Figure 1-7**

Draft animals are still the most important nonhuman power source in developing countries.



in the foreseeable future (Figure 1-8). In addition, animals are used in research to benefit animal health, resulting in healthier, longer-lived pets and healthier, more productive livestock.

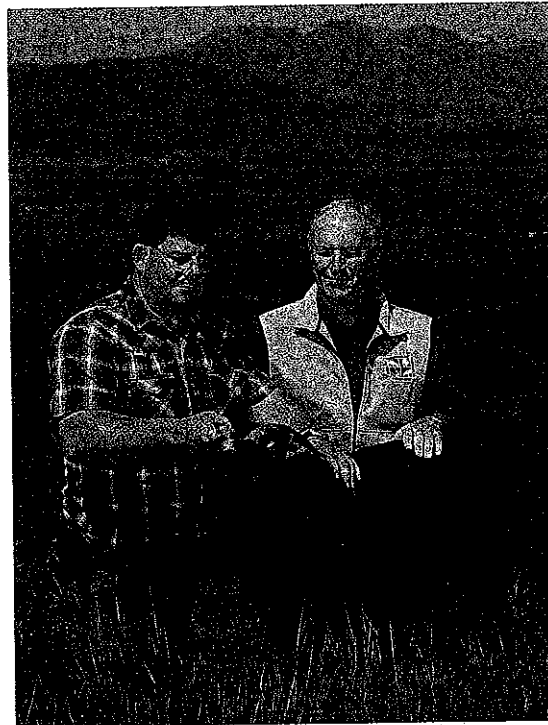
Animal companionship is important to people around the world, enhancing human physical, emotional, and spiritual well-being. Specially trained animals assist people with visual disabilities (guide animal), hearing disabilities (hearing or signal animal), and other disabilities (service or assistance animal), helping people live more independently (Figure 1-9). Therapy animals are commonplace.

In addition, many entertainment industries such as racing, rodeos, and bull-fighting are based on animal use (Figure 1-10).

Agricultural animals convert inedible feeds to valuable products. About two-thirds of the feed used in the U.S. livestock industry is not suitable for human

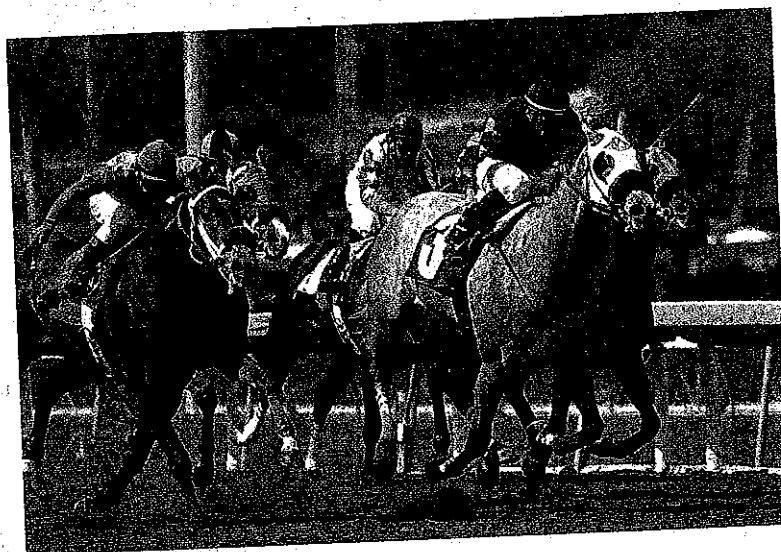
Figure 1-8

Biomedical research depends on the use of animals as research models. This two-year-old Spanish goat underwent a successful cleft palate repair in utero. Goats were first developed as an animal model for the study of lupine-induced crooked calf syndrome. The model is now playing a role in developing procedures for prenatal repair of cleft palate in children. (Photographer Peggy Greb. Courtesy of USDA-Agricultural Research Service.)



**Figure 1-9**

Service dogs help people with disabilities. Here, a Seeing Eye® dog in action, with student and instructor, on the streets of Morristown, New Jersey. The dog has stopped the person from proceeding across the driveway as the van turns. (Photo courtesy of The Seeing Eye, Inc. Used with permission.)

**Figure 1-10**

Many entertainment industries are based on animal use. Horse racing is among the most popular. (Source: Clarence Alford/Fotolia)

consumption. Hay, pasture, coarse forages, by-products, garbage, and damaged food are examples. Animal use diversifies agriculture, the food supply, and the economy. Diversified agriculture is more stable and more sustainable.

THE FUTURE OF LIVESTOCK PRODUCTION

Global livestock production is undergoing huge increases in animals and products with further increases predicted. To keep pace with demand, many are predicting the need to double animal product output by 2050. This increasing animal production is being referred to as the **livestock revolution**, and it is being likened to the cereal grains boom of the **green revolution**, which began in the 1960s and is credited with saving millions of lives and building many national economies.

The forces driving increased global demand for animal products are simple: human population growth and increasing income. Unprecedented economic development around the world is increasing **per capita** income. The world's human population is increasing and is projected to reach approximately 9 billion by 2050. These factors are causing increased per capita consumption of animal products and large increases in total demand. Most of the new demand for animal products is in

Livestock revolution

Large increases in supply and demand of livestock and animal products worldwide at the end of the 20th century and into the 21st century.

Green revolution Dramatic improvements in grain production in developing countries during the 1960s to the 1980s because of technological innovation and application.

Per capita Per unit of population: by or for each person.



Biofuel Gas or liquid fuel made from biological materials, such as crops and animal waste.

developing countries, which are expected to soon produce the majority of the world's meat and milk. Along with the increased demand for animal products is an increased demand for other agricultural commodities to feed people and livestock. In addition, the world's developing demand for **biofuel** production will increasingly play a role in food availability and prices.

The challenges associated with these profound changes in agriculture are significant. The prime agricultural lands are already in use, and, worldwide, the potential new agricultural lands are covered by forests, under human settlements and infrastructure, or likely to be marginally productive. With increased human population, agricultural land per person will continue to decrease. Therefore, agricultural land will need to be more productive. To make this happen, there is a pressing need for research and subsequent technology development to increase productivity per unit of land. Agriculture of all kinds has the potential to affect the environment both negatively and positively. For the sake of future generations, we must achieve these massive increases in yield while protecting air, soil, and water quality. Combined, the opportunities and the challenges suggest an unprecedented dynamic period in the world agricultural order.

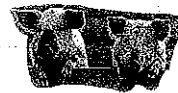
SUMMARY AND CONCLUSION

Animal science has its roots in the challenges that the first domesticators of animals encountered many millennia ago when they permanently brought in animals from the wild. Today, animal science is a vital field with specialties in genetics and animal breeding, nutrition, physiology, animal health, animal behavior, meat and dairy product science, and biotechnology. Animals are used for a myriad of purposes, including food, fiber, work, research, companionship, and entertainment.

Although agricultural animals have come under attack in recent years by those who feel they are a luxury, the numbers of agricultural animals are steadily increasing, and they are becoming more important in helping to feed the human population. For this reason, we should learn something about the factors that determine the kinds of agricultural animals found throughout the world. Chapter 2 explores in depth the contributions animals make to humankind.

STUDY QUESTIONS

1. Define animal science. When did animal science begin?
2. Explain why all of the world's occupations are tied to agriculture.
3. When did animal domestication occur? When were each of the major species domesticated? Was domestication a conscious decision by humans?
4. Define the specialties of animal science.
5. Why is the specialization in animal science disciplines both a help and a hindrance?
6. Study Table 1-1, which gives livestock numbers in the world. Notice the relative numbers of each species. Offer some reasons why animals are distributed as they are. Based on the numbers in this table, what are the world's major farm species?
7. Table 1-2 gives an overview of the goods and services derived from domestic animals by humans. (These are explored in detail later in the text.) Develop a list of uses from this table that are ranked from "most useful" to "least useful" from your current perspective. (At the end of the book, come back to your list and see if your perspective has changed.)
8. What proportion of human food energy and protein comes from animal products?
9. What proportion of the U.S. calorie and protein supply comes from animal products? How do other countries compare?
10. If a person does not eat meat, what are the most common reasons?
11. Which animals supply most of the world's meat?
12. Meat is important as a food for the human population because it is nutrient dense. What does "nutrient density" mean?
13. List some of the important products made from by-products of the slaughter industry.



14. How important are draft animals to subsistence agriculture? Name six important draft animals.
15. What is the role of animals in medical research?
16. Briefly discuss some of the ways that animals provide companionship, recreation, and entertainment to humans.
17. What types of humanly unusable feeds do animals convert to valued products?
18. Why is a diversified agriculture important, and what role do animals have in diversification?
19. What is the livestock revolution, and what are some of its challenges?

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