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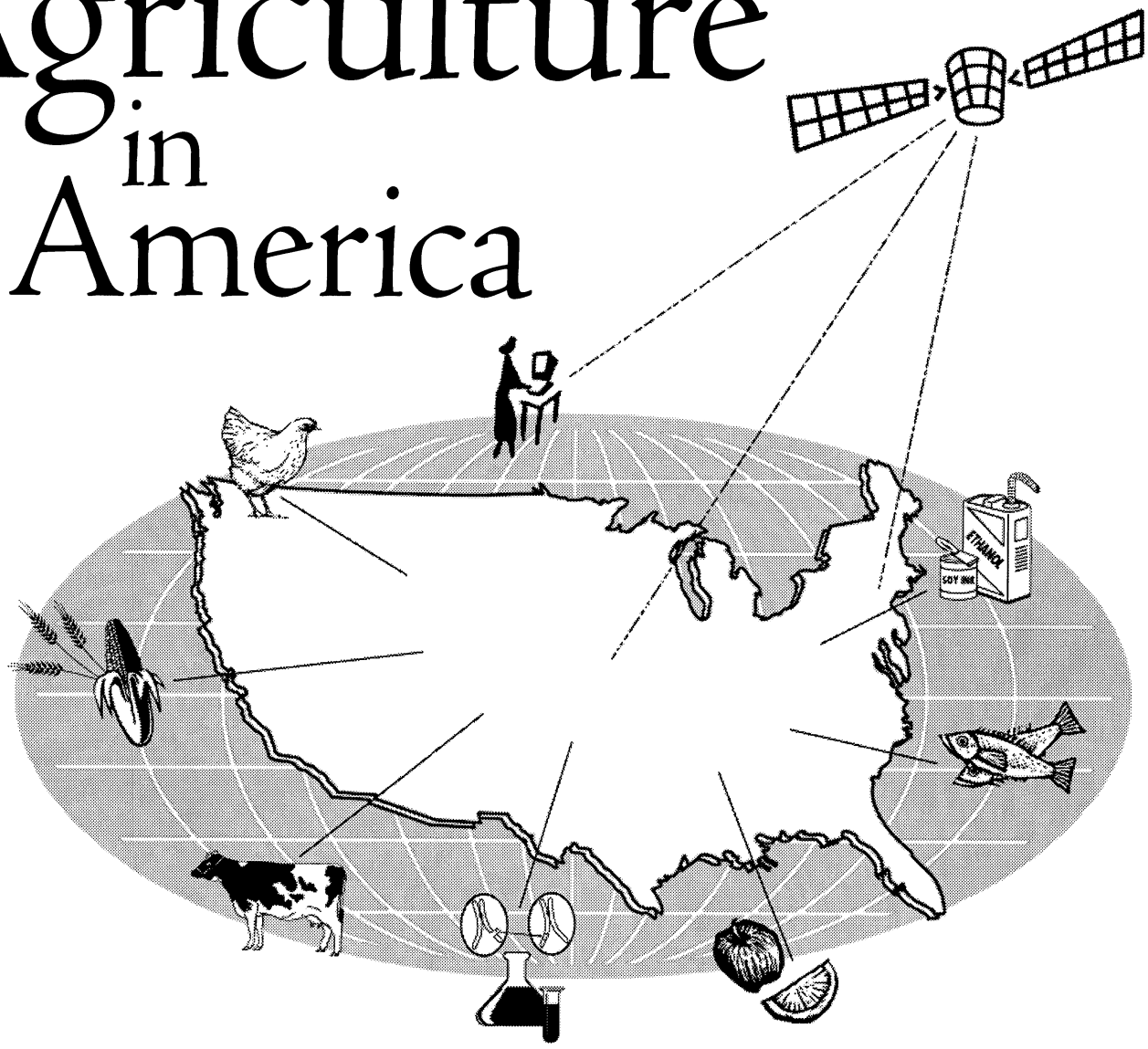
Exploring Agriculture in America



Student Reference

MISSOURI AGRICULTURAL EDUCATION

In cooperation with Agricultural Education Department • College of Agriculture, Food and Natural Resources • University of Missouri-Columbia

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Student Reference

Exploring Agriculture in America

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Foreword

Instruction about agriculture is important for the development of an educated citizenry. Every person has a vested interest in agriculture. The future of human beings is directly dependent upon agriculture. *Exploring Agriculture in America* was developed to inform students about the industry that is so vital to their future.

This student reference contains seven units: Introduction to Agriculture, Plant Science, Animals in Society, Products from Agriculture, Natural Resources and Conservation, Leadership and Personal Development, and Basic Home and Farmstead Safety and Maintenance.

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Exploring Agriculture in America

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Lesson 1: Agriculture: What Is It?

The concept and definition of agriculture has changed during the years. Early definitions focused on farming of crops and raising of livestock. Today agriculture has evolved to encompass a much broader scope and to include many related careers.

What Is Agriculture?

The term agriculture is derived from Latin words meaning the science and art of cultivating the soil. This definition may have described agriculture in the early days of our nation but is not accurate today.

Changes in society, demand for more food, and greater variety of foods have prompted changes in agriculture. Traditionally, agriculture has been defined as providing food and fiber for the increasing world population. Used by many in the past, this definition may limit the new and emerging career areas of agriculture.

Today's more encompassing definition of agriculture is as follows:

All aspects of the global food, fiber, and natural resources systems including

- the development, production, processing, marketing, and distribution of food and fiber products;
- the health and nutrition of food consumption;
- the use, conservation, and maintenance of environmental and recreational resources; and
- the related scientific, economic, sociological, political, and cultural characteristics of the food, fiber, and natural resources systems.

Figure 1.1 shows the increasing world population trend. Many people employed in agricultural careers will be needed to help meet the world's needs for food, fiber, shelter, and conservation of natural resources, as well as many other areas. As a result, there are and will be a variety of careers and opportunities in agriculture.

Agriculture in Your Daily Life

Agriculture is the largest industry in the United States, providing employment for over 22 million people. The industry is larger than the steel, transportation, and automotive industries combined. Agriculture provides much more than just quality food and fiber products for U.S. and world consumers.

Approximately 20% of the U.S. population derives its livelihood from agribusiness. These careers are related to the work involved in taking food and fiber from the farm to the consumer. In contrast, less than 2% of Americans are involved in farming or production agriculture. The job title of farmer is one of over 200 rewarding and diverse careers in agriculture. Changing world food needs and rapidly developing technology mean that agricultural career opportunities will continue to grow.

Americans enjoy low food costs compared to all the items they buy. The average American family spends approximately 11% of its disposable

Figure 1.1 - World Population Growth

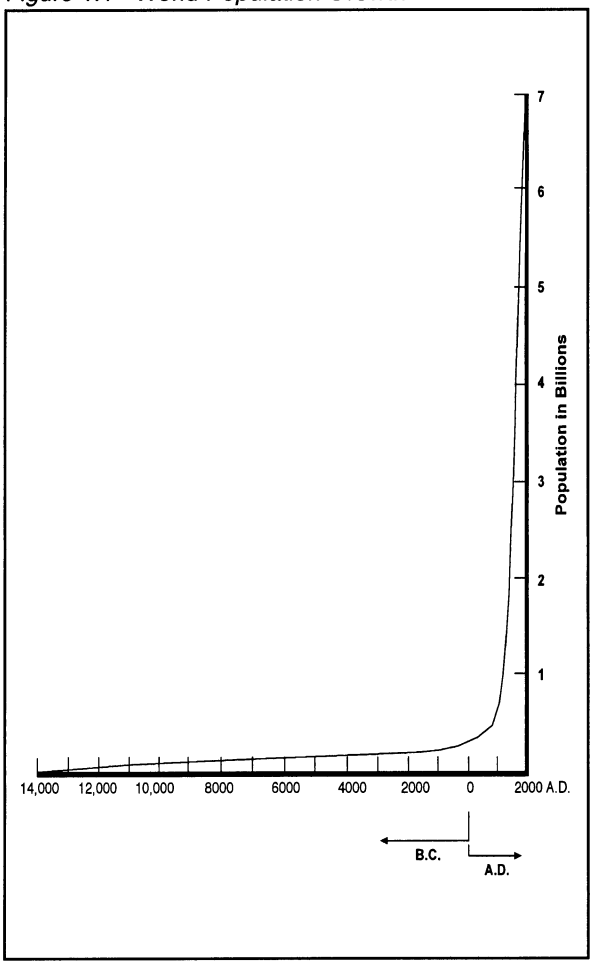
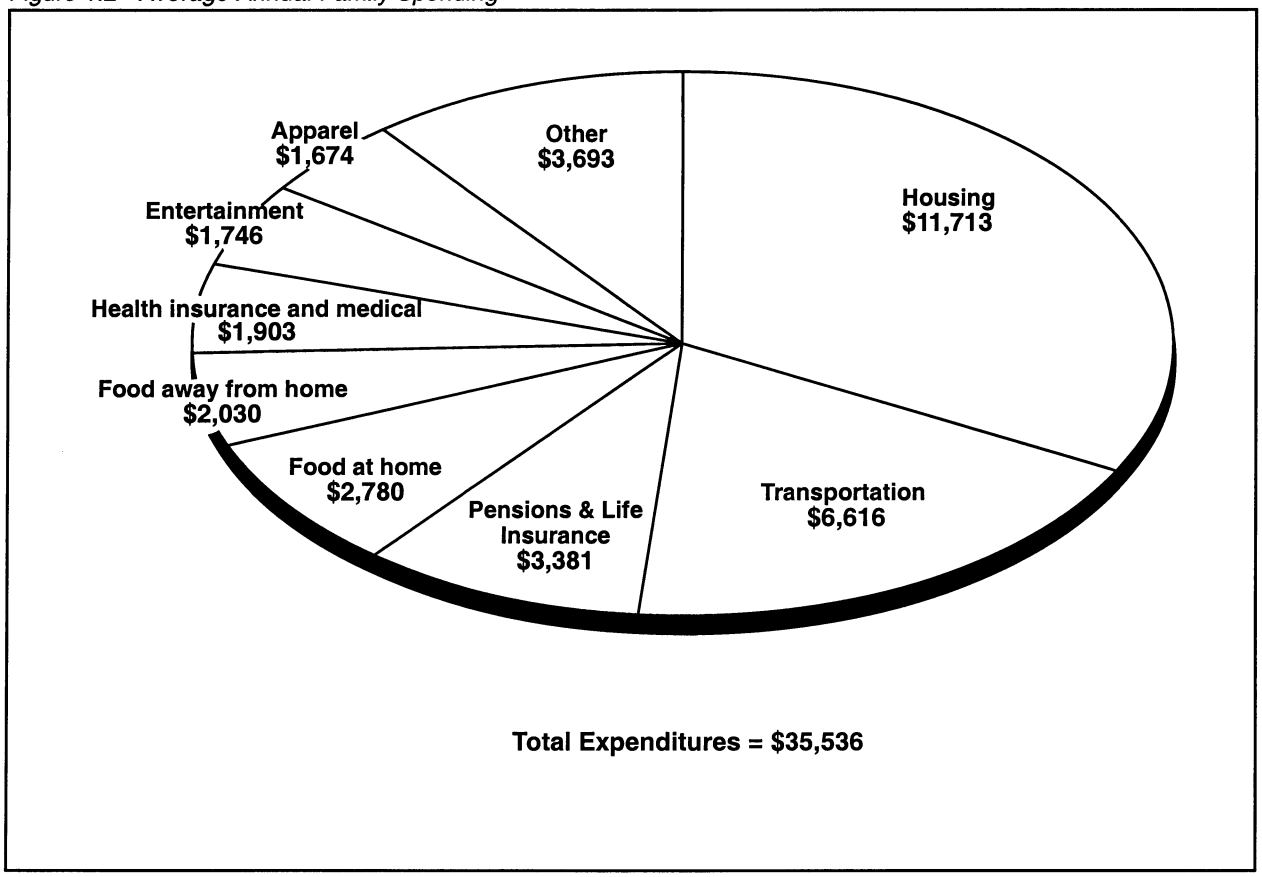
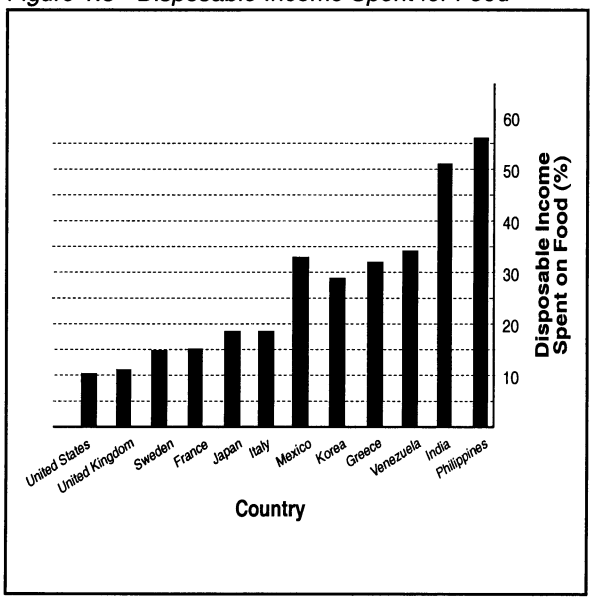


Figure 1.2 - Average Annual Family Spending



income on food. (Disposable income is income after taxes, also known as take-home pay.) This means that for every $1.00 a family has to spend, 11 cents is spent on food. Figure 1.2 shows the major areas where the average family spends its money.

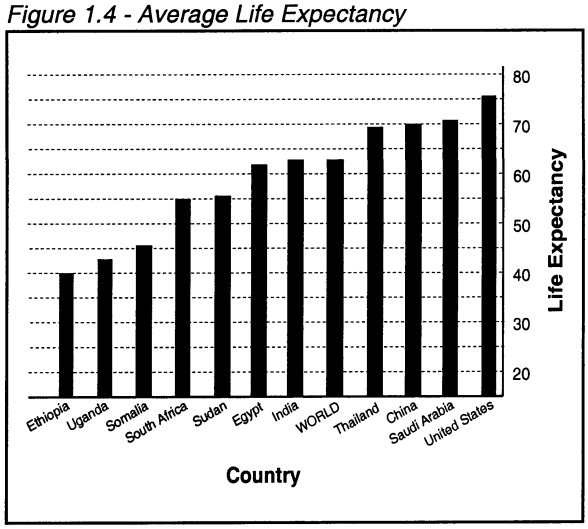
Figure 1.3 - Disposable Income Spent for Food



Americans spend less money on food than people in other countries. This is possible because of high production levels, new technology, efficient transportation, and many other factors. Figure 1.3 shows what percentage of disposable income other countries spend.

Agricultural research and a healthy food supply have contributed to a much longer life expectancy. For example, researchers at the University of Missouri Agriculture Experiment Station discovered Aureomycin, which led to the use of antibiotics for human health. Research on animal tuberculosis eventually led to the development of a vaccine to prevent tuberculosis in humans. Agricultural research has helped to solve many human health and nutrition problems. These advancements in agriculture and medical science have made good health and longer lives a reality. As shown in Figure 1.4, the average life expectancy in the United States is the highest in the world.

Figure 1.4 - Average Life Expectancy



Agriculture generates millions of dollars of taxes. Taxes help support the local, state, and national governments. Many rural school districts receive a major portion of their funding from agricultural property taxes.

Major Sectors of the Agricultural Industry

There are many different ways to categorize the major sectors of agriculture; however, a common and accepted classification system is as follows.

Agricultural systems technology - Engineers plan and design machinery, equipment, and structures used in agriculture. Agricultural technicians play a key role in keeping all operations functioning smoothly and profitably through proper installation, repair, and maintenance. Examples of careers in this sector are agricultural electrician, agricultural engineer, and engine technician.

Agricultural processing and marketing - This sector involves processing, inspecting, grading, packaging, distributing, and marketing agricultural commodities (corn, soybeans, beef, pork, etc.) as they move from the source of production to the consumer. Examples of careers in this sector are meat department manager, food scientist, grain elevator manager, and citrus processor.

Agricultural supplies and services - People employed in this sector play an important role in selling items or services needed by the general public. Many times this sector has been identified as agribusiness. Examples of careers in this sector are agricultural journalist, genetic engineer, agricultural loan officer (banker), and veterinarian.

Forestry - The management and business practices associated with timber and trees provide agricultural careers in this sector. Examples of careers in this sector are park ranger, forester, and timber manager.

Horticulture - This fast-growing career sector of agriculture involves the major areas of floriculture, fruits and vegetables, nursery/landscape, and turf grass. Examples of careers in this sector are floral designer, landscape architect, and turf grass specialist.

Production agriculture - Accounting for less than 10% of all agricultural careers, this sector involves producing crops and livestock. In general, a job title in this sector would be farmer, producer, or rancher, and could be more specific depending on what is produced on the farm or ranch in the United States. Examples of career titles are beekeeper, livestock herdsman, and grain producer.

Natural resources - The conservation of our air, soil, water, and wildlife is becoming increasingly important. Examples of careers in this sector are fish and wildlife specialist, soil conservationist, and water quality specialist.

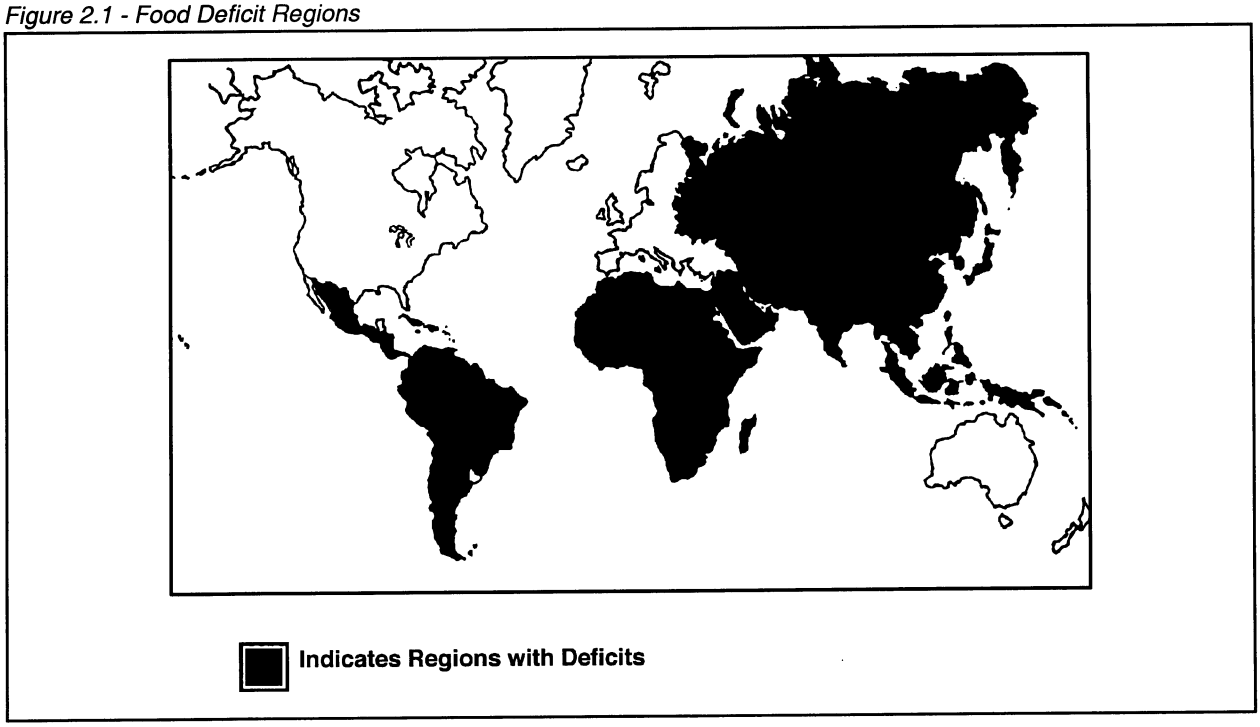
Summary

Agriculture is more than farming. The definition of agriculture has evolved to include career areas in seven major sectors of the agricultural industry. The global aspect of agriculture is concerned with the increasing world population. The country's largest employer is agriculture. Several major benefits are provided by agriculture including a low food cost compared to other countries and helping to increase the life expectancy of humans. Agriculture benefits everyone each and every day.

Lesson 2: Agriculture in the World

This lesson is about the role of agriculture in the world. Billions of people in the world depend on agriculture to provide them with food, clothing, and shelter. Most of these items are provided by a small number of countries that produce enough food for export, with the United States being a leader in this area. In addition, the United States imports key food items that cannot be grown in our climate.

Figure 2.1 - Food Deficit Regions



An export is a product that is transported from the United States to a foreign country, primarily by shipping. An import is a product that is brought into this country from another country. Trade balance refers to the value of goods exported from the United States compared to the value of imports.

Importance of Agriculture in the World

Agriculture is an important industry in the world economy. At the most basic level, agriculture produces the food, clothing, and shelter that the world population needs for survival. However, some countries cannot produce the food needed to feed their citizens. Figure 2.1 shows the regions in the world with food deficits. Other countries are fortunate to produce more than they need. Countries with a surplus can export food to countries that have food shortages.

Countries that export agricultural products may use the income to buy other products on the world market. Countries will buy goods for a variety of reasons. Some will buy goods, such as medical supplies, that improve the quality of life for their citizens. Others will buy weapons and equipment to improve their military power.

Agricultural science and technology has provided medicines and pharmaceuticals for many people in the world. These advances have helped to improve the quality of life and have contributed to a longer life expectancy.

The United States exports large amounts of agricultural products to other countries. Agricultural exports generate billions of dollars of income for the United States. Income obtained from the sale of agricultural products enables the United States to import goods needed to maintain a high standard of living in this country. In 1999, major U.S. imports consisted of crude oil and refined petroleum products, automobiles, consumer goods, and food that cannot be grown in the U.S. climate.

Agricultural Differences in the World

Climate affects the growing of plants, crops, and animals in the world. Temperature and precipitation are two major factors that influence the type of production agriculture that is possible in a country. For example, the tropical climate of Central America is ideal for producing specialty crops such as bananas that cannot be grown in other areas of the world. Countries that are closer to the equator have longer growing seasons and can produce crops, especially fruits and vegetables, almost year-round.

There are thousands of different types of soil in the world, each with a high, medium, or low fertility level. When combined with the soil's ability to drain or hold water, a soil may or may not produce a crop. Topography is the shape of the ground surface as determined by such major features as hills, mountains, or plains and indicates the slope of the land. Land that is hilly is difficult to farm and may lose valuable topsoil through erosion. Topography has a large influence on soil drainage.

Economic development is another factor that explains agricultural differences in the world. Many countries have a very low standard of living. These countries can be classified as developing, which means they are evolving from a less-developed status to an industrialized level. Less-developed countries are characterized by low incomes, poor health care, low literacy rates, and a shortage of money. As a result, they do not have the technology, skill, or management level to produce a high quality and quantity of food and fiber for their people. The developed countries of the world are characterized as having excellent educational systems, using modern technology in agriculture, and having a marketing and distribution system to provide agricultural products for use by their population or for export.

Agricultural Commodities Produced in Major World Regions

Because of agricultural differences in the world, a variety of commodities are produced in various continents. For example, Africa is known for its production of cotton, metals, and petroleum products. Asia produces such commodities as rice and tea. Australia is a leader in producing wheat, sheep, and wool. Europe is associated with floriculture, potatoes, cereal grains, and textiles. North America is a leader in corn, soybeans, beef, pork, and wood products, while South America is associated with coffee, soybeans, metals, and wood products.

Primarily due to growing conditions, especially climate, the United States must depend on other countries to produce certain agricultural commodities. For example, the United States imports food products such as bananas from Costa Rica and Ecuador; cashews from Brazil and India; coffee from Columbia, Brazil, and Mexico; olives from Spain, Morocco, and Greece; and peppers from Mexico.

Role of U.S. Agriculture in the World Market

Producers in the United States produce enough food to feed the entire population in the United States and to export to many foreign countries. Over 95% of the world's consumers live outside United States borders. Some countries with large populations or limited natural resources do not produce enough to feed their people. Although the United States is not the only provider of food and fiber products in the world, many countries purchase U.S. products.

Agricultural exports are vitally important to the U.S. economy and totaled $61.8 billion in 1998. Table 2.1 lists the top five exports by value.

Table 2.1 - Top Five U.S. Exports

Exported Product	Value
Soybeans	$6.1 billion
Coarse grains (corn, oats, barley, sorghum, and rye)	$5.0 billion
Consumer food (beef, pork, and lamb)	$4.0 billion
Wheat	$3.8 billion
Cotton	$2.5 billion

Table 2.2 lists the leading countries that purchased U.S. agricultural exports in 1998.

Table 2.2 - Leading Purchasers of U.S. Exports (1998)

Country	Amount of Agricultural Exports Purchased	Percent of U.S. Agricultural Exports
Japan	$12.1 billion	19.6%
European Union (15 countries)	$10.0 billion	16.3%
Canada	$9.0 billion	14.6%
Mexico	$6.3 billion	3.9%
South Korea	$2.4 billion	3.9%

The United States also plays a key role in providing assistance to countries that cannot produce the food needed for their citizens. Technical and educational assistance is provided to some developing countries. In addition, the U.S. Department of Agriculture (USDA) administers a number of foreign food assistance programs. Through humanitarian efforts, many needy countries receive emergency assistance from food that is shipped from the United States.

Summary

Agricultural products play an important role in the world economy. Agriculture varies from country to country primarily due to climate and technology. Imports supply countries with agricultural products that cannot be produced in that country. The United States continues to play a key role in providing assistance to countries that cannot produce the food and other products needed for their citizens. Such programs involve providing technical and educational assistance to developing countries.

Lesson 3: Agriculture in the United States

The United States produces an abundant variety of agricultural products for use at home and abroad. Agriculture is the largest industry in the United States and has impacted history in many ways.

Agricultural Production

Agricultural products are produced in every state. However, different areas produce different crops and animals for a variety of reasons. Agricultural production is concentrated in areas with favorable growing conditions.

Climate is an extremely important growing condition. Many crops produced in the southern United States would not survive the colder growing conditions in the north. The length of the growing season is related to this factor. In general, the growing season lengthens in relation to how far south the area is located.

Water is needed to produce agricultural crops. Areas that receive limited rainfall must use irrigation to produce crops. Temperature extremes in summer and winter months may also limit the crops or livestock that can be produced in some areas.

Soil conditions, such as topography and fertility, affect what crops can be grown. In general, livestock production is located where crops grown for livestock feed is readily available.

Success of Agriculture in the United States

The United States is a world leader in the production, processing, and marketing of agricultural products. Much of the wealth Americans enjoy as a nation can be attributed to the tremendously successful agricultural industry.

A combination of factors contributes to the success of agriculture in the United States. The fertile soil in this country is some of the finest in the world. Growing conditions, such as temperature and rainfall, are very favorable for producing a variety of crops.

America has been blessed with many leaders and inventors who have made important agricultural discoveries. Scientists and researchers have developed technology that has been adopted by agribusiness to improve production and efficiency. Finally, an advanced and extensive transportation and marketing system has been developed to make agricultural products available to consumers.

Goals of Agriculture

The long-standing goal of agriculture has been to provide food, clothing, and shelter for humankind. That has not changed, but several important goals have been added in recent years.

Food safety and the environment have become critical issues for the agricultural industry. As a result, ensuring food safety and protecting the environment have become important aspects of agriculture's efforts to feed, clothe, and provide shelter for the increasing world population.

Agriculture has been a leader in using technology for production and agribusiness. Technology is considered the practical application of science. Knowledge gained from scientific research is used to create equipment, processes, machines, and new varieties of plants and animals. These technologies are used to improve production methods on farms, and to improve the processing

and marketing of agricultural products. Two examples are computers used to monitor the environment of livestock and grain facilities, and genetically modified organisms (GMOs) like Bt corn that resists the corn borer.

Evolution of U.S. Agriculture

The importance of agriculture in the United States can be traced to a point in history before this land was a nation. Most of the first settlers who set foot on the land that was to become the United States were farmers. These early colonists produced crops under ideal growing conditions and exported agricultural products to England.

As people moved west, this expansion opened new land and opportunities. Farmers and ranchers claimed large areas of land. The growth and development of the United States were made possible by the ability of farmers and ranchers to efficiently produce agricultural products.

This efficiency has allowed the United States to shift from a nation of farmers to an agribusiness economy. At the time of the American Revolution, over 90% of the colonists made their living as farmers. Today, that percentage is less than 2%. However, the scientific and technological advances in agriculture have made it possible for approximately 20% of the U.S. population to be employed in agribusiness.

Many advances have taken place in agriculture due to management, technology, and agricultural research. In general, crop yields have increased and meat animals have become leaner and more cost efficient in converting feed stuffs to meat or milk. Table 3.1 provides historical evidence of this progress.

Historical Impact of Changes in Agriculture

As the United States grew, agriculture contributed to its growth. Inventions such as the cotton gin by Eli Whitney (1793) and the grain combine (1836) enabled American farmers to increase agricultural production. In 1837, John Deere began manufacturing plows, thereby making the soil much easier to work. Barbed wire was invented in 1867 and helped to manage cattle herds and sheep flocks.

John Froelich built the first gasoline tractor in 1892. Tractors came into general use in the 1920s and 1930s, and replaced horses in supplying farm power. As the need to increase crop yields grew, American researchers responded with the development of hybrid seed corn in 1922. The 1950s brought the adoption of commercial fertilizer by producers and increased mechanization. Herbicides and insecticides gained popularity in the 1960s, and the 1970s brought confinement structures for raising livestock and the increased use of artificial insemination of livestock.

Computers started to play an integral role in farm operations and agribusinesses in the 1980s. There was less emphasis on the plow as a tillage method in the 1980s, and erosion control measures such as conservation tillage gained popularity. Agriculture in the 1990s was characterized by increased use of emerging technology such as the global positioning system (GPS). During the mid-1990s, the first crops improved through biotechnology were commercialized. In 1997 a sheep was genetically cloned from adult cells. These are just a few of the advances that enabled agriculture to supply the food and fiber needs of a growing United States and world population.

Table 3.1 - Progress of American Agriculture

Year	Hours of labor required to produce 100 bushels of corn	Corn yield (bushels/acre)	Percent of U.S. population that are producers	Number of people fed by one U.S. producer
1850	85	20	64	<1
1900	38	25	38	2
1950	12	38	12	27
Today	2	135	1.8	135

Legislation played a key role in the development of agriculture. In 1862, the U.S. Congress passed the Morrill Act. This act granted land to each state to establish land-grant colleges to teach agriculture and mechanical arts. The University of Missouri-Columbia was developed as a land-grant college. Sanborn Field on the University of Missouri-Columbia campus is the oldest Agricultural Experiment Station west of the Mississippi River.

In 1914, the Smith-Lever Act established the Extension Service as a way to educate producers. The Smith-Hughes Act of 1917 established agriculture, home economics, trade, and industry in high schools. See Table 3.2 for a listing of the events.

Table 3.2 - Significant Events in the History of Agriculture

Year	Event
1793	Eli Whitney invented the cotton gin.
1836	The grain combine was patented.
1837	John Deere plows were first manufactured.
1862	The Morrill Land-Grant College Act was passed.
1867	Barbed wire was invented.
1892	John Froelich built the first gasoline tractor.
1914	The Smith-Lever Act established the Extension Service.
1917	The Smith-Hughes Act was passed.
1922	Hybrid seed corn was developed.
1950s	Mechanization increased and commercial fertilizer was adopted.
1960s	Herbicides and insecticides gained popularity.
1970s	Use of confinement structures increased and artificial insemination of livestock began.
1980s	Use of conservation tillage and computers increased.
1990s	Global positioning systems (GPS) technology emerged.
Mid-1990s	First crops improved through biotechnology were commercialized.
1997	A sheep was genetically cloned from adult cells.

Summary

The United States is fortunate to have ideal growing conditions for the production of a variety of crops and livestock. Many inventors, legislators, researchers, scientists, and entrepreneurs were instrumental in the development of agriculture in the United States. They have contributed to the efficiency and productivity of American agriculture. At the same time, agriculture has remained true to its goal of providing food, clothing, and shelter as well as fulfilling the recent goals of protecting the environment, ensuring a safe food supply, and using technology to benefit consumers.

Lesson 4: Agriculture in Missouri

Missouri is one of the nation's leading producers of a variety of high-quality agricultural products. Farming and agribusiness have a rich heritage in the state. This lesson will review the agricultural commodities produced in Missouri, the importance of agriculture to the state, and how agriculture has changed in Missouri.

Commodities Produced in Missouri

Missouri is a leading agricultural state. Based on statistics for 1998, Missouri ranks second in the United States for the number of farms. The state ranks high in the production of several agricultural commodities. Missouri is second in number of beef cows produced and fourth in grain sorghum and hay production. Grain sorghum and hay are used for livestock feed. The abundance of pastureland reduces the effect of erosion and provides an ideal environment for cattle grazing. Cattle producers in states with more grain production buy Missouri feeder calves for their feedlots. Table 4.1 lists Missouri's ranking in the United States.

Although national rankings are not available, other agricultural commodities deserve mention. In Missouri, nearly 2500 firms are involved in logging and wood products manufacturing. These businesses employ more than 33,000 people and contribute $3 billion each year to Missouri's economy. In 1998 there were 323 horticultural businesses that produced almost $68 million in sales. They operated over 7 million square feet of greenhouses. Missouri is a large supplier of Golden and Red Delicious, and Jonathan apples.

More than 40 million pounds of apples are produced annually.

Table 4.1 - Missouri's 1998 Ranking in the United States

Category/Commodity	Rank
Number of farms	2nd
Beef cows	2nd
Grain sorghum	4th
Hay (all types)	4th
Turkeys raised	5th
Concord grapes	6th
Rice	6th
Soybeans	6th
Hogs and pigs	7th
Cheese	9th
Watermelons	9th
Broilers	10th
Corn	10th
Winter wheat	11th
Cotton	12th
Ice Cream	12th
Tobacco	12th
Eggs	14th
Milk	15th

Importance of Agriculture in Missouri

Diversified is the word most commonly used to describe Missouri agriculture. The environmental factors of geography, vegetation, climate, and soil fertility vary throughout the state. As a result, agricultural production varies in a similar manner. Table 4.1 is evidence of this variety and diversity. In 1999 the value of agricultural products produced in Missouri was approximately $4.5 billion.

Producers have selected agricultural commodities to raise based on the environmental factors in their area. For example, the rich and productive soils of Missouri's northwest, central, northeast, and southeast regions are ideal for crop and livestock production. The hilly and wooded areas of the Ozarks provide timber, pasture, and favorable weather for growing fruits and vegetables.

Missouri is among the nation's leading purebred livestock producers with livestock and related products accounting for slightly over 50% of the state's agricultural receipts. Large quantities of hogs are raised in the north and north central part of Missouri. Hay production, pastureland, beef cows, and dairy cows are most highly concentrated in the southwest.

The leading production areas of soybeans (Missouri's largest cash crop), corn, wheat, and grain sorghum are found in the northern third of the state, the west central area, and the Bootheel of Missouri.

More than 30% of Missouri is forested. The state is a leading producer of wooden pallets, charcoal, and walnut products. Lumber, hardwood flooring, wine barrels, and treated wood products are exported to other countries as well as being used in Missouri and the rest of the United States.

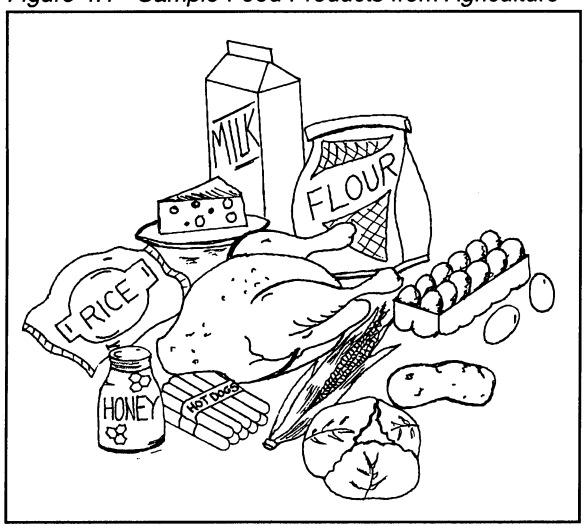
Missouri is a leading producer of grapes. This produce is marketed fresh and made into jams, jellies, juices, and wines.

Missouri operates trade offices in countries such as Brazil, Chile, Japan, Korea, Mexico, and Thailand in response to overseas demand for Missouri agricultural products.

Production of agricultural commodities on the farm is only part of the importance of agriculture to Missouri's economy. Agribusiness, the other key component, employs more than 15% of Missouri's labor force. That is one of every six workers in Missouri, or more than 400,000 people.

The agricultural processing and marketing sector of agriculture provides job opportunities for many people in the state. The processing of products raised on Missouri farms by almost 2,000 Missouri firms provides employment for approximately 92,000 persons. These people earn more than $1.8 million in annual wages. Processing by these businesses adds over $7 billion to the value of the basic farm products.

Figure 4.1 - Sample Food Products from Agriculture



It is not possible to list all the major agricultural businesses in Missouri, but several deserve noting due to their national and international scope. Monsanto and Ralston Purina are two well-known businesses located in St. Louis. Farmland Industries, the largest farm cooperative in the United States, and Dairy Farmers of America, the nation's largest dairy cooperative, are both based in Kansas City.

Missouri Agriculture Has Changed

Agriculture in Missouri has and will continue to change. The number of farms in Missouri dropped approximately 12% during the decade of 1980-1990. This was primarily in response to the agricultural crisis.

Since that time, the decline in the number of Missouri farms has slowed and stabilized. Medium-size farms have declined the most in the past, while large-size farms have increased. As a result, the average size of farms has increased.

The number of small-size farms has stabilized as the rural areas have become a favored place to live and raise a family. Most of the families living on small-size farms have dual incomes from jobs off the farm and they treat their farm business as a hobby or specialty farm.

The average age of producers has increased and lower numbers of people under the age of 35 have selected farming as a career. Agricultural businesses, however, are hiring more employees, especially females.

Producers are continuing to adopt new technology in an attempt to be as efficient as possible. Special attention has also been directed toward practices that conserve soil and maintain quality water supplies. Special interest groups have challenged agriculture to have high standards in regard to those areas as well as directing livestock producers to evaluate the livestock industry.

Most recently, agriculture has witnessed economy-of-size principles being applied to farms and businesses. The trend has been toward larger farming operations with more acres and livestock numbers, the formation of farmer cooperatives, and the consolidation of agricultural businesses. Combining agricultural businesses with biotechnology, pharmaceutical, and food companies has resulted in unique mergers and the development of the life sciences industry.

The number of businesses involved in biotechnology and life sciences are increasing in Missouri. Businesses, such as Monsanto, have selected the St. Louis area to locate their research facility.

Summary

Agriculture is very diverse in Missouri and is the most important industry. Agricultural production provides raw products, agricultural business, and career opportunities that directly contribute to the state's economy. More than 15% of Missouri's labor force is employed in agribusiness. Missouri products are used by consumers in the state, across the United States, and throughout the world. Missouri has changed and will continue to change agriculturally. However, the importance of the industry to the economy of the state will continue.

Lesson 5: Advances in Agricultural Technology

Agriculture and agricultural research have improved the quality of life in the United States. The abundance of quality food products, healthier diets, and low-cost food products are the result of a progressive agricultural industry. This lesson is about recent advances in technology and future changes expected in agriculture.

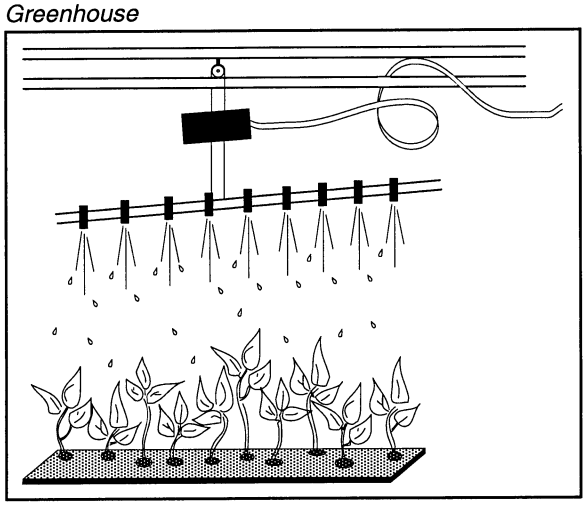
Recent Changes in Agriculture

Agriculture has changed and will continue to change as technological advances are made. The following information is a summary of some of the current changes in agriculture.

Computers - Management records for producers and agribusinesses are maintained on a computer. Consulting and management advice, commodity price updates, and communication by e-mail and the Internet through a computer have become standard procedures in agriculture. Computers are used to monitor the environment of livestock and grain facilities. Animals even have computer chips containing genetic information that can be scanned into a computer.

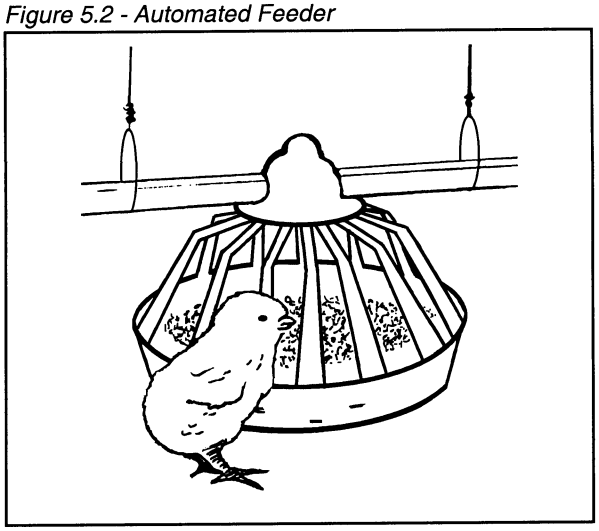
Mechanical - The use of electronic monitoring devices, laser-guided equipment, surveying instruments, and robotics have been used in various phases of agriculture. Technology is being used to reduce human labor costs. Reducing the cost of labor to produce, process, market, and transport food and fiber products helps to reduce the cost of production.

Figure 5.1 - Automated Watering System in a Greenhouse



Livestock management - Automated systems of feeding, watering, and waste disposal have reduced the amount of manual labor involved in caring for animals. Totally controlled environments have helped improve animal efficiency. Buildings to house animals have increased in size and also in concentration in areas favorable for production.

Figure 5.2 - Automated Feeder



Embryo transfer - This process involves taking eggs from genetically superior donor females and implanting them in recipient females. This allows multiple offspring from one animal to be born in 1 year. For example, a cow can produce eight calves in 1 year.

Cloning - This process involves reproducing a fertilized egg to create a genetically identical individual. In this process, reproduction of superior genetics is possible. Currently, cloned embryos are available for purchase by producers.

Genetically-modified crops - One of the most controversial subjects to arise in agriculture in recent years involves the development of genetically-modified organisms, or GMOs. Bt corn controls the corn borer insect by creating a substance that is toxic to the worm when it attacks the corn plant. Soybeans with herbicide resistance allow for better control of weeds, thus improving soybean yields.

Precision agriculture - Through satellite technology and yield monitors, global positioning systems (GPSs) have allowed producers to be more efficient. Soil and crop management can better fit the different conditions found in each field. "Farming by the inch" is possible through this new technology.

Future Changes

By the year 2040, some experts predict that the world population will double. Feeding and clothing these additional billions with a limited supply of suitable farmland poses a tremendous challenge.

Will research and new technology help agriculture meet this huge task?

In the future, biotechnology and precision agriculture will help increase production of crops and food. As a result, crop yields will continue to increase and machinery and animals will become more cost efficient. Traditional agricultural products will take on value-added dimensions as new uses are discovered for by-products. For example, recycled newspapers and soybean flour are being combined to make countertops and paneling for homes.

Research in science, agriculture, food, and health will result in new technology and unique products. For example, medicines and vitamins may be genetically engineered into plants or animals. In this way, the correct dose of anticancer medicine or just the right amount of vitamins would be consumed when eating a bowl of corn flakes or a hamburger.

Implications of Change

All of these changes in agriculture will help to feed and clothe the increasing world population. At the same time, agriculture must preserve the environment and maintain water and air quality.

Worldwide, 6 million square miles of land is used for the production of food. Surprisingly, this is the same amount as in the 1950s. And yet during this time, world agricultural productivity tripled. Clearly, the future challenge is to continue increasing productivity with about the same amount of land.

The United States will continue to be a world agricultural leader. Almost one-fourth of the most productive agricultural land is in the United States. Approximately 30% of all U.S. agricultural production goes to export markets. In the future, global trade will increase and more people will recognize its importance. As agriculture adapts to meet the needs of its global customers, new career opportunites will be created in areas such as biotechnology, marketing, commodity trading, agricultural science, economics, agribusiness, sales, computer technology, communications, international relations, transportation, and plant science.

Summary

Agriculture has and will continue to change. The fundamental goal will be to continue to produce quality food and fiber for the increasing population.

New technology and research will help to increase productivity without compromising resources. Preserving natural resources is a top concern for everyone in agriculture. There will be many career opportunities in agriculture as the demand for food and fiber continues to increase.

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Lesson 1: The Importance of Plants

Plants provide people with oxygen to breathe, food to eat, clothing, shelter, and landscaping beauty. This lesson discusses the importance of plants and the areas of plant science.

Benefits of Plants

Plants are essential to the survival of human beings. Plants provide biological, physical, and emotional benefits. Biological effects include the ability of the plant to convert carbon dioxide to oxygen through the process of photosynthesis. Photosynthesis also reduces carbon dioxide levels in the air. Plants are also the basis for the human food supply. People eat plants and animals that have eaten plants.

Plants provide many physical benefits. Trees provide materials that are used to build shelters. Fibers from plants, such as cotton, are used in making clothing. Plants can also supply shade, control wind, and provide cooling effects. Control of these climatic factors can aid in reducing both wind and water erosion. Energy sources such as firewood or alcohol-fuels can be made from plant materials. Plants also provide a habitat for wildlife.

Emotional benefits include the beauty of well-landscaped areas as well as the enjoyment of interesting individual plants. Many Americans receive enjoyment from gardening and growing plants. Plants also provide a way to reduce stress by the relaxing effect of gardening and tending flowers.

Plant Science Areas

Four areas of science are closely related to the study of plants. These areas study plants for different reasons.

Botany is the science of plants and consists of such areas as anatomy, ecology, physiology, and taxonomy.

Horticulture includes producing, processing, and marketing fruits, vegetables, flowers, ornamental shrubs, and trees; nursery and landscaping; and turf management.

Agronomy is the study of field crops and soil management.

Forestry is the science of managing trees for lumber, paper, and other wood products.

Economic Importance in Missouri

Based on 1998 figures, the value of plants produced in Missouri was approximately $3 billion. See Table 1.1 for a list of the leading crops and plants. This value would put Missouri plant production in the list of Fortune 500 companies (the wealthiest companies in America).

Table 1.1 - Value of Leading Missouri Crops in 1998

Crop	Approximate Value (in millions)
Soybeans	$857
Corn	$550
Hay	$533
Winter wheat	$137
Cotton	$119
Rice	$64
Grain sorghum	$46
Floriculture	$44
Tobacco	$11
Potatoes	$10
Watermelons	$6
Apples	$5
Peaches	$4
Grapes	$1
Oats	$1

A closer look at several of the major areas of floriculture in 1998 shows there were $21 million dollars (wholesale value) of bedding plants (flats) and baskets, $11 million in indoor/patio plants, and $.6 million in cut flowers produced by Missouri commercial groups.

Summary

Plants are essential for humans to breathe and eat. Plants make life more comfortable because they provide shelter, clothing, and shade. Plants also make our world more pleasant through their

beauty. Botany, horticulture, agronomy, and forestry are all related plant sciences. The value of plants produced in Missouri in 1998 was approximately $3 billion, which would make the Fortune 500 list.

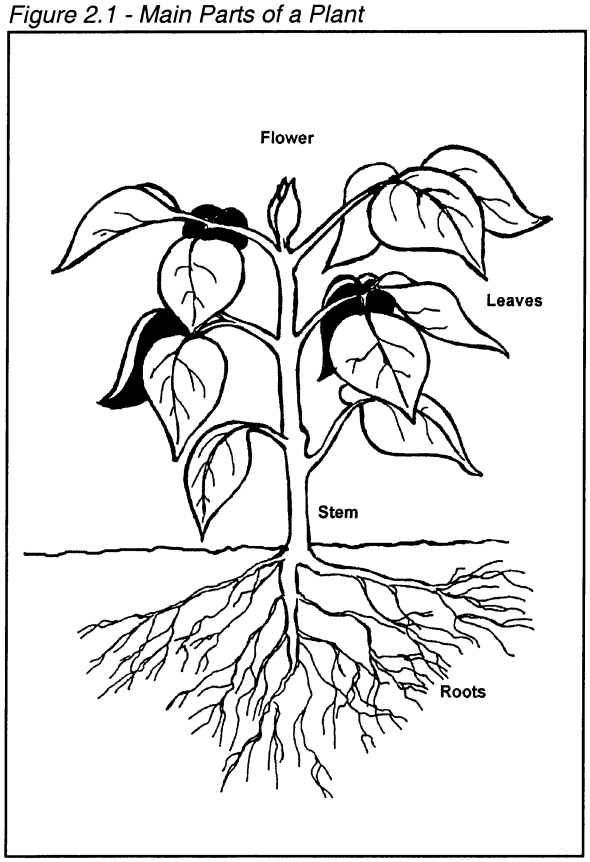
Lesson 2: Plant Parts and Processes

The major parts of plants are essential to the growth and reproduction of the plant in various ways. This lesson will discuss plant parts and their unique functions, reproduction, germination, and photosynthesis.

Main Parts of a Plant

Plants are made of four main parts: roots, stems, leaves, and flowers. See Figure 2.1. Each of the major parts is essential to the growth or reproduction of the plant.

Figure 2.1 - Main Parts of a Plant



Roots absorb water and minerals from the soil. Roots anchor the plant in the soil, allowing it to grow upright. They also act as a food storage area, like in turnips, beets, or carrots.

The stem supports the plant as a whole, but it mainly supports leaves and flowers. Stems transport water and minerals from the roots and transport manufactured food (simple sugars) to all parts of the plant. Stems can also be sites for photosynthesis and food storage.

Leaves are the location of food production for the plant. This production is through the process of photosynthesis. Respiration (release of energy and waste products) and transpiration (release of water vapor) also occur in the leaves. Leaves also can be the food storage area, like in cabbage or lettuce.

The flower is the site of sexual propagation. This is where the fruits and seeds are formed. During propagation the flower attracts insects that help transfer pollen from flower to flower. Insects can be attracted by color, pleasant fragrances, and unpleasant odors.

Plant Reproduction

Plants can be reproduced both sexually and asexually. Sexual propagation occurs within the flower, which produces fruit and seeds. It starts with the transfer of pollen from the male part of the flower to the female part. This is called pollination. Asexual propagation produces new plants from vegetative parts. New plants of some species can be produced from leaves, stems, and roots using asexual methods. Common asexual propagation methods are cuttings, grafting, division, layering, budding, and tissue culture. See Figure 2.2.

Figure 2.2 - Asexual Propagation Methods

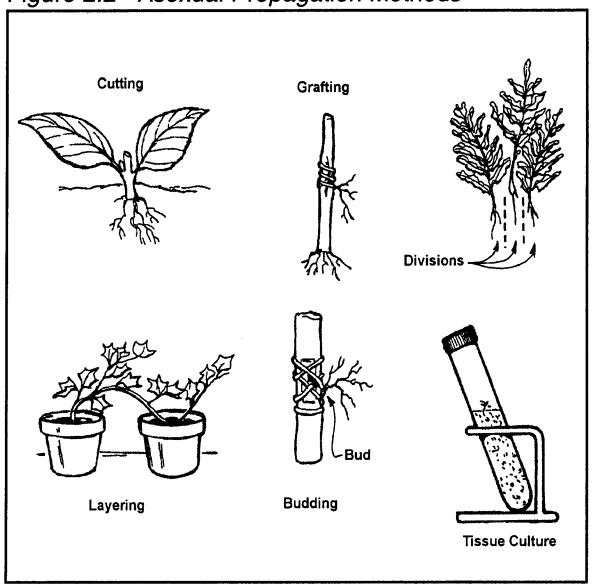
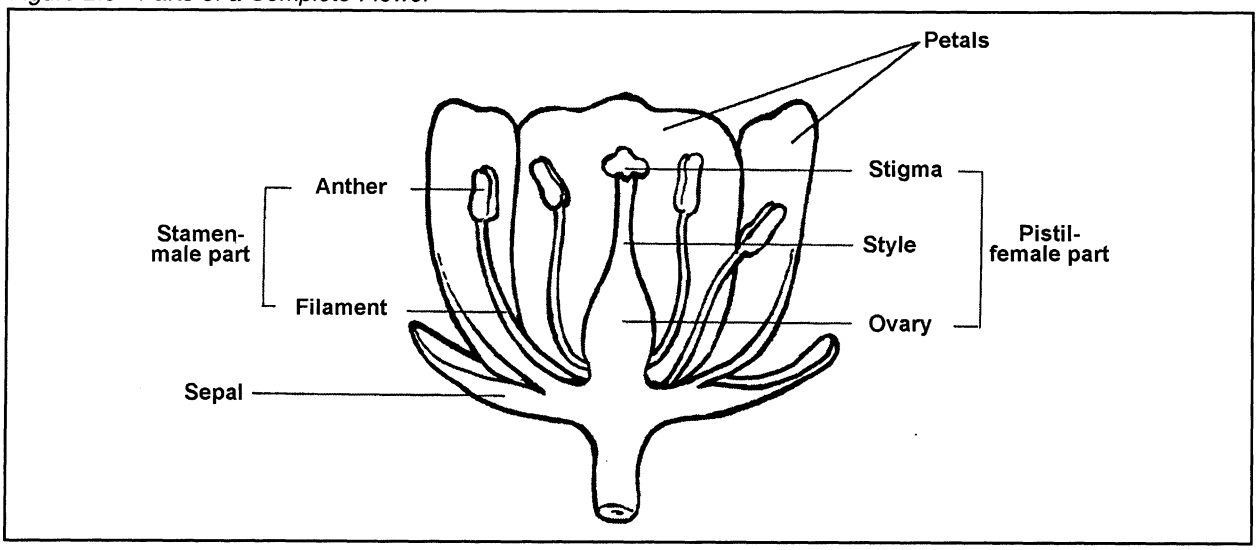


Figure 2.3 - Parts of a Complete Flower



Asexual propagation is used because (1) some plants do not produce seed or seeds are difficult to germinate, (2) it is usually a faster process than growing plants from seed, and (3) it is economical for horticultural businesses.

Parts of the Flower

Flowers are the site of sexual propagation. Flowers have four main parts: the petals, the pistil, the sepal, and the stamen. Refer to Figure 2.3.

The petals attract insects for pollination.

The pistil, which is the female structure of the flower, is the site of fruit and seed formation. The pistil is made up of the stigma, style, and the ovary.

The sepal protects the flower in the bud stage.

The stamen, which is the male structure of the flower, contains the filament and the anther. Pollen is produced in the stamen.

Pollen is transferred by a variety of methods to the pistil. This transfer of pollen is called pollination.

Seed Germination

After the seed has been produced by sexual propagation, it will germinate, or sprout, when conditions are favorable. The seed is in a dormant, or resting, stage with a supply of food and a protective seed coat until the requirements for germination are met. The following are needed for a seed to germinate: favorable temperature that varies by species, sufficient moisture, air, and the presence or absence of light (depends on the plant species). Thus germination, or sprouting of the seed, is the beginning of plant growth.

Photosynthesis

Photosynthesis is a process that occurs in green parts of the plant, mainly in the leaves and stems. Green plants contain chlorophyll, which reacts with water, carbon dioxide, and sunlight to produce oxygen and simple sugars. These sugars are the food source for the plant.

Annual, Biennial, and Perennial

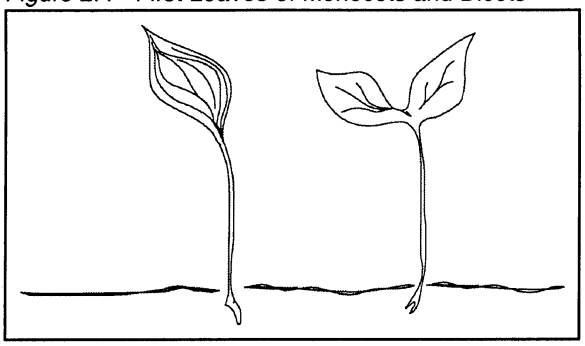
Plants may be classified as annuals, biennials, or perennials based on their life cycle. Annuals complete their life cycle (grow, flower, produce seed, die) in 1 year. Biennials live for 2 years. They grow during the first year and flower, produce seed, and die during the second year. Perennials live for more than 2 years. They can grow year after year without replanting.

Monocots and Dicots

Agricultural plants can be classified as monocotyledonous plants and dicotyledonous plants. Monocotyledonous plants, frequently called monocots, have seeds with a single

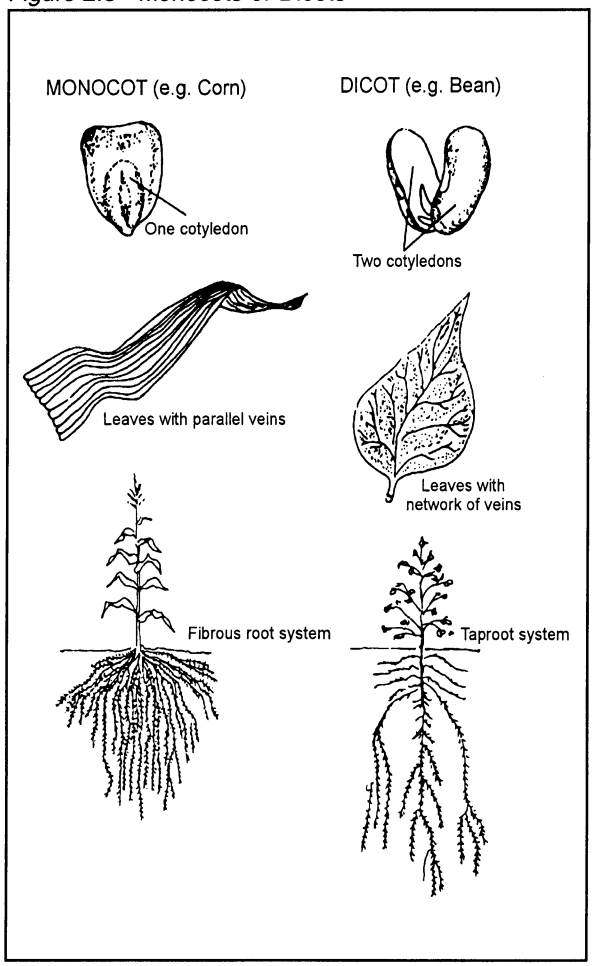
cotyledon (seed leaf or first leaf). Refer to Figure 2.4.

Figure 2.4 - First Leaves of Monocots and Dicots



Dicotyledonous plants, which are frequently called dicots, have seeds with two cotyledons (seed leaf or first leaves). The differences in these two major classes of plants can be clearly seen by comparing their seeds, leaves, and root systems. Figure 2.5 provides this visual comparison.

Figure 2.5 - Monocots or Dicots



Monocots have one cotyledon. The leaves have parallel veins and a fibrous root system. Corn, wheat, and lawn grass seed are several examples.

Dicots, such as soybeans and alfalfa, have two cotyledons. The leaves have a network of veins and a taproot system.

Summary

Plants have major parts that serve important functions and are important for plant survival or reproduction. Plants can be reproduced sexually by germinating seeds or asexually using vegetative plant parts. The main parts of a flower are the petals, pistil, sepal, and stamen. Germination is the sprouting of a seed when conditions are favorable. Photosynthesis occurs when the chlorophyll in the plant reacts with water, carbon dioxide, and sunlight to produce oxygen and simple sugars (food for the plant). The plant's life cycle may be completed in 1 year (annual), 2 years (biennial), or more than 2 years (perennial). Plants may be classified as monocots (single-seed leaf) or dicots (two-seed leaves).

Lesson 3: The Growing Medium

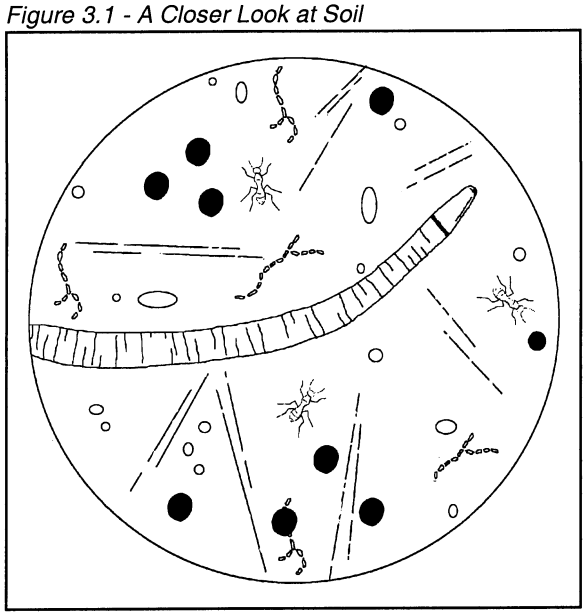
Plants require a certain environment for proper growth. Plants have an aboveground environment that affects the visible parts of a plant such as the stem, leaves, and flowers. They also have an underground environment where the roots live and grow. People who produce and grow agricultural plants must properly manage the underground environment to ensure a healthy and productive plant. This lesson focuses on the plant's underground environment.

Soil

Soil is the living and naturally occurring top layer of the earth's surface that provides food, water, air, and support for plant life. Soil is a renewable natural resource that humans depend on for food, clothing, and materials for shelter. It may be considered the basis for all life on earth.

Soil is composed of a great amount of life. Scientists agree there is more life below the surface of the earth than there is above it. In addition to the living plant roots, the life-forms are earthworms, insects, bacteria, fungi, and many other microscopic organisms. See Figure 3.1.

Figure 3.1 - A Closer Look at Soil

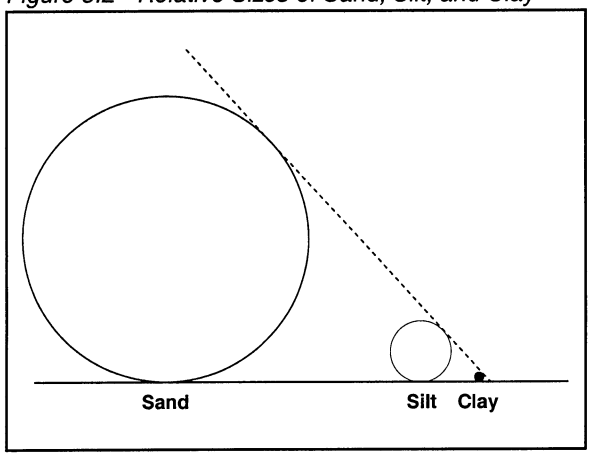


It is not accurate to refer to soil as dirt. Dirt is defined as misplaced soil. It gets on your clothing, under your fingernails, and blows into the house. Soil, on the other hand, is composed of millions of living organisms and is vital for the production of the world's food and fiber crops.

Components of Soil

An ideal soil contains 45% mineral matter, 5% organic matter, 25% water, and 25% air. Mineral matter is inorganic (from a nonliving source) and varies in size. Sand particles are the largest, feel gritty, and do not hold water effectively. Silt particles are medium-sized and have a smooth feel, like flour. The smallest mineral particles are clay, and they hold moisture much more effectively than larger particles. See Figure 3.2.

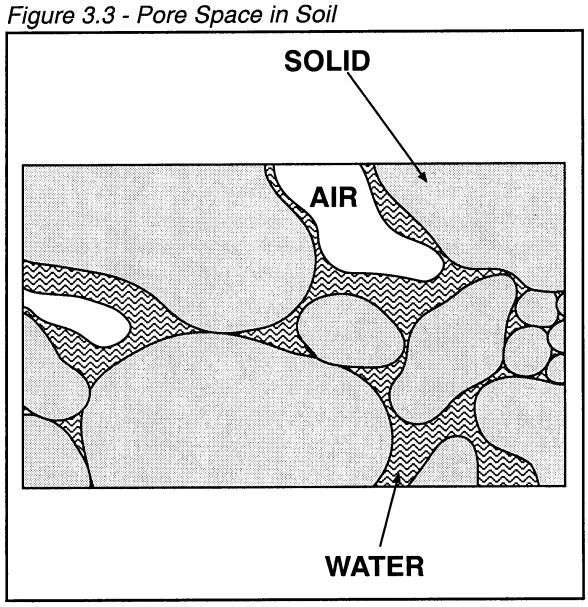
Figure 3.2 - Relative Sizes of Sand, Silt, and Clay



Organic matter originates from a living source, usually a plant or animal. This residue in the soil can be in various stages of decomposition.

Pore space is the area between soil particles. Depending on the weather and/or management practices, these small holes are filled with varying amounts of water and air. See Figure 3.3.

Figure 3.3 - Pore Space in Soil



Growing Medium

Greenhouse and nursery plants are grown in material called growing medium. Growing medium (singular) or growing media (plural) are the materials in which the roots of plants grow. An important function of a growing medium is to support, or anchor, the plant in place, even after watering.

The ideal growing medium must be able to retain sufficient moisture for good plant growth. However, the medium must also be porous enough to allow excess water to drain away from the plant roots.

Soilless Mix

Soil-based media were used in the horticultural industry for many years to grow plants. However, today almost all greenhouses and nurseries use a soilless medium to grow plants in flats, pots, and other containers.

A soilless mix is a medium that contains no soil. These mixes are commercially prepared and ready-to-use from the bag. Soilless mixes contain various combinations of the following materials.

Perlite - Perlite is gray-white material of volcanic origin. These particles are easily seen in the medium and are used to improve aeration. Perlite is also used to asexually propagate cuttings.

Vermiculite - Vermiculite is heat-treated mica (a very thin, layered mineral) that has been fired at 1400°F. It has a high moisture-holding capacity and is frequently used to asexually propagate cuttings.

Peat moss - Peat moss is partially decomposed vegetation that has been collected from marshes, bogs, or swamps. This spongy material has a high moisture-holding capacity. Most plant industry people prefer sphagnum peat moss.

Tree bark - Tree bark is used as a source of organic matter in soilless mixes. The particle size of the bark should be 1/4 inch or less in diameter. Bark of fir, pine, or cedar trees is commonly used.

There are several advantages to using a soilless medium rather than soil. Soilless mixes are lighter in weight, making them easier to handle and less expensive to ship. They are sterile and thus contain no diseased organisms, insects, or weed seeds. On the other hand, soil can harbor diseases or insects and consequently must be pasteurized by heating at 180°F for 30 minutes.

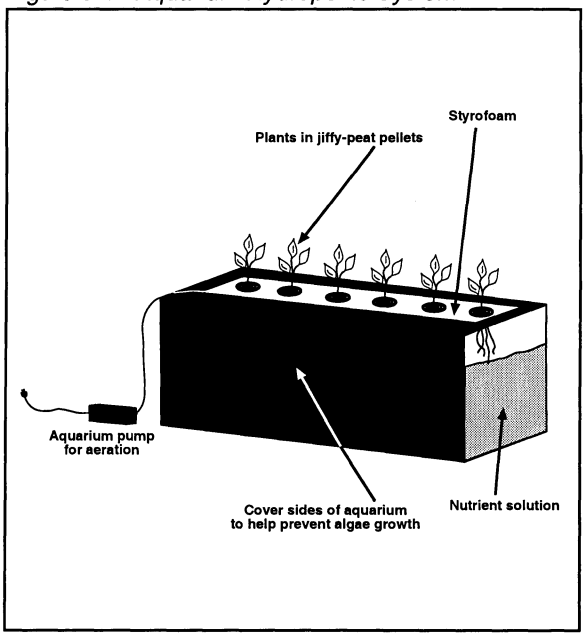
Soilless mixes drain very well. This makes it harder to overwater plants, thereby decreasing the chance of root rot diseases. In addition, soilless mixes are more uniform and do not vary in fertility or texture as much as soil.

Hydroponics

Hydroponics is a method of growing plants in water (nutrient solution) rather than soil. This technique is used to grow high-value crops in greenhouses, especially during the winter.

Some hydroponic systems use sand, gravel, rockwool, peatlite, or sawdust, rather than soil. Bare root systems mist plant roots at regular intervals with a nutrient solution, use shallow pools with plants floating on the surface, or use recirculating streams of nutrient solutions. See Figure 3.4.

Figure 3.4 - Aquarium Hydroponic System



Summary

The plant's underground environment is very important to its overall health. Nearly every product people use or consume can be traced back to the soil. The ideal soil is 45% mineral matter, 5% organic matter, 25% water, and 25% air. The growing medium is the material in which the roots of plants grow and is critical to the overall health of a plant. Today almost all greenhouses and nurseries use a soilless mix to grow plants in flats, pots, and containers. Hydroponics is a technique of growing plants in water (nutrient solution) rather than soil.

Lesson 4: Plant Care Requirements

This lesson will focus on the aboveground needs of plants and the nutrients essential for plant growth.

Plant Growth Factors

Several factors are important for plant growth: water, growing medium, nutrients, light, temperature, humidity, gases, and pest control. Water is essential to maintain the shape of plant cells and for use during photosynthesis. Water enables nutrients to be absorbed from the soil and transported throughout the plant. The manufactured food is transported to all parts of the plant by water.

The growing medium provides support for the plant. It should allow for infiltration and movement of water and air throughout the root zone. The growing medium also stores nutrients for use by plants. There are 16 essential nutrients for plant growth, which are discussed in the next section.

Plants need different levels of light intensity. Some need full sun and others need partial or full shade. Light is needed for the photosynthesis process.

Temperature is a major influence on plant survival in particular environments. Plants differ greatly in their tolerance of hot and cold temperatures. Extremes in temperature can cause slow growth, fruit or flower damage, or death of the plant. Temperature and light are related in their influence on plant growth.

Humidity, or moisture in the air, helps to reduce the drying effects on leaves. Higher humidity slows the amount of water lost from plant leaves.

Gases are important in photosynthesis. Carbon dioxide is used during the process and oxygen is produced.

Pest control is also an important consideration. One of the best ways to reduce pest problems is to keep the plant actively growing. A weakened plant is more susceptible to pests. Diseases and insects must be monitored and controlled.

Essential Nutrients

Plants need 16 essential nutrients in order to grow and develop properly. They require macronutrients in larger amounts than micronutrients. The three most essential nutrients that must be supplied to plants in the largest amounts are classified as primary macronutrients and are nitrogen (N), phosphorus (P), and potassium (K). Secondary macronutrients, needed by plants in moderate amounts, are calcium (Ca), magnesium (Mg), and sulfur (S).

Micronutrients are required by plants in small amounts, and these nutrients are boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn).

All of the above nutrients are absorbed by the plant in mineral form through the plant's root system. There are three essential nutrients, however, that are available to the plant in unlimited amounts from the atmosphere: carbon (C), hydrogen (H), and oxygen (O).

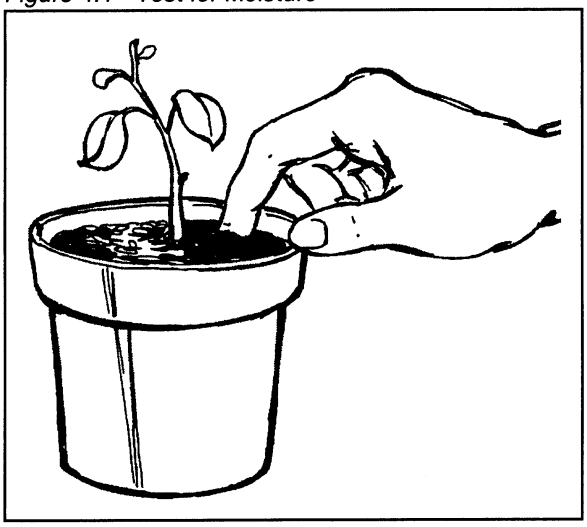
Care of Indoor Plants

For indoor plants, the watering rate will depend on the type of plant, growing medium type, temperature, light, and humidity. There are three general watering rules to follow: (1) use a well-drained growing medium, (2) water plants as needed, and (3) water thoroughly at every watering.

Select a medium that is highly porous yet retains water. Such a medium will retain sufficient water following watering to satisfy the needs of a plant for a reasonable length of time while at the same time be porous enough to supply adequate amounts of oxygen to the root system.

More plants are damaged or die from overwatering than from underwatering; therefore, care should be taken to water a plant only when it needs water. Observing the change in color of the growing medium is helpful in determining when to water. Most media turn lighter in color as they dry. Touching the medium to feel its moisture status is also a useful method of gauging when to water. Hands should be clean and no pesticides should be in the growing medium. To test for moisture, push your index finger into the medium approximately 1 inch (to the first joint). See Figure 4.1. If no medium clings to the finger when pulling it out, water the plant thoroughly. This method does not work well for plants requiring moist or dry conditions.

Figure 4.1 - Test for Moisture



In addition to watering indoor plants as needed, water thoroughly at every watering. Saturating the growing medium in a pot will make full use of the medium and its ability to store water for the plant, thus reducing the frequency of watering. The thorough watering will also leach out excess fertilizer salts that may build up and damage the root system. How can you tell if the plant has been watered thoroughly? Water should flow out the bottom of the container.

Some plants require specific humidity levels for best growth. The majority of indoor plants grow best when the temperature is approximately 70°F. Every indoor plant has varying requirements for best growth. They typically cannot tolerate extremely cold temperatures. Indoor plants require different amounts of light. Some indoor plants may not get enough light because of lack of natural light from windows. Indoor plants require good growing medium (potting mixture). Indoor plants require fertilization, according to the plants' needs. Plants should be pruned of dead or damaged leaves and branches as needed. Pruning or pinching is also done to improve the shape of plants.

Care of Outdoor Plants

Humidity is not easily controlled with outdoor plants. Many outdoor plants usually require watering only during dry periods. Smaller plants such as turf grasses, flowers, and vegetables may require more watering, depending on their specific needs. Outdoor plants are heavily influenced by the climate. This is why plants should be selected for the climate. A plant that requires the temperature to remain above 32°F will not grow well in an area where the temperature drops below freezing.

Outdoor plants vary in their need for light or shade. Plants should be selected for the level of light available. Pollution can also be a problem with outdoor plants. Trees and shurbs generally need only one fertilization per year. Turf grasses, flowers, and vegetables may need several fertilizations during the year. Prune occasionally to remove dead and damaged leaves and branches. Also, prune to maintain the plant's natural shape when it is needed.

Summary

Many factors need to be considered in caring for plants. Plants differ in their need for these factors depending on the variety and location. However, all plants require three major nutrients: nitrogen (N), phosphorus (P), and potassium (K). A key skill to be mastered in caring for plants is watering. More plants are damaged or die from overwatering than underwatering. Keeping a plant in good health will reduce the possibility of having pest problems.

Lesson 5: Technologies Used in Plant Agriculture

This lesson will focus on the current and emerging technologies in plant agriculture and the issues surrounding these technologies.

Satellite Systems Used in Plant Production

In the early 1980s, the U.S. Department of Defense started Global Positioning System (GPS), a satellite-based navigation system. Originally designed to serve as a worldwide navigational aid for the U.S. military, GPS now serves industrial, commercial, and civilian interests as well. Using 24 satellites orbiting the earth, the exact location of a tractor, combine, car, airplane, person, etc., can be determined. With the most accurate and expensive equipment, this location can be pinpointed to the nearest centimeter (.4 inch).

GPS allows a producer to improve plant management skills in many ways. Two of the more important skills are the following:

1. Use a yield monitor to measure a crop yield on-the-go and associate each yield value with a specific location on the surface of the earth.

2. Apply a variable rate of inputs (fertilizer, seed, herbicide, and insecticide) to match the field conditions.

High-tech equipment is being used in agriculture today to help producers do a better job of growing plants. Through the use of satellites and computer technology, a very detailed picture can be created about a field or plants being grown there. This is called precision farming. Precision farming is managing crop inputs such as fertilizer, seed,

herbicide, and insecticide on a subfield basis. Instead of managing a large field of 90 acres, for example, the field is subdivided into subfields measuring 4 to 10 acres each.

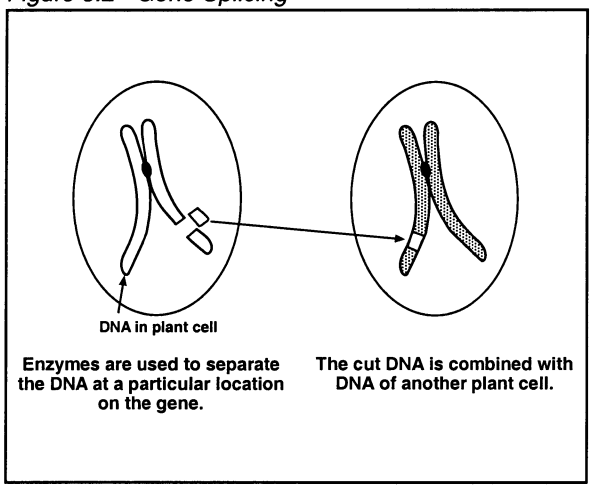
The goals of precision agriculture are (1) managing small areas within a field to reduce input amounts and costs, (2) improving the environment, and (3) increasing yields.

Genetic Engineering

Genetic engineering is modifying and enhancing the genetic components of organisms to benefit society. It is a process in which genetic material (DNA) is taken from one organism and inserted into the cells of another organism. It might also be the rearrangement of the location of genes. The resulting plant is called a genetically modified organism (GMO). This technology is being used to develop new plants with extraordinary potential for increased productivity that will help to feed the world.

In 1975, after many years of research, scientists developed enzymes that could cut DNA at precise points, thus making genetic engineering possible. See Figure 5.2. Ten years later, in 1985, genetically engineered plants resistant to insects, viruses, and bacteria were field-tested for the first time. And in 1994, the Flavr Savr tomato, the first genetically engineered whole food, was approved for sale. This tomato has a tougher skin that softens more slowly than other tomatoes. As a result, the Flavr Savr can ripen on the vine for a better taste, stay firm, and has a longer shelf life at the supermarket. Scientists accomplished this by putting a copy of the gene that causes softening of tomatoes in backwards.

Figure 5.2 - Gene Splicing



In recent years, corn and soybeans have been genetically modified for resistance to insects and herbicides. Figures from 1999 showed that North American producers planted about one-third of their corn acres to a GMO, primarily Bt corn, which resists the corn borer. In addition, about 55% of soybean acres had the Roundup Ready gene, which makes the soybeans resistant to herbicides.

Effects of Emerging Technologies on Plant Production

The intent of technology is to help supply the increasing world population with adequate food and clothing. The productivity of crops and plants will be increased so marginal land is not converted to crop ground and hurt by erosion. Pesticide use will be reduced as genetic traits are added to plants. According to the National Agriculture Statistics Service, written by the USDA, the overall volume of herbicide usage on U.S. soybeans fell by around 9% in 1998 compared to 1997. The increased usage of the herbicide-resistant Roundup Ready gene contributed to this decline.

Plants of the future will be developed with a much more specific purpose than today. Crops will be designed to meet specific needs. It will mean food can be produced that will be more nutritious, taste better, and be of higher quality. The nutritional value of crops for livestock and humans will be enhanced.

Scientists are using the term nutraceuticals to describe health supplements or vitamins delivered through food. Health could be improved and malnutrition alleviated in the world by supplementing needed nutrients through genetic engineering in corn, wheat, or rice. Daily diets that are low in adequate vitamins or proteins could be improved by nutraceuticals.

Farmaceuticals is another term being used today to describe the use of antibodies, medicines, or vaccines that could be inserted into plant-based products. It may one day be possible to prevent and treat a disease, such as cancer, by having a daily bowl of corn flakes.

Because these new technologies are associated with food production, they have come under close scrutiny by scientists, governmental organizations, and consumers.

Plant Technology Issues

New technology always seems to create controversy, and plant technology issues have generated considerable discussion. Some people view biotechnology as an answer to problems like world hunger and more nutritious food, but others see it as a source of environmental and ethical concerns. Most of the debate centers on two areas: genetically modified organisms (GMOs) and cloning.

The major issues can be categorized into five groups. The first category deals with the safety of consuming genetically engineered foods. Are there any negative effects from eating these foods? Is it possible that modified foods will trigger allergies? What are the long-term effects of a diet containing genetically modified foods?

The second set of issues relates to the labeling of genetically modified foods. Should these foods be labeled so that consumers have a choice? If the U.S. Food and Drug Administration has approved the genetically modified food, are different labels needed?

A third group of issues involves the safety of growing genetically modified plants in the environment. What will be the effect of these new life-forms and will the accidents be irreversible?

The fourth set of issues involves moral questions about whether genetic engineering and cloning of plants are ethical. Do scientist have the right to interfere with nature?

And finally, the last issue deals with the impact biotechnology has on the structure of agriculture. Will using biotechnology improve the profits of producers? Or will it lead to food production being controlled by a few companies? How will U.S. genetically modified products be regarded around the world?

At some future time, these issues may be resolved. Today, students are a part of this historical era of emerging plant technologies. Each can help to form public opinion on these issues.

Summary

Current and emerging technologies in plant agriculture will help to improve productivity and the environment in order to help feed and clothe the increasing world population. Humans will be supplied with more nutritious, higher quality, and better tasting food. Plant scientists continue to work on genetic engineering so medicines and vitamins can be delivered through food. The use of new technology, particularly genetic engineering, will cause debate and close scrutiny by many people and organizations. Biotechnology promises to raise food production to new levels, but concerns held by the public may slow its acceptance.

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Lesson 1: The Importance of Animals

Animals have always played an important role to humans. Early man used animals for food, clothing, tools, and transportation. Modern society continues to use animals for food, clothing, medicines, services, and many other valuable products.

The Importance of Animals

Animals are an important part of American agriculture. They provide food, clothing, services, and a variety of products. Early man hunted animals to provide food and clothing essential to survival. Over time, animals were domesticated. Domestication is taking animals from nature and raising them in a controlled environment. Some animals were tamed and raised to adapt to human control.

The domestication of animals allowed humans to make improvements that have led to an advanced civilization. Planned production of animals increased the production of food and other products contributing to the growth of world economy.

Types of Animals in Agriculture

Primary animals in production agriculture include livestock and fish. They supply a variety of goods, services, and products. Major categories of livestock include beef cattle, dairy cattle, sheep, swine, poultry, and horses. Some producers raise companion animals. Companion animals, also called pets, provide humans with fun, friendship, and sometimes provide services. Dogs, for example, are often used to round up sheep and cattle on farms and ranches. Other alternative markets include beekeeping, ostriches, bison, fish bait production, and laboratory animal production.

Beef Cattle

Beef cattle are valued for their ability to convert grasses and hay into a high-quality source of protein for human consumption. They require minimum management. Mature female beef animals that have given birth are called cows. Young females that have not yet given birth are called heifers. Male beef animals are called bulls. Males that have been castrated, which means having their testicles removed, are called steers. Castration is done at a young age and makes steers fast growers and efficient producers of meat. A group of cattle is referred to as a herd.

Dairy Cattle

Dairy cattle are valued for their ability to produce milk. This milk provides people with drinking milk, cheeses, and other milk products such as cream. Dairy cattle must be managed carefully to maintain a healthy status while producing large volumes of milk. Their nutrition, reproduction, and milking schedules are kept under careful supervision. The terms for dairy animals are the same as for beef cattle.

Sheep

Sheep is another animal that is valued for its ability to convert low-quality grasses into a product that becomes a source of meat and wool for humans. The meat produced by sheep is referred to as lamb or mutton. A sheep's coat, or wool, can be considered as fine, medium, or coarse. Different types of wool have different uses in industry. A mature female sheep is referred to as a ewe. A mature male sheep that is used for breeding is referred to as a ram. A male sheep that has been castrated and used for meat purposes is referred to as a wether. Male or female sheep that are less than 1 year old are called lambs. A group of sheep is referred to as a flock.

Swine

Swine are also commonly referred to as hogs or pigs and are valued as a source of pork and pork products. A mature male swine used for breeding is called a boar. A mature female swine is called a sow. Male swine that have been castrated for meat purposes are referred to as barrows. Young female swine that have not yet produced a litter of pigs are called gilts.

Poultry

Poultry are a group of birds raised for use as food and other products. The most common types of poultry used for food are chickens and turkeys. On average, each American citizen consumes 78 pounds of poultry per year. Both chickens and turkeys are valued for their low cost of production

and their ability to convert feed into a high-quality, low-fat protein source. Chickens are also important for egg production. Sexually mature female chickens that have started to lay eggs are called hens. Pullets are young females that are not of breeding age. The mature male chicken is called a rooster. Male chickens that are less than 1 year old are called cockerels. A group of chickens is called a flock. A mature male turkey is called a tom. Young male turkeys are called tom poults. As with chickens, a mature female turkey is called a hen, and a young female turkey is called a hen poult. A group of turkeys is referred to as a flock.

Horses

Horses, although not a food source, are important to American agriculture. Horses are important companion and recreation animals. They provide recreation such as horseback riding, trail riding, and rodeo and racing events, which are important hobbies for Americans. The mature female horse is called a mare, and the immature female is a filly. The mature male horse used for breeding is a stallion. A castrated male horse is a gelding. Horses associate in groups called herds.

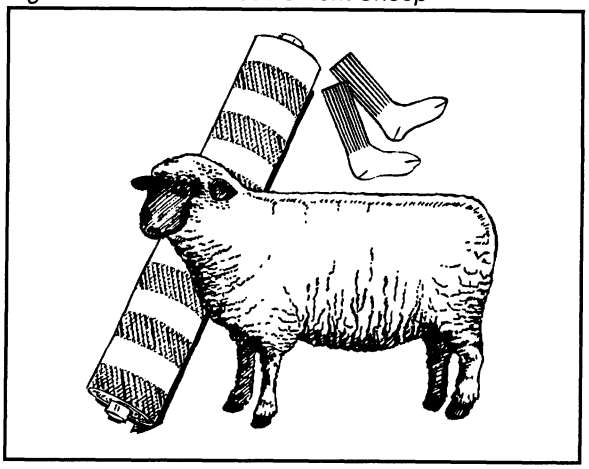
Fish

Aquaculture, the science of raising fish, has become a growing business in animal agriculture. Fish farms raise a variety of fish, such as trout, tilapia, and catfish.

Services and Products

Animals provide a major source of food for both humans and other animals. For example, people eat beef from cattle, mutton from sheep, pork from swine, milk and cheeses from dairy, and eggs from poultry. Animal coats and hides, such as leather in cattle and wool in sheep, are sources of clothing (see Figure 1.1). The by-products from processing animals for food are used in other consumer products. For example, inedible fats from animals are used in the production of cosmetics, waxes, and soaps. Bones, horns, and hooves are used in the production of glue, piano keys, buttons, and wallpaper. Hair from animal hides is used to make brushes, rugs, and insulation.

Figure 1.1 - Wool Products from Sheep



Animals are also important in scientific research. Many medicines used in human health can be traced to animal sources. Insulin, for example, is produced from cattle and swine.

Animals provide companionship to people. Dogs, cats, fish, horses, and a variety of exotic and native pets are valuable to Americans and to the economy.

Animals provide specialized services as well. Dogs provide assistance to persons with disabilities, serving as seeing-eye dogs for the visually impaired. Law enforcement uses dogs to find drugs, weapons, and missing people.

Summary

Animals provide many vital products and services for humans. Farm livestock are a major industry in the United States, providing food, clothing, medicine, and services. Pets provide humans with companionship and specialized services.

Lesson 2: Responsibilities of Animal Ownership

Owning and caring for animals are rewarding experiences. However, the care of living things brings about some great financial and physical responsibilities. Owners should be concerned with the welfare of their animals and abide by animal control regulations to ensure the health and safety of their animals, themselves, and other animals as well.

Responsibilities

The first responsibility of owning an animal is to ensure that it is fed and watered properly. Each animal is different in the type and amount of food that it requires.

Animal owners need to provide the proper health care. A veterinarian can inform the owner of all aspects of animal care. The veterinarian can also provide vital information on the yearly costs associated with checkups and vaccinations.

Animals must be provided proper shelter to house them from the environment and weather conditions. Each animal differs in the type of shelter necessary for its survival. It is important to consider the space requirements for each animal. Overcrowding animals can cause disease and distress for the animals.

The costs associated with food, health maintenance, and general welfare of the animal should be considered before purchasing any animal. Owners who do not properly research the purchase costs and ongoing maintenance costs associated with animal ownership often end up with animals they cannot afford.

Animal Welfare

The term animal welfare has different meanings to different groups of people. The definition most accepted is providing care for the well-being of an animal.

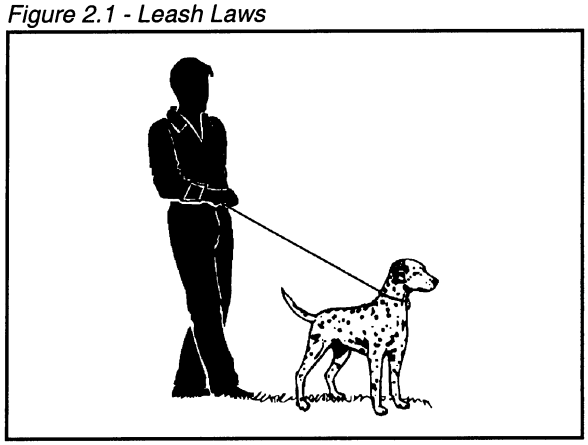
To producers of food, it means providing humane care for animals. Animal ownership brings with it the responsibility to provide appropriate care to ensure the well-being of the animal. Mismanagement or improper care and treatment would mean endangering the animal or the entire production operation because of disease or loss of income. Producers and ranchers spend many hours providing for the needs of their animals to prevent sickness, injury, or disease.

Animal rights supporters believe animals should not be used as resources by humans, whatever the benefits of their use. This would mean the elimination of all methods of animal production for food or research.

Animal Control Regulations

Animal control regulations are designed to protect people from animals. Animals do not possess the reasoning ability required to keep themselves, other animals, or humans from danger. Fencing, caging, and leash regulations protect people and other animals from harm or property damage (see Figure 2.1). For instance, animals that are allowed to roam freely can be hit on the road, harm other animals, or endanger people.

Figure 2.1 - Leash Laws



Health regulations protect against the spread of diseases that can kill other animals or humans. For example, rabies is a disease that is highly infectious to humans and other animals. A person or animal that contracts rabies risks death and poses a threat to society. Some states have laws to prevent diseased animals from entering their area. Animals crossing state lines must have the proper papers signifying they are healthy, disease free, and up-to-date with vaccinations and health checks.

Local laws also require animals to be tagged with proper identification. This provides proof of animal ownership. Animal breed associations require specific registration papers and proof of ownership. Such guidelines provide documentation of the animal's history.

Many areas have animal abuse ordinances to prevent cruel treatment of animals. Owners who have been proven to abuse animals can be fined or serve jail time.

Some communities possess laws that control the type, number, and caging requirements for animals. For example, livestock cannot be raised

within city limits. Local laws also serve to reduce noise and disruption created by animals in populated areas.

States outline regulations to control the fishing and hunting of wildlife species. Hunting helps to reduce overpopulated species that could be a nuisance and a danger to humans. Hunting and fishing regulations control the type and amount of animals hunted to prevent overkilling certain species.

Summary

Animal ownership is a responsibility to be taken very seriously. Owners of animals should provide proper food, shelter, and medical care to ensure the welfare of animals under their care. Animal control laws and regulations should be followed to protect humans and animals.

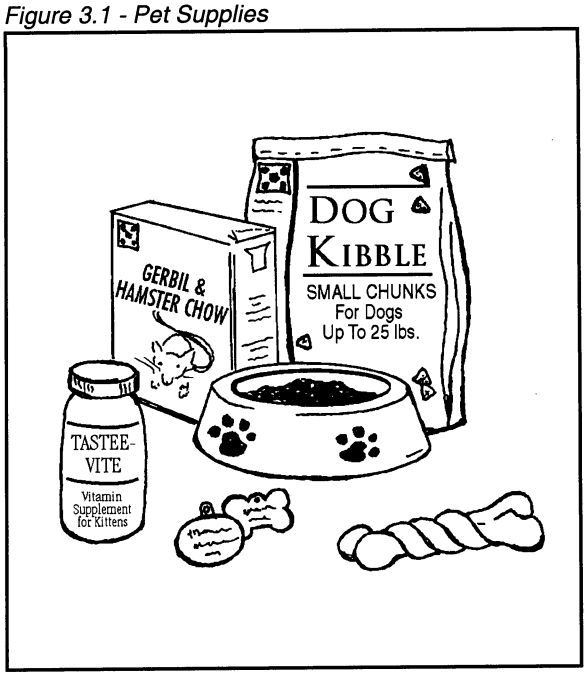
Lesson 3: Selecting an Animal

Determining whether to own livestock, fish, or companion animals is an important decision that involves a great deal of responsibility. Potential animal owners should carefully evaluate the resources and costs involved with each type of animal and select the animal that best fits their needs or lifestyle.

Facilities and Resources

Animals must be provided with some key resources to ensure their well-being. Food and a water supply must be made available. This could be in the form of pasture for grazing, a farm pond for drinking, self-feeding and watering systems, or manual feeding. Animals must have appropriate shelter to protect them from the weather. Farm livestock need barns, sheds, or shelter of some type to protect them from extreme weather conditions. Fish require water, a pond, and proper nutrition. Pets may be kept indoors or out and some may require cages. All facilities need to be cleaned to some degree to reduce chances of disease and to reduce odors. Companion animals may need bathing and grooming supplies and exercise equipment such as a leash or an exercise wheel for a pet kept in a cage. Medical equipment and supplies are also a necessary resource for raising animals. All of these items require costs that must be considered when determining needed resources. Costs are involved to purchase the animal, equipment, and supplies to effectively maintain a healthy animal.

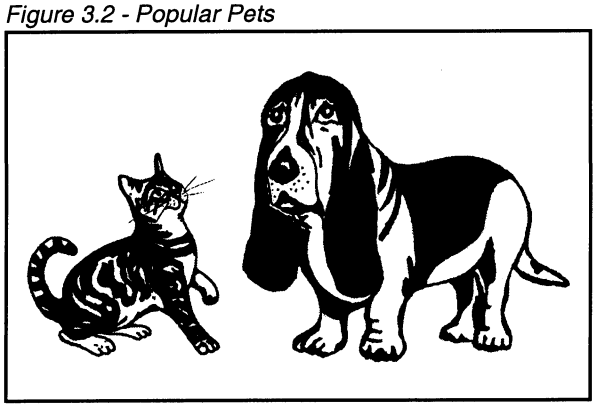
Figure 3.1 - Pet Supplies



Selecting a Pet

When selecting a pet, potential owners must consider the purpose of the pet. Some owners prefer purebreds that may be used for breeding or show purposes. Some people enjoy affectionate pets that interact well with humans. The cost of the pet is another consideration. Some purebred or exotic animals are very expensive whereas other animals can be purchased at a minimal cost or obtained for free. Some pets may require more maintenance or upkeep costs, such as food, equipment, and facilities than other pets. Fish, for example, require lower maintenance and food costs than a large dog. The amount of space a pet requires is also a consideration. Some pets require minimum space whereas others may need special cages where lighting and temperature are strictly controlled. Persons living in a small apartment may not want a very large dog as a pet, or the apartment may restrict them from having pets. Finally, the amount of time required to take care of the pet is a consideration. Some pets may require exercise or their cage may need routine cleaning.

Figure 3.2 - Popular Pets



Sources of Pets

One important source of pets is the local animal shelter or animal welfare institution. Their original owners have abandoned these animals or the owners have found they can no longer care for the animal. The cost of obtaining an animal from a shelter will vary.

Owners looking for a specific breed of pet or a purebred animal may have to contact animal seedstock producers. Animal seedstock producers normally advertise in magazines, newspapers, or on the Internet. Owners will usually pay more for a purebred animal but may feel more confident they are purchasing a higher-quality animal. Purebred pets are registered and their breed history is recorded.

Newspaper advertising is also a source of available pets. If a potential owner relies on newspaper advertising to locate a particular pet, availability may vary and the individual may have to search to find the right pet.

Pet stores provide a valuable source for a wide variety of pets. A pet store is a fast, convenient place to find exotic, purebred, or mixed breed pets. They can provide information on the care and maintenance of the pet. The pet food, equipment, and supplies can all be purchased at a pet store.

Selecting Livestock or Fish

The selection of a livestock species or fish will reflect the owner's goals, available money to purchase and maintain the animal, available resources required to house and raise the animal, and time commitment. Market prices can affect the ability of the producer to make a profit and thus affect the decision to own the animals.

Another selection factor is the intended purpose of the animal. The animal's purpose can be for producing food, for breeding purposes, or for showing at livestock exhibitions. Purebred livestock may require more costs and care than other livestock.

Livestock require a large amount of money for the initial start-up costs and for ongoing maintenance. Space requirements for each species will vary. Cattle and horses require more space and larger equipment than sheep. Equipment needs are similar to space considerations when choosing a species of livestock. Smaller species often require less equipment than larger species.

And finally, the time commitment to care for the animals must be a consideration. Some species, such as dairy cattle, will require daily attention, whereas beef cattle require relatively less attention.

Sources of Livestock or Fish

Livestock can be purchased in a variety of settings. Seedstock producers advertise in magazines, newspapers, or on the Internet. A seedstock producer specializes in the specific breed or a number of breeds that they raise and can normally ensure high-quality animals to the potential buyer. Animals from individual breeders may be usually costlier than from other sources such as sale barns. Fish can be obtained as fingerlings from fish hatcheries.

Livestock sale barns are places where livestock owners of any type bring animals to be sold. The advantage to this type of situation is that the animals are sold at auction. Thus, the buyer can usually find animals at cheaper prices. However, when unknown sources are involved, often the age, health, breed, and general quality of the animal are hard to predict.

Important sources of livestock are independent livestock producers. They may advertise in newspapers, on the Internet, or in livestock magazines. Independent producers can be smaller operations that serve as important sources of livestock in their own communities.

Additional sources of livestock include hatcheries, coops, and alliances.

Summary

Individuals who are selecting pets or livestock for ownership should carefully evaluate their personal goals for the animal. They should select an animal that meets their financial needs and personal resources. They must be able to provide for the welfare of the pet or livestock species. Important factors such as time, money, space, and equipment should all be considered when selecting a species of livestock or pet to raise.

Lesson 4: Current and Emerging Technologies

Animal agriculture is an evolving science that has expanded and advanced with the use of technology. Technological advances in alternative reproduction and self-management systems have allowed for the expansion and improvement of present-day animal agriculture.

Natural Mating

Advanced reproduction techniques have improved the genetics of many livestock species. However, natural mating procedures remain a viable choice for many livestock producers. Natural mating involves allowing a male and female to breed by copulation. The female undergoes a monthly cycle in her natural reproductive phase, called estrus, or heat. During estrus, the female will allow herself to be bred by the male. Thus, the only time a female may become impregnated is during estrus, and this is the time that natural mating can occur.

Natural mating is a low-management, often cost-effective alternative for many producers. In most cases, animals do not have to be monitored closely because it is a natural process. In addition, natural mating situations do not require special facilities, equipment, or trained technicians.

Alternative Reproductive Practices

Alternative reproductive practices allow producers to select and breed for superior traits and to make faster progress toward improvement. These practices are also making advancements that are improving the quality of life for animals and humans.

Artificial insemination (AI) refers to the process of placing sperm in the reproductive tract of females by using means other than natural mating. Artificial insemination has the advantage of allowing the producer to select superior males with which to breed the females. This procedure can be planned according to gestation so that the young can be born at opportune times of the season. Synchronization is essential for optimum breeding.

Cloning involves reproducing a fertilized egg to create an organism with the exact genetic makeup as the original organism. Researchers have experimented with cloning to make exact reproductions of superior genes. In addition, clones may be produced to provide organ replacements or to produce valuable medicines for other species.

Embryo transfer is the process of flushing the embryos from the reproductive tracts of superior, donor females and implanting them in other females of lower quality. Embryo transfer creates a greater number of superior offspring in a much shorter period of time. A female that could normally produce one offspring per year would be capable of producing several that were transplanted to many different females.

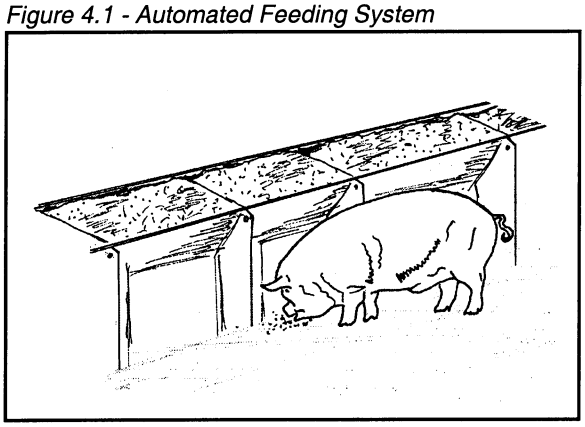
Genetic engineering is the alteration of animals by human intervention. It involves finding and selecting desirable genes in an animal and producing an organism with those genes. For example, scientists can select the size, sex, and desirable genetic characteristics of an animal by selecting or altering certain genes. Scientists have also experimented with genes that produce valuable medicines and vaccines for animals and people. Disease-resistant animals can be created by genetic engineering. Genetic engineering, along with cloning, has faced many moral, ethical, and environmental challenges.

Systems Management Technology

Technology has made raising animals a precise science where animal needs can be monitored by computers and where management decisions can

be made by computer readings. Automated systems of feeding, watering, waste disposal, milking, and even gate release have reduced the amount of manual labor involved in animal care. Technological advances have paved the way for large production units where a smaller number of people are capable of managing several thousand head of animals. As a result, smaller, one-family operations are being replaced by large corporations.

Figure 4.1 - Automated Feeding System



Modern technology has advanced many animal facilities by having a totally controlled environment. Self-feeders and waterers set on timing devices have been developed to reduce the hours spent feeding and watering animals. These machines also cut down on wasted food because it can be precisely measured and provided at precise intervals. Present-day facilities have been designed to be self-cleaning. Such facilities include pits for waste removal or specially designed flooring that drops at intervals to remove animal waste. Technology has allowed animal management systems to greatly reduce the manual labor involved in raising animals.

Summary

Technological advances in animal production and breeding have allowed agriculture to evolve into a precision business focused on creating superior products for the consumer. Advancements will continue to decrease manual labor as well as produce genetically superior animals resistant to disease with maximum production capabilities.

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Lesson 1: Agriculture in the Food Chain

Energy is required to sustain all forms of life on this planet. Life-forms can range from a single-celled organism to the most complex animal. This lesson discusses food chains and how people, through agriculture, have learned to control them to produce more food.

Nature's Food Chain

The food chain is a sequence in which living organisms obtain food. It shows how food energy from the initial source in plants is transferred through a series of organisms by repeated eating and being eaten. There are four main parts to a food chain (see Figure 1.1).

1. The sun provides energy for everything on the planet.
2. The producer is plants that capture energy from the sun. These plants make their own food through a process called photosynthesis.
3. The consumer is an organism that eats another organism (food). It cannot produce its own food, so it gets its energy from other plants and animals. Specific consumer names are carnivores (organisms that eat only animals), herbivores (organisms that eat only plants), parasites (organisms that live off of another living animal or plant, usually at its expense), and scavengers (organisms that eat other organisms that are dead).
4. The decomposer is an organism, mainly bacteria and fungi, that breaks down dead matter and wastes into a form that can be used by other organisms. Without decomposers, the earth would be covered with trash.

A simple food chain occurring in the natural environment might be as follows: (1) caterpillars eat leaves, grass, and stems; (2) quail consume the caterpillars; and (3) foxes eat the quail. The sequence of one organism eating another happens continuously. Although quail eat caterpillars, they also feed on bugs and worms, so there are other organisms involved in this food chain.

There are also food chains in the aquatic environment. For example, algae are eaten by water insects (food energy flows from the algae to the insects), which in turn are eaten by minnows, which are eaten by larger fish. The larger fish may be caught and eaten by large herons or even predatory birds like eagles or ospreys (see Figure 1.2). Humans may enter into this food chain by catching and eating fish. Waste products from higher life-forms are in turn used by lower life-forms to begin the process again.

The food chain is not actually just one chain, but really a complex web much like a spider web. The differences among food chains are brought about by environmental differences. Each environment, or ecosystem, is home to specific organisms.

Figure 1.1 - A Simple Food Chain in the Natural Environment

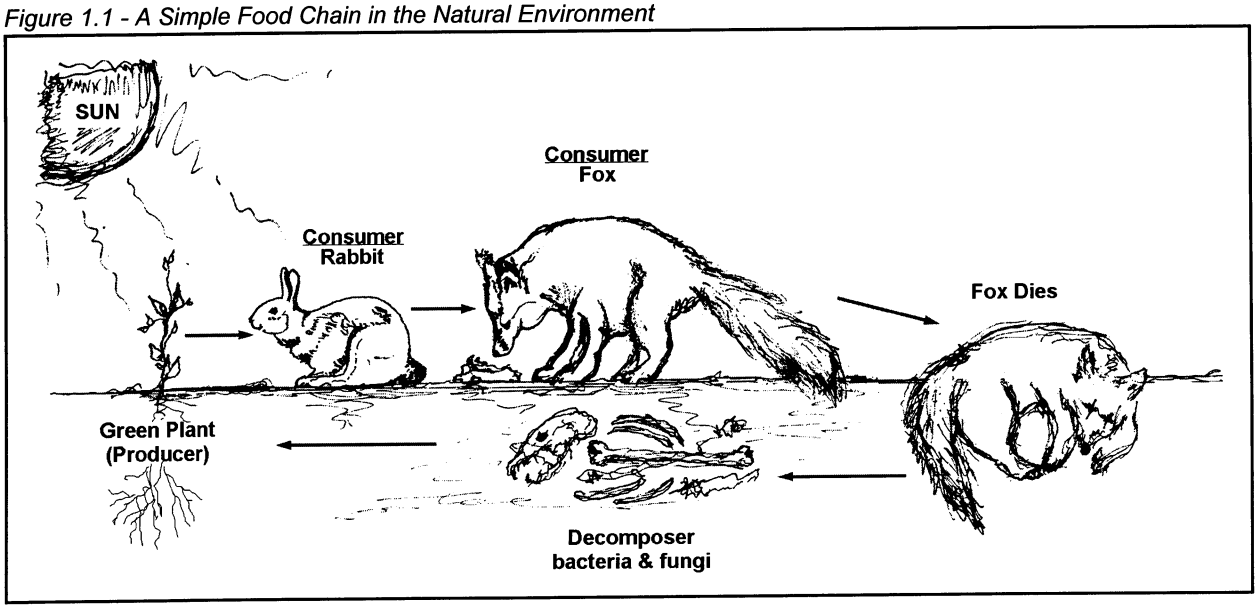
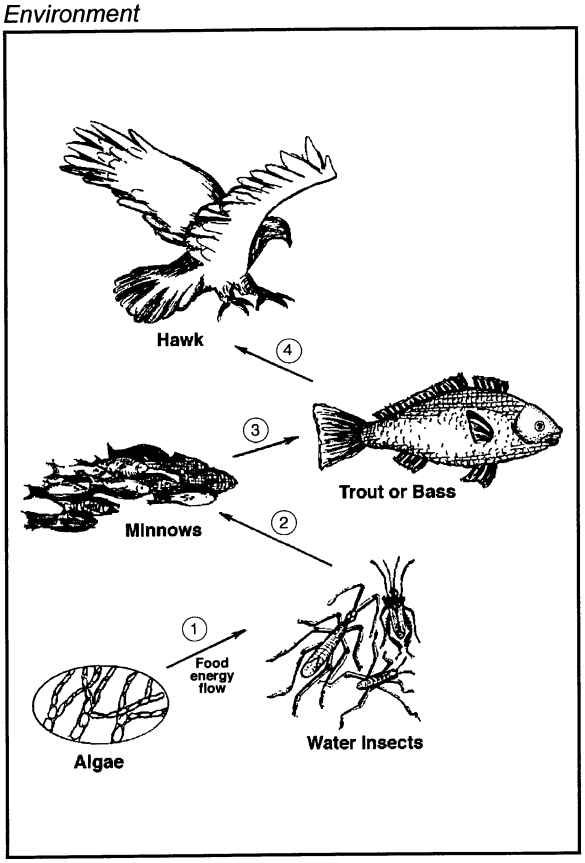


Figure 1.2 - A Simple Food Chain in the Aquatic Environment



The Food Chain and People

The world population can no longer survive with food available from the natural food chain. The population is simply too large. Many countries have learned how to produce large amounts of food. Agricultural production in these countries provides enough food for humans, livestock, and exports to other countries. Countries that are not able to produce enough for their human population must purchase food from other countries.

In the agricultural food chain, the primary producers are plants. Food plants include crops like corn, wheat, barley, oats, and millet. Plants that produce vegetables and trees that produce fruits and nuts are considered primary producers. Crops such as grasses and forages used as livestock feed are also primary producers.

Some countries have the ability to produce enough to feed their human populations and their livestock. Food for humans can be obtained from both plant and animal sources. Nutritionally balanced diets for humans can be provided when both plant and animal products are used. Unfortunately, many countries do not have enough to feed their human and animal populations adequately. This creates greater competition between humans and livestock for food crops. During periods of food shortages, livestock production is greatly decreased, and humans eat plant products of lower nutritional value.

Figure 1.3 - All People Depend on the Food Chain

Agriculture and the Food Chain

Throughout history, humans have used the natural food chain to obtain food. Eating berries, catching fish, and hunting larger game animals provided food for individuals and communities. As the world population increased, the demand for more food prompted the controlled production of food also known as domestication. This involves the taming of wild animals, such as sheep and horses. Another example is raising plants such as tomatoes, cotton, beans, etc., in an organized arrangement rather than just letting the plants grow wild. Domestication of animals and plants is important in producing food and clothing for the world.

Agriculture and agricultural practices have enabled people to produce larger amounts of food than would be produced naturally in the food chain. Large-scale agricultural production has helped reduce food shortages in many parts of the world.

Although people have learned to manage the food chain, care must be taken to protect the environment and the natural food chain for wildlife.

Summary

Natural food chains occur throughout the world in every environment. Agriculture and agricultural practices have enabled people to produce larger amounts of food than would be produced naturally in the food chain. Domestication of animals and plants has helped to produce food and clothing for humankind. Agricultural practices must protect the environment and the natural food chain for wildlife.

Lesson 2: Food Products from Plants

Plants supply food products such as grains, vegetables, fruits, and many other products in various forms. As consumers, it is important to understand the information listed on food labels.

Food Products from Grain

Plants supply a large portion of the food in the human diet. Some foods from plants can be eaten fresh. Grains usually require some form of processing before being eaten. Grain crops grown in Missouri include corn, milo, rice, soybeans, and wheat.

Flour is a food product processed from wheat grain. Flour is used to make bread and other pastries. Cold and hot cereals are processed from grains. Cooking oil can be processed from corn, soybeans, and sunflowers. Pasta, including macaroni and noodles, is produced from wheat. Soybean products are used as a protein alternative to meat and may be added to many foods.

Starch processed from grain has many purposes. Dextrose is a corn product that is used as a major source of sweetener in human foods. Several snack foods are made from grains, including snack chips and crackers. Popcorn is a common snack food made from grain.

Food Products from Vegetables

Many types of vegetables are grown in the Midwest. Vegetables are usually grown in home gardens or on farms that grow produce. Vegetables are used in a variety of ways. Fresh vegetables can be eaten raw or cooked. They can be canned, frozen, juiced, or used in soups.

Food Products from Fruits

In the Midwest, many types of fruits are grown including apples, cherries, grapes, peaches, plums, raspberries, and strawberries. They can be grown in home plots or in commercial orchards. Fruits can be processed and consumed in the following forms: fresh, canned, frozen, dried, juiced, and in jams and jellies.

Food Products from Other Plants

Other plants are used to make food products such as maple syrup, herbs, chocolate, nuts, mustard, tea, coffee, and spices. Many of the plants that produce these products are not grown in Missouri. However, pecans are an important crop in the state.

Understanding Food Labels

The Food and Drug Administration (FDA) food label provides valuable information that will help consumers make informed buying decisions. The key nutritional information found on a food label is listed below and illustrated in Figure 2.1.

1. Nutrition facts - This title indicates the FDA has approved the information on the label.

2. Serving size - The nutritional information found on the label is based on the indicated serving size. Serving sizes are standardized so that similar products can be compared. This part also indicates the number of servings per container.

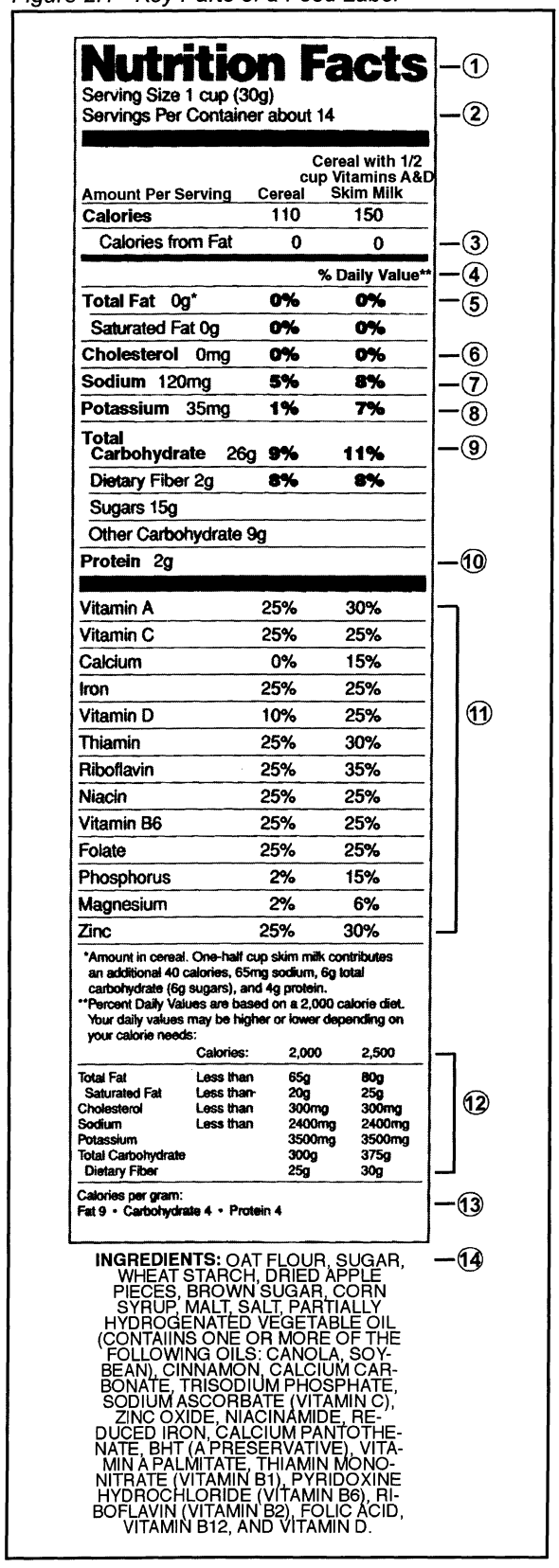
3. Total calories and calories from fat - The total calories figure is the amount in one serving. As the amount of calories from fat approaches the total calories, more fat is contained in the food.

4. Percentage (%) daily value - This column lists the percent of key nutritional items (total fat, saturated fat, cholesterol, sodium, etc.) supplied by the food. This is based on a daily 2000-calorie diet.

5. Total fat - This figure is the total grams of fat.

6. Cholesterol - This figure is the total milligrams of cholesterol.

Figure 2.1 - Key Parts of a Food Label



Nutrition Facts —①

Serving Size 1 cup (30g)
Servings Per Container about 14 —②

Amount Per Serving	Cereal	Cereal with 1/2 cup Vitamins A&D Skim Milk
Calories	110	150
Calories from Fat	0	0 —③
		% Daily Value** —④
Total Fat 0g*	**0%**	**0%** —⑤
Saturated Fat 0g	**0%**	**0%**
Cholesterol 0mg	**0%**	**0%** —⑥
Sodium 120mg	**5%**	**8%** —⑦
Potassium 35mg	**1%**	**7%** —⑧
Total Carbohydrate 26g	**9%**	**11%** —⑨
Dietary Fiber 2g	**8%**	**8%**
Sugars 15g		
Other Carbohydrate 9g		
Protein 2g		—⑩
Vitamin A	25%	30%
Vitamin C	25%	25%
Calcium	0%	15%
Iron	25%	25%
Vitamin D	10%	25%
Thiamin	25%	30%
Riboflavin	25%	35%
Niacin	25%	25%
Vitamin B6	25%	25%
Folate	25%	25%
Phosphorus	2%	15%
Magnesium	2%	6%
Zinc	25%	30%

⑪

*Amount in cereal. One-half cup skim milk contributes an additional 40 calories, 65mg sodium, 6g total carbohydrate (6g sugars), and 4g protein.
**Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Potassium		3500mg	3500mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

⑫

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4 —⑬

INGREDIENTS: OAT FLOUR, SUGAR, WHEAT STARCH, DRIED APPLE PIECES, BROWN SUGAR, CORN SYRUP, MALT, SALT, PARTIALLY HYDROGENATED VEGETABLE OIL (CONTAIINS ONE OR MORE OF THE FOLLOWING OILS: CANOLA, SOYBEAN), CINNAMON, CALCIUM CARBONATE, TRISODIUM PHOSPHATE, SODIUM ASCORBATE (VITAMIN C), ZINC OXIDE, NIACINAMIDE, REDUCED IRON, CALCIUM PANTOTHENATE, BHT (A PRESERVATIVE), VITAMIN A PALMITATE, THIAMIN MONONITRATE (VITAMIN B1), PYRIDOXINE HYDROCHLORIDE (VITAMIN B6), RIBOFLAVIN (VITAMIN B2), FOLIC ACID, VITAMIN B12, AND VITAMIN D. —⑭

7. Sodium - This figure is the total milligrams of sodium.

8. Potassium - This figure is the total milligrams of potassium.

9. Carbohydrates - This figure is the total grams of carbohydrates

10. Protein - This figure is the total grams of protein. Due to individual needs, the food label does not specify a daily guideline for protein consumption.

11. Vitamins and minerals - These figures are the percentage of each vitamin and mineral provided in the product. The FDA requires only Vitamin A, Vitamin C, iron, and calcium, although food companies can voluntarily list others. The daily recommendation is for 100% of each of the noted nutrients.

12. Daily values footnote - This chart is a summary of the key nutritional items that an individual should eat daily. The guidelines are based on a 2000-calorie diet.

13. Calories per gram footnote - This last section summarizes the amount of calories in each gram of fat, carbohydrate, and protein.

14. Ingredients - This part of the label lists the items that were processed to make the food product. The first item represents the greatest quantity in the product. The last item listed represents the least amount present in the product.

Summary

Foods from plants make up a large portion of the human diet. Foods from grains, vegetables, fruits, and other plants may be eaten fresh or in a variety of processed forms. Food labels provide nutritional information to help consumers make informed buying decisions.

Lesson 3: Food Products from Animals

Animals supply food products in the form of meat, seafood, eggs, dairy products, and in many other forms. As consumers, it is important to understand the information listed on meat labels.

Food from Meat Animals

The primary source of food from meat animals comes from cattle, hogs, sheep, and poultry.

Beef Cattle

Beef comes from cattle and is often eaten as hamburger, steak, and roast. Veal is produced from young cattle and is a very lean meat.

Hogs

Pork is produced from hogs. Common products from hogs include pork chops, ham, and bacon.

Sheep

Lamb meat comes from young sheep. Meat from sheep of more than 1 year of age is called mutton. Common cuts from sheep are lamb chops and leg of lamb.

Poultry

Eggs are produced by several species of poultry. In most areas, only chicken eggs are eaten. Most chickens produce white eggs. However, some breeds of chickens produce brown eggs. Meat is also a major food product from poultry (chicken, turkey, duck, goose, etc.). Birds raised for egg production are usually not of the same breed as those produced for meat. Per capita consumption of chicken and turkey has increased in recent years.

Retail cuts for all the above types of meat are purchased by the consumer at the meat department in a grocery store. They are cut from the larger wholesale cuts that are shipped from the processing company to the grocery store.

Dairy Products

Dairy products come from both dairy cattle and dairy goats. Most of the fluid milk consumed in the United States is produced by dairy cattle. Milk is the most common dairy product and is the base for other dairy products. Milk is generally pasteurized to kill germs and homogenized to keep the milk and cream particles mixed. Whole milk contains about 5% cream. Two percent milk has all but 2% of the cream removed before packaging. Skim milk has all the cream removed. Other dairy products include assorted cheeses, ice cream, butter, yogurt, sour cream, and cottage cheese.

Fish and Seafood

Freshwater fish include catfish, trout, and bass. Catfish and new hybrid fish are raised on fish farms. Catfish can also be raised in ponds and lakes. Some farmers have experimented with raising catfish in indoor tanks to control the environment.

Saltwater fish are harvested from the sea. Tuna, salmon, halibut, cod, and shark are examples of saltwater fish.

Besides fish, many types of seafood are available in markets and restaurants. Seafood includes lobster, scallops, clams, shrimp, oysters, and crabs. Even lobster's freshwater cousin, the crawdad (or crayfish), is eaten in some areas.

Processed Meats

Processed meat products are popular today due to their long shelf life, convenience, low waste, and controlled portion size. Processed meats often combine beef, pork, and poultry. Processed meats such as luncheon meats and hot dogs may be produced with only one type of meat or by blending beef, pork, and poultry. Examples of processed meats include sausages, such as luncheon meats (bologna, etc.), hot dogs, and pepperoni. Other processed foods include chicken patties and nuggets. Food science researchers are striving to develop processing methods to create new products that would be acceptable to the public.

Meat Labels

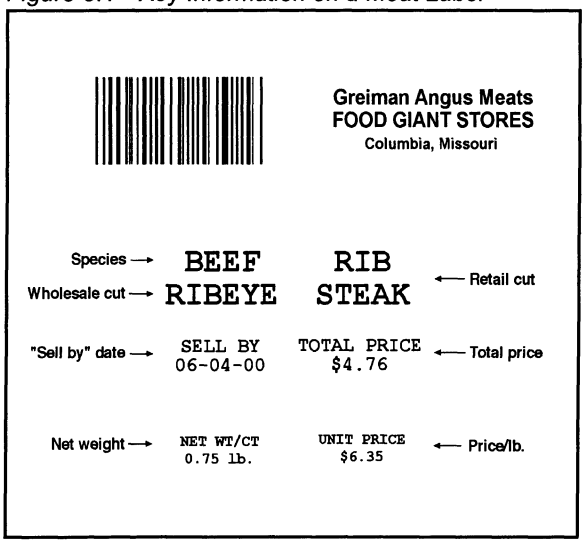
Information is provided on meat labels to help consumers make buying decisions. The key information found on a meat label is listed below and illustrated in Figure 3.1.

Species - The meat product is identified as beef, pork, or lamb.

Wholesale cut - The specific wholesale cut is identified.

Retail cut - The name of the retail cut is identified.

Figure 3.1 - Key Information on a Meat Label



Total price - This is the price paid at the checkout counter.

Price/lb. - This price is used to calculate the total price (price/lb. x net weight).

Net weight - The actual weight of the meat product is identified.

"Sell by" date - The last date the meat should be sold. This is a freshness indicator for the meat department and consumers.

Summary

There is a wide variety of food products produced from animals. Some foods are served fresh and others are processed. Meat contains protein needed to maintain good health. Protein can also be acquired from dairy and fish products. Information is provided on meat labels to help consumers make informed decisions.

Lesson 4: Food Processing and Food Safety

Any food product intended for human consumption, whether plant or animal, requires careful handling. This unit covers reasons and methods used in the processing of food, describes how food progresses from the producer to the consumer, and addresses issues pertaining to food safety.

Food Processing

Processing includes all the steps used to change raw agricultural products into consumable products. Raw products may go through one to several steps in processing. Raw products can be cleaned, dried, weighed, refrigerated, preserved, stored, and changed in form. The more processing steps a product goes through, the higher the marketing cost. Processing raw products can be as simple as picking a peach off a tree to as involved as changing the form of a product by changing its taste, color, shape, and packaging. Whether simple or involved, food is processed to maintain or improve its fitness for consumers.

Reasons for Processing

Many foods are processed before they get to the consumer to make them more tasty. Some foods cannot be eaten raw. Processing is needed to change the raw product into a product that consumers can eat. Wheat is an example of a crop that is not very tasty in its raw form. Wheat is usually ground into flour. Flour is then made into breads, baked goods, or cereals.

Food processing also permits longer storage of food products by preserving them. Preservation maintains food quality and makes food safer for consumption. If food is not preserved properly, spoilage and contamination can occur, which can lead to health problems. Salmonella, dysentery, typhoid, and cholera are diseases that can be caused by eating unsafe food. Care should always be taken to ensure food is properly stored and prepared.

Transportation is an important step in food processing. Not all foods are produced in every state or country. Shipping food from centers of production to consumers is very important. Food that is not properly processed may spoil during transportation. This is a very costly problem for everyone involved.

Another reason for processing food is for the convenience of consumers. Most people are not willing to buy a live chicken to lay eggs. Also, few people would purchase a live animal when they want meat for their families.

Methods for Processing

Foods may be processed in many different ways. The method used depends on the raw product, consumer demand, health, and safety. Following are several major processing methods.

Freezing - Freezing is achieved by reducing the temperature to 0^0F, which virtually stops microbial growth and even kills some. Refrigeration (33^0F-40^0F) is useful to slow microbial growth.

Heating - Heating food products to a temperature greater than 180^0F is a technique used to destroy harmful bacteria. This process, called pasteurization, is mainly used on dairy products.

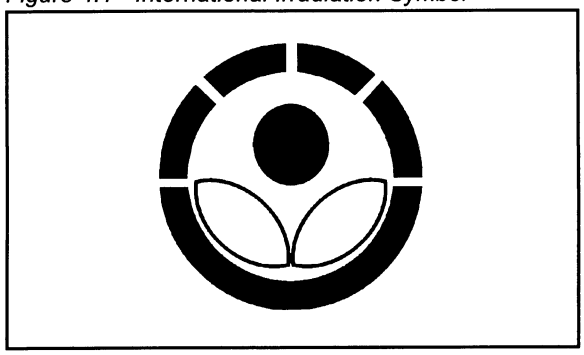
Fermentation - Fermentation uses selected microorganisms to break down complex carbohydrates. Fermentation processes produce pickles, sour cream, yogurt, cottage cheese, and wine to name a few.

Smoking and curing - Smoking preserves foods by exposing them to smoke for a specified amount of time. Curing preserves by using salt, brine, or by aging the product. Ham, corned beef, and bacon are commonly preserved by curing.

Vacuum packing - Foods that have been vacuum packed have the air removed from the container to prevent microbial activity and increase their shelf life. For example, very few grocery stores purchase beef in the carcass form today. Instead, wholesale cuts are shipped as "boxed beef." These cuts are wrapped under a vacuum with a film that keeps out moisture and air.

Irradiation - This food processing method subjects food to radiant energy to kill microorganisms. Irradiation will kill *E. coli*, which can cause death. Several deaths and recalls of contaminated beef products in 1998 led to the use of irradiation as a food safety measure. It is a safe method of controlling harmful organisms, extending the shelf life of fruits and other foods, and killing unseen insects. In 2000, the FDA permitted beef, pork, and lamb to be irradiated. To allow consumers a choice, the international symbol of irradiation known as "radura" is required on meat products that have been irradiated (see Figure 4.1).

Figure 4.1 - International Irradiation Symbol



Grinding - The particle size of the raw product is reduced by grinding. For example, wheat is reduced to flour by using rollers to crush the larger particles. Various wholesale cuts of beef, pork, or lamb are processed into ground beef (hamburger), ground pork (pork patties), or ground lamb (lamb patties).

Homogenization - Homogenizing food refers to a process forcing the food through a small valve under pressure to reduce the size of the globules of fat. When the large globules are reduced to a small size, the food's consistency remains constant. Milk is homogenized to keep the milk fat in suspension.

Dehydration - In dehydration, the moisture is removed from a food. Beef jerky and dried fruit, such as raisins, are common dehydrated foods.

Emulsification - Certain food products contain both water and oils/fats. Naturally, these two ingredients repel each other and separate. Emulsifiers are materials that keep this separation from occurring. Mayonnaise, margarine, salad dressing, sausage products, and ice cream are processed with emulsifiers.

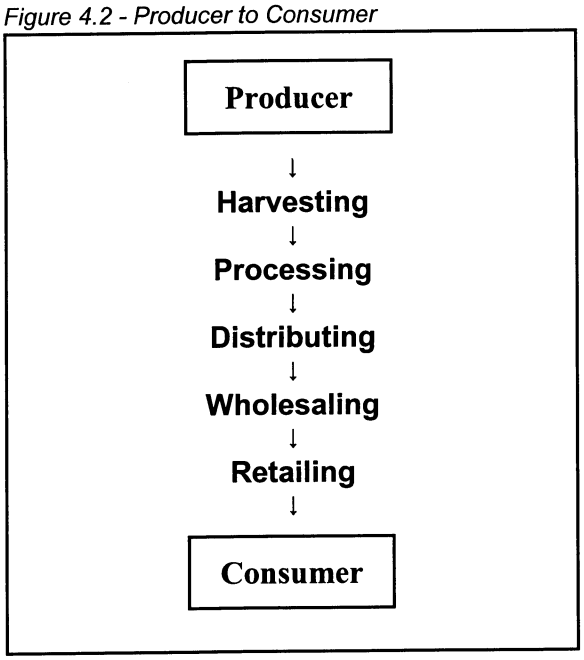
Extrusion - Extrusion is a process where a formulated dough is forced through an extruder under high pressure. High pressure causes the starch molecules to expand. The steam generated by the heat of the process causes a puffing of the product, which forms a new shape. Breakfast cereals are commonly extruded.

Separation - Bones and fat are removed from a product.

Processing from Producer to Consumer

Raw products go through several steps to get from the producer to the consumer as illustrated in Figure 4.2. Producers grow plants and raise animals for the raw food products. Harvesting

Figure 4.2 - Producer to Consumer



involves removing the edible portions from plants in the field. During processing, the raw product is cleaned, separated, handled, and prepared for distributing. Distributors store food until it is needed by wholesalers. Wholesaling involves selling fresh or processed foods to retailers. Retailers sell foods to consumers. Although consumers usually purchase food from retailers, in some cases they may purchase food from the producer or wholesaler. For example, farmers' markets allow producers to sell directly to consumers.

Food Product Safety

Chemical preservatives may be used in food preservation to retain the color and fresh appearance desired in food products. Regulations affecting the use of preservatives have been established by the federal government. Consumers are ensured a safe food supply because food quality is monitored by government agencies. The Food and Drug Administration (FDA) sets guidelines and restricts chemicals used as preservatives. The U.S. Department of Agriculture (USDA) employs inspectors to monitor the use of chemicals in food processing. The Environmental Protection Agency (EPA) regulates the use of pesticides in crop and livestock production. Such regulations are enforced to ensure the nation's food supply is safe. Government inspectors also examine food imported from other countries to ensure it is safe for human consumption.

During the past decade, the livestock industry has responded to the public's demand for safe food by implementing quality assurance programs. Beef and pork producers, for example, follow management plans that ensure the production of a safe and wholesome product. Producers' health plans and practices are reviewed by veterinarians.

Food Preparation, Quality, and Safety

The partnership for Food Safety Education recommends following these four steps to keep our food safe from harmful bacteria.

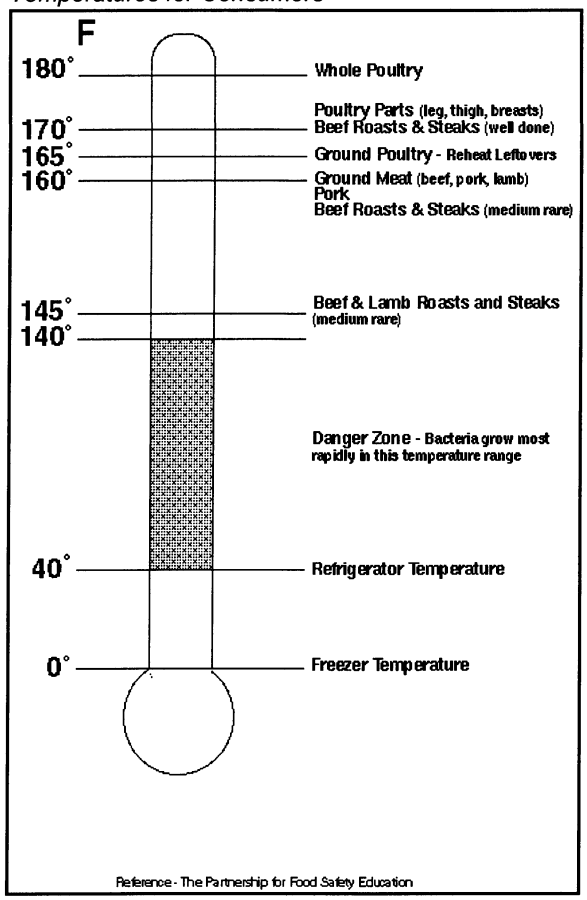
1. Clean - Always wash hands in hot, soapy water for at least 20 seconds before preparing or eating food. Use disinfectant cleaners to clean kitchen counters and other surfaces that come in contact with food. Hot water and soap do a good job too but may not kill all strains of bacteria. Be sure to always rinse vegetables and fruit in cold water (no soap) before eating or preparing them.

2. Separate - Bacteria can spread from one food to another through cross-contamination. To decrease this risk, keep raw meat, poultry, seafood and their juices away from ready-to-eat foods. If possible, use one cutting board for raw meat products and another for salads and other ready-to-eat foods. Never place cooked food on a plate that previously held raw meat, poultry, or seafood.

3. Cook - Foods are properly cooked when they are heated for a long enough time and at a high enough temperature to kill harmful bacteria that can cause foodborne illness. Always use a clean food thermometer to check the internal temperature of cooked foods as noted in Figure 4.3.

4. Chill - Refrigerate or freeze leftovers within 2 hours or less. Set your refrigerator no higher than 40^0 F and set the freezer at zero. Check these temperatures occasionally with an appliance thermometer. Never defrost food at room temperature. Thaw food in the refrigerator or in the microwave if it will be cooked immediately.

Figure 4.3 - Recommended Safe Cooking Temperatures for Consumers



Summary

Food safety and processing affects everyone because of the need for safe, wholesome food. Processing involves all the steps of going from a raw agricultural product to a consumable product. We process food to improve taste, maintain quality, prevent spoilage, and to provide a safe and convenient product for consumers. Many different methods and steps can be used to process food. U.S. government inspectors monitor the food processing industry to ensure safe food for consumers. Keeping food safe from harmful bacteria is an important food safety principle.

Lesson 5: Fiber Products from Agriculture

In this lesson, you will learn about several sources of fiber products: plants, animals, and synthetic sources.

Fiber Products from Plants

Most of the fibers produced in agriculture are made into clothes or material. Cotton is the most common fiber. For many years in the southern part of the United States, cotton was the most dominant crop.

Figure 5.1 shows the Seal of Cotton (top) that identifies products made from 100% Upland Cotton (a common type grown in the United States). The Natural Blend (bottom) indicates fiber products containing at least 60% Upland Cotton.

Figure 5.1 - Seal of Cotton and Natural Blend Symbols

Used with permission of Cotton Incorporated.

Flax is the plant used to produce linen cloth.

The hemp plant was used for many years to produce high-quality rope, burlap, and twine. Smoother nylon materials have been replacing hemp in rope production.

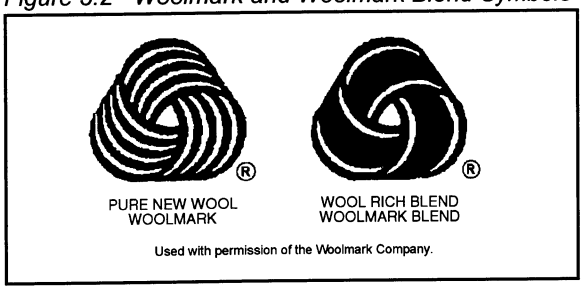
Products have also been developed using cellulose from tree fibers. Acetate and rayon are both materials that are manufactured from cellulose fibers.

Fiber Products from Animals

Animals produce some fiber products. Wool is the most common fiber produced by animals. Figure

5.2 shows certification trademarks owned by The Woolmark Company. The Woolmark trademark (left) can be used on products made of 100% wool. The Woolmark Blend trademark (right) can be used on products that contain a minimum of 50% wool. Angora goats produce mohair. Silk is the product of silkworms. The fibers used to spin the silkworms' cocoon can be unwound to make silk and rewoven to produce silk cloth. Paint brushes, violin strings, feathers, and surgical sutures are other items made from animal products.

Figure 5.2 - Woolmark and Woolmark Blend Symbols



Synthetic Fibers

Most of the fibers described above are produced from natural sources. Synthetic fibers are manufactured from raw materials such as coal, petroleum, and natural gas. Common synthetic fibers include acrylic, nylon, and polyester.

Natural Fibers vs. Synthetic Fibers

Natural fibers come from inexhaustible resources, such as plants and animals, which reproduce over and over. Synthetic fibers come from exhaustible resources. Once the source of synthetic fibers is depleted, no more can be produced. Table 5.1 lists examples of natural and synthetic fibers.

Table 5.1 - Natural Fibers vs. Synthetic Fibers

Natural Fibers		Synthetic Fibers
Plant origin	Animal origin	
Cotton Rope (hemp) Rayon Linen (flax) Acetate Burlap (hemp) Twine (hemp)	Wool Silk Mohair Paint brushes Violin strings Feathers Surgical sutures	Acrylic Polyester Nylon

Summary

Many fiber materials are processed from agricultural products. Cotton and wool are produced in the United States to help meet the demand for quality fabric. Cotton is grown in southern states. Wool is from sheep that are raised throughout the United States. Many other fiber products are by-products of agricultural production. Fiber products produced from agricultural sources are inexhaustible whereas synthetic fibers are produced from raw materials that are limited in supply.

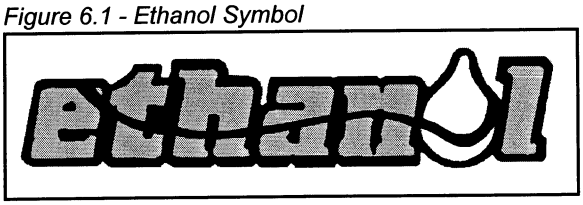
Lesson 6: Nonfood Products from Agriculture

In this unit, nonfood products supplied from grain, trees, other plants, and livestock are discussed.

Products from Grain

The most common nonfood use of grain is for livestock feed. However, many other nonfood products are now produced from grains. In fact, there are more than 3,500 different uses for corn products, and more uses are being found each day. One of the most well-known products is ethanol (see Figure 6.1). Produced from the fermentation of starchy materials such as corn, this alcohol product is blended with gasoline to make gasohol. The first blends in the 1970s were 10% ethanol by volume (E-10) and are still available at gas stations. In 2000, Missouri's first ethanol plant was opened near Macon.

Figure 6.1 - Ethanol Symbol



Corn is refined into starch, syrup, and dextrose. These items can be found in many products such as adhesives, dyes, mouthwash, paints, paper products, plastics, soaps, shoe polish, and toothpaste. Some recent examples of industrial uses of corn are the following:

- Corn-derived citric acid (a substitute for phosphate) increases the cleaning

power of detergent and decreases the volume needed.

- Packing peanuts, a loose fill for shipping products in boxes and other containers, are replacing Styrofoam. The peanuts are made of approximately 95% cornstarch.
- Noncorrosive road deicer made from corn is an environmentally safe alternative to chloride salts.
- Starch-based superabsorbent polymers absorb up to 2,000 times their weight in water. They are used in some baby diapers, automobile fuel filters, and in the horticultural industry to hold moisture near the roots of plants during planting.
- Golf tees are manufactured from cornstarch. They begin degrading within 20 days and save over 50,000 trees per year.
- Biodegradable plastics are processed from corn.

Soybeans are processed for their meal and oil. The meal is used in animal feeds as a protein source. Thousands of other products are processed from soybeans including industrial products such as adhesives, caulks, cements, and fabric softeners. One of the most well-known nonfood uses of soybeans is soy printing ink. Many inks used by newspapers and magazines are processed from soybeans instead of oil. Soybean oil sprays have virtually eliminated the risk of deadly dust explosions at grain elevators. New construction materials such as plywood and countertops that contain soybeans are being used by builders. Even crayons are now being made from soybean oil rather than petroleum-based paraffin wax.

More recently, soybeans are being used in a biodiesel called soy diesel. When added to diesel fuel, the soybeans increase the fuel's lubricating properties, which in turn reduces engine wear. Soy diesel also helps reduce exhaust emissions.

Products from Trees

Many nonfood products are produced from trees including lumber, paper, and cardboard. Wood pulp (very fine wood fibers) is processed into various paper products. Some varieties of evergreen trees are also raised for Christmas trees. Charcoal, a timber product, is produced by partially burning the wood. Bark chips and mulch are also by-products of the lumber and paper industry and are used in landscaping. In addition, turpentine, varnish, and paints are by-products of the forest industry.

Products from Other Plants

Some plants are grown for special purposes. Trees, shrubs, ground covers, and grasses are all grown for ornamental purposes. Such plants are used for landscaping, erosion control, and producing shade. Flowers are grown in landscapes and used in floral arrangements.

Plants can also produce things such as natural insecticides and medicines. Aloe vera is a plant that produces an oil used to ease the pain of minor burns. Perfumes are also made from plant parts.

Products from Livestock

Very little is wasted in the processing of livestock. It has been said that the only thing not used in the processing of hogs is the "oink." The excess fat from animal carcasses is made into detergent. Products from hogs are also helpful in saving lives. Hogs help save human lives by providing insulin needed by diabetics and replacement heart valves for heart patients. Animal fats are also used to make soaps, glues, and candles.

Feathers from chickens and ducks are used to fill pillows. The hides of cattle and hogs can be used to make a wide variety of leather products. Leather is used to make clothing, upholstery, luggage, and book covers, just to name a few. Lanolin is an oil product extracted from sheep wool. Lanolin is used as a skin protector in hand lotion.

Many high-protein meal products are produced during meat processing. Bones, feathers, blood, and fish by-products can be crushed, dried, and ground into meal products, fertilizers, or animal feeds.

Summary

Many nonfood products are processed from animals and plants. Some plants and animals are raised specifically for the special products they provide. Other products are by-products of plant or animal production.

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Lesson 1: Natural Resources

This lesson considers natural resources that humans use, differentiates between those that are inexhaustible and exhaustible, and addresses issues concerning conservation and preservation.

Natural Resources

Natural resources originate from the environment to provide essential materials in human lives; thus natural resources affect everyday life. Examples of natural resources are minerals, oil, trees, wildlife, fish, water, soil, air, fossil fuels, and sunlight.

Inexhaustible and Exhaustible Resources

Natural resources can be classified into two categories: inexhaustible and exhaustible. Inexhaustible resources are resources that renew themselves naturally and will not run out. Air and water are two good examples of inexhaustible resources. Inexhaustible resources can, however, be limited and damaged by human mistreatment. Water, for example, can be limited in certain areas during drought years. Water and air can both be polluted and become unsafe to use. Thus, even though a resource is considered inexhaustible, it is still important to manage it wisely. Inexhaustible resources can be used up, but they can be replaced through proper management practices. For example, wildlife is considered an inexhaustible resource. Early in American history, wildlife such as bison and bald eagles were hunted almost to extinction. Due to great conservation efforts, both species are thriving and are no longer considered endangered. People successfully **renewed** these important wildlife resources.

Trees are another inexhaustible resource. Individual trees may be used, but trees can be renewed by replanting. Trees in a natural forest that are left to grow eventually become mature forests. A forest is similar to a city because it provides food and shelter for its inhabitants. Forests provide many ecological benefits to humans. In cities, trees help purify the air, provide shade for buildings, and serve as a sound barrier against traffic noise.

Exhaustible resources cannot be replaced or renewed when they are used. Once they are used up, they are gone forever, for all practical purposes. Exhaustible resources must be monitored and used carefully to avoid their complete loss.

An example of an exhaustible natural resource is the soil. It is estimated that 6.4 billion tons of soil are lost each year to erosion. Erosion is the wearing away, loosening, or dissolving of earth or rock material. This means that the soils become less fertile for growing crops and other plant life. The soil also becomes unable to filter toxins that might pollute the water and other parts of the environment. Soil is considered exhaustible because it is not practical for humans to make "new" soil, and it takes approximately 500,000 years for soil to regenerate itself.

Crude oil is an exhaustible resource that is distilled into various products such as fuels, lubricants, and chemicals. Once crude oil supplies are depleted, all the products made from crude oil will no longer be available unless research develops synthetic products.

Other examples of exhaustible resources include coal and minerals such as gold, copper, and iron ore. Each of these materials is used extensively in the United States. Research is ongoing to find other ways to produce products that have been made from exhaustible resources in the past. Finding other sources would help reduce dependence on a decreasing supply of exhaustible resources.

Conserving Natural Resources

Natural resources must be used wisely. Overuse of resources can create problems with the natural environment. For example, dumping trash or raw sewage into a lake or stream can destroy the habitat for fish. Over time, the fish may fail to reproduce, which upsets the balance of nature. Other examples of the abuse of natural resources can be identified in many communities. Each person should take steps to conserve natural resources so they can be enjoyed by many generations to come.

Natural resources interact with and depend upon one another. For example, wildlife can be affected by the quality of water available. Soil quality affects the growth of trees and crops. Forest or tree growth impacts the air quality.

When one natural resource is affected adversely, others suffer.

Conservation and Preservation

It is important to understand the difference between conservation and preservation. Conservation involves the careful use and management of resources to avoid wasting them for future generations. People depend on natural resources for food, clothing, shelter, energy, and enjoyment. Wasting natural resources endangers them to the point that they must be preserved.

Preservation involves maintaining a natural resource that already exists by prohibiting its use and returning it to a natural state. Careful monitoring will preserve many forests, wetlands, and prairies by replenishing them and protecting them from overuse.

In general, people involved in agricultural endeavors are very concerned with the conservation of natural resources. Agriculturalists know that natural resources are vital to farming, agribusiness and industry, and human enjoyment as well. Thus, people in agriculture take great pains to conserve natural resources for their continued use as well as for the enjoyment of generations to come.

Protective Agencies

There are many U.S. government agencies within the Department of the Interior that have been established to manage natural resources. These agencies monitor the use of air, water, forest, and mineral resources to ensure they are protected. The U.S. Department of Agriculture is also responsible for protecting natural resources. In addition, the Environmental Protection Agency (EPA) monitors the safe use of resources in the environment.

Several U.S. agencies and a description of their responsibilities are identified below.

The Bureau of Land Management is an agency of the Department of the Interior. It manages public lands, issues rights-of-way for crossing federal lands under another agency's jurisdiction, surveys federal lands, and maintains public land and mining claim records. One important concern for the Bureau of Land Management is overseeing mined lands so that our exhaustible mineral resources are mined properly and conserved to the point that they will be around for generations.

The Department of Fish and Wildlife is an agency under the Department of the Interior. It is responsible for conserving, protecting, and enhancing fish, wildlife, and plants and their habitats. It does this by managing and caring for wild birds, endangered species, certain marine mammals, and inland sport fisheries. It also enforces federal wildlife laws and manages wetland areas.

The National Park Service is an agency under the U.S. Department of the Interior. Its mission is to "...promote and regulate the use of the...national parks...which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein...." This agency manages and administers the national parks located in the United States. It also assists states and local governments in the development of park areas.

The Environmental Protection Agency ensures environmental safety and protection by research and legislation. Also, it sets safety standards in air, water, land, chemicals, and many other areas that affect all life-forms. It is the EPA's mission to "...protect human health and to safeguard the natural environment–air, water, and land–upon which life depends."

The Forest Service is under the Department of Agriculture. It manages public lands in national forests and grasslands. As stated under law, its mission is to "achieve quality land management under sustainable multiple-use management to meet the diverse needs of people...."

The Natural Resources Conservation Service provides technical expertise and field experience to help land users solve their natural resources challenges and maintain and improve their economic viability. It is under the Department of Agriculture, and its stated mission is to "provide leadership in a partnership effort to help people conserve, improve, and sustain our natural resources and environment."

The Ozark National Scenic Riverways is important to mid- and south Missouri. It was the

first protected riverway in the country and was established as a national park in 1964. It offers various outdoor activities within its 30,000 acres and 134 miles of managed riverways.

The Missouri Department of Conservation's mission is to "protect and manage the fish, forest, and wildlife resources of the state; to serve the public and facilitate their participation in resource management activities; and to provide opportunity for all citizens to use, enjoy, and learn about fish, forest, and wildlife resources." It fulfills this mission by providing hunting, fishing, and trapping permits across the state as well as implementing and conducting conservation and educational efforts across the state of Missouri.

The Missouri Department of Natural Resources serves Missouri's citizens by dealing with energy and mineral resources. It also works to protect land, air, and water resources as well as to preserve the state's historic and cultural heritage. Its stated mission is to "preserve and protect the state's natural, cultural and energy resources and inspire their enjoyment and responsible use for present and future generations."

Pollution

Pollution is the presence of substances in water, soil, or air that affects its usefulness or makes it offensive. Pollutants in the soil, water, or air can damage those resources for animal, plant, and human consumption.

There are two forms of pollution: point source and nonpoint source. Point source pollution can be traced to a specific point of discharge and is readily identifiable. For example, an oil spill from a large oil tanker would be point source pollution. Nonpoint source pollution occurs from sources that cannot be directly traced to a specific point of discharge. For example, smog in the air caused by vehicle emissions would be nonpoint source pollution. Pollution is a very serious problem and regulations must be followed to reduce pollution so that the quality of our resources is maintained.

Summary

Natural resources include all living and nonliving things that are commonly found in nature. Inexhaustible resources renew themselves and will not run out but are still limited in some cases. Inexhaustible resources can be replaced. Exhaustible resources are not replaced when they are used. Conservation of natural resources requires the active participation of individuals working together to wisely manage needed resources. There are several agencies in the U.S. government that regulate the use of natural resources. These include the Bureau of Land Management, the Department of Fish and Wildlife, the National Park Service, the Environmental Protection Agency, the Forest Service, the Natural Resources Conservation Service, and the Ozark National Scenic Riverways. State agencies include the Missouri Department of Conservation and the Missouri Department of Natural Resources. Pollution, which involves making natural resources ineffective or unusable, can exist from point sources and nonpoint sources. Wise use of natural resources, including avoiding or reducing pollution, will ensure their availability for future generations.

Lesson 2: Soil Conservation

Soil is a vital natural resource that is needed for the production of food and fiber crops and is the basis for all life on earth. Nearly every product people use or consume can be traced back to the soil. Soil is not considered to be an inexhaustible resource, because it takes several hundred years to form 1 inch of soil.

Factors in Soil Erosion

Soil erosion is the movement of soil from one place to another by wind or water. It is possible that soil erosion can remove 1 inch of topsoil on steep land in a single heavy rainfall. Movement of soil by erosion creates many problems. When soil is lost, not only is the productivity of the land destroyed, but also the soil itself may become a pollutant to water sources. Many factors contribute to the speed and scope of soil erosion.

Human activity, such as plowing the soil or constructing new buildings and highways, can cause soil erosion. It is often referred to as accelerated erosion because the soil is removed at a much faster rate than by natural processes.

Water erosion occurs when excess rainfall cannot be absorbed into the earth and runs off the

surface, carrying large amounts of soil with it. Water erosion can also occur from a raindrop splash. As a raindrop hits the ground, it can cause the soil particles to become separated and thrown about. This action can also cause the soil to become less permeable because the soil becomes compacted and the water does not absorb as easily, resulting in more runoff. Wind erosion is caused by small particles of the soil being carried away by gusts of wind. Wind erosion occurs in dry climates where the soil is loose and not covered by vegetation or trees.

Natural events such as earthquakes, floods, and tornadoes can also create soil erosion. These events are beyond human control but can have a tremendous impact on erosion

Land slippage, referred to as landslides or mudslides, occurs on wet, sloping land. When saturated with water, soil becomes too heavy to maintain its structure and slips down the face of the steep slope. In addition to carrying away large amounts of soil, landslides and mudslides also carry buildings, trees, and other important structures.

Soil Erosion and Food Production

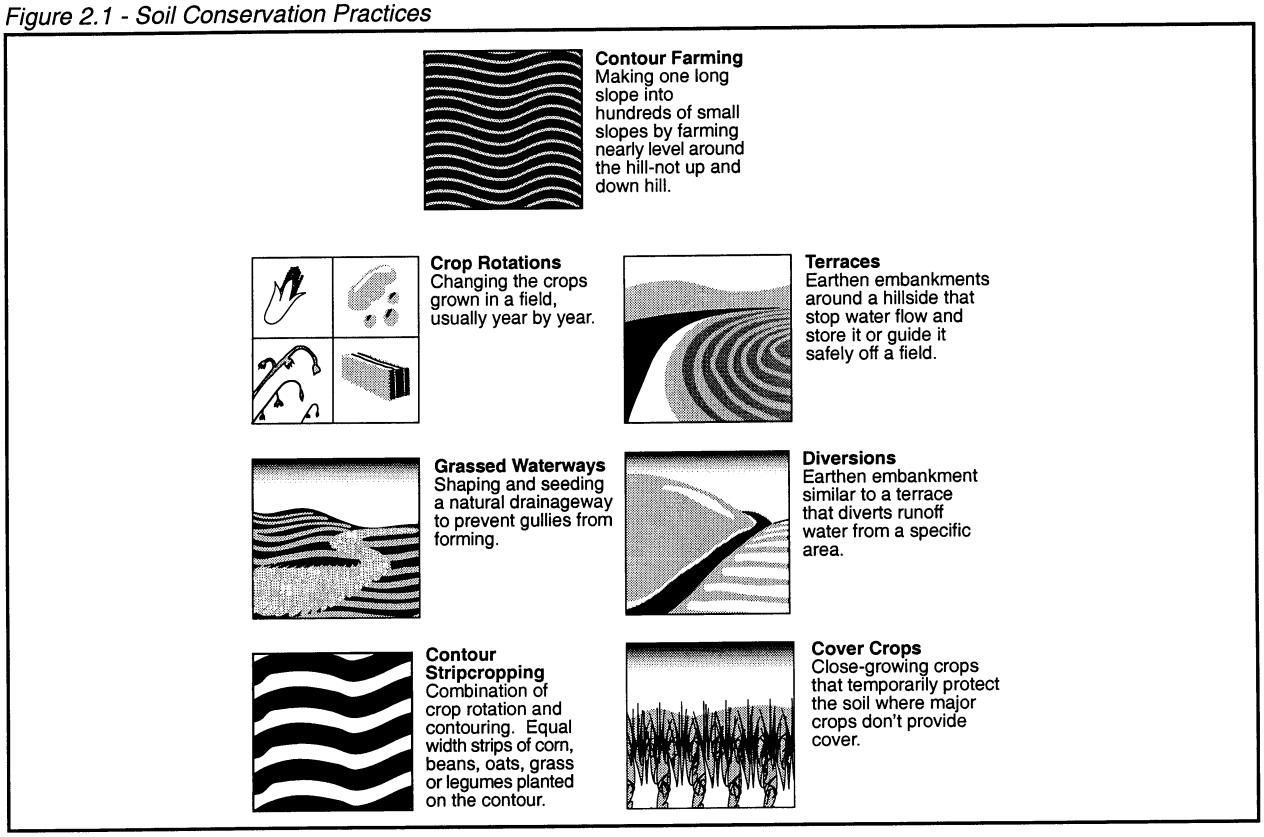
The erosion of soil has a great impact on food production. Soils that have been eroded lose their nutrients and ability to hold water. Thus plant life is unable to thrive and grow. When plants cannot grow, crops cannot be produced, affecting food production.

Healthy plants provide the necessary nutrients to maintain the health of animals whose survival depends upon eating plants. When soils erode to the point where healthy plants cannot grow, animals cannot receive the proper nutrients from those plants. Thus, animals cannot thrive and grow, affecting the production of animals raised for food.

Soil Conservation

Soil conservation involves the protection, wise use, management, and improvement of the soil. Knowledge of conservation practices in urban as well as agricultural areas is essential to ensure the viability of the soil for future use.

Figure 2.1 - Soil Conservation Practices



Soil Conservation Practices

Agriculturalists have made great strides in reducing soil erosion through extensive research, education, and implementation of soil conservation practices. Following are just a few examples of how farmers and ranchers are working to reduce soil erosion.

Contour planting involves tilling and planting crops around or across hillsides rather than up and down the slopes. This reduces the amount of soil that will slip down the slope. Crop rotation practices involve planting different crops in the field each year. This reduces soil loss because the residue produced by changing crops holds the soil in place and enhances fertility. Terracing involves placing a ridge of earth across a slope. This will cause a more gradual drop for the flow of water and prohibit rapid runoff. Grass strips placed near plowed areas will slow and filter water flow and prevent gully formations outside planted areas. Diversion ditches can be built around slopes to help control the amount of runoff. Strip cropping involves planting alternating strips of crops on sloped land to slow water flow and help hold topsoil in place. Cover crops, such as forages, can be planted after fall harvest to protect soil from erosion in fallow seasons. Figure 2.1 illustrates these soil conservation practices.

Summary

The loss of productive soil affects the world's food supply. Soil erosion can be controlled through soil conservation practices. Efforts to implement conservation practices will be beneficial for everyone.

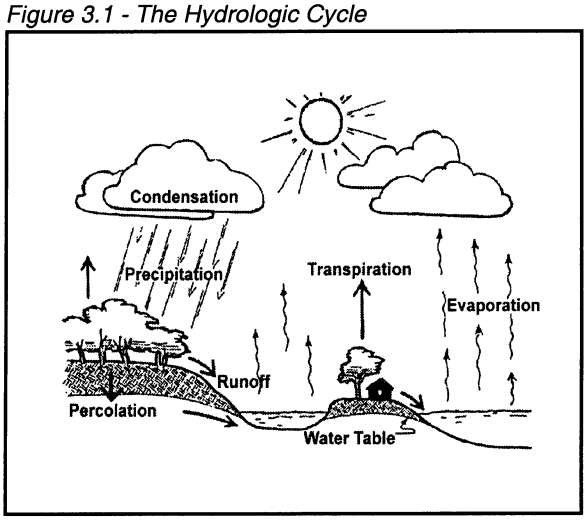
Lesson 3: Water Quality

Water is an important resource to sustain life. It is another precious natural resource that is used in many ways

The Hydrologic Cycle

The process whereby water moves from place to place on the earth is known as the water cycle, or hydrologic cycle. This process keeps the total amount of water fairly constant on or around the earth. This means that the general supply of water on the earth is neither added to nor reduced; it is just regenerated by natural processes. Through natural processes, water evaporates from plants, soil, and water surfaces into the atmosphere. Water vapor collects and is stored in clouds. When the temperature drops, the water vapor condenses. The condensed water vapor, called precipitation, falls to the earth in the form of rain, sleet, hail, or snow, depending on the temperature. After the precipitation falls to the earth, the process repeats itself. This process is called the hydrologic (water) cycle. See Figure 3.1.

Figure 3.1 - The Hydrologic Cycle



Water Quality

Water quality is defined as the condition of water for a particular use. Water has different quality standards depending upon the use for which it is intended. For example, water used for drinking purposes would be regarded more strictly for quality standards than water used for industrial purposes. Many people take their sources of drinking water for granted. The quality of this water is often hard to determine unless tests are conducted. It is important to have well water and city water tested by professionals to ensure that it is safe to drink.

Factors Affecting Water Quality

Many factors affect the quality of the water supply. It is important to test for each of the factors affecting water quality to ensure that the drinking supply is fit and safe for use.

Odor and taste are obvious indicators of quality. Normal processes in the earth can cause the water to have an "earthy" odor. Pollutants can cause the water to smell or taste bad. Any water that has unusual odors or tastes should be tested to ensure that it is safe to drink.

Color is another factor in water quality. The most desirable water for drinking is clear. However, sediments, minerals, and organic matter may give water a rusty or murky color. Color in water does not immediately mean that the water is unfit to drink.

Another important factor in water is pH. Water with a high pH indicates a presence of calcium or other minerals. Water with a very low pH indicates the presence of acids. It is important to maintain a pH of around 7.0, which is neutral, to prevent excess damage to water pipes.

Water quality is also defined by hardness. Hard water is an indication of calcium and magnesium in the water. Hard water causes buildup in pipes, sinks, and showers. More soap is needed to wash in hard water. Laboratory tests can determine the hardness of water.

Water turbidity is the amount of materials suspended in the water. Materials such as soil and microorganisms give water a cloudy appearance. Turbidity can be removed by filtering out the suspended materials.

The presence of heavy metals such as mercury and lead can affect the water quality, causing it to be toxic to animals and humans. Old lead plumbing systems can create the presence of lead in the water. If lead is indicated, old plumbing systems should be immediately replaced.

Chemical residues can also affect the quality of water. All drinking water should be tested for the presence of chemicals. The effects of very small amounts of chemicals in water are not yet known; however, it is a good practice to buy bottled water if household water is found to have any chemical residues present.

Bacteria can also affect the quality of water. Water containing coliform or E. coli bacteria is polluted with human or animal waste and considered unfit for human consumption. Boiling water can destroy the presence of bacteria.

Types of Water Pollution

There are many types of pollutants that can enter water sources, both aboveground and underground. Pollutants can cause water to be unusable or hazardous to humans, animals, and plants.

Sediments are tiny soil particles that become suspended in water from the direct result of soil erosion. Sediments can cloud the water, preventing light from passing through. This is especially harmful to aquatic life. Cloudy water from sediments will not allow light to pass freely. Water plants and algae are unable to use the light for growth, causing them to die.

Pathogens such as parasites, bacteria, worms, and viruses are organisms that cause disease. Pathogens such as the coliform and E. coli bacteria are dangerous water pollutants. These pathogens can cause disease or death of the humans and animals that drink the polluted water.

Organic wastes are wastes from living materials. Organic wastes pollute water sources through their own decay. Decaying organic material such as rotting wood has large amounts of bacteria present. These bacteria use up the oxygen in the water. Thus living organisms, such as fish species, die from lack of oxygen in water found to have high amounts of organic wastes.

Inorganic substances are water pollutants from nonliving materials. Heavy metals, salts, and industrial wastes can all be inorganic water pollutants. The presence of such materials makes water unfit to drink and can damage wildlife.

Organic chemicals such as oil, detergents, pesticides, paint, and plastics are chemicals created from organic materials. When humans are careless in disposing these materials, pollutants can enter the water supply. These pollutants also damage wildlife and make water unfit to drink.

Thermal pollution is a final form of water pollution that can damage organisms and wildlife living in

the water. Thermal pollution occurs when large amounts of water are released into a water source, causing the stream or lake to change temperatures. For instance, electric power plants use water to create electricity. When the process is finished, the water used is much warmer than the natural water in a pond or stream. If power plants release this warm water into a pond or stream, it could heat the water temperatures enough to kill living species.

Summary

The supply of water in the earth is sustained by the hydrologic cycle. Pollution of water resources from sediment, pathogens, organic wastes, inorganic materials, organic chemicals, and thermal pollutants are serious problems throughout the world. Monitoring water quality involves determining the condition of water for particular uses. For example, water for human consumption must be of higher quality, that is, free from odor, off-taste, color, abnormal pH, hardness, turbidity, heavy metals, chemical residues, and bacteria. It is important to continually monitor this water to ensure the safety of humans, animals, and plants.

Lesson 4: Air Quality

The quality of the air must be protected to ensure the health and well-being of all living things. This lesson addresses various sources of air pollution and focuses on how these toxins are monitored.

Air Quality

Air quality can be defined as the purity of the air that is used by living organisms. Air that is considered high in quality is free of pollution. Air with low quality contains materials that are toxic for living organisms to breathe. It is important to maintain the quality of air because it affects the health of humans, animals, and plants as well as the environment.

Types of Air Pollution Affecting Air Quality

There are different types of pollutants emitted into the air that affect the quality of air. Once they reach certain levels they can become hazardous to human, animal, and plant health.

Gaseous Pollutants

Gaseous pollutants include carbon monoxide, nitrogen dioxide, sulfur dioxide, and hydrocarbons. These pollutants are produced from automobile exhaust and the burning of coal, oil, and natural gas. Gaseous pollutants are a serious problem on expressways and urban streets when traffic is slow and carbon monoxide fumes accumulate. Passengers and pedestrians can become drowsy and have slower response times when exposed to carbon monoxide.

Natural gas water heaters and furnaces may also cause a buildup of carbon monoxide inside a closed building. Without proper ventilation, this odorless gas can be fatal to inhabitants.

Burning coal that is high in sulfur content releases large quantities of sulfur compounds into the air. High levels of sulfur dioxide in the air contribute to "acid rain." Acid rain contains high levels of sulfuric acid and can contribute to the destruction of trees and other plants near industrial areas. Acid rain falling into ponds or lakes also changes the acidity of the water, which is harmful to fish and plant life.

Nitrogen dioxide is produced from burning gasoline and diesel fuel in automobiles and trucks. Many large cities suffer from nitrogen dioxide pollution because of the large number of vehicles used for transportation. Smog that contains these pollutants can result in breathing problems and eye irritation.

Hydrocarbons are evaporated petroleum products that can become a gaseous pollutant. Two major sources of hydrocarbons are gasoline engines and petrochemical refineries. Hydrocarbons come from fuel tanks, carburetors, crankcase vents, and exhaust systems. All new automobiles are designed with emission controls to recycle hydrocarbon vapors back through the engine.

Odor

This type of air pollution is unique from other types. Extreme odors make it difficult and at times harmful to fully enjoy the environment. Irritants in the air can cause illnesses in many people. Some food processing plants and chemical plants emit strong odors that affect large areas. Confinement livestock production units

and waste handling facilities can also produce offensive odors. Pungent smells of any kind can be offensive and may be considered a form of air pollution.

Particulate Matter

Particulate matter is solid material that is light enough to be carried in the air. Sources of particulate pollution include human-generated process from coal- and oil-fueled generating plants, automobiles, jet aircrafts, diesel-powered engines, and wood-burning stoves. Natural particulates such as dust, smoke, and soot produced from burning also contain small particles of ash.

Sources of Pollution

Air pollution and the types of pollutants listed above occur from two major sources: human activities and natural processes. Human activities such as factory emissions, automobiles, boats, lawn mowers, home heating systems, burning trash, burning coal and wood for energy, and even aerosol cans contribute to pollution of the air. It is important to monitor and control activities causing air pollution to reduce the human contribution to air pollution.

Natural events are also a source of air pollution. Volcanic eruptions naturally emit large amounts of soot and ash into the air that can travel great distances. Wind erosion creates dust particles that pollute the air. Plant pollens and the decay of natural materials also contribute to some pollution of the air. Although natural events are impossible to control, they still contribute to some air pollution.

Maintaining Air Quality

It is important to maintain the quality of air in the environment to improve human and plant health. Human lungs take in pollutants with the air that is inhaled. Thus, air quality must be maintained to reduce respiratory problems and diseases such as cancer. Plants use carbon dioxide in the air to grow and create food. They give off oxygen used for humans in this process. In order for plants to grow and produce food, the quality of the air must be maintained.

Air quality must be maintained to keep the earth's climate stable. High amounts of pollution in the air hold heat close to the earth, a process called global warming. The process creating this climate change is known as the greenhouse effect. This problem has the potential to change animal and plant life.

Air quality is important to maintain the beauty of the surroundings. Materials such as smog or other pollutants in the air make it appear smoky and hazy. The environment becomes dirty and the surroundings are no longer pleasing to the eye.

Air quality should be maintained to reduce damage to property. Materials in the air can make property rust and corrode, causing damage and an unpleasant appearance.

Ensuring Air Quality

The government has passed stricter laws in recent years to ensure that pollution by human sources is reduced and air quality is maintained. New sources of fuel and energy are being developed and improved that will ensure air quality for future generations.

Car manufacturers are required to meet specific emission control standards set by the Federal Motor Vehicle Control Program. These standards limit the amount of gaseous and particulate pollutants that enter the air. Vehicle inspection stations monitor the exhaust systems on vehicles. The use of public bus and rail transportation is encouraged.

Another method used to ensure air quality has been the development of alternate fueling and energy sources for vehicles. Ethanol, a form of alcohol produced from corn, is being added to gasoline to improve fuel efficiency and reduce pollutants in gasoline. Vehicles that mainly rely on electricity as their source of energy are being used as a pollution-free alternative to gasoline-powered automobiles.

Various energy sources are being used as pollution-free alternatives to burning wood, coal, oil, or natural gas to produce energy. Solar power converts and stores the heat energy from the sun in solar cells into useful electrical energy. Wind

and water power are also alternative sources of natural energy and result in little to no pollution of the air.

Summary

Clean, fresh air is essential for human, plant, and animal life. There are many types of air pollution that affect the quality of the air we breathe. Pollutants include gases, odors, and solid particles suspended in the air. These pollutants originate from either human processes or natural processes. Although natural processes are difficult to control, human processes can be altered to reduce pollution in the air. It is important to maintain the quality of the air in order to ensure the health of living things, the stability of the climate, maintain natural beauty, and reduce property damage. To control pollution and improve the quality of the air, many new processes and products and are being used. Some examples are motor vehicle emission controls and exhaust inspection, increased use of public transportation, use of more environment-friendly fuels such as ethanol, and use of alternate forms of energy.

Lesson 5: Wildlife Management

Wildlife includes all animals that live in the natural environment without human intervention. Domestic animals require care by humans and may struggle to survive in nature.

Wildlife Management

Wildlife management refers to the practices involved in caring for wildlife and their environment to ensure the continuation of the species. Some species of wildlife have been hunted to near extinction. Wildlife environments are destroyed by building houses, cutting down trees, and farming and mining the lands inhabited by wildlife. Many wildlife management practices have been implemented to ensure the continuation of species nearly destroyed by humans.

Factors Affecting Wildlife Habitat

Human advancement and habitation often come at the expense of wildlife habitats. A major impact on wildlife habitat is that of urbanization. Wildlife habitats are often destroyed to expand cities and towns. As the human population grows, more space is required for buildings. Cutting trees, damming rivers, and clearing land for the construction of human habitats have a negative impact on the habitats of the wildlife native to the area.

Tilling the land for planting crops and pasture for livestock has an effect on wildlife habitat. Tilling the land can destroy wildlife nesting areas and reduce available food. Lands converted to pastures for livestock grazing also affect wildlife habitat. Pastureland for grazing livestock reduces the vegetation and shrubbery that form natural wildlife habitats.

Manufacturing and industry create wastes, polluting the air that wildlife breathe and water they drink. Excessive wastes can often destroy many species of wildlife.

Mining lands for minerals and other resources affects wildlife habitat. Before lands were mined, they were a source of wildlife vegetation. Mining also causes runoff of minerals and pollutes lakes and streams that could poison wildlife.

Cutting trees in forests affects wildlife habitats. Forests provide crucial environments for many species of wildlife. Clearing these trees reduces areas in which many species can live.

Large recreation areas created for humans affect wildlife habitat. Ski slopes, theme parks, athletic fields, and parking lots for these facilities require large spaces of land formerly used by wildlife.

Wildlife Management Agencies

Wildlife management is conducted on federal, state, local, and individual levels. Many agencies have been established to ensure the maintenance, protection, and production of wildlife and wildlife habitats.

One of the most important of these is the U.S. Fish and Wildlife Service. This federal agency is responsible for the management and protection of wildlife species and habitats in the United States. Major duties of this agency include protecting and preserving endangered species, controlling natural wildlife refuges, monitoring migratory bird populations, managing the nation's fisheries,

protecting wildlife habitats, conducting research efforts, enforcing wildlife management laws, and administering federal aid to wildlife management programs.

A federal agency that has a more indirect responsibility for maintaining wildlife habitat is the U.S. Department of Agriculture (USDA). This agency controls the Conservation Reserve Program. This program takes highly erodible land out of production for 10 years and plants a vegetative cover. This reduces land erosion and restores heavily cropped areas for natural wildlife habitats.

The Bureau of Land Management manages several million acres of federal public lands. Management of wetland areas and prairie restoration has become an important concern for this agency.

The Forest Service manages millions of acres of public forest lands. The forests, which are important sources for fish and wildlife habitat, are managed to ensure the survival of species once endangered by clear-cutting of forests.

Each state has local agencies that govern the management and protection of wildlife specific to its region. The Missouri Department of Conservation is responsible for managing hunting and fishing. Employees enforce wildlife management regulations and monitor wildlife habitat throughout the state. The Missouri Department of Natural Resources protects the air, water, land, mineral, and energy resources. This agency includes five divisions: Environmental Quality; State Parks; Energy, Geology, and Land Survey; Administrative Support; and the Environmental Improvement and Energy Resources Authority.

Each agency offers educational materials and activities directed toward maintaining wildlife habitat, species preservation, and enhancing the beauty and enjoyment of wildlife for future generations.

Wildlife Management Practices

Human progress and development have done much to destroy wildlife and its habitat. With the development of government agencies and a concerned population, many management practices have been implemented to preserve wildlife.

Habitat management practices include creating food plots, water resources, and nesting areas useful to wildlife. This involves planting food, providing water for wildlife to drink, cutting small areas of timber, and clearing undergrowth to open up areas for wildlife.

A practice that is essential to the maintenance of wildlife species is disease control and prevention. Species such as waterfowl that tend to flock together in large groups can be threatened by large outbreaks of disease. Therefore it is essential to reduce potential disease factors. Ensuring that the species' natural habitat is not polluted is one way to prevent diseases. Preventing overcrowding and poor nutrition can also help to reduce disease in wildlife species.

Hunting helps to manage wildlife species by keeping down populations to manageable numbers. Overpopulation of wildlife can create hunger and disease among a species. Hunting regulations are closely monitored to protect wildlife populations from overhunting or overfishing.

Artificial stocking involves raising species and stocking areas with wildlife where no wildlife previously existed. Wild turkeys, once a very rare species in areas of the United States, now flourish due to artificial stocking.

Funds from federal, state, and local organizations help to establish and maintain all of the programs and practices involved in wildlife management. As with wildlife, money is a resource that must be managed properly.

Summary

Wildlife management includes all activities that care for wildlife and its environment to ensure the continuation of wildlife species. Agencies such as the U.S. Fish and Wildlife Service, the USDA, the Forest Service, the Bureau of Land Management, the Missouri Department of Conservation, and the Missouri Department of Natural Resources are involved in wildlife management. These agencies conduct practices such as managing habitat,

controlling and preventing the spread of disease, regulating hunting practices, stocking wildlife species, and managing funds that support wildlife management practices. The proper management of wildlife is essential to ensure the success of this vital renewable resource.

Lesson 6: Conservation Issues in Agriculture

Up until 1935 when the Soil Conservation Act was passed, farming practices were unregulated, resulting in extensive erosion and destruction of ecosystems. Through careful management of agricultural conservation practices, the overall quality of the land has improved.

Agriculture-Related Conservation Issues

People involved in agriculture and the production of food are faced with many difficult issues concerning the conservation of our natural resources.

Maintaining productivity of the soil is a conservation issue. Soil erosion is a major concern because it pollutes the environment and decreases crop productivity. Agriculturalists are concerned with maintaining the soil for the productivity of future generations.

Proper waste disposal is an agriculture-related conservation issue. Wastes from livestock facilities must be handled and disposed of properly to avoid contamination of water resources.

Pollution control is a major conservation issue in agriculture. Chemicals help crops grow and keep them free of weeds and insects, thus ensuring a plentiful and high-quality food supply. However, such chemicals serve to pollute the air and water.

The depletion of forests is a major issue concerning those involved in wildlife management and those who harvest timber. Wood and wood products are valuable resources, but cutting old growth forests destroys wildlife habitats and endangers many species of wildlife. In addition, trees are the major source of oxygen for human respiration. Cutting forests depletes the human oxygen supply.

Conservation Legislation

Conservation legislation in general is designed to provide educational activities, technical assistance, and additional funding to support efforts of producers who alter their production practices to conserve our natural resources.

The 1985 Farm Bill created the Conservation Reserve Program, which sets aside land to be maintained as natural vegetation for a 10-year time span. This land, designed to remain idle, serves as a natural habitat for wildlife populations originally displaced by cropping procedures. It also allows the land once eroded by heavy cropping practices to regain its production capabilities.

The 1996 Federal Agriculture Improvement and Reform Program modified and extended agriculture- related conservation programs. It also created several new conservation programs intended to protect wildlife and grazing lands. The new Environmental Quality Incentives Programs created by this act encourage farmers and ranchers through technical assistance, education, and incentive payments to adopt practices that reduce environmental and resource problems. The Conservation Farm Option offers payments to producers who implement practices that address soil, water quality, wetland, or wildlife habitat concerns. The Flood Risk Reduction Program offers incentives to farmers who forego planting crops in acreage that is frequently flooded. The Conservation of Private Grazing Land Initiative offers funds and educational support to owners of private grazing lands to maintain wildlife habitats in such areas.

Natural Resource Conservation in Agriculture

Persons involved in agriculture production have become increasingly committed to the conservation and maintenance of the soil and wildlife habitats.

Global Positioning System (GPS) is an advanced technology implemented in 1993 that uses sophisticated satellite equipment with remote sensors to closely monitor nutrients, water, soil, and other factors in the soil. This technology is referred to as precision farming. This system allows producers to precisely monitor the need for

fertilizers and chemicals in specific areas of fields. This results in reduced amounts of chemicals, thus reducing pollution and other harmful effects. Precision farming allows producers to make very precise and accurate decisions about farming practices and becoming more efficient and environmentally friendly as a result.

Crops are being genetically altered to be resistant to certain pests, resulting in reduced use of pesticides. Alternative methods of pest control such as biological predators are used more often to further reduce the need for pesticides.

Pesticide manufacturers are now reclaiming pesticide containers to reduce amounts of pesticide residues that could possibly contaminate the water and soil. Conservation tillage practices such as no-till, strip-till, crop rotation, and terracing help to prevent runoff of soil and chemicals into streams and rivers. Rotational livestock grazing practices reduce overuse of the land.

Many landowners set aside acreage to form natural habitats for wildlife and to reduce erosion. Alternative sources of power such as wind and solar power are being developed to operate agriculture equipment, thus reducing the air pollution caused from equipment emissions.

Summary

In the past, people were not very concerned with the conservation of their natural resources for future generations, due to a lack of knowledge regarding conservation issues. As a result, many issues concerning the conservation of resources in agriculture arose. People concerned with natural resource conservation, the general public, and people who make their living from agricultural practices have differing points of view on agriculture-related conservation issues regarding soil productivity, pollution control, waste disposal, and destruction of forests. Legislation efforts such as the 1985 Farm Bill and more recently the 1996 Federal Agriculture Improvement Reform act have been designed to support producers in their conservation efforts. New technologies and practices such as precision farming, genetically modified crops, biological pest control, pesticide container reclamation, minimum tillage, rotational grazing, set aside acreage, and alternative power sources have been developed that reduce pollution and make crop production more precise.

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Lesson 1: Developing Personal Leadership Skills

Leadership skills, setting goals, and developing good communication skills can help develop a pathway to success. Good leaders come in all shapes, sizes, races, religions, and from all different backgrounds.

Personal Leadership

Personal leadership is the ability to motivate and organize oneself and others to achieve goals. Some important characteristics of a good leader include the ability to set goals and the ability to persuade and motivate others to achieve goals. To accomplish this task, a good leader must have good communication skills.

Personal leadership also involves a variety of other skills such as motivating yourself and others, having good character, working well in teams, being confident in your abilities, and being goal oriented.

Importance of Leadership Skills

Leadership skills are important to people for many reasons. Leaders can direct themselves and others in a variety of ways, good or bad. For example, the captain of a sports team could lead the team to victory whereas the leader of a gang could lead the members into a life of crime. The responsibilities of personal success and the influence one has on others come with leadership.

Leadership skills help improve confidence and acquire respect from others. Good leaders are admired by others and are often well known by the people whose lives they influence.

Leadership skills give the opportunity to help others and make a contribution to society. For example, Martin Luther King, Jr. was a famous African American leader who contributed to society by helping to break down the walls of racism. His actions and skills helped provide many opportunities for African Americans in the United States.

Strong leadership skills offer the opportunity for unlimited success in career or personal choices. A good leader could be a famous star, a political leader, a leader in the church or community, or even a leader in a family. Leadership involves people making a difference in the lives of those around them.

Setting Goals

The first step to becoming an effective leader is to establish goals. Goals are important tools for leaders for a variety of reasons.

Goals help people focus energy on what is to be completed. It is easy to feel overwhelmed by all there is to accomplish, but a set of clear goals can outline tasks, making them easier to attain.

A clear set of goals motivates people to complete those tasks. Goals give direction and motivation. They make it easier to monitor progress. Effective leaders set goals for themselves or their organizations and for the teams of people for which they work.

There are three basic types of goals: short term, intermediate, and long term. Short-term goals are goals that can be easily reached in a short time span, usually within 1 year. They can include tasks such as receiving an "A" in a specific class or getting accepted on a sports team.

Intermediate goals are mid-range goals usually achieved within 3 to 5 years. Intermediate goals can also build on short-term goals. For example, graduating in the top 10 percent in a class or leading a sports team to a championship would build on the previous short-term goals.

Finally, long-term goals are long-range future goals that could take 5 to 10 years or even a lifetime to complete. They are usually the end product of many sets of short-term and intermediate goals. Becoming the head of a major corporation or the star on a major sports team would be examples of long-term goals. It is important to remember that any goal is possible, provided that one has the determination and completes each task one small step at a time.

Communication Skills

Another key element to effective leadership is good communication skills. Good leaders are good communicators; thus leadership and communication go hand in hand. Communication skills are important to leaders for a number of reasons.

Good communication skills assist people in getting a job, a promotion, or a raise. The work environment is becoming increasingly more competitive. Often, people are judged more by how well they communicate ideas rather than by the ideas themselves. Success as a leader in the workplace depends on communication skills.

Good communication skills are essential for creating a strong personal image. Good leaders are admired and respected by others. To gain such respect, leaders must be able to communicate their image. This could be as simple as a handshake and a hello.

For leaders to motivate and persuade people, they must build good relationships. Communication skills help leaders build better relationships with people. Leading a sports team, conducting a meeting, or completing a sale all require a relationship with people, and communications is the key to building those relationships.

Parliamentary Procedure

One area that contributes greatly to personal leadership and communication skills is the knowledge of parliamentary procedure. Parliamentary procedure involves a set of rules and methods for conducting a meeting. The rules of parliamentary procedure help leaders to conduct meetings that are fair, democratic, and efficient. Parliamentary procedure aids in developing communication skills and public speaking abilities that are helpful in meetings as well as in personal or professional settings. Finally, skill in parliamentary procedure helps individuals to respect others and to make effective decisions in a timely fashion.

National FFA Organization

Leaders must establish goals and polish communication skills to achieve success. These skills can be developed through participation in an organization, club, or team. One premier youth organization that provides young people with many leadership opportunities is the National FFA Organization.

Students aged 12-21, across the nation, or who are in the 9th grade in the state of Missouri, and are enrolled in agricultural education programs can join the 450,000 + membership of the FFA. The FFA provides career opportunities, scholarships, competition, travel, community service, supervised experience, and fun. This leadership organization is the largest youth organization in the United States. It offers youth from a wide variety of backgrounds the opportunity to develop skills in leadership and communication and help make themselves successful and achieve their goals.

Activities such as Career Development Events, held at the local, district, state, and even national levels, provide members with the opportunity to compete individually and on teams in order to test their knowledge and skills in a variety of agricultural areas. FFA members also have the opportunity to exercise leadership by conducting a Supervised Agricultural Experience (SAE) in an agricultural field of their choice. Students may also receive awards for excellent SAEs at the local, district, state, and national levels as well. Finally, local chapters, state officers, or even national programs offer a wide variety of leadership camps, seminars, and workshops in the FFA. The Missouri State FFA Convention held every spring in Columbia, Missouri, as well as the National FFA Convention conducted in the fall in Louisville, Kentucky, each provide Missouri FFA members with excellent local and national leadership opportunities.

Summary

Becoming an effective leader is important to success and satisfaction in life. Effective leaders inspire, motivate, and persuade others to achieve goals. Elements of leadership include setting goals, possessing good communication skills, and obtaining knowledge and skills in parliamentary procedure. The National FFA is a leadership organization that provides opportunities to exercise leadership, communication, and parliamentary skills while participating in activities such as Career Development Events, Supervised Agricultural Experience Programs, and Leadership Conferences at the local, state, and even national levels.

Lesson 2: Importance of Financial Records

Planning for the future requires several key steps. Personal and career goals must be set. Next a financial plan is developed that considers these goals and includes a plan for financing them.

Saving Money for the Future

As individuals identify goals in life, almost all of them require financial management and planning. What do you plan to do after graduation from high school? What will you be doing at age 30, 50, and 70? Reaching goals in life will require saving for the future.

A key time in a person's life is immediately after high school graduation. Moving away from home means that living expenses will become your responsibility. For students who continue their education by attending college, costs may range from $2,000 to $3,000 per year to $15,000-20,000 per year or even more. This will depend on costs at the college, its location in the United States, and scholarships obtained. Developing a plan at an early age will help individuals reach their goal of pursuing education beyond high school.

Major purchases also require planning. Making large financial purchases for a car, house, land, machinery, or business requires a significant amount of money. Will you have enough money saved to purchase major items?

Savings accounts, certificates of deposit (CDs), and retirement accounts such as tax-sheltered annuities (TSAs) will be needed to provide financial security for an individual upon retirement. It is critical that a financial plan is followed to provide financial security for retirement, because the salary from your job will no longer be available.

Figure 2.1 Planning for the Future

The key point about saving for the future is to start early and let interest work over a period of time. The rule of 72 can be used to better explain this concept. For example, if $100 is deposited in a savings account that earns 6% interest, this will grow to $200 in 12 years and $400 in 24 years. The rule of 72 formula is as follows:

72 ÷ Rate of return = Number of years for money to double

Calculating Interest

Understanding interest is a starting point in financial management. When borrowing money from a bank, interest is charged. Thus, interest is the cost paid for borrowing money.

There are many ways that interest can be charged and calculated. A basic way to charge interest is referred to as simple interest. This is interest charged for only the time the money is used. The simple interest formula is as follows:

Simple interest = P (principal) x R (rate) x T (time)

In the simple interest formula:

- Principal is the amount of money borrowed.
- Rate is the interest rate.
- Time is the part of a year or year(s) the money is used.

For example, if $3,000 is borrowed at 12% interest and it is paid back in 1 year, $360 in simple interest will have accumulated ($3,000 x .12 x 1 = 360).

Expenses and Receipts

An expense is a financial outlay, or cost. This may range from major costs, such as buying a new truck, house, or land to operating costs, such as purchasing inputs (seed, feed, fertilizer, etc.), insurance, repairs, utilities, and interest.

A receipt is revenue, or income. For an individual, a monthly paycheck is an example of income. There may be many sources of revenue for a business. The most common example is the money generated by selling a commodity or product, such as the income from the sale of crops, livestock, or other products.

Importance of Personal Financial Records

Financial planning involves recording money received and spent and using this information to plan how to meet personal and financial goals. This process enables an individual to monitor income and spending. Making adjustments early, especially in spending, will help an individual accomplish his or her goals.

Summary

A financial plan can help an individual manage his or her money so that personal and financial goals can be reached. Being able to calculate simple interest is a basic skill of financial management. It is important to begin this process early so that time and interest can increase savings. Monitoring the plan, especially in regard to saving and spending, will help individuals reach their goals.

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Lesson 1: Electricity

Electricity is an extremely important home and farm utility essential to sustaining life as well as livelihood. Humans rely heavily upon electricity in their daily lives. It is important for people to consider factors such as energy conservation and safety in their daily consumption of electricity.

What Is Electricity?

Electricity is a form of energy created by the flow of negatively charged particles in a circuit through a conductor. An electrical conductor is a wire that allows electricity to flow through it. The circuit is the controlled path that the electrons follow. The path flows from where the electricity is generated and goes to where it is used. This process is similar to the natural flow of a river. Rivers must flow from a high point to a lower point of land. Electricity flows from negative charges toward positive charges. The flow of water in a river is referred to as the current, and similarly, the flow of charged particles in electricity is called the current. Finally, the river banks contain the flow of water and determine its direction just as a conductor determines the flow of electricity.

Generating and Transporting Electricity

Electricity is generated by mechanically passing coils of wire through a magnetic field. There are a variety of ways in which the mechanical generators can be driven. Some methods include water power, steam power, wind power, and solar power. Each method is evaluated based upon cost, amount of energy produced, pollution and environmental concerns, and the source of energy available.

Water Power

Water power is used by water that is flowing from a higher point to a lower point. This water flow is used to turn the generator. The action of using water power to generate electricity is called hydroelectric generation. One requirement for using water power to generate electricity is a water source. This may be a river or large stream that has been dammed up. Water power is not a good method to generate electricity in desert areas.

Steam Power

The majority of electricity is generated by steam power. With steam power, water is heated to very high temperatures and creates steam, which turns the wheels in the generator. These steam-powered generators are also called thermal-powered generators. Heat to produce the steam is a requirement for steam-powered generators. This heat is created in a variety of ways.

Fossil fuels, such as coal, oil, and natural gas, can be burned to create heat. One concern with using fossil fuels is that they are an exhaustible resource. When these fuels are used up, they are gone forever. Mining fossil fuels sometimes destroys the land, and burning fossil fuels can add to pollution in the environment if not handled properly.

Nuclear fission can also be used to create steam power. Nuclear fission involves splitting atoms in half like a chef would split a piece of fruit. Atoms are very small and cannot be seen by the naked eye. This process creates a great deal of energy and must be controlled in a specific container called a nuclear reactor. This method creates vast amounts of heat that can be used to produce the steam power necessary to generate electricity. Nuclear energy is an efficient and affordable source that generates almost one-fifth of the electricity used in the United States. Nuclear energy is also considered to be an exhaustible energy source. However, it does not require mining and burning, which is harmful to the environment. Precautions must be taken when using nuclear power and disposing waste products. Splitting atoms can create radioactive waste, which becomes an environmental concern and a health concern.

Another method of creating steam power to generate electricity is called geothermal power. There are several normal breaks in the earth's surface that were created by forces from within the earth. Underneath the breaks are heated rocks. When water is poured over the heated rocks, steam rises up to the surface and can be used to generate electricity. This is an environmentally safe, efficient, and inexhaustible energy resource. However, this method is limited to areas of the country where natural faults, or breaks, in the earth occur.

Steam power can also be created through the burning of solid waste, which is an inexhaustible resource. As with fossil fuels, solid human wastes can be burned to heat water and create steam. With this method, not only is energy being created, human waste materials are being disposed of in a relatively safe and efficient manner.

Wind Power

A third resource for generating electricity is wind power. With this method, air currents turn blades that generate electricity. This source of power is limited in the amount of power that it can generate. It also relies heavily upon consistent currents of air.

Solar Power

Another source for generating electricity is solar power. With solar power, solar cells convert sunlight directly into electricity. This does not require the use of a generator. However, solar power requires vast amounts of sunlight to generate this type of power. Areas where collecting direct sunlight is difficult would be a challenge for solar power.

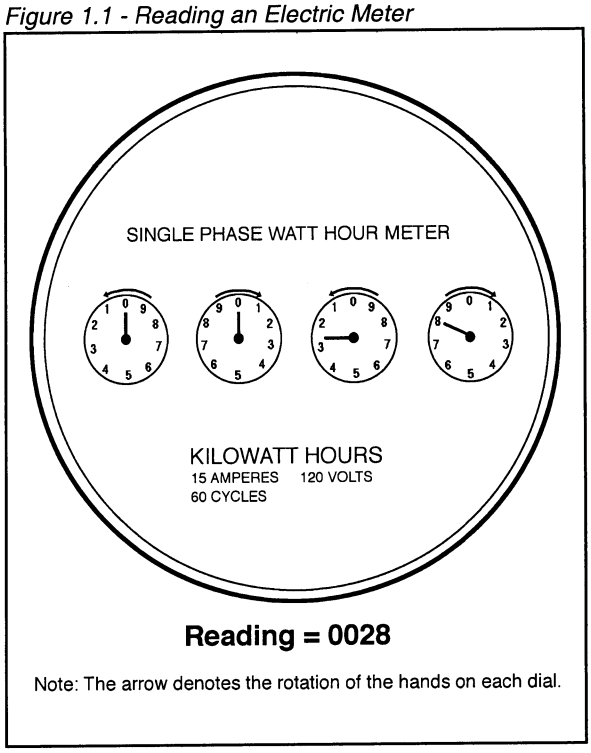
Electricity is transported from the plant where it is generated through a series of power lines to the local electric company. It then moves through an additional series of aboveground or underground power lines to the customer. The types of lines used to move electricity from the power plant to the local electric company are called transmission lines. Transmission lines carry high voltages of electricity. The types of lines used to move electricity from the local electric companies to the home and farm are called distribution lines. Distribution lines can be either overhead or underground.

Measuring Electricity

Once electricity moves from the local plant to the farm or home, it is ready to be used by the customer. Electrical use is measured in units of watt-hours called kilowatt-hours. Each month, electric companies read meters attached to homes and buildings or consult computer readings to determine how much electricity has been used (see Figure 1.1).

The measurement of electricity is similar to measuring the flow of water, as discussed previously. Water flowing through a hose puts out a certain amount of pressure. Voltage is the measure of electrical "pressure" in a circuit. If a person measures the gallons of water flowing through a hose per minute, the quantity, or output, of the flow would be measured. Similarly, amperage is the measure of electrical "flow." Electrical use is computed by multiplying the pressure times the flow (i.e., volts times amps), which yields watts. Electrical use is measured in kilowatts (i.e., 1,000 watts). Kilowatt-hours are the amount of kilowatts of electricity used over time. One kilowatt-hour represents the use of 1,000 watts of electricity over a 1-hour time period.

Figure 1.1 - Reading an Electric Meter



Reading = 0028

Note: The arrow denotes the rotation of the hands on each dial.

Electric companies charge customers for their usage by the kilowatt-hour. It is important for users to be aware of practices to conserve energy, which could decrease their electrical usage and save them money in the long run.

Fuses and Circuit Breakers

When electricity is transported to individual homes through distribution lines, the electrical power (i.e., voltage) has been reduced so it can be used safely in the home. However, electrical equipment must be installed to protect circuits from being overloaded from surges in electricity. Circuits are the paths of electrical flow within homes and

buildings. Fuses and circuit breakers are two methods of current protection.

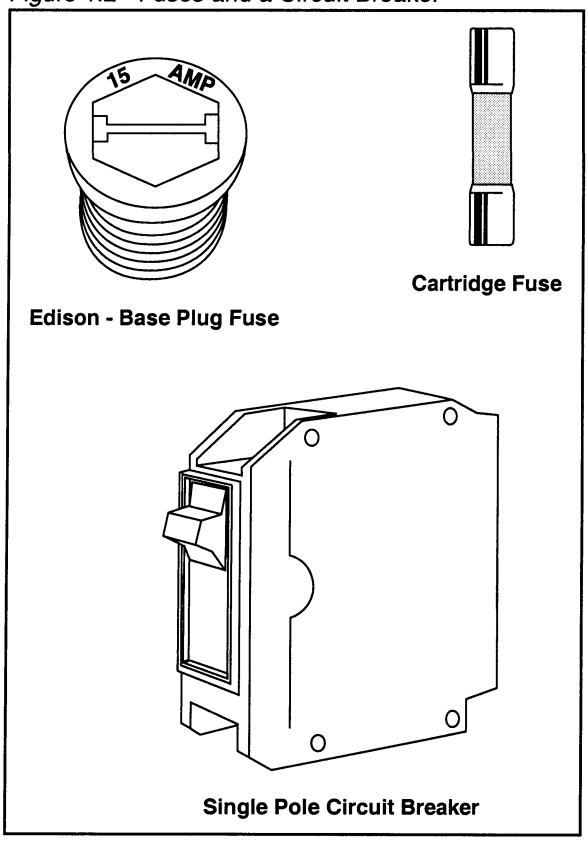
A fuse is a short piece of metal that will melt at a predetermined number of amps. Thus, if the amount of electricity flowing through a fused circuit is too high, the fuse will melt and stop the flow of electricity. Fuses can either be cartridge types, which are bullet-shaped objects designed to fit within brackets in the electrical panel, or they can be plugs that screw into or out of the electrical panel. Fuses are disposable devices that are removed and replaced when blown.

Circuits that are not properly fused may become overloaded and cause a fire from the overheated wire and/or burning insulation. Overloading occurs when too much electricity flows through the circuit. If there is an overload or electrical short problem in a circuit, the fuse will blow. This stops the flow of current to that specific area before it overheats the system. A new fuse must be installed before service can be restored to the circuit. Without safety devices to disrupt the flow of current, the continued flow of electricity could heat up the wire to the point of causing a fire. Oversized fuses should never be used to replace a blown fuse. To do so would override the safety factors provided by a fuse of the proper size. A blown fuse should always be replaced with a new one of the same size. Replacing fuses with ones of larger amperage would allow too much electricity to flow, causing the wires to melt and possibly create a fire.

A circuit breaker works in a similar fashion to a fuse. If the circuit overloads, the circuit breaker will trip. This means that the switch on the circuit breaker will trip to the "off" position. This stops the flow of current into the circuit. Repairing the circuit requires the circuit breaker to be reset by switching the toggle to the "on" position. If the circuit breaker continues to trip, it is a sign that there is an electrical problem in the line. Thus, before resetting the circuit, the home or business owner should determine the cause of the problem in the circuit and have the circuit repaired by a trained professional.

The difference between a fuse and a circuit breaker is that the circuit breaker must only be reset, whereas a fuse must be replaced each time it is blown. Occasionally a circuit breaker may wear out and have to be replaced with one of the same size.

Figure 1.2 - Fuses and a Circuit Breaker



Hot, Neutral, and Ground Wires

Electricity travels from its source to your electrical tools and appliances through a series of wires. The first type of electrical wire is the hot wire. Hot wires are the positive wires that conduct the electrical power to the appliance or tool. They are usually coated with red or black plastic. The next type of wire found in an electrical system is the neutral wire. Neutral wires help to complete the electrical circuit by carrying the electrical current from the appliance or tool back to its source. Neutral wires are usually coated with gray or white plastic. The final type of wire is the ground wire. Ground wires, usually coated in green plastic, serve as a connection from the electrical appliance or tool to the earth. If electricity travels outside its normal path, ground wires help to provide an alternate path for this electricity back to its source.

Types of Lightbulbs

There are several types of lightbulbs used in the home and around the farm. There are a variety of choices regarding types of indoor and outdoor

lighting. It is important to keep energy efficiency and safety in mind when choosing the right bulb for a particular job.

Incandescent lightbulbs are the most common type of lighting. Incandescent lighting works by electric current traveling through the filament in the bulb. The current heats up a filament wire inside the bulb and produces light. The light produced is a softer light used indoors.

Fluorescent lightbulbs are coated on the inside with a material that glows when the gases trapped inside the tube are charged with an electric current. Fluorescent lighting is efficient, inexpensive, and produces little heat. Used indoors and in greenhouses, they can produce large amounts of light for plants to grow without putting out heat that may damage the plants.

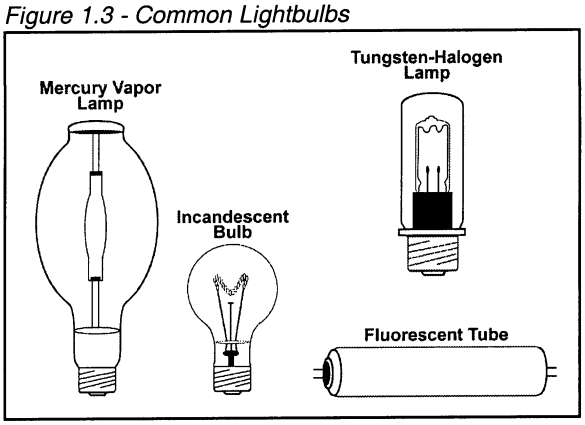
Halogen lighting involves heating halogen gases. These gases glow when charged with an electric current. Halogen lights produce large amounts of light; however, they tend to become very hot and must be monitored carefully for fires. Halogen lamps are recommended for outdoor use due to the immense output of heat that may cause fire hazards inside a building.

Mercury vapor lights have a two-lightbulb configuration. The inner bulb is made of quartz and is called the arc tube. This tube contains sodium with a mixture of argon and neon gas. The light produced is greenish-blue. These lamps last for a long period of time; however, they may take several minutes to heat up and reach full brightness. Mercury vapor lamps are used primarily outdoors to light the outside of homes and other buildings.

Metal halide lights contain compounds of metal and halogen with a basic two-bulb design. They produce a more naturally colored light. They have a long life and a high output of light, making them excellent sources for outdoor lighting. Metal halide lights would be poor indoor lights but are commonly used in shops. They put out a high quantity of light with a harsh glow that would be too bright and unpleasant to the eye indoors.

Sodium lights are composed of an arc tube made of aluminum oxide containing a solid mixture of sodium and mercury. These lamps produce an orange-white light and have a long life and very high light output. They are also an excellent source for outdoor lighting. As with metal halide lights, sodium lights would be too bright for indoor use.

Figure 1.3 - Common Lightbulbs



Hazards Associated with the Use of Electricity

There are two primary hazards associated with electricity. These are the dangers of electric shock and fire. Following safety precautions is important when working with electricity. The following are important electrical safety tips:

- Stay clear of electric power equipment. This means do not tamper with, touch, or climb on utility poles, transmission towers, electrical meters, etc.
- Never touch any outdoor wires.
- Do not fly kites or other toys near electrical transmission wires.
- Be alert for damaged electrical cords or plugs.
- Keep electrical appliances away from water and never work with electricity near wet or damp areas.
- Stay away from metal fences that are electrified.
- When a fuse blows or a breaker trips, always locate the source of the problem before replacing fuses. Then once determined, replace fuses with new ones of the exact amperage. Higher amp fuses in a circuit will cause overheating and fire.
- Determine the exact wattage of lightbulbs that lamps and lighting sources require. Higher wattage bulbs may cause overheating and fire.
- Be sure to follow all installation instructions and electrical codes when installing electricity or electrical equipment. The main power source should be turned off.

- Do not use extension cords as permanent fixtures in a poorly wired room. Overused cords can become worn or overloaded, causing shock or fire.

Summary

Electricity, or the flow of charged particles, can be generated, controlled, and channeled to serve the needs of people. Many different sources from water to nuclear to solar are utilized to generate electricity. Three different types of wires, hot, neutral and ground wires, can be found in electrical circuits. Guards referred to as fuses and circuit breakers monitor electricity channeled in the form of circuits. Lightbulbs convert electricity into light. Electricity should always be taken seriously for its awesome power and positive impact on human lives. However, safety is of number one importance to ensure that this great power source does not damage property or human lives by fire or electrical shock.

Lesson 2: Common Measurements and Their Uses

One important skill in the study of agricultural mechanics is the ability to take correct measurements and to convert one unit of measurement to another.

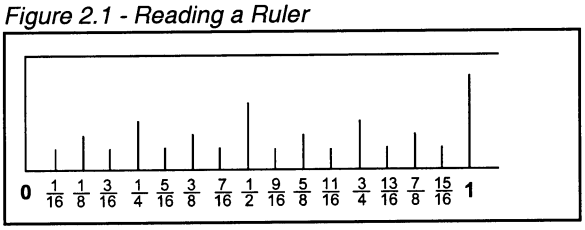
There are two common systems of measurement. The English system of measurement is the most commonly used in the United States. This system includes units such as inches, feet, and miles. The agricultural mechanics student will use this system the most often in course work. The metric system is used widely around the world and its practices are becoming more prevalent in the United States, namely in the automotive industry. This system includes measurements such as centimeters, meters, and kilometers. Objects can be measured in a number of ways including linear, area, volume, and weight.

Linear Measurements

Linear measurement involves measuring distances in straight lines. Common English linear measurements include inches, feet, yards, rods, miles, and knots. A standard ruler is 12 inches (1 foot) long. An inch is typically divided into sections for more accurate measurements: half, quarters, eighths, and sixteenths. Refer to Figure 2.1.

When reading a ruler or tape to accurately measure inches, remember to always read from left to right. The fractions of an inch should always be converted to simplest form. For example, 8/16 of an inch is read as 1/2 of an inch.

Figure 2.1 - Reading a Ruler



Additional linear measurements are feet, yards, rods, miles, and knots. There are 3 feet in 1 yard; 16.5 feet in a rod; 5,280 feet in a mile; and 6,080 feet in a knot.

Inches and feet can be used to measure distances such as the length of a piece of paneling or the length of a flower bed. Yards and rods measure longer distances such as lengths of rows in a field. Miles typically cover road distances, and knots are distances measured by ships in the oceans.

Common metric linear measurements include millimeters, centimeters, meters, and kilometers. One advantage to using metric measurements is that they are easy to convert and calculate. For instance, there are 1,000 millimeters in a meter, 100 centimeters in a meter, and 1,000 meters in a kilometer. Metric measurements are used to measure distances similar to those in the English system. However, the metric system is not commonly used in the United States; it is prevalent in European countries.

Area Measurements

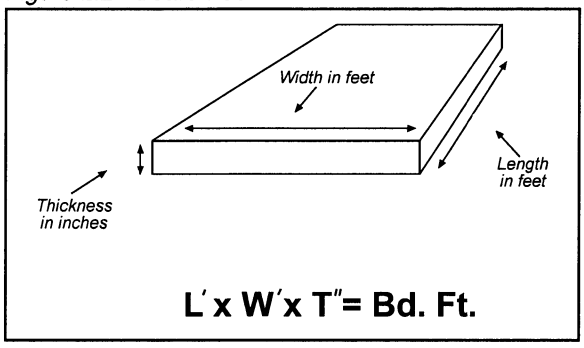
In many instances, objects cannot be measured simply by a straight-line method. The length and width of an object must be calculated to measure the surface area of an object. Measuring area involves multiplying the length by the width of an object. This can also be written as A=LxW. Common area measurements include square feet and square yards. A square foot is calculated by multiplying the length of an object in feet by the width of the object in feet. A square yard is calculated by multiplying the length of an object in yards by the width of an object in yards. There are 9 square feet in 1 square yard.

Volume Calculation

Another method of measuring objects involves calculating the volume. The volume of an object is the length of an object times its width times its thickness. This can also be written as LxWxT. Common volume measurements include cubic feet, cubic yards, and board feet. A cubic foot is calculated by multiplying the length of an object in feet by the width in feet by the thickness in feet. Similarly, a cubic yard is calculated by multiplying the length of an object in yards by the width in yards by the thickness in yards. There are 27 cubic feet in 1 cubic yard.

One common way of calculating the volume of wood used in a project involves calculating the board feet. This is similar to cubic feet; however, the thickness is normally calculated in inches. The way to measure the board feet in a piece of wood is to multiply the width in feet by the length in feet by the thickness in inches. Refer to Figure 2.2. It is important for the builder to use this measurement correctly so not to confuse it with cubic feet.

Figure 2.2 - Board Feet



Weight Measurements

Another way to measure an object is to calculate the object's weight. Weight is also described as the mass of an object. Common English units of weight include ounces, pounds, and tons. There are 16 ounces in 1 pound. Common metric units of weight include milligrams, grams, and kilograms. There are 1,000 grams in 1 kilogram.

Weight measurements are used for food products, such as sugar, flour, raw meat, and margarine. Weights are also used for shipping items through the postal service and express delivery systems.

Summary

Measurements are used daily in everyone's life. It is important to understand common linear measurements, area measurements, volume measurements, and weight measurements.

Lesson 3: Common Tools and Their Uses

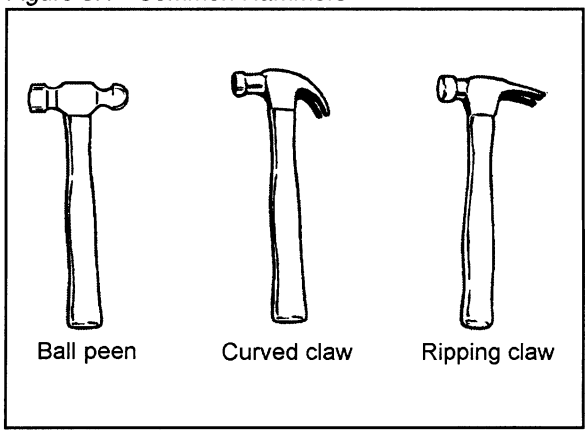
There are many types of tools. Each tool is designed for a specific job. Tools should be used only for their intended purposes. Using tools for other purposes than for what they were intended may cause personal injury or damage the tool.

Common Hand Tools and Their Uses

Identifying and correctly using hand tools are important in agricultural mechanics. A hand tool is any tool operated by the hand to do work. Hand tools can be used to perform small jobs around the home and farm where it is inappropriate to use large power tools. They can also be used to perform nearly any type of operation, only at a reduced power than power tools. There are a large number of hand tools used to serve a number of purposes.

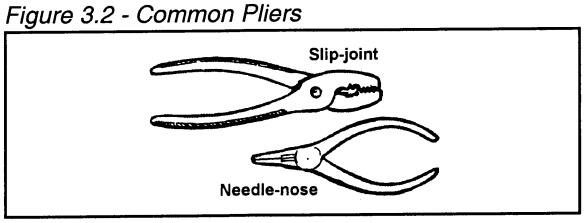
An important basic hand tool is the hammer. Hammers are considered driving tools because they are used to drive nails. They can also be used to drive other tools or objects. Various types of hammers include the ball peen hammer, which is ball-shaped on one end and flat on the other end. The curved claw hammer can be used to remove nails or to pry objects. The ripping claw hammer has a straighter claw end.

Figure 3.1 - Common Hammers



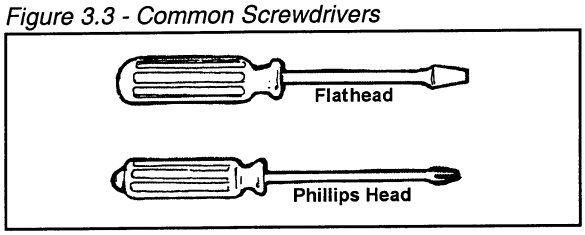
Pliers are used to grip and turn objects. Needle-nosed pliers have a long slender point that is ideal for gripping objects in narrow openings or for gripping wire and other small objects. Slip-joint pliers are used to grip or twist larger objects and have an adjustable bolt that opens up to grip larger objects.

Figure 3.2 - Common Pliers



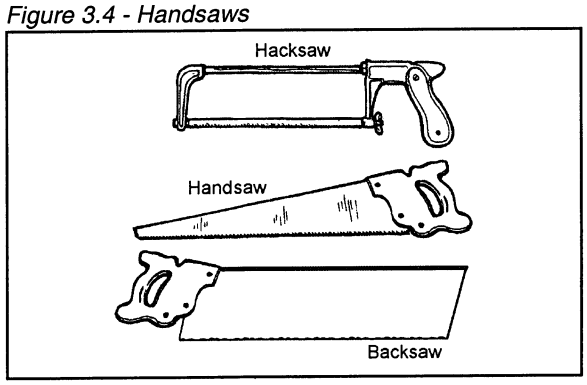
Screwdrivers are an important hand tool used to turn bolts or screws. Two common types of screwdrivers include the Phillips head screwdriver and the flat-head screwdriver. These screwdrivers differ in the shape of their turning ends. The Phillips has a round and slotted tip. The flat-head has a tapered, flat, and straight tip.

Figure 3.3 - Common Screwdrivers



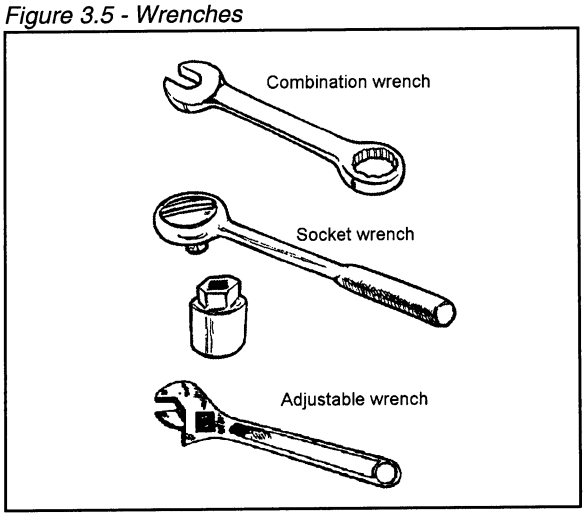
Handsaws are used to cut wood, metal, or plastic materials. They are classified by the cut made or the type of material to be cut. A hacksaw is used mainly to cut metal. The common handsaw is used mostly for common cuts in wood materials. The backsaw is used to make very precise cuts. It has very fine teeth and a straight metal back. It is used often in combination with a special device called a miter box, which correctly measures the angle of the cut.

Figure 3.4 - Handsaws



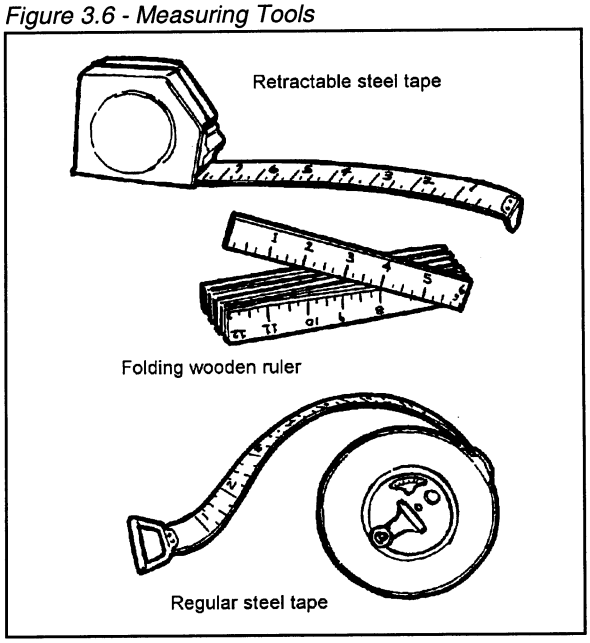
Wrenches are used to tighten and loosen bolts and nuts. Combination wrenches are normally open at one end and circular at the other end. Socket wrenches are used in combination with sockets of various sizes to fit directly over the nut to be adjusted. Adjustable wrenches are equipped with a screw that will adjust the wrench to various sizes depending upon the object.

Figure 3.5 - Wrenches



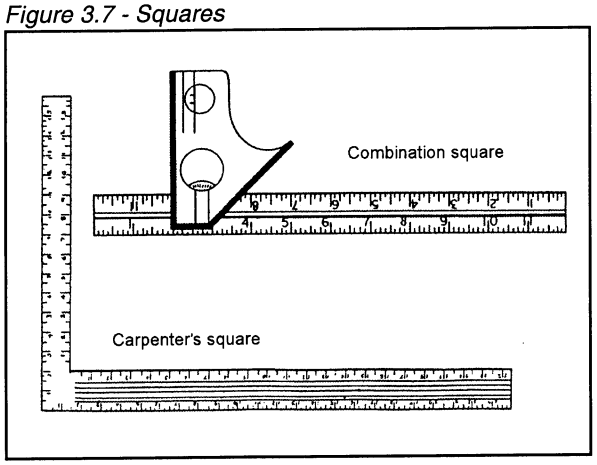
Measuring tools are used to determine the dimensions of specific areas. The retractable steel tape will wind itself up after being used. Regular steel tape must be manually wrapped after usage. The folding wooden rule is a long wooden ruler that folds into a form that is much easier to store.

Figure 3.6 - Measuring Tools



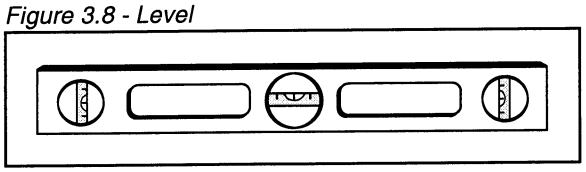
Squares are used as layout tools. They form 90° square corners on objects. A combination square includes a sliding ruler and an angle device that assist the user in measuring and cutting angles. A carpenter's square is normally utilized to make square corners only.

Figure 3.7 - Squares



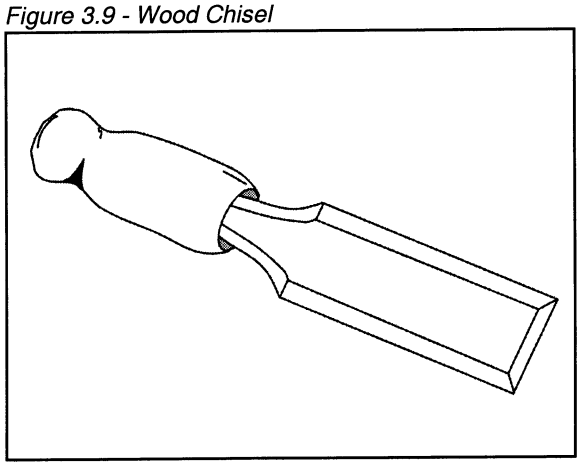
An additional type of layout tool is the level. Common levels use a system of air bubbles to determine the straightness, or level, of an object or line. An air bubble is positioned in the middle section to indicate that a point is level.

Figure 3.8 - Level



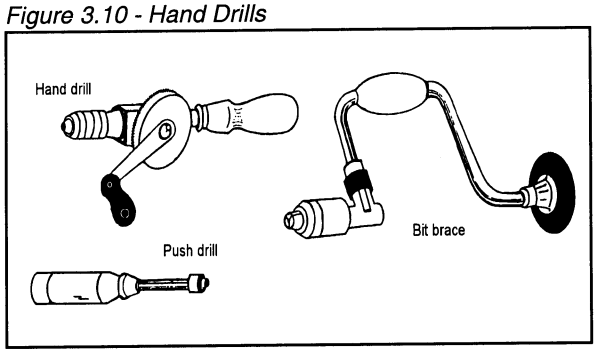
Wood chisels are cutting tools with a sharpened blade used to cut, shave, or carve wood. They are used where shaving or chipping processes are necessary that might not work well with larger power tools.

Figure 3.9 - Wood Chisel



Hand drills are tools used to drill holes in surfaces where it may not be possible or appropriate to use a power drill. The push drill is a smaller type of hand drill that is operated by a pushing motion. The bit brace is used where more force is necessary. The operator must physically hold and turn the bit brace.

Figure 3.10 - Hand Drills

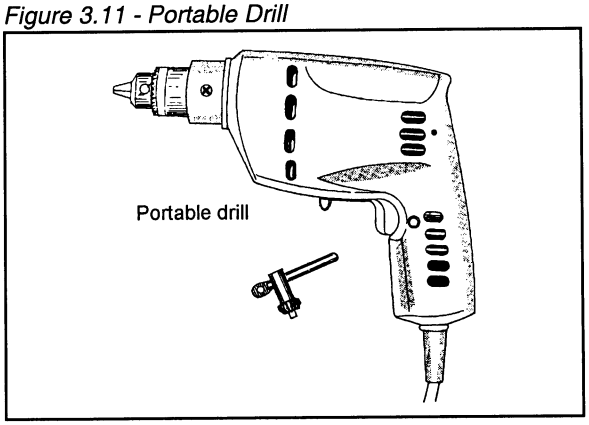


Common Power Tools and Their Uses

Power tools are operated by some source of power other than human power such as batteries, electric, or hydraulic power. They are faster, more efficient, and much more powerful than hand tools of the same nature. Power tools can either be portable or stationary, which means they are either easily transported from job to job or must remain in one place.

Portable drills are a lightweight type of drill that can be taken nearly anywhere. They are typically powered by electricity or batteries. As with a hand drill, a portable drill is used to drive screws or to drill holes in objects.

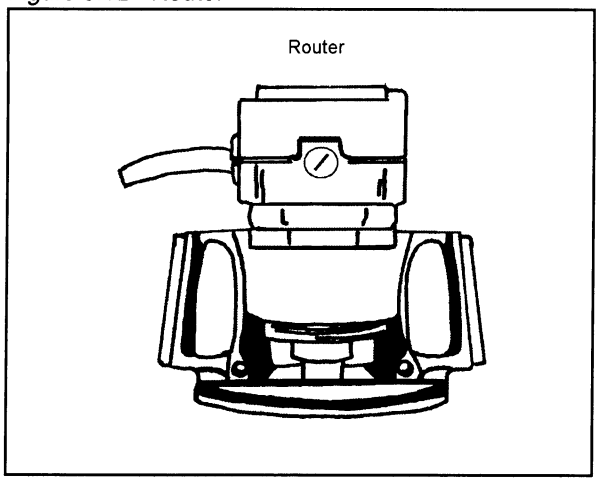
Figure 3.11 - Portable Drill



The router can either be a stationary or a portable power tool. It is used to create a groove or a cut in wood. Routers can be used for creating special

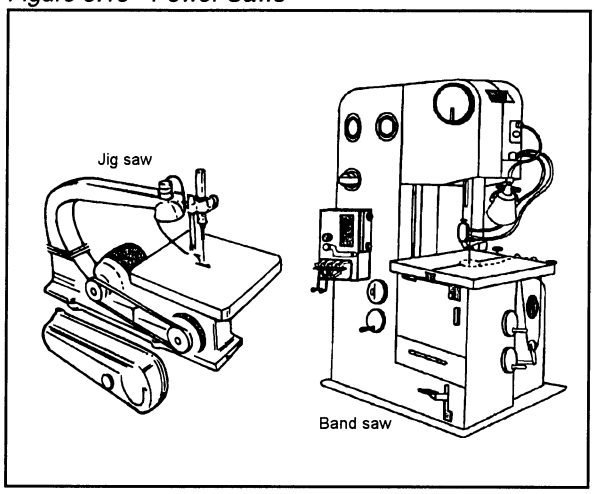
joints (to join pieces of wood together) or to create decorative grooves in wood.

Figure 3.12 - Router



The jig saw (or scroll saw) is a small stationary or portable power tool used primarily to cut curved lines in wood. It is not recommended for straight cuts. The band saw, however, is a large stationary power tool. It can be used to cut a variety of materials including wood and metal. The band saw can cut straight or curved lines.

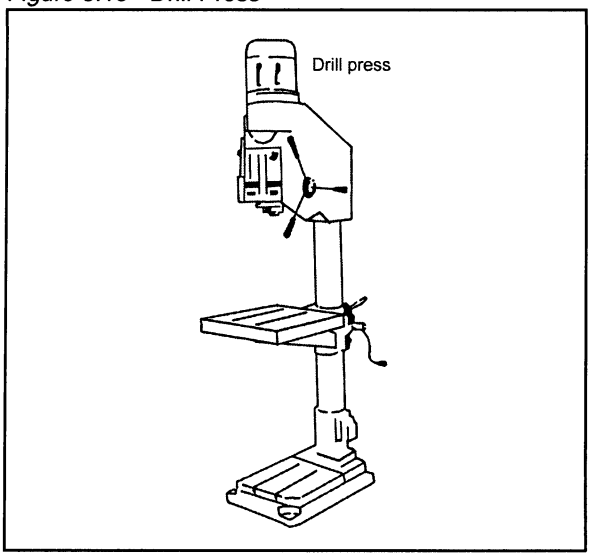
Figure 3.13 - Power Saws



A drill press is a larger stationary power tool. It is used to cut or drill holes in metal, wood, and other materials. It is preferred over the portable drill when many precision cuts are necessary or when cutting larger holes.

Power tools can make jobs faster and more efficient. Often they are necessary for jobs requiring more power than the human hand can provide. It is essential for the safety of the operator and for the long life of the tool that proper instruction is provided before operating any power tool.

Figure 3.13 - Drill Press



Summary

Hand and power tools were developed to make the performance of tasks faster, easier, and more efficient. A good working knowledge of hand and power tools and their proper uses will assist in completing tasks at a faster rate.

Lesson 4: Personal Safety Practices

Safety when working with tools is critical. This lesson addresses various practices that will help ensure personal well-being of those working with tools in a variety of settings.

Eye Protection

When working in an agricultural mechanics shop, in the home, or on the farm, one of the most important safety tasks is to properly protect the eyes. Proper eye protection includes safety glasses or safety goggles. Safety glasses and goggles protect the eyes from debris from the front. They should have side shields to protect the eyes from debris that could enter from the side. Safety glasses are a requirement when working with hand tools, power tools, or when standing near others who are using tools.

Proper Clothing

Proper clothing is another safety item necessary when working around the farm, home, or shop area. Clothing must fit well and be free from tears. Loose, baggy, or frayed clothing is a safety hazard because it can become entangled in the moving parts of a machine or easily catch fire. Protective clothing such as coveralls, shop aprons, or shop coats are highly recommended to protect clothing from damage such as staining or tearing. Protective clothing should be fire resistant.

If hair is long, hair restraints must be worn to keep hair out of the way of machines that have moving parts. Long hair can easily become entangled in a machine or catch fire. Protective head covering is recommended to protect the head from fire or injury when tearing out walls or performing any demolition work.

Leather shoes with steel toes and high tops are recommended to protect feet from injury that can occur from falling or dropped objects. Leather shoes are more resistant to fire. Face masks should be worn when working around fumes or dust, such as when spraying chemicals, painting, or sanding.

Cleanliness

A messy shop is a hazard in the home or on the farm for a number of reasons. Tools strewn about on the floor and work benches are obstacles. Persons working in the home or farm shop could stumble and fall over tools that have been left on the floor. Tools need to be returned to their proper areas to avoid the risk of becoming damaged and creating a safety hazard for the next operator.

Debris strewn about the shop is also a fire hazard. Waste materials must be cleaned and disposed of in a proper manner to avoid fires. A home or shop fire can be especially devastating due to the risk of burning the shop as well as the entire house. A clean shop is an efficient and safe area in which to work.

Hand Tool Safety

There are many factors to consider when maintaining safe operation of hand tools. The first is to be sure that the eyes and clothing are properly protected before entering the shop area. Next, the operator must be certain of using the correct tool for the job. Each tool has its own specific purpose, and using a hand tool for the wrong purpose makes it an unsafe tool.

Next, the operator should inspect the hand tool to be certain that the tool is not damaged in any way. Dull or damaged tools are also a safety hazard. The operator should then be careful to operate the tool carefully and in the proper manner for its intended use. It is important for a person to obtain instruction in the safe and proper use of each tool.

When finished using a hand tool, it should be inspected to ensure that it is clean and undamaged. The tool should then be returned to its proper storage area to keep the shop clean and free from debris and safety hazards. Although hand tools may seem simpler and much safer than power tools, they can still cause injury to persons working in the shop if not used safely and correctly.

Power Tool Safety

Power tools are fast-moving, powerful machines most often operated by an electrical power source. This makes them extremely dangerous if used improperly. It is extremely important for the operator of a power tool to master the safety rules associated with the power tool.

Before using any power tool, obtain permission to use it. At school, obtain permission from the instructor if the tool is to be used in a school laboratory. If the tool is to be used at home or on the farm, obtain permission from an adult in charge of the tool. Be sure that eyes and clothing are properly protected before entering the home, farm, or school shop.

Next, the operator must inspect the tool to be sure that the blade or cutter is clean and sharp, the power cord and switch are in good condition, and all guards are in place. Dull tools damage the tool or may cause injury to the operator. Frayed cords can cause electric shock, and faulty guards fail to protect the operator from turning blades and other moving parts. Each power tool has its own unique set of operating and safety instructions. The operator should use a power tool only after reading the safety manual and mastering the safety rules for the particular tool.

Before turning a tool to the "on" position, inform others in the shop that the power tool will be turned on. This will give them time to clear

themselves from the safety zone around the tool. Before making any adjustments to the tool, the operator should make sure the switch is off and the tool is unplugged. After using a power tool, it should be properly cleaned and stored in the appropriate location.

Summary

Safety in the shop, home, or on the farm is not a matter to be taken lightly. Mastering safety procedures helps tool and machine operators ensure their own safety as well as the safety of others in the area. Some important general safety procedures involve wearing safety glasses or safety goggles at all times when operating any type of tool or equipment; wearing proper clothing for the home shop, farm shop, or classroom laboratory; and keeping work areas clean and clear of tools and debris. Hand tools should always be inspected before use and stored in the proper area after use. Power tools should always be operated according to proper safety instructions for the particular machine, with careful attention to safety guards, and should never be operated without permission from an instructor, a parent, or the owner of the tool. Safe and proper operating procedures help to maintain the condition of the tools and shop equipment.

Lesson 5: Safety and Maintenance Procedures for Lawn and Garden Equipment

Lawn and garden tools, whether operated manually or electrically, must be handled safely and used appropriately. In this lesson, the features of hand lawn and garden tools and of power lawn equipment are described.

Common Lawn and Garden Hand Tools

Hand lawn and garden tools are tools that are held in the hand and operated by manual labor. Common hand tools used to work on lawns or in the garden are pictured in Figure 5.1.

It is important to remember that each tool has a specific use and should not be used for any other purpose. Tools should be cleaned, inspected for damage, and placed in the proper storage area after each use.

Common Power Lawn Equipment

Power lawn equipment is operated either by a two- or four-stroke gas engine or an electrical source. Power equipment makes the operator's job faster and more efficient. Types of power equipment used in lawn work are illustrated in Figure 5.2.

The operator should read all instruction and safety manuals before attempting to use any power lawn equipment and follow proper maintenance procedures.

Differences Between Two- and Four-Stroke Engines

There are several differences between two- and four-stroke engines in power lawn equipment. Large riding mowers contain a four-stroke engine, whereas most small trimmers and blowers have two-stroke engines. Each engine has advantages and disadvantages that make it the suitable choice for the intended job.

The major difference between two- and four-stroke engines is the type of fuel used in each. The two-stroke engine requires an oil-fuel mixture directly in the fuel chamber. The four-stroke engine strictly requires fuel in the fuel tank and oil in the oil reservoir. Never place the wrong type of fuel in a particular engine; severe damage can result to the engine. See Table 5.1 for a comparison between two- and four-stroke engines.

Safety Guidelines for Using Hand Lawn Equipment

Safety is extremely important when working with any type of lawn tool. It is important to know the tools well and use only the appropriate tool for the job. Misuse of tools can cause injury and damage to the tool.

The operator should be careful to avoid baggy, loose-fitting clothing. Loose clothing can become caught in tools and cause injury. To avoid damage to the eyes, always wear safety glasses when using any tool and particularly when sharpening tools. Wear gloves to protect the hands from cuts and blisters.

Inspect the tool to ensure that it is sharp and in good working condition before use. Clean the tools and replace them in the proper area after using each tool. To avoid injuring anyone, be

Figure 5.1 - Common Lawn and Garden Hand Tools

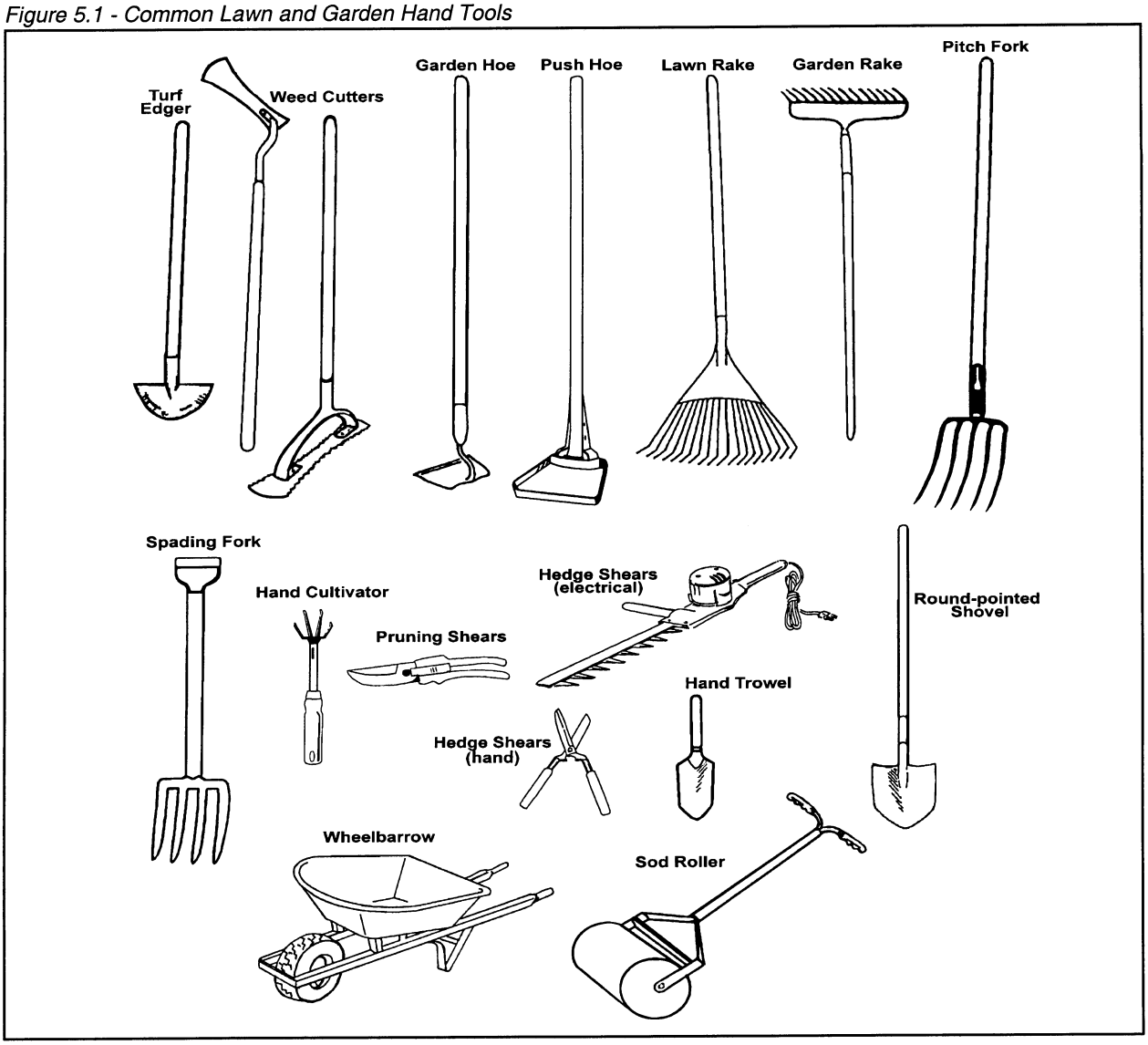


Figure 5.2 - Common Power Lawn Equipment

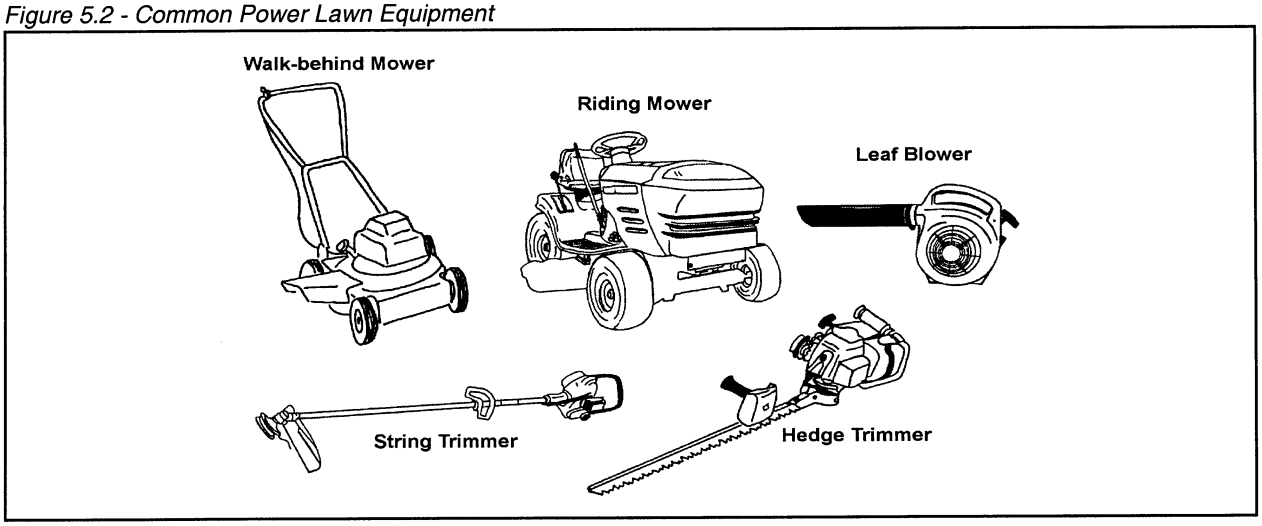


Table 5.1 - Two-Stroke vs. Four-Stroke Engines

	Four-Cycle Engine (equal hp) One Cylinder	**Two-Cycle Engine (equal hp) One Cylinder**
Number of moving parts	Nine	Three
Running	Cooler running	Hotter running
Overall	Larger	Smaller
Engine	Heavier construction	Lighter in weight
Fuel and Oil	No mixture required	Must be premixed
Fuel Consumption	Fewer gallons per hour	More gallons per hour
Oil consumption	Oil recirculates and stays in engine	Oil is burned with fuel
Sound	Generally quiet	Louder in operation
Operation	Smoother	More erratic
Acceleration	Slower	Very quick
General Maintenance	Greater	Less
Initial Cost	Greater	Less
Versatility of Operation	Limited slope operation (receives less lubrication when tilted)	Lubrication not affected at any angle of operation

conscious of others' locations before swinging sharp tools.

Safety Guidelines for Power Lawn Equipment

Power lawn equipment can be a dangerous tool to the operator as well as others nearby if used in an unsafe manner. The operator should master safety guidelines for each tool to ensure the safety of all involved. Carefully read the instructions and operating procedures in the owner's manual before attempting to operate any power lawn tool. Each tool has its own unique safety feature that should be mastered by the operator.

As with the use of other tools, the operator should avoid wearing loose or baggy clothing, because it can become entangled in moving parts of the equipment. Safety goggles should also be worn to protect the eyes. The equipment should be inspected before use to be sure blades are sharp and in good working condition. Dull or damaged tools are dangerous to the operator, do a poor job of cutting, and can cause damage to the equipment itself.

Before turning on a power tool, alert others so that they are aware that a power tool is in use. When mowing or cutting, keep hands and feet away from all moving parts. Remove debris and large movable objects from areas where mowers and trimmers will be operated to ensure that the operator or others around will not be hit by flying objects.

Never smoke or attempt to refill the fuel tank while the equipment is running. Fuel can easily ignite and burn the operator. Keep all safety shields in their proper places. Safety guards generally protect against blades or objects flying from the blades. Use caution when mowing on slopes to avoid falling or overturning equipment.

Only mow grass when it is dry. Cut grass to a height of 1 1/2 to 3 inches depending upon time of year and type of grass.

Maintenance Procedures for Hand Lawn Equipment

Hand tools should be properly maintained to ensure the safety and long life of the tool. Hand tools should be cleaned and inspected for any damage after each use. First, inspect wooden handles to be certain they are in good condition. Restore rough, dry, and splintered wooden handles by first sanding them, rubbing them with

linseed oil, and then rubbing the handles again with a soft cloth.

Metal parts must be maintained against rust. Prevent rusting by keeping all metal surfaces dry. If a surface becomes rusty, first clean the area to remove all dirt and debris. Then wire brush metal surfaces to remove the accumulated rust. Finally, shine the area with a light oil to remove existing rust.

Blades on tools should be kept sharp at all times. A dull blade is dangerous and does a poor job. Blades can be sharpened with files, various types of stones, and grinders. Different blades require different angles of sharpening. Oversharpening reduces the life of the tool, and uneven sharpening throws off the balance of the tool.

Maintenance Procedures for Power Lawn Equipment

Air cleaners and filters should be kept clean to ensure the longevity of the tool. Check air cleaners and filters every 25 hours of operation or sooner when working in extremely dusty conditions. The oil should be checked in four-stroke engines before each use and changed every 25 hours of use.

It is important to understand that four-stroke engines have separate reservoirs for the fuel and the oil and that one should never be mixed within another. However, two-stroke engines require a fuel-oil mixture in the fuel chamber. Always use the correct fuel-oil mixture in a two-stroke engine. This is determined by reading the owner's manual of the tool.

Check spark plugs frequently and clean them by scraping off the dirt, soaking in a solvent, and drying them. Change the spark plugs after 100 hours of use.

It is important to follow proper procedures when storing power tools for long periods of time to ensure that they run well when they are needed. The fuel tank should be drained, the oil and filters should be changed, the exterior and the chains should be cleaned and lubricated, and the belts should be loosened.

Summary

As a homeowner, it is very important to identify and know the proper use, maintenance, and safety procedures for lawn and garden equipment. Appropriate practices will help ensure the safety of the operator, the ease of operation, and the longevity of the tool.

Credits

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