

Introduction to Agriscience

Student Edition

Developed by the
Curriculum and Instructional Materials Center
for the Division of Agricultural Education
Oklahoma Department of Career and Technology Education

AG3001

Introduction to Agriscience

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Oklahoma Department of Career and Technology Education
Curriculum and Instructional Materials Center

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Printed in the United States of America by the Oklahoma Department of Career
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Unit 1

Agriscience Opportunities

OBJECTIVES

- Explain how agriculture is a science.
- Discuss how agriculture affects our daily lives.
- Discuss career opportunities in agriculture.
- Outline the steps to setting career goals.
- Explore your interests and skills as they relate to careers.

KEY WORDS

agriculture
agriscience
biofuels
biotechnology
career clusters
career pathways
requirements

What do you think of when someone says “agriculture”? Many people envision farms with cattle or crops, not a laboratory with research projects. Agriculture is both—agriculture is a science that involves many different areas. The farmer that grows corn and the scientist that researches new technology for insect resistant crops are both involved in agriculture. Agriculture encompasses a broad range of careers such as marketing and education, crop production, and scientific research. Agriculture has a significant effect on our daily lives—even those who are not employed in agricultural industries are affected by agriculture. Agriculture provides products for consumer goods from food and clothing to building materials. Agriculture is a diversified field and individuals with varying interests and skills can often find a career in agriculture they enjoy.

Is Agriculture a Science?

Science and technology are fascinating areas that continue to grow through research efforts. New methods and products are continually developed to make our lives easier and safer. Many of the jobs involved in science and technology are part of agriculture. Science is a term that comes from the Latin term *scientia*, which means knowledge. Science encompasses a system that uses observation and experimentation to describe and explain the physical world. Some of the fields of study within science include biology, physics, chemistry and earth science.

What exactly is agriculture and how does it relate to science? **Agriculture** is the production of plants and animals, and related supplies, services, mechanics, products, processing and marketing. Because agriculture continues to expand, the term **agriscience** is often used to describe the application of agricultural principles and new technologies. Many aspects of agriculture involve some type of science—botany, ecology, genetics, organic chemistry, environmental science, geography, hydrology, and meteorology to name a few!

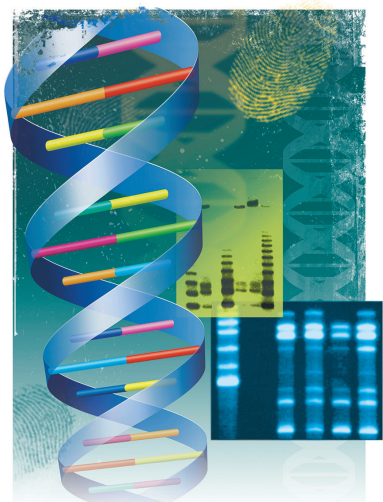


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Growing crops is related to botany, a part of the field of biology. *Botany* is the study of plants. The knowledge gained through botany enable today’s producers to grow crops that meet the needs of consumers. Throughout the history of agriculture, producers have selected and cultivated varieties of plants that are able to successfully grow in a region. The science of agriculture also involves *ecology*, the study of interactions of organisms and their environment. Ecology includes the study of environmental problems. Producers today understand the need to protect and care for the environment for agricultural production to remain sustainable.

Raising animals is related to zoology. *Zoology* is the study of animals, their behavior, and how they interact with the environment. Producers care about the health and welfare of their animals, and having an understanding of animal behavior is important. Producers today also care about how agriculture affects wildlife and take steps to help wildlife in their area, such as leaving areas near fence lines undisturbed.

From crops to cattle, agricultural producers take into account genetics. *Genetics* is the study of heredity—how characteristics are passed from one generation to another for all living organisms. Livestock breeders select animals to keep as breeding stock because of the characteristics they will pass to their offspring.



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What does organic chemistry have to do with agriculture? *Organic chemistry* is the study of compounds that are carbon-based. Knowledge of organic chemistry is needed to develop many of the fertilizers and pesticides used in agriculture.

Agriculture also encompasses environmental science. *Environmental science* is the science of the physical, chemical, and biological aspects of the environment and their effect on organisms. Environmental science also includes the effect that humans have on the environment. Environmental science and ecology are closely related; environmental sciences are viewed as a much broader science. How drought or an unusually wet period may affect various types of plants would be one question an environmental scientist might attempt to answer.

Geography is the science of the earth's surface and how human activity relates to the earth's surface. Agriculture has developed in various regions of the world in large part because of the geographical conditions that made growing possible. Agriculture today makes use of geographical technologies such as geographic information system (GIS), Global Positioning System (GPS), and remote sensing. GIS is a system that is designed to manage spatial and geographical data. GPS is a satellite-based navigation system providing location and time data. Remote sensing obtains information about an area from aircraft or satellites.



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Agriculture production is dependent upon water. Producers must use water wisely and also must have practices that help protect water quality. *Hydrology* is the study of water. Agriculture often uses irrigation systems to water crops. Understanding agriculture and the use of water sources is vital for the sustainability of crops in many regions.

Does weather affect agriculture? Weather has a significant impact of many types of agricultural operations. While the weather can't be changed, understanding the weather and how it may affect production is vital for successful agricultural operations. *Meteorology* is the science of the Earth's atmosphere and includes weather forecasting.

Agriculture is a science that overlaps and involves many branches of science. Areas of agriculture today are on the cutting edge of scientific development. Some of the current scientific developments in agriculture are related to biotechnology. **Biotechnology** is the manipulation or genetic engineering of living organisms or their components to create new products. A recent agricultural technology is Arctic apples®, non-browning genetically modified apples that were recently approved in the United States. Current research in agriculture that could someday have worldwide effects include engineering rice plants to carry out photosynthesis more efficiently, providing the opportunity to dramatically increase production.

Agriculture is much more than growing crops or raising livestock—those involved in agriculture today must have an understanding of the science that accompanies agriculture. Today's agriculture has changed tremendously because of science and will continue to change. Keeping up with those changes is important to be successful in agriculture. Understanding why agriculture is a science is important because all sciences rely on a method when attempting to understand issues.



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Just as in other areas of science, research in agriculture follows the *scientific method*. The scientific method uses logical steps and procedures to come to a conclusion.



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SCIENTIFIC METHOD

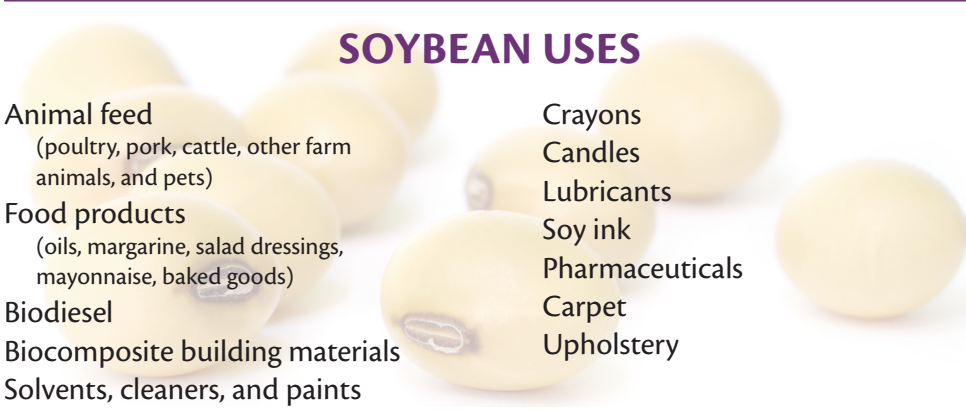
1. Ask a question or determine a purpose
2. Conduct background research and observation
3. Construct a hypothesis
4. Perform an experiment
5. Analyze data
6. Come to a conclusion

Agriculture, just as many other sciences, relies on math. The ability to understand and apply math is vital in agriculture and is used for tasks such as figuring fertilizer and pesticide application rates, calculating crop yields, and developing accurate business reports.

Is agriculture a science? Yes! Not only is agriculture a science, but it is a science that our lives depend on for the food that nourishes us.

Agriculture in Our Lives

How does agriculture affect you? Agriculture affects many areas of our lives—the food we eat, the clothes we wear, and many of the products we use are possible because of agriculture. While food products and cotton clothing are obvious, agricultural products are included in numerous consumer products, such as foods, cosmetics, soaps, cleaners, medicines, pharmaceuticals, leather goods, biofuels, construction and many others. **Biofuels** are fuels, such as ethanol and biodiesel, made from living things.



SOYBEAN USES

Animal feed (poultry, pork, cattle, other farm animals, and pets)	Crayons
Food products (oils, margarine, salad dressings, mayonnaise, baked goods)	Candles
Biodiesel	Lubricants
Biocomposite building materials	Soy ink
Solvents, cleaners, and paints	Pharmaceuticals
	Carpet
	Upholstery

Who produces all of the agricultural products we use? Farmers today are responsible for providing agricultural products to a growing population. While farmers represent less than 2% of the U.S. population today, they are more productive than previous generations and produce more, using fewer resources. Today's average farmer produces enough to feed 155 people each year; compared to just 26 people in 1960. Today's agriculture provides 24 million jobs in industries related to agriculture. Farms today vary greatly in size, from small retirement farms to very large family-owned farms and corporate farms. The average farm size is a little over 400 acres. Large farms are those consisting of those over 2,000 acres. One of the largest ranches in the world is the King Ranch in south Texas, with over 825,000 acres!

The United States population is expected to continue to grow—increasing from approximately 320 million today to 438 million in 2050. The world population is expected to continue to increase from 7.3 billion today to 9.7 billion in 2050. Farmers in the United States, and around the world, will have to continue to improve efficiency and produce more food to meet the increasing demands. Research in agriculture, such as improved photosynthesis in rice, along with increasing use of technology, may help farmers meet the increased demand.

As farmers strive to keep up with increasing demand, the predominance of information aimed at consumers continues to increase. Special interests and various organizations attempt to sway consumer opinion about agricultural issues. As consumers, it is important to have consumer awareness and to distinguish fact from fiction. Some of the biggest hot-button consumer issues in agriculture today include the use of genetically modified organisms (GMOs), hormone and antibiotic use, organic vs. non-organic products, and humane treatment of animals.

GMOs refer to organisms that have been modified by the transfer of genetic material that comes from another organism. Through genetic engineering, the DNA of an organism is changed. Organisms have always undergone modifications in nature; genetic engineering makes these modifications through scientific techniques so they occur faster. GMOs have been approved for use in many different agricultural applications and used in consumer foods since the mid-1990s. GMOs provide farmers with the potential to grow crops that use far less pesticides and provide enough food for an increasing population. Although there has been a recent push against GMOs, they are considered safe and effective. The U.S. agencies with the responsibility of overseeing and approving genetically modified crops include the Food and Drug Administration (FDA), the Department of Agriculture (USDA), and the Environmental Protection Agency (EPA).



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GMOs can help producers increase production of a crop, but they also have consumer benefits. For example, golden rice is genetically modified so that it contains beta-carotene, the source of Vitamin A. Vitamin A deficiency is a significant health concern in many areas of the world, and golden rice is one method of countering the health problems associated with Vitamin A deficiency.

Another issue that has garnered widespread consumer attention is the use of hormones and antibiotics in agricultural production. In the U.S., the use of added hormones is not permitted in poultry or swine. Cattle farmers may use small amounts of hormones to increase weight gain, but the concentrations have very strict tolerance levels that are set by the FDA. Antibiotics are used in agriculture to treat, prevent and control diseases, and are also used to promote growth. Antibiotic residues in meat and poultry products are generally very low, if even present.

Are “organic” foods better? The organic vs. non-organic debate is a current issue in agriculture. The USDA National Organic Program is responsible for national standards for organically-produced agricultural products. Products that have the USDA organic seal are certified and must meet consistent, uniform standards. Products that are certified by the USDA as organic cannot use synthetic fertilizers, sewage sludge, irradiation, or genetic engineering. Organic foods are produced using methods that differ from producers of non-organic foods. Foods that are organic are produced without most of the conventional pesticides and fertilizers. USDA does not address the nutritional value of organic foods. Both conventional and organically grown foods provide nutrients, and there have not been conclusive studies indicating organic foods are higher in nutrients. For many consumers, the issue of organic vs. non-organic is a personal preference.



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The humane treatment of farm animals is another issue that is often used to sway consumers. There are many different production methods for various animals—however, regardless of the method used producers must address the health and welfare of the animals. For example, pigs today may be raised in an indoor area, often referred to as “confinement.” Confinement allows producers to protect animals from the elements and more easily provide treatment and care. The poultry industry is also often criticized for its



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production methods; much of the criticism is unfounded. For example, broilers (young meat chickens) are generally raised in large, open structures not cages. The environment is controlled to provide a comfortable area. Every system has its advantages and disadvantages, but producers who do not adequately care for animals are much less likely to be successful. In addition, some major buyers, such as restaurant chains, have put into place policies regarding treatment of animals from suppliers.

Consumers must realize there are always two sides to any issue—just because someone states something does not mean it is factual. Consumers today must look at the facts, not opinion, and make purchasing decisions that are best suited for them.

Career Opportunities

Since agriculture is all around us, there are many jobs considered to be agriculture that you may not think of. For example, a golf course manager or graphic designer could be considered an agricultural job depending upon the type of work being performed. The opportunities in agriculture are limitless. The key is finding the career suited for you.

Around 1995, the U.S. Department of Education divided all jobs or careers into 16 divisions called **career clusters**. This was completed by looking at the skills and knowledge needed for each career and grouping careers with similar characteristics together. Funding for the program initially began with the U.S. Department of Energy. When those funds ceased, the National Association of State Directors of Career and Technical Education took over the funding and oversight of the Career Clusters Initiative.

Within each career cluster is a variety of pathways that further break down careers by skills and knowledge. The Agriculture, Food and Natural Resources cluster has seven **career pathways**. For each of these pathways, dozens of career opportunities exist. There are nearly 22 million jobs in agriculture and related fields in the U.S. today. Fewer than two million of these are traditional farming jobs. Agriculture in the 21st century is based on science and often calls upon the latest in technology.

With the variety of career opportunities available in agriculture, so are the **requirements** or needs for obtaining those jobs. Each pathway includes careers that range from the certification to graduate degree level. Certification may require a few hours, while a graduate degree may take many years to attain. Depending on your goals for salary and standard of living, you will want to consider pursuing a career that will allow you to reach those goals.

CAREER CLUSTERS

- Agriculture, Food and Natural Resources
- Education and Training
- Hospitality and Tourism
- Manufacturing
- Architecture and Construction
- Finance
- Human Services
- Marketing, Sales and Service
- Arts, A/V Technology and Communications
- Government and Public Administration
- Information Technology
- Science, Technology, Engineering and Mathematics
- Business, Management and Administration
- Health Science
- Law, Public Safety, Corrections and Security
- Transportation, Distribution and Logistics

Agribusiness and Management

The Agribusiness and Management pathway includes the study of agricultural finance, policy, marketing, farm and agribusiness management, rural sociology, and agricultural law. These areas of study have gained importance as agriculture has matured and has become more diverse.

Agricultural Communications

Careers within the Agricultural Communications pathway include those that report and write agriculture-related news, prepare educational publications for printing, produce radio and television segments and videotapes, or perform marketing and public relations functions.

Agricultural Power, Structures and Technology

Agricultural Power, Structures and Technology has developed in the past century, at first through improved farm equipment. In more recent years, engineers have produced machinery that have been useful in the development of many agricultural fields of study. Agricultural engineering includes work in mechanical, electrical, environmental, and civil engineering; construction technology; and hydraulics.



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Animal Science

Animal Science includes the work to improve the production of a variety of animals used as food and other commodities throughout the world. The sciences include animal physiology, nutrition, breeding and genetics, ecology, and livestock and poultry management. Veterinarians study the health and diseases of animals.



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Food Products and Processing

Food Products and Processing are actually a group of sciences and technologies related to the processing, storage, distribution, and marketing of agricultural commodities and by-products. The most significant development in this technology has been genetic engineering, which has used various chemical and biological processes to improve the production of food.



Jupiter Images

Natural Resources and Environmental Science

The Natural Resources and Environmental Science pathway includes those careers that work to regulate and preserve resources such as forests, wildlife and water. They also work to take care of the environment through pollution and waste control, soil testing, and education.



Wildlife conservationist
Jupiter Images

Plant and Soil Science

Plant and soil sciences have been important to farmers for generations as they have improved crop management. Modern areas of study include physiology, nutrition, ecology, breeding and genetics, pathology, irrigation, fertility, and weed science. These areas of study have led to modern plant breeding, which has greatly increased the production of food by tailoring crops to the climates of various regions.

Career Goals

The choice of a career is one of the most important decisions you can make. However, career decisions are not easy. They result from careful searching and planning. Success in finding a rewarding career will depend on the work you put into a career search or interest inventory. By determining what your interests are, you will be better able to determine what path to follow when choosing a career. By following the steps in career decision-making and using sources of occupational information such as online databases, career counselors, and teachers, you can create a personal career plan and career goals.

1. Define your future needs and wants.

Where will you want to live? How much time will you want to devote to your job? How much traveling do you want to do? How much money will you need?

2. Identify possible careers that suit you.

Choose possible careers that match your interests, skills, and personality, as well as your needs and wants. Are you interested in the public sector, private sector, or either? Does being an entrepreneur interest you?

3. Gather career information about each possible career.

Research the employment outlook, job duties, working conditions, education and training requirements, and salary range.

4. Evaluate your choices.

Compare your information from steps 1 and 3. Are your skills and abilities appropriate for the career? Will your personal values agree with the demands of the career? Will the rewards of the career satisfy you?

5. Choose a career path.

You can always revise your plan, or even change your mind!

6. Design a plan to reach your goal.

What is the career path that leads to the career you want? Where can you get needed education and training? How will you afford it? What courses should you take? If you're now in school, what part-time jobs could give you useful education and skills for the career you want? Are internships available?

7. Be flexible.

Have a "plan of action" that you can modify if you change your plans or if the career field changes.

JOBS IN DEMAND

While the difficulties of family farms in today's economic climate have been well publicized, there are career paths in agriculture that are expected to see dramatic growth. In a report about a new study from Purdue University, the Farm Bureau News reported that food scientists and engineers will be in the greatest demand in the agricultural job market over the next four years. Annual job openings for U.S. food and agricultural sciences graduates are projected to be around 58,000, while the number of graduates for those jobs will be slightly more than 57,000.

	Agribusiness and Management Pathway	Oklahoma Median Salary	Job Growth/Job Openings Per Year
Graduate Degree College/University	Economists Agricultural Economist	\$77,000 (\$37.03/hr)**	7% growth/550**
Bachelor's Degree College/University	Sales Managers Farm Investment Manager Securities, Commodities, and Financial Services Sales Agents: Agricultural Commodity Broker Loan Officers Bank/Loan Officers Farm, Ranch, and Other Agricultural Managers Farmers / Ranchers / Feedlot Operator / Livestock Rancher / Breeder	\$63,600 (\$30.60/hr) \$65,300 (\$31.38/hr) \$49,900 (\$23.97/hr) \$43,800 (\$20.08/hr) \$52,100 (\$25.03/hr)**	20% growth/130 15% growth /170 2% growth/20 9% growth/ 90 2% growth /110**
Certification 2-Year College/Technology Center	Sales Representatives Field Representative for Bank, Insurance Company, or Government Program / Field Service Representative / Animal Health Products Distributor / Livestock Seller / Produce Commission Agent Purchasing Agents and Buyers, Farm Products Agricultural Products Buyer Sales Representatives Chemical Sales Representative First-Line Supervisors/Managers of Retail Sales Worker Feed and Supply Store Manager	\$42,400 (\$20.39/hr) \$36,900 (\$17.75/hr) \$42,400 (\$20.39/hr) \$29,100 (\$13.99/hr)	12% growth/400 14% growth/10 12% growth/400 3% growth/380

Unless otherwise indicated, all salary and employment outlook data is from O*Net Online. <http://online.onetcenter.org> and Careeronestop. <http://www.careerinfo.org>.
**National Wage Data, same source.

	Agricultural Communications Pathway	Oklahoma Median Salary	Job Growth/Job Openings Per Year
Bachelor's Degree College/University	Marketing Managers Retail Marketing Coordinators	\$76,100 (\$36.58/hr)	20% growth/50
	Advertising and Promotions Managers Account Executives/Media Buyers/Planners	\$52,900 (\$25.45/hr)	20% growth/20
	Graphic Designers	\$31,400 (\$15.12/hr)	12% growth/50
	Editors Publisher/Editor/Journalist/Reporter, Print Broadcast	\$40,100 (\$19.25/hr)	17% growth / 140
	Writers and Authors Play Writer/Screen Writer/Screen Editor/Script Writer	\$44,700 (\$21.51/hr)	14% growth / 40
Associate's Degree 2-Year College/ Technology Center		\$32,600 (\$15.65 /hr)	12% growth/50
Certification 2-Year College/ Technology Center	Retail Sales	\$18,100 (\$8.70/hr)	17% growth/2,500
	Customer Service Representatives	\$23,600 (\$11.36/hr)	24% growth/1,040
	Advertising Sales Agents Account Supervisors	\$32,600 (\$15.65/hr)	12% growth/50
	Radio and Television Announcer	\$17,100 (\$8.21 /hr)	-8% growth / 30
	Photographers Commercial Photographers, Digital, Still, Video Film	\$20,800 (\$10.02/hr)	20% growth / 70

Unless otherwise indicated, all salary and employment outlook data is from O*Net Online, <http://online.onetcenter.org> and Careeronstop, <http://www.careerinfo.org>.

	Agricultural Power, Structures and Technology Pathway	Oklahoma Median Salary	Job Growth/Job Openings Per Year
Bachelor's Degree College/University	Agricultural Engineers	\$66,030 (\$31.75/hr)	13% growth / 1000
	Computer Systems Analysts Agricultural Applications Software Developers/Programmers	\$60,000 (\$28.95/hr)	22% growth / 160
	Database Administrators	\$53,000 (\$25.46/hr)	36% growth / 160
	Cartographers and Photogrammetrists Remote Sensing Specialists	\$36,900 (\$17.74/hr)	14% growth / 10
	Farm and Home Management Advisors Education and Extension Specialists/Agricultural Extension Engineering Specialists	\$41,700 (\$20.06/hr)	5% growth / 280
Associate's Degree 2-Year College/ Technology Center	Electrical and Electronic Engineering Technicians Electronics Systems Technicians	\$49,700 (\$23.90 /hr)	12% growth / 70
	Computer Support Specialists Computer Service Technical Support Technicians / Information Lab Specialists	\$32,300 (\$15.55/hr)	18% growth / 180
	Environmental Science and Protection Technicians, Including Health Recycling Technicians	\$26,700 (\$12.82/hr)	12% growth / 20
Certification 2-Year College/ Technology Center	Telecommunications Equipment Installers and Repairers Communications Technicians	\$45,200 (\$21.75/hr)	1% growth / 50
	Surveying and Mapping Technicians GPS Technicians	\$31,800 (\$15.27/hr)	9% growth / 30
	Machinists	\$32,200 (\$15.47/hr)	8% growth / 170
	Mobile Heavy Equipment Mechanics, Except Engines Heavy Equipment Maintenance Technicians	\$35,100 (\$16.89/hr)	6% growth / 40
	Welders, Cutters, Solderers, and Brazers	\$29,000 (\$13.96/hr)	8% growth / 300
	Water and Liquid Waste Treatment Plant and System Operators Waste Water Treatment Plant Operators	\$24,000 (\$11.55/hr)	23% growth / 100
	Parts Salespersons Equipment/Parts Managers	\$23,400 (\$11.23/hr)	-7% growth / 100
	Agricultural Equipment Operators Machine operators	\$17,300 (\$8.41/hr)	-3% growth / 40

Unless otherwise indicated, all salary and employment outlook data is from O*Net Online. <http://online.onetcenter.org> and Careeronestop. <http://www.careerinfo.org>.

**National Wage Data, same source.

		Animal Science Pathway	Oklahoma Median Salary	Job Growth/Job Openings Per Year
Graduate Degree College/University	Veterinarians		\$60,700 (\$29.17/hr)	31% growth /40
	Bachelor's Degree College/University	Sales Representatives Feed Sales Representative / Feed Sales Specialist / Animal Health Salesperson	\$48,300 (\$23.45)	12% growth /190
Agricultural Education Teachers, Secondary School		\$39,800 (\$19.30/hr)	11% growth /40	
Farm, Ranch, and Other Agricultural Managers Farmers / Ranchers / Dairy Producers / Animal Caretakers / Poultry Managers / Equine Managers / Livestock Producers / Aquaculturists		\$52,100 (\$25.03/hr)**	2% growth /110**	
Purchasing Agents and Buyers, Farm Products Livestock Buyers		\$36,900 (\$17.75/hr)	14% growth /10	
Animal Scientists Meat Science Researcher / Equine Managers / Animal Nutritionists		47,800 (\$22.98/hr)	10% growth /220	
Agricultural Inspectors Livestock Inspectors / USDA Inspectors		\$32,100 (\$15.43/hr)	6% growth /10	
Associate's Degree 2-Year College/ Technology Center	Veterinary Technologists and Technicians Embryo Technologists / Embryo Transfer Technicians		\$21,700 (\$10.42 /hr)	41% growth/30
	Certification 2-Year College/ Technology Center	Animal Breeders	\$27,100 (\$13.02/hr)	4% growth /300
Nonfarm Animal Caretakers Pet Store Operators		\$17,000 (\$8.16/hr)	31% growth /100	
Veterinary Assistants and Laboratory Animal Caretakers		\$17,600 (\$8.45/hr)	27% growth /50	

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	Food Products and Processing Pathway	Oklahoma Median Salary	Job Growth/Job Openings Per Year
Graduate Degree College/University	Biochemists	\$76,300 (\$36.69/hr) **	16% growth/730**
	Microbiologists Bacteriologists	\$43,400 (\$20.86/hr)	26% growth / N/A
	Medical Scientists, Except epidemiologists Meat Processors-Toxicologists	\$42,500 (\$20.42/hr)	31% growth /60
Bachelor's Degree College/University	Industrial Engineers Quality Control Specialists	\$66,200 (\$31.81/hr)	20% growth/60
	Agricultural Engineers Food and Fiber Engineers	\$66,000(\$31.75/hr)**	9% growth /100**
	Dietitians and Nutritionists	\$38,000 (\$18.20/hr)	14% growth /30
	Purchasing Agents & Buyers, Farm Products	\$36,900 (\$17.75/hr)	14% growth /10
	Food Scientists and Technologists Meat Science Researchers	\$53,800 (\$25.87/hr)**	10% growth /480
	Agricultural Inspectors Food and Drug Inspectors / Meat Cutter-Meat Graders	\$32,100 (\$15.43/hr)	6% growth /10
	First-Line Supervisors & Manager/Supervisors of Farming, Fishing, & Forestry	\$37,800 (\$18.15/hr)**	1% growth/40**
	Agricultural and Food Science Technicians	\$38,700 (\$18.59/hr)	7% growth /10
	Butchers and Meat Cutters Meat Cutters-Meat Graders	\$22,500 (\$10.80/hr)	2% growth /40
	Sales Representatives Fieldman	\$48,300 (\$23.24/hr)	12% growth/90
Certification 2-Year College/ Technology Center	Supervisors, Transportation and Material Moving Workers Storage Supervisors	\$42,200 (\$20.27/hr)	14% growth /80
	Food and Tobacco Processing Machine Operators and Tenders Food Processors	\$23,500 (\$11.30/hr)**	11% growth /910
	Food Batch Makers Cheese Makers	\$23,100 (\$11.10/hr)	13% growth /30

Unless otherwise indicated, all salary and employment outlook data is from O*Net Online. <http://online.onetcenter.org> and Careeronestop. <http://www.careerinfo.org>. **National Wage Data, same source.

	Natural Resources and Environmental Science Pathway	Oklahoma Median Salary	Job Growth/Job Openings Per Year
Graduate Degree College/University	Geoscientists, Except Hydrologists and Geographers Geologists	\$130,100 (\$49.58/hr)	N/A growth / 20
	Natural Sciences Managers Wildlife Managers	\$85,400 (\$41.04/hr)	9% growth / 10
	Medical Scientists, Except Epidemiologists Toxicologists	\$42,500 (\$20.42/hr)	31% growth / 60
Bachelor's Degree College/University	Mining and Geological Engineers, Including Mining Safety Engineers	\$72,000 (\$34.69/hr)**	10% growth / 230**
	General and Operations Managers Park Managers	\$59,400 (\$28.55/hr)	16% growth / 930
	Cartographers and Photogrammetrists	\$36,900 (\$17.74/hr)	14% growth / 10
	Farm, Ranch, and Other Agricultural Managers Fish Hatchery Managers	\$52,100 (\$25.03/hr)**	1% growth / 2180**
	Social and Community Service Managers Youth Program Directors	\$34,700 (\$16.67/hr)	22% growth / 70
Associate's Degree 2-Year College/ Technology Center	Geological and Petroleum Technicians Geological Sample Test Technicians / Soil Geology Technician	\$45,700 (\$21.96/hr)	16% growth / 20
	Environmental Science and Protection Technicians Water Monitoring Technician	\$26,700 (\$12.82/hr)	12% growth / 20
	Biological Technicians Fisheries Technicians	\$24,200 (\$11.64/hr)	18% growth / 30
	Operating Engineers and Other Construction Equipment Operators Heavy Equipment Operators	\$28,300 (\$13.60/hr)	10% growth / 150
Certification 2-Year College/ Technology Center	Fish and Game Wardens Fish and Game Officers	\$40,400 (\$19.40/hr)	13% growth / 10
	Logging Equipment Operators Logging Tractor Operators	\$29,500 (\$14.20/hr)	6% growth / 30
	Hazardous Materials Removal Workers Hazardous Materials Technicians	\$28,400 (\$13.65/hr)	25% growth / 10
	Excavating and Loading Machine and Dragline Operators Heavy Equipment Operators	\$29,100 (\$13.99/hr)	5% growth / 50

Unless otherwise indicated, all salary and employment outlook data is from O*Net Online, <http://online.onetcenter.org> and Careeronestop, <http://www.careerinfo.org>. **National Wage Data, same source.

	Plant and Soil Science Pathway	Oklahoma Median Salary	Job Growth/Job Openings Per Year
Graduate Degree College/University	Microbiologists Bioinformatics Specialists	\$43,400 (\$20.86/hr)	26% growth / N/A
Bachelor's Degree College/University	Transportation, Storage, and Distribution Managers Grain Operations Superintendents	\$48,500 (\$23.30/hr)	11% growth /30
	Securities, Commodities, and Financial Services Sales Agents: Commodity Marketing Specialists	\$49,900 (\$23.97/hr)	2% growth /20
	Conservation Scientists Soil and Plant Scientists/Plant Pathologists/Aquaculturists/Plant Breeders and Geneticists/ Forest Geneticists/Soil and Water Specialists	\$50,400 (\$24.21/hr)**	10% growth /20**
	Farm, Ranch, and Other Agricultural Managers Crop Farm Managers/Greenhouse/Growers/Farmers/Ranchers	\$52,100 (\$25.03/hr)**	2% growth /110**
	Sales Representatives	\$32,300 (\$15.54/hr)	19% growth /130
	Farm and Home Management Advisors Education and Extension Specialists	\$41,700 (\$20.06/hr)**	5% growth /280**
	Forest and Conservation Technicians Soil & Water Specialists	\$35,000 (\$16.84/hr)	N/A
Associate's Degree 2-Year College/ Technology Center	Biological Technicians Biotechnology Lab Technician	\$24,200 (\$11.64/hr)	18% growth /30
	Agricultural and Food Science Technicians Biotechnology Lab Technicians	\$38,700 (\$18.59/hr)	7% growth /10
	First-Line Supervisors/Managers Golf Course Superintendents	\$29,900 (\$14.37/hr)	14% growth /40 -3% growth /40
Certification 2-Year College/ Technology Center	Agricultural Equipment Operators Custom Hay/Silage Operations	\$17,500 (\$8.41 /hr)	

Unless otherwise indicated, all salary and employment outlook data is from O*Net Online, <http://online.onetcenter.org> and Careeronestop, <http://www.careerinfo.org>. **National Wage Data, same source.

Organizing/Researching

Keeping records, cataloging
Making diagrams
Planning, making decisions
Set up and keep time schedules

Analyzing/Investigative

Developing budgets
Mathematical reasoning
Using scientific rules and methods
to solve problems
Analyzing, interpreting, evaluating
statistical data

Management/Leadership

Delegate responsibility
Increase productivity and efficiency on budget and time
Persuade others to change their minds or behavior
Persuading, negotiating, selling

Create/Innovate

Drafting, drawing, painting, sculpting
Performing, creating art
Express ideas or create images through art form
Create innovative solutions to complex problems

There may also be specific skills you have such as welding or cutting, taking photos, administering medications to animals, driving a tractor, or identifying plants that would make you more marketable to an employer. The goal is to determine what skills you have and work to develop skills you may need in order to be successful in a particular career.



Unit Summary

Agriculture provides consumers products necessary for everyday lives. Behind the breakfast foods and jeans is the science of agriculture. Agriculture involves many different aspects of science such as botany and environmental science. Research in agriculture follows the scientific method, just as research in other fields. Research in agriculture must have a hypothesis and experiments, and researchers must analyze the data to come to a conclusion. While shopping for products, consumers often do not think of the research or the agricultural production efforts behind their purchases. Agriculture affects everyone and is much more than food.

Agricultural products are included in many items such as clothing, construction materials, biofuels, cosmetics, cleaners, and pharmaceuticals. Farmers today are more efficient and produce more than previous generations. As technology plays a larger role in agriculture, topics such as genetic engineering become much more relevant to agriculture. Consumers today are surrounded by contrasting views of topics such as GMOs, hormone and antibiotic use, and organic vs. non-organic agricultural products. Consumers must become educated and be able to tell fact from fiction.

Agriculture or agriscience has many career opportunities. With the use of career clusters and pathways, you will be better able to match your skills and interests to a particular job area. It is important to set career goals and use a personal career plan when deciding the type of work you like. By using a personal career plan, you can determine the amount of money you would like to make along with the amount of further education needed. For those who choose a career in agriculture, their individual skills and interests will eventually lead them to a productive and rewarding career.

Unit Review

1. What is the difference between agriculture and agriscience?
2. What is the scientific method and its steps?
3. How many people does the average farmer feed each year?
4. How can GMOs benefits farmers and consumers?
5. Why are antibiotics used in agriculture?
6. What agricultural animals cannot have added hormones?
7. What does the USDA organic seal mean on products?
8. Describe career clusters and career pathways.
9. Name five career clusters other than Agriculture, Food and Natural Resources.
10. What are the pathways within the Agriculture, Food and Natural Resources cluster?
11. Which career pathway deals with animal genetics, physiology, and breeding?
12. What types of careers are within the Natural Resource and Environmental Science pathway?
13. Name the steps to creating a personal career plan.
14. Besides salary, what job characteristics would you need to consider when choosing a career?
15. What skills do you have that would benefit an employer?



Unit 2

Supervised Agricultural Experiences

OBJECTIVES

- Discuss the types of Supervised Agricultural Experiences.
- Outline a personal Supervised Agricultural Experience (SAE) plan.
- Explore the various records kept for an SAE.
- Discuss the awards and recognition available through SAEs.

KEY WORDS

assets
capital
chattel mortgage
current
debt
depreciate
enterprise
entrepreneurship
equity
expenses
experience
exploratory
income
internship

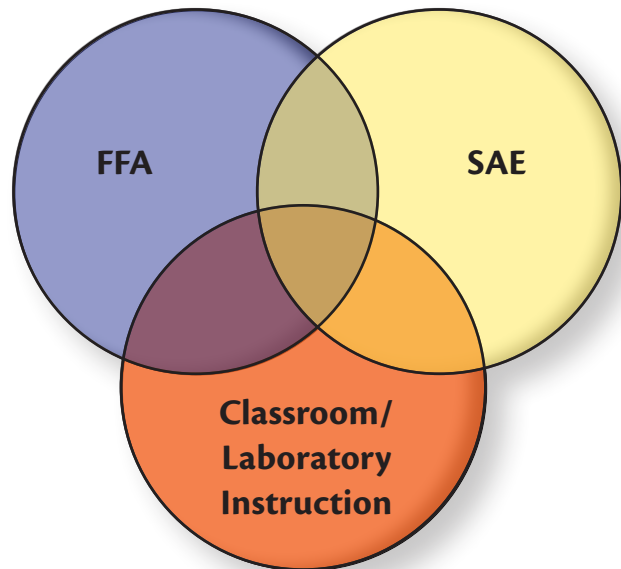
inventory
liability
non-current
operating
ownership
placement
principal
productively invested
research
school-based
 enterprise
service learning
transaction

Agricultural Education programs are comprised of three parts: classroom and laboratory instruction, FFA activities, and supervised agricultural experience (SAE) participation. This is also known as the three-circle model. These three parts work together to provide students with experiential learning and career awareness. One of the circles in particular gives students the opportunity to apply what is learned in the classroom – SAEs or supervised agricultural experiences. Through these experiences students are able to explore careers, develop specific industry skills, and learn soft-skills such as communication.

SAEs are a required component of the Agricultural Education program, and each student must plan and implement an SAE during his or her experience. The Agricultural Education instructor provides supervision and guidance for students in planning and implementing an SAE.

A successful SAE combines all four of these components:

1. Teacher-supervised
2. Hands-on
3. Agricultural-related
4. Curriculum-based



Types of SAEs

Supervised agricultural experiences allow students the opportunity to experience agriculture in a more hands-on way. There are six types of SAEs that students can choose from: exploratory, placement/internship, ownership/entrepreneurship, research, school-based enterprise, and service learning. With these options, every student in Agricultural Education will be able to effectively have an SAE according to his or her interests and abilities.

An **exploratory** SAE is one that allows a student to explore career opportunities in the agriculture industry. This could include shadowing a veterinarian, feed mill operator, cattle rancher or agricultural loan officer. It will hopefully help direct students toward a career goal.

A **research** SAE is designed to expose students to the scientific side of agriculture. Students can select an area to research and determine outcomes. Since agriculture is science, this type of SAE and agriculture go hand in hand. A research SAE will not qualify students for advanced FFA degrees; however awards and other recognitions are available.

An **ownership/entrepreneurship** SAE allows a student to own his or her own business. Examples include producing and marketing livestock, crops, nursery plants, or forest products. It also includes services such as lawn care; processing of agricultural products; or repair, design, or fabrication of equipment related to agriculture.

A **placement/internship** SAE is where a student works for someone, either for pay or for the experience. These SAEs may be located in agribusinesses, school labs, farms and ranches, or community facilities.



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As another option, students can participate in a student-managed, entrepreneurial program in the school setting called a **school-based enterprise** SAE. This type of SAE is designed to imitate the work environment as closely as possible. School-based enterprise examples include school gardens, production greenhouses, agricultural equipment fabrication or a school store. It is important for students to gain hands-on experience in the school setting; however, it should be the goal for students to progress past the school-based SAE to one that is managed outside the school day.

Students may also develop and manage a **service learning** SAE for a school, community organization, or non-profit organization. All steps from the needs assessment to planning and implementation to evaluation must be done by the student or group of students. This project cannot be part of an ongoing chapter project or community fundraiser.

The agriculture industry has over 300 various careers available. Through SAEs students can gain experiential learning that can lead to a rewarding career in agriculture. It is essential for students to not only learn skills through SAEs but also document those skills and experiences through a variety of record keeping methods.



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Personal SAE Plan

After learning about the different SAEs, it is important for a student to develop a personal SAE plan. This plan can start out simple and adapt as interests in agriculture change. The first step is to determine your interests. An online interest survey or simply visiting with your instructor can help guide you.

There are few factors to consider when developing an SAE plan. After determining your interests, you will want to consider your budget, capital investment such as land or animals, time commitment, and what you would like to learn.

If your interests lead you to an SAE that will require a financial commitment, it will be important to discuss this with a parent or guardian. A budget is an outline of possible expenses and income for an SAE project. This will help guide you in determining the scope and magnitude of your SAE. As your project grows and changes, so will your budget. For this reason, budgets should be assessed on a continual basis.

Some SAEs require a capital investment, such as the purchase of land, livestock or equipment. Investments such as this can be productive over time, but must be accounted for in your budget planning. If you desire an SAE that requires capital investments, there are SAE student financing programs available. You can also ask local business owners for sponsorships and support to start your SAE project.

As you plan your SAE, it is also important to take into account the amount of time you have to spend on a project. Each type of SAE requires a different time commitment. For example, livestock projects need daily care, whereas an agriculture-related job may not be every day. If you have questions about the amount of time a particular SAE may require, discuss with your instructor, parent or guardian.

What do you want to learn? Learning experiences are a large part of SAE programs. When planning your SAE, determine what it is that you would like to gain from the project. Are there skills you want to learn? Would these skills lead toward further education or employment after graduation? Since skills and experiences are recorded in your record book, it will be important to determine how you would like to see your SAE grow and the learning you would like to gain.



Budget planning is essential in developing an SAE.
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Record Keeping

Maintaining good records is essential in personal finance and in managing an SAE. This record keeping does not just involve financial transactions but also skills learned, certifications attained, and planning and reflection. Each type of SAE has necessary documentation, some being more financial than others. This documentation can be used to show program and student growth, and can at times be used for industry certifications and as part of the SAE grading component of the agricultural education program. Keeping records takes time and effort, but it is essential. Sound decision making for an SAE program is supported by the quality of the records that were kept to help make those decisions. A student should work as hard at record keeping as any other part of the SAE program.

Often times there are records kept that do not directly relate to the SAE, such as non-SAE income, jobs performed not related to agriculture, or volunteer work. For example, winnings from a speech contest or a gift from a family member is considered non-SAE income. Working as a babysitter or at the local fast-food restaurant is an example of a job performed not related to the SAE. All of these records are worth keeping because the income derived from the non-SAE income could be used to finance a students' SAE program. Providing information on the sources of funds is important.

Entrepreneurship Records

An entrepreneurship SAE is a student-owned business; so the records kept are like that of any other business. Businesses track sales, expenses, customer information, supplies or materials on hand, and other details needed to operate.

Inventory

So, how does a business know what **assets**, or supplies or materials, are on hand? By conducting an inventory. An **inventory** is a list of the items or assets a business owns. It includes all the goods the business sells such as livestock or crops, as well as items that are consumed in order to produce those goods such as feed, fuel, or fertilizer.

An inventory may also include items the business uses to operate such as land, machinery, and computers. An inventory is used for several reasons. It is needed to complete financial statements and insurance records, manage taxes, determine what goods need to be stocked, and other important purposes. The term **productively invested** refers to all asset costs including the initial investment plus other expenses on the asset. An inventory will assist in determining the amount productively invested in an SAE.



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Inventories are an essential component of SAE record keeping. Knowing what is in the inventory allows for planning and decision making. They provide a “snapshot” for a specific time during the record keeping period, and are broken into two main categories: current (operating) inventory and non-current (capital) inventory.

Current (operating) inventory is assets that can be converted to cash or used within approximately one year. This includes feed, fertilizer, veterinary supplies, livestock purchased for resale, or market animals raised. **Non-current (capital)** inventory is assets that have an expected useful life of more than one year. This could include most breeding stock (cows, sows, ewes), land, buildings, and equipment such as feeders, panels, and trailers.

Since buildings, fences, machinery, and equipment **depreciate** or decline in value over time, the cost minus depreciation method should be used for calculating the value of these items. There are various scenarios in which depreciation is used depending upon the particular investment asset. When calculating the value of capital livestock animals, a generally accepted practice is to deduct depreciation if the animals are purchased, and not deduct depreciation if the animals have been raised by the individual.



Capital purchases such as tractors depreciate over time.
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UNITS AND VALUATION

Livestock

- price per pound (lb.)
- price per hundred weight (cwt.)
- price per head

Stored Crops

- small grains — price per bushel (bu.)
- peanuts, pecans, soybeans — price per ton or price per pound
- hay — price per ton or price per bale
- cotton — price per ton

Growing Assets

- growing crops — production costs invested per acre
- growing horticulture plants not ready for market — production cost invested per flat, pot, or individual plant
- purchased animals for resale — purchase price plus production costs invested per individual animal

Other Assets

- feed — price per hundred weight or price per ton
- fuel — price per gallon
- fertilizer — price per ton or price per bag
- equipment and machinery — price per item
- land — price per acre

Transactions

To determine if an entrepreneurship SAE is profitable, all financial transactions must be recorded. A **transaction** is any exchange of money including the purchase of feed, livestock, entry fees, or supplies (expenses), or it could be the sale of hay, livestock, or labor in exchange for supplies (income). **Expenses** are the transactions where money is spent, and **income** is where money is gained. It is important that records are accurate to determine the profitability of the SAE program.

Current (operating) income, or cash sales, is money received from the sale of current (operating) assets. Examples would be market animals for show or commercial use, crops, and raised market livestock. Income or premiums derived from exhibition should be recorded as income. Non-current (capital) sales include money received from the sale of assets that are non-current (capital) assets. Examples would be breeding livestock, machinery, and land.



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Expenses are the cost of goods and services involved with producing a product or a service. Non-current (capital) expenses are the total purchase price of non-current (capital) assets. Some examples include machinery, breeding livestock, land, or buildings. Current (operating) expenses are those that are required to conduct and manage an SAE. Some examples of cash current (operating) expenses are the purchase of goods you intend to resell later (such as bedding plants or market animals), animal supplements and feeds, fertilizer, seed, chemicals, fuel, veterinary supplies, insurance, and machinery rent.

Often times bartering, exchange labor, and gifts are used to operate an SAE, also known as non-cash transactions. This is done when products are gifted/bartered or labor is performed in exchange for goods. A parent/guardian or sponsor often pays for the expenses in an SAE in exchange for work. In a record keeping system, there will be two transactions for non-cash expenses: one showing the expense amount, and one denoting the barter, exchange or gift, and the two must be equal.



Veterinary visits are operating expenses.
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Non-Cash Transaction Examples

EXAMPLE #1: Three bred gilts were traded to a neighbor in exchange for 225 bushels of corn valued at \$600. This is an example of bartering and the \$600 should be recorded as non-cash operating expense-feed, as well as a barter exchange.

EXAMPLE #2: A veterinary office visit was received in exchange for summer labor; record the estimated value of \$150 as non-cash operating expense-veterinary, as well as a labor exchange.

EXAMPLE #3: A gift of 20 fence T-posts was received with an estimated value of \$80. Record the amount as a non-cash capital expense-supplies.

Liabilities and Equity

Liabilities can also be categorized as current (operating) or non-current (capital). A **liability** is any money, goods, and/or services for which you owe. Current (operating) liabilities include items you owe that are due within the next 12 months, such as taxes, rent, or leases, as well as outstanding feed bills, veterinary invoices, past due insurance premiums, and charge accounts. Non-current (capital) liabilities are notes, chattel mortgages, and contracts that are *not* due within the next 12 months. A **chattel mortgage** is a loan secured by moveable personal property rather than by land or permanent fixtures.

If a partial payment is due in the current year on a non-current (capital) asset such as a chattel mortgage, contract or deed, it would be recorded as a total current portion of non-current debt. For example, a student has a chattel mortgage of \$9,000 for a pickup truck that is payable over a four-year period, and \$2,400 must be paid on the principal this next year. **Principal** is the actual amount borrowed; it does not include any interest, or late payment finance charges, but may include loan origination finance charges. The remaining \$6,600 becomes a non-current liability.

All assets and liabilities show owner's **equity** or net worth. All of the liabilities and debts against the SAE are subtracted from the SAE assets and investments. **Debt** is the amount of money owed on an asset or investment, such as money owed to a co-op or an individual. What remains is the owner's equity in the SAE program. There is a maximum possible increase in owner's equity. The increase cannot be greater than the difference between the total source of funds (earnings) and the total use of funds including personal expenses, such as entertainment, clothing, school tuition, books and other expenses associated with education.

It is not uncommon for a student's owner's equity to be negative, especially in the first year or two of the SAE program. Large increases in inventory, coupled with the debt incurred in increased inventories with no return on the investment yet, could lead to a negative owner's equity. It is not bad to have a negative owner's equity at first, but eventually, students should begin to see a return on their investments.



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Placement Records

A placement SAE does not involve ownership or inventory; instead, it involves receiving work experience without ownership. Examples of this would be working at a veterinary clinic, grooming at a horse stable, working at a nursery, or working at a corporate swine facility. Students gain experience, skills and work-based training without the financial investment of an ownership (or entrepreneurship) SAE, which is beneficial for students who are unable to purchase livestock, feed, and supplies.



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A placement SAE also involves no market risk unlike an entrepreneurship SAE where students may deal with the rise and fall of wheat or cattle prices. The income derived from the placement SAE can count toward the net profit requirement for the State and American FFA Degree; however, the investment requirements must still be met. All proficiency award areas have either a placement, entrepreneurship, or combination application.

There are required records for a placement SAE, such as hours worked or volunteered. Along with these hours, the skills performed or attained are also recorded. If there is income or expenses involved with the placement SAE, those details would also need to be recorded.

Exploratory Records

An exploratory SAE allows students to discover a variety of agricultural areas and careers. Examples of exploratory SAEs include observing a florist, interviewing an agricultural loan officer, assisting on a cattle ranch for a day, attending an agricultural career day at a college or university, or writing a research report on an agricultural career.

With any exploratory activity, there are records to be kept. These records will likely not have a financial component; however, skills learned and observed, or written details of an interview or experience can be recorded. Any experience completed through an exploratory SAE should be documented to show SAE growth.

Research Records

Agriculture is science, and with science comes research. Advancements in agriculture have prospered through the efforts of scientific researchers and technicians who seek to answer questions and make agriculture better. As an SAE option, students can choose to complete a scientific research project. The records for a Research SAE include all documentation that pertains to the research process, also known as the scientific method.

Scientific Method

1. State the problem – what question do you want answered?
2. Form a hypothesis – what do you believe will be the experiment outcome based on information gathered?
3. Test the hypothesis – what experiment will you conduct to test your hypothesis?
4. Analyze the data – what data can you record and summarize?
5. Report the data – what are the written conclusions to support or reject your hypothesis?



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An experiment should include a dependent variable that does not change and an independent variable that does change. An experiment should also include an experimental group and a control group. The control group is what the experimental group is compared against.

School-Based Enterprise & Service Learning Records

When an SAE is completed at the school using school resources or as a service project, the hours worked or volunteered should be recorded. The skills attained through these projects are an important part of the learning assessment for these types of SAEs. Other project documents such as the written project plan or evaluation can also be used as recorded documentation. In some instances, there might be inventory to keep if the projects require supplies.

Awards and Recognition

After you've started your SAE and have shown growth, you may choose to apply for awards. The Agricultural Proficiency Awards program allows students to showcase the skills, achievements and records attained through their SAE program. There are over 45 official proficiency award areas and two types within those areas: placement and entrepreneurship. Some proficiencies offer both placement and entrepreneurship while others may offer one option. Examples of proficiency awards include areas such as Agricultural Communications, Dairy Production, Equine Science, and Outdoor Recreation to name a few. A full list of proficiency awards can be found on the National FFA website or in the FFA Student Handbook.



National proficiency award winner, Kaylee Brunker
Photo Provided

For students who have chosen a research SAE, agriscience fairs are available to showcase their research. There are six categories of agriscience: Animal Systems; Environmental Services/Natural Resource Systems; Food Products and Processing Systems; Plant Systems; Power, Structure and Technical Systems; and Social Systems. Along with the agriscience fair competition awards, state and national awards are available. National FFA supports an Agriscience Student Recognition Program for members to receive scholarships in pursuit of a career in agricultural sciences. Agriscience proficiency awards are also available in the areas of Plant Systems, Animal Systems and Integrated Systems.

The FFA and SAEs overlap in the three-circle model, and that overlap provides students the opportunity to earn FFA degrees partly based on their SAEs. The youngest FFA members have the opportunity to earn the Discovery FFA Degree. As part of the requirements for this degree, members must have knowledge of agriculture-related careers and SAE opportunities.

The requirements for an SAE expand as students progress through the Agricultural Education program. The Greenhand FFA Degree requires students to have a plan for a supervised agricultural experience program, where the Chapter FFA Degree requires students to have either productively earned and invested \$150 or worked/volunteered 45 hours in an SAE program. The requirements continue to change with the State FFA Degree and American FFA Degree as a student's SAE grows and becomes more productive.

FFA DEGREE SAE REQUIREMENTS*

Discovery FFA Degree

Have knowledge of agriculture-related careers and ownership and entrepreneurial opportunities

Greenhand FFA Degree

Have satisfactory plans for a supervised agricultural experience (SAE) program

Chapter FFA Degree

Have earned and productively invested at least \$150 or worked/volunteered 45 hours outside of scheduled class, and have developed plans for continued growth and improvement in a supervised agricultural experience (SAE) program

State FFA Degree*

Have earned and productively invested at least \$1,000 or worked/volunteered at least 300 hours outside of scheduled class, or a combination thereof

American FFA Degree **

Have earned at least \$10,000 and productively invested at least \$7,500; or earned and productively invested \$2,000 and worked 2,250 hours outside of scheduled class

* Some states have varying degree requirements. For example, in Oklahoma the requirement to earn the State FFA Degree is \$2,000 productively earned and invested, and unpaid hours are not accepted.

** Additional details can be found in the FFA Student Handbook or the National FFA Website www.ffa.org, or in your respective state's FFA constitution

Unit Summary

What records have you kept? Maybe you keep record of your grades or the money you make from doing household chores. There are many types of records kept throughout our lifetime. Your opportunity to have a Supervised Agricultural Experience program will strengthen your record-keeping skills. It is important to remember that keeping good records reflects on the quality of your SAE program and can one day lead to proficiency awards, degrees and other recognitions. Poor records may show a false picture of your program and more importantly may lead to poor decision making.

Unit Review

1. Explain the six types of SAEs and give an example of each.
2. When might a student choose to have an exploratory SAE?
3. Why is it important to develop an SAE plan?
4. What factors should be considered when developing an SAE plan?
5. Why is record keeping important?
6. What are two examples of non-SAE income?
7. What is the purpose of an inventory?
8. What is the difference between current and non-current?
9. Define current (operating) income and give one example.
10. Define non-current (capital) sales and give one example.
11. What is a liability?
12. How is a placement SAE different than an entrepreneurship SAE?
13. What is an example of a record for an exploratory SAE?
14. Explain the scientific method for research.
15. What are three different awards or recognition available based on SAEs?



Unit 3

The Food Industry

OBJECTIVES

- Discuss major operations that occur in the food industry.
- Identify government requirements and other assurance of food quality.
- Discuss food preparation and safety guidelines.
- Identify sources of food products and by-products.
- Discuss food customs of major world populations.

KEY WORDS

carbohydrates
complete protein
convenience store
food processing
fortified
Good Manufacturing
Practices
grades
harvesting
Hazard Analysis of
Critical Control
Point

marketing
migratory worker
multipurpose retailer
retail
saturated fat
supermarket
unsaturated fat
value-added
wholesale

What did you have for dinner last night? Do you ever think about where your food comes from? What about 100 years ago? Do we eat the same things as our ancestors? Food is a necessity in life. It has evolved over time from farmers raising crops to provide food for their own families to one farmer feeding more than 155 people. Today, an entire industry from grocery stores to restaurants is focused on providing tasty, safe and healthy foods to consumers. The food industry consists of numerous operations. As food consumers, it is important to understand the system that assures the safety of the food supply, where food comes from, and food customs from around the world.

Food Industry Operations

Many consumers take for granted the availability and selection of products in the United States. But, getting a product from the producer to the final consumer requires different steps such as production, harvesting, processing, transportation, and marketing. Each of these areas plays a vital role in taking food from the farm to the table. Technologies have been developed in each area to efficiently complete the processes necessary to make a variety of foods available for the consumer. Consumers are better able to make informed choices on the foods they purchase by being aware of the processes involved in the food industry and how they affect the final product. When any part of the food industry has an increase in cost, that cost is often ultimately passed on to the consumer. For example, if producers must spend more on livestock feed, the price of beef will increase.

Production

Whether it is planting crops or raising livestock, production must occur for products to become available to consumers. The producer must make decisions on many different aspects of production. A crop producer must make decisions such as what crops will be best to plant, when to plant, and what types of fertilizers or pesticides to use. Animal production operations require that animals be properly taken care of and given the correct feed, space, and medical treatment. Many factors can affect production—a drought can destroy crops, affecting many consumer products that rely on that crop. Drought can also affect animal production as livestock producers may not have as much forage for grazing animals. A producer who is successful in production will have either a crop to harvest or animals that are ready to be processed for meat products.



Corn growing is an example of the production stage.
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Harvesting

Harvesting is the process of gathering mature crops from the area where they are grown or produced, or the slaughtering of animals for meat products. It is important the crop is harvested at the correct stage of maturity. Harvesting at the optimum time will allow for the best yield, as well as the best product quality. Animals for meat production must also be harvested at the proper time for product quality and profit.

The methods of harvesting have changed greatly over the past few decades. Harvesting is now highly mechanized. Machines are available for many harvesting operations, which make harvesting more efficient. Crops can be harvested quickly while still maximizing yield. Labor is also necessary for harvesting because some crops require more hand picking than others. When hand picking is required, migratory labor is often used. A **migratory worker** moves from place to place as harvesting occurs, such as custom wheat harvesters. Harvesting of animals for meat production generally occurs through processing facilities often with the use of mechanical systems. The Humane Methods of Slaughter Act was originally passed in 1958 and is enforced by the USDA Food Safety and Inspection Service. The act requires the proper treatment and humane handling of all food animals slaughtered in USDA inspected slaughter plants. The Humane Methods of Slaughter Act does not apply to chickens or other birds.



Pork carcasses are the result of slaughtering pigs. *Thinkstock Photos*

OKLAHOMA FOOD AND AGRICULTURAL PRODUCTS CENTER

The Oklahoma Food and Agricultural Products Center (FAPC) is located on the campus of Oklahoma State University in Stillwater, Oklahoma. The primary goal of the center is to help develop successful, value-added businesses in Oklahoma. The center houses animal harvesting, food manufacturing, grain milling, sensory profiling, food microbiology, and laboratory facilities. This diverse facility allows entrepreneurs or businesses to develop and test value-added food and agricultural products.

FAPC was the location for the development of peanut butter slices. Other food items that have been developed or tested at FAPC include salsa, barbeque sauce, and chili - just to name a few.

Do you have a food product idea? FAPC is the place in Oklahoma to begin the development of a new or improved food item.

Processing

Food processing includes all the steps involved in transforming raw ingredients into food products for consumers. Some foods require minimal processing while others require extensive methods. The term **value-added** is used to describe foods that have been processed. The value of the product has increased due to the addition of ingredients or the processing that occurs. Value-added products are more appealing to the consumer.



Ready-to-eat chicken nuggets add value for the consumer.
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There are many benefits to food processing such as increased food consistency and shelf life.

Processing also improves the marketability, convenience, and seasonable availability of food. Probably the most important benefit is increased convenience. Consumers demand foods that are quick and easy to fix. Today's American lifestyle does not allow for long hours of meal preparation. Food products are designed to be conveniently prepared. Some foods are precooked, while others are pre-assembled and cooked at home.

Transportation

The food industry has evolved from farmers growing their own food for their families to consumers purchasing food from various retail outlets. Today most food production and processing occurs in facilities across the world. A complex global food system allows consumers to have access to fresh and processed foods year round. Trucks, trains, boats, and planes are all part of a system that allows food to be transported worldwide.



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The transportation system of the food industry allows consumers to obtain perishable foods from distant areas. Trucks are the main source of transportation. Insulated and refrigerated trucks allow for the transportation of perishable foods year round. Planes allow perishable foods to be imported from other countries. Bananas and other fruits are available to people all year even though they are grown in warmer climates. Trains are used to ship less perishable foods such as potatoes. The complex food transportation system allows consumers in the United States to have a large variety of foods available at all times of the year.

Marketing

Marketing is the way in which a product is sold to a target audience. It involves research and planning to develop the best approach for selling a product. Marketing also includes the development of new and improved products.

Good marketing is about understanding what people need and want, then persuading those people that a specific product meets those needs or wants. There is an important distinction between a need and a want: a need is something one must have, such as food or shelter; a want is something that one desires but could live without. As an example, people need food to live, but they want specific types of food. Some people want healthy food, others want a comfort food, and still others look for a convenience food. Marketing food products is all about understanding these various wants that different people have.

There are two types of food marketing: wholesale and retail. **Wholesale** marketing sells in large quantity to a buyer who then resells the product. Most agricultural food products are sold through wholesale. In some instances, small, local farmers may sell directly to a local grocery store or natural food store. Wholesalers purchase food from the packing house or food processing plant.

Retail marketing consists of the sale of food for personal consumption. There are several types of retail stores where consumers can purchase food products. Three of the predominant types of stores are supermarkets, convenience stores, and multipurpose retailers. The number of items stocked and the size of the facility differentiate the types of stores.

A **supermarket** is a large retail store that has between 25,000 and 35,000 food items commonly used in a home. The benefit of a supermarket is the large variety of food items and brands. The supermarket has expanded to include bank branches, pharmacies, and floral departments, making it the most popular type of food store in the United States.

A **convenience store** is a smaller store that stocks a limited number of food and household items. Convenience stores are usually associated with a gas station. One important aspect of a convenience store is its location. Convenience stores are located close to main streets and highways, allowing consumers to pick up items in a convenient manner.

One-stop shopping has become very popular for many. A **multipurpose retailer** offers consumers a place to buy food items as well as clothing, electronics, toys, hardware, and other household items. These large stores can offer lower prices than smaller, hometown retailers.

SAE IDEA

Entrepreneurship

Make jams and jellies for sale at a farmer's market.



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Quality Assurance

People expect to purchase high-quality food that is fresh and wholesome. There are numerous systems in place to ensure that consumers receive food that is safe and flavorful. There are two main agencies in charge of food inspection. The United States Department of Agriculture (USDA) focuses on protecting the public from foodborne illness. The USDA ensures that the meat, poultry, and egg products processed in the United States are safe for consumption. The Food and Drug Administration (FDA) is responsible for ensuring safety and labeling accuracy of all food products with the exception of meat, poultry, and egg products. With these two agencies in place, consumers can trust that their food supply is safe and of high quality.

Quality Grades

Quality grading creates a set of standards that gives buyers and sellers a common language to use when setting prices and marketing agricultural commodities. Consumers also use information from quality grades to help them make food-purchasing decisions.

The USDA has established a grading system that provides a uniform set of standards. These quality standards are used to determine *grades*. Quality grades are established for dairy, poultry, livestock, fresh fruit and vegetables, processed fruit and vegetables, and nuts. These grades are based on quality factors such as taste, texture, and appearance.

What's Your Beef? A guide to understanding USDA's beef grades.

USDA PRIME Prime beef is produced from young, well-fed beef cattle. It has abundant marbling, and is generally sold in hotels and restaurants. Prime roasts and steaks are excellent for broiling, roasting or grilling.

USDA CHOICE Choice beef is high quality, but has less marbling than Prime. Choice roasts and steaks from the loin and rib will be very tender, juicy, and flavorful and are suited for broiling, roasting or grilling. Less tender cuts are perfect for braising, roasting or simmering on the stovetop with a small amount of liquid.

USDA SELECT Select beef is very uniform in quality and normally leaner than Prime or Choice. It is fairly tender, but, because it has less marbling, it may not have as much juiciness or flavor. Select beef is great for marinating or braising.

USDA Produced by the U.S. Department of Agriculture
Agricultural Marketing Service
www.ams.usda.gov/grading

background photo courtesy KyleWITh

Sanitation and Safety

The United States has the safest food supply in the world due to the strict safety regulations set by the USDA and FDA. The USDA inspects processing plants and slaughter facilities to ensure the food sent to consumers is safe. Strict attention to cleanliness is essential for the production of safe, wholesome food. A clean, properly regulated production environment ensures that food is not contaminated with harmful substances.

Food safety must start with the production of crops and animals for consumption. Crop producers must follow pesticide and fertilizer guidelines. Producers that raise animals must follow withdrawal times for medications given to animals before they are slaughtered. Consumers have become more aware of issues in production such as the use of antibiotics and hormones. By understanding food production and issues surrounding it, consumers can make informed food choices.



The issue of genetically modified organisms (GMOs) in food production has also caused consumers to show a greater interest in understanding the food production process. GMOs must undergo a regulatory approval process before being grown in the United States. The safety of GMOs is regulated by the USDA, FDA, and the Environmental Protection Agency (EPA). The Environmental Protection Agency (EPA) helps to ensure that GMOs are safe for the environment.

The food industry uses proven scientific methods, in addition to compliances with federal regulations, to keep food safe from contamination. Approved procedures must be in place for cleaning and sanitizing food production and preparation areas. This includes all equipment, utensils, and surfaces. Specific detergents, sanitizing agents, and cleaning routines are used to minimize the presence of microbes. In addition to cleanliness and sanitation, two other common systems are used in food processing and preparation: Good Manufacturing Practices (GMP) and Hazard Analysis of Critical Control Points (HACCP).

Good Manufacturing Practices are procedures that have been developed to ensure a safe food product, as well as a safe working environment. GMP is regulated by the FDA in the United States. GMP regulations require a quality approach to food processing, enabling companies to minimize or eliminate contamination or errors.

Examples of Good Manufacturing Practices

- Preventing people with communicable diseases or open wounds from handling food.
- The use of microbe-resistant, easily cleaned surfaces such as stainless steel.
- Effective pest-management strategies to control rodents, birds, and insects.
- Stringent personal hygiene requirements, including frequent hand washing and restrictions on jewelry.

The **Hazard Analysis and Critical Control Point** system is a management program designed to analyze food processing procedures from the raw material to the finished product. During the analysis, key production and contamination points are identified. Hazards are classified as biological, chemical, and physical. HACCP is designed to be used for all aspects of the food production system from growing, harvesting and processing to distributing, merchandising and preparing food for consumption.

HACCP PRINCIPLES

HACCP is a systematic approach to the identification, evaluation, and control of food safety hazards based on the seven principles.

Principle 1: Conduct a hazard analysis.

Principle 2: Determine the critical control points (CCPs).

Principle 3: Establish critical limits.

Principle 4: Establish monitoring procedures.

Principle 5: Establish corrective actions.

Principle 6: Establish verification procedures.

Principle 7: Establish record-keeping and documentation procedures.



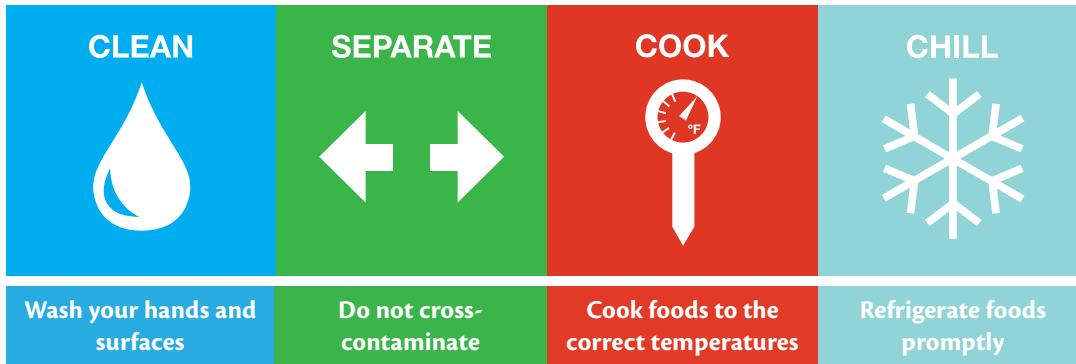
ICE CREAM SCARE

In 2015, Blue Bell Creameries recalled all of its products on the market because their potential to be contaminated with the bacteria *Listeria monocytogenes*. Because of this contamination, 10 people from four states were hospitalized with three deaths occurring. Listeriosis is a rare but serious illness caused by eating food contaminated with the bacteria. Symptoms include fever and muscle aches, sometimes preceded by diarrhea or other gastrointestinal symptoms.

Recalls can be devastating to a company. Blue Bell Creameries closed all their production plants for over 5 months and slowly reintroduced ice cream flavors to grocery stores. This example shows the importance of following Good Manufacturing Practices and HACCP. Prevention is the best practice in producing a safe and healthy food supply.

Food Preparation and Safety

Once consumers purchase food, the steps needed to ensure food safety fall upon the consumer. Many people prepare foods and eat without giving it much thought—but, food safety is essential in helping prevent foodborne illness. Foodborne illnesses not only make people sick—they can result in fatalities. In order to help address food safety and consumers, The Food Safe Families campaign was initiated. The Food Safe Families is a cooperative effort of the USDA, FDA, Centers for Disease Control and Prevention (CDC) and the Ad Council. The campaign emphasizes four steps to follow in every phase of food preparation: clean, separate, cook, and chill.



USDA Image

Consumers can take actions to help ensure their food is safe. Food safety starts when shopping. Purchasing refrigerated or frozen items after choosing non-perishables helps ensure food remains safe until it is put away. Consumers should not purchase food items in packaging that is torn, leaking, or past the expiration date. When placing items in the shopping cart, separate meat, seafood, eggs and poultry from other food items and keep them in separate bags at checkout.

Once food is home, it should be stored properly. Promptly refrigerate perishable food items. The refrigerator and freezer should be set at the correct temperatures. Recommended guidelines for the refrigerator are between 32° F and 40° F, and the freezer to be set at 0° F or below. Consumers should be aware of when they purchased items and use foods before they spoil. If there is any question as to the safety of a food item, do not risk it!

Meat and poultry should be securely packaged so they retain quality and do not leak, possibly contaminating other foods. If meat and poultry will not be used within a few days, freeze them. Consumers also need to be aware of the safety aspects of non-perishable items such as canned foods. While canned foods stored properly can remain viable for a long time, cans that are dented, rusted, or swollen should be discarded and never used.



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Food preparation involves many different steps, each of which can provide an opportunity for contamination to occur. Properly washing hands, utensils, cutting boards, and dishes is vital to prevent spreading bacteria. It is important to wash hands with warm water and soap before and after handling food. Hands should be washed for at least 20 seconds. Fruits and vegetables should also be washed by rinsing under running water before using, even if you plan on peeling them as bacteria can spread as they are being peeled. Do not wash raw meat and poultry as this can spread bacteria onto surfaces such as sinks or countertops.



Cutting boards and utensils should be washed after cutting raw meat.
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A common mistake many people make in food preparation is thawing raw meats, poultry, or seafood on the counter. Bacteria can multiply rapidly at room temperature. Food should be thawed safely in the refrigerator. When using the refrigerator to thaw food, ensure that cross-contamination does not occur with juices from the thawed food. Microwaves can also be used to thaw foods safely, but they should be cooked immediately after being thawed. Foods can also be thawed by placing in cold water, but again, they must be cooked immediately.

Cross-contamination is a significant issue when cooking—always keep raw meats, poultry, fish, and seafood separate from other food. In addition, always wash cutting boards and utensils after use. Surfaces should also be washed properly. When marinating meats and poultry they should be placed in the refrigerator.

It is important when cooking foods such as meats and poultry to make sure they have been heated to a high enough temperature so that harmful bacteria are killed. The best way to ensure that food is properly cooked is to use a food thermometer. Consumers should refer to charts, such as those put out by the USDA, and follow minimum temperature guidelines. For example, ground meats should be cooked to an internal temperature of 160° F, and poultry should be cooked to an internal temperature of 165° F.



A food thermometer should be cleaned with hot, soapy water after each use.

Consumers can help ensure the food they purchase and prepare at home is safe by paying attention to food safety. Restaurants and other food retailers are regularly inspected by local public health departments to ensure they are following safe food handling procedures.

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Sources of Food

There are two main categories of food sources: plant and animal. The number of food products derived from these two categories is vast. Cereal grains, legumes, fruits and vegetables are all derived from plants. Milk, milk products, meat, poultry, fish and shellfish are products that come from animals. Fats and oils can be obtained from both plants and animals.

Cereal Grains and Legumes

Cereal grains are the edible seeds produced by different types of grass plants. The food from cereal grains constitutes a major portion of most people’s diet. There are many different types of cereal grains used around the world. Some of the most familiar grains are wheat, corn, rice, rye, oats and barley. These grains are processed into products like bread, breakfast cereals or pasta.



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SAE IDEA
Placement
Work for an agricultural seed cleaning and bagging company.

All cereal grains are an excellent source of complex **carbohydrates**, which provide the body with energy. In fact, the composition of cereal grains is approximately 75 to 80 percent carbohydrates. Whole grains are a good source of dietary fiber. Depending on the type and how they are processed, cereal grains can also be a good source of B vitamins, iron and other minerals.

Legumes come from legume plants that grow seeds contained in pods. Edible legumes include peas, beans, peanuts and soybeans. Legumes are an excellent source of plant protein, carbohydrates, fats, minerals and vitamins, and are often used as ingredients in casseroles, salads, soups and stews.

Fruits and Vegetables

Fruits and vegetables are plant-based foods that are almost ready to eat when harvested. The processing of fruits and vegetables can be as simple as washing and eating, or as complex as canning. Depending on the type of processing, fruits and vegetables could potentially be stored for years.



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Different types of fruits and vegetables offer different levels of nutrition. In general, fruits and vegetables are naturally low in fat, low in sodium, and have no cholesterol. They are usually high in fiber and water content, and also tend to be high in vitamins and minerals.

Milk and Milk Products

Most milk and milk products in the United States come from cow's milk. Fluid milk is consumed as a beverage. It is also manufactured into other products including concentrated and dried milk, butter, cultured products, ice cream and cheeses.

Milk and milk products are a source of both protein and carbohydrates. It is also a source of saturated fat and cholesterol, though milk products are commonly processed to reduce fat levels. Milk is also a good source of the calcium. Fluid milk is usually fortified with vitamin D. **Fortified** food products have been enhanced with additional vitamins or minerals.

Meat and Poultry

Meat generally refers to the meat of cattle, hogs and sheep, though other types of animals such as goats and rabbits are also raised for meat. Meat has long been used as the centerpiece of most meals in the United States. It can be cooked in many different ways, as well as processed into products such as sausages, frozen foods and cold cuts.

Most meat consists of approximately 70 percent water, 21 percent protein, 8 percent fat, and 1 percent mineral content. Meat is a **complete protein** source, meaning it provides all the essential amino acids that humans require in their diet. Meat is also a good source of iron, B vitamins, and zinc.

Poultry refers to the meat from chickens, turkeys and other birds such as geese and ducks. Poultry is also a source of high-quality complete protein and is lower in fat than the typical serving of beef or pork. Poultry is a good source of many minerals and B vitamins. Poultry has increased in popularity in the United States because it is perceived as a healthier meat alternative to beef or pork.



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Fish and Shellfish

Fish and shellfish are available across the United States thanks to modern processing techniques. They are popular because of the diversity and availability in many forms. Since fish and shellfish tend to spoil rapidly, they are marketed as a fresh or frozen product, or are processed into pre-cooked products.

Fish and shellfish are a source of easily digestible, high-quality protein. They also provide a variety of vitamins and minerals. Fish is somewhat different from red meat and poultry as a protein source because of the fat composition it contains. Although some types of fish can be fairly high in fat, most of the fat in fish is unsaturated, which makes it healthier.

SAE IDEA

Exploratory

Prepare a food safety information kit covering safe handling of meat, eggs and other fresh food products.

Fats and Oils

Fats and oils are derived from both plants and animals. Fat is a necessary part of a healthy diet. It is also an important component of recipes and food products. Some common types of plant-based oils are olive oil, canola oil, corn oil and coconut oil. Some common types of animal-based fats are lard, tallow and butter. As a food ingredient, fats and oils serve several useful purposes. Fats and oils enhance flavor, as well as contribute to the desired texture of the food product.

One of the most important facts to understand is the difference between unsaturated and saturated. A **saturated fat** is generally a solid at room temperature. Saturated fats are usually of animal origin. An **unsaturated fat** is usually liquid at room temperature and is of plant origin. Nutritionally, the difference between saturated and unsaturated fat is important because saturated fats in the diet contribute to higher levels of cholesterol.

World Food Customs

Food is essential to life. However, the type of food prepared and the way it is prepared is different from culture to culture. Many times eating habits are determined by the food that is most readily available in that region or country. In Japan, fresh fish are available daily. It is customary in Japan to eat sashimi, or raw fish. Some Americans will enjoy this culture while others do not find raw fish appetizing. In Mexico and Latin America, it is common to have beans with each meal throughout the day. In the warm and wet climates of Asia, rice is consumed on a daily basis. In North Africa, couscous is more commonly served with meals. In Mediterranean countries, fresh squeezed orange juice is often served for breakfast.

Food availability is not the only factor that determines what people eat. Religious beliefs can also affect food consumption. In India, the cow is considered sacred; therefore, Hindus do not eat beef. Another example would be that Muslims do not eat pork. In the Jewish religion people eat Kosher food, which is food prepared according to Jewish dietary laws.

The way people eat also varies from culture to culture. In the United States, it is proper etiquette to use utensils while eating. In Ethiopia, it is common for people to eat with their hands. In Asian countries, chopsticks are used to eat. In many cultures, food is often served “family style” with food eaten from shared platters. The time spent eating also varies—in the United States, takeout food and fast food are very popular while in other countries, such as Italy or France, takeout is not as common and meals are generally eaten more slowly.



Japanese sashimi is often eaten with chopsticks.
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Food types not only vary in different countries. Regional foods are influenced by ethnicities and food availability. In the U.S., fresh seafood is available and less expensive on the east or west coast. In the New England region, it is common to have dishes such as chowder or clam bake. In the South, sweat tea is a common beverage. In the Southwest region, Tex-Mex is a cuisine of choice. The mild temperatures of the west coast allow for fruits and vegetables to be readily available.

Around the world, food is also much more than just sustenance—food is a part of the culture and a part of the celebrations of that culture. In the United States, Thanksgiving immediately conjures visions of turkey at the dinner table. At the end of Ramadan, the breaking of the fast is often a community event. Food helps to define a culture and a community. Around the world, food can also be viewed as a status symbol. Some foods are much more expensive, such as beluga caviar, which is one of the most expensive foods in the world and can exceed \$5,000 per kilogram (2.2 pounds).

While every country has its unique food customs, globalization has made some food products more commonplace throughout the world. Restaurant chains such as KFC, Burger King, Taco Bell, and McDonalds can be found throughout the world in many countries. Manufacturers of food products often slightly change their products to meet demands in different areas of the world. Coca-Cola® is sold throughout the world but has slight variations in taste because of differences in bottling in countries. For example, cane sugar may be used instead of corn syrup in some countries. McDonald's varies its menus to reflect local cultural preferences and tastes. For example, in France McDonald's sells a variety of pastries, and in India they have veggie burgers on the menu.

Throughout the world, food is also used for its health benefits. Many modern pharmaceuticals have originated from plants. Different areas of the world use foods for their health benefits, depending upon what is available locally. While the food available in countries varies along with the customs surrounding food, in every culture food plays an important role not in only providing sustenance but in helping to define a culture.



Food is often centered on cultural holidays such as Thanksgiving.
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Unit Summary

As you eat your next meal, think about the food products that were used to prepare it. Where did the products come from? Were they produced in your state or flown in from another country? Food is a part of our everyday lives, and we often do not consider all the steps needed to get food to consumers. Many different areas are included in the food industry such as production, harvesting, processing, transportation and marketing. We are dependent on agencies such as the USDA and FDA to ensure safety in the products purchased and consumed. Each step of food industry operations is vital to the profitability of the industry.

Once consumers purchase food, they must follow food preparation and safety guidelines. Foodborne illnesses can result when foods are not properly prepared or stored. The four steps to follow in food preparation are clean, separate, cook and chill. The two main categories of food are plant and animal. The food products that are derived from these two categories are vast. Cereal grains, legumes, fruits and vegetables are all derived from plants. Milk, milk products, meat, poultry, fish and shellfish are products that come from animals. Fats and oils can be obtained from both plants and animals. These two categories are found throughout the world, but the customs and types of food in different areas vary greatly. Food not only provides sustenance for a culture, it helps define a culture. The food industry is ever changing. As technology advances, people will continue to enjoy new and innovative food products.

Unit Review

1. What are the five general operations in the food industry?
2. What is migratory labor?
3. Explain three benefits of food processing.
4. What is the main mode of transportation for food products?
5. What affects the type of transportation used to ship products?
6. Why is it important to understand food marketing?
7. Describe the difference between a wholesale and retail store.
8. List three types of retail food stores.
9. What two governmental agencies regulate food inspection?
10. What types of food are these two governmental agencies in charge of?
11. What is quality grading?
12. Explain the importance of GMP and HACCP.
13. What are the four steps that should be followed in every phase of food preparation?
14. How should foods be thawed?
15. What is the best way to ensure that food is properly cooked?
16. Name three plant derived foods.
17. Name three animal derived foods.
18. What provides the largest amount of carbohydrates to a diet?
19. Describe the difference between saturated and unsaturated fat.
20. Compare food customs in two different countries.



Unit 4

Plant and Soil Science

OBJECTIVES

- Determine how plants are taxonomically named.
- Discuss how plants are classified.
- Examine the processes that occur within a plant leaf.
- Determine the requirements for plant growth.
- Identify types of plant growth media.
- Discuss soil formation and major components.
- Read the soil textural triangle.

KEY WORDS

annual
biennial
chlorophyll
climate
deciduous
dormant
evergreens
hydroponics
loam
minerals
organic matter
parent material
peat moss
perennial
perlite
photosynthesis
pine bark
respiration
sphagnum
topography
transpiration
vermiculite

People in many professions need a good knowledge of plants and soil because they are important for so many of our everyday needs, such as food, shelter and transportation. Outdoor activities such as golfing, hiking, or bike riding involve plants and soil. Sports such as football, tennis, and baseball use plants and soil, as well. There are hundreds of activities that people enjoy every day that take place on plants and soil that have been modified for that specific use. Like the farmer or rancher, people who design parks, playing fields, golf courses, or hiking trails need a good knowledge of plant and soil management.

When scientists began to study plants and soil to determine how they work together to provide humans and animals a food source, there became a need to name plants, as well as soil, according to a variety of characteristics. Naming and classifying plants, along with determining how plants grow and soil is formed, has led to advancement in plant growth and production.

Plant Taxonomy

Like animals, plants are scientifically classified and named using the same taxonomic system. This hierarchical system has seven levels of classification. The top level is the kingdom. All plants belong in the kingdom *Plantae*. The lowest two levels of classification, genus and species, give the plant its individual scientific name. This is also called its botanical name, or simply its Latin name, because the taxonomic names are all in Latin.

Latin names for plants are important for precise identification. Every plant has a unique Latin name. Many plants are known by more than one common name, or one common name may apply to more than one plant. For example, Purple Coneflower is commonly known throughout the Great Plains. However, Mexican Hat is a plant that is quite different in its growing habits and appearance, but it is sometimes called “Coneflower.” Of course, people in the United States normally don’t speak Latin, so it may seem like a chore to memorize the scientific plant names. Luckily, the English language is based in large part on Latin. Therefore, a Latin word is often quite similar to an English word. Also, the species names given to plants are frequently descriptive of the plant itself. For instance, the species name may describe the plant’s color, leaf shape, or the terrain where it grows.



Purple coneflower
Thinkstock Photo

THE FATHER OF TAXONOMY



Photo courtesy of Wikimedia Commons

Carl Linnaeus lived in Sweden in the 1700s. He is widely known for beginning the taxonomic system in use today for classifying plants and animals. The system that Linnaeus developed continues to undergo revisions, as scientists learn more about plant and animal species.

Kingdom
Phylum/Division
Class
Order
Family
Genus
Species

Latin Words That Describe a Plant's Color

Cardinalis or rubra	Red
Rosea	Pink
Citrina	Yellow
Purpurea	Purple

Latin Words That Describe a Plant's Location

Canadensis	From Canada
Alpina	From the mountains
Riparia	From the riverbanks
Occidentalis	Western

Latin Words That Describe the Shape, Location, or Color of a Plant's Leaves or Flowers

Dendron	Tree
Phyllus, phyla	Leaf, leaves
Flora, florum, florus	Flower
Caulis	Stem of a plant

Latin Words or Prefixes That Describe the Size or Other Characteristics

Fragrans	Fragrant
Giganteum	Large
Arborea	Tree-like
Elegans	Elegant, slender
Compactus	Compact, dense
Armatus	Armed
Diversi	Varying
Plumosus	Feathery
Macro	Large
Micro	Small
Nana	Dwarf
Edulis	Edible

You may come across the Latin word *grandiflora*, derived from the Latin root words *grandi* (large, showy) and *flora* (flower). It means "large, showy flowers." Similarly, the word *microphylla* means "small leaves." When using Latin (scientific) names, the genus name is always capitalized and the species is not capitalized. The entire name is italicized.

EXAMPLES: *Helianthus annuus* (annual sunflower); *Buchloe dactyloides* (buffalograss).

Classifying Plants

Although plants are scientifically classified and named, they can also be grouped based on their longevity or structures. These common classifications are important to know because they affect decisions about what plants should be grown in a particular location or for a particular purpose. Some plants such as grasses and trees are able to live longer than others, like marigolds or periwinkles. Can you imagine the grass in yards dying in the fall and having to be replanted every spring? Grasses are one plant that will come back year after year without replanting.

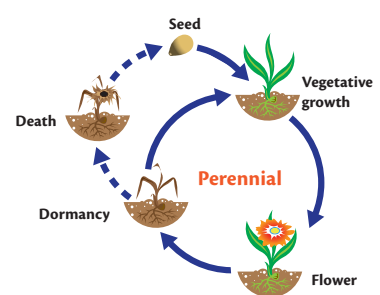
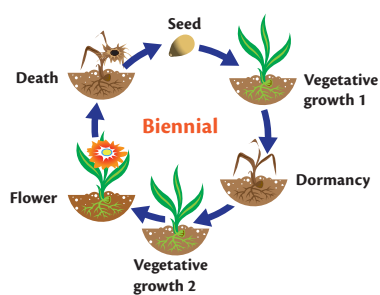
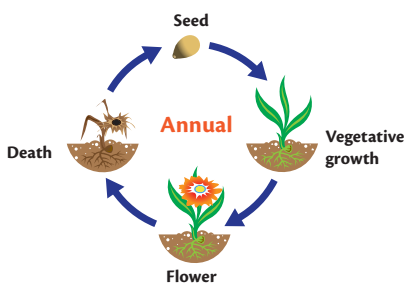
SAE IDEA
Exploratory
Take pictures and make a CD for plant or insect identification.

Longevity

Plants are often grouped according to the length of their life cycle. A plant's life cycle is the time between germination and death, assuming proper living conditions. Plants are grouped into three categories: annual, biennial and perennial.



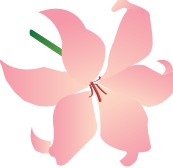





Annual plants complete their entire life cycle, including reproduction, within one growing season (usually, the spring, summer, and fall months). Many ornamental flowers are annuals because producing many flowers quickly is how the plant best reproduces. **Biennial** plants need two growing seasons to complete their life cycle. These plants germinate and grow during the first growing season, overwinter, and reproduce or set flowers during their second growing season.

Perennial plants grow season after season. They may flower the first growing season, as in the case of some grasses, or not for many years, as is characteristic of some trees, but they may reproduce each season thereafter. Trees and many shrubs are perennials. While perennial plants live through all seasons of the year, they still experience different amounts of growth during each season. During the cold winter season, most are **dormant**, meaning they either slow their growth or stop growing completely. Some plants lose their leaves as part of this dormant period. The leaves die during the autumn, sometimes turning beautiful red, orange, and yellow colors, and then fall from the tree or shrub. These plants are called **deciduous**. Other plants keep their leaves and green color throughout the year. These plants are called **evergreens**. Their leaves do drop, but only a few at a time.



Structures

Plants can also be grouped according to common structures or parts. The two principal categories are monocots and dicots. The word “mono” means one and “cot” means leaf, which indicates that when a monocot sprouts it has only one seed leaf. A dicot has two seed leaves because the word “di” means two. Monocots tend to be simpler in their structural design, while dicots tend to be more complex. These differences can be seen in the roots, seed leaves, leaf veins, and floral parts.

Monocot	One cotyledon 	Usually parallel 	Multiples of three 	Fibrous 
Dicot	Two cotyledon 	Usually netlike 	Multiples of fours and five 	Taproot 

Bright Career Futures

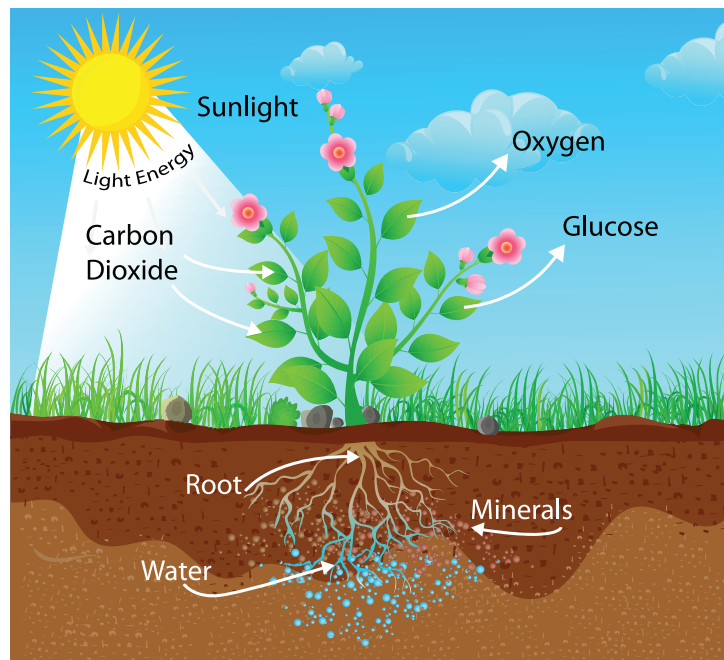
Biochemists and Biophysicists
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 Foresters

Landscaping and Groundskeeping
 Workers
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Leaf Processes

How do plants obtain food? If they don't eat like humans and animals, how do they obtain nutrients in order to grow? Plants are unique because they are able to manufacture food within their leaves and store it for future use. This process of food production is called **photosynthesis**, which involves carbon dioxide, water, light energy, and **chlorophyll**, or the green pigment in the leaves. During photosynthesis, light energy is taken in by chlorophyll-containing cells in leaves along with carbon dioxide from the air. Water is taken in by the leaves or roots. The leaf cells then use these ingredients to manufacture food for the plant through a chemical reaction, which also results in oxygen that is released into the atmosphere. The newly manufactured food is distributed throughout the plant or stored.



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When the plant is ready to use the food in the form of sugar produced through photosynthesis, the plant goes through a process like humans called **respiration**. During respiration the plant uses oxygen taken in through the leaves and water from the roots to convert the stored sugar into usable energy. Humans undergo this same process when breaking down food. Once food has been changed into energy, plants just like humans expel carbon dioxide into the atmosphere.

Do plants sweat? Sure they do. Plants lose water via openings in the skin of the leaf through a process called **transpiration**. Unlike humans, plants have the ability to control when they sweat. On hot, sunny days, plants will close the openings of the leaf to prohibit water from exiting. On cooler days, the openings will reopen because there is less of a chance for water to evaporate from the leaves due to the heat.

Each of these three processes is important in ensuring the health of the plant. Without the ability to make, store, and process food, along with being able to release or retain water, plants would not be able to function. This is much like when humans are unable to digest what they have eaten.

Plant Growth Requirements

Growth is the process by which plants become larger by increasing the size and the number cells, which is reflected in an increase in the number of leaves, stems, and roots. Plant growth is a progressive development from seed germination through flowering and fruiting. Many factors influence the various stages of plant growth.

Plants are living organisms that have certain requirements for successful growth. While these requirements may differ drastically from one species to another, the basic factors remain the same. Water is essential, even for plants that are adapted to very dry climates. Like humans and other animals, a plant's structure consists mostly of water. Plants receive hydrogen from water as a nutrient.

SAE IDEA

Research

Investigate the best types of artificial lights for plant growth.



Germination of a pumpkin seed
Thinkstock Photos

Light is required for the process of photosynthesis to take place. In fact, “photo” means light, and “synthesis” means combining different parts into one whole. Outdoor plants get the light they need from the sun. The amount of light they receive can trigger reactions in the plant, such as growth when days get longer in the spring, or dormancy, a period of rest, when days get shorter in the fall. The amount of sunlight needed for growth varies greatly depending on the plant species.

Air supplies the carbon dioxide that plants use in photosynthesis. Plants absorb this compound from the atmosphere, as well as from air trapped within the spaces between soil particles. Nutrients for plants come from air, water and minerals. Carbon, hydrogen and oxygen are supplied by the air and water. There are 14 additional “essential nutrients” that plants must have to thrive. These are supplied in mineral form and absorbed from the soil by the plant's roots. Without the proper nutrients, the plant will not thrive and may not be able to reproduce. Most soils do not have the proper amounts or balance of these nutrients, so growers usually add what is needed in the form of fertilizers.



Hydroponic growing of iceberg lettuce
Thinkstock Photos

plants rely on soil as their growth medium, plants grown in nurseries may be placed in “soilless media” made from organic and mineral materials. Another way of growing plants without soil is called **hydroponics**, which is a growing method that uses a mineral nutrient water solution without soil. There is even a plant class that anchors to surfaces without soil and obtains their nutrients almost entirely from air and water. Whether or not soil is used, a plant must have a source of mineral nutrients.

Plant Growth Media

Dirt is what most people think of when they picture a plant’s growing media, but in fact, dirt is considered a bad word in the world of soil science. Plants often require different growing conditions, which will affect the type of growth media. Some growth media is considered organic, or all-natural, while other growth media is composed mainly of minerals. This type of media is inorganic. Some media occurs naturally on the earth and is referred to as soil.

Organic Media

Leaf mold, compost, and sawdust are common and popular organic materials used for home gardens and greenhouses, but they are not used in commercial greenhouses or nurseries because they contain seeds and toxins. Some commonly used organic materials include peat moss, sphagnum (sfag-num) moss, and pine bark. These are safer because they generally do not include the seeds and toxins found in materials such as leaf mold or compost.

Peat moss is partially decomposed plant matter. The benefit to peat moss is its high water and nutrient retention capabilities. Peat forms under water and is preserved by water. It is collected from marshes, bogs, and swamps. As with any crop, the peat harvest can be plentiful or scarce according to climate conditions.

Temperature is another important factor that affects a plant’s growth. The temperature of both air and soil affects the plant. Most agricultural plants prefer a temperature between 60° and 90°F. Other plants around the world are adapted to warmer or colder temperatures.

Soil is a necessity for most plants, although in some cases plants do grow without soil. For most plants, soil provides an anchor for the roots. It is also the source of mineral nutrients for the plant. While most agricultural

Sphagnum is a type of peat moss. It is dehydrated stems and leaves of acidic bog plants, which is shredded and used to cover planted seeds. Sphagnum moss also has good water retention, absorbing 10 to 20 times its dry weight in water. Another benefit to sphagnum is its ability to control disease.

Pine bark when used is broken into small pieces of 1/4 inch or smaller. The bark absorbs nutrients and releases them slowly. Most tree bark mixtures use pine, although some use oak bark. Redwood and fir barks are less popular. Nurseries use tree bark more frequently than greenhouses do because they tend to decompose slowly.

Inorganic Media

For a material to be considered organic, it must have once been living. Although materials such as perlite and vermiculite are found in nature, they are considered inorganic since they did not originate from a plant or animal.

Perlite is volcanic rock that has been crushed and heated to 1800° F. It is used to improve aeration in growth media and has the ability to hold three to four times its dry weight in water. One disadvantage to perlite is its inability to hold nutrients. **Vermiculite** is a heated mica compound. Mica is a mineral formed as sheets in rocks and is apparent by its shiny luster. It is used to improve moisture retention, and absorbs and gradually releases nutrients.



Mixture of perlite (white) and vermiculite
Thinkstock Photo

SAE IDEA
Entrepreneurship
Grow and sell red worms used to produce compost.

Natural Soils

The uppermost layer of soil, consisting of air, water, minerals, and organic matter is called topsoil. It is the most important layer or natural soil for plant production. Topsoil is typically a combination of sand, silt, and clay particles with the ratios of each varying from location to location. If a soil has approximately equal parts of sand, silt, and clay it is considered a **loam**. A loam soil has the optimum characteristics for plant growth. It allows water to drain but not so quickly that it is unavailable for plants to use. It also allows air to move throughout the soil, allowing aeration of the roots.

Another natural soil that can be used is masonry or plaster sand, which consists of sharp, coarse particles. Disadvantages of this type of soil are that it must be cleaned and sterilized before use, does not hold water, and contains very few nutrients.

Formation and Major Components of Soil

Every building needs a solid foundation, and that foundation is generally placed on soil. Builders need to understand soil properties when they design and construct houses, apartment buildings, office buildings, roads, railroad tracks, bridges, airport terminals, or anything that people live in, work in, and travel on. If a construction project is built on inadequate soil that doesn't give good support, the building will settle and cause cracked walls, broken pipes, and other damage. Soil is also used as a building material. One common example is adobe, which is used extensively in Mexico and the Southwest United States.



Dirt preparation for building a home
Thinkstock Photo

One essential use for soil is in waste disposal facilities. These range from the home septic system to large landfills. In either case, as waste material moves through soil, organic elements are broken down and incorporated into the soil. A serious problem with waste disposal is the movement of hazardous material, such as harmful bacteria and toxins, through the soil and into the water table. Engineers must study and analyze potential waste disposal sites to make sure that contaminants cannot leach out of the soil and into areas where they would pose a health risk.

If you ever consider soil, you might think of it as something lifeless that simply sits there, never changing. In fact, soil is constantly forming, changing, and aging at all times. Soil formation is a process that is affected by five factors: parent material, climate, topography, living organisms, and time.

A CROOK'S DIRTY LITTLE SECRETS

Do you like mysteries? Enjoy foiling criminals? Soil is frequently a clue that leads to solving crimes. By analyzing the soil on a suspect's shoes or vehicle, investigators can determine what kind of soil it is and even pinpoint exactly where it came from... potentially placing that suspect at the scene of the crime. Interested in learning more about how soil examination is used to solve crimes? Visit Devil in the Details at www.forensicgeology.net/science.htm.

Formation

The **parent material** of a soil is the original matter from which the soil particles are formed. Most soils are mineral in origin, meaning the parent material is rock. Some examples are sandstone, marble and granite. Other soils are organic in origin, meaning the soil is made mostly from living organisms that have decayed. The parent material of organic soils is plant life.

Weathering, in the form of temperature and rainfall, helps to initially break apart the parent material into smaller particles. **Climate** conditions, such as humidity and wind, also create changes in already formed soil by affecting the amount of organic matter the soil holds. Rainfall also serves to move materials through the soil.



The soil's location affects its development, as well as exposing it to different forces. **Topography** is the variation of the earth's surface, such as elevation and slope. If soil is located on a slope, gravity and water will cause the soil to move downhill and accumulate at the base of the slope. Soil in a sunny location will tend to be drier than soil that is shaded.

All organisms that live on or in the soil affect its formation. These include plants, insects, microbes, and animals— including humans. Like people, soils change and age over time. Soil may become deeper, thinner, or more or less productive as time allows other factors to affect it.

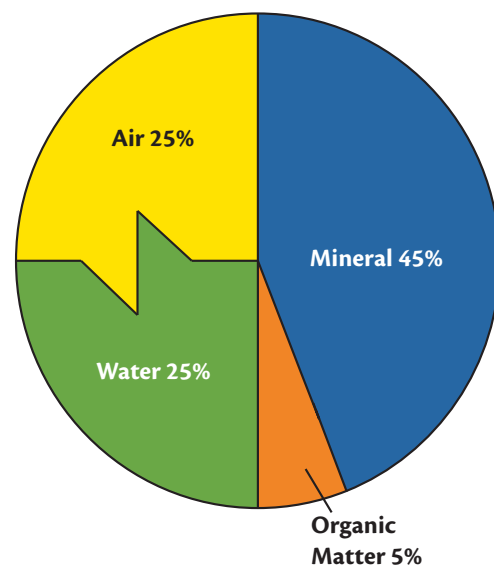
Composition

Soils contain four components: minerals, water, air, and organic matter. **Minerals** are the small rock particles in the soil. These contain various nutrients that are important for plant growth, such as calcium and iron. About 45 percent of an average soil is mineral matter.

Organic matter, or humus, in soil is made of decaying material from living organisms such as plants, worms, insects and animals. While minerals are considered inorganic matter, organic matter is anything that is, or once was, living. Organic matter supplies additional important nutrients for growing plants. About 1 to 5 percent of an average soil is organic matter.

Air and water fill the small spaces between particles in soil. These spaces are called pores and make up about 50 percent of an average soil. For ideal plant growing conditions, the soil would have nearly equal amounts of air and water. A dry soil will have mostly air in its pores, while a very wet soil will contain more water than air.

Average Soil Composition



Soil Textural Triangle

A simple way to classify soils is by texture. This method is commonly used by growers to determine how well crops may grow in a certain soil. With this method, soils are classified by the size of the mineral particles. Particle size is important because it affects how well the soil holds and drains water, as well as the nutrients necessary for plant growth. There are three main soil particles: sand, silt, and clay. Soil is rarely composed 100 percent of a particle. Soils in different areas are a variant mixture of each of the soil types.

Sand

Sand is the largest particle of the three types. Sand particles are between 0.05 and 2.0 millimeters in diameter. Soil with a sandy texture feels gritty when rubbed between your fingers. The large particles allow water to drain through the soil quickly. Sandy soil is not usually good for growing crops because nutrients are also washed away easily.

Silt

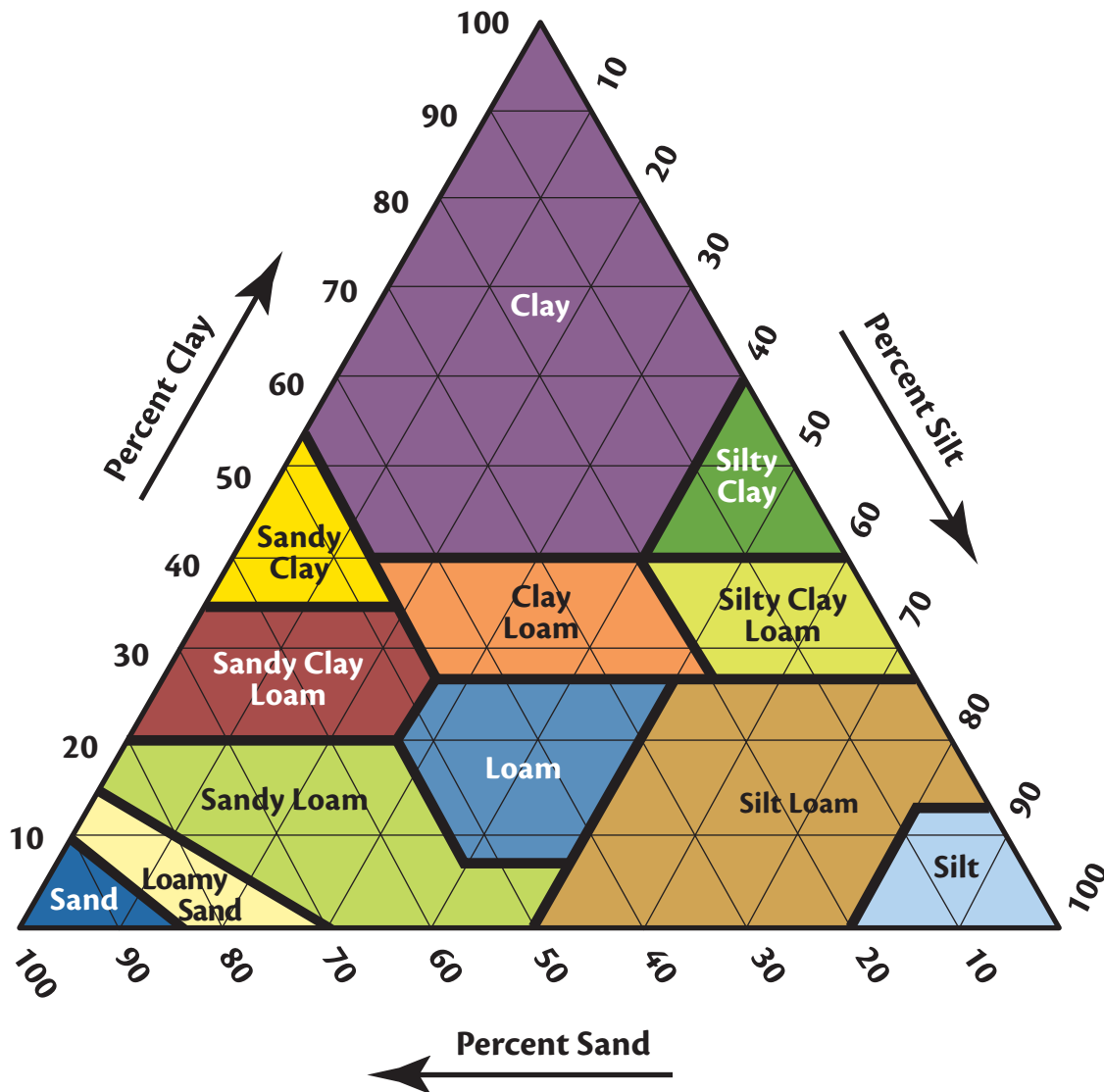
Silt is finer than sand, with particles between 0.002 and 0.05 millimeters in diameter. Silt feels powdery to the touch. Silt's finer texture holds water and nutrients in the soil well, making it a better texture for growing crops.

Clay

Clay is the smallest soil particle, measuring less than 0.002 millimeters in diameter. Clay tends to be very hard when dry and sticky when wet. Wet clay stains the fingers when handled. Clay soils are heavy and hard to work and do not allow water to penetrate or drain well, making them less desirable for growing most crops.



To determine the texture of a soil, one must first know the percentages of two soil types. For example, if a soil consists of approximately 30 percent clay and 20 percent sand, then that would mean the remaining amount, or 50 percent, is silt. The actual soil texture can be determined by where the lines of each percentage intersect. The lines for each soil type run the same direction in which the percentage numbers appear. If the lines intersect on a texture division line, either soil texture can be used.



Unit Summary

Plants and soil have been a part of the Earth for thousands of years. They provide a food source and circulate the oxygen we breathe. Without the soil, many of the plants we enjoy would not be able to grow, and without many plants, humans and animals would not be able to survive. Plants have been named using a taxonomic system identifying it first as part of the plant kingdom and continuing through the system to the lowest levels of classification, genus and species. Besides scientific classification, plants can also be grouped by their growing cycle and structures. Plants perform many processes including photosynthesis, respiration, and transpiration. Each of these processes plays a vital role in growth and health of the plant.

All plants need water, light, air, proper temperature, and a growing medium such as soil in order to grow. Without these requirements, plant health can suffer. Many of the requirements can be obtained from the growth media or soil. Not all plants grow in soil; many are planted in potting soil or mixes that contain organic and inorganic materials. Soil is formed over many years from the weathering of rocks with the help of climate and topography. Every soil is composed of different materials depending upon where it was formed. The soil texture is important because it shows how much sand, silt, and clay are in a soil. The proper mixture of these three minerals will greatly impact soil health and plant growth.

Unit Review

1. Why are plants given a scientific name along with a common name?
2. What language is used to scientifically name plants?
3. Give five Latin words and what they mean.
4. What is the difference between an annual, biennial and perennial plant?
5. What do the prefixes “mono” and “di” mean?
6. How do monocots and dicots differ?
7. Describe each of the three processes that occur in the leaf.
8. Which of the three plant processes described also occurs in humans? Explain.
9. What are the six requirements for plant growth?
10. What is hydroponics?
11. What is organic media?
12. Give two examples of organic media.
13. How is inorganic media different from organic media?
14. Describe how soil is formed.
15. Name the four components of soil and their average percentages.
16. What is the difference between sand, silt, and clay?
17. Explain how a soil textural triangle is read.



Unit 5

The Beef Cattle Industry

OBJECTIVES

- Discuss the history of the beef cattle industry and its role today.
- Identify major breeds of beef cattle and their characteristics.
- Identify factors to consider when selecting beef cattle for a specific purpose.
- Discuss the phases of beef production.
- Locate the parts of a beef animal.
- Determine the consumer products derived from beef cattle.

KEY WORDS

bovine
bull
calf
castrate
composite breed
cow
crossbred
heat tolerance
heifer
polled
purebred
roan
steer

The beef cattle industry contributes more than \$44 billion to the national economy. The top producing states for cattle and calves are Texas, Nebraska, Kansas, California and Oklahoma. A beef producer's income depends on the ability to identify cattle breeds and select quality animals. For consumers, it is important to know as much as possible about the beef industry to ensure purchases of beef products are wise and cost effective.

Beef Cattle History

Cattle have played an important role in the development of mankind. Not only have they always been used as a food source, but they serve as beasts of burden as well. As they were domesticated, the appearance of cattle changed. Today, modern cattle have been developed to suit the changing needs of the beef industry.



PhotoDisc Image

It is believed that cattle were first domesticated in Europe and Asia during the Stone Age. Modern cattle are descended from two species of wild cattle. These two species are called *Bos taurus* and *Bos indicus*. The *Bos taurus* species produced European-style cattle breeds, such as the Angus and the Hereford. These breeds are adapted to cooler climates and tend to have a docile nature. The *Bos indicus* species comes from India. Cattle breeds that are descended from this species are adapted to hot climates. They have a hump over the neck, droopy ears, and loose skin. They are also known as the Zebu type. The word *Bos* is the genus name for cattle also known as **bovine**.

Cattle were first brought to North America by early settlers from Europe and the British Isles. The settlers primarily used them as work animals, rather than raising them for beef as is done today. The beef industry began to develop as the United States expanded into the Great Plains during the nineteenth century. The vast grassy areas of the plains were well suited for grazing animals such as cattle.



Jupiter Images



Chisholm Trail Heritage Center Photo

Before the invention of refrigeration, there was no way to keep meat fresh while it was being transported from one area of the country to another. Cattle had to be slaughtered near the consumer markets. This gave rise to the great cattle drives. Cattle were brought from the range to the market where they were then sold. As refrigerated transport in trains (and later refrigerated trucks) became available, the cattle drives were discontinued.

Cattle are raised all across the United States, but the modern cattle industry is concentrated in the South and Midwest. Because of large areas of grazing land and an abundance of crops used to produce feed for the cattle, conditions in these areas are best suited to raising cattle.

In the past 40 years, consumers have developed a desire for leaner beef. Because of this, many different breeds of cattle have been developed that better meet this need. Newer breeds that produce a leaner carcass are more commonly raised today. In addition, cattle breeders will continue to improve breeds to meet changes in production conditions. For example, a drastic change in the types of feed available could make it more beneficial to switch to raising other types of cattle.

Hereford, Angus, and Shorthorn breeds were predominant in the past. Today there are more than 40 breeds of cattle raised for the beef industry. Many of these breeds combine *Bos taurus* and *Bos indicus* types of cattle to make use of the best characteristics of both.



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MAD COW DISEASE

Mad cow disease (bovine spongiform encephalopathy), a fatal disease of the central nervous system in cattle, was first identified in cattle in the United Kingdom in 1986. Scientists believe that the disease was spread among cattle from the practice of using meat and bone meal in the animals' diet. The exact cause of the disease is not yet known. Strong actions have been taken to eradicate the disease in Great Britain. In 2003, mad cow disease appeared in the U.S. and Canada in isolated cases. However, the USDA takes stringent measures to ensure that it does not become a widespread problem.

Major Breeds

Three breeds dominated the United States in the mid-1900s—the Hereford, Angus, and Shorthorn. Although these breeds still exist today, other breeds have joined them. As America's demand for leaner meat grew, more exotic breeds were introduced. The Charolais, Limousin, Simmental, and Maine Anjou are a few breeds brought to the United States for their leanness of meat and efficient growth.

Typically each breed is characterized by particular colors or characteristics. Some may have one or two solid colors while other breeds may be **roan**, a mixture of colors. Some breeds are horned while others are **polled**, naturally without horns. Each breed has characteristics that make them desirable over other breeds, such

SAE IDEA

Placement

Work as a beef feedlot assistant.

as meat quality, milking ability, fertility, heat tolerance, growth efficiency and disposition, to name a few. For example, the Angus is known for its excellent meat quality, while the Brahman is known for its **heat tolerance** or ability to withstand hotter climates.

Once breeders learned the desirable characteristics of each breed, new breeds began to develop in the United States. There was need for a breed that would withstand the heat of southern states, such as Texas, and provide superior meat quality. As a result, the Brahman and Angus were crossed to develop the Brangus. The Beefmaster breed is a combination of the Brahman, Shorthorn, and Hereford breeds. A cross between the Shorthorn and Brahman resulted in the Santa Gertrudis. A breed formed from two or more established breeds is considered to be a **composite breed**.

Due to the beef market's desire for black-hided cattle, many breed colors have changed from their once characteristic color to mostly if not all black. Cattle with black hide tend to sell at a higher price than cattle with other color hides. As the first step in qualifying for programs such as Certified Angus Beef, cattle producers have started to incorporate Angus genetics into their herds leading to cattle with mostly black hide, which is the USDA definition on Angus-type cattle.



American Angus Association Photo

Angus

The origin of the Angus breed is unknown, but it can be traced back to two Scottish breeds. Today, the Angus is the most widely known breed of beef cattle due to marketing efforts. Certified Angus Beef has increased the visibility of the black breed. The Angus is known for its solid black color along with its excellent meat quality. This is a polled breed with a moderate frame. Because many people associate black cattle with the Angus and high meat quality, black hides are becoming desired in many breeds.



ACA-AJA Photo

Chianina

This horned breed originated in Italy and was named after the Chianina (pronounced Kee-a-nee-na) Valley. As one of the oldest breeds in the world and dating back to pre-Roman empire, they were originally used for draft and meat production. The Chianina was originally white with black pigmentation on tongue, palate, nose, tail switch, and around its eyes. Today, many Chianinas are found to be black in color. Chianinas are sometimes crossed with Angus cattle (Chiangus), Herefords (Chiford), and Maine-Anjous (Chimaine). The Chianina Association is located in Kansas City, Missouri.



Jupiter Images



Mini Hereford Photo provided



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American-International Charolais Association Photo

Hereford

The Horned Hereford originated in England and was originally much larger, weighing more than 3,000 pounds, than it is today. A farmer in Iowa developed the Polled Hereford by breeding Horned Herefords that failed to develop horns. Physically the Hereford (polled or horned) is red with a white face and may also have white on the neck, underline, legs, and tail switch. It is moderate in size, docile and hardy. The Hereford has very little pigmentation to the mucous membranes, which may make them more susceptible to eye diseases. The American Hereford Association includes both polled and horned cattle.

The Mini Hereford breed was genetically developed with the use of dwarf-free Hereford bloodlines. This breed looks like a typical Hereford, just smaller in frame size. To be classified as miniature, the frame is measured at the hip with most Miniature Herefords ranging from 38 to 43 inches.

Shorthorn

The Shorthorn is from northern England and was often called a Durham after the county in which it originated. Even though the Shorthorn can be variations of red and white, roan (mixture of hair color) is the most common. This horned or polled breed was originally used for both milk and meat production, and the females are considered good mothers. Today, there are associations for both the beef Shorthorn and the dairy Shorthorn.

Charolais

This breed originated in central France and was developed as a dual-purpose breed for milk and meat production. The Charolais is typically white or off-white in color and can be polled or horned. It is a large-framed, heavy-muscled breed. Charolais have light color pigmentation to the nose, inner ears, and other body cavities. The King Ranch in Texas is noted for importing the first Charolais bulls to the United States. Today, the American International Charolais Association is located in Houston, Texas.



Jupiter Images

Simmental

The Simmental breed gets its name from where it originated, the Simme Valley in Switzerland. When first introduced, the color was light yellow, red, or spotted, with a white head, brisket, and belly and red spots around its eyes. Today, Simmentals can still be found with these color patterns; however, they also can be black, solid in color, or have white on the face. Simmentals can be horned or polled. They were originally used for milk and meat production and as a draft animal.



DeRouchey Cattle Company Photo

Maine Anjou

Originating from Brittany, France, the Maine-Anjou was developed as a cross between the Shorthorn and Mancelle breeds. These two breeds combined to create a rugged, meat-producing breed. The Maine-Anjou was named after two provinces that border Brittany: Maine and Anjou. It originally was a dark cherry red or black, with some white spots. Today, it is often found solid black and can be polled or horned. It is a docile breed with good marbling in the meat.



North American Limousin Foundation Photo

Limousin

This breed was developed in France near Limoges, which is how the breed gained its name. Limousin cattle are typically a red-gold color fading to light buckskin around their legs and muzzle. Current day Limousins can be solid black. The breed is noted for carcass leanness and having large loin areas. Many colleges use Limousin cattle in their beef research programs.

Bright Career Futures

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Production Workers, All Other
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Technicians
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Jupiter Images

Brahman

In India, cattle are only used for milk and drafting. It was with breeds of cattle from India, Brazil, and West Indies that the Brahman was developed in the United States. Brahman cattle are characterized by the large hump over their shoulders, droopy ears, sloped rump, and loose skin. This breed can be a variety of shades of gray, black, and red. Brahmans have an unpredictable temperament and are genetically resistant to some diseases such as tick fever.



Jupiter Images

Brangus

The Brangus was developed in the United States as a cross between the Angus and Brahman breeds. In order for a Brangus to be registered with the American Brangus Breeders Association, it must be 5/8 Angus, 3/8 Brahman, polled, and black. The hump on a Brangus is slightly less prominent than a Brahman but is apparent on many animals. The Brangus was developed to combine many of the desirable characteristics of an Angus and Brahman into one breed.



Beefmaster Breeders United Photo

Beefmaster

The Beefmaster is another cross between breeds. Developed in south Texas, it is a cross between Hereford (1/4), Shorthorn (1/4), and Brahman (1/2) cattle. There is no standard color for Beefmaster cattle, but this breed is typically red or dun color. The ears on a Beefmaster are set slightly lower and drooped. They are a hardy breed and the females are good milkers.



Santa Gertrudis Breeders International Photo

Santa Gertrudis

The Santa Gertrudis was developed in Texas at the King Ranch, which was in search for a breed that could withstand the harsh climates and insects while continuing to be productive. It is a 3/8 Brahman, 5/8 Shorthorn blend, deep red in color, and can be horned or polled. It is a hardy breed and adaptable to many environments.



Jupiter Images

Red Angus

The Red Angus shares many of the same traits as the black-hided Angus. The Angus breed is primarily black; however, the breed carries a recessive gene for red hides. Many breeders in warmer climates prefer the Red Angus because of its meat quality, quick growth, and easy calving traits while having a cooler hide due to the red color.

No matter the beef breed, certain terms remain consistent throughout the beef industry. When a beef animal is born, it is called a **calf**. This calf is either a **bull**, young uncastrated male, or a **heifer**, young immature female. If a producer plans to raise the bull for breeding stock, the breeder will not **castrate**, or remove its testicles. If the purpose of the calf is for slaughter, the animal will most likely be castrated, which then turns the male calf into a **steer**. If a heifer is kept as breeding stock and gives birth to a calf, she is then called a **cow**.

THE TEXAS LONGHORN—A SYMBOL OF SURVIVAL

Like the buffalo, the Texas Longhorn, a romantic symbol of the Old West, was once nearly wiped out. However, unlike the buffalo, the Longhorn was not slaughtered and hunted, but rather it was almost bred into nonexistence. The Longhorn is the only breed naturally adapted to North America. The origin of the breed can be traced to cattle brought to Mexico more than 500 years ago by the Spanish. For centuries, they bred naturally in Mexico and the southwestern parts of the United States. The breed developed strong endurance and resistance to diseases and harsh conditions.



Jupiter Images

After the Civil War, cattle breeders began to prefer European-style cattle, and the demand for Longhorns began to fade until they were on the brink of extinction. In 1927, a federal grant allowed for the purchase and preservation of one of the few remaining herds of Longhorns. In the early 1960s, there were about 2,500 in the United States. Today, largely because of the high-quality meat and the colorful hides, the demand for Texas Longhorn cattle has never been greater.

As the only breed supported by federal legislation, the Texas Longhorn, along with animals such as the American bison and white-tailed deer, is protected on at the Wichita Mountains Wildlife Refuge in Oklahoma. The refuge, established by Congress in 1901, serves as a sanctuary for cattle preserving them as a cultural and historical species.

Selecting Beef Cattle

The cattle producer’s decision of which breed to produce is almost as important as the initial decision to enter the cattle business. Before purchasing cattle, there are many factors to consider, such as the intended use, performance, environmental tolerance, and personal preference. These factors should be understood and prioritized.

First of all, producers should ask themselves, “How will the cattle be used?” Producers may raise cattle for different purposes. For example, the Texas Longhorn is often raised as a hobby or novelty breed. Some breeds, such as the Dexter, are used as a dual-purpose breed (milk and meat production). Other breeds are used for commercial beef production or a purebred breeding operation.

SAE IDEA
Exploratory
Plan and implement a hands-on livestock field trip.



Thinkstock Photos

For any specific purpose, different breeds may be available that emphasize traits that are useful for that purpose. Examples of such traits for a beef animal include frame size, structural soundness, muscling, and carcass quality. Each breed also has performance traits that should be considered including weaning weight, carcass quality, growth rate, and reproductive ability.

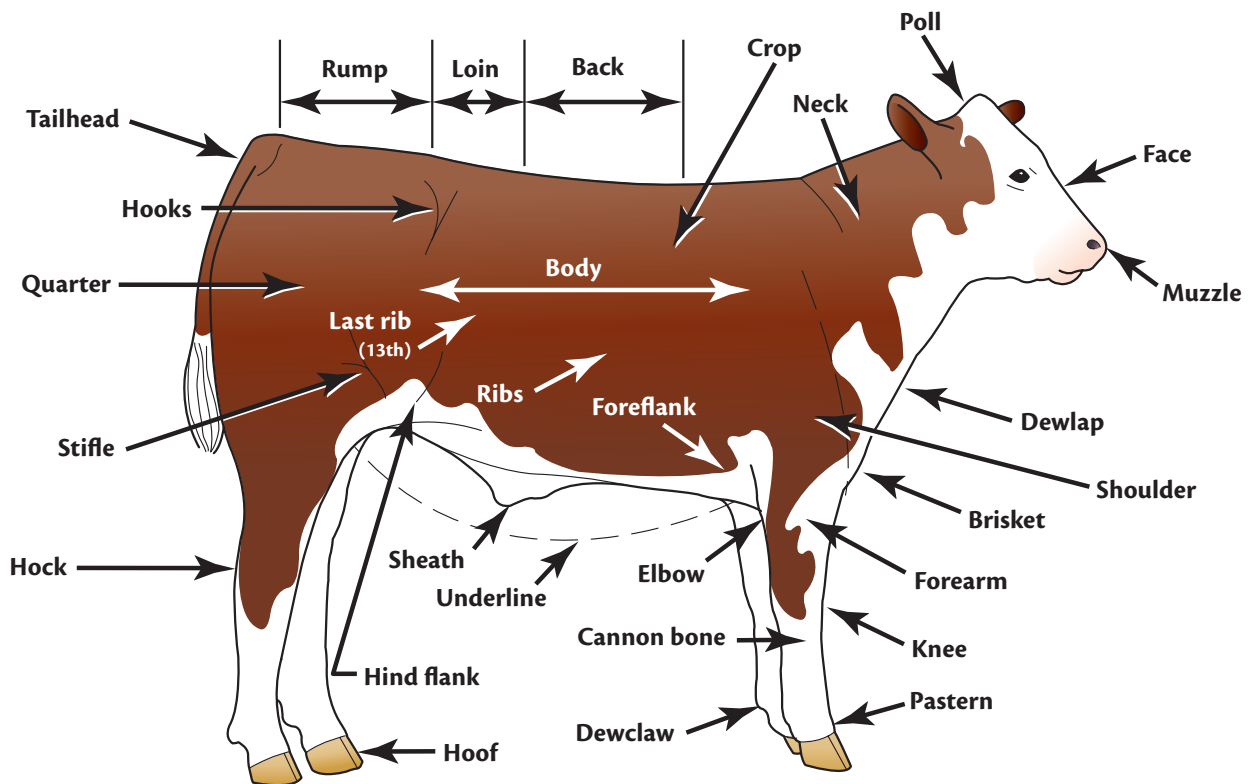
Different breeds of cattle are adapted to thrive in different conditions. Such factors include heat and cold tolerance, feed preference and foraging ability, and disease and parasite resistance. The producer should feel comfortable with the breed of cattle selected. Factors that may influence personal preference include horned or polled, temperament, and management requirements.



Thinkstock Photos

Parts of a Beef Animal

Beef cattle and dairy cattle are very similar in their body parts; however, the focus on a beef animal is to produce meat instead of milk. The parts most important on a beef animal for meat production include the loin, quarter, shoulder, brisket, and ribs. Each of these parts provides cuts of meat purchased by the consumer. Indicators of fat can be found on the ribs, brisket, and tailhead, to name a few.



Phases of Production

There are four major phases of beef production: purebred, cow-calf, stocker, and feedlot. Some producers may implement more than one phase, while some may focus only on a cow-calf or stocker operation.

Purebred Operations

A purebred operation is the first phase of production. A **purebred** animal is one that has only the original breed within its bloodlines. If two breeds, such as an Angus and Hereford are bred, the offspring is considered a **crossbred**. Different breeds will produce animals with different characteristics. For instance, some animals have a smaller or larger frame, some are adapted to different climates, and some may grow faster than others. This provides producers with animals that have the characteristics they desire.

Cow-calf Operations

A cow-calf operation produces the calves that will be grown and sold for beef. The operator keeps a breeding herd of cows and one or more bulls. The cows and bull are sometimes of different breeds, which allow the producer to further accentuate the traits he or she desires. Each year, the cows are bred so they will all calve within a relatively short period, usually during the late winter or early spring. The calves are kept on pasture with their mothers until weaning age, which usually occurs in the fall at about six to eight months. During this time, the calves grow to a weight of about 300 to 500 pounds. Prior to weaning, the operator will castrate, dehorn, and mark the calves (with branding or ear tags).

Cow-calf operators who use a pasture-breeding system will need one mature bull for every 25 to 30 cows.



USDA-ARS Photo

Stocker Operations

The next phase of beef production is the stocker operation. The stocker purchases weaned calves from a cow-calf operation. The calves are raised on forage or range for several months while they grow. The goal of a stocker operation is to allow the animal to mature to a point where it is heavy enough to be sold to the next phase of production. The animal needs to stop growing so its body can store fat in the desired way. There is a trend toward sending weaned calves directly to the feedlot. Production methods that allow a calf to be weaned at a heavier weight make it possible to bypass the stocker phase of production.

Feedlot Operations

When the animal has reached a sufficient maturity and weight, it will be sold to a feedlot. Feedlot operations are the final phase before the animal is sent to slaughter. During this time, the animal is fed a high-grain diet that is designed to put the correct finish or fat on the animal. Feedlots are often large, automated operations. The animals are penned together and fed as much of the ration as they will eat. The goal is to fatten the animals to improve the quality of meat and then send them to slaughter. The beef animal typically spends about 120 days at the feedlot and is 18 to 24 months old when it is ready for slaughter.

SAE IDEA

Entrepreneurship

Purchase stocker calves for wheat pasture in the winter or grass in the summer.

Consumer Products

Beef may be what's for dinner, but that's not the only use for beef. Beef by-products are also in the walls around you, the asphalt in roads, the fluids in cars, and the magazines you read. Because of the many uses for beef by-products, 99 percent of the beef animal is used. From household items to pharmaceuticals, beef by-products are benefiting people in everyday life.

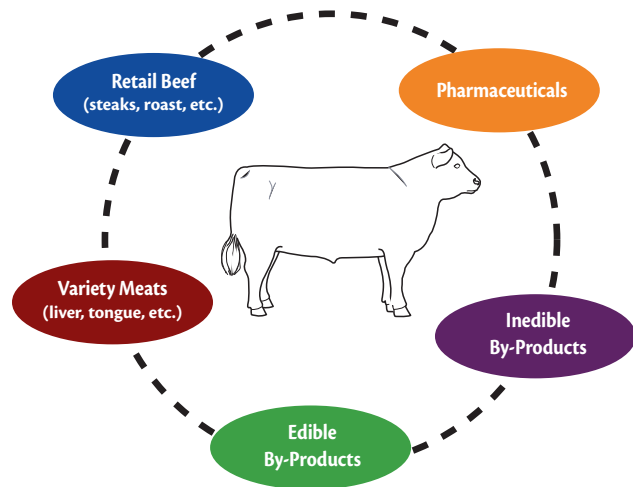


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Household Items

Many household items use ingredients derived from beef by-products. Stearic acid, which is derived from beef fat, is commonly found in cosmetics, soaps, and shampoo. Photographic film for cameras is made using a beef by-product. Pet foods and pet toys, such as rawhide chews, are often made from beef by-products. Other examples include bone china, leather goods, candles, crayons, toothpaste, insecticides, shaving cream, fabric softeners, glue, paints, upholstery, and floor wax.

Products and By-Products From Cattle



Industry and Manufacturing

You might be amazed at the products that have beef by-products in them. Lubricants, cleaners, fertilizers, and printing ink are just a few of these items used in industry. Additional examples include hydraulic brake fluid, car polishes and waxes, asphalt, high gloss for magazines, molds for plastics, cement blocks, whitener for paper, textiles, and drywall.

Edible Goods

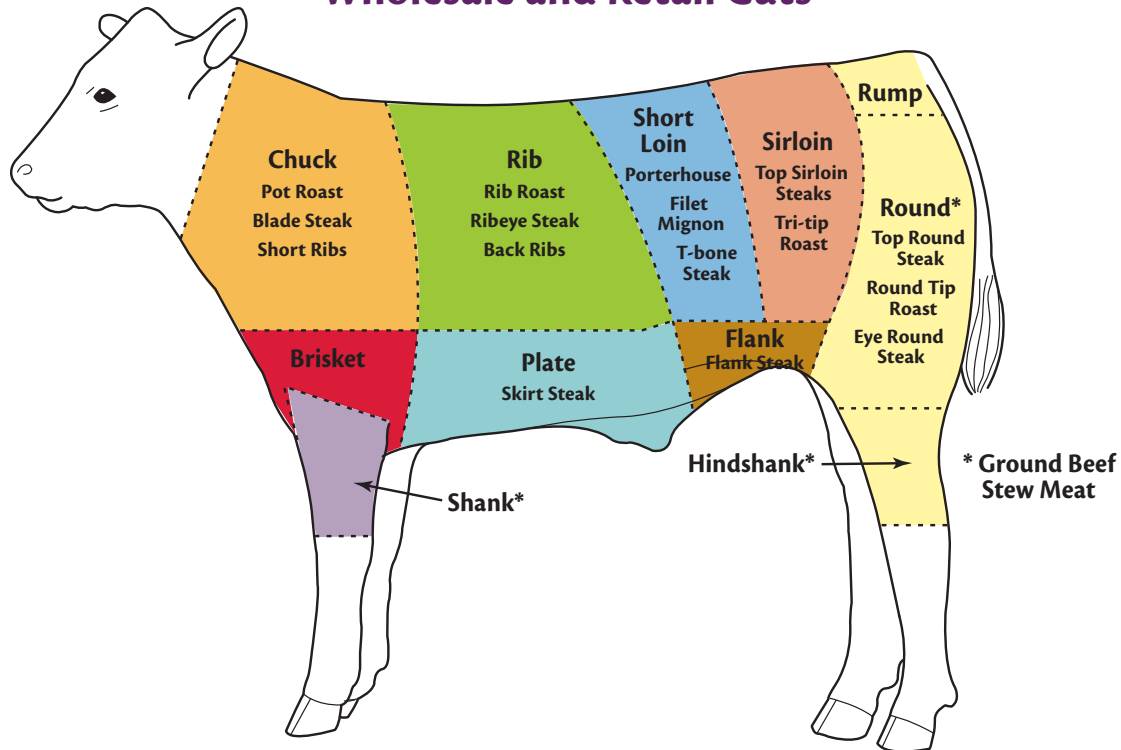
You may think only of hamburger or steak when you think of beef, but there are many edible goods that make use of beef or its by-products. Beef provides a variety of meat cuts which are sometimes ground for uses such as hamburgers. The liver, heart, kidneys, and tongue are called variety meats. These are sold at the grocery meat counter. Other foods, such as candy, shortening, ice cream, and chewing gum, often use a beef by-product as an ingredient. Some other examples are mayonnaise, marshmallows, sausage casings, yogurt, head cheese, gelatin, cookies, and shortening.

SAE IDEA

Research

Survey homes in your community to determine awareness of the use of animal by-products.

Wholesale and Retail Cuts



Pharmaceuticals

Many medicines use cattle hormones and other beef by-products. Some common ways they are used include thyroid replacement therapies, wound cleansing agents, anemia treatments, suppositories, and pill coatings.

Although beef and its by-products are a renewable resource, it is important to use as much of the animal as possible to get the maximum economic value from the animal and to reduce waste. As a consumer, you can also prevent waste in purchasing wisely and using all of what you purchase.

PHARMACEUTICAL PRODUCTS

- **blood factors** used making anti-rejection drugs and treating hemophilia
- **chymotrypsin** promotes healing of skin
- **collagen** used in plastic surgery
- **glucagon** used for treating low blood sugar
- **heparin** an anticoagulant (blood thinner) used to treat blood clots
- **insulin** used for treating diabetes or high blood sugar
- **pancreatin** aids in food digestion
- **thrombin** a coagulant that helps blood clot
- **vitamin B-12** supplement used to prevent B- complex deficiencies

Unit Summary

The uses of beef cattle have greatly changed since they were first brought to North America. Today, beef cattle fulfill the needs of the consumer by providing a food source, as well as other valuable products such as pharmaceuticals and cosmetic supplies. There are a variety of breeds to suit a producer's desires. While all beef cattle breeds are raised to produce a meat product, there are other factors taken into consideration such as heat tolerance, disposition, and growth efficiency. A producer may choose to engage in one or more phases of beef cattle production; however, some may choose to specialize in a particular area. No matter the phase operated, beef cattle producers have a common goal to produce a good quality meat product for consumers while raising healthy livestock for profit.

Unit Review

1. What is the difference between *Bos taurus* and *Bos indicus* cattle?
2. Why were cattle first brought to North America by early settlers?
3. What brought about the need for cattle drives?
4. Give an example of a composite breed.
5. Give a physical description for five breeds of beef cattle.
6. What color are many breeds of cattle today?
7. Name three breeds that are a crossbred using the Brahman breed.
8. What is the difference between a heifer and a cow?
9. State five factors a cattle producer may take into consideration when selecting beef cattle.
10. What are eight of the main parts on a beef animal?
11. Explain each of the phases of beef cattle production.
12. What are three household items made from cattle?
13. How has industry and manufacturing used cattle by-products?
14. What uses has the medical industry had for cattle?



Unit 6

The Swine Industry

OBJECTIVES

- Discuss the history of the swine industry and its role today.
- Identify major breeds of swine and their characteristics.
- Locate the key parts of a hog.
- Identify consumer products derived from swine.
- Apply the universal ear notching system.

KEY WORDS

barrow
boar
erect
farrow
gestation
gilt
lard
litter
porcine
pork
sow
wean

Pigs were the one of the first animals to be domesticated, and the Chinese were the first to raise wild pigs for food. **Pork** is the meat of pigs, and the production of pork has seen many changes over the years with the most dramatic of these changes occurring within the last few decades. At one point in time, many small family farms each raised relatively few pigs. Now, large farms, though fewer in number, each raise large numbers of pigs.

Swine are useful as meat animals, research animals, entertainers, and pets. There are not many other animals that can claim so many occupations. Some people think pigs are dirty and ignorant. In fact, pigs wallow in mud to stay cool because they don't have the ability to sweat, and they are as intelligent as dogs.

Swine Industry History

The pig has been a part of human life for several thousand years. There is evidence that humans may have used pigs as early as Neolithic times. The Chinese were the first to domesticate pigs, perhaps as early as 7000 B.C. Europeans were raising pigs by 1500 B.C. The pig has been with us long enough to have found a place in nearly every facet of our lives—in our food (the average American eats more than 60 pounds of pork products each year), our literature (ever read *Charlotte's Web*?), our cultural icons (don't forget Miss Piggy), our language (hogwash!), our health (insulin and heart valves), and even the backbone of our economy (Wall Street is so named because it is where Manhattan residents built a wall to protect their dwellings from scavenging pigs).

SAE IDEA

Research

Test the selection of young pigs based on grade and lean yield at slaughter.

The domestic pig descends from two wild types—*Sus scrofa* is a European wild boar, and *Sus vittatus* is an East Asian pig. The genus *Sus* means pig, and the species *scrofa* or *vittatus* determine the type of pig. **Porcine** is a general Latin term relating to all pigs. While Christopher Columbus did bring pigs on his voyage to the New World, Hernando DeSoto is credited with starting the first pig herd in North America. Thirteen pigs landed with him in Tampa Bay, Florida, in 1539. Those 13 pigs began breeding, and three years later the colony had a herd of 700 pigs.



Jupiter Images

Other explorers and colonists brought their share of pigs to the New World. By 1660, pigs in the Pennsylvania Colony numbered in the thousands. Most farmers kept a few pigs, which supplied meat for their families and provided additional income. For most of their history, pigs were allowed to scavenge for their food, or they were fed household scraps and garbage. Finishing pigs on a corn diet first became common practice in Pennsylvania.

In the mid-1800s, Cincinnati, Ohio, became the first city to commercially slaughter pigs. As refrigerated transport became available in the latter part of the 19th century, pig production began to concentrate in the Midwest “corn belt.” Producers took advantage of the abundance of grain available in this area to feed their pigs, and production became cheaper than raising pigs close to consumer centers.

Corn Belt



Iowa has long been the country’s largest producer of swine. Before the 1950s, **lard**, or fat, was a major product from pigs. People used it extensively in cooking, as well as for making soaps and candles. Until that time, pigs were developed to produce large amounts of fat. Since the advent of vegetable oils and synthetic products that have largely replaced lard, pigs have been developed to emphasize the type of meat the health-minded consumer wants. The modern pig produces leaner meat and much less fat than its ancestors.

Major Breeds

While there are not as many different breeds of swine as there are cattle, there are still several breeds from which to choose. Each breed has been developed to emphasize certain characteristics. Breeds can be identified by observing the color of the animal, its general size and shape, and the type of ears, either **erect** (upright) or drooped. Breeds whose names end in “shire” have erect ears. The Duroc, Hampshire, and Yorkshire breeds are three of the most popular breeds in the United States.

The Duroc is known for its variations of red color and droopy ears. It is desired by breeders for its meat production. The Hampshire is a heavily muscled, lean-meat breed that is identified as being black with a white belt circling its shoulders, front legs and feet. The Yorkshire is known as the “mother breed” with its white body and erect ears.

SAE IDEA

Exploratory

Conduct a survey of all livestock operations in your area.

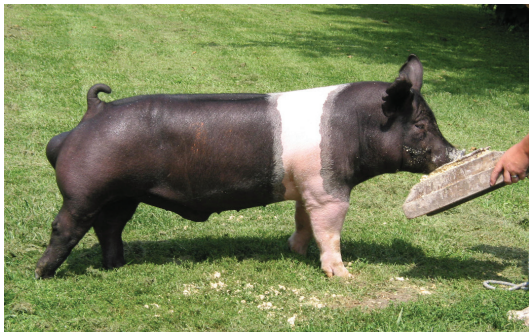
Other breeds produced in the United States include the Berkshire, Chester White, Spot, Poland China, and Landrace. Some of the less popular breeds include the Pietrain and Hereford. These breeds all have desirable characteristics depending upon the use and personal preference. Some breeds have superior mothering qualities while others contribute to high-quality meat production.



National Swine Registry Photo

Duroc

Durocs were developed in the U.S. and are a solid red color with no white on their body. There can be variation in the color, ranging from a very light golden red to a very dark red. This breed has a medium-length body and a slightly dished face. The ears droop over the eyes and should not be held erect. The Duroc is considered a good meat-type hog.



Prairie State Semen, Inc. Photo

Hampshire

The Hampshire was developed in Kentucky from imported Old English pigs. They have a distinctive color pattern. The body is black with a broad white "belt" that encircles the shoulders, including the front legs and front feet. The body is medium length, and the ears are erect, not covering the eyes. Hampshires are a heavily muscled, lean-meat breed.



CIMC Photo

Yorkshire

Developed in the county of York, England, the Yorkshire has a white body with small, erect ears. The goal of the Yorkshire breed is to be a source of durable mother lines that can contribute to longevity and carcass merit. The breed motto is, "The mother breed and a whole lot more."



Prairie State Semen, Inc. Photo

Berkshire

As one of the oldest identifiable breeds, the Berkshire, originating in England, has a black body with six white points (the feet, face, and tail tip). The ears are short and erect, and it may also have splashes of white on the body. The Berkshire is a breed with traits of fast and efficient growth, reproductive efficiency, and meatiness. At one time, it was a popular lard breed.

ABOUT THE NATIONAL SWINE REGISTRY

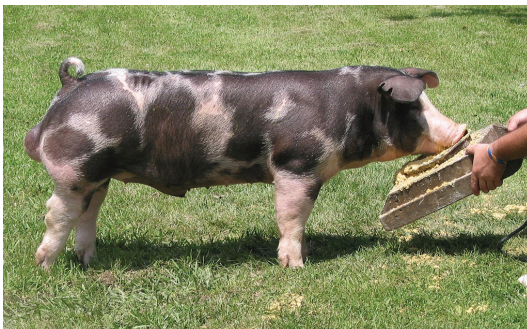
The National Swine Registry (NSR) was formed in 1994. Four breed registries were combined to create the NSR—Hampshires, Landraces, Durocs, and Yorkshires. These four breeds represent 87 percent of the total purebred hog population in the United States. Genetic trends are monitored for all four breeds and incredible advances have been made in the past few years. For more information about the NSR, visit their web site at www.nationalswine.com.



Prairie State Semen, Inc. Photo

Chester White

The Chester White has an all-white body with drooping ears. It is named for Chester County in southwest Pennsylvania where it was developed in the early part of the 19th century. The sows are known to be very prolific with, on average, more than 11 pigs weaned per litter. Chester Whites also have good mothering ability, durability, and soundness.



Prairie State Semen, Inc. Photo

Spot

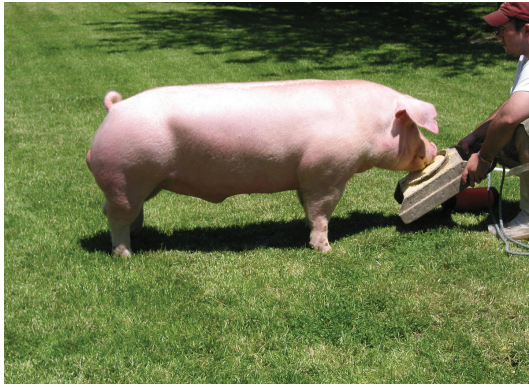
The roots of today's Spot breed can be traced to the Poland China. Once called the Spotted Poland China, the breed was largely developed in Ohio and Indiana. The Poland China was dropped from the name in 1960. The breed is known for its spotted body with an ideal ratio of 50 percent black to 50 percent white. Its ears are forward leaning or drooped, and they are fast-gaining and feed efficient.



Prairie State Semen, Inc. Photo

Poland China

This breed came from neither Poland nor China. Rather, it was developed in Ohio and the origin of its name is a mystery. The Poland China has a black body with six white "points" - the feet, nose, and tail tip - and drooping ears. This breed was originally considered a lard-type hog, but recent selection efforts have resulted in the breed conforming more to a meat-type hog.



Prairie State Semen, Inc. Photo

American Landrace

Also known as the Landrace, this breed was developed using a foundation of Danish Landrace hogs. They may look similar in color to a Chester White; however, the Landrace is longer bodied with larger ears. The Landrace is known for its mothering ability and prolificacy with an average 10 to 12 pigs per litter. The breed is typically gentle, but the large ears interfere with vision, which can easily startle a hog if approached unexpectedly.



Photo provided

Hereford

The Hereford breed was developed in about 1920 by a group of breeders in Iowa and Nebraska. The Duroc and Poland China was used along with possibly some Chester White and Hampshire hogs to develop the bloodline. Once the Hereford was established, a breed registry was opened in 1934. The Hereford breed has a white face with not less than two-thirds red aside from the face and ears. The pig should have at least two white feet not less than one inch above the hoof. The shade of red can vary from light to dark.

WHY DON'T PEOPLE IN SOME CULTURES EAT PORK?

In some cultures, laws were handed down that pork was from an "unclean" animal and was not to be eaten. Even though some of the reasons for avoiding pork were based on religious beliefs, this made a great deal of sense from a health perspective. Hundreds of years ago, the risk of eating contaminated pork was very high. Obviously, refrigeration and freezing were not available. Salt for preserving meat was a precious commodity, as was firewood for smoking meat. Illnesses due to the consumption of contaminated pork can be life threatening. Today, sanitation, proper preparation, and safe handling of pork, coupled with up-to-date farm management and inspection practices, have reduced the threat of contamination in foods. But for those living hundreds of years ago who did not have access to a safe food supply, it can be said that early religious laws functioned as the world's very first health departments.

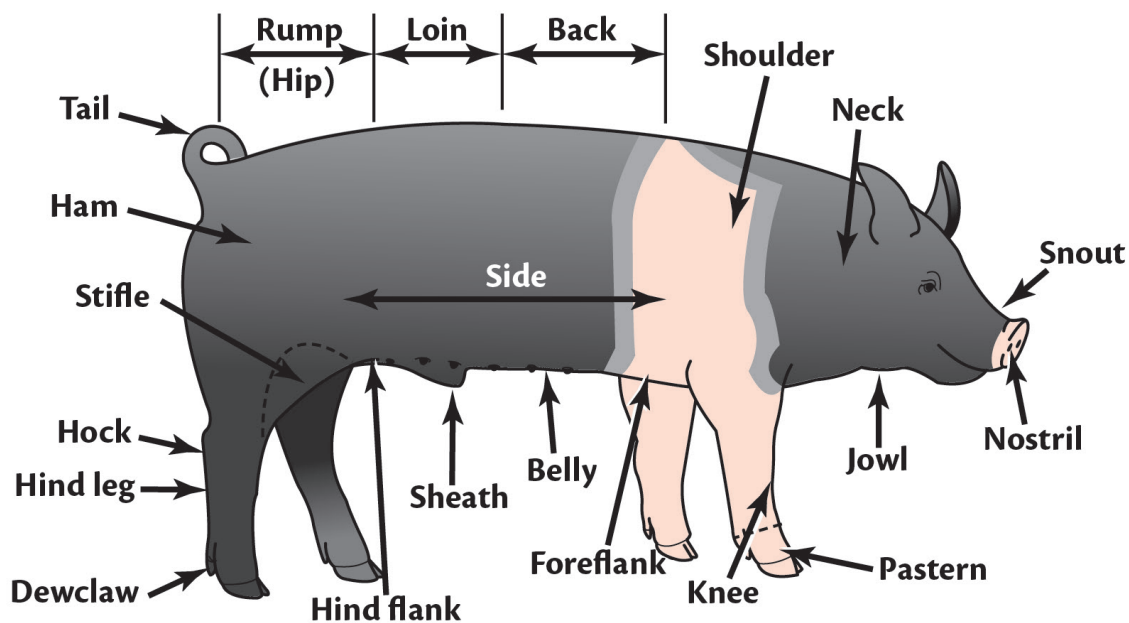


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Parts of a Hog

It is important to know and use the correct terms for the parts of the body when discussing swine. When evaluating the muscling of a hog, the ham, loin, and rump are often the main focus. To determine the amount of fat a hog may have, the jowl, shoulders, and loin are often viewed. The sheath is specific to male hogs – boars or barrows. A **boar** is a male hog that has not been castrated and can reproduce, while a **barrow** is a castrated male hog.

An immature female is a **gilt**. After a gilt is bred, she will **farrow**, or give birth. On average, swine will give birth to 8 to 10 pigs, also known as a **litter**. Once the gilt farrows a litter of pigs, she is then termed a **sow**. It takes a gilt or sow an average of 114 days (3 months, 3 weeks, 3 days) from breeding to farrow, which is called **gestation**. A producer will **wean** the litter, or remove from the mother, somewhere between 3 to 6 weeks depending upon facilities, care, and production schedule.



**Bright
Career
Futures**

<p>Agricultural and Food Science Technicians</p> <p>Environmental Compliance Inspectors</p> <p>Food Scientists and Technologists</p>	<p>First-Line Supervisors of Animal Husbandry and Animal Care Workers</p> <p>Geneticists</p> <p>Slaughterers and Meat Packers</p>
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For more information visit, O*Net Online www.onetonline.org

Consumer Products

In the past, farmers who raised pigs took pride in using “everything but the oink.” This ability to get every possible use from a resource is still important today and is just one aspect of the sustainable agriculture concept. These days, however, the products and uses that are gained from swine range far beyond any that the long-ago farmer could have imagined.

Human health care is one area where swine contribute in unique ways that other animals cannot duplicate. Many of their physiological systems, such as the cardiovascular and digestive systems, are very similar to our own. For this reason, pigs are used in different types of health research and to produce a variety of health-care products and medicines.

Animal models in research

Pigs are considered an excellent animal model for conducting cardiovascular research. The pig’s heart-to-body-size ratio is similar to a human’s. Pigs are also susceptible to a number of the same cardiovascular diseases and stressors. They have been used in research on diabetes, alcoholism, gastrointestinal diseases, peptic ulcers, liver transplant studies, wound healing, and plastic surgery. Pigs used for medical research are not slaughtered for human consumption.

Treatments for wounds and diseases

Swine are the source of over 40 kinds of medications. Other treatments derived from pigs include the use of tissue from pig skin to treat severe burns or skin rashes, pig heart valves as replacements for human heart valves, and insulin taken from the pig’s pancreas gland to treat diabetes. In addition to its contributions to the health care industry, the pig offers by-products in other areas as well.



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Household

The fatty acids and glycerin from slaughtered pigs are ingredients in many products: cellophane, floor waxes, insulation, plastics, and matches. The bones from slaughtered pigs are used to create such items as bone china, glass, glue, porcelain enamel, and water filters.

Hobbies

The fatty acids and glycerin from slaughtered pigs are used to make chalk and crayons. The blood from slaughtered pigs is used to create fabric dye. Hair is used to make artist’s brushes. And, as most people know, a football is sometimes called “pigskin” because leather from pig hides is often used to make them.



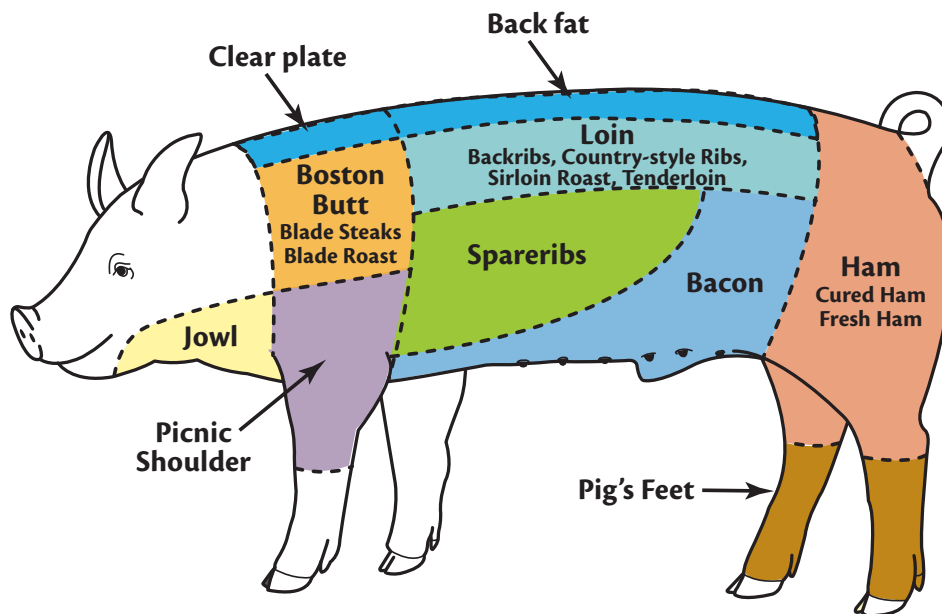
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Industrial/Agricultural

The fatty acids and glycerin from pigs are ingredients in cement, antifreeze, rubber, insecticides, and weed killers. Bone meal and manure are used for fertilizers. Swine play a vital though largely unrecognized part in our lives. So the next time you feel inclined to call someone a “pig,” remember how pigs help us live longer, healthier, happier lives. You will be giving that person a compliment of the highest order.

Food Products

When you think of food that comes from swine, you might think about bacon, ham and sausage. Those are very common food products, yet other foods use by-products from swine, such as gelatins and pork rinds. According to the USDA, Americans eat approximately 50 pounds of pork per person each year.



SWINE FLU? IS THERE SUCH A THING?

Nearly a decade ago, a strain of Influenza A, also known as H1N1, was labeled a pandemic by the World Health Organization. This strain of flu was first labeled as “swine flu” because it was thought to have originated from swine. After genetic testing of the virus, scientists concluded that the virus is very different from the virus that typically circulates in North American pigs.

The novel H1N1 virus actually has genes from European and Asian pigs, along with birds and humans.



Universal Ear Notching System

The Universal Ear Notching System is used by pork producers to identify pigs. Notches made in the pig's right ear identify the litter in which it was born. Notches made in the pig's left ear give the pig a unique number from that litter. The pig's "name" is its litter number combined with its individual number.

For example, a pig born in the 42nd litter of the year at a particular farm, and the last in a litter of 8 would be pig 42-8. The "dash" is spoken, so you would say, "forty-two dash eight" to refer to this pig. Each ear is divided into numbered quadrants. There can be up to two notches in each quadrant, and the tip of the ear can be notched as well.

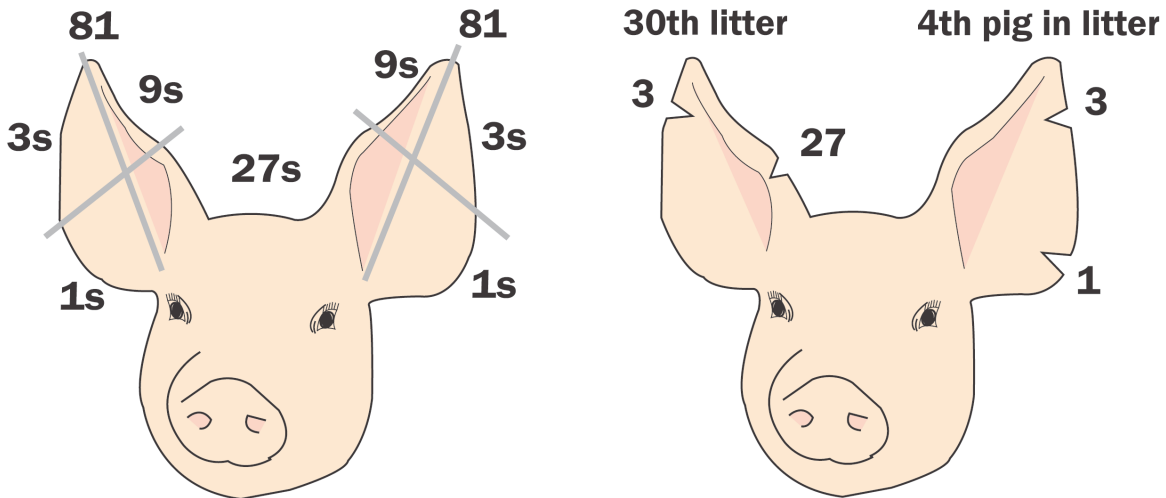
- Each notch in the outside, lower quadrant counts as "1"
- Each notch in the outside, upper quadrant counts as "3"
- Each notch in the inside, upper quadrant counts as "9"
- Each notch in the inside, lower quadrant counts as "27"
- A notch in the tip of the ear is "81"

All the notches in the pig's right ear are added to make the litter number. All the notches in the pig's left ear are added to make the individual number. With this system, all numbers between 1 and 161 can be represented.

SAE IDEA

Placement

Work for a swine breeder or corporate swine facility.



EXAMPLE:

This pig's ear notches show that it comes from the 30th litter on the farm that year, and it was the 4th pig in the litter. On the litter ear, one notch in the 3 quadrant plus one notch in the 27 quadrant adds up to 30. On the individual ear, there is one notch in the 1 quadrant, plus one notch in the 3 quadrant. This adds up to 4. The pig is 30-4.

Unit Summary

Swine, wild and domesticated, have been a part of human existence for thousands of years. Throughout the years, the use of hogs has shifted from a fatter animal to one that produces a much leaner meat in response to consumer demand. The variety of breeds allows producers to select a breed for its meat production or mothering ability. Many times breeds are crossed to combine traits most desirable into one animal. Swine have been used in many ways from research to medicine and glue to paintbrushes with the most popular use being meat products. Beginning in the Neolithic times, swine proved to be useful and still continue to do so today.

Unit Review

1. How has the production of pork changed over the years?
2. What two wild pig types do most domestic hogs originate?
3. Who started the first pig herd in North America?
4. Why is the largest hog population in the Midwest?
5. What in a breed name will indicate erect ears?
6. Choose four breeds and describe the physical characteristics of each.
7. Name three breeds that originated in the U.S.
8. Which breeds are known for their mothering ability?
9. What is the difference between a boar and barrow?
10. How long does it take a pig from the point of breeding to have a litter of pigs?
11. What have been some research uses of swine?
12. Name five household uses of swine products.
13. Draw and label a pig with the universal ear notching system quadrants.



Unit 7

The Sheep Industry

OBJECTIVES

- Discuss the history of the sheep industry and its role today.
- Identify major breeds of sheep and their characteristics.
- Locate the parts of a sheep.
- Identify consumer products derived from sheep.
- Recall facts about wool composition and quality.

KEY WORDS

closed-faced	shearing
crimp	staple length
ewe	wether
fiber diameter	worsted
fleece	wool
lamb	yield
lanolin	
mutton	
open-faced	
ovine	
pelt	
ram	

Sheep have many advantages as a livestock species. Not only do they produce both fiber and meat, but they are also adaptable to a variety of production systems. Careful selection of breeding stock and assessment of existing pastureland and buildings can make sheep production a profitable enterprise. In the latter part of the 20th century as synthetic fibers were developed that replaced wool, the sheep industry in the United States began to decline. According to the USDA, the U.S. sheep and lamb population peaked at 56.2 million head in 1942. By 1996, the number of sheep and lambs had declined to 8.4 million. Today, there are approximately 5.8 million head of sheep and lambs in the United States.

History of the Sheep Industry

Sheep were among the first animals domesticated by humans. Although they are not as important as cattle or swine in today's economic picture, they have been a significant source of fiber and meat for much of human history. Sheep are thought to have been domesticated about 10,000 years ago. There is even some evidence that people were using sheep's wool as long as 20,000 years ago.



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Modern domestic sheep are descended from wild sheep of Asia and Europe called Mouflon.

Over the centuries, the production of wool became a priority. Sheep breeds were developed that gave finer wool fiber. Archeological evidence in Iran suggests that sheep were being selectively bred for their wool 6,000 years ago. The fine wool sheep breeds of today originated with the Spanish Merino, which was developed more than 1,200 years ago. The first Merino wool sheep were imported to New England in 1793. Within the following 20 years, the demand for Merino sheep swept across the Northeastern United States.

Columbus and other European explorers carried sheep with them on their voyages to the New World. Spanish missionaries introduced sheep to Indian tribes in Mexico. Sheep are still a major part of the Navajo tribe's culture. In fact, the Navajo name for sheep translates as "that by which we live."

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Major Breeds of Sheep

There are as many as 1,000 distinct breeds of sheep in the world today, with about 50 breeds found in North America. However, many of these breeds are quite rare, and some are even at risk of extinction. In the United States, the Suffolk breed is most popular comprising nearly 60 percent of the sheep population. A purebred breed is one that has stayed true to its breed lines with no crossing with other breeds. Many breeds were developed by crossing two or more breeds until a distinct breed began.

Sheep are raised primarily for wool and meat, though some sheep dairies provide milk for cheese-making. Breeds can be classified by the type of wool they produce. The classifications are fine wool, medium wool, long wool, crossbred wool, and hair sheep. There are distinctive characteristics that separate the various breeds. For example, some breeds are considered *open-faced* breeds, which indicate they have no wool on their face, while other breeds are considered *closed-faced* breeds, which means they do have wool on their face. The general Latin term for all sheep is *ovine*.

SAE IDEA
Entrepreneurship
Raise sheep for breeding, show or market.



Photo Courtesy of American Southdown Breeders' Association

Southdown

Originating from the Downs of Sussex County, England, the Southdown is a medium- to small-sized breed, though the American Southdown is larger than the traditional. The Southdown actually has been used in the development of other breeds including the Hampshire, Shropshire and Suffolk. Southdowns are a polled, medium-wool breed raised mostly for its meat. They are an early maturing breed, and ewes have good lambing ability and average milk production. They are characterized by light colored wool, with a mousy-brown color on the face and legs. Southdowns also have small ears and dark nostrils.



American Hampshire Sheep Association Photo

Hampshire

The Hampshire is a large, medium-wool breed that originated in Hampshire County, England. Most of the Hampshires in the United States today were imported post-Civil War. The Hampshire has a mild disposition and is best known for the production of club show lambs. The breed is also noted for rapid growth and efficient feed conversion. Hampshires are characterized by a dark, relatively wool-free face and legs with large ears, along with a wool cap and wool on the legs.



Jupiter Images

Suffolk

With the use of Southdown rams and Norfolk Horned ewes, the Suffolk was developed. Originating in England, the Suffolk was brought to the United States in the late 1800s and is now the most common sheep breed in the country. Suffolks have a black head with a Roman nose. The breed can also be distinguished by its black, wool-free legs and large, semi-droopy ears. It is a medium-wool, polled breed that is raised mostly for its meat.



Banner Sheep Magazine Photo

Shropshire

The Shropshire is a multi-purpose breed suitable for meat, wool, and dairy production. They originated in England as a cross between Southdown, Leicester, and Cotswold breeds. Shropshires, or Shrops for short, were introduced into the United States in 1855 and were one of the most common breeds at that time. They are a medium-sized sheep and one of the heaviest wool producers among medium-wool breeds. Shrops are characterized by wool on their legs, jaw and cap with small ears.



Jupiter Images

Dorset

The Dorset breed is one of the oldest English breeds that actually dates back to the Middle Ages. Dorsets are predominantly white with a wool-free face. The nose, eye membranes, and hooves are pigment free. As a medium-sized, medium-wool breed, the Dorset can be either horned or polled, though the polled variety is more common. The ewes are good mothers and good milkers, and can breed out of season giving lambs at any time of the year.



Jupiter Images

Rambouillet

The Rambouillet originated in France and descends from the Spanish Merino, an old breed that produces some of the world's finest wool. Some distinguishing characteristics include a wool-free face below the eyes and forward-facing, downward-tilting ears. The Rambouillet has good carcass characteristics and is considered a dual-purpose breed. They adapt well to most climates; however, they are susceptible to maggots living in their fleece, which is why they aren't too often found in damp, humid climates.



Montadale Sheep Breeders Association

Montadale

Developed near Kansas City, Missouri, the Montadale began as a cross between a Cheviot ram and a Columbia ewe. The breeder, E.H. Mattingly, was looking for a breed that combined the qualities of wool quality, fertility, and meat production. The Montadale is a medium-wool, dual-purpose breed. They are noted for producing high-quality carcasses and excellent wool that is very white in color. Due to the small head size of the breed, there are rarely birthing issues that arise.



USDA-ARS Photo

Dorper

The Dorper breed originated in South Africa when the Dorset Horn and the Blackhead Persian were crossed. It is considered to be a hair sheep due to the hair fibers it produces rather than wool. There are two Dorper breeds – the Dorper, which is black headed, and the White Dorper, which is white headed. The Dorper is known for its fat tail and ability to withstand warm climates with little rainfall.



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Speckled Face

The Speckled Face breed (also known as the Beulah Speckled-Face) originated in Wales. Its wool-free face is white speckled with black. It also has a black muzzle and black around the eyes and ears. Ewes are often crossed with other breeds such as the Suffolk to produce market lambs for meat. Purebred Speckled Face sheep do not meet the market's demand for lean, fast-growing sheep.

DAMARA SHEEP—A HERITAGE BREED

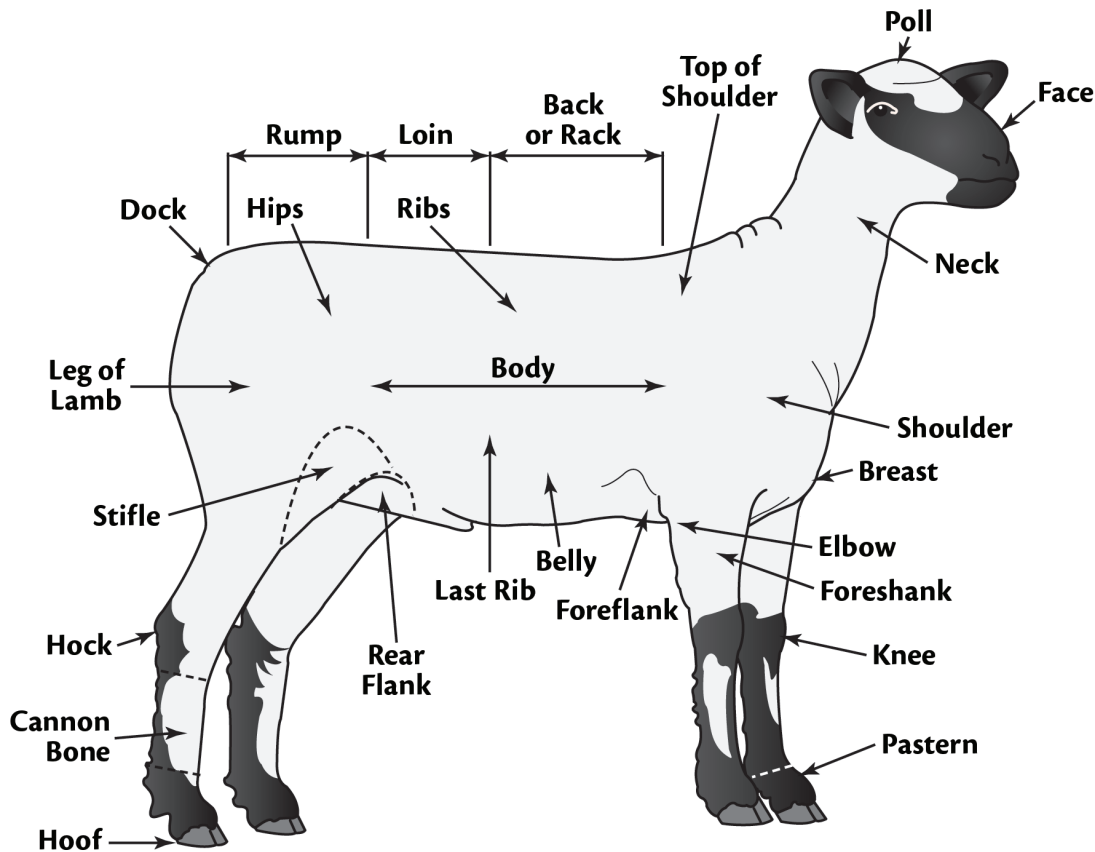
Most sheep raised today belong to breeds that have been selectively bred for a commercial purpose. But hundreds of other sheep breeds exist. Some of these lesser-known breeds, called heritage breeds, were popular at one time but have fallen out of favor in today's production climate. Some heritage breeds are considered "natural breeds" because they developed their unique characteristics without any intervention by humans. An example of one of these hardy and ancient breeds is the Damara Fat-Tailed Sheep. Such breeds can be saved from extinction through the efforts of people who raise them for their own use or as a commercially viable breed; the Web site <http://www.damaras.com> shows one such farm. To learn about preserving heritage breeds and the importance of maintaining the genetic diversity of all livestock, visit the American Livestock Breeds Conservancy at <http://www.albc-usa.org>.



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Parts of a Sheep

When studying parts of animals, it is important to know the anatomical differences between males and females. A **ewe** is a female sheep of any age and is distinguished from a ram by certain body parts. A **ram** is a male sheep that has not been castrated. A ram will have a sheath and testicles, while a ewe will have neither of these parts. A **wether** is male sheep that has been castrated, which is typically done when lambs are raised for market.



Consumer Products

The major products from sheep are meat and wool. Milk from sheep is also used to make specialty cheeses. Like other livestock, confined sheep produce manure that is valuable when used as a fertilizer. **Lanolin**, a grease-like substance that naturally coats the sheep's wool, is a common ingredient in lotions and moisturizers. Slaughtered sheep provide the raw materials for many other by-products, such as glue, soap, fertilizer, and cosmetics.

SAE IDEA

Exploratory

Visit a sheep rancher during a time when they are shearing sheep.

Meat

The meat from sheep younger than one year old is called **lamb** and is the type of sheep meat most often eaten in the United States, as well as most Western countries. Meat from sheep that are older than one year is called **mutton**. While neither meat is widely popular in the United States, other countries and cultures regard it as a staple. Middle Eastern and Greek cultures consider lamb or mutton a central part of their diets, and Australian families tend to eat lamb on a weekly basis. In the United States, lamb consumption is most frequent in a restaurant setting. On average Americans eat less than one pound per capita each year, which is much less than countries such as Australia and Saudi Arabia. People in those countries consume over 25 pounds per person each year.



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Wool

Wool is the fiber taken from the sheep by **shearing** (shaving or clipping) from the sheep's skin. The wool taken from one sheep is called a **fleece**. Wool is a very warm and strong fiber, but it is also elastic, which allows it to be spun into yarn. While wool is the product most often associated with sheep, it is less profitable than meat or even milk. However, wool is still an important product that is used in a variety of ways. Wool sweaters and suits, blankets, and batting for futons or quilts are just a few examples. Selling fleeces to people interested in fiber arts, such as hand spinning, knitting, and weaving, provides a small but popular market.

Pelts

When the hide taken from a slaughtered lamb or sheep still has the wool attached, it is called a **pelt**. If the pelt has less than one inch of new wool on it and is clean and in good condition, it can be used for products such as slippers, mattress pads, and carseat covers.

Milk

Most sheep's milk is made into cheeses. Feta, Pecorino Romano, and Roquefort are some of the more well-known types of cheeses made from sheep's milk. Some people also drink sheep's milk, which is considered a very nutritious and easily digestible product with a slightly sweeter taste than cow's milk. Sheep dairying is more common in European countries than in the United States. The breed of sheep most often used in dairies is called the East Friesian.



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Wool Composition and Quality

Wool is a versatile fiber that is used in a variety of ways, from woven and knitted fabrics to insulation, carpets, rugs, and felt. It meets the needs of all these uses because it is strong, soft, warm, water-repellent, fire-resistant, and durable. The relative fineness or coarseness of the wool fibers is one of the primary factors that determine the type of product made. Fiber length is also important. Fine fibers that are at least three inches in length can be processed into **worsted** fabrics, while shorter fibers are processed into woolen fabrics. Worsted yarns produce a lighter, finer fabric and are used for high-quality garments such as suits. Woolen yarns have more bulk and softness and are used for garments such as sweaters and coats.

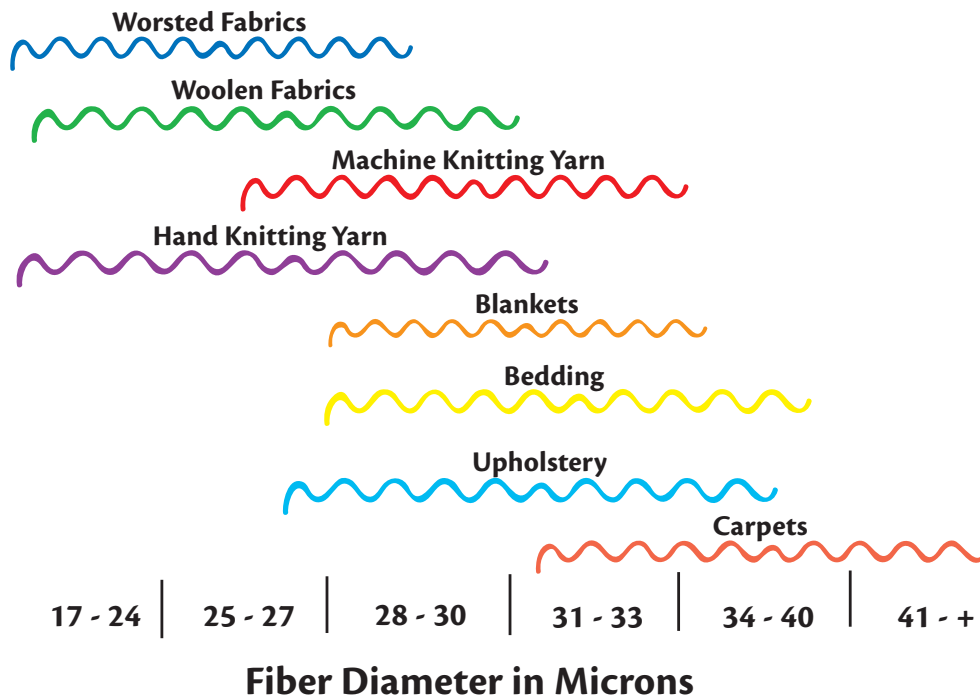
SAE IDEA

Placement

Work for a sheep producer that prepares show lambs for sales.

Evaluating wool quality is done after the fleece is taken from the sheep, which normally occurs once a year. Several factors are evaluated. The **fiber diameter** is an average of the fibers in a fleece. On any sheep, fibers on the shoulder will be the finest, while fibers from the hind leg are the coarsest. A good fleece will not have much variation.

The larger the measurement in microns, the coarser the wool. The average for a fine fleece can be as low as 14 to 15 microns, while the average fiber diameter for a coarse fleece may be 40 to 45 microns. An older system of determining fiber diameter is called “spinning count.” In this system, the higher the spinning count, the finer the fiber diameter.





Jupiter Images

Staple length will determine what the wool can be used for. The length of the fibers should be fairly consistent throughout the fleece. The **yield** is the weight of the fleece after it has been cleaned of the lanolin and any dirt or plant matter. It is expressed as a percentage. For instance, a clean fleece that weighs half of what it did prior to cleaning has a yield of 50 percent.

The fiber strength is tested by pulling on both ends of a sample tuft of wool from the fleece. If it breaks easily and unevenly, it is considered tender. If all the fibers in the tuft break at the same length, it is called broken wool. Both of these conditions are undesirable.

The **crimp** is the waviness of the fibers. Usually, wool with a smaller fiber diameter will have more crimp. The color is important because most commercial buyers want a white fleece with no colored fibers. Any colored fibers, even in a mostly white fleece, means it will be considered a colored fleece.



WHY DOES WOOL SHRINK?

Everyone has heard the joke about the well-meaning person who does the laundry and accidentally shrinks a favorite woolen sweater to doll-size. The care of woolen garments isn't difficult, but doing it the wrong way can lead to a laundry disaster.

In fact, wool doesn't exactly "shrink." Instead, the moisture, rubbing, and heat from washing and drying causes the wool to felt. Felting locks the wool fibers together in a way that prevents them from expanding to their full length. This happens because of the wool fiber's structure. Each wool fiber has microscopic scales on it. When the fiber is on the sheep, all these scales are growing in the same direction (toward the tip). But once the wool is removed from the sheep and processed, the individual fibers end up pointing in opposite directions. This means that as each fiber rubs next to its neighbor, the microscopic scales catch and hold on to each other.

The tiny scales create a ratcheting effect on the fiber; instead of being able to stretch back to its normal length, it can only get smaller and smaller. Ultimately, all the fibers are compressed tightly together and the unfortunate garment is no longer the soft, fluffy, wearable size it once was. The good news is that fabric manufacturers now have methods of treating wool that allow it to be washed normally with no ill effects.

When done intentionally, felting is a way of processing wool. Felting uses the short fibers that cannot be processed into yarn. It produces a fabric called felt or boiled wool.

“NATURAL” WOOL

Naturally colored wool is growing in popularity, particularly among people who like to do their own spinning and weaving. Most commercial buyers prefer white wool so they can dye it any color they want, but there is a market for naturally colored wool that has not been dyed. No one particular breed of sheep gives naturally colored wool. In fact, colored wool can come from almost any breed of sheep because it can be selectively bred for color, just as white wool has been. These natural colors come in an array of red, gray, brown, blonde, and black. For more information about naturally colored wool, visit the Web site of the Natural Colored Wool Growers Association at <http://www.ncwga.org>.

Unit Summary

As one of the first domesticated animals, sheep have provided many beneficial products to humans. Fiber, meat, and milk production all have played a role in the U.S. economy with fiber and wool being the most important. There is a variety of breeds raised dependant on a producer's desires. Some breeders prefer breeds that provide more meat where others may focus on wool production. As consumers, we benefit from sheep by the clothes we wear, hygiene products we use, and food we eat. Wool fibers can be used for clothing, blankets, bedding, or carpets depending on a variety of factors such as fiber diameter, staple length, and crimp. Although the uses of sheep have declined over the years, they still provide us with many valuable products.

Unit Review

1. Why did the need for wool decline in the 20th century?
2. Where are modern domestic sheep decedents from?
3. What is the primary purpose for raising sheep?
4. What is the difference between an open-faced and a closed-faced breed?
5. Outline the distinguishing characteristics of four sheep breeds.
6. Which breed can give birth to lambs any time of the year?
7. What is the difference between a ram and a wether?
8. What sheep product is common in lotions and moisturizers?
9. What is the difference between wool and a pelt?
10. Name five finished products made from sheep.
11. Is wool coarser or finer as the fiber diameter increases?
12. Describe staple length, yield, and crimp in terms of wool.
13. Why does wool shrink?



Unit 8

The Dairy Cattle Industry

OBJECTIVES

- Discuss the history of the dairy cattle industry and its role today.
- Identify major breeds of dairy cattle and their characteristics.
- Locate the parts of a dairy cow.
- Identify consumer products derived from dairy cattle.
- Explain the physiology of milk production.
- Discuss recent technological advances in dairying.

KEY WORDS

aveoli
cisterns
colostrum
cream
curds
dry cow
emulsifiers
lactation
lactose
mammary system
oxytocin
pasteurization

springer
vertically integrated
whey

How often do you drink milk, eat yogurt or ice cream, or spread butter on your toast? If you are like most Americans, the answer is “every day!” The dairy cattle industry, the source of all of these products, is one of the most important agricultural industries. While California, Wisconsin, and New York are the states with the most dairies, Oklahoma boasts its own unique claim to dairy fame— Braum’s Dairy, one of the world’s largest. Braum’s is unusual in the dairy cattle industry because it is truly **vertically integrated**, which means that it does everything from milking the cows and growing food for the herd to manufacturing dairy products and selling the products from its own stores. The dairy cattle industry is an important part of agriculture and continues to advance in its methods of production.

History of the Dairy Cattle Industry

Using the milk from other mammals as food for humans has been a practice for many thousands of years. Archeological records show that Egyptians used milk, cheese, and butter in 3,000 B.C., and milking cows is an activity recorded as early as 9,000 B.C. The history of dairying in the United States began when the first dairy cattle were brought to the Jamestown colony in 1611. For hundreds of years, dairy cattle were kept in small numbers on family farms. Milk, butter, and cheese could be processed and sold only in small quantities to local customers. Because milk and milk products are quite perishable, the lack of refrigerated transportation made large-scale dairying difficult. The mid-1800s saw the beginning of a series of inventions and processes that allowed dairying to become a thriving industry. In 1856, Gail Borden invented a process for making canned condensed milk. This allowed fluid milk to be stored for long periods. Condensed milk was a major food source during the Civil War. In 1861, mechanical refrigeration allowed milk to be transported much greater distances without spoiling.



USDA-NRCS

In 1890, Stephen Babcock invented a method for determining the amount of butterfat in milk products. The Babcock Butterfat Test helped dairy farmers market and price their products according to the value of their fat content. In 1895, milk pasteurization became commercially available. **Pasteurization** is the process of heating a food product to kill bacteria. Pasteurized milk can be kept longer and is safer to drink. The first decades of the 20th century saw the introduction of homogenized milk, as well as milk fortified with Vitamin D. During the 20th century, new breeding technologies had a major effect on how dairy herds were managed. Artificial insemination became commercially available in the 1930s, and embryo transfers were introduced during the 1970s.

In the 1990s, a hormone called recombinant bovine somatotropin (rBST), also known as recombinant bovine growth hormone (rBGH), began to be used on cows to increase milk production. The FDA has ruled that milk from cows treated with this hormone is safe, but controversy over its use continues. Advances in health, production, nutrition, breeding, and technology are bringing about radical changes in the dairy cattle industry. Today, dairying involves detailed computer records kept for each cow, expensive machinery for milking, and use of the latest reproductive technologies.

SAE IDEA

Research

Study the effects of genetic selection in groups of animals over time.

Major Breeds of Dairy Cattle

Milk production is one of the most important characteristics of any dairy animal. Milk production is calculated in pounds on a yearly basis per cow, with each cow being milked an average of 305 days a year. Cows are typically milked in a dairy parlor and must have a calm disposition to keep them from becoming nervous during the milking process. Each breed of dairy cattle has its own characteristics with some known to produce more milk on average or milk with a higher fat content.



Eileen DeBruin Photo
Courtesy of Oklahoma State University

Holstein

The Holstein, also known as the Holstein-Friesian, is the most popular breed of dairy cow in the United States. This breed originated in the Netherlands. Holsteins are large with distinctive black and white or red and white markings. They are known for excellent milk production, with the average yearly production per cow at 21,167 pounds of milk. The Holstein's milk is lower in butterfat and protein than the milk of other dairy breeds.



Mark Jensen Photo
Courtesy of the American Jersey Cattle Association

Jersey

The Jersey is a British breed that originated on the Isle of Jersey. Their color varies from nearly white to mousy gray to a dark tan or fawn color. They are often darker around the head and shoulders than on the body and also may have a dark tail switch. The Jersey breed is famous for the amount of butterfat and protein in the milk. They are smaller than other breeds of dairy cattle and average approximately 16,100 pounds of milk per cow.



American Guernsey Association Photo

Guernsey

The Guernsey is a British breed. They are of intermediate size and are a fawn color with white markings. The Guernsey's milk is noted for its golden color, which occurs because the milk is high in beta-carotene. According to the USDA, the average yearly milk production for Guernseys is approximately 18,000 pounds.



Ayrshire Breeders Association Photo

Ayrshire

The Ayrshire breed originated in Scotland and is a particularly hardy breed. Ayrshires are moderate-sized animals that are spotted red and white in color. Ayrshire milk has a moderate amount of butterfat, but it is relatively high in protein. The average Ayrshire cow can produce about 17,230 pounds of milk.



Bruce Kuehl Photo
Courtesy of the American Shorthorn Society

Milking Shorthorn

This breed originated in England and is one of the oldest breeds in the world. They can be red, red and white, or roan in color. The Milking Shorthorn is not a distinct breed, but rather a segment of the Shorthorn breed. On average, Milking Shorthorns produce 15,030 pounds of milk per year.



Cybil Fisher Photo
Courtesy of The Brown Swiss Bulletin

Brown Swiss

Aptly named, this breed originated in Switzerland and is brown in color ranging from light to dark including grayish to black-brown. The breed adapts well to all types of weather and is noted for good udders, feet, and legs. Milk production is good, with the average cow's yearly production at 21,127 pounds.

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Parts of a Dairy Cow

A dairy cow has many of the same parts as a market beef animal such as the muzzle, dewlap, brisket, elbow, knee, heel, pastern, dewclaw, and tailhead. A dairy cow does have some parts not discussed on a market beef animal. The udder and teats are more apparent on a dairy cow and are of more importance due to their functionality. Also, the pin bones on a dairy cow are a prominent and significant feature. If pin bones cannot be seen on a dairy cow, the cow is storing fat instead of turning the grain and forage she eats into milk. For this reason, the visibility of the pin bones is needed.

SAE IDEA

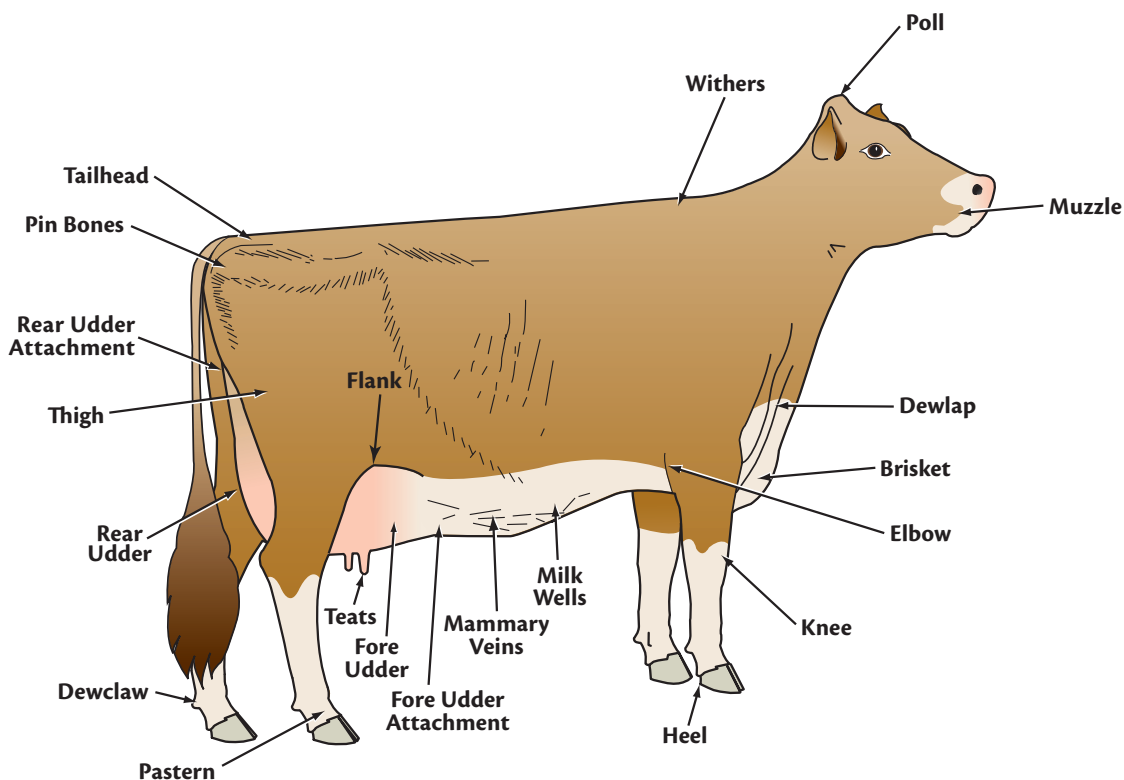
Exploratory

Visit a milk processing plant or a cheese factory to examine how cheese is made or how milk is processed.

The **mammary system**, or milk producing system, on a dairy cow is vitally important to the production of milk. On the underneath side of a cow, mammary veins should be present leading into the fore udder. These mammary veins carry blood to and from the udder. A good flow of blood to the udder helps it produce more milk. Before a cow gives birth, the blood flow increases, which stimulates milk production leading to an enlarged udder.

A cow's udder has four compartments, one for each teat, and can weigh nearly 40 pounds when empty. It is important for a cow to have strong support by ligaments to hold not only an empty udder but also an udder that is full with milk. The udder is not held by the skin, which only acts as a protective covering.

All cows are made up of these parts, but the mammary system for a dairy cow is especially important because milk production is its primary purpose. Proper placement and support of all parts is essential for maximum production.



Consumer Products

“Little Miss Muffet, sat on a tuffet, eating her curds and whey.” This common nursery rhyme tells of two milk production products. When milk is curdled and strained, the watery portion left is the **whey**. In the rhyme, Little Miss Muffet was eating cottage cheese because the **curds**, or solid portion, were left with a slight bit of the whey left in the mixture.

The dairy cattle industry provides consumers with a wide range of products. Most of these are derived from milk, though veal and beef are also products of the industry. There are so many different products made from milk that it is easiest to consider them in categories: fluid milk, creams, concentrated milks, cultured milk, frozen products, cheeses, and butter.

SAE IDEA Entrepreneurship

Make products such as butter to sell at a local farmer’s market.

Fluid Milk Products

Most fluid milk products can be separated into whole milk, reduced-fat, low-fat and fat-free types. Whole milk has not had the fat content reduced. It has no less than 3.25 percent milk fat and contains 8 grams of fat per eight-ounce serving. It is pasteurized, homogenized, and fortified with Vitamin D.



Jupiter Images

Reduced-fat, low-fat, and fat-free milk have had some or all of the fat removed from them. Reduced-fat milk is 2 percent fat; low-fat milk is 1 percent fat; and fat-free milk has no fat (also called skim milk). These products are normally pasteurized, homogenized, and fortified with Vitamins A and D.

Raw milk is whole milk that has not been homogenized, pasteurized, or fortified. This is milk in the same form that it comes out of the cow, so it contains some types of bacteria and proteins that are normally destroyed in the pasteurization process. Because it is not homogenized, the milk will separate and the cream will rise to the top. Raw milk must be labeled as such, since state and federal food safety laws generally require that milk be pasteurized. Dairies that produce raw milk for sale must undergo very strict health and safety inspections of the cows, the dairy, the employees, the machinery, and the milk itself to ensure that it is safe for people to drink.

Flavored milks are popular with kids and adults. Chocolate milk is the most common, though you will also find flavors such as vanilla, strawberry, and mocha on the grocery store shelf. Flavored milks are usually made with reduced-fat or low-fat milk and have had flavorings and stabilizing agents added.

Lactose-reduced and lactose-free milk is available for people who are lactose intolerant. **Lactose** is a naturally occurring sugar in milk. Lactose intolerance means that a person's digestive system does not have the enzymes needed to break down the sugar. Drinking milk can make these people feel ill. Lactose-reduced and lactose-free milks are a good alternative for such individuals.

Creams

Cream is the portion of the milk that rises to the top. It consists of about 40 percent milk fat in its normal state. Cream is combined with varying amounts of milk and other ingredients, such as emulsifiers and stabilizers, so that different types of cream products can be made. Cream is normally pasteurized or ultra-pasteurized.

TYPES OF CREAM

- **Half-and-half** — blend of milk and cream and contains between 10.5 and 18 percent milk fat
- **Light cream** — 18 to 30 percent milk fat, “table cream” or “coffee cream”
- **Light whipping cream** — 30 to 36 percent milk fat
- **Heavy whipping cream** — at least 36 percent milk fat, whips more readily than light whipping cream

Concentrated and Dry Milks

Evaporated milk is pasteurized milk that has had 60 percent of the water removed from it. It is then homogenized, usually fortified, and canned. This product is often used for cooking. Sweetened condensed milk is another canned milk product often used in recipes. As with evaporated milk, about 60 percent of the water is removed from pasteurized milk that has been sweetened with sugar. The sweetener also prevents spoilage.

Dry milk comes in non-fat and whole forms. This milk is in powdered form and can be used for cooking, or it can have water added to reconstitute as fluid milk. Dry buttermilk is also available. Malted milk makes a tasty beverage. It is made from milk that has malt added before the mixture is dehydrated into powdered form.

THE STORY OF MALTED MILK— A REAL ‘WHOPPER’

Did you know that malted milk—the all-American treat—was originally sold as a health food? Malted milk was first invented in the 1870s by brothers James and William Horlick of Racine, Wisconsin. Their process for making malted milk involved mashing malted barley and wheat flour, mixing in whole milk, and then evaporating the milk to a dry form under a vacuum.

The product was originally marketed as a nutritious drink mix for infants and invalids. Also, for reasons then not fully understood, it was recognized that malted drinks helped people to fall asleep. Because of this, the product was also promoted as “a cure for night starvation.”

The Horlicks’ product was sold in powdered and tablet form. In addition, it was featured at drugstore soda fountains as an ingredient in chocolate milkshakes, which later became known as “malted” or simply “malts.”

The malt in a malted milkshake makes the drink very different from a regular milkshake. Malt is made from grain which is allowed to soak and sprout before being lightly roasted. Sprouting converts most of the grain’s sugar into starch. Toasting then caramelizes the sugars and gives the malt a nutty, sweet taste. As you may have guessed, because of the sugars, malt is high in calories.

The Horlick Company was eventually sold and moved to England, and the Racine plant closed in 1975. Horlick malt tablets and powdered drink mixes are now hard to find in the United States, though they can often be ordered through specialty food stores. But malted milk can still be found in many other food items such as the candy favorite “Whoppers.”

Cultured Dairy Foods

Yogurt is a very popular cultured product. It is made with a mixture of milk and cream fermented by an active culture of lactic acid-producing bacteria. It can be found plain or with a variety of fruit flavorings and sweeteners.

Acidophilus cultured milk has the active culture *Lactobacillus acidophilus* added to it. This bacterium is considered an aid to digestion. Acidophilus milk is also normally pasteurized and homogenized. Sour cream is cream that has been treated with lactic acid-producing bacteria to produce a thickened product with a characteristic tangy taste.



Yogurt with berries and granola
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Buttermilk was once a by-product of making butter but is now generally made through culturing milk with appropriate types of bacteria. It can be made with whole, reduced-fat, or non-fat milk.

Frozen Dairy Foods

Ice cream is a mixture of milk, cream, sweeteners, and flavorings that is stirred together as it is frozen. Commercial ice cream usually includes other ingredients such as stabilizers and emulsifiers. **Emulsifiers** are substances that keep together liquids that tend to separate such as oil and water. Ice cream has a minimum of 10 percent milk fat. Ice milk is similar to ice cream, but it contains less milk fat at 3 to 5 percent.

Sherbet contains less milk fat and more sugar than ice cream. It is usually made with a mix of syrup or fruit juice and contains between 1 and 2 percent milk fat. Frozen yogurt is a mixture of pasteurized milk, lactic acid cultures, and other ingredients that is stirred and frozen to make either a hard or soft, frozen product. Frozen yogurt that is pasteurized before it is frozen will not contain the live active cultures that are part of what some claim makes yogurt a healthful food. Some manufacturers add these live cultures after pasteurization.

Cheese

According to the National Dairy Council, about one-third of all the milk produced in the United States is used to make cheese. Natural cheeses are made from milk protein called casein. There are more than 400 varieties of natural cheese that are classified according to their degree of hardness.



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Processed cheeses are made using natural cheeses blended with other ingredients, such as emulsifiers, to produce a moister product with a more uniform texture. Pasteurized processed cheeses are blends of natural cheeses that have been processed using heat. Cold pack is a blend of natural cheeses that are processed without using heat. Special flavorings are often added. Cheese spreads are flavored, spreadable cheeses such as garlic-flavored or pimento cheese spread.



CHEESE CLASSIFICATION

Hard cheeses

Firm cheeses

Semi-soft cheeses

Soft cheeses

Parmesan, Swiss, Romano, Cheddar, Gruyere, and Colby Edam, Gouda, and Provolone
Bleu, Mozzarella, and Limburger
Brie, Camembert, Feta, Ricotta, Cottage Cheese, and Cream Cheese

Butter

Butter is made from pasteurized cream and is 80 percent milk fat. Lightly salted butter has salt added, which modifies the flavor and acts as a preservative. Unsalted butter has not had salt added to it – many cooks prefer to use unsalted butter in recipes. Whipped butter has air mixed in to increase its volume, making it softer and more spreadable.

Milk Production

Like all other mammals, a cow produces milk to nourish her young. She will not produce any milk unless she has a calf. Dairy heifers begin their milking life by being bred at about 15 months of age, and since the gestation period is nine months, a heifer will give birth around two years of age. A cow is rebred about three months into her **lactation**, or milking period in order to complete a yearly cycle of calving, lactation, drying off, and calving again. After a cow has been bred and begins to show signs of pregnancy, she is called a **springer**.

About two months before calving, a cow will begin to dry up, or stop producing milk in preparation for birth. During this time, she is deemed a **dry cow**. This period is important to ensure cows restore nutrients and health in preparation for the next lactation period. The first milk a cow produces after calving is called **colostrum**, which contains nutrients vital to the health of the newly born calf.



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The cow's udder has four quarters, each with its own mammary gland. Within the mammary gland are groups of tiny units called **aveoli**, where the milk is actually produced. The aveoli are connected with a system of ducts to larger holding areas called **cisterns**. Each quarter of the udder has a gland cistern, which holds about two pounds of milk. Each gland cistern drains into its own teat cistern, which is connected to the outside of the teat by the streak canal. On average, one cow can produce 6-8 gallons of milk each day.

To get milk from the cow, she must be stimulated to have a milk letdown reflex. In the natural state, a calf sucking on the teat would cause this reflex to happen. At a dairy, the procedures associated with being milked serve the same purpose. When the cow experiences this type of activity, she produces a hormone called **oxytocin** that starts the milk letdown reflex. After milking, the process of manufacturing and storing milk begins again.

SAE IDEA

Placement

Work for a local dairy farmer.

Technological Advances

The dairy cattle industry has been at the forefront of many of the technologies in use with livestock today. Dairy farmers continue to boost production and efficiency through expanding knowledge and new technologies. Just a few examples are found with reproductive technology, electronic animal identification, and robotic milking.

Embryo Transfer

A dairy farmer's success largely depends on the productivity of the cows. A high-producing cow is a valuable asset and one from which the farmer will want to raise many replacement heifers. In the past, this process was slow, since even the best cow can only bear one calf per year. However, the ability to transfer an embryo from one cow to another is a relatively new technology that allows cows to produce several calves in a year. Like artificial insemination, which allows a bull to sire far more offspring than would be possible from natural service, embryo transfer allows a cow to pass her traits to numerous offspring each year.

Embryo transfer is performed by removing fertilized eggs from the superior cow and transplanting them into surrogate cows. The embryo grows and is born to the surrogate mother, but the calf is a genetic offspring of the donor. One problem associated with embryo transfer is that any potential genetic problems the cow has are transferred to more calves than would normally be possible. Along with the transfer of embryos, it is now possible to test semen and embryos for gender, which would allow producers to add offspring of a particular gender to their herds.

Electronic Identification

Electronic identification is used with all kinds of animals, including pets and livestock. In the dairy cattle industry, electronic identification can be attached as an ear tag, a tag on a neck chain, as an injectable microchip, or as a rumen bolus that the animal swallows. An electronic reader gathers the coded information from the transponder in the animal. Information encoded on the electronic dairy tag could include the breed, date of birth, the animal's location, and health and performance data. At a dairy farm, this information can be used to identify the animal when it enters the milking parlor. Such systems may even provide cows with individual feed rations. Data from the electronic identification system and the milking system are recorded in a database to make a complete production record for the cow.



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Robotic Milking

Because milking a herd of dairy cows is extremely labor-intensive, automating this chore with a robotic milking system could save a great deal of work and expense. Robotic milking systems are far from common, though they can be found more frequently in Europe than in the United States. Robotic milking requires cows to be trained to use it. Cows enter a milking stall voluntarily.

Once in the stall, the system recognizes and records the cow's identity electronically. It then provides feed for the cow and begins the robotic milking process. The robot cleans the cow's udder and attaches the milking machine to her udder just as a human worker would do. The milking machine automatically detaches when the cow has finished producing milk and the cow is allowed to exit the milking stall. Robotic milking allows producers to milk hundreds of cows in one day and is part of some of the largest dairy operations in the world.



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Unit Summary

The dairy cattle industry provides consumers with a variety of products but not without the hard work of thousands of dairy farms across the nation. Each of these dairy farms houses different breeds of dairy cattle each for different reasons such as milk yields or milk fat content. Of all the parts on a dairy cow, the mammary system is the most important. The functionality of this system is what allows a cow to produce milk after each calf is born, with each cow averaging 6-8 gallons of milk each day. Milk production is a complex process controlled by natural hormones. Through technological advances, consumers have products such as fluid milk, cheese, ice cream, and butter to name a few. As technology continues to increase, dairy production will also continue to become more efficient, resulting in a better product for consumers.

Unit Review

1. Explain the term vertically integrated.
2. What made large-scale dairy farming difficult before the 1800s?
3. How has pasteurization changed the dairy cattle industry?
4. How many days on average are cows milked?
5. Which breed of dairy cattle is the most popular in the United States?
6. Which breed produces milk high in beta-carotene?
7. Which breed is a segment of another breed of cattle?
8. Why is it important that pin bones be visible on a dairy cow?
9. Name the four classes of treated fluid milk and explain the differences.
10. How is evaporated milk made?
11. Name two examples of cultured dairy foods.
12. What must a cow or heifer do before she is able to produce milk?
13. Explain embryo transfer.
14. What is robotic milking?



Unit 9

The Horse Industry

OBJECTIVES

- Discuss the history of horses and their role today.
- Identify common breeds of horses and ponies, and their characteristics.
- Discuss the use of equine for work and recreational uses.
- Locate the parts of the horse.
- Identify horse colors and markings.

KEY WORDS

colt
dorsal stripe
draft horse
equine
feathers
feral
filly
foal
gelding
hands
light horse
mare

points
pony
stallion
withers

Many people love horses. But just because people enjoy working with horses, does that mean they are suited for a horse-related career? More than likely, the answer is yes. In fact, an enthusiasm for horses is a tremendous bonus. However, the horse industry is very diverse, and the various jobs in the horse industry require different types of education, skills and interests. Some jobs require a college education, but many do not. Also, some jobs require a high level of horsemanship, while other jobs require a better ability to work with people than animals.

The equine industry is a multimillion dollar enterprise. The business is more than just horses—it encompasses feed, tack and equipment, publications, veterinary care, advertising, clothing, education, and many other fields that are either directly or indirectly affected by the equine industry.

SAE IDEA

Exploratory

Coordinate and conduct a horse safety camp.

History of the Horse Industry

Horses are, quite literally, the maker of legends. From Alexander the Great's Bucephalus to Walter Farley's mythical black stallion, people have seen the horse as the embodiment of freedom, power, strength, beauty, and nobility.

The scientific name for the modern domesticated horse is *Equus caballus*. Also known as **equine**, the horse has been in existence for about two million years. Fossil evidence indicates that the horse originated in North America and then migrated into Asia and Europe. However, the horse subsequently became extinct in North America for unknown reasons.



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The horse was first domesticated about 5,000 years ago in Europe and Asia. At first, horses were used to pull chariots— horseback riding did not come about until later. Over the centuries, many cultures in Eurasia and Africa learned to rely on horses for transportation, work, and military purposes. Many of the military conquests that occurred throughout history could not have happened without the use of horses. In fact, without horses, the history of the human race would likely have been much different.

In the 16th century, Spanish explorers brought horses with them as they sailed to the New World, reintroducing the horse to North America. Over the years, some of these horses escaped and eventually formed the original herds of what are now called Mustangs—the “wild” horse of this continent. Mustangs are considered to be **feral**, or descendants of domestic horses that now live in undomesticated areas.

The Plains Indians, previously unfamiliar with the horse, soon learned to use its fleet strength to their advantage. The horse became an integral part of the Native American culture and was used for buffalo hunts, transportation, and in battle.

The horse continued to be an indispensable work animal until the early 20th century, when automobiles and other motorized machines offered ways to do the work of the horse far more quickly and efficiently. However, rather than disappearing from human society, the horse has instead taken on new, economically important roles in both recreation and sports.

SAE IDEA

Research

Study the different breeds of horses and their particular uses, such as the differences in Quarter Horses versus Thoroughbreds.

Common Breeds

Horses can be categorized by size as light horses, draft horses, and ponies. All horses are measured in terms of **hands** at the level of the **withers**, or the highest point on the shoulder. A hand is four inches.

EXAMPLE: A horse that is 59 inches tall is 14.3 (pronounced “fourteen three”) hands, because it is 14 hands and 3 inches tall.

A **light horse** is usually between 14.2 and 17 hands tall and is suitable for riding. **Draft horses** are much heavier and usually taller than light horses. They are bred, as the name implies, to do heavy draft work. A **pony** is shorter than a light horse and can be anywhere from 8 to 14.2 hands high. While there are thousands of breeds of horses in the world, certain breeds are consistently the most popular in the United States.

Within the first year of life, a male and female horse is called a **foal**. If a horse is younger than three years, a female is called a **filly** and a male is called a **colt**. After maturing past three years, the female is called a **mare**. The male horse is either a gelding or a stallion. A **gelding** has been castrated while a **stallion** has not been castrated. These terms are universal for all breeds of horses.



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Arabian

This breed is considered the oldest purebred horse in the world and many other breeds are derived from it. The Arabian was developed in the deserts of the Middle East. It is an extremely hardy breed with a distinctive appearance and exceptionally friendly disposition. The head is characterized by a dished profile, prominent eyes, large nostrils, and small muzzle. The neck is arched with a back that is shorter than most breeds, and it has a high-set tail.



The Quarter Horse is often used to move and work cattle.
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Quarter Horse

The Quarter Horse got its name because of its great speed at short distances, particularly at a quarter mile. The breed was developed in the United States, and while its origins extend all the way back to colonial times, it was not until 1940 that an official breed registry was established. The Quarter Horse has thick muscling and is known for its ability to outmaneuver cattle. They are easy to handle and have a calm temperament.

Thoroughbred

The Thoroughbred breed was developed in England around the turn of the 17th century. Its original purpose was to carry weight with sustained speed over extended distances. The ancestry of this breed is traced back to three foundation sires—the Darley Arabian, the Godolphin Arabian, and the Byerly Turk. Each of these stallions was named after its respective owner. Today, the registry is managed by The Jockey Club. The modern Thoroughbred is a tall, leanly muscled horse. Horses of this breed are capable of running at speeds of 35 to 40 miles an hour. However, not all Thoroughbreds are raced. Many are used for jumping and dressage competitions and as pleasure horses.

Appaloosa

The most easily recognized characteristic of the Appaloosa is its distinctive spotted coat. The spots can occur in a variety of ways, from large, egg-shaped spots on a white “blanket” over the hindquarters, to large or small spots scattered over the entire body. Some Appaloosas do not display this typical color pattern and may be a solid color. These animals must be blood-typed to verify their parentage. The Appaloosa is a versatile horse that participates in all types of equine competitions.

THE WILD MUSTANG—A SYMBOL OF THE AMERICAN WEST



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The Mustang is the breed that roams wild in the western United States. It is descended from horses that strayed from Spanish explorers in the 1700s, but over the years it has been influenced by many other breeds that escaped from farmers, settlers, and U.S. Cavalry soldiers. Because it is descended from domestic horses, it is considered a feral horse rather than a true wild breed. In fact, the name “Mustang” is derived from a Spanish word which means “wild” or “stray.”

The Mustang’s history is full of hardship. At the beginning of the 20th century, more than two million Mustangs roamed the western ranges of the U.S. As farmers and ranchers moved into these areas, they saw the Mustangs as competition for rangelands grazed by their cattle. With no laws to protect them, Mustangs were routinely killed and brutalized until, by the middle of the 20th century, their numbers had been reduced to several thousand. Finally, the efforts of concerned citizens helped the public become aware of the Mustang’s plight. A bill called The Wild Free-Roaming Horses and Burros Act, passed in 1971, offered the Mustangs protection from the slaughter they had experienced.

Today, the Bureau of Land Management is in charge of controlling the numbers of Mustangs that roam wild on public lands. It does this by routinely capturing the horses and offering them for adoption through the Adopt-a-Horse program. Mustangs are small but hardy horses. They come in a variety of colors. While it sometimes takes a great deal of patience and expertise to tame a wild Mustang, with the right handling, most Mustangs can become good riding horses.



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Morgan

Morgans are small to medium-sized horses with a compact body, stylish movement, and kind disposition. They are extremely versatile horses that compete in any kind of event, from pulling carriages to working cattle. The founding sire of the Morgan breed was a stallion called Figure, who was born in 1789. Figure became famous for his style, speed, endurance, and gentle disposition. Figure was a working horse, but he was also a popular sire. The Morgan breed was named for Figure’s owner, Justin Morgan.



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Belgian

As the name implies, this breed of draft horse originated in Belgium. In the early 1900s, an American type of Belgian became the standard in this country. It is now considered “America’s Favorite Draft Horse.” The American Belgian is almost always a sorrel color. It is large and muscular with a willing and kind disposition. The Belgian is often used in pulling competitions or in a wagon hitch.



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Percheron

The Percheron is an old breed that originated in France. They were first imported to the United States in 1839. Today, the Percheron is a popular carriage horse in many large cities, and it is used for pulling competitions, dressage, and in halter classes. The Percheron is somewhat shorter, more refined, and more stylish than many draft horses, but it is still a tall animal with great strength.



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Clydesdale

The Clydesdale breed originated in Scotland and was developed to perform work on the farm and to pull freight. The Clydesdale is a tall horse with characteristics of strength, agility, and docility. They are commonly bay, black, brown, chestnut, or roan in color, and they frequently have four white legs and a white face. Their lower legs are covered with a long, fine hair called **feathers**. They are active horses with high head carriage and good action that makes them a beautiful sight when pulling a hitch.

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Shetland

The Shetland pony is a tiny breed that originated in the Shetland Islands off the coast of Scotland. It is one of the most popular breeds of ponies. It was bred to withstand the harsh climate of its homeland. Consequently, it is small but very strong for its size, extremely hardy, and has a heavy coat with a thick mane and tail. Shetland ponies are popular today as children's pets. They can be ridden or driven, and are sometimes used in pulling competitions.



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Welsh

The Welsh Pony originated in the hills of Wales. Surviving in an area where winters were difficult and vegetation sparse, the breed developed into a hardy, strong, and intelligent animal. Taller than the Shetland pony, the Welsh has a refinement that shows the influence of Arabian ancestors. The Welsh Pony can be any color other than piebald or skewbald, which are color patterns that include patches of white or colorless skin. It is an excellent riding horse for children.

Work and Recreational Uses

Many horses today are kept purely as pleasure mounts. Other horses are used for everyday work, such as cattle ranching, police work, or carriage driving. Horses are also used in many equine sports, from local competitions to international and Olympic events. Many equine sports are offered on both an amateur and professional level.

The two most common types of riding are English and western riding. Within these broad categories are many different specialties, such as jumping, barrel racing, or cutting. Each specialty often requires its own tack, expertise, and a horse trained in that discipline.

Combined Training/Eventing

Combined training, a sport for English riding, consists of competitive events that test the fitness, ability, and training of both horse and rider in three areas: cross-country riding, dressage, and show jumping.



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Cutting and Team Penning

These are western riding events. In cutting, a specific cow is separated from the herd. In team penning, several riders work together in separating cattle.

Dressage

Dressage is a form of English riding that focuses on developing the natural movements of the horse. Through training, the horse learns to carry the rider with balance and suppleness, while the rider learns to communicate with the horse using the subtlest of aids. Dressage has been likened to a form of dance with horses.

Driving

Driving competitions involve one or more horses pulling a cart, wagon, or carriage. Such events may take place in a show ring or as a more rigorous cross-country-style competition.

Endurance Riding

Endurance riding is a very strenuous sport that tests the horse's ability to cover very long distances, such as 50 or 100 miles, in a single day. Both horse and rider must be fit for this sport.

Fox Hunting

In fox hunting, hounds are used to track and chase foxes (or a lure that represents a fox, pulled by a wily person) while horses and riders follow. The horses must traverse unknown terrain and jump obstacles.

Gymkhana

Gymkhana games test a horse and rider's speed and agility. Many of the games are designed to help young riders practice basic skills, such as mounting, dismounting, starting, and stopping, in a way that is fun and competitive.

Polo

Polo is a team sport (consisting of four members on each team) in which riders use mallets to hit a ball in a goal.

Racing

Racing focuses on the speed at which a horse can complete a specific type of race, such as flat racing, steeplechase racing (over jumps), and harness racing.

Rodeo

Rodeos are western riding events in which riders compete in various activities. Most events are derived from skills required for cattle ranching. Events common at rodeos include bronc riding, calf roping, steer roping, team roping, steer wrestling, and barrel racing.

Show Ring

Horse shows consist of events that test a rider's basic skills, such as equitation, and events that test the skill of both horse and rider, such as reining and jumping. Other types of equine sports are perhaps less common, but they offer just as much fun for the participant. There are many ways that people enjoy their partnerships with horses.



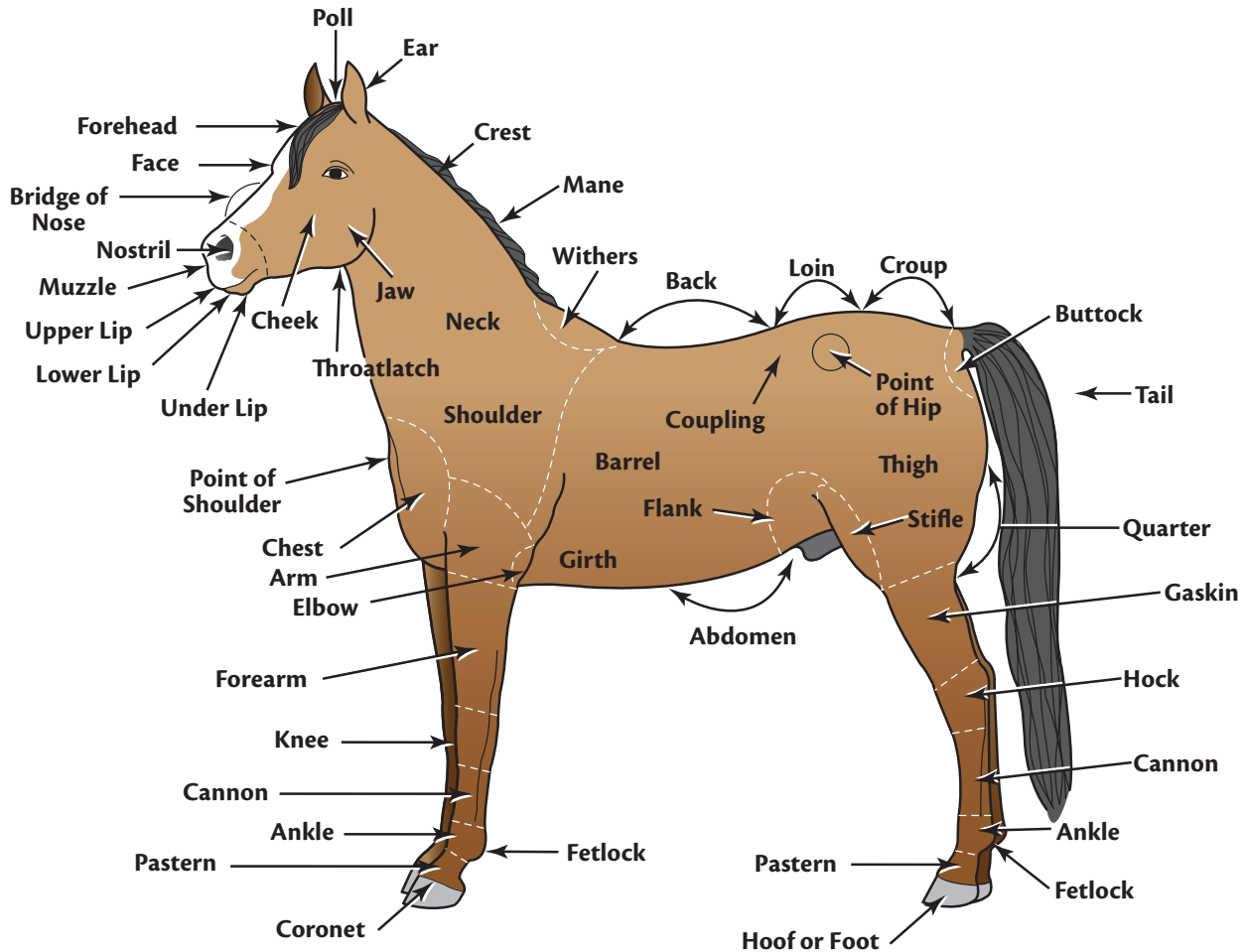
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Parts of a Horse

Horses are unique in that they have specific parts not found on other livestock. The throatlatch and under lip are not present or typically discussed in other animals. However, there are many parts that a horse has in common with other animals. For example, horses – like cattle, sheep, and hogs – have pasterns, hooves, hocks, flanks, and shoulders. The importance of horse parts lies in the purpose the horse serves – cutting, showing, racing, hunting, and so on.



Colors and Markings

Horses come in a wide variety of colors and markings, and the terms used to describe those colors and markings can be different from region to region and from breed to breed. However, basic horse identification is by color, breed, and gender (for instance, “the bay Quarter Horse mare”), so it is important to know the various colors and markings that occur in horses.

SAE IDEA

Placement

Assist a horse group that works with disabled students.

Basic Colors

Sorrel/Chestnut

The terms sorrel and chestnut both describe a solid red or brownish red color, including the legs, with mane and tail any color but black. Some breed registries, such as the Thoroughbred and Arabian registries, do not use the term sorrel and call a horse of this coloring a chestnut. Other breed registries, such as the American Quarter Horse Association, make a distinction between a sorrel and a chestnut. Sorrel describes a horse whose body color is reddish or coppered. The mane and tail are usually the same color as the body, but may be flaxen (blonde). Chestnut horses have a dark red or brownish-red (bronze) body color, with the mane and tail usually dark red or brownish red, but sometimes flaxen.

Bay

A bay horse has a brown or red body color, ranging from tan to reddish brown to very dark brown. The **points**, which are the tips of the ears, the muzzle, the lower legs, and the mane and tail, are black. The body color of a bay may be the same as that of a chestnut, but if the points are black, it is a bay horse.

Brown

Brown may also be classified as a chestnut by some people. If the body color is brown or black with light areas at the muzzle, eyes, flank, and inside upper legs, then it can be called brown. However, if the animal has black points, it would be called a brown bay.

Black

Black is a less common, but popular color in horses. The body color is a true, solid black without any light areas (other than possible white markings on the face and legs). The mane and tail are also black.



Bay colored horse
Jupiter Images



Dapple-gray mare and foal
Jupiter Images

Palomino

The palomino has a body color of golden yellow with a white or flaxen mane and tail. A palomino does not have a **dorsal stripe**, which is a dark stripe along the spine.



Palomino colored horse
Jupiter Images



Buckskin colored horse
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Buckskin

The buckskin has a yellowish or gold body color with black points. Buckskins do not have a dorsal stripe.

White Variations

Genetically, there are different types of colors that appear white. Unlike a gray horse, which is born dark and turns gray after it loses its first foal coat, any of these colors is white at birth and will not change color as it ages.

A horse that is a very light cream color with “pumpkin” skin and blue eyes is a cream. There are different variations of cream, including cremello (cream colored body, white mane and tail) and perlino (a light cream body color, but a reddish tinge to the mane and tail).

A cream horse may even have white markings, which appear as white or “ice” hair against the cream of the basic color. A white horse is truly white all over and lacks pigment in all the hair and skin. It usually has brown eyes.



Eyes of a cream horse
Jupiter Images

Dun colors

Dun is a term for a color pattern that always includes darker points (not necessarily black), a dorsal stripe, “zebra stripes” or barring on the legs, and a shoulder stripe across the withers.

- Mouse dun or grulla—The body color is a bluish, smoky, or mouse gray. The points and dun markings (dorsal stripe, leg barring, and shoulder stripe) are black.
- Buckskin dun—The body color is yellowish or gold. The points and dun markings are black.
- Red dun—A form of dun with a yellowish or light red body color. The points and dun markings are a darker red.



Dorsal stripe on buckskin dun
Wikipedia Commons/Arsdelicata Photo

Roans

Roan describes a color that includes a mixture of white hairs with any other dark color on the body. The white hairs are usually more predominant on the body, particularly the flanks and barrel, and are less likely to appear on the head and lower legs. While a gray horse may show a mix of white and black hairs, a gray horse will always get lighter with age.

A roan horse may look like a solid color when it is born, but it will show the roaning pattern by the time it loses its first foal coat, and then it will remain the same shade throughout its life. A red roan is a chestnut or sorrel horse with the roaning pattern. The body has a fairly uniform mixture of white with red hairs on the body. Usually the points are a darker red, though the mane and tail may be lighter.

A blue roan color shows a mixture of white and black hairs on the body, but it is usually darker on the head and lower legs. It can be distinguished from a gray because the roaning does not appear on the head and lower legs. It also does not get lighter as it gets older. A bay roan horse has a mixture of white with red hairs and the points are black.

Pintos and Paints

The terms pinto and paint are sometimes used interchangeably to describe a horse with a spotted coat. However, there are currently two different registries that make a definition between Pintos and Paints. The Pinto Horse Association of America registers horses and ponies of any breed that exhibit the spotted coat coloring. The American Paint Horse Association requires horses to be of Quarter Horse or Thoroughbred descent, as well as have the desired color. The Pinto and Paint spotted coloration occurs in a variety of patterns, including overo and tobiano.



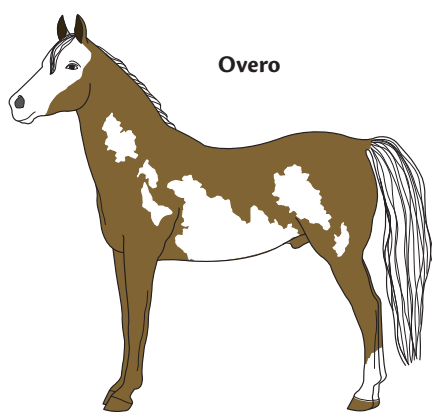


Paint or pinto horses
Jupiter Images

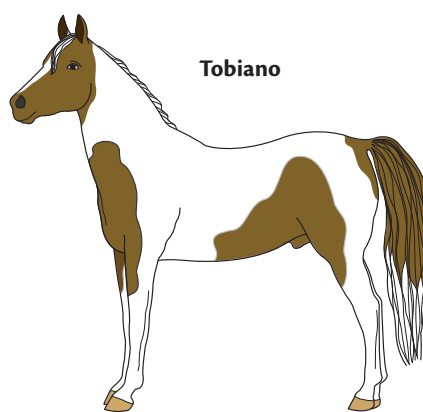
On an overo pattern, the white originates on the underside of the horse and will rarely cross the back of the horse between its withers and its tail. Usually, at least one and often all four legs will be the dark color. Head markings are predominantly white. The tail is usually one color. An overo horse may be either predominantly dark or white.

The tobiano normally exhibits white across the spine extending downward between the ears and tail in a clearly marked pattern. Head markings will be like those of a solid-colored horse. With a

tobiano, all four legs are usually white, at least below the hocks and knees. The tobiano rarely has more than one or two solid-colored legs. The spots are generally regular and distinct as ovals or round patterns that extend down over the neck and chest, giving the appearance of a shield. The horse will usually have the dark color on one or both flanks. A tobiano may be either predominantly dark or white.



Overo



Tobiano

Appaloosas

The Appaloosa color pattern actually occurs in several different breeds. Not all Appaloosas will show a “flashy” Appaloosa color pattern—they may be any solid color. In fact, the Appaloosa color pattern on an individual horse can even change over time. There are several recognized Appaloosa color patterns. Three common patterns are the leopard, blanket, and snowflake.

The leopard pattern is white all over with dark spots scattered all over the body. The blanket pattern is a very common one. The horse is a dark color with a blanket of white hair over the hips and croup area, sometimes extending farther up the back. Usually, there are dark spots within the white area, but sometimes there are no spots. A snowflake pattern is any color with small white spots scattered randomly over the body.



Appaloosa horse
Thinkstock Photo

Common Head and Leg Markings

Head Markings

- **Star**—Any marking on the horse's forehead
- **Snip**—Any marking between the horse's nostrils, usually vertical
- **Strip**—A narrow marking between the horse's forehead and nostrils, extending vertically
- **Star and strip**—A marking on the horse's forehead with a strip to the nasal peak; the strip is not always an extension of the star
- **Star, strip, and snip**—A marking on the horse's forehead with a narrow extension of the nasal peak and opening up again between the horse's nostrils; the star, strip, and snip may be connected
- **Blaze**—A vertical marking that extends the length of the face and is of medium width and is relatively uniform
- **Bald face**—A broad blaze; it can extend out and around the horse's eyes and also down to the horse's upper lip and around the nostrils



Star



Snip



Strip



Star and
Strip



Star, Strip
and Snip



Blaze



Bald
Face

Leg Markings

- **Coronet**—Any narrow marking around the horse's coronet above the hoof
- **Half pastern**—A marking that includes half of the horse's pastern above the coronet
- **Pastern**—A marking that includes the horse's entire pastern
- **Sock**—A marking that extends from the horse's coronet halfway up the cannon bone, either half way to the knee on the foreleg, or halfway to the hock on the back leg
- **Stocking**—An extended sock that is a full marking to the area of the horse's knee on the foreleg and to the area of the hock on the hind leg



Coronet



Half Pastern



Pastern



Sock



Stocking

A HORSE OF A DIFFERENT COLOR



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Relatives of the domestic horse still exist in the wild. The Equus family includes seven close cousins, three of which are distinct species of zebras. Zebras are unique to the continent of Africa. They have a conformation much like that of a short, stocky horse and they have a short mane that stands upright. All zebras show distinctive black and white stripes, which are the zebras' best defense against predators. The striped pattern varies from species to species, but there are also slight differences between individuals, so no two zebras are exactly alike. Researchers now think that the striped pattern also helps zebras recognize one another.

Can a zebra be domesticated like horses and donkeys? No, because they are truly wild animals, unlike feral horses. But because zebras are so closely related to domestic horses, they can crossbreed with them. The umbrella term for a zebra hybrid is "zebroid." Like mules and hinnies, zebroids are sterile. The offspring from a zebra-horse crossing is a zorse, while the result of a zebra-donkey crossing is a zebross. A zorse usually looks more like a horse than a mule, but it has stripes. A zebross more closely resembles a striped mule.

Unit Summary

Horses are used for a variety of reasons, most commonly for pleasure. Not all breeds are used for the same purpose. The Quarter Horse is commonly used for working livestock on a ranch, where a breed such as the Arabian is often used for showing. There are breeds of all shapes and sizes suited for any need. A horse is measured by hands, and each hand equals four inches. There are also many markings and colors to make each horse unique. Many times the color and markings determine which breed association the horse can be registered. The markings on the head and legs of a horse will also make it one-of-a-kind.

Unit Review

1. Where is it believed that horses originated?
2. How long ago was the horse domesticated?
3. What is another term for a feral horse?
4. How is a horse measured?
5. What is the difference in height between a draft horse and a pony?
6. Which breed of horse is known for running long distances?
7. Name three draft horse breeds.
8. What are five work or recreational uses for horses?
9. Which parts are unique to a horse compared to other animals?
10. What is the difference between a sorrel and a chestnut colored horse?
11. Describe the differences between a cream and a white horse.
12. What breed must a Paint horse be in order to be registered with the American Paint Horse Association?
13. Which head marking is between a horse's nostrils?
14. What leg marking covers the horse's coronet, pastern, and halfway up the cannon bone?



Unit 10

The Goat Industry

OBJECTIVES

- Discuss the history of the goat industry and its role today.
- Identify common breeds of goats and their characteristics.
- Identify consumer products derived from goats.
- Determine the advantages of goat milk.
- Discuss the difference between goat fibers.
- Locate the parts of a goat.

KEY WORDS

buck
cabrito
cashmere
chevre
chevon
doe
homogenized
kidding
kids
mohair
wether

Goats are traditionally used around the world for dairy products, meat and fiber. The goat industry in the United States is much smaller than cattle, pork, or chicken, but goats are still valuable to the economy. While many goats are kept in small numbers for household use, the number of goats commercially slaughtered for meat has more than doubled in the last decade. As a relatively easy species to care for and the capacity to produce multiple products, goats have much to offer as a commercial endeavor.

History of the Goat Industry

Goats were one of the first animals domesticated by humans. For several thousand years, goats and the many valuable products derived from them have been a vital resource for humans. In addition to their value as livestock, goats are highly personable and intelligent animals that are also popular as pets.

The scientific name for the domestic goat is *Capra hircus*. The ancestors of the domestic goat originated in the arid areas of Asia and the Mediterranean. The world's first livestock registry started in Switzerland in the 1600s was for goats. Goats were imported to the New World with the earliest explorers and settlers. Because of their small size and adaptability, they were frequently brought on ship voyages as a source of fresh milk. Many settlers also brought goats with them so they would have livestock for their new farms.

In 1849, Angora goats were first imported to the United States. Angora goats are used to produce mohair fiber and meat. Texas soon became the leading Angora goat producing state in the country. In 1893, goats of a Swiss breed called Toggenburg were the first purebred dairy goats to be imported to the United States. Worldwide, goats are still a vital resource, especially in arid or underdeveloped countries. More people in the world drink goat's milk than cow's milk. In the United States, goats are a small but growing industry that is scattered fairly evenly across the country. While there are some large herds of dairy, meat and fiber goats in this country, many goats are kept in small numbers by families to provide milk and meat for their household.



Bright Career Futures

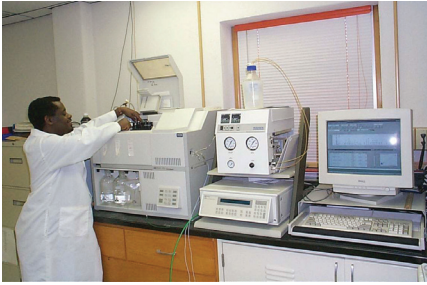
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A WORLDWIDE OKLAHOMA CONNECTION...

The E (Kika) de la Garza American Institute for Goat Research



Langston University Photo

An Ethiopian woman uses a goat for income and as a source of milk for her children—with an Oklahoma connection. The program to provide goats and training to Ethiopian villagers is one of the many projects of the E (Kika) de la Garza American Institute for Goat Research at Langston University in Langston, Oklahoma.

The Institute's mission is to develop and share information about goat production, with impacts at local, state, regional, national, and international levels. This mission is achieved through research, extension programs, and international activities. The Institute has become well known for its dedication to improving the lives of goat producers throughout the world. The majority of goats are raised in foreign countries, so the Institute must have strong international ties and impacts. Visiting scholars come from all parts of the world to conduct research projects. Researchers come from many African countries, Europe, Asia, China, Mexico, South America, and the United States. "The presence of these scientists contributes to the international flavor of the Institute and also assists Institute scientists in more fully understanding goat production in foreign lands," says Roger Merkel of the E (Kika) de la Garza Institute for Goat Research.

The Institute's research covers a broad range of areas relating to goats for meat, milk, and/or fiber production. Much of the research deals with dairy goat nutrition and determining nutrient requirements of goats. The Institute continues to focus on the different types of goat industries with the intent of increasing economic return to those involved in the goat industries. The research at the Institute benefits many individuals. "Local goat producers benefit from much of the research conducted at the Institute through the dissemination of knowledge through our extension programs. Research results also benefit producers in other areas of the United States and the world. Of course, scientific exploration also benefits the scientific community through expansion of knowledge and stimulation of further research based upon previous results," says Merkel.

Common Breeds

Goats have been bred to produce several useful products. Some breeds are considered dairy goats, while others are raised primarily for their meat or the fiber from their coats. A few breeds are raised as pets. The meat goat industry in the United States is much larger than the dairy goat industry with 3.2 million meat goats and 370,000 dairy goats inventoried. One of the most popular meat goats in the United States is the Boer goat, with the breed gaining popularity in the livestock show arena.

Meat Breeds



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Boer

The Boer goat is African in origin. As a meat breed, Boers are distinctly heavier and stockier than dairy breeds. A common color pattern is white with a dark-colored head, though solid colors are also seen. Advantages to the Boer as a meat breed include its docile temperament and ability to breed year-round.



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Spanish

Until recently, most meat goats in the United States were a type called Spanish goats. The Spanish goat is not a distinct breed; rather, it is a catch-all name for a type of goat that ran wild in the southern United States and was commonly captured or raised for meat. They are also called brush goats. Because of its feral background, there is little consistency in color or size.



Photo courtesy of Wikimedia Commons

Myotonic

Another breed of goat sometimes used for meat is called the Tennessee Fainting goat. This unusual animal is known for “fainting” spells when it is excited or frightened. The goat will suddenly fall over and lie stiffly for several seconds. The condition called myotonia is the result of a recessive gene. The breed is also known as Myotonic goats or Wooden Leg goats.



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Kiko

This Kiko goat breed was bred in New Zealand specifically for meat production. The Maori word “kiko” means flesh or meat. The breed was developed by crossbreeding feral goats with Anglo-Nubian, Toggenburn and Saanen bucks, until crossbreeding was closed due to the breed being established in 1986. Kikos were brought to the U.S. in the 1990s.

Dairy Breeds



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Alpine

The Alpine, or French Alpine, is a dairy breed that originated in the French Alps. Alpines have no single coat color or pattern and may occur in almost any color. Wattles or small clumps of hair-covered skin may appear on either side at the base of the neck. They are known for their excellent milk production and well-shaped udders. Alpines also adapt well to a wide variety of climates.



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Nubian

The Nubian is a popular and easily recognized goat. The breed originated in Africa and was developed in England by crossing the African imports with smaller local goats. The Nubian breed is long-legged with a roman nose, pendulous ears, and a short, sleek hair coat. While any color is acceptable, black, red, or tan are the most common colors. The milk from Nubian goats has a relatively high butter-fat content, though they do not usually give as much milk as other breeds. Because of their larger size, they are sometimes considered a dual-purpose breed that is raised for both milk and meat.



Bob Davis Photo

Toggenburg

The Toggenburg (often called “Togg”) is the oldest known dairy breed, originating in the Swiss Alps. They are small, compact goats, but they are excellent milkers. Color is any shade of brown with distinct white markings on the legs, around the tail, and in stripes down either side of the face.



Bob Davis Photo

LaMancha

The LaMancha is an American breed developed in the mid-1900s. While any color is acceptable, a LaMancha goat may look like it has no ears, but instead it has tiny external “gopher” ears. Some LaManchas produce as much or more milk as the Swiss breeds. They are known for their high butterfat milk, long and consistent lactations, hardiness and ability to produce under adverse conditions, and calm temperament.



Jupiter Images

Saanen and Sable

The Saanen breed is named for the Saanen Valley in Switzerland in which they originated. It is a very popular, high-producing dairy breed. The Saanen is typically white, and colored offspring were once discriminated against until a group of breeders developed the Saanen Breeders Association in which colored Saanens were able to register. Any colored variation of the breed is referred to as a Sable. Saanens (and Sables) are large and big-boned with moderately long, erect ears.



Jupiter Images

Oberhasli

The Oberhasli (also called “Ober” or “Obi”) is a Swiss breed. They are of medium size. The color should be chamois, which is a light or dark red-brown, with black on the face, legs, belly, udder, and a dorsal stripe.

Fiber Breeds



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Angora

Angora goats are raised primarily for fiber, with less emphasis on meat. The fiber they produce is called mohair, not Angora. Angora fiber comes from rabbits. The breed originated in Turkey. They are generally smaller than dairy goats. The coat is almost always white and hangs in long curly locks all over the body. The mohair is shorn twice a year, and the average goat produces nearly 11 pounds of mohair in one year.

Consumer Products

Goats are an extremely useful livestock species, providing us with milk, meat, fiber, hides, and even the companionship of pets. Goat manure is useful as a fertilizer, and slaughter by-products provide materials for the usual array of everyday products such as glue, soap, fertilizer, and cosmetics.

Meat

Currently, the demand for goat meat in the United States is greater than the supply. The demand for **chevon**, or the meat from an older animal, is focused in the eastern and southwestern United States where there are concentrations of people from cultures that frequently eat chevon, particularly Greek, Muslim, Arabic, and Mexican communities. It is also a part of certain religious and celebratory events, which create peak demand times. About one-third of the chevon consumed in this country is imported.

Goat meat from a very young goat prior to weaning and usually less than 40 pounds live weight is **cabrito**. Cabrito is commonly used for barbecue.

Despite the demand for goat meat, producers face challenges in marketing their product. Goats are seasonal breeders, and it is difficult to provide the retail market with a consistent supply of the meat. Consequently, retail markets are reluctant to stock chevon. There is also little consistency in the meat quality. Lack of retail outlets means that a large proportion of the goat meat in this country is sold through private channels or on-farm sales. Producers do not yet have the advantage of the research and support systems that other segments of the meat industry enjoy.

Dairy

A popular myth is that goat's milk tastes bad. In fact, properly produced goat's milk does not taste any different than whole cow's milk. One difference between cow and goat milk is that goat milk is "naturally homogenized." The fat content in goat milk stays in emulsion, and does not separate as readily as cow's milk does. In order to separate the cream from goat milk, a mechanical separator is used. Any milk product that is made from cow's milk can be made from goat's milk, including cultured products such as yogurt and buttermilk. However, the greater labor involved in extracting the cream means that products made from cream, such as goat butter and ice cream, are not commonly marketed. However, goat's milk is often used as an ingredient in soaps.

Goat cheese is called *chevre*. It has seen a gain in popularity in recent years, particularly in the gourmet market. There are many varieties of goat cheese, and nearly every country in the world has its own versions. In the United States, chevre is generally known as a soft, white cheese with a mild tangy flavor.

Fiber

The most common type of fiber taken from goats is the wool-like mohair provided by the Angora breed. Mohair is similar to sheep's wool, but it lacks wool's crimp. Mohair is used to make all types of clothing, from dresses to coats, as well as upholstery and carpets. The other type of fiber taken from goats is cashmere. Cashmere can be harvested from almost any goat, except Angoras. The fiber grows as a soft winter undercoat and is usually harvested by shearing before it is shed. Most of the cashmere sold today comes from goats in Middle Eastern countries, such as Afghanistan, or from Australia or New Zealand. The leather from goat skin is used for making many high-fashion items such as gloves, clothes, and the like. Pelts can also be used as rugs or throws.

SAE IDEA

Exploratory

Conduct a local survey on the perceptions of goat products.



Jupiter Images



Hill Shepard Farm Photo

Goat Milk

Goat milk is considered by many to be a healthful alternative to cow milk. It is more easily digested and is often given to those who are ill or suffering from digestive maladies such as gastric ulcers. It is not usually a successful substitute for those who are lactose intolerant or have milk allergies since goat milk contains essentially the same components that cause these problems.

SAE IDEA

Placement

Work for a goat producer.

Nutrition

Goat milk has a slightly different nutritional profile than cow milk. It is whiter in color because it does not contain the beta carotene that cow milk does. It is also naturally **homogenized** due in part to the smaller fat globules in goat milk. This is one factor that makes goat milk easier to digest. In addition, the protein in goat milk has a slightly different chemical make-up. This accounts for some of the digestibility and the lack of fat separation, as well as a different action during curd formation.



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Compared to cow milk, goat milk is higher in vitamins A and B-6, thiamin, niacin, and overall mineral content. But goat milk is lower in riboflavin, vitamin B-12, and folic acid. Neither goat milk nor cow milk has significant amounts of some important nutrients such as zinc and iron.

Using Goats to Control Weeds and Brush

Goats make excellent weed eaters! If given a chance, goats will eat thistles and many other plants that are often avoided by most grazing animals. When pastured with cattle or sheep, goats will usually eat the weeds and not compete for the desirable grasses. Given that many ranchers are looking for ways to reduce the use of herbicides and other chemicals, goats can provide an environmentally friendly solution to a weed problem.

Quality

All dairies must abide by certain regulations for safety, whether they are cow dairies or goat dairies. Governmental regulations require dairies to produce milk that is, above all, safe to drink. This means that milk must not be contaminated by harmful substances such as disease-causing organisms, bacteria, or antibiotic residues.

Goat milk, like cow milk, must be pasteurized before being offered for sale. In addition, the fat content of the milk must follow regulatory guidelines for labeling as whole, low-fat, skim, and so forth. Besides producing safe milk, goat dairies also strive to produce milk that tastes good. Herd management and hygiene are vital factors for both the safety and the taste of milk. The composition of the fat in goat milk makes it more susceptible than cow milk in picking up off-flavors. Therefore, some herd management guidelines that prevent this from happening include:

- Keeping the herd healthy.
- Keeping bucks away from the milking does, because the buck's odor will be picked up in the milk, creating an off-flavor.
- Avoiding strong-flavored feeds that would create objectionable flavors in milk, such as wild onion, wild garlic, and silage. If silage is used as a feed, it should not be given within five hours prior to milking.
- Avoiding the use of certain chemicals, such as pesticides, in areas where dairy goats are kept.
- Preventing contamination of milk during milking or milk transfer.

Goat Fibers

Two types of fiber are produced by goats—mohair and cashmere. **Mohair**, produced by Angora goats, is the more common. **Cashmere**, taken from a goat's undercoat, is a valuable fiber, but it is not produced in the United States in very large commercial quantities. Most cashmere is imported from other countries. Notice in the table that an animal produces much less cashmere fiber than mohair fiber. Also, cashmere fibers are finer, which makes it much softer to the touch than mohair.

Characteristics of Mohair and Cashmere Fibers		
	Mohair	Cashmere
Pounds per Year	10.5 pounds	Less than 1 pound
Staple Length	Approximately 6 inches	1-1/4 to 3 inches
Diameter	23 to 38 microns	Less than 19 microns
Crimp and Luster	Not crimped, high luster	Crimped, low luster

Mohair

Mohair is similar to coarse sheep's wool in size and strength, but it has a much smoother surface. While wool fibers have a distinct scale, mohair fibers have a much thinner, smoother type of scale. For this reason, mohair lacks the felting properties of wool. Mohair is elastic, has good luster, and takes dye exceptionally well. Finer fiber, taken from young goats, is more valuable than coarser fibers. Angora goats can also be classified according to the type of mohair fiber they grow. B type has a flat lock, which is usually wavy and more bulky. C type grows hair in tight ringlets and is a finer mohair.



Jupiter Images

Goat selection and genetics are important factors for profitable mohair production. Breeding animals should be chosen for their ability to grow a desirable fleece, as well as for growth, survivability, and efficiency.

Proper feeding, health, and cleanliness are also important production considerations. Studies have shown that Angora goats grow better-quality fleeces when they have adequate amounts of protein in their diets. Cleanliness of the fleece is important because the value can be severely discounted when there is a large amount of vegetative matter or dirt present. For this reason, some producers fit goats with coats that protect the fleece. Shearing practices will also affect the final value of the fleece.

Mohair fleece is evaluated essentially the same way as wool. Factors contributing to the fleece's value are color, fiber diameter, staple length, tensile strength, fleece yield, number of kemp fibers, and lack of vegetative matter. Mohair is used in both woven and knitted fabrics. These are made into garments, blankets, carpets, upholstery, draperies, and many other items.

Cashmere

As an extremely soft and luxurious fiber, cashmere is used primarily for sweaters, scarves, socks, and other luxury garments. Cashmere fibers are finer than mohair. The Cashmere goat breed is fairly new to the United States with the first goats being imported in the 1980s from Australia and New Zealand. Although there is an actual Cashmere breed, cashmere fiber can be collected from any breed of goat other than the Angora.

Cashmere is crimped, low in luster, and less than 19 microns in diameter. Length is between 1-1/4 and 3 inches. The cashmere fibers must be separated from the goat's coarse outer coat, or guard hairs. Cashmere occurs in any color, including brown, gray, and white, although a fleece is more valuable if it is a single color rather than mixed. The quality of the cashmere fiber is determined

SAE IDEA

Research

Study the difference between the types of goat fibers.

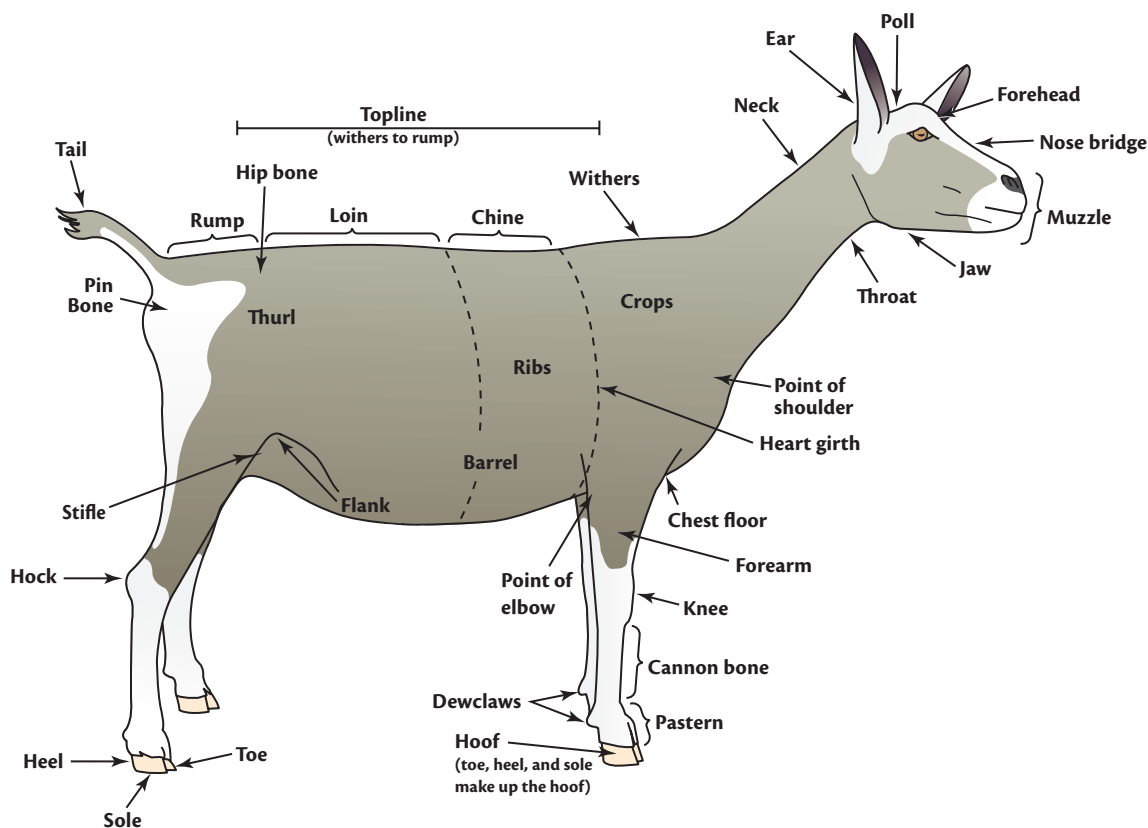
by color, crimp (more crimp is desirable), diameter (finer is desirable), and length. Staple length determines how the cashmere will be used. Shorter fibers are used for woven fabrics, and longer fibers are used for knitted fabrics. The goat's undercoat grows in response to changes in day length, preparing it for cold weather. The cashmere will begin to fall out if it is not harvested in the early part of the year.

While cashmere in some places is harvested by hand combing, in the United States the goat is generally sheared and the cashmere is separated from the guard hairs by machine. Only a few ounces of cashmere fiber are produced by a goat each year.

Parts of a Goat

Goats are similar to other livestock in their body parts; however, there are differences between a meat goat and a dairy goat. A meat goat is viewed for its ability to produce meat, so parts such as the loin and rump are more important than they are on a dairy goat. On the other hand, a dairy goat is looked at for her ability to produce milk, so teat placement and udder attachments are important parts.

A **doe**, or female goat, must first give birth in order to produce milk. The term for giving birth for goats is **kidding** and offspring are called **kids**. Once the doe has given birth and weaned the kids from nursing, the producer may choose to either castrate the male goats making them **wethers** or leave them as **bucks**, uncastrated males.



Unit Summary

As one of the first animals to be domesticated by humans, goats have been a valuable food and fiber resource for humans. Goat breeds can be commonly separated into meat, dairy, and fiber breeds; however, some breeds serve multiple purposes. Although the popularity of goat products is less than that of beef, swine, or chicken, there is a demand in ethnic populations for particularly meat and dairy products. Goat milk is different than cow's milk in characteristics such as color, chemical make-up, and nutrition. The two types of fiber collected from goats (mohair and cashmere) are not produced in large quantities in the United States and are often imported from other countries. As the goat industry continues to gain popularity in the United States, the uses and products will also begin to grow.

Unit Review

1. Where did the ancestors of the domestic goat originate?
2. Where is the largest concentration of goat herds in the United States?
3. What is the most common meat goat breed?
4. Name the three uses of goats in which the species can be divided.
5. Describe three goat breeds and their uses.
6. What is the difference between chevon and cabrito?
7. What challenges do producers face in marketing their goat meat?
8. Why is goat milk whiter in color compared to cow milk?
9. Explain why goat milk is said to be a healthy alternative to cow milk.
10. Compare the nutrition of goat milk to cow milk.
11. What breed of goat produces mohair?
12. Does the Angora goat produce Angora fiber? Explain.
13. Compare mohair and cashmere fibers.
14. How much cashmere is produced by one goat each year?
15. How is a dairy goat and meat goat different in important parts?



Unit 11

The Poultry Industry

OBJECTIVES

- Discuss the history of the poultry industry and its role today.
- Distinguish among terms and major species of poultry.
- Identify common breeds of chickens and their characteristics.
- Locate the parts of a chicken.
- Examine the development of an egg.
- Discuss methods for incubating eggs and chickens.
- Identify consumer products derived from poultry.

KEY WORDS

albumen	gander
bantams	giblets
broilers	goose
brooding	gosling
capon	hen
chick	incubator
cock	layers
cockerel	offal
cull	oviduct
debeaking	poult
drake	poultry
dual-purpose	pullet
duckling	rooster
flock	spent hen
gaggle	tom

People in the United States are eating poultry in ever increasing quantities. The U.S. is the world's largest broiler producer and the second largest egg producer. The total farm value of U.S. poultry production exceeds \$20 billion. Broiler production accounts for the majority of this value, followed by eggs, turkey, and other chicken. While facilities for growing broilers or egg layers can be expensive, broiler producers can raise more than 80,000 birds per year. That's a lot of chicken!

History of the Poultry Industry

Poultry is the term used to describe domesticated birds that are kept for eggs or meat. This includes chickens, turkeys, geese, and ducks, as well as less common birds such as quail, pigeons, peafowl, and even ostriches. However, chickens dominate the United States poultry industry.



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Chickens and other poultry have been used by humans since primitive times. Ancient Egyptians are known to have raised poultry for eggs and meat, and they even used clay incubators to hatch eggs. The first chickens in North America were brought by settlers to Jamestown Colony in the early 1600s. Until the mid-1800s, family flocks were the norm with eggs and meat being sold or bartered. As with other livestock, the advent of refrigerated transport, centralized feed mills, and processing plants saw the beginnings of the commercial poultry industry.

The first commercial hatchery in the United States opened in 1870, and the American Poultry Association was founded in 1873. The following year, the association released the first edition of the *American Standard of Perfection*, which describes the various poultry breeds. The first years of the 20th century saw the introduction of battery raised chickens, a method that has since become standard in many parts of the industry. A battery refers to the use of a series of stacked cages to house the birds. Between 1926 and 1928, the USDA began inspecting poultry products for wholesomeness through the Federal Poultry Inspection Service. In 1940, mechanical poultry dressing was first used. This led to the current large-scale, highly mechanized style of poultry processing used today.

Colonel Sanders began his first Kentucky Fried Chicken franchise business in 1952. These restaurants alone now serve more than 900 million pounds of chicken each year. Congress passed the Poultry Products Inspections Act in 1957 and was strengthened by the Wholesome Poultry Products Act of 1968. Since then, virtually all poultry products are processed in federally inspected plants. In the early 1980s, cash receipts for poultry sales began to exceed those for hogs. By the 1990s, chicken consumption increased to the point that it began to equal or exceed that of beef, which until then had been America's most-consumed meat.



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Today, chicken is a popular meat because it is relatively inexpensive, easy to prepare, and is perceived as a healthy protein source. The fat and cholesterol contents of chicken are generally lower than that of beef or pork. At the same time, it has very high-quality protein with an excellent balance of all the amino acids. Chicken is also easy to digest, making it a good meat choice for children and invalids.

Eggs are one of the most nutritionally complete foods. Because the egg supplies all of the needs of the developing embryo, it has to be a nutritionally balanced powerhouse. The protein quality in eggs is considered superior to other protein sources, including cow's milk, fish, and beef. Some common misconceptions about eggs are that eggs with colored shells are more nutritious than white-shell eggs, and that fertile eggs are healthier than unfertilized eggs. Neither of these claims is true.

SAE IDEA
Exploratory
Compete in a poultry Career Development Event.

Poultry Species

While chickens account for a large percentage of the U.S. poultry industry, chickens are not the only type of poultry raised. Other major species of poultry include turkeys, ducks, and geese. All poultry are closely related and are part of one subdivision classification. The differences in feathers, body structure, land or water inhabitant, or ability to fly separate many of the species of poultry.

Turkeys

Domestic turkeys are descended from the wild turkey of North America. Turkey meat is growing in popularity because it is low in fat and can be used in a variety of ways. Turkeys, of course, still reign as the centerpiece on the Thanksgiving dinner table. Benjamin Franklin wanted the wild turkey as the national bird because it is considered to be highly intelligent, respectable, and courageous.

The most commonly raised breed of turkey for commercial production is the Broad Breasted White. It is marketed at 17 to 30 pounds. The commercially raised turkey is not usually bred naturally. Artificial insemination is used to breed the male turkey to the female. This is largely due to genetic changes such as larger birds with heavier muscling, which leaves the turkey unable to breed naturally. A young turkey is called a **poult** no matter if it is male or female. Once a poult matures past one year of age it is either called a **tom** (mature male) or a **hen** (mature female).



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Ducks

Ducks are the third most important type of commercial poultry. They are raised mostly for their meat, with little demand in the United States for duck eggs. The best breeds for meat production are the Aylesbury, Muscovy, and White Pekin. They are generally marketed as a **duckling**, a young duck, at six to seven pounds. After a duckling reaches maturity, it is called either a **drake** (mature male) or a **hen** (mature female).

Geese

Geese are raised in the United States for meat and eggs. They are also popular as farm pets, weeders, and even as guard birds. The most popular breeds for commercial production are the Toulouse, Emden, and African. Weights of these breeds range from 18 to 26 pounds.

You may have heard the term, “What’s good for the goose is good for the gander.” A **goose** is the term for a female and a **gander** is a male goose, while a young goose of either gender is called a **gosling**. A group of geese is called a **gaggle**.



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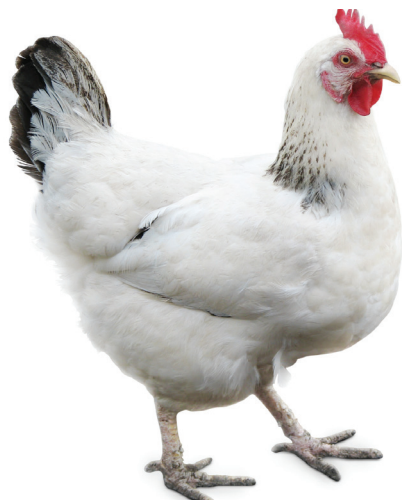
Other poultry

Other species of poultry that occupy a smaller niche in the industry are swans, peafowl, guinea fowl, quail, and ratites. Ratites are a type of flightless birds. Ostriches, emus, and rheas are all ratites. A few years ago, these became very popular in the United States and sold for high prices. However, the market for products from these birds never developed sufficiently, and their popularity has since declined.

Common Breeds of Chickens

As descendants from wild jungle fowl in Asia and India, chickens occupy the largest portion of the poultry industry. While there are more than 200 breeds of chicken listed in the American Poultry Association’s *Standard of Perfection*, most of these breeds are not of importance to the commercial industry. Commercially, chickens are raised as **broilers** (young meat chickens) or as **layers** (egg-producing chickens).

Broilers can be either male or female chickens, while a layer is strictly a female because it must be able to produce eggs. A young, immature chicken is called **chick**. To separate by gender, a young male chicken under one year of age is called a **cockerel**, and a young female chicken is called a **pullet**.



Jupiter Images

A producer may evaluate his/her **flock** or group of chickens to choose which males to castrate (caponize), which then gives it the name **capon**. Others will be allowed to mature into a **cock** or **rooster**, which is a mature male chicken after one year of age. Just as in ducks and turkeys, a mature female chicken over one year of age is called a hen. If a hen is no longer producing eggs, she is known as a **spent hen**, and a producer may choose to **cull** or discard her from the flock.

The modern-day broiler chicken has been developed to grow quickly and efficiently. In order to produce a desirable broiler, specialty breeders use breed crosses. The two breeds of chicken most commonly used to create this hybrid are the Cornish and the White Plymouth Rock. Usually the genetic strains that result from these crosses are named after the company that developed them, such as Peterson-Cobb.

Egg-laying hens are also bred to lay eggs as efficiently as possible. The majority of eggs sold in the United States have white shells. Commercial strains of white egg-laying hens are usually developed from the White Leghorn. A popular strain of brown egg-laying hens is called the Production Red and is developed from a breed called the Rhode Island Red.

Non-Commercial Breeds

The idea of commercially breeding beautiful chickens began in the mid-1800s, when exotic breeds were first brought to Europe and the United States from the Orient. People greatly admired the new colorful breeds in much the same way that hobby gardeners admire special varieties of plants and flowers.

Chickens have been bred into a wide variety of exotic sizes, shapes, colors, and textures. Some chickens have distinctive feather patterns, while others have puffy “muffs” or beards, feathery feet, large feather crests, striking combs, or long, flowing tails. Chickens also vary in the size and color of eggs they produce. Today, many breeds are still raised in backyard flocks for home meat or egg production, for exhibition, or as ornamental pets. Chicken breeds can be categorized as large breeds and **bantams**, which are a smaller size.

Large breeds’ mature weights range from about five pounds up to 11 or 12 pounds. Large breeds are further categorized into six classes based on their origins: American, Asiatic, English, Mediterranean, Continental, and other.



Barred Plymouth Rock
Jupiter Images

Some large breeds, such as those in the Mediterranean class, are best suited for laying eggs. Others are bigger and make better meat birds, while still other breeds have been developed as excellent **dual-purpose** birds (good for both meat and eggs). The Langshan, Plymouth Rock, and Orpington are all considered good dual-purpose breeds. Some breeds of large chickens and all breeds of bantams are considered ornamental breeds, due to unusual plumage or coloring. The White-Crested Black Polish, with its exaggerated crest and striking color, is one of these breeds. The Buff Brahma matures to a very large chicken that is good for meat and beautiful to look at, with its heavy plumage, coloring, and feathered feet.



Orpington
Jupiter Images



Dutch Bantam
Jupiter Images

Bantam breeds generally weigh only one or two pounds when mature. Bantams have sub-classifications based on their physical characteristics, such as comb style and feathering. The Black-Tailed Japanese Bantam is an excellent example of the beauty and style that make raising bantam chickens a popular hobby. Most breeds of chicken, whether large or bantam, have different recognized varieties within the breed based on plumage color. For instance, the Cochin, a leather-footed chicken developed as both large and bantam breeds, is found in more than a dozen color varieties.

The Brown Leghorn is another color variety of the same breed used to develop commercial egg-laying chickens. Purebred chickens, while not commercially important, are enjoyed by poultry breeders, collectors, and other enthusiasts. Sadly, many of these breeds have declined in numbers to the point where the American Livestock Breed Conservancy considers them to be in danger of surviving.

Bright Career Futures

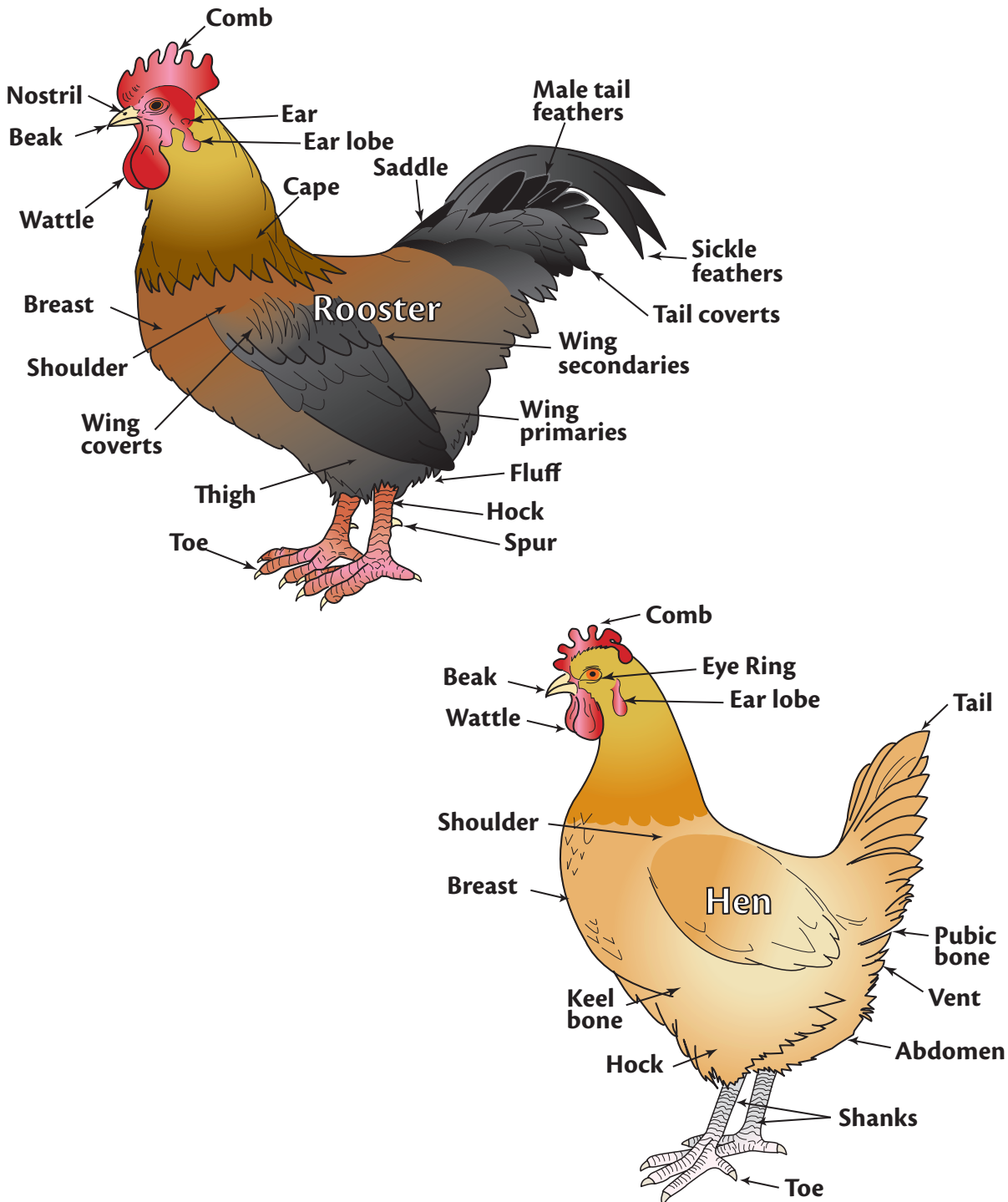
Animal Scientists
Biological Technicians
Farm and Ranch Managers
Food Processing Workers, All Other

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and Weighers
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Parts of a Chicken

Chickens are well known for their distinctive head combs and wattles below the beak. However, there are many other important parts a rooster and a hen display that will help you tell them apart. A rooster will generally be larger in size than a hen while displaying a cape of feathers around its neck and spurs on the back of its legs. A hen usually has shorter tail feathers and a smaller wattle. Depending upon the breed, the ear lobes may or may not be apparent. Some breeds also have feathers that cover their eyes and legs.



Egg Development

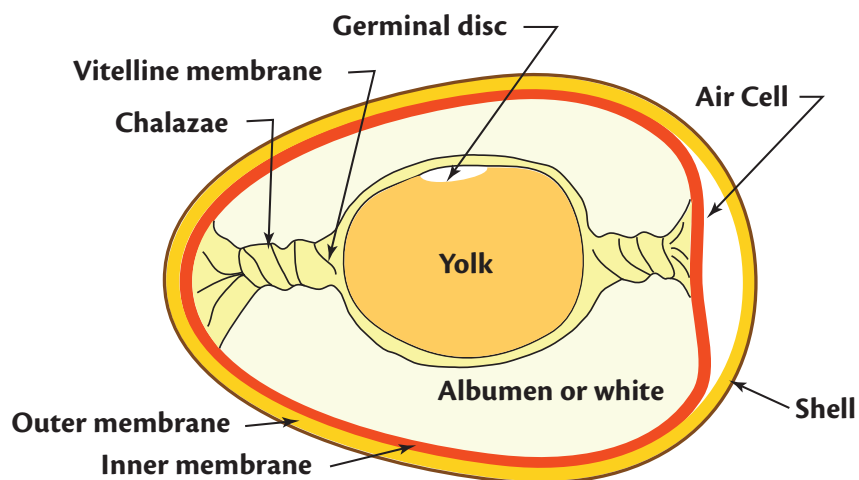
A chicken requires slightly more than 24 hours to complete an egg. Most hens will lay one egg a day for four days, skip a day, then begin laying again. Production layers average about 250 eggs per year. Fertilization is not necessary for hens to lay eggs. The egg begins as a tiny ovum within the hen's body. The ovum matures into a yolk and begins to move down the hen's **oviduct**, or reproductive tract. As the yolk travels, various layers of **albumen** (egg white) and membranes are built up around the yolk. If the yolk had been fertilized, which occurs just as it begins moving through the oviduct, these structures would serve as protection for the developing embryo. The portion of the egg that takes the longest to develop is the shell. The shell is made primarily of the mineral calcium carbonate and takes approximately 21 hours to be completed. Depending on the breed, chicken egg shells may be shades of white, brown, green or blue. Once the shell is complete, the egg passes on through the remainder of the oviduct and is expelled from the hen's vent. Occasionally, an abnormality during this process creates a defect in the egg. Some defects such as blood spots, meat spots, and double yolks can occur.

Blood spots are small spots of blood on the yolk. They occur when a bit of blood is released along with the yolk. Although blood spots are harmless, commercial eggs are screened for this type of abnormality because it is unsightly. Meat spots are similar to blood spots; this is a brown spot of tissue on the yolk. These are also harmless but unsightly. Double yolks occur when an egg contains two (or more) yolks due to the hen's ovulation cycle not being properly synchronized.

SAE IDEA

Placement

Work for a poultry producer.



Incubating Eggs and Chickens

Most chickens today are hatched and raised through artificial means. Mechanical incubators and brooders now take the place of the mother hen. Artificial methods for hatching and raising chicks result in greater control and consistency for producers. However, it also increases labor requirements and needs for appropriate facilities. The process begins when breeder hens lay fertile eggs.

Fertile eggs are collected as soon as possible after they are laid to prevent the eggs from getting dirty or broken. Cleanliness is very important because any dirt or bacteria on the eggshell can be drawn into the egg and damage the developing embryo. For this reason, eggs are fumigated with a sanitizing agent before they are placed in the incubator. The **incubator** is a device that regulates the environment so embryos can develop properly. The eggs must be kept at the correct temperature, which is about 100°F. The relative humidity must be maintained between 60 and 70 percent. Air must be circulated around the eggs to prevent the build-up of toxic gases. The eggs must be positioned properly in the racks, with the large end up, and turned regularly each day. Eggs remain in the incubator until just prior to hatching, which takes 21 days for a chicken egg.

EGGS AND THE FLU VACCINE

Did you know the first step in making influenza vaccines involves chicken eggs? In fact, millions of specially prepared chicken eggs are used to produce our nation's supply of flu vaccine. Each year in the months preceding flu season, hundreds of thousands of 11-day-old fertilized eggs are delivered to drug manufacturing labs where they are cleaned with a disinfectant and injected with a strain of the influenza virus. Once injected, the eggs are incubated for several days to allow the virus to multiply and grow. After incubation, the egg white that contains the virus is collected. The vaccines are then produced in a clean environment where each step of the production process is closely monitored to ensure quality and safety.



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Ever wonder why doctors sometimes run out of flu vaccine? The manufacturing of the doses of one season's flu vaccine depends on approximately 90 million eggs. Eggs are ordered a year in advance to ensure a steady supply of eggs for vaccine manufacturing. Once egg orders are in place, there is really no way to buy more fertilized eggs. Grocery store eggs won't work because they are unfertilized. Also, the making of the vaccine is a six- to nine-month process. Even if production could begin immediately, the vaccine produced wouldn't be ready until flu season was over.



Egg incubator
USDA-AS Photo

Once in the optimal environment the incubator provides, embryos develop quite rapidly. Within the first 24 hours, the embryo begins to form a vertebral column, nervous system, head, and eyes. The heart begins to beat by the end of the second day. Legs and wings begin to develop on the third day. Feathering begins to develop on the eighth day. By the end of the second week, scales and claws are present. On the nineteenth day, the yolk is drawn into the almost fully developed chick's body. This will provide nutrition for the newly hatched chick during the first days of life.

Eggs are candled occasionally to see if they are developing properly. Candling involves shining a bright light through the egg to view the contents. If eggs are found to be developing improperly, they are discarded.

Commercial hatcheries move the eggs from the incubator to a hatching room just prior to hatch. This keeps bacteria from the newly hatched chicks from contaminating the incubating eggs. On the twenty-first day of incubation, the chick breaks open the egg shell by tapping it with the hard egg tooth on the end of its beak. Once the chick is out of the shell and has dried, procedures such as determining the chick's sex, vaccinating, and **debeaking**, or the removal of the beak tip, are performed. Debeaking is performed to prevent chicks from pecking and harming each other. The chicks are then boxed in special containers and shipped to the customer.

For the first few weeks of life, chicks require special care. This is called **brooding**, and the cage, pen, or house where the chicks are kept is called a brooder. Like the incubator, environmental conditions in the brooder must be strictly controlled. If the chicks are allowed to get chilled, overheated, hungry, or thirsty, they will experience stress that at best will slow their growth and at worst will kill them. The temperature must be within the range of 90 to 95 degrees for the first week. Each week after that, the temperature can be dropped by five degrees. When the chicks are fully feathered, they can withstand cooler temperatures.

Chicks should be given at least 10 square inches of floor space per chick for the first week. More space is required as the chicks grow. Food and water should be available at all times, with enough space for all the chicks to eat. The chicks should be protected from drafts, moisture, and fumes with proper ventilation. They should also be kept on dry, clean litter.



A LESSON IN PARENTING



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Many people have all kinds of animals as pets, other than the usual dog or cat. But there is something unique about birds. Those who have watched babies emerge from their shells know that, to a certain extent, these little birds consider their owners to be their parents. All young birds learn by interacting with others of their own species.

This process is called *imprinting*. If humans assume the role of the parent, young birds learn to see humans as one of their own kind. For a wild bird, such as a Bobwhite Quail, this can become a problem. People pose a hazard to birds, especially game birds, yet imprinting removes their fear of humans because they have not learned to take defensive precautions when people are nearby.

Imprinting on humans will prevent a bird from being able to live a natural life in the wild. This is why you should never take an egg from a nest in the wild. If you find an egg, leave it alone or put it back on the nest, if possible. Imprinting is also why many people object to the hunting of game birds that were raised and released.

Consumer Products

Poultry products enrich our lives in many different ways. The millions of birds raised by poultry producers each year contribute in the areas of nutrition, industry, arts, medicine, and science. The United States is the world's largest poultry producer and the second-largest egg producer. Exports of poultry products are also a large contributor to the economy, with the United States being the second largest in poultry meat exports.

Meat

All poultry can be consumed as meat, but only chickens, turkeys, geese, and ducks are commonly eaten in the United States. Other species of poultry are considered specialty meats. Along with the meat, some of the organs are also edible. These are called ***giblets*** and consist of the heart, liver and gizzard. Poultry's popularity has increased among health-conscious consumers over the years because it is lower in fat and cholesterol than beef or pork. Since 1970, per capita consumption of chicken and turkey has more than doubled.

SAE IDEA

Research

Conduct feed trials for growing broiler chickens.

Eggs

Most of the eggs sold for consumption in the United States are chicken eggs. Eggs are given a grade, or are evaluated and sorted according to specific qualities. Grades include A, AA, and B, with AA being the highest.

Eggs are sold as fresh, in-the-shell eggs. Some eggs are processed through an egg-breaking operation and are marketed as a liquid, frozen, or dried product. Consumer concerns about the cholesterol levels in eggs caused per capita consumption to drop about 25 percent between 1970 and 1990. Since then, these concerns have eased somewhat, and egg consumption has increased slightly in the last few decades. Eggs are also used for artwork using painting, dyeing, and other techniques. Ostrich and emu eggs can even be carved to make beautiful decorations.



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Feathers and Down

Feathers are used in a variety of ways, from fly-tying and craft-making to insulation and feather dusters. Goose or duck down, which are small, fluffy feathers that grow under the outer feathering, is highly regarded as a soft, insulating filling for pillows, comforters, and outdoor clothing. The feathers of peacocks, ostriches, and game birds are often used as decoration.

Offal and Manure

The *offal*, or parts inedible by humans, from slaughtering operations and the manure from production operations are used as fertilizer and animal feed. Broiler litter is the subject of much research to determine how it can be utilized as a portion of the feed for different species of livestock.

Skin

Ostrich skin is used to make fine-quality leather. Visit any rodeo and you will find those fashion-conscious cowboys and cowgirls wearing boots made of leather from ostrich skin.

Drugs

Many medications use eggs in the manufacturing process. Eggs and their components are used to prepare ointments, antidotes, vaccines, and culture media. Another poultry product used for medical purposes is emu oil. Research indicates that emu oil is a natural anti-inflammatory agent. It is used to treat such problems as burns, wounds, and muscle or joint pain.

Scientific Research

Poultry is an invaluable resource for a multitude of research projects. Eggs and chicks were the basis of nutritional studies that taught us how many vitamins and minerals are used by living organisms. Fertile eggs are also used to study various types of disease-causing organisms. Chickens, ducks, and geese have been instrumental in behavioral research. Our understanding of social phenomena such as pecking order (a group's social organization) and imprinting was developed from studying these birds.



USDA-ARS Photo

Unit Summary

Poultry of all species have provided humans with food for centuries through the consumption of meat and eggs. Chicken is especially popular for its ease in preparation and perceived health benefits. As close relatives to the chicken, turkeys, ducks, and geese are also raised for consumption. Depending upon the use, some chicken breeds are chosen over others. The Cornish and White Plymouth Rock are popular for meat production while the White Leghorn is widely used for egg production. Chickens are able to produce many eggs each year, which will either be fertilized for chick production or left unfertilized for human use. Poultry have proved to be useful past food production. The feathers, offal, manure, and skin can be used for many other products. The various uses of poultry make it an essential animal to humans.

Unit Review

1. Who brought the first chickens to North America?
2. What is the *American Standard of Perfection*?
3. Why is chicken a popular meat?
4. What are three other species of poultry besides chickens?
5. Why are turkeys not typically bred naturally?
6. What is the difference between a broiler and a layer?
7. How do a hen and a rooster differ in their parts?
8. Describe the process of egg development.
9. What are egg blood spots?
10. Why are most chickens hatched and raised artificially?
11. What are the optimal conditions for eggs in an incubator?
12. Why is debeaking performed on chicks?
13. What are some non-food uses for chicken products?
14. How have poultry contributed to scientific research?



Unit 12

Small Animal Care

OBJECTIVES

- Discuss the history and domestication of small animals.
- Determine the economic importance of small animals.
- Describe the types and uses of various small animals.
- Discuss how to properly feed and care for small animals.

KEY WORDS

common house cat
domestication
euthanized
exotic pet
herding dogs
hounds
neutering
non-sporting
purebred cats

spaying
sporting dogs
terriers
toy breeds
working dogs

Dog is man's best friend. Dogs along with many other small animals have become a large part of society and everyday living for many people. Examples of small animals include dogs, cats, birds, rabbits, and turtles. Basically a small animal is any animal not considered livestock that is used as a personal companion. All animals large and small require special attention and care to ensure proper health and growth. Just as in livestock animals, small animals often require specialized diets to maintain proper function.

Domestication of Small Animals

Throughout history, humans have used animals for a variety of uses. At first, humans simply hunted animals for food. Over time, humans shifted from being hunters to farmers. Humans began using animals for work, clothes, transportation, and companionship. As humans began to interact with animals, domestication occurred. **Domestication** is the process of animals being tamed by humans.

Historians agree that dogs were the first domesticated animal, followed by cats. One popular theory suggests that dogs evolved from wolf pups. Wolves may have lived around humans scavenging for food. The wolf pups became companion animals for humans and eventually evolved into today's dog. Fossils have been found that are believed to belong to dogs as far back as 15,000 years ago.



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Domestication of the cat occurred approximately 4,000 years ago. The solitary nature of cats probably prevented them from being domesticated earlier. Egyptians depicted cats in statues and inscriptions. Mummified cats have also been found in Egyptian tombs. Cats have long been known for their ability to control rats and mice. Domestication has played an important role in the development of human societies and has allowed for the shift of humans from hunters and gathers to the farmers we know today.

Economic Importance

The small-animal industry contributes billions of dollars to the U.S. economy. Approximately 65 percent of U.S. households own a pet according to the 2016 National Pet Owners Survey conducted by the American Pet Products Association. More than 163 million dogs and cats are pets in the United States.

SAE IDEA Entrepreneurship

Operate a kennel cleaning service.

Pets require more than just a loving home. They require food, toys, grooming, boarding, and veterinary care. Each year, Americans spend over \$60 billion on pets including food, supplies, services and so on.

Total Number of Pets Owned in the U.S.*	
Birds	14.3 million
Cats	85.8 million
Dogs	77.8 million
Fish	105 million
Reptiles	9.3 million

*2015 American Pet Products Association Data

Breakdown of Pet Industry Sales*	
Food	\$23 billion
Supplies/OTC Medicine	\$14.4 billion
Vet Care	\$15.7 billion
Live animal purchases	\$2.2 billion
Pet Services: grooming & boarding	\$5.2 billion

Types and Uses of Small Animals

Small animals are used for everything from companionship to food. People enjoy the company of pets and many times they become part of the family. There is such a wide variety of small animals kept as pets that a person is sure to find one that will fit with his or her lifestyle.

Dogs

Dogs have been “man’s best friend” for hundreds and possibly even thousands of years. Dogs are typically companion animals or pets but are used for other purposes, too. There are 129 breeds recognized by the American Kennel Club. These breeds are divided into seven groups: sporting dogs, hounds, working dogs, terriers, toys, herding dogs, and non-sporting dogs.



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Sporting dogs are naturally active and alert. This group includes pointers, retrievers, setters, and spaniels. Sporting dogs are known for their instincts in the woods and water. Numerous breeds in this group are still used for hunting today. This group of dogs requires invigorating exercise on a regular basis.

Hounds are used for tracking either by scent or sight. Some use an acute sense of smell to follow a trail. Others are relentless in tracking animals or people. Examples of dogs in the hound group are beagles, bassets, dachshunds, and coonhounds. These dogs are used by hunters to track game and by law officials to track criminals.

Working dogs have been developed to perform jobs such as protecting property or livestock, or pulling sleds. This group also contains rescue dogs and police dogs. Working breeds are intelligent and quick learners. A few breeds included in the group are the Great Pyrenees, German Shepherd, and Siberian Husky.

Terriers are a group of energetic, feisty dogs. The terriers' ancestors were bred to hunt and kill vermin. A spunky attitude is still seen in terriers today. This group includes breeds such as the Fox Terrier and Miniature Schnauzer. Terriers usually do not have a tolerance for other dogs or animals.

The **toy breeds** are known for their companionship. Toy breeds are great city dogs as they are small, which tends to minimize shedding, messes, and cost. This group includes the Chihuahua, Pug, Shih Tzu, and Pekingese. These friendly breeds are great lap dogs.



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Herding dogs are known for their instincts to herd other animals. These dogs have a great ability to control where other animals move. This group includes breeds such as the Australian Shepherd, Collie, Border Collie, and Old English Sheepdog. These dogs are very intelligent and are easily trained.

The **non-sporting** group consists of numerous breeds with a great diversity of characteristics. These dogs range in terms of appearance, size, and personality. Examples of this group are the Boston Terrier, Dalmatian, Poodle, and Bulldog. Overall, this group makes great companion animals.

There are many options for dog lovers when it comes to choosing a pet. When selecting a breed there are many things to consider including space requirements and breed characteristics. Choose wisely when getting a dog. Many dogs are abandoned because their owners were not able to care for them properly and did not realize the responsibility required.



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SPAYING AND NEUTERING

Nationwide, more than 3 million cats and dogs are **euthanized** , or medically put to sleep, in shelters. Homeless animals have to be euthanized because there is not enough space in shelters. One method of controlling the animal population is to spay or neuter pets. **Spaying** is the process of preventing female animals from reproducing by removing the reproductive organs. **Neutering** is the removal of the male reproductive organs.

Spaying and neutering not only prevents unwanted offspring, but it may also reduce the risk of some health problems. Spaying and neutering can also have a calming affect on the animal. Although spaying and neutering can be expensive if you have multiple animals, there are assistance programs to help cover the cost of the surgery.

Cats

Cats are loving and playful, as well as independent and self-sufficient. Cats are kept for companionship or pest control and many times are used for both purposes. Most cats are social animals that adapt well as indoor animals. Those used for pest control have a natural hunting instinct. Cats will catch birds, mice, and other small animals. Because cats have an independent nature, they tend to require less care than dogs.



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Cats fall into one of two categories: purebred cats and common house cats. **Purebred cats** have stayed true to breed lines and are commonly divided into two groups: short-haired breeds and long-haired breeds. Short-haired breeds require less maintenance as these cats have, as their name indicates, short hair. Brushing is not as necessary on short-haired cats. Long-haired breeds require more grooming to maintain their hair coat. There are 36 breeds of cats recognized in the United States.

SAE IDEA

Research

Research the best diet to help obese pets lose weight.

Most people are probably most familiar with the **common house cat** , which is a mix or cross of various breeds. The roaming nature of cats has allowed purebred cats to breed and repopulate. The common house cat can be a variety of colors ranging from a solid to multi-colored.

Rabbits

Rabbits can be raised commercially or as a hobby. Commercially raised rabbits are used for meat production, fur and wool production, laboratory research, and as pets. Rabbits that are raised as a hobby are often shown or used for home companionship.

Rabbits raised for meat production are marketed to grocery stores and restaurants. Rabbit meat is a very fine textured, mainly white meat. The fiber content in rabbit meat is low, making it easily digestible. Americans have a certain image of rabbits and, therefore, eating rabbit is not as popular in the United States as in Europe. It is estimated that more than 35 million pounds of rabbit meat is eaten by Americans each year.



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Clothing, hats, gloves, and yarn are items that can be made with rabbit fur. There are specific wool-breed rabbits that can produce fur or wool, although the wool can vary among the different breeds. The most common rabbit breeds raised for wool or fur are the Rex, Satin, and Angora. The Rex produces short fur that is very soft. Satin fur has an intense color and tends to have a slick, shiny appearance because of the transparent outer shell of the fur. The wool from Angora breeds is softer, warmer, and lighter than sheep's wool. This wool is used primarily by hand spinners in the United States.

Rabbits have been used for research for many years. The use of rabbits as research animals has allowed scientists to produce drugs for treatment of disease, as well as to determine the skin irritability of cosmetics. Nutrition and genetic research has also been conducted on rabbits. In recent years, some testing on rabbits has become controversial. Due to this controversy there has been a decrease in rabbit use in the laboratory. In 1991, almost 400,000 rabbits were used for research compared to approximately 240,000 used in 2006. The USDA now provides guidelines for laboratory techniques to protect the welfare of the rabbit.



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Rabbits make lovable pets. They are playful but gentle. Rabbits tend to be clean animals and can be trained to use a litter box. This makes them a great small indoor pet. There are more than 45 breeds of rabbits recognized by the American Rabbit Breeders Association, which range in size from dwarf to large. Depending on the breed, a dwarf rabbit will weigh 4 pounds or less. A large breed can weigh 16 pounds or more.

Exotic Pets

People keep a variety of animals as pets. Most have a cat or dog, but some want a unique companion. An **exotic pet** is a rare or unusual animal that is kept as a pet. An exotic pet can range from a snake or reptile to a hamster or gerbil. Many times exotic pets are not actually domesticated but just tamed wild animals. This is an important fact to remember if you choose to own an exotic animal.



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Before purchasing an exotic pet, one must research the needs extensively. It can be challenging to own an exotic pet. Veterinary care is not as readily available for exotic pets as it is for dogs and cats. Exotic companion animals tend to require additional care not common to traditional pets. It is also important to research the laws in the area in which you live. Many times there are restrictions on the types of pets a person can own.

Care of Small Animals

Small animals, like any domesticated animal, rely on humans to care for them. Unfortunately, many pets are abandoned each year. Before purchasing or adopting a small animal, you must be prepared to provide for its needs – food, water, shelter, and attention.

There are many questions one should ask before becoming a small-animal owner. These questions must be answered honestly. A pet is a commitment and responsibility. This domesticated animal relies solely on a person to provide for its needs. Below are a few questions one should answer before accepting the responsibility of a pet:

1. What type of pet is right for me?
2. What type of shelter can I provide?
3. What will I need to do on a daily basis to take care of my pet?
4. Does my lifestyle allow the time for a pet?
5. How much will a pet cost?

SAE IDEA

Exploratory

Take small animals to nursing homes for visits.

Choosing a Pet

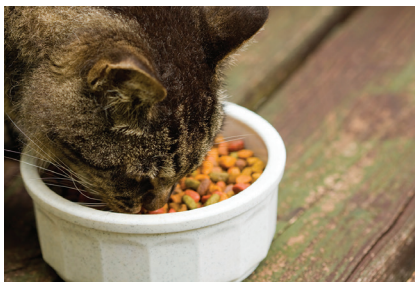
Choosing the right type of pet is essential when taking on the responsibility of a small animal. Animals are perfect for companionship, but a person must determine the ideal pet for his or her situation. What are the living quarters: an apartment in the city or a large farm? What is the amount of living space the pet will have? Is there enough room for a large dog to exercise? Is there a backyard where a dog house could be placed or will it be necessary for the pet to be kept inside the house? These questions should be asked before investing in a pet.



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Routine Care

Routine care requirements depend on the animal. Each type of pet requires different amounts of care. A person's lifestyle will determine the type of pet that he or she can care for responsibly. Dogs need exercise daily and tend to be more dependent on their owner. Cats require less care and, therefore, require less time. A fish or hamster might make a better pet for someone who is away from home a lot.



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All pets require basic maintenance including feeding, bathing, grooming and health care. Some animals require more time than others. The health of your pets depends upon your willingness to care for it. Animals can become sick if not properly fed or vaccinated. Dogs and cats have a vaccination schedule that should be followed to ensure the health of the animal. Many of these vaccines are given to prevent life-threatening illnesses. Other animals may not require vaccinations, but through proper feeding and protection from the elements, they can stay healthy and avoid disease.

Puppy and Dog Vaccinations	
Age	Vaccination
6- to 8-week old puppy	Distemper-Measles-Parainfluenza (CPI), Parvovirus
8- to 12-week old puppy	DHLPP (Distemper, Hepatitis, Leptospirosis, Parainfluenza, Parvovirus)
12 weeks	Rabies
16 weeks	DHLPP
12 months	Rabies
Boosters of some vaccinations such as rabies will be needed.	

Kitten and Cat Vaccinations	
Age	Vaccination
6-8 weeks	Panleukopenia (FPV), Pinotracheitis (FVR), Calicivirus (FCV)
12 weeks	2nd FPV, FVR, and FCV; 1st Feline Leukemia (FeLV) if negative to ELISA test
16 weeks	1st Rabies; 2nd FeLV; 3rd FPV, FVR, and FCV
16 months and each year	FPV, FVR, VCV, FeLV, Rabies

All animals require proper facilities and equipment; however, these will be different for each species of pet. Dogs kept outside need to be fenced to keep them from straying along with proper housing to keep them cool in the summer and warm in the winter. Cats should be provided a place to sleep and play, as well as a litter box to urinate and defecate. Other pets such as birds, rodents, and reptiles will need proper housing according to the type of animal.

Dogs and cats especially need regular grooming. This could be brushing a cat daily to rid it of excess hair, or bathing a dog when it becomes dirty. The nails of animals should also be examined and trimmed when needed. Ears, eyes, teeth and gums should also be checked to make sure there is no excess discharge, mites, ticks, infection, and so on. A change in any of these areas may cause an animal to become sick or feel lethargic, which will lead to not eating. Proper maintenance in all areas will keep your animal healthy and energetic.

One of the most important aspects to routine maintenance is feeding. Just like humans, dogs, cats, hamsters, snakes, and birds all get hungry. Feeds have been developed to target the needs of each particular species. There are certain vitamins and minerals found in some food rations that you may not find in others. For example, dog food does not contain as much protein as cat food and should not be fed to cats for this reason. There are also special rations for puppies and dogs, which should be fed accordingly. If you have questions about the feeding or care of your animal, there are many pet stores that offer assistance or contact your local veterinarian.



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Cost

Many times people do not consider the cost of a pet past the initial purchase price. Buying a puppy, kitten, or other small animal can be rather inexpensive when compared to the cost of food, grooming, veterinary bills, and other related expenses. In the first year, a puppy can cost \$500 - \$1000. Kitten care for the first year will cost \$400 - \$800, where a small bird such as a finch would be less expensive, costing approximately \$250 for the first year.

It is important to research the associated costs of the pet you choose. The first year will cost more because of the need to purchase new equipment. Yearly costs that should be expected are food, vaccinations, and veterinary expenses.



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Unit Summary

The domestication of animals has allowed humans to use small animals for companionship, service, sporting, work, and food. This use is a billion-dollar industry in the United States. Over half of the households in the U.S. own a pet. When deciding on what type is best, a person should determine the amount of money he or she wants to spend, the time able to devote to the animal, and if the pet will fit into his or her lifestyle. Pets of all kinds require routine care such as feeding, grooming, and health care. Researching different types of pets will allow one to provide a loving home.

Unit Review

1. What are small animals used for?
2. What is domestication?
3. How is it believed dogs were domesticated?
4. Explain the economic importance of the small animal industry.
5. Name and describe three groups of dogs.
6. Describe the two types of cats.
7. How have rabbits been used for research?
8. Why might an exotic pet not be the best for everyone?
9. Explain three things that should be considered before owning a pet.
10. What basic maintenance is required for all pets?
11. Why should a person estimate the cost of owning a pet before purchasing?



Unit 13

Agricultural Mechanics Safety

OBJECTIVES

- Identify common hazards in agricultural mechanics.
- Determine the importance of maintaining shop safety.
- Match personal protective equipment with their purposes.
- Discuss important welding safety practices.
- Match classes of fire to their correct descriptions and extinguisher type.
- Identify the colors used for safety coding.

KEY WORDS

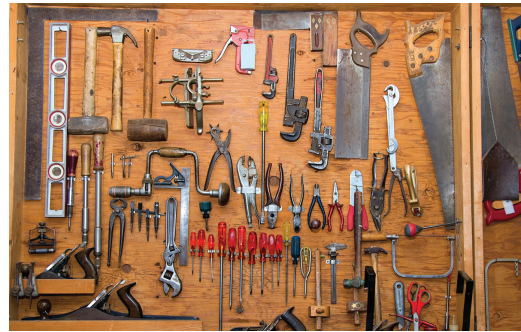
accident
combustible
flammable
flash point
hazard
non-synthetic
personal protective
equipment
welding arc

The agricultural industry is becoming more technical and sophisticated every year. Many occupations involve the use of modern, highly technical agricultural equipment. Proficiency in this area can help you earn more money, do your own home repairs, and keep your vehicles and machinery maintained. It may even help you develop some fun and artistic hobbies.

While learning a skill is important, it is even more important to practice safety when in the agricultural mechanics shop. Safety is so important that laws have been passed by legislators that regulate the use of proper safety measures, such as eye protection. Governmental agencies such as the Occupational Safety and Health Administration (OSHA) have also been established to prevent work-related injuries, illnesses, and deaths.

Maintaining Shop Safety

General safety precautions apply in any shop situation, regardless of the work being performed. Specific areas of agricultural mechanics, such as welding, have additional safety rules that are taught within that area of instruction. Behaving responsibly, using common sense, and exercising good judgment can help ensure safety in the shop.



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Shop Safety Rules

- Wear appropriate clothing that fits properly.
- Use appropriate personal protective equipment, such as eye protection.
- Remove rings and dangling jewelry, and tie back long hair.
- Keep the shop and work area clean and well organized.
- Put all items in their proper places after use.
- Properly store work materials at the end of the work period.
- Only use tools for their specific purpose.
- Never work with tools or equipment for which you have not received instruction.
- Keep tools and equipment properly adjusted or repaired.
- Know the location and proper use of fire extinguishers.
- Make sure fire extinguishers are properly charged.
- Place oily or greasy rags in covered metal cans.
- Turn off all electrical equipment after use.
- Repair or replace all worn or frayed electrical cords.
- Never touch metal that could be hot.
- Use proper lifting techniques.
- Know and observe shop safety procedures given by your instructor.
- Stay alert to possible hazards.
- Correct or report unsafe conditions.
- Be responsible and conduct yourself in a safe manner.

SAE IDEA Entrepreneurship

Create safety videos to sell to local businesses.

Common Hazards

A **hazard** is a situation that poses a danger. The agricultural mechanics shop is a workplace that has a variety of potentially hazardous situations. Good safety habits will greatly reduce the severity of these hazards, but one should always be aware that the risk for **accident**, or unintentional harm, and injury is present when working in the shop. There are many sources of hazard including human error, machinery, and electricity.

Most injuries that occur in the shop or elsewhere are the result of human error. In other words, accidents occur when someone is being careless, not paying attention, showing off, or indulging in horseplay. Behaving responsibly is the best way to avoid causing an accident that could injure you or an innocent bystander.



Machinery is useful because it is powerful. For the same reason, machinery poses an extreme hazard. If a machine is operated improperly or if it breaks, a person can be injured by moving parts, flying pieces, or falling objects. Machinery should only be operated by someone with the proper knowledge, skill, and ability.

Electrical hazards may result in fire and injury from shock or electrocution. Even a small electric shock is painful, while standard household current can kill. Along with electrical hazards, hazardous materials pose a risk. An agricultural mechanics shop often contains chemicals such as fuel, paints, and solvents. Such material must be stored, handled, and disposed of properly.

Working in an agricultural mechanics shop can involve the use of torches, internal combustion engines, and other sources of heat and explosive energy. If these are not properly handled, serious injury and property damage may result.



CUTTING THE CHATTER DOES MATTER

Next time you're working on a shop project, take time to notice where your attention is focused. Are you concentrating on what you're doing? Or are you talking with a friend as you work? If you are in the habit of multi-tasking, or doing more than one thing at a time, while working, your attention is not always where it should be, and that's dangerous. For instance, researchers found that talking on a cell phone while driving is dangerous – not because the driver's hands are busy with the cell phone, but because his or her attention is divided. Instead of keeping the eyes moving and alert for problems, the driver who is talking on a cell phone or to a passenger tends to keep his eyes fixed on one thing, such as the car ahead. Consequently, that driver is in much greater danger of not seeing, and not avoiding, a sudden hazard. The same holds true when you are working in the shop. When you are working with tools or machinery, pay attention to what you are doing. Also, don't distract someone else who is working. Save your conversation for a time when you are not working; you will be much safer in the shop... or in the car!

Personal Protective Equipment

Equipment worn to protect you from injury while working is called **personal protective equipment** (PPE). Such equipment may be used to protect your eyes, skin, hearing, body, head, lungs, feet, and hands. The type of PPE you should wear depends on the type of work you are doing, because different kinds of work pose different hazards. For instance, cutting wood poses a hazard to your eyes from flying objects, but it does not pose any hazard of chemical burns to your skin. Welding requires skin protection to prevent burning, as well as extra shielding for the face and eyes.

The agricultural mechanics shop you work in should be equipped with all the necessary personal protective equipment. Always wear the right PPE for the work that you are performing, and follow your instructor's guidance. Examples of the types of PPE that are available are listed below.

Types of PPE

- Safety glasses and goggles protect your eyes. Different varieties of glasses or goggles are suited for different purposes. Clear safety glasses with side shields protect your eyes from flying particles when you are cutting, grinding, or sawing. Goggles protect your eyes from splashing liquid as well as flying particles. Goggles can also be worn over prescription glasses.
- Coveralls protect the body, arms, and legs from dust and flying debris.
- Steel-toed boots protect the feet from falling objects.
- Rubber boots protect the feet from water and mild chemicals.
- Clear face shields are sometimes worn in addition to safety glasses. The face shield protects the entire face from flying particles or liquid splashes.
- Helmets and shaded face shields protect the face and eyes from heat, harmful rays, and hot metal when welding.
- Gloves protect the hands from splinters, hot or sharp metal, and chemicals.
- Ear plugs or ear muffs protect the hearing from loud or continuous noise.
- Dust masks protect you from breathing dust.
- Respirators protect you from breathing toxic gases, fumes, and harmful fibers such as asbestos.



The type of PPE worn should be designed for the intended use. For example, dust masks may not offer adequate protection from asbestos fibers. Likewise, tinted safety glasses should not be used when welding. Kitchen gloves do not offer adequate protection from chemicals.

Welding Safety

Welding creates hazards of skin burns, eye damage, electric shock, and fire. *Always follow proper safety precautions when welding.* Careful attention to hazard prevention reduces the chance of an accident.

You should never look at the **welding arc**, or light, without proper eye protection, which is a shaded lens ranging from No. 9 to No. 12. If you do not have suitable eye protection, you should look away from the arc. It is important to use a welding helmet that is in good condition. Notify your instructor immediately if the helmet material or shaded lens is cracked or broken. Clothing should be worn to protect all parts of your body, including your arms and legs. Do not allow your own or bystander's skin to be exposed near the arc. A long-sleeved shirt of **non-synthetic**, or natural fiber such as cotton, leather gloves, pants with cuffs turned down, and high-topped leather shoes or boots are best.

SAE IDEA
Exploratory
Lead a farm safety program for elementary students.



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Before beginning a weld, you should alert others to the presence of the arc by yelling “Cover!” before striking. Never strike an arc or weld until you are sure that those in the vicinity are wearing protective eye equipment or will look away from the arc. Never pick up hot metal or metal you think may be hot with your bare hands or leather gloves; pliers or tongs should be used.

It is important to have good ventilation when welding so that gases and fumes can escape. You should also remember to wear safety glasses when chipping a weld and keep the welding area clean and free of objects that may cause tripping.

To avoid electrical shock, you should ensure that welding cables are not frayed or missing insulation, and always stand on dry footing when welding. The electrode holder should never be left on the welding table or in direct contact with grounded metal. You should also never touch an electrode when the machine is on.

Bright Career Futures

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Fire Inspectors	Occupational Health and Safety Technicians
Fire-Prevention and Protection Engineers	Product Safety Engineers

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Fires and Extinguishers

Fires are a serious threat to both life and property. A fire in the shop can start and spread quickly. There is no time to learn about fire and how to deal with it after one has already started! The best way to deal with fire is to prevent it. Keeping the shop clean and following safety rules regarding combustible or flammable material will prevent most fires from starting. **Combustible** material is anything that is able to ignite easily and burn quickly, such as wood or paper. If a material has a **flash point**, or a temperature at which it will burst into flame, of less than 100°F, it is considered **flammable**.



Fires are classified according to the type of material feeding the fire. This is important because not all fires can be put out with water. Some fires can only be put out by extinguishers that use special chemicals to create a reaction that stops the fire. Fire extinguishers are designed to put out specific classes of fire, and they should not be used with other types of fire.

Fire Classes

Class A – occurs in ordinary combustible materials such as wood, rags, and rubbish. This type of fire can be put out with water or an extinguisher labeled for use on Class A fires.

Class B – fueled by flammable liquids such as gasoline, oil, grease, paints, and thinners. Water should not be used to fight this type of fire because water can help to spread rather than stop the fire. Only an extinguisher labeled for use on Class B fires should be used.

Class C – electrical fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring. Water should not be used to fight this type of fire, because electric shock or electrocution may result. Only an extinguisher labeled for use on Class C fires should be used.

Class D – fueled by flammable metals, such as magnesium. This type of fire must be fought with a chemical extinguishing agent. Only an extinguisher labeled for use on Class D fires should be used.



HOW SMOKE DETECTORS WORK

Smoke detectors are an inexpensive and effective safety device. They work by using a sensor that detects the presence of smoke. A common type of sensor used in smoke detectors is called a photo detector. This sensor actually senses light rather than smoke. Inside the smoke detector a small beam of light shines across the entrance of a chamber where the photo detector sits. The light doesn't shine into the chamber, so the sensor cannot "see" it. But when smoke crosses the path of the light beam, it diffracts the light, which then bounces toward the photo detector. Once the photo detector "sees" the light, a switch is activated that sets off the alarm.

Many fire extinguishers are designed to fight multiple classes of fire. Make sure you know the locations and types of fire extinguishers available in the shop or home. Learn how to use the fire extinguisher properly. Finally, understand that home fire extinguishers are designed to put out only very small fires. Always follow proper fire safety procedures if a fire does start.



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Safety Color Code

Creating a safe work environment in agricultural mechanics is essential to avoiding accidents and injuries. Color coding helps individuals identify specific hazards or dangers. It also helps individuals locate objects and organize the work area. Agencies such as OSHA and ANSI have standardized colors to provide consistency in work areas. Workers should become familiar with the color code to reduce the number of accidents and injuries.

RED – used to identify fire protection equipment and apparatus, and to designate “danger” or “stop.” Red is used to identify portable containers of flammable liquids. The color is also used to show emergency shut-off switches, stop bars, and stop buttons. Safety signs indicating danger should be painted red.

YELLOW – used to designate caution and mark physical hazards such as stumbling, falling, tripping, striking against, and caught-between. Colors used for designation may be solid yellow, yellow and black strips, or checkers.

ORANGE – used to designate dangerous parts of machinery and parts of equipment that can cause electric shock. This color identifies parts of machinery or equipment that can cause injuries by cutting, crushing, shocking or other means. Orange is used to identify hazards such as exposed edges and openings of pulleys, gears, rollers, cutting devices, and power jaws.

GREEN – used to designate safety and first-aid equipment. Green is used to identify areas where medical treatment may be given, such as safety deluge showers.

BLUE – used to warn against starting equipment, moving equipment, or using equipment under repair or being worked on.

PURPLE or **BLACK AND YELLOW** – designates radiation hazards.

BLACK AND WHITE – used to designate traffic movement and housekeeping areas.



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Unit Summary

Safety is the number one priority when working in the agricultural mechanics shop. It is important to be aware of potential hazards to prevent accidents. While working in the shop, all shop safety rules should be followed to ensure that you or someone else is not harmed. Proper PPE should be worn depending on the type of work being done, and eye protection of some kind should be worn at all times. Welding is often done in the agricultural mechanics shop. Knowing the rules and procedures for welding safety will help you avoid mistakes that may lead to injury. If a fire does occur in the shop, you should first identify the fuel for the fire. Fire extinguishers have been designed to target the fuel for the fire, and water should be used with caution because it could cause some fires to spread. Shop safety color coding decreases accidents by highlighting areas of caution and safety.

SAE IDEA

Research

Research some of the most hazardous jobs in the United States.

Unit Review

1. What is the purpose of OSHA?
2. What should be done with rings and jewelry when working in the shop?
3. State five shop safety rules and why they are important to follow.
4. What causes most injuries in the mechanics shop?
5. Explain the potential hazards in a mechanics shop.
6. Give five examples of personal protective equipment.
7. What should never be done without eye protection when welding?
8. What PPE should be worn when welding?
9. What should be done to avoid electrical shock when welding?
10. Name the classes of fires and the fuel for each.
11. Which classes of fire should never be fought with water?
12. What is the purpose of the color safety code?
13. Summarize what each of the safety code colors indicates.



Unit 14

Arc Welding and Oxyfuel Cutting

OBJECTIVES

- Distinguish among the methods of welding.
- Identify equipment used for shielded metal arc welding.
- Demonstrate procedures for striking an arc and running a bead.
- Identify equipment used for oxyfuel cutting.
- Explain the purpose of oxygen and fuel gases used in oxyfuel cutting.
- Discuss the oxyfuel cutting process.
- Determine how to properly adjust an oxyfuel flame.
- Demonstrate the procedure for cutting steel.
- Discuss errors made when cutting steel.

KEY WORDS

AC
AC/DC
backfire
chipping hammer
DC
electrode
electrode holder
flashback
flux
ground clamp
kerf
metal inert gas
oxidation
scratching

shielded metal arc
welding
slag
stringer bead
tapping
tungsten inert gas
weaving
wire brush

Arc welding and cutting is one of the most versatile and useful agricultural mechanics skills, and it can be easily developed into a strong career choice. Welding and cutting are used for everything from creating art sculptures to constructing nuclear facilities. Ranchers and farmers use these skills to fabricate tools, build structures, and repair equipment. For those who choose metal fabrication and repair as a career, it is a profession with a rich past, a multi-faceted present, and a dynamic future.

Welding Methods

Arc welding is the use of electric current as a heat source to bond metal together by fusion. The arc that generates the heat is an electrical discharge sustained between the electrode and the base metal. There are several types of arc welding processes, each of which uses a different welding machine.

Shielded Metal Arc Welding

Shielded metal arc welding (SMAW) is also known as stick welding. With this type of arc welding, the welder uses an electrode. As the coating on the electrode burns, it creates a gaseous shield around the melted metal, which helps the base metal mix with the welding rod or electrode. SMAW work is done with AC, DC, or AC/DC welding machines.

AC (alternating current) machines are simple transformers that plug into normal 220V wiring. These welding machines are relatively inexpensive, suitable for most common uses, and simple to use. However, they offer the operator less control over the welding process.

DC (direct current) machines act as electrical generators. Some DC welders are operated by an internal combustible engine, which means they are mobile and can be used in places where electricity is not available. DC machines also have a manual control that allows the operator to change the direction of current flow in the welding circuit. The two possible directions are referred to as *straight polarity* and *reverse polarity*. Using this option allows the operator to modify the characteristics of the weld to suit the application.

AC/DC welding machines allow the operator to use the type of current (AC or DC) most suitable for application. When powered by a gas or diesel engine, machines of this type can be used as portable generators as well. As the machine offers the operator more choices and greater control over the current used, it is both more complicated to use and suitable for a wider variety of situations.



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SMAW welders allow the user to set the amperage level. The amperage setting affects the strength of the current flow and, therefore, the amount of heat produced. Welders used in agricultural mechanics usually have a range of 20 to 225 amps. Welders also require a certain amount of cool-down time when operating. The amount of time that a welder can be used before it must be allowed to cool down is called the *duty cycle*. This is expressed as the percentage of time in a 10-minute cycle that the welder can operate before it overheats.

Metal Inert Gas Welding

Metal inert gas (MIG) machines use a combination of electricity and an inert shielding gas. The electrode is a consumable wire that is fed automatically from a spool. The wire moves through a gun nozzle, through which the shielding gas is also injected. MIG welding is especially suited for welding thin-gauge steel or for applications that require fast welding with good control of the weld. MIG welding is also referred to as gas metal arc welding or GMAW.



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Tungsten Inert Gas Welding

Tungsten inert gas (TIG) welding machines also use a combination of electricity and an inert gas. The electrode is considered non-consumable because it is made of tungsten, which has a very high melting point. The electrode is located inside the TIG torch. An inert gas, such as helium or argon, is injected from the torch and around the arc to shield the molten metal while welding. A filler rod is used in combination with the TIG torch. TIG machines use either AC or DC current. TIG welding is slower than MIG welding, but it offers the greatest amount of control of the weld. It is used in situations where high quality of the weld is essential. TIG welding is also referred to as gas tungsten arc welding or GTAW.



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Welding Equipment

As with most hands-on professions, welding requires knowledge of specialized terms and equipment. SMAW requires certain equipment in addition to the arc welding machine, regardless of the type of machine being used.

The **electrode** is the metal welding rod that is coated with flux. **Flux** provides a gas shield for the molten pool during the welding process, which helps fuse metals together. Different types of electrodes are available and are classified according to their use.



Also known as rods or sticks, SMAW electrodes are available in a variety of types. All electrodes, regardless of type, consist of a metal rod coated with flux. The diameter and tensile strength of the rod, the type of flux coating, and the metal that the rod is made of will vary according to the specific welding need. Common types of electrodes include mild steel, hard surfacing, high-carbon steel, and alloys/special purpose.

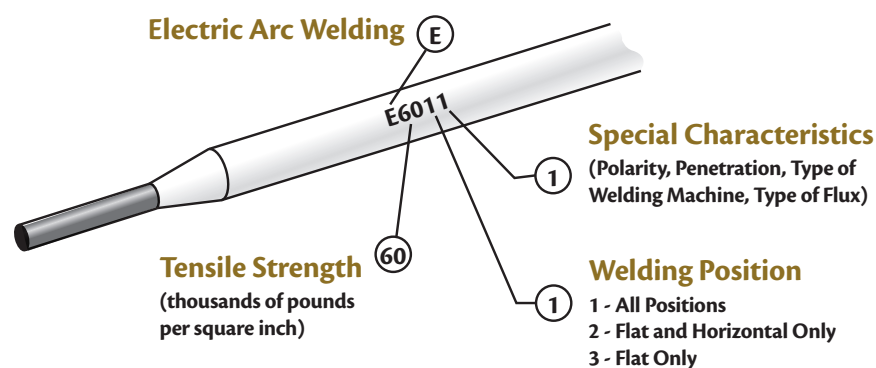


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Electrodes are also classified according to the welding position and type of current with which they can be used. In order to easily identify an electrode's type, the American Welding Society (AWS) has developed a coding system. Most electrode manufacturers stamp this five- or six-digit code on the electrode coating.

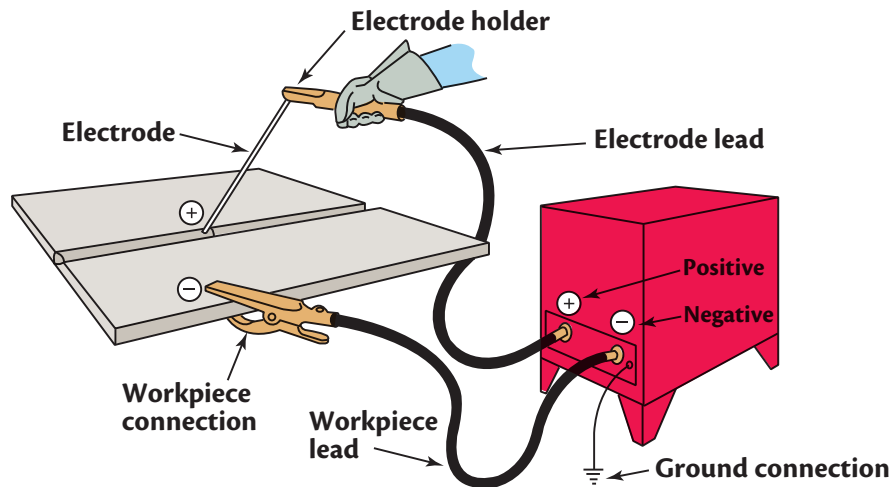
- The letter "E" at the beginning of the code indicates that it is for electric arc welding.
- The next two digits indicate the tensile strength in thousands of pounds per square inch. The number 60 in this position means that a one-square-inch weld made with this electrode should withstand 60,000 pounds of tension. Some electrodes require a three-digit number to express this strength.
- The next number in the code indicates the welding position(s) in which the electrode should be used. The code "1" means that the electrode is usable in any welding position.
- The last number in the code indicates special characteristics of the electrode, such as the type of current to be used, the polarity, or the type of flux coating.

E6011 Mild Steel Electrode



Pocket guides and wall charts available through the AWS provide guidance in the exact meaning for the last two digits of the stamped electrode code. The most common types used in agricultural mechanics are E6011 and E6013, both of which are all-purpose, any position electrodes that can be used with AC or DC current. Newer high-strength metals require E7013.

The **electrode holder** is a clamp that grips the electrode. The handle of the electrode holder is insulated to protect the operator from electric shock. The **ground clamp** is a clamp attached by a cable to the arc welder. It completes the electrical current. Cables are used to connect the electrode holder and the ground clamp to the machine. Copper or aluminum wires are used for the core of the cable. These wires must be sized to carry the current produced at the maximum machine setting.



Striking an Arc and Running a Bead

The appropriate personal protective equipment (PPE) is needed when welding. A welding helmet with a properly shaded lens, safety glasses or goggles, leather welding gloves, leather apron, sleeves or jacket, and leather steel-toed boots should be worn for protection.



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When welding, it is important to understand how the process works and what you are seeing when you look at a weld. This will help you create good welds and improve your work as you gain experience. With welding equipment in place and the arc welder turned on, the welding process begins by striking an arc with the electrode. The arc is kept burning by keeping the electrode an appropriate distance from the base metal. The operator moves the end of the electrode slowly across the base metal to form a bead. The electrode should be kept at about a 15-to 30-degree angle from perpendicular in the direction of travel. Right-handed welders weld from left to right, and left-handed welders weld from right to left.

The arc burns at temperatures between 6,000 and 9,000°F. Heat from the arc melts the base metal and the electrode, creating a molten pool or puddle of melted metal. Melting the base metal causes penetration below the surface, which fuses the metal together. Heat from the arc also burns the flux from the electrode. This creates the gaseous shield that protects the molten pool of metal from the effects of the surrounding air. This gaseous shield also stabilizes the arc. In addition to the effects of the gaseous shield, flux promotes fusion of the metals during welding. It also serves to float non-metallic impurities out of the molten puddle. As the weld cools, the burned flux and these impurities float to the top of the weld and create a layer called **slag**.

SAE IDEA

Placement

Work as an auto, truck or tractor mechanic assistant.

A **chipping hammer** is used to knock away slag, and a **wire brush** is used to remove slag, clean metal in preparation for welding, or clean beads after welding. A grinder with a wire wheel is sometimes used. Tongs or pliers are used to handle metal that is still hot from welding.

As the metal cools, you will see the weld and the slag. The penetration of the weld cannot be observed with the naked eye. This requires the use of X-ray equipment.

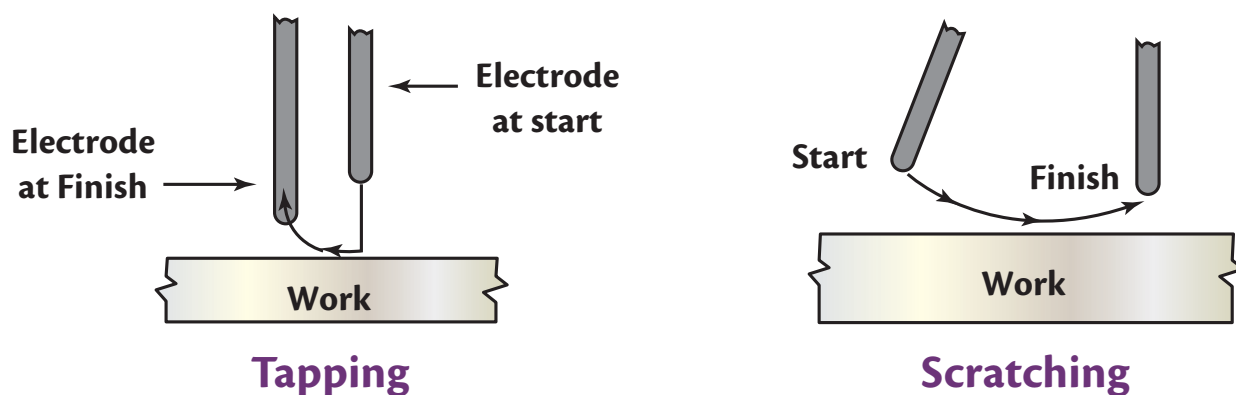
There is much more to welding than just making pieces of metal stick together. However, striking an arc and running a bead are basic welding skills that you must have before doing any welding job.

Striking an Arc

There are two methods for establishing an arc, scratching or tapping. Either one is acceptable. The **scratching** method works by touching the electrode to the base metal in a scratching motion similar to striking a match. The **tapping** method works by touching the electrode to the base metal and quickly raising it.

If the electrode gets stuck to the base metal, which will happen if it is left close to the metal for too long, you can either pull it off or release the electrode from the electrode holder. Do not turn off the welder before releasing the electrode, as this will damage the machine. Once you have established an arc, you will need to monitor its length. The length should be between 1/8 and 1/16 of an inch.

If the arc is too short, the electrode may stick to the base metal. If the arc is too long, you will hear an erratic sound. An arc of the correct length produces a frying sound, and the machine will have a steady hum.



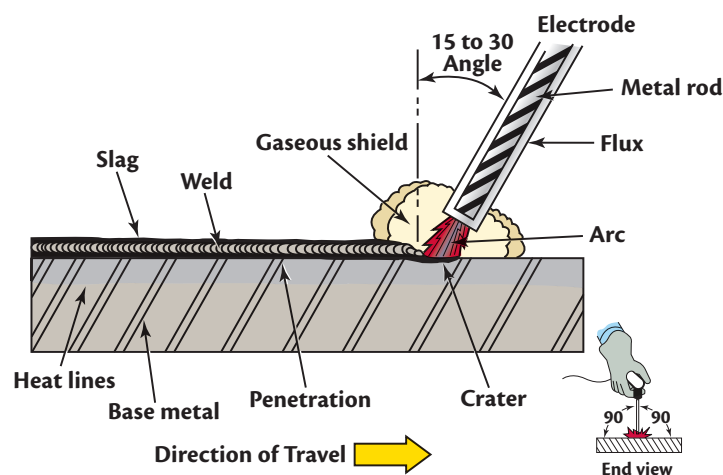
Running a Bead

The simplest type of bead is called a *stringer bead*. To do this, the electrode is moved along a straight line. To develop this skill, you will need to practice using a steady arm motion, keeping the electrode at the proper angle, and feeding the electrode as you monitor the arc and the puddle, or pool of melted metal. As your skill at welding develops, you will want to practice *weaving*. Frequently, you will need to make wider beads or control the heat of the arc by moving the electrode in a weaving pattern. Welders use different weaving patterns such as circles, crescents, or triangles for different needs.

In order to run a practice bead, you must first set up your equipment in a safe and suitable manner. With your machine set to the proper amperage, your PPE in place, a piece of practice metal in front of you, and the correct electrode type in your electrode holder, you are ready to begin running a bead using the following process.

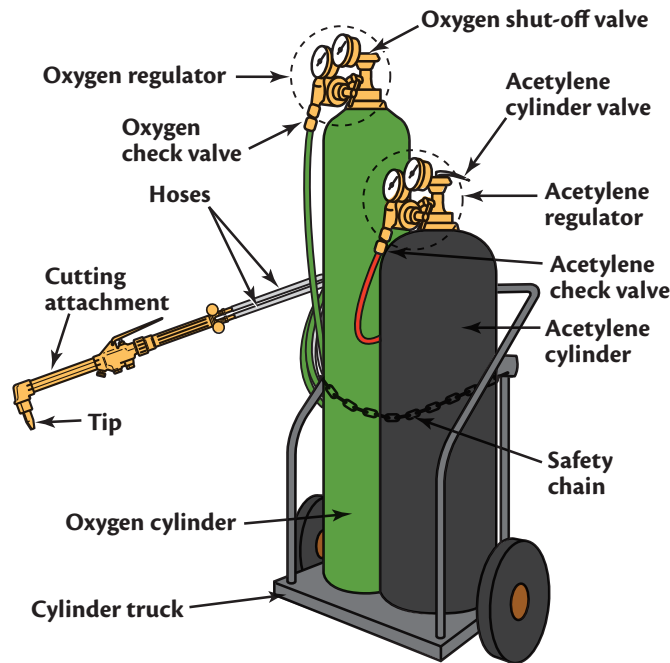
- Turn on the machine.
- Yell “Cover!” to alert others to the presence of the arc so they can look away or cover their eyes.
- Lower your helmet.
- Strike an arc on the base metal near the beginning of the bead.
- Hold the electrode perpendicular to the base metal, angled slightly in the direction of travel. If you are right-handed, move the electrode from left to right. If you are left-handed, move from right to left.
- Move the electrode across the base metal at an even speed, monitoring your arc length as you go.
- Use a speed that produces a bead width two to three times the diameter of the electrode.
- Feed the electrode evenly.
- Lift the electrode quickly to stop.
- Turn off the machine.

The machine can overheat if turned on and off repeatedly. Allow the machine to cool before shutting it off. The completed bead should be cleaned of slag and examined for quality.



Cutting Equipment

An oxyfuel cutting rig consists of a truck (cart), cylinders, torch, regulators, and hoses. Auxiliary equipment for safety and lighting the flame is also used. Knowing about each part of the equipment is very important from a safety standpoint.



Gas cylinder

Gas or fuel cylinders are usually black. Acetylene is a common fuel used for cutting, and because acetylene cannot be stored under pressure greater than 15 psi, the interior of the acetylene cylinder is filled with a porous material and liquid acetone. The acetone absorbs the acetylene gas and renders it stable. There is also a reserve capacity left in the acetylene cylinder, since the gas expands when the temperature rises.

Gas cylinder valve

The gas cylinder valve should never be opened more than 1-1/2 turns; 3/4 of a turn is preferable. This allows the operator to close the valve quickly in an emergency.

Gas regulator

The gas regulator is attached to the cylinder outlet (or manifold outlet) to regulate gas pressure to the torch. Gauges on the regulator show the pressure of fuel gas in the cylinder and the amount of pressure being supplied to the torch.

Gas hose

The fuel gas hose is color coded red or black. It is attached to the regulator and supplies gas from the cylinder to the torch.

Oxygen cylinder

Oxygen cylinders are usually green. The oxygen is compressed and stored under high pressure.

Oxygen cylinder valve

Oxygen is released by opening the valve. The oxygen valve should be opened all the way to prevent oxygen from leaking.

Oxygen regulator

The oxygen regulator is attached to the cylinder outlet (or manifold outlet) to control gas pressure to the torch. Gauges show the amount of pressure in the cylinder (how full it is) and the pressure being supplied to the torch.

Oxygen hose

The oxygen hose is color coded green. It is attached to the oxygen regulator and supplies oxygen from the cylinder to the torch.

Oxygen and gas check valves

Check valves are installed between the hose and torch to prevent backflow if a reverse flow starts. Without a check valve, fuel and oxygen could cause combustion in the hose and regulator. A flashback arrestor connects in the same way as a check valve and includes a trap that is spring loaded, which cuts the gas flow in the event of a flashback.

Safety chain

The safety chain is used to keep the cylinders upright and stable.

Cylinder truck

The cylinder truck holds the cylinders and allows safe movement of the entire rig.

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Torch Handle

Control valves

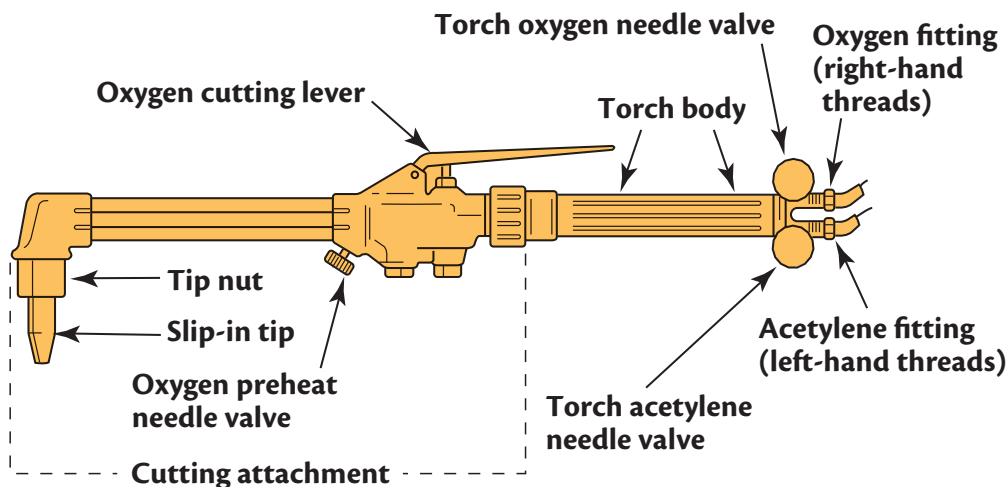
The torch handle separates into a “Y” formation to allow attachment of the oxygen and fuel gas hoses. The supply of each gas is controlled separately. Each valve attachment is labeled “OXY” or “GAS” to ensure that the proper supply hose is attached. In addition, the oxygen fitting uses right-hand threads and the fuel gas fitting uses left-hand threads.

Barrel

The oxygen and gas are kept separate within the barrel of the torch handle. Oxygen and fuel gas travel through tubes inside the barrel.

Torch head

The torch head is threaded to accept attachments and is designed to be gas-tight. The oxygen and fuel gas are still separated as they move through the torch head into the attachment.



Cutting Attachment

Coupling nut

The coupling nut is used to connect the cutting attachment securely to the torch handle. Oxygen and fuel gas travel separately through this connection.

Mixing chamber

Oxygen and fuel gas are mixed within this tube. The mixture flows out of the tip of the cutting attachment to feed the flame.

Oxygen preheat valve

This valve controls the supply of oxygen from the supply hose. When the cutting attachment is used, the oxygen control valve on the torch body should be opened slowly to regulate the amount of oxygen in the flame.

Oxygen tube

Pure oxygen is fed through this tube. It flows out of a separate opening in the tip of the cutting attachment.

Oxygen cutting lever

Depressing this lever allows oxygen to travel through the oxygen tube. This high-pressure stream of oxygen is actually what cuts the preheated metal.

Cutting head

The cutting head is designed to accept different types of cutting tips, which are securely attached with a tip nut. The cutting head also keeps the mixed gas and cutting oxygen streams separate.

Tip

The tip has tiny holes that allow mixed gas and cutting oxygen to exit separately. Different sized tips are used for different cutting operations.

Auxiliary Equipment

Flint lighter

The flint lighter is used to create a spark to light the torch.

Welding goggles

Goggles used for oxyfuel cutting must have a No. 4 or darker-shaded lens.

Shaded face shield

A shaded face shield may be used in place of welding goggles.

Safety glasses

Safety glasses must be worn at all times.

Gloves

Leather gloves protect the operator's hands and forearms from molten metal and sparks.

Gases Used in Oxyfuel Cutting

The terms *oxygas* or *oxyfuel* refer to a mixture of oxygen with a fuel gas. This mixture is combustible and is used to create a very hot flame. The oxyfuel flame can be used for a number of applications, such as welding, cutting, brazing, soldering, heating, and flame hardening.

Role of Oxygen

Oxygen is a colorless, odorless, tasteless gas. It is an essential component of the oxyfuel mixture. Oxygen itself is not flammable, but it supports and sustains combustion. Remember that one way to put a fire out is to smother it, or deprive it of oxygen. Pure oxygen, when combined with a combustible fuel gas, greatly intensifies the temperature of the flame. By mixing oxygen with a fuel gas in the right proportions, a very hot flame can be produced, capable of melting metal. In addition to its role in sustaining combustion, oxygen in the oxyfuel mixture combines with iron when working with ferrous metals (metals that come from iron ore). This combination is called **oxidation** and results in the consumption of the oxidized element. Burning and rust are both examples of oxidation.

Fuel Gases

There are several fuel gases used in oxyfuel welding and cutting. Each has its own characteristics, flame temperature, and suitable uses. The characteristics of various types of fuel gases are described in the table. Acetylene is the fuel gas most commonly used in schools, and it is the most versatile for gas welding operations. Propane is often used as a fuel gas on farms and in rural areas, as it is easily accessible and is often less expensive than acetylene. MAPP® gas (a registered trademark of Air Reduction Company, Inc.) is used mostly in industry.

Type of fuel gas	Flame temperature with oxygen	Characteristics	Suitable uses
Acetylene	5720 to 6300°F	Unstable under pressures above 15 psi Distinct odor Colorless Low toxicity	Welding Cutting Brazing Smoldering
MAPP® gas	5301 to 6000°F	Stable Distinct odor Colorless Low toxicity	Cutting Brazing Smoldering
Propane (LPG)	4579 to 5300°F	Stable Distinct odor (artificially added) Colorless Low toxicity	Cutting Brazing Smoldering
Natural gas	4600°F	Stable Distinct odor (artificially added) Colorless Low toxicity	Cutting Brazing Smoldering

Oxyfuel Cutting Process

The use of an oxyfuel flame for welding and cutting metal dates back to the early 1900s. Because the equipment is portable and the amount of heat can be varied and controlled, oxyfuel equipment is extremely useful for agricultural producers. It is also used in many manufacturing, construction, and service industries.

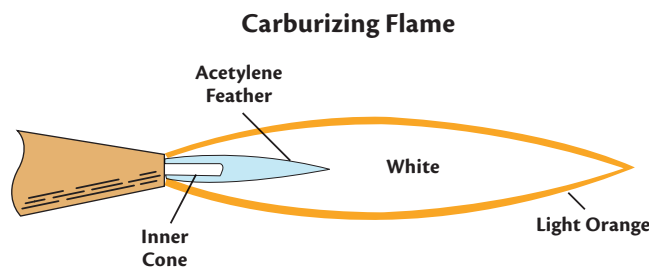
Oxyfuel cutting is used on ferrous alloys such as steel because iron has the property of burning in the presence of pure oxygen. The cutting process occurs in two steps: 1) the metal to be cut is preheated with the flame of the cutting torch to a cherry red color. This color indicates that the metal is hot enough to burn when pure oxygen is introduced. The temperature of the metal must be between 1600°F and 1800°F to burn. This temperature is lower than that required to actually melt the metal; 2) a stream of pure oxygen is introduced by depressing the oxygen-cutting lever on the cutting torch. This shoots oxygen at the heated metal, which ignites and burns away where the oxygen hits it. The slit in the metal that results from this process is called a *kerf*. Slag and residue from the burned metal are forced out of the kerf by the force of the oxygen stream. Nonferrous metals can be cut in a similar fashion using a plasma arc cutter.

Adjusting an Oxyfuel Flame

The correct type of flame for heating, cutting, and welding with oxyfuel equipment is called a neutral flame. It is established by adjusting the mix of oxygen and fuel gas at the torch needle valves to achieve the correct balance of gases. You should analyze the flame to determine if the mixture has too much fuel gas (carburizing flame), too much oxygen (oxidizing flame), or is correctly balanced (neutral flame).

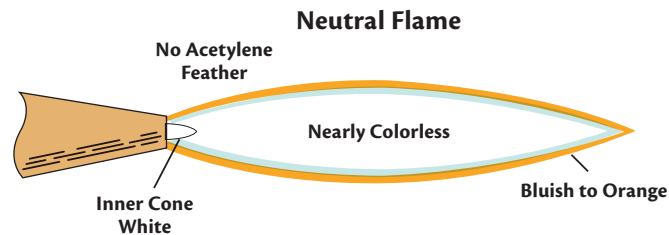
Carburizing Flame

This type of flame will show three parts—a white inner cone, a blue gas feather, and a white outer flame with a light orange edge. The carburizing flame (sometimes called a carbonizing flame) has excess gas in the mixture. It is cooler than the other types of flames.



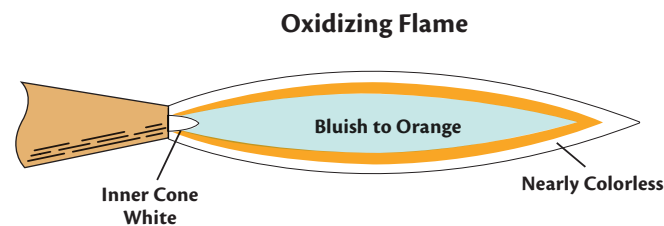
Neutral Flame

This type of flame shows two parts—a white inner cone and an outer flame that is nearly colorless with a bluish to orange edge. The gas feather grows smaller as the amount of gas in the mixture is reduced until it essentially matches the size of the inner cone and disappears. This is the correct type of flame to use for cutting.



Oxidizing Flame

This type of flame also shows two parts—a short, white inner cone and an outer flame that is bluish to orange with a nearly colorless outer edge. You will also hear a whistling sound associated with this type of flame. This flame has excess oxygen in the mixture. It is hotter than the other types of flame, and it will burn metal, causing it to become brittle.



Cutting Steel

Cutting steel is a skill that is developed with practice. Long cuts, circular cuts, or patterned cuts require devices to assist in controlling the movement of the torch. However, you should know and practice the basic technique for making straight cuts before moving on to more difficult types of cuts.

Occasionally, backfire and flashback can occur when using oxyfuel equipment. **Backfire** is a condition in which the torch flame momentarily burns back into the tip. It is characterized by a loud snap or pop. Usually the flame is blown out, although it may continue to burn. Backfire may be caused by a number of conditions including a dirty tip, insufficient pressure, or overheating of the tip caused by bringing the tip too close to the molten puddle. If a torch backfires, notify your instructor. The condition that caused it must be corrected before continuing to work. Backfire can sometimes cause a more dangerous condition known as flashback.

PROCEDURE FOR CUTTING STEEL

1. Mark the metal to be cut.
2. Position the metal over a slag box.
3. Light the torch and establish a neutral flame.
4. Preheat the metal. Point the tip at an angle toward the edge of the plate at the point where you will begin your cut. The tips of the preheat cones should be about 1/8 inch from the metal. Hold the torch here until the metal becomes a bright red.
5. Rotate the torch tip to an upright position perpendicular to the surface to be cut. Depress the oxygen cutting lever.
6. Rotate the tip backward at a slight angle so the cutting oxygen is directed first at the corner of the metal to be cut.
7. Without moving forward, rotate the tip back through the perpendicular position until the tip is pointing at a very slight angle in the direction of the cut. The tips of the preheat flames should remain about 1/8 inch from the metal.
8. Move the torch smoothly forward along the mark to be cut. Maintain the slight angle of the tip in the direction of the cut.
9. Continue a steady motion forward until the cut is complete and the torch tip has cleared the edge of the metal. Release the cutting oxygen lever.

Flashback occurs when the flame burns back into the torch body. It is characterized by a shrill hissing sound. The flame may disappear and smoke or sparks are emitted from the torch tip. If flashback occurs, you must act quickly to cut off the gases fueling the flame. Perform these steps immediately upon indication of flashback.

If using a cutting attachment, you should:

- close the oxygen preheat valve.
- close the torch fuel gas valve.
- close the oxygen torch valve.
- release the oxygen regulator screw.
- release the fuel gas regulator screw.

If heavy smoke comes out of the torch tip and the torch body becomes hot, the flashback has probably traveled past the mixing chamber into the hose. In this case, quickly shut off the oxygen cylinder valve and the fuel gas cylinder valve. Then notify your instructor. Once the unit is turned off, allow the cutting attachment to cool (flashback will make it very hot). Examine the unit for problems that may have caused the flashback and correct them if found. If flashback reoccurs, the unit should be examined by a qualified repair person.

SAE IDEA

Research

Study the possible modifications in agriculture equipment for persons with disabilities.

Errors Made When Cutting Steel

There is a right way and a wrong way to cut metal. You can determine what type of errors you are making by examining your completed cuts. The characteristics of the cut will show if errors involving any of these factors have occurred. Four factors contribute to the quality of an oxyfuel cut—travel speed, cutting oxygen pressure, preheat, and clearance of the torch tip. A quality cut has clean and square edges on the top and bottom. The surface of the cut is smooth with uniform vertical drag lines that bend back slightly at the bottom.

SAE IDEA

Exploratory

Interview area agriculture producers about the changes in technology over the past 50 years.

Travel Speed

A cut made with the travel speed too fast will have excessive slag on the bottom edge of the cut. The surface of the cut is rough with the drag lines slanting away from the direction of the cut. There may be uncut metal present. A cut made with the travel speed too slow also will have excessive slag on the bottom edge. The lower section of the surface is gouged, while the upper section is smooth.

Oxygen Pressure

A cut made with too much cutting oxygen pressure will leave a top edge uneven or dished. The surface of the cut shows irregular drag lines. A cut made with not enough cutting oxygen pressure will have excessive slag on the bottom edge of the cut. The surface of the cut will be relatively smooth, but the drag lines will slant away from the direction of travel. The cut may be incomplete at the bottom.



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Preheat

A cut made with too much preheat will have a melted and rounded top edge with slag on the bottom edge. The surface is smooth with regular drag lines. A cut made with too little preheat will leave a cut with the top edge out of square and the bottom edge irregular. The drag lines are well defined with some pitting or gouging.

Clearance

A cut made with the cutting tip too far from the metal will result in the top edge of the cut being flared, and the drag lines on the surface will be vertical. A cut made with the cutting tip too close to the metal will leave a rough top edge, and the drag lines on the surface will be irregular. There may also be gouging.

Unit Summary

Arc welding and oxyfuel cutting are skills that are highly valuable in agriculture. The ability to create new products or repair machinery is beneficial to the agricultural producer. It often saves time and money to complete a project on site rather than taking a piece of equipment to a repair shop. It is important to remember safety practices when welding or cutting, as it can be dangerous. There are various types of machines and equipment to be used depending upon the job and type of metal, and knowing the uses of each can lead to a stronger weld or smoother cut. Just as in any learned skill, welding and cutting will take practice to master.

Unit Review

1. Name three welding methods and the differences in each.
2. Compare the machines used in shielded metal arc welding.
3. What is an electrode?
4. Draw an example of an electrode and label the code.
5. What are the two methods to striking an arc?
6. Describe the process of running a welding bead.
7. What color are the gas and oxygen hoses on a cutting assembly?
8. Name four gasses used in oxyfuel cutting.
9. What are the uses for acetylene and natural gas?
10. What are the two steps that occur in the cutting process?
11. Name the differences between the three oxyfuel gas flames.
12. How does flashback occur when cutting metal?
13. What are the causes of error in cutting steel? Explain.

Glossary

A

AC letters used to represent an alternating electrical current welding machine

AC/DC letters used to represent a welding machine that can use alternating or direct electrical current

accident unintentional harm

agriculture production of plants and animals, and related supplies, services, mechanics, products, processing and marketing

agriscience application of agricultural principles and new technologies

albumen protein that makes the white of the egg

annual plants that complete their life cycle within one growing season

assets possessions; items of value that a business owns

aveoli groups of tiny units where milk is produced within an animal's mammary system

B

backfire condition in which the torch flame momentarily burns back into the tip when oxygen cutting

bantams term that represents small sized breeds of chickens

barrow castrated male hog

biennial plants that complete their lifecycle in two growing seasons

biofuels fuels, such as ethanol and biodiesel, made from living things

biotechnology the manipulation or genetic engineering of living organisms or their components to create new products

boar male hog that has not been castrated

bovine general Latin term relating to cattle

broilers young meat chickens

brooding specialized care of chicks during the first few weeks of life

buck uncastrated male goat

bull uncastrated male beef animal

C

cabrito meat from a goat under 40 pounds live weight and not yet removed from the mother

calf young beef animal

capital items or inventory purchased or sold outside a one-year time period; non-current

capon castrated male chicken

carbohydrates simple organic compound that provides the body with energy

career clusters division of all jobs into 16 areas by the U.S. Department of Education

career pathways subdivisions of career clusters that further define a career by skills and knowledge

cashmere fiber taken from the undercoat of any goat breed other than the Angora

castrate removal of male testicles

chattel mortgage loan secured by moveable personal property rather than by land or permanent fixtures

chevon meat from an older goat

chevre goat cheese

chick young, immature chicken

chipping hammer used to knock away slag after welding

chlorophyll green pigment in leaves; needed for photosynthesis

cisterns holding area for milk within an animal's mammary system

climate environmental conditions such as humidity and wind

closed-faced type of sheep with wool on the face

cock mature male chicken that has not been castrated or caponized; rooster

cockerel young male chicken under one year of age

colostrum first milk a female animal produces after giving birth

colt male horse younger than three years old

combustible able to ignite easily and burn quickly; example, wood and paper

common house cat cat that is a mix of various breeds

complete protein food that provides all of the essential amino acids that humans require in their diet

composite breed breed formed from two or more established breeds

convenience store small store that stocks a limited number of food and household items

cow female beef or dairy animal that has given birth to a calf

cream portion of milk that rises to the top

crimp waviness of wool fibers

crossbred breeding together of two different breeds of animal within a species

cull to discard from a flock or herd

curds solid portion of milk after it is curdled and strained

current items or inventory purchased or sold within one year's time; operating

D

DC letters used to represent a direct electrical current welding machine

debeaking removal of the beak tip on young chicks

debt amount of money owed on an asset or investment

debt-to-equity ratio extent to which debt capital is being combined with equity capital

deciduous plants that lose their leaves in the autumn

depreciate decline in value over time

doe female goat

domestication process of animals being tamed by humans

dormant to slow or stop growing

dorsal stripe dark stripe along the spine of an animal

draft horse horse that is taller than 17 hands; used for heavy work

drake mature male duck

dry cow cow approximately two months before calving that has stop producing milk in preparation for birth

dual-purpose animals used for more than one purpose such as milk, meat, eggs, and fiber

duckling young duck weighing six to seven pounds

E

electrode holder clamp that grips the welding electrode

electrode metal welding rod coated with flux

emulsifiers substances that keep together liquids that tend to separate such as oil and water

entrepreneurship type of SAE that allows a student to own his or her own business

equine horse or member of the horse family

equity net worth; liabilities and debts against the SAE are subtracted from the SAE assets and investments

erect term for ears that stand up as opposed to droop

euthanized medically put to sleep

evergreens plants that keep their leaves and green color throughout the year

ewe female sheep of any age

exotic pet rare or unusual animal that is kept as a pet

expenses transactions where money is spent

experience one part of a total SAE program

exploratory type of SAE that allows a student to explore opportunities in the agriculture industry

F

farrow to give birth to a litter of pigs

feathers long, fine hair covering the lower legs of some animal breeds such as the Clydesdale horse

feral type of animal that descended from domestic animals now living in undomesticated areas

fiber diameter average diameter of the fibers in a fleece

filly female horse younger than three years old

flammable material with a flash point below 100°F

flash point temperature at which a material will burst into flames

flashback occurs when the flame burns back into the body of an oxy-gas torch

fleece all the wool taken from one sheep

flock group of chickens

flux provides a gas shield for the molten pool during welding

foal male or female horse under one year old

food processing steps involved in transforming raw ingredients into food products for consumers

fortified enhancing a food product with additional vitamins or minerals

G

gaggle group of geese

gander term for a male goose

gelding male horse older than three years of age that has been castrated

gestation amount of time from breeding to birth

giblets specialty poultry meats such as the heart, liver and gizzard

gilt immature female pig that has not given birth

Good Manufacturing Practices procedures that have been developed to ensure a safe food product as well as a safe working environment

goose specific term for a female goose

gosling young male or female goose

grades quality standards that are established by the United State Department of Agriculture

ground clamp clamp attached by a cable to the arc welder that completes the electrical current

H

hands measurement of horses; four inches

harvesting process of gathering mature crops from the area where they are grown or produced

Hazard Analysis of Critical Control Point management program designed to analyze food processing procedures from the raw material to the finished product

hazard situation that poses a danger

heat tolerance ability to withstand hotter climates

heifer young immature female that has not given birth

hen mature female chicken, duck or turkey

herding dogs dogs that have the instinct to herd other animals

homogenized process or state in which small particles are uniform and evenly distributed

hounds dogs that have the capability to track either by scent or sight

hydroponics plant growing method that uses a mineral nutrient water solution without soil

I

income transaction where money is gained

incubator device that regulates the environment so chicken embryos can develop properly

internship where a student works for someone, either for pay or for the experience; placement

inventory list of the items or assets a business owns

K

kerf slit in metal as a result of oxy-gas cutting

kidding process of goats giving birth

kids goat offspring

L

lactation milking period of an animal

lactose sugar naturally found in milk

lamb meat from a sheep younger than one year old

lanolin grease-like substance that naturally coats sheep's wool

lard fat from a pig

layers egg-producing chickens

liability money, goods and/or services for which you owe

light horse horse between 14.2 and 17 hands in height

litter group of pigs born from a sow

loam soil with approximately equal parts of sand, silt and clay

M

mammary system milk producing system within an animal, especially important for a dairy cow

mare female horse older than three years of age

marketing way in which a product is sold to a target audience; research and planning to develop the best approach for selling a product

median number in the middle of a group of consecutively listed numbers

metal inert gas welding method that uses a combination of electricity and an inert shielding gas; also known as MIG or GMAW

migratory worker hand labor who moves from place to place as harvesting occurs

minerals small rock particles in the soil

mohair fiber produced by Angora goats

multipurpose retailer offers consumers a place to buy food items as well as clothing, electronics, toys, hardware and other household items

mutton meat from a sheep older than one year

N

neutering process of preventing male animals from reproducing by removing the reproductive organs

non-current items or inventory purchased or sold outside a one-year time period; capital

non-sporting diverse breed of dog that ranges in terms of appearance, size and personality

non-synthetic natural fiber such as cotton and leather

O

offal parts of an animal after slaughter that are inedible by humans

open-faced type of sheep with no wool on the face

operating items or inventory purchased or sold within one year's time; current

organic matter humus; decaying material from living organisms found in the soil

oviduct reproductive tract of a female chicken

ovine general Latin term for sheep

oxidation combination of oxygen and iron in ferrous metals; examples, burning and rust

oxytocin hormone produced by an animal that signals the milk letdown reflex

P

parent material original matter from which soil particles are formed

pasteurization process of heating a food product to kill bacteria

peat moss partially decomposed plant matter; high nutrient and water retention capabilities

pelt hide from a slaughtered lamb or sheep with the wool still attached

perennial plant that grows season after season

perlite volcanic rock that has been crushed and heated to 1800°F

personal protective equipment equipment worn to protect you from injury while working

photosynthesis process of food production in plants

pine bark bark of pine trees broken into small pieces and used as a type of media

placement type of SAE where a student works for someone, either for pay or experience

points parts of an animal that are typically white; used to describe areas such as ears, nose, tail, and legs on some animals

polled animal naturally without horns

pony horse shorter than 14.2 hands

porcine general Latin term relating to all pigs

pork meat of pigs

poult young male or female turkey

poultry term used to describe domesticated birds that are kept for eggs or meat

principal actual amount borrowed on a loan

productively invested all asset costs including the initial investment plus other expenses on the asset

pullet young female chicken under one year of age

purebred cats pedigreed animal of unmixed lineage

purebred animal that has only the original breed within its bloodlines

R

ram male sheep that has not been castrated

requirements needs or necessities as in applying for a job

research type of SAE designed to expose students to the scientific side of agriculture

respiration plant process in which food produced through photosynthesis is used

retail sale of products for personal use or consumption

roan mixture of hair colors on an animal

rooster mature male chicken that has not been castrated or caponized; cock

S

saturated fat fat that is generally solid at room temperature, usually of animal origin

school-based enterprise student-managed, entrepreneurial program in the school setting; designed to imitate the work environment as closely as possible

scratching method of striking an arc that works by touching the electrode to the base metal like striking a match

service learning SAE where a student develops and manages a project for a school, community organization or non-profit organization

shearing process of shaving or clipping wool from a sheep's skin

shielded metal arc welding welding method in which an electrode is used; also known as stick welding or SMAW

slag layer of burned flux and impurities at the top of a weld

sow mature female hog that has farrowed a litter of pigs

spaying process of preventing female animals from reproducing by removing the reproductive organs

spent hen hen that no longer produces eggs

sphagnum shredded, dehydrated stems and leaves of acidic bog plants; type of peat moss

sporting dogs dogs which are known for their instincts in the woods and water

springer bred cow showing signs of pregnancy

stallion male horse older than three years of age that has not been castrated

staple length length of wool fibers

steer castrated male beef animal

stringer bead simplest type of welding bead where the electrode is moved in a straight line

supermarket large retail store that as between 25,000 and 35,000 food items commonly used in the home

T

tapping method of striking an arc that works by touching the electrode to the base metal and quickly raising it

terriers energetic and feisty breed of dog

tom mature male turkey past one year of age

topography variation of the earth's surface, such as elevation and slope

toy breeds small dogs that are known for their companionship

transaction exchange of money for the purchase or sale of assets or supplies

transpiration loss of water through plant leaf openings; sweating

tungsten inert gas welding method that uses a combination of electricity, inert gas and non-consumable electrode; known as TIG or GTAW

U

unsaturated fat fat that is generally liquid at room temperature, usually of plant origin

V

value-added increasing the value of a food due to the addition of ingredients or the processing that occurs

vermiculite heated mica compound used as an inorganic plant media

vertically integrated combination of processes into one company; example, Braum's Dairy

W

wean removal of young animals from their mothers

weaving movement of an electrode to make wider beads or control arc heat

welding arc light produced from welding

wether male sheep or goat that has been castrated

whhey water portion of milk after it is curdled and strained

wholesale selling products in quantity to a buyer who then resells the product

wire brush used to remove slag, clean metal in preparation for welding or clean beads after welding

withers highest point on a horse's shoulder; point of height measurement

wool fiber taken from a sheep

working dogs dogs that have been developed to perform jobs such as protecting property or livestock, or pulling sleds

worsted fabric made from fine wool fibers at least three inches in length

Y

yield weight of wool fleece after it has been cleaned of lanolin, dirt and plant matter

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