

Sixth Edition

# AGRISCIENCE

## FUNDAMENTALS AND APPLICATIONS

**L. DeVere Burton**



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**Agriscience: Fundamentals and Applications,  
6E Precision Exams Edition**

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# PREFACE

**W**elcome to the agriscience world of the twenty-first century! *Agriscience: Fundamentals and Applications, Sixth Edition* is about a new century of agricultural and agriscience developments.

This textbook will be used by a generation of students whose lives may span two different centuries and two different millennia. It is interesting to consider that in all of the ages since humans first engaged in agricultural pursuits, nearly all of the agricultural innovations and technologies ever known to humankind have evolved in fewer than 100 years.

It is to the agriscience students of the new millennium that this textbook is dedicated, for the agriculturists, scientists, and innovators of tomorrow are today's high school students. The "millennium generation" will be called on to feed the world as the human population nearly doubles to 10 billion people. To do this, they must learn more than any other generation has ever learned, and they need to discover more ways to increase food production than any other generation has ever discovered. They must accomplish this using marginal land because many of our fertile farms have been swallowed up to build cities and towns. *Agriscience: Fundamentals and Applications, Sixth Edition* is the modern agriscience textbook that will introduce the "millennium generation" to agricultural careers. This generation will also lead the industry that the people of the United States depend on to feed and clothe them and to export surplus agricultural products to other regions of the world.

This edition of the book expands on the original text and the ideas of earlier editions. The science component has been strengthened with some new lab exercises. Statistics and text have been modified to reflect changes that have occurred since the last edition was published, and new examples of agricultural applications of science and technology have been added. The book is intended for introductory-level agriscience classes in the ninth and tenth grades.

## NEED FOR AN INTRODUCTORY TEXTBOOK

This book is an introductory textbook in a series of modern secondary agricultural textbooks published by Cengage. It addresses the most basic levels of agriscience using language and examples that are matched to the needs of beginning students in the natural science career pathway.





Revisions in this new edition are the work of current Cengage agriscience author L. DeVere Burton. He is also the author of three other textbooks in the agriscience series: *Agriscience & Technology, Second Edition*; *Fish and Wildlife: Principles of Zoology and Ecology, Third Edition*; and *Introduction to Forestry Science, Third Edition*. He also edited a new textbook titled *Environmental Science Fundamentals and Applications*. Each of these works, including this edition of *Agriscience: Fundamentals and Applications*, reflects the premise on which agricultural education was founded—that most students learn best as they apply the principles of science and agriculture to real-life problems.

## ORGANIZATION

This edition of *Agriscience: Fundamentals and Applications* is organized into 10 sections and 36 units. Each section introduces the subjects that will be covered in the individual units. The text and illustrations for each section have been revised. Each unit begins with a stated objective and a list of competencies to be developed. Important terms are listed at the beginning of each unit and highlighted in the text. They are also included in the glossary at the end of the book. Each unit contains profiles on science, careers, and agriculture and concludes with student activities and a section on self-evaluation. The book includes a complete and thorough index.

## NEW AND ENHANCED CONTENT



The *Precision Exams Edition* of *Agriscience: Fundamentals and Applications, 6E* combines current top notch content with new information aligned to Precision Exams' *Agricultural Science* exam, part of the *Agriculture, Food and Natural Resources* Career Cluster. The *Agriculture, Food and Natural Resources* pathway connects industry with skills taught in the classroom to help students successfully transition from high school to college and/or career. For more information on how to administer the *Agricultural Science* exam or any of the 170+ exams available to your students, contact your local NGL/Cengage Sales Consultant.

Features that remain in this enhanced text, and continue to engage and educate students, include the following:

- “Suggested Class Activities” in each unit give both the student and the instructor an innovative way to become actively involved with the content of each unit.
- “Hot Topics in Agriscience” is a standard unit feature that describes recent scientific discoveries for which an agricultural application has been identified.
- Internet icons are placed throughout each unit. These icons include key search terms that will help students and instructors explore agriscience topics beyond the scope of the textbook.

- Broad applications to science, math, agriculture, natural resources, and the environment provide the appropriate balance for the evolving agriscience curriculum.
- Hundreds of updated full-color photos and illustrations help stimulate interest and enhance learning. Photos now reflect today's digital student, and dozens of illustrations have been redrawn in full color to improve quality for the visual learner.

## EXTENSIVE TEACHING/ LEARNING MATERIALS

A complete supplemental package is provided with this textbook. It is intended to assist teachers as they plan their teaching strategies by providing materials that are up to date and efficiently organized. These materials are also intended to assist students who want to explore beyond the confines of the textbook. They include the following resources:

### Lab Manual

ISBN: 978-1-13368-689-7

The lab manual has been updated to correlate to the content updates made in the textbook. This comprehensive lab manual reinforces the text content. It is recommended that students complete each lab to confirm understanding of essential science content. Great care has been taken to provide instructors with low-cost, strongly science-focused labs to help meet the science-based curriculum needs of the Introductory Agriscience course in secondary schools.

New to this edition, optional Internet supplements offer additional research opportunities and educational resources to learn more about topics covered in the lab exercises. Each lab exercise has been enhanced with new photos and illustrations to help stimulate visual learning.

### Classmaster CD-ROM

ISBN: 978-1-13368-734-4

This technology supplement provides the instructor with valuable resources to simplify the planning and implementation of the instructional program. It has been expanded for this edition to include the following support materials:

- Performance Objectives, Competencies to Be Developed, and Terms to Know lists with definitions for each unit
- A PDF version of the **Instructor's Manual**. The *Instructor's Manual* has been expanded for the sixth edition to provide the following materials for instructors:
  - Teaching Aids and Suggested Resources, including Suggested Class Activities and ideas for Supervised Agricultural Experiences
  - Lesson Plans for each unit

- Answers to the Self-Evaluation questions at the end of each unit
- Suggested essay/discussion questions
- New! Correlation guides map textbook content to the National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards and identify Science, Technology, Engineering, and Mathematics (STEM) focused content
- An **Image Library** with all the illustrations from the textbook; use in slide presentations or as part of classroom discussion
- A PDF of the **Lab Manual Instructor's Guide**, which provides answers to lab manual exercises and additional guidance for the instructor.
- A **computerized test bank** created in ExamView® makes generating tests and quizzes a snap. With 1500+ questions and different question formats from which to choose, you can create customized assessments for your students with the click of a button. Add your own unique questions and print rationales for easy class preparation.
- **Instructor support slide presentations** that can be customized in PowerPoint® format focusing on key points for each chapter. Approximately 700 slides (about 20–25 slides per unit) are available to accompany the textbook.

## Instructor Companion Web Site

New! The instructor companion Web site provides online access to many of the instructor support materials provided on the ClassMaster CD-ROM, including the *Instructor's Manual*, *Lab Manual Instructor's Guide*, computerized test bank files, correlation guides, and support slides. To access the available materials, sign up for a faculty account at [login.cengage.com](http://login.cengage.com). Add the core textbook to your bookshelf using the 13-digit ISBN that appears on the back cover of the textbook.

## MindTap for *Agriscience: Fundamentals and Applications, 6e*, Precision Exams Edition

The MindTap for *Agriscience: Fundamentals and Applications, 6e*, Precision Exams Edition features an integrated course offering a complete digital experience for the student and teacher. This MindTap is highly customizable and combines an enhanced, interactive e-book along with a multitude of engaging activities and assignments, including PowerPoint, videos, matching, image labeling, crossword puzzles, lab exercises, and auto-graded quizzing to enable students to directly analyze and apply what they are learning and allow teachers to measure skills and outcomes with ease.



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The author and publisher also gratefully acknowledge the unique expertise provided by the contributing authors to the text. Their work provided the core material upon which successive editions have expanded. The contributing authors are the following:

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It is most appropriate to remember the work of the late Elmer L. Cooper, who authored the early editions of this textbook and whose imprint will always remain on its contents. He will be remembered as a forward-looking agriscience educator who left his indelible mark on his profession and on the lives of innumerable agriscience students.

Appreciation is expressed to Renee Peugh, who consulted with the author on various sections of the text. She also provided information on science lab materials and student activities for recent editions of *Agriscience: Fundamentals and Applications*.

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# HOW TO USE THIS TEXTBOOK

**W**elcome to the world of agriscience! This section highlights important features of this textbook. In this textbook, content is broken into units, each of which explores an important aspect of agriscience. Each unit begins with the following tools:

- A core *objective* explains the purpose of the unit.
- *Competencies to be developed* lists specific goals to meet as you read and review the unit.
- A *materials list* identifies items you will need to complete the unit.
- *Suggested class activities* provide you and your instructor with hands-on ways to explore critical concepts discussed in each unit.
- A list of *Terms to Know* identifies key vocabulary to master.

Throughout each unit:

- *Hot Topics in Agriscience* features describe recent scientific discoveries for which an agricultural application has been identified.

## UNIT 33

### Food Science

**OBJECTIVE**  
To explore the nutrient requirements for human health and the processes used in food science to ensure an adequate and wholesome food supply.

**MATERIALS LIST**

- bulletin board materials
- Internet access

**COMPETENCIES TO BE DEVELOPED**

After studying this unit, you should be able to:

- discuss nutritional needs of humans and the food groups that meet these needs.
- categorize foods in the U.S. Department of Agriculture MyPlate nutrition initiative.
- discuss food customs of major world populations.
- relate methods used in processing and preserving foods.
- list the major steps used in slaughtering meat animals.
- list the major cuts of red-meat animals.
- identify methods of processing fish.
- describe techniques used to enhance retail sales of food commodities.

**SUGGESTED CLASS ACTIVITIES**

1. Conduct a class competition to identify the greatest number of processed food products. Divide the class into teams of four to five students. Assign each team to make a collage of photos or graphics that depict food items, using magazines and other printed materials. Each food item must be a completely different product, not just different brand names of the same thing. Ten points are scored when the product is represented in the collage by a graphic from its package. Five points are earned when the product is represented in the collage by a picture from an advertisement. One point is scored when the product name is printed. Only the highest category is scored for each

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**HOT TOPICS IN AGRISCIENCE** SAE—INSIDE THE DAIRY BUSINESS

**T**he Dairy Heifer Replacement Project is a program that is in place in many areas of the United States. It is designed to increase the knowledge and interest of young people in the dairy industry. The goal is to enhance life skills of its youth participants. The project begins when the participant purchases a heifer calf from a program-approved seller. For the next few months, the participant cares for the animal. Specific care must be provided, vaccinations must be given, and a magnet needs to be administered. Quality feed must be provided to ensure proper weight and good health. The participant is required to keep detailed records on the animal. In some instances, the heifer is bred to an approved sire, and the project culminates in the sale of the pregnant heifer when she is presented for show and sale. The Dairy Replacement Project is a challenging SAE that allows each participant to gain an understanding of a crucial part of the dairy industry. Contact the agriculture teacher in your high school or your local extension office for more information about such a program in your area.

**INTERNET KEY WORDS:**  
weeds  
annual weed  
biennial weed  
perennial weed  
noxious weed

Damage by pests to agricultural crops in the United States has been estimated to be one-third of the total crop-production potential. Therefore, an understanding of the major pest groups and their biology is required to ensure success in reducing crop losses caused by pests.

### Weeds

Weeds are plants that are considered to be growing out of place (Figure 13-3). Such plants are undesirable because they interfere with plants grown for crops. The word *weed* is therefore a relative term. Corn plants growing in a soybean field or white clover growing in a field of turfgrass are examples of weeds, just as crab-

- *Internet Key Words* icons are placed throughout each unit. These icons include key search terms that will help students and instructors explore agriscience topics beyond the scope of the textbook.



**SCIENCE CONNECTION**

**THE SEARCH FOR PERFECT PLANTS**

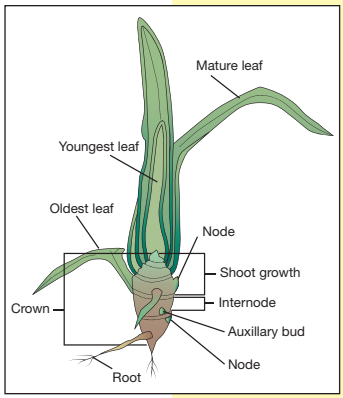


Plant geneticist Keith Schertz examines grain sorghum bred for tropical climates. Bags prevent the sorghum flowers from cross-pollinating, so the plant breeder can control which plants provide the male pollen to fertilize the female part of any given plant.

The plants we use today for food, clothing, fiber, and ornamental use are quite different from those found in the wild. Domestic plants or plants grown for a specific use have generally been selected or bred to survive better, grow faster, look different, or in some way perform differently from their ancestors in the wild. However, it is becoming increasingly apparent to plant breeders that we must have wild plants that are not closely related to our favorite domestic species to inject new characteristics into our favored domestic plants.

Pest resistance is an area that requires a continuous reserve of foreign genetic sources. This is to be expected because the very pests that we breed plants to resist are constantly adapting to our plants through survival of the fittest among their kind. Insects and disease-causing pathogens have an amazing capacity to adapt to and eventually break crop resistance. Resistant varieties usually become obsolete in 3 to 10 years. It generally takes 8 to 11 years to breed a new variety to resist the changing individuals of a given pest. Therefore, plant

- *Science Connection* features profile important science-related aspects of agriculture.
- *Key terms* are indicated in color to alert you when an important vocabulary word is used.
- Hundreds of *full-color photographs and illustrations* help you visualize the topics discussed.



At the end of each unit, *Student Activities* provide additional hands-on activities to help you master the content. Some activities provide ideas for *Supervised Agricultural Experiences* for you to explore with your instructor.

**SELF-EVALUATION**

**A. MULTIPLE CHOICE**

1. An acre of plant material can produce enough oxygen to keep
  - a. 5 to 10 people alive each year.
  - b. 10 to 16 people alive each year.
  - c. 16 to 20 people alive each year.
  - d. nobody alive. It does not produce enough oxygen to be of any value.
2. A border planting
  - a. is used as a single plant to highlight a fence or some other special feature of the landscape.
  - b. is used to separate some part of the landscape from another.
  - c. is a number of trees or shrubs planted together as a point of interest.
  - d. is a collection of plants that are placed in the landscape as needed.
3. When planning the location for planting trees and shrubs, which is not a major consideration?
  - a. fruit size and type
  - b. flower color
  - c. other structures
  - d. bare-root plants
4. The term *Cornus florida rubra* is a
  - a. common name.
  - b. scientific name.
  - c. name that was developed in Florida.
  - d. type of annual deciduous plant.
5. Planting of trees and shrubs may be done
  - a. in spring, summer, or fall.
  - b. in spring only.
  - c. in fall only.
  - d. in spring and summer.
6. Mulch should be applied
  - a. 1 to 2 inches deep.
  - b. 2 to 2.5 inches deep.
  - c. 3 to 4 inches deep.
  - d. 6 inches deep to keep out the weeds.

**B. MATCHING**

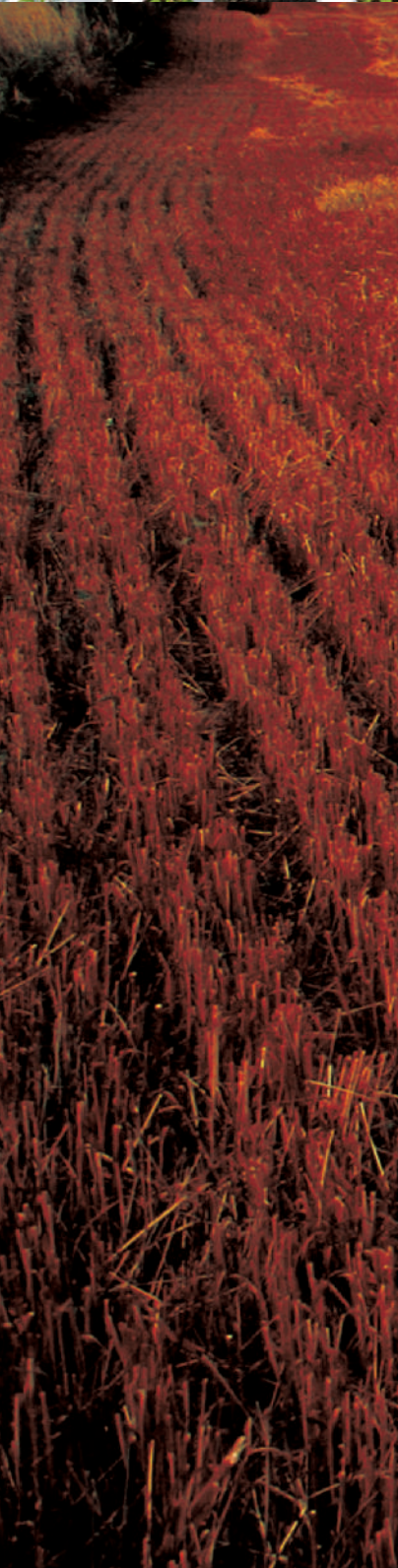
_____ 1. Urban foresters	a. The removal of dead, broken, unwanted, diseased, and insect-infested wood
_____ 2. Shrubs	b. Used as a single plant to highlight it or some other special feature of the landscape
_____ 3. Specimen plant	c. A systematic method of naming plants
_____ 4. Nomenclature	d. Woody plants that normally grow low and produce many stems or shoots from the base
_____ 5. Pruning	e. The top of the plant; has the framework and leaves
_____ 6. Canopy	f. Help install and maintain trees in large cities

**C. COMPLETION**

1. Plant material can cut noise pollution by \_\_\_\_\_.
2. A rule of thumb is that 1 cubic yard of mulch can be spread over a(n) \_\_\_\_\_ square-foot area.
3. Newly planted trees may have to be \_\_\_\_\_ to prevent wind damage.
4. Plants should be fertilized every \_\_\_\_\_ to \_\_\_\_\_ years, starting with the growing season after the first year.

*Self-Evaluations* allow you to review the unit content using multiple choice, matching, and completion question.





# SECTION 1

## BETTER LIVING THROUGH RESEARCH

Science and technology are modern miracles that have opened the doors to new areas of research, turning the dreams of humankind into realities. Space station research, new frontiers to investigate, and our never-ending quest for knowledge have exploded into many new and exciting careers.

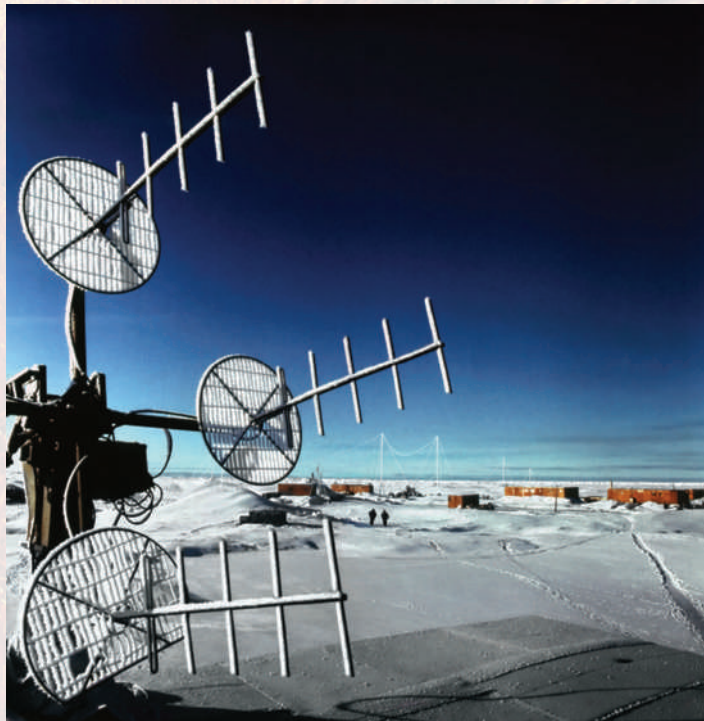
You could become one of the people growing plants or animals in a space station high above the Earth. Or, you might become an engineer who designs the animal- or plant-growing module of the space station, or a molecular geneticist or plant breeder designing new plants to grow well in low gravity, or a food scientist developing packaging for space-grown produce. Closer to home, you might discover ways to prevent plant or animal diseases. Perhaps you will become a researcher who discovers a better way to preserve food or a safe way to sanitize fresh fruits and vegetables. You may have personal attributes and skills that will propel you to become a teacher of agriscience, giving you an opportunity to have a positive influence on the lives of many students.

One career area in ever-expanding demand is plant science. As you will learn, plants are “green machines” that capture, package, and store energy from the sun through photosynthesis. They supply food and fiber for animals and humans to help sustain life. But, human knowledge and energy are required to help plants function in the overall “green machine” that constitutes our food, fiber, and natural resources system. Students of the twenty-first century will become the agricultural professionals of the twenty-first century. They will become the agricultural producers, processors, marketers, and scientists who discover new ways to feed the citizens of the United States and the world. This will be accomplished by conducting basic research and applying it to the agricultural food system.



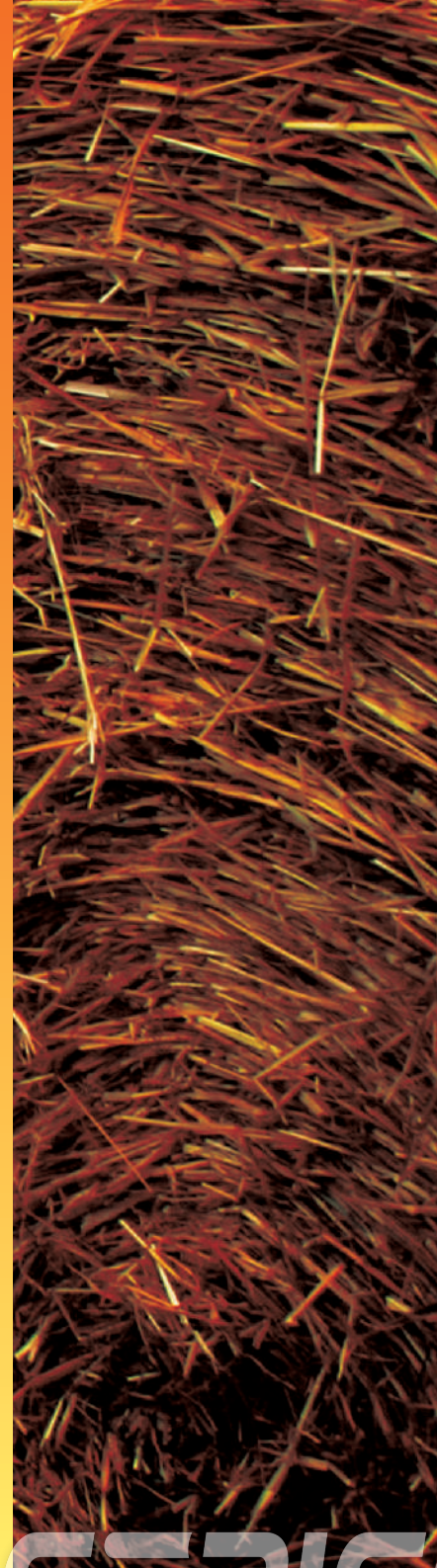
# Agriscience in the Information Age

Whether you choose a career in plant or animal science, sales and marketing, mechanics, or processing, it is certain to be rewarding. By studying agriscience, you are opening the door to exciting educational programs and careers that contribute to better living conditions for people everywhere. What role will you play in the challenging task of producing the food and fiber that will be required by future generations?



Biosphere 2

© iStockphoto/Andrey Pavlov





# UNIT 1

## The Science of Living Things

### OBJECTIVE

To recognize the major sciences contributing to the development, existence, and improvement of living things.

### MATERIALS LIST

- writing materials
- newspapers and magazines
- online encyclopedias
- Internet connection

### COMPETENCIES TO BE DEVELOPED

After studying this unit, you should be able to:

- define agriscience.
- discover agriscience in the world around us.
- relate agriscience to agriculture, agribusiness, and renewable natural resources.
- name the major sciences that support agriscience.
- describe basic and applied sciences that relate to agriscience.

### SUGGESTED CLASS ACTIVITIES

1. Invite a retired farmer to be a guest speaker on the topic of improvements or advances in the science and technology of agricultural production that he or she has experienced during his or her career. Have the students make a list of the agricultural technologies that are discussed. Speculate on new agricultural technologies that the students may experience during their careers.
2. Obtain a copy of the application process for the National FFA Agriscience Student Award. This award offers excellent scholarship opportunities to students who plan and carry out agriscience research projects. Discuss some local agricultural problems that might be addressed by students who express interest in planning a research project in agriscience.
3. Create a team competition based on measurements and math. Develop a set of problems addressing standard and metric measurements OR determining length, area, or volume measurements. Two or more teams compete in a game show format with the teacher acting as moderator. Allow the students to add some creative elements to the competition. This activity can be used as a fun way to conduct a unit review.



## TERMS TO KNOW

agriscience  
agriculture  
agribusiness  
renewable natural resources  
technology  
high technology  
aquaculture  
agricultural engineering  
animal science technology  
crop science  
soil science  
biotechnology  
integrated pest management  
water resources  
environment  
biology  
chemistry  
biochemistry  
entomology  
agronomy  
horticulture  
ornamentals  
animal sciences  
mathematics  
statistics  
sociology  
geography  
agricultural economics  
agricultural education

4. In groups of four or five students, research “organic farming” on the Internet. Compare and contrast organic farming and traditional farming. In your search, you may include factors such as cost versus yield, consumer demand, or any other factor that drives production.

**L**ife in the United States and throughout the world is changing every moment of our lives. The space we occupy, as well as the people we work and play with, may be constant for a brief time. However, these are quick to change with time and circumstances. The things we need to know and the resources we have available to use are constantly shifting as the world turns.

Humans have the gift of intelligence—the ability to learn and to know (Figure 1-1). This permits us to compete successfully with the millions of other creatures that share the Earth with us (Figure 1-2). In ages past, humans have not always fared well in this competition. Wild animals had the advantages of speed, strength, numbers, hunting skills, and superior senses over humans. These superior senses of sight, smell, hearing, heat sensing, and reproduction all helped certain animals, plants, and microbes to exercise control over humans to meet their own needs.

The cave of the cave dweller, lake of the lake dweller, and cliff of the cliff dweller indicate early human reliance on natural surroundings for basic needs (food, clothing, and shelter) (Figure 1-3). Those early homes gave humans some protection from animals and unfavorable weather. However, they were still exposed to diseases, the pangs of hunger, the stings of cold, and the oppressions of heat.

The world of agriscience has changed the comfort, convenience, and safety of people today. According to the USDA/Economic Research Service, Americans spent only 9.4 percent of our wages to feed ourselves in 2010 (Figure 1-4). Despite fluctuations in the percentage of income that is spent for food, the percentage of annual income spent for food in the United States has tended to decrease. People in many nations spend more than half of their incomes on food. We are fortunate

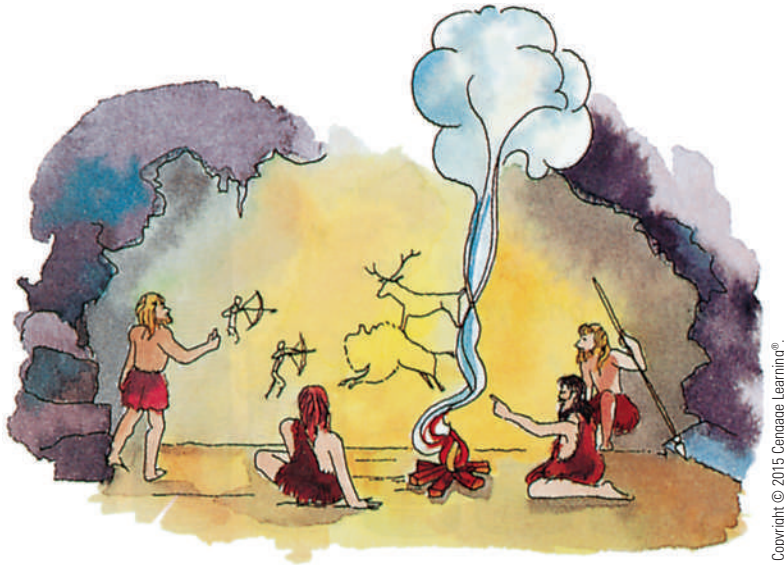


**FIGURE 1-1** Humans have the gift of intelligence—the ability to learn and to know.



**FIGURE 1-2** The gift of intelligence has permitted humans to compete with and benefit from animals, even though most animals are superior to humans in other ways.

Photo by Scott Bauer. USDA/ARS K7102-12.



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**FIGURE 1-3** Early humans had to rely on features in their natural environment to shield them from danger and the elements.



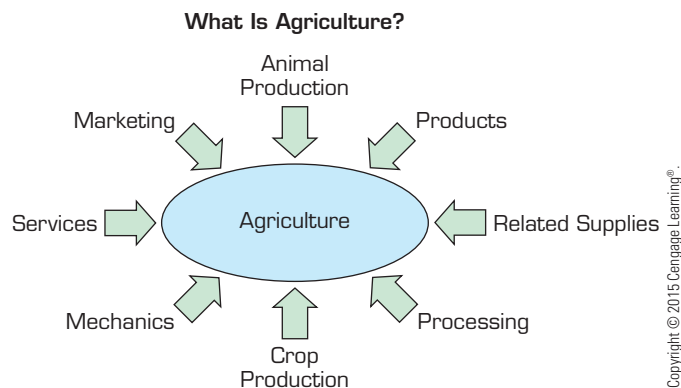
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**FIGURE 1-4** Americans spend only 9.4 percent of their disposable income on food.

that our scientists have discovered new ways to produce greater amounts of food and fiber (such as cotton) from each acre of agricultural land. They have done this by finding ways to stimulate growth and production of animals and plants and to reduce losses from diseases, insects, parasites, and storage. We have learned to preserve our food from one production cycle until the next without excessive waste; however, spoilage of stored food remains high among agriscience research priorities. The agriscience, agribusiness, and renewable natural resources of the nation provide materials for clothing, housing, and industry at an equally attractive price.

## AGRISCIENCE DEFINED

Agriscience is a relatively new term that you may not find in your dictionary. **Agriscience** is the application of scientific principles and new technologies to agriculture. **Agriculture** is defined as the activities involved with the production of plants and animals and related supplies, services, mechanics, products, processing, and marketing (Figure 1-5). Actually, modern agriculture covers so



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**FIGURE 1-5** Agriculture consists of all the steps involved in producing a plant or animal and getting the plant or animal products to the people who consume them.





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**FIGURE 1-6** Farming and ranching account for approximately 12 percent of the agricultural jobs in the United States.



Courtesy of DeVere Burton.

**FIGURE 1-7** Agricultural education teachers and agricultural extension educators are among those whose careers are related to agriculture.

many activities that a simple definition is not possible. Therefore, the U.S. Department of Education has used the phrase *agriculture/agribusiness and renewable natural resources* to refer to the broad range of activities in agriculture.

Agriculture generally has some tie-in or tieback to animals or plants. However, production agriculture, or farming and ranching, accounts for only 12 percent of the total jobs in agriculture (Figure 1-6). The other 88 percent of the jobs in agriculture are nonfarm and nonranch jobs, such as sales of farm equipment and supplies, plant and animal research, processing of agricultural products (Figures 1-7 and 1-8), agricultural education, and maintaining the health of plants and animals. **Agribusiness** refers to commercial firms that have developed in support of agriculture (Figure 1-9).



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**FIGURE 1-8** Veterinarians and veterinary technicians are people whose careers relate to agriculture in the field of animal health.



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**FIGURE 1-9** Agribusinesses are important to the people and the stability of most communities.



## HOT TOPICS IN AGRISCIENCE WORLD FOOD CRISIS



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Unemployment and high food prices drive those who are most affected to seek food from charitable organizations.

**A** serious food issue surfaced in late 2007 as the world supply of rice, wheat, and corn dropped to dangerously low levels. The result was a substantial worldwide increase in the purchase price for all grains. This crisis continues to this day, and prices have increased far beyond expectations. In the United States and other nations, the cost of bread and other grain products increased as food processors adjusted the price of their products to compensate for the high cost of raw materials and transportation. The cost of grain and energy has also affected the price of meats, eggs, milk, and other foods, driving the price upward.

Political turmoil across the world as a result of economic recessions and in the form of revolutions has become a serious deterrent to affordable food prices in other ways. The price of oil has been driven up by reduction in the production of crude oil, which is often associated with military conflicts in many oil-producing nations. This has raised production costs for most food items because the cost of fuel has increased and remained high.

Among the poor nations of the world and among those living on fixed incomes or in poverty here at home, obtaining enough food to meet the needs of individuals and families has become difficult. What should be done to overcome and resolve a world food crisis?

### INTERNET

#### TIPS:

Forming your search into a question will narrow the results. Example: What is agriscience?

### INTERNET

#### KEY WORDS:

renewable natural resources

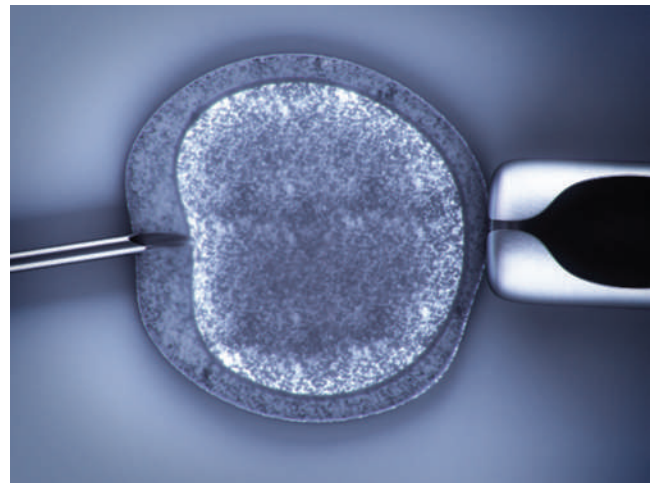
**Renewable natural resources** are the resources provided by nature that can replace or renew themselves. Examples of such resources are wildlife, trees, and fish (Figure 1-10). Some occupations in renewable natural resources are game trapper, forester, and fisher (someone who harvests fish, oysters, and other seafood).

**Technology** is defined as the application of science to solve a problem. The application of science to an industrial use is called *industrial technology*. *Agriscience* was coined to describe the application of high technology to agriculture. **High technology** refers to the use of electronics and state-of-the-art equipment to perform tasks and control machinery and processes (Figure 1-11). It plays an important role in the industry of agriculture.



Courtesy of DeVere Burton.

**FIGURE 1-10** As mature trees are harvested, sunlight on the forest floor stimulates the growth of seeds and seedlings, providing a renewable source of wood for the future.



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**FIGURE 1-11** Advances in technology make it possible to create identical cloned animals by dividing the cell mass of a growing embryo.

## HOT TOPICS IN AGRISCIENCE

### AGRICULTURAL RESEARCH: FEEDING A HUNGRY WORLD



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Environment refers to all the conditions, circumstances, and influences surrounding and affecting an organism or group of organisms.

**T**he world's population reached 7 billion people in 2011, and it is projected that it will reach 8 billion in 2025. During the same period, the amount of land and fresh water per person will decrease. Food production must become much more efficient if the people of the world are to have enough food to eat. During the past 50 years, food production has increased at a rate that is greater than the increases in the domestic population; however, food shortages and famine still exist in the world. Agricultural production is driven by a worldwide market. Agricultural research has resulted in greater productivity of food, plants, and animals, and new technologies have made it possible for farmers to perform their work with greater efficiency. The key to an adequate food supply for the growing human population in the new millennium is agricultural research. New agricultural technologies that lead to the development of more efficient plants and animals and more efficient agricultural machinery will be needed. In addition, we will need to discover new food sources and maintain a healthy environment as the population approaches 10 billion people.

Agriscience includes many endeavors. Some of these are aquaculture, agricultural engineering, animal science technology, crop science, soil science, biotechnology, integrated pest management, organic foods, water resources, and environment. **Aquaculture** means the growing and management of living things in water, such as fish or oysters. **Agricultural engineering** consists of the application of mechanical and other engineering principles in agricultural uses. **Animal science technology** refers to the use of modern principles and practices for animal growth, production, and management (Figure 1-12). **Crop science**



Photo by Scott Bauer, USDA/ARS K5441-1.

**FIGURE 1-12** Veterinarians use animal sciences to help keep our pets and production animals healthy.