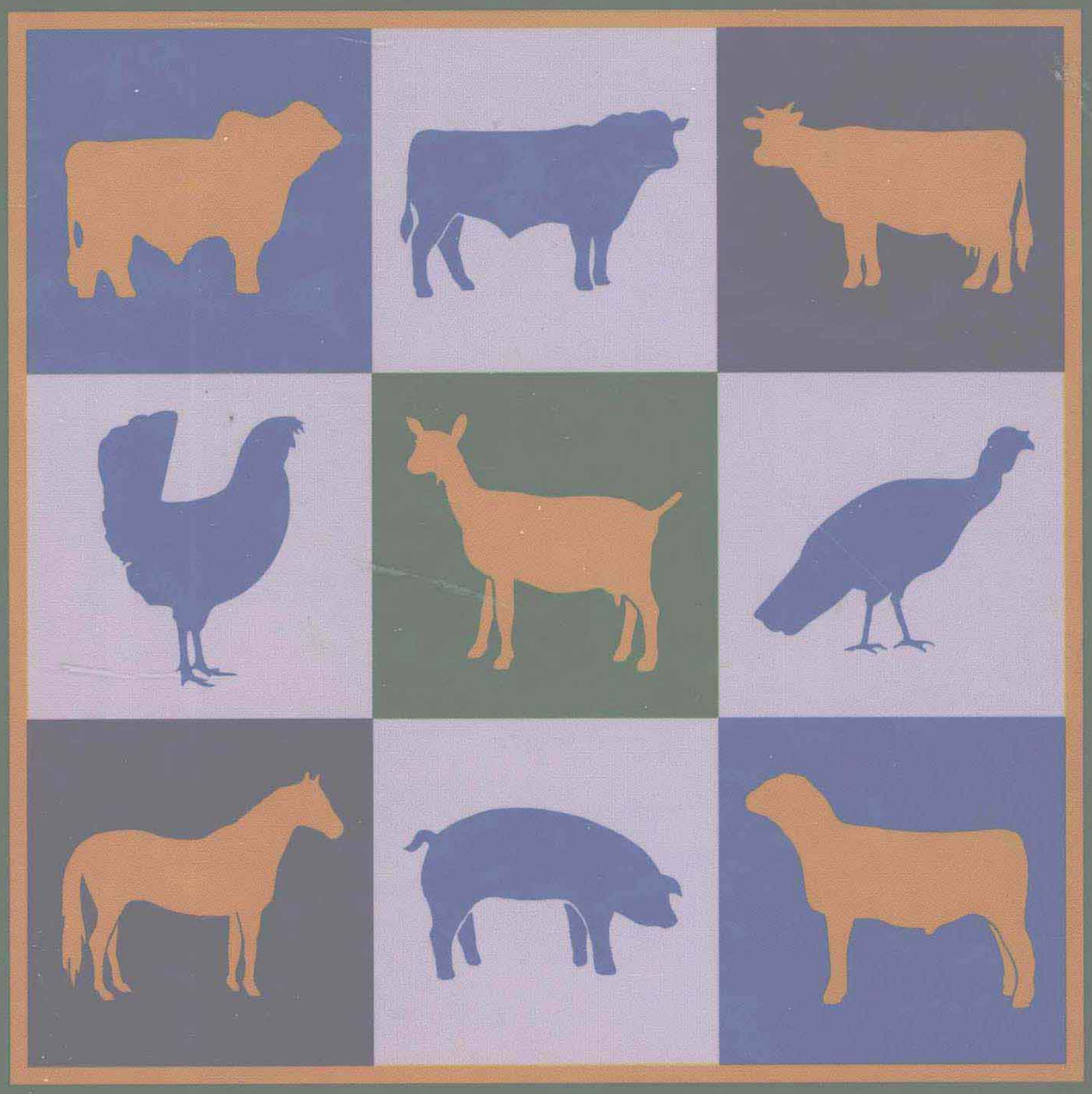
Sixth Edition

SCIENTIFIC FARM ANIMAL PRODUCTION

An Introduction to Animal Science



ROBERT E. TAYLOR
THOMAS G. FIELD

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AN INTRODUCTION TO ANIMAL SCIENCE

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Dedication

This book is dedicated to the hundreds of students the authors have taught. The positive and rewarding interactions with these students have provided the stimulus to write this book. Hopefully, the reading and studying of *Scientific Farm Animal Production* will be a motivational influence to current and future students as they seek to enhance their education.

Preface

Scientific Farm Animal Production is distinguished by an appropriate combination of both breadth and depth of livestock and poultry production and their respective industries. The book gives an overview of the biological principles applicable to the Animal Sciences with chapters on reproduction, genetics, nutrition, lactation, consumer products, and others. The book also covers the breeding, feeding, and management of beef cattle, dairy cattle, horses, sheep, swine, poultry, and goats. Although books have been written on each of these separate chapters, the authors have highlighted the significant biological principles, scientific relationships, and management practices in a condensed but informative manner.

Target Audience

This book is designed as a text for the introductory Animal Science course typically taught at universities and junior or community colleges. It is also a valuable reference book for livestock producers, vocational agriculture instructors, and others desiring an overview of livestock production principles and management. The book is basic and sufficiently simple for urban students with limited livestock experience, yet challenging for students who have a livestock production background.

Key Features

Chapters 1–9 cover animal products and give an overview of the livestock and poultry industries, Chapters 10–21 discuss the biological principles, while livestock and poultry management practices are presented in Chapters 22–33.

The glossary of the terms used throughout the book has been expanded so students can readily become familiar with animal science terminology. The bold-lettered words in the text are included in the glossary.

Many illustrations in the form of photographs and line drawings are used throughout the book to communicate key points and major relationships. If "a picture is worth a thousand words," the numerous photographs and drawings expand the usefulness of the book beyond its pages.

Selected references are provided for each chapter to direct students into greater depth and breadth as they become intrigued with certain topics. Instructors can also use the references to expand their knowledge in current background material. Also included in the selected-references section are references to visuals that relate to the specific chapter. Instructors are encouraged to review these visuals and use those which will enrich their course.

Using The Book

The book is designed to accommodate several instructional approaches to teaching the introductory course: (1) the life-cycle biological principles approach, including such areas as consumer products, reproduction, breeding, nutrition, and animal health; (2) the species approach (teaching the course primarily in reference to the various species); or (3) a combination of the previous two. The latter appears to be the most popular teaching approach, covering principles in lecture and combining principles and species into laboratory exercises.

Some instructors will assign one or more papers on a topic selected by them or the students. The references at the end of each chapter are designed for students who want or need to explore certain topics in more depth.

Most instructors will not have sufficient time in their course to assign all the chapters. Course outlines can be developed to include the chapters assigned and put them in the sequence that meets their preference.

Changes In This Edition

This edition has been updated with current technical and applied information. Numerous tables and figures have been revised with current data, especially Chapters 1–5. Major changes have been made to Chapter 26, Swine Breeds and Breeding, and Chapter 34, Animal Behavior. Chapter 35, Issues in the Animal Industries, has been rewritten to update an increased number of current issues. Students should understand the issues in animal agriculture because many of them will be involved in finding solutions to these issues.

The management emphasis, where bioeconomics focuses on combining biology with economics, is expanded. The global dimensions of the animal industries are also emphasized.

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Many instructors who teach the introductory animal science course completed a questionnaire and made numerous helpful suggestions. Those individuals who offered helpful comments that were incorporated into the sixth edition are:

W. R. Backus, University of Tennessee
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Robert E. Taylor
Thomas G. Field

About The Authors

Dr. Taylor was raised on an Idaho livestock operation where several livestock species were produced. He received his B.S. and M.S. degrees from Utah State University. This background, combined with his Ph.D. work in animal breeding and physiology from Oklahoma State University, has provided much depth to his knowledge of livestock production. He has had practical production experience with beef cattle, dairy cattle, horses, poultry, sheep, and swine.

Dr. Taylor received teaching awards at Iowa State University (where he also managed a swine herd) and at Colorado State University. He also received the Distinguished Teaching Award from the American Society of Animal Science and the USDA National Excellence in Teaching Award. Many of his concepts for effective teaching are used in this book.

Dr. Field was raised on a Colorado cow–calf and seedstock enterprise. He managed a seedstock herd after completing his B.S. degree. A competitive horseman as a youth, he has had practical experience with seedstock cattle, commercial cow–calf, stockers, and horses. He has an M.S. and Ph.D. in animal science from Colorado State University.

Dr. Field is highly respected by the hundreds of students he has taught. He has received numerous teaching awards including the NACTA National Teaching Fellow and the USDA National Excellence in Teaching Award.

Contents

CHAPTER 1

Animal Contributions to Human Needs

Our basic human needs are food, shelter, clothing, fuel, and emotional well-being. Animals and animal products supply many of these basic physical and emotional needs and contribute to a high standard of living which is associated with a high consumption of animal products.

Since the domestication of dogs, horses, cattle, sheep, and other animals, some 6,000 to 10,000 years ago, wide differences have developed among people in various regions of the world in using agricultural technology to improve their standard of living. But in all societies, domestic animals are a source of food, other consumer products, and companionship for people.

Of particular importance among the multitude of benefits that domestic animals provide for humans are food; clothing; by-products used for consumer goods and animal feeds; power; manure for fuel (Fig. 1.1), buildings, and fertilizer; information on human disease from research using experimental animals; and pleasure for those who keep animals. Table 1.1 shows the major domesticated animal species, their approximate numbers, and how they are used by people throughout the world. Chickens (12.0 billion) are most numerous, followed by cattle (1.3 billion), sheep (1.1 billion), and swine (875 million).

CONTRIBUTIONS TO FOOD NEEDS

When opportunity exists, most humans consume both plant and animal products (Fig. 1.2). Meat is nearly always consumed in quantity when it is available. Its availability in most countries is closely related to the economic status of the people and their agricultural technology. Vegetarianism in countries such as India may be the long-term result of intense population pressures and scarcity

FIGURE 1.1 A load of cow-dung cakes en route to a market in India. Courtesy of R. E. McDowell, Cornell University.

of feed for animals because of competition between humans and animals for food. Rising population pressures, particularly in developing regions (Southeast Asia, Africa, and Latin America), force people to consume foods primarily of plant origin. Some major groups in human society practice vegetarianism for ethical reasons. In the Buddhist philosophy and some religions of India, for example, all animal life is considered sacred.

The contribution of animal products to the per-capita calorie and protein supply in food is shown in Table 1.2. Animal products comprise approximately 16% of the calories and 35% of the protein in the total world food supply. Large differences exist between developed countries and developing countries in both total daily supply of calories and protein. For example, the contribution of animal products in calories is more than 30% in some developed countries and less than 10% in several developing countries. Some developed countries have more than 50% of their daily per-capita protein supply from animal products, while several developing countries are less than 25%. The United States ranks high compared to other countries in the contribution of animal products to the available calories and protein.

Changes in per-capita calorie supply and protein supply during the past 25–30 years are shown in Table 1.3. Both per-capita caloric and protein supply have increased in most areas of the world. The contribution of animal products to the per-capita protein supply has increased in most of the world.

Selected recommended daily intakes (recommended daily allowance) of calories and protein are given in Table 1.4. Although the data in Table 1.4 do not represent an average of the U.S. population, a comparison of these data with those in Table 1.2 is interesting. Some countries have a larger supply of calories and protein than needed, where other countries have an inadequate calorie and protein supply. This assumes an equal distribution of the available supply, which in reality does not occur.

The large differences among countries in the importance of animal products in their food supply can be partially explained by available resources and development of those resources. Most countries with only a small percentage of their population involved in agriculture have higher standards of living and a higher per-capita consumption of animal products. When comparing Table 1.5

TABLE 1.1 Major Domesticated Animal Species—Their Numbers and Uses in the World

Animal Species	World Numbers (mil)	Leading Countries or Areas with Numbers[a] (mil)	Primary Uses
Ruminants			
Cattle	1,288	India (193), Brazil (152), United States (101), China (91), Russian Fed. (49)	Meat, milk, hides
Sheep	1,087	Australia (133), China (112), New Zealand (51), Iran (45), United States (10)	Wool, meat, milk, hides
Goats	609	India (118), China (106), Pakistan (41), Nigeria (26), United States (2)	Milk, meat, hair, hides
Buffalo	149	India (79), China (22), Pakistan (19), Thailand (4)	Draft, milk, meat, hides, bones
Camels	19	Somalia (6.0), Sudan (2.8), India (1.5), Pakistan (1.1)	Packing, riding, draft, meat, milk, hides
Yaks	13	Russian Federation,[b] Tibet[b]	Packing, riding, draft, meat, milk, hides
Llamas	13	South America[b]	
Nonruminants			
Chickens	12,002	China (2,692), United States (1,530), Brazil (680), Indonesia (640)	Meat, eggs, feathers
Swine	875	China (403), United States (58), Germany (26)	Meat
Turkeys	247	United States (88), France (33), Italy (23)	Meat, eggs, feathers
Ducks	681	China (443), Vietnam (30), Indonesia (27), United States (4)	Meat, eggs, feathers
Horses	58	China (10), Mexico (6), Brazil (6), United States (4), Ethiopa (3)	Draft, packing, riding, meat, companion animals
Asses	44	China (11), Ethiopa (5), Mexico (3), United States (0.05)	
Mules	15	China (5.6), Mexico (3.2), Brazil (2.1), United States (0.03)	

[a] U.S. numbers are given for comparison; may not always be among the leading countries.
[b] Data not available.
Source: Adapted from several sources, including the 1994 *FAO Production Yearbook*.

with Table 1.2, note that the countries in Table 1.5 are listed by percentage of their population involved in agriculture.

Agriculture mechanization (note tractor numbers in Table 1.5) has been largely responsible for increased food production and allowing many people to work in other industries. This facilitates the provision of many goods and services and thus raises the standard of living in a country.

The tremendous increase in the productivity of U.S. agriculture and the relative cost of food are vividly demonstrated in Table 1.6. From 1820 it took 100 years to double productivity. Then productivity doubled in shorter, successive time periods—30 years (1920–50), 15 years (1950–65), and 10 years (1965–75). A dramatic change occurred after World War II, when productivity increased more than fivefold in 30 years. During that time, the abundant production of feed grains provided a marked stimulus in increasing livestock production, thus providing large amounts of animal products for the human population.

FIGURE 1.2 Animal food products, such as meat, milk, and eggs, are the preferred foods in countries with high standards of living. Courtesy of The American Egg Board.

Releasing people from producing their own food in the United States has given them the opportunity to improve their per-capita incomes. The increased per-capita income associated with an abundance of animal products has resulted in a decrease in relative costs of some animal products with time (Table 1.7).

United States consumers allocate a smaller share (12%) of their disposable income for food than do people in other countries. In contrast, people of India and China spend 55–65% of their incomes for food.

Table 1.8 shows that cereal grains are the most important source of energy in world diets. The energy derived from cereal grains, however, is twice as important in developing countries (as a group—there are exceptions) as in developed countries. Table 1.8 also shows that meat and milk are the major animal products contributing to the world supply of calories and protein.

Most of the world meat supply comes from cattle, buffalo, swine, sheep, goats, and horses. There are, however, 20 or more additional species, unfamiliar to most Americans, that collectively contribute about 6.5 billion lb of edible protein per year or approximately 10% of the estimated total protein from all meats. These include the alpaca, llama, yak, deer, elk, antelope, kangaroo, rabbit, guinea pig, capybara, fowl other than chicken (duck, turkey, goose, guinea fowl, pigeon), and wild game exclusive of birds. For example, the former Soviet Union cans more than 110 million lb of reindeer meat per year, and in West Germany the annual sales of local venison exceed $1 million. Peru derives more than 5% of its meat from the guinea pig.

Meat is important as a food for two scientifically based reasons. The first is that the assortment of amino acids in animal protein more closely matches the needs of the human body than does the assortment of amino acids in plant pro-

TABLE 1.2 Animal Product Contribution to Per-Capita and Protein Supply

Country	Per-Capita Kilocalorie Supply (kilocalories per day)			Per-Capita Protein Supply		
	Total Kilo calories	From Animal Products		Total Protein (g/day)	From Animal Products	
		Kilo calories	Percent		Grams	Percent
Denmark	3,664	1,596	44	99	63	64
Greece	3,815	961	25	114	59	52
Iceland	3,005	1,218	40	123	95	77
United States	3,732	1,228	33	113	74	66
United Kingdom	3,317	1,075	32	91	52	57
Germany	3,344	1,163	35	100	64	64
Australia	3,179	1,214	38	100	68	68
Japan	2,903	629	22	98	56	57
Mexico	3,146	543	17	78	31	40
Brazil	2,824	470	17	52	18	35
Kenya	2,075	255	12	54	16	30
China	2,727	345	13	67	16	24
Egypt	3,335	210	6	87	13	15
Nigeria	2,124	64	3	43	5	12
India	2,395	162	7	58	10	17
Bangladesh	2,019	58	3	42	5	12
Afghanistan	1,523	173	11	43	10	23
Rwanda	1,821	49	3	44	3	7
World Total	2,718	428	16	71	25	35

Source: 1994 *FAO Production Yearbook.*

TABLE 1.3 Changes in Per-Capita Calorie and Protein Supply in the World

Area	Year	Per-Capita Calorie Supply (calories per day)			Per-Capita Protein Supply		
		Total Calories	From Animal Products		Total Protein (g/day)	From Animal Products	
			Calories	Percent		Grams	Percent
World	1961–63	2,287	359	16	63	20	32
	1988–90	2,697	424	16	71	25	35
	1994	2,718	428	16	71	25	35

Source: 1994 *FAO Production Yearbook.*

TABLE 1.4 Recommended Daily Caloric and Protein Intake for Selected Males and Females in the United States

Sex	Age (years)	Weight (lb)	Height	Average Daily Calories	Protein (g/day)
Female	25–50	120	5 ft 4 in	2,000	44
Male	25–50	155	5 ft 10 in	2,700	56