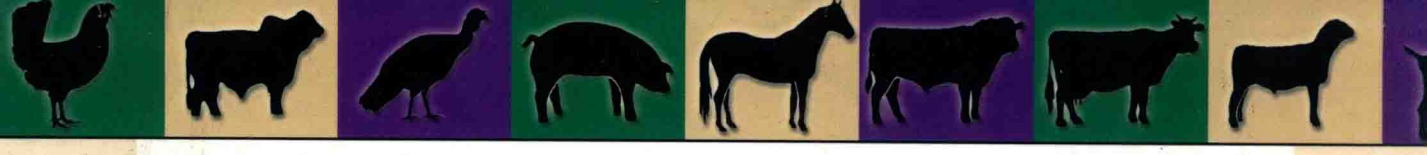
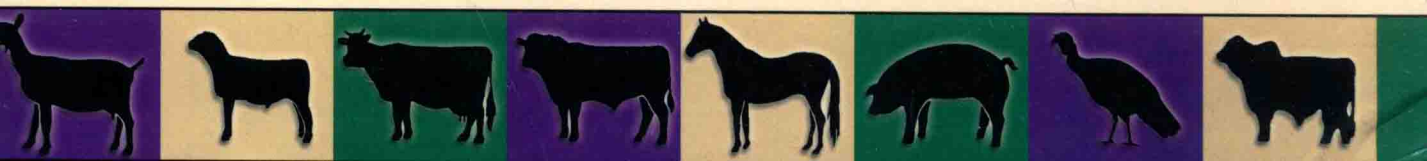


# SCIENTIFIC FARM ANIMAL PRODUCTION

## AN INTRODUCTION TO ANIMAL SCIENCE


SEVENTH
Edition

Robert E. Taylor & Thomas G. Field



SEVENTH EDITION

# Scientific Farm Animal Production

## AN INTRODUCTION TO ANIMAL SCIENCE

ROBERT E. TAYLOR
THOMAS G. FIELD
Colorado State University

Prentice Hall

Upper Saddle River, New Jersey 07458

**Library of Congress Cataloging-in-Publication Data**
Taylor, Robert E. (Robert Ellis), 1934-
Scientific farm animal production : an introduction to animal science / Robert E. Taylor, Thomas G. Field.— 7th ed.
p. cm.
Includes bibliographical references (p. ).
ISBN 0-13-020032-8
1. Livestock. I. Field, Thomas G. (Thomas Gordon)
SF61 .T39 2001
636—dc21 00-022436

Publisher: *Charles E. Stewart*
Executive Editor: *Debbie Yarnell*
Associate Editor: *Kate Linsner*
Production Liaison: *Eileen O'Sullivan*
Assistant Editor: *Kimberly Yehle*
Director of Manufacturing and Production: *Bruce Johnson*
Managing Editor: *Mary Carnis*
Manufacturing Manager: *Ed O'Dougherty*
Art Director: *Marianne Frasco*
Cover Design: *Wanda España*
Interior Design: *North Market Street Graphics*
Production Editor: *Stephanie Landis*
Composition: *North Market Street Graphics*
Printing and Binding: *Courier Westford*

Prentice-Hall International (UK) Limited, *London*
Prentice-Hall of Australia Pty. Limited, *Sydney*
Prentice-Hall Canada Inc., *Toronto*
Prentice-Hall Hispanoamericana, S.A., *Mexico*
Prentice-Hall of India Private Limited, *New Delhi*
Prentice-Hall of Japan, Inc., *Tokyo*
Prentice-Hall Singapore Pte. Ltd.
Editora Prentice-Hall do Brasil, Ltda., *Rio de Janeiro*




10 9 8 7 6 5 4 3 2 1
ISBN 0-13-020032-8

| Aquaculture: | |
|---|---|
| Center for Tropical and Subtropical Aquaculture | Library.kcc.hawaii.edu/ctsa |
| North Central Regional Aquaculture Center | ag.ansc.purdue.edu/aquanic/ncrac |
| Northeastern Regional Aquaculture Center | www.usmassd.edu/specialprograms/nrac/ |
| Southern Regional Aquaculture Center | www.msstate.edu/dept/srac/ |
| Western Regional Aquaculture Center | www.fish.washington.edu/wrac/ |

| Beef Cattle: | |
|---|---|
| Beef Home Page | www.beef.org |
| Beef New Zealand | www.beef.org.nz |
| Beef Today | www.farmjournal.com |
| Breeds | www.ansi.okstate.edu/BREEDS/index.htm |
| Cattle-Fax | www.cattle-fax.com |
| Chicago Mercantile Exchange | www.cme.com |
| Livestock Marketing Information Center | Http://lmic1.co.nrcs.usda.gov |
| Morgan's Forage Site | www.forage.com |
| Noble Foundation | www.noble.org |

| Dairy Cattle: | |
|---|---|
| Animal Improvement Programs Laboratory | www.aipl.arsusda.gov |
| Dairy Breeds | www.ansi.okstate.edu/BREEDS/index.htm |
| Dairy Management, Inc. | www.dairyinfo.com |
| Dairycenter | www.dairycenter.com |
| Dairy Today | www.farmjournal.com |
| National Dairy Council | www.nationaldairycouncil.com |
| National DHIA | www.DHIA.org |
| The Babcock Institute | http.babcock.cals.wisc.edu |
| U.S. Dairy Export Council | www.usdec.org |
| World Dairy Expo | www.world-dairy-expo.com |

| General Statistics/Demographic Data: | |
|---|---|
| Agricultural Marketing Service | www.ams.usda.gov |
| American Farm Bureau | www.fb.com |
| American Farmland Trust | www.farmland.org |
| Economic Research Service | www.econ.ag.gov |
| Farm Economy Issues | http://isufarmeconomyteam.org |
| Food and Agriculture Organization | www.fao.org |
| Foreign Agriculture Service | www.ffas.usda.gov |
| International Food Policy Research Institute | www.cgiar.org/ifpri |
| National Agricultural Statistics Service | www.usda.gov/nass |
| United States Department of Agriculture | www.usda.gov |
| Winrock International | www.winrock.org |
| World Trade Organization | www.wto.org |

| Goats: | |
|---|---|
| American Boer Goat Association | www.abga.org |
| American Dairy Goat Association | www.adga.org |
| Animal Improvement Programs Laboratory | www.aipl.arsusda.gov |
| Dairy Goat | www.ics.uci.edu/~puzzani/4H/dairygoats.html |
| Goat Breeds | www.ansi.okstate.edu/BREEDS/index.htm |
| The Goat Farmer | www.caprine.co.nz |

| | |
|---|---|
| **Horses:** | |
| American Association of Equine Practitioners | www.aaep.org |
| American Horse Council | www.horsecouncil.org |
| American Horse Publications | www.americanhorsepubs.org |
| Blood Horse | www.bloodhorse.com |
| Chronicle of the Horse | www.chronofhorse.com |
| Cyber Steed | www.cybersteed.com |
| Horse Breeds | www.ansi.okstate.edu/BREEDS/index.htm |
| Horse Country | www.horsecountry.com |
| United States Pony Club | www.ponyclub.org |
| Western Horseman | www.westernhorseman.com |
| **Poultry:** | |
| American Egg Board | www.aeb.org |
| Egg Nutrition Center | www.enc-online.org |
| Goldkist | www.goldkist.com |
| Pilgrim's Pride | www.pilgrimspride.com |
| Poultry Breeds | www.ansi.okstate.edu/BREEDS/index.htm |
| Poultry Information Network | www.wattnet.com |
| Poultry Internet Information Resources | www.oneglobe.com/agrifood/aginform/poultry |
| Ross Breeders | www.rossbreeders.com |
| Tyson Foods, Inc. | www.tyson.com |
| USA Poultry and Egg Association | www.poultryegg.org |
| **Sheep:** | |
| American Sheep Industry Association | www.sheepusa.org |
| Australian Wool Exchange | www.dev.inter-serv.com.au/awex-corp |
| Land's End, Inc. | www.landsend.com |
| Livestock Marketing Information Center | http://lmic1.co.nrcs.usda.gov |
| National Sheep Improvement Program | www.nsip.org |
| Pendleton Woolen Mills | www.pendleton-usa.com |
| Sheep Breeds | www.ansi.okstate.edu/BREEDS/index.htm |
| Woolmark Company | www.wool.com.au |
| **Swine:** | |
| Iowa Pork Industry Center | www.extension.iastate.edu/ipic |
| Livestock Marketing Information Center | http://lmic1.co.nrcs.usda.gov |
| National Pork Producers Council | www.nppc.org |
| National Hog Farmer | www.homefarm.com/nhf |
| National Swine Registry | www.nationalswine.com |
| Purdue Pork Page | www.anr.ces.purdue.edu/anr/anr/swine/porkpage.htm |
| Swine Breeds | www.ansi.okstate.edu/BREEDS/index.htm |
| Swine Information Network | www.swine.net |
| Swine Testing and Genetic Evaluation System | www.ansc.purdue.edu/stages/index.htm |

# Scientific Farm Animal Production

# Dedication

This book is dedicated to the many teachers and students who have invested themselves in the process of improving animal agriculture so that humanity might one day be free of hunger. Since the first edition, this book has been inspired by the marvelous relationships that exist when teachers and students are motivated to learn and discover.

Robert Taylor was my teacher and mentor. He was the embodiment of good stewardship. He was a great stockman who took care of the land, the herds, the people, and the abundant natural resources God has bestowed upon us. He nurtured his students while challenging them to always strive for excellence. He was a source of wisdom, a builder of community, and a visionary leader.

This book is a compilation of our work as students of livestock management systems. We hope that readers will benefit from this book and be inspired to a life of continual learning and service.

# 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 other subjects. The book also covers the breeding, feeding, and management of beef cattle, dairy cattle, horses, sheep, swine, poultry, goats, and aquaculture. Although books have been written on each of these separate subjects, 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 10–22 discuss the biological principles, while livestock, poultry, and aquaculture management practices are presented in Chapters 23–38.

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 sections are references to visuals that relate to the specific chapter. Instructors are encouraged to review these visuals and use those that will enrich their courses.

## 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 courses to assign all the chapters. Course outlines can be developed to include the chapters assigned and put them in the sequence that meets an instructor's preference.

## CHANGES IN THIS EDITION

This edition has been updated with current technical and applied information. Whenever possible, tables and figures have been revised with current data. A chapter on aquaculture has been added to the text, and major revisions of the careers chapter (37), the species breeding and management chapters (25–36), and the reproduction chapter (10) have been made. This revision provides more detail in terms of selection strategies and tools, management benchmarks, endocrinology, and food safety issues. The emphasis on bioeconomics and global perspectives has been continued. A list of useful Web sites is provided to allow students and faculty the opportunity to explore a variety of information sources that complement the text. The addition of a CD-ROM that provides interactive study questions for each chapter also adds to the value of this edition.

# 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 a Ph.D. in animal breeding and physiology from Oklahoma State University, provided the foundations of his knowledge about livestock production. He worked with beef cattle, dairy cattle, horses, poultry, sheep, and swine during his career.

Dr. Taylor received teaching awards from Iowa State University, Colorado State University, the USDA National Excellence in Teaching program, and the American Society of Animal Science. Many of his concepts for effective teaching are utilized in this book. Dr. Taylor passed away in 1998.

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

Dr. Field has received teaching awards from the USDA National Excellence in Teaching program, the National Association of Colleges and Teachers of Agriculture, the Western Section of the American Society of Animal Science, and Colorado State University. Dr Field is the teaching coordinator for the Department of Animal Sciences at Colorado State University and is responsible for coordinating the teaching herd.

# Acknowledgments

Appreciation is expressed to those individuals and organizations that have reviewed all or part of the sixth and seventh editions and offered suggestions to strengthen the book. To Barbara Holst, who typed the seventh edition, special thanks for her professionalism and commitment.

Many instructors who teach the introductory animal science course completed a questionnaire and made numerous helpful suggestions. The following individuals were of particular help in the preparation of the seventh edition:

Patrick Burns, Colorado State University
Russ Danielson, North Dakota State University
Temple Grandin, Colorado State University
Polly Grant, Colorado State University
Ronnie Green, Colorado State University
Wilton Heinemann, Yakima Valley Community College
Steve LeValley, Colorado State University
Tim Marshall, University of Florida
Mark Mirando, Washington State University
Paul Sammelwitz, University of Delaware
Tony Seykora, University of Minnesota
J. D. Tatum, Colorado State University
Bill Wailes, Colorado State University

The professional contributions of Stephanie Landis of North Market Street Graphics and Kate Linsner of Prentice Hall are greatly appreciated.

*Thomas G. Field*

# Scientific Farm Animal Production

# Contents