

Pearson New International Edition

Scientific Farm Animal Production
Robert E. Taylor Tom G. Field
Tenth Edition

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Pearson Education Limited

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glossary

glossary

abomasum The fourth stomach compartment of ruminant animals that corresponds to the true stomach of monogastric animals.

abortion Delivery of fetus between conception and a few days before normal parturition.

abscess Localized collection of pus in a cavity formed by disintegration of tissues.

absorption The passage of liquid and digested (soluble) food across the gut wall.

accessory organs The seminal vesicles, prostate, and Cowper's glands in the male. These glands add their secretions to the sperm to form semen.

accuracy (ACC) of selection Numerical value, ranging from 0–1.0, denoting the confidence that can be placed in the EPD (expected progeny difference); e.g., high (≥ 0.70), medium (0.40–0.69), low (≤ 0.40).

adipose Fat cells or fat tissue.

ad libitum Free choice; allowing animals to eat all they want.

afterbirth The membranes attached to the fetus that are expelled after parturition.

AI Abbreviation for artificial insemination.

air dry Refers to feeds in equilibrium with air; they would contain approximately 10% water or 90% dry matter.

albumen The white of an egg.

alimentary tract Passageway for food and waste products through the body.

alleles Genes occupying corresponding loci in homologous chromosomes that affect the same hereditary trait but in different ways.

allelomimetic behavior Doing the same thing. Animals tend to follow the actions of other animals.

alveolus (plural *alveoli*) A hollow cluster of cells. In the mammary gland, these cells secrete milk.

amino acid Any of a class of 20 molecules that are combined to form proteins in living things.

amnion A fluid-filled membrane located next to the fetus.

ampulla The dilated or enlarged upper portion of the vas deferens in bulls, bucks, and rams, where sperm are stored for sudden release at ejaculation.

anabolic A constructive, or “building up,” process.

anaerobic Able to survive or function where there is no oxygen.

anatomy Science of animal body structure and the relation of the body parts.

androgen A male sex hormone, such as testosterone.

anemia Deficiency of hemoglobin, often accompanied by a reduced number of red blood cells. Usually results from an iron deficiency.

anestrous Period of time when female is not in estrus; the nonbreeding season.

antemortem Before death.

anterior Situated in front of, or toward the front part of, a point of reference. Toward the head of an animal.

anterior pituitary (AP) The part of the pituitary gland, located at the base of the brain, that produces several hormones.

anthelmintic A drug or chemical agent used to kill or remove internal parasites.

antibiotic A product produced by living organisms, such as yeast, which destroys or inhibits the growth of other microorganisms, especially bacteria.

antibody A specific protein molecule that is produced in response to a foreign protein (antigen) that has been introduced into the body.

antigen A foreign substance that, when introduced into the blood or tissues, causes the formation of antibodies. Antigens may be toxins or native proteins.

anti-inflammatory An agent that acts to decrease inflammation and associated pain, heat, and swelling.

antiseptic A chemical agent used on living tissue to control the growth and development of microorganisms.

antitoxin An antibody that is capable of neutralizing poisons from animal and vegetable sources.

AP See *anterior pituitary*.

APCS A popular milk testing system where weight is recorded at two milkings.

arteriosclerosis A disease resulting in the thickening and hardening of the artery walls.

artery Vessel through which blood passes from the heart to all parts of the body.

artificial insemination The introduction of semen into the female reproductive tract (usually the cervix or uterus) by a technique other than natural service.

artificial vagina A device used to collect semen from a male when he mounts in a normal manner to copulate. The male ejaculates into this device, which simulates the vagina of the female in pressure, temperature, and sensation to the penis.

ascaris Any of the genus (*Ascaris*) of parasitic roundworms.

as fed Refers to feeding feeds that contain their normal amount of moisture.

assimilation The process of transforming food into living tissue.

atherosclerosis A condition of the circulatory system characterized by formation of fatty deposits on the inner walls of arteries.

atrophy Shrinking or wasting away of a tissue or organ.

auction A market facility where an auctioneer sells animals to the highest bidder.

autopsy A postmortem examination in which the body is dissected to determine the cause of death.

avian Refers to birds, including poultry.

balance sheet A statement of assets owned and liabilities owed in dollar terms that shows the equity or net worth at a specific point in time (e.g., net worth statement).

band (1) a relatively large group of range sheep; (2) method of identification (e.g., put a band around the leg of a chicken).

Bang's disease See *brucellosis*.

barren Not capable of producing offspring.

barrow A male swine that was castrated before reaching puberty.

basal metabolism The chemical changes that occur in an animal's body when the animal is in a thermoneutral environment, resting, and in a postabsorptive state. It is usually determined by measuring oxygen consumption and carbon dioxide production.

base pair Two nitrogenous bases (adenine and thymine or guanine and cytosine) held together by weak bonds. Two strands of DNA are held together in the shape of a double helix by the bonds between base pairs.

beef The meat from cattle (bovine species) other than calves (the meat from calves is called *veal*).

beri-beri A disease caused by a deficiency of vitamin B₁.

biologicals Medicinal products used primarily to prevent disease, including serums, vaccines, antigens, antitoxins, etc.

biotechnology The use of microorganisms, plant cells, animal cells, or parts of cells (such as enzymes) to produce industrially important products or processes.

birth weight expected progeny difference (EPD) The expected average increase or decrease in the birth weight of a beef bull's calves when compared to the other bulls in the sire summary.

blemish Any defect or injury that mars the appearance of, but does not impair the usefulness of, an animal.

bloat An abnormal condition in ruminants characterized by a distention of the rumen, usually seen on an animal's upper left side, owing to an accumulation of gases.

blood spots Spots in the egg caused by a rupture of one or more blood vessels in the yolk follicle at the time of ovulation.

BLUP Best linear unbiased prediction, method for estimating breeding values of breeding animals.

boar (1) A male swine of breeding age. (2) Denotes a male pig, which is called a *boar pig*.

bog spavin A soft enlargement of the anterior, inner aspect of the hock.

bolus (1) Regurgitated food. (2) A large pill for dosing animals.

bone spavin A bony (hard) enlargement of the inner aspect of the hock.

bots Any of a number of related flies whose larvae are parasitic in horses and sheep.

bovine A general family grouping of cattle.

boxed beef Cuts of beef put in boxes for shipping from packing plant to retailers. These primal and subprimal cuts are intermediate cuts between the carcass and retail cuts.

boxed lamb See *boxed beef*. Similar process except lamb instead of beef.

break joint Denotes the point on a lamb carcass where the foot and pastern are removed at the cartilaginous junction of the front leg.

bred Female has been mated to the male. Usually implies the female is pregnant.

breech The buttocks. A breech presentation at birth is where the rear portion of the fetus is presented first.

breed Animals of common origin with characteristics that distinguish them from other groups within the same species.

breeding value A genetic measure for one trait of an animal, calculated by combining into one number several performance values that have been accumulated on the animal and the animal's relatives.

brisket disease A noninfectious disease of cattle characterized by congestive right heart failure. It affects animals residing at high elevations (usually above 7,000 ft).

British breeds Breeds of beef cattle originating in England. Examples are Angus, Hereford, and Shorthorn.

British thermal unit (Btu) The quantity of heat required to raise the temperature of 1 lb of water 1°F at or near 39.2°F.

brockle-faced White-faced with other colors splotched on the face and head.

broiler A young meat-type chicken of either sex (usually up to 6–8 weeks of age) weighing 3–5 lb. Also referred to as a *fryer* or *young chicken*.

broken-mouth Some teeth are missing or broken.

brooder Fish that have reached reproductive maturity.

broodiness The desire of a female bird to sit on eggs (incubate).

browse Woody or brushy plants. Livestock feed on tender shoots or twigs.

brucellosis A contagious bacterial disease that results in abortions; also called *Bang's disease*.

buck A male sheep or goat. This term usually denotes animals of breeding age.

bulbourethral (Cowper's) gland An accessory gland of the male that secretes a fluid which constitutes a portion of the semen.

bull A bovine male. The term usually denotes animals of breeding age.

buller-steer syndrome A behavior problem where a steer has a sexual attraction to other steers in the pen. The steer is ridden by the other steers, resulting in poor performance and injury.

bullock A young bull, typically less than 20 months of age.

buttermilk The fluid remaining after butter has been made from cream. By use of bacteria, cultured buttermilk is also produced from milk.

buttons May refer to cartilage or dorsal processes of the thoracic vertebrae. Also see *cotyledons*.

by-product A product of considerably less value than the major product. For example in U.S. meat animals, the hide, pelt, and offal are by-products, whereas meat is the major product.

C-section See *cesarean section*.

calf A young male or female bovine animal under a year of age.

calorie The amount of heat required to raise the temperature of 1 g of water from 15°C to 16°C.

calve Giving birth to a calf. Same as parturition.

calving interval The amount of time (days or months) between the birth of a calf and the birth of a subsequent calf, both from the same cow.

candling The shining of a bright light through an egg to see if it contains a live embryo.

canter A slow, easy gallop.

capon Castrated male chicken. Castration usually occurs between 3 and 4 weeks of age.

capped hocks Hocks that have hard growths that cover, or "cap," their points.

carbohydrates Any foods, including starches, sugars, celluloses, and gums, that are broken down to simple sugars through digestion.

carcass merit The value of a carcass for consumption.

carnivorous Subsisting or feeding on animal tissues.

carotene The orange pigment found in carrots, leafy plants, yellow corn, and other feeds, which can be broken down to form two molecules of vitamin A.

caruncle (1) The red and blue fleshy, unfeathered area of skin on the upper region of the turkey's neck. (2) The "buttons" on the ruminant uterus where the cotyledons on the fetal membranes attach.

casein The major protein of milk.

cash-flow statement A financial statement summarizing all cash receipts and disbursements over the period of time covered by the statement.

castrate (1) To remove the testicles. (2) An animal that has had its testicles removed.

cattalo A cross between domestic cattle and bison.

cecum (ceca) Large, sock-shaped pouch between the horse's small and large intestines; important in cellulose digestion.

cervix The portion of the female reproductive tract between the vagina and the uterus. It is usually sealed by thick mucus except when the female is in estrus or delivering young.

cesarean section Delivery of fetus through an incision in abdominal and uterine walls.

chalaza A spiral band of thick albumen that helps hold the yolk of an egg in place.

chemotherapeutics Chemical agents used to prevent or treat diseases.

chevon Meat from goats.

chick A young chicken that has recently been hatched.

chorion The outermost layer of fetal membranes.

chromosome The self-replicating genetic structure of cells containing the cellular DNA that bears in its nucleotide sequence the linear array of genes.

chyme The thick, liquid mixture of food that passes from the stomach to the small intestine.

chymotrypsin A milk-digesting enzyme secreted by the pancreas into the small intestine.

class A group of animals categorized primarily by sex and age.

clip One season's yield of wool.

clitoris The ventral part of the vulva of the female reproductive tract that is homologous to the penis in the male. It is highly sensory.

cloaca Portion of the lower end of the avian digestive tract that provides a passageway for products of the urinary, digestive, and reproductive tracts.

closed face A condition in which sheep cannot see because wool covers their eyes.

clostridium Genus of anaerobic bacteria. Many produce potent toxins that cause such diverse diseases as tetanus, botulism, and gas gangrene. Some of these anaerobic bacteria inhabit the soil and feces.

clutch Eggs laid by a hen on consecutive days.

coccidia A protozoan organism that causes an intestinal disease called *coccidiosis*.

coccidiosis A morbid state caused by the presence of organisms called coccidia, which belong to a class of sporozoans.

cock A male chicken; also called a *rooster*.

cockerel Immature male chicken.

cod Scrotal area of steer remaining after castration.

coefficient of determination Percentage of variation in one trait that is accounted for by variation in another trait.

colic A nonspecific pain of the digestive tract.

colon The large intestine from the end of the ileum and beginning with the cecum to the anus.

colostrum The first milk given by a female after delivery of her young. It is high in antibodies that protect young animals from invading microorganisms.

colt A young male of the horse or donkey species.

comb The fleshy outgrowth on the top of a chicken's head, usually red in color, with varying sizes and shapes.

commercial (1) a carcass grade of cattle; (2) livestock that are not registered or pedigreed by a registry (e.g., breed) association.

compensatory gain A faster-than-normal rate of gain after a period of restricted gain.

compensatory growth See *compensatory gain*.

complete feed A nutritionally adequate feed for animals other than humans by specific formula compounded to be fed as the sole ration and capable of maintaining life and/or promoting production without any additional substance, except water, being consumed.

composite breed A breed that has been formed by crossing two or more breeds.

concentrate A feed used with another to improve the nutritive balance of the total and intended to be further diluted and mixed to produce a supplement or a complete feed.

conception Fertilization of the ovum (egg).

conditioning The treatment of animals by vaccination and other means before putting them in the feedlot.

conformation The physical form of an animal; its shape and arrangement of parts.

contagious disease Infectious disease; a disease that is transmitted from one animal to another.

contemporaries A group of animals of the same sex and breed (or similar breeding) that have been raised under similar environmental conditions (same management group).

Continental breeds Breeds of beef cattle originating in countries other than England. Sometimes called European or exotic breeds. Examples are Charolais, Limousin, and Simmental.

contracted heels A condition in which the heels of a horse are pulled in so that expansion of the heel cannot occur when the foot strikes the ground.

core samples Samples (wool, feed, or meat) taken by a coring device to determine the composition of the sample.

coronary band (coronet) Boundary between the top of the hoof wall and the skin at the bottom of the pastern where hoof growth begins.

corpus luteum A yellowish body in the mammalian ovary. Follicular cells develop into the corpus luteum, which secretes progesterone. It becomes yellow in color from the yellow lipids that are in the cells.

correlation coefficient A measurement of the association of one trait with another.

cost of gain The total cost divided by the total pound gained; usually expressed on a per-pound basis.

cotyledon An area of the placenta that contacts the uterine lining to allow nutrients and wastes to pass from the mother to the developing young. Sometimes referred to as *button*.

cow A sexually mature female bovine animal—usually one that has produced a calf.

cow-calf operation A management unit that maintains a breeding herd and produces weaned calves.

cow hocked A condition in which the hocks are close together but the feet stand apart.

creep An enclosure in which young can enter to obtain feed but larger animals cannot enter. This process is called *creep feeding*.

crimp The waves, or kinks, in a wool fiber.

crossbred An animal produced by crossing two or more breeds.

crossbreeding Mating animals from genetically diverse groups (i.e., breeds) within a species.

crutching See *tagging*.

cryptorchidism The retention of one or both testicles in the abdominal cavity in animals that typically have the testicles hanging in a scrotal sac.

cud Bolus of feed a ruminant animal regurgitates for further chewing.

cull To eliminate one or more animals from the breeding herd or flock.

curb A hard swelling that occurs just below the point of the hock.

curd Coagulated milk.

cutability Fat, lean, and bone composition of meat animals. Used interchangeably with yield grade. (See also *yield grade*.)

cutting chute A narrow chute where animals proceed through gates in single file such that animals can be directed into pens along the side of the chute.

cwt An abbreviation for hundredweight (100 lb).

cycling Infers that nonpregnant females have active estrous cycles.

dam Female parent.

dark cutter Color of the lean (muscle) in the carcass has a dark appearance, usually caused by stress (excitement, etc.) to the animal before slaughter.

debeaking To remove the tip of the beak of chickens.

dehorn To remove the horns from an animal.

deoxyribonucleic acid (DNA) A complex molecule consisting of deoxyribose (a sugar), phosphoric acid, and four nitrogen bases (a gene is a piece of DNA).

depreciation An accounting procedure by which the purchase price of an asset with a useful life of more than one year is prorated over time.

dewclaws Hard horny structures above the hoof on the rear surface of the legs of cattle, swine, and sheep.

dewlap Loose skin under the chin and neck of cattle.

DHIA Dairy Herd Improvement Association, an association that dairy producers participate in keeping dairy records. Sanctioned by the National Cooperative Dairy Herd Improvement Program.

DHIR Dairy Herd Improvement Registry, a dairy record-keeping plan sponsored by the breed associations.

diet Feed ingredients or mixture of ingredients (including water) that are consumed by animals.

digestibility The quality of being digestible. If a high percentage of a given food taken into the digestive tract is absorbed into the body, that food is said to have *high digestibility*.

digestion The reduction in particle size of feed so that the feed becomes soluble and can pass across the gut wall into the vascular or lymph system.

diploid Having the normal, paired chromosomes of somatic tissue as produced by the doubling of the primary chromosomes of the germ cells at fertilization.

disease Any deviation from a normal state of health.

disinfect To kill, or render ineffective, harmful microorganisms and parasites.

disinfectant A chemical that destroys disease-producing microorganisms or parasites.

distal Position that is distant from the point of attachment of an organ.

DM See *dry matter*.

DNA (deoxyribonucleic acid) The molecule that encodes genetic information. DNA is a double-stranded molecule held together by weak bonds between base pairs of nucleotides.

DNA fingerprint Pattern of DNA fragments unique to an individual. Often found by using restriction enzymes to

cut the DNA into fragments. These fragments can be sorted and documented, forming a unique “fingerprint.” This technology, the same used as a forensic tool at crime scenes, is also used to DNA parentage test animals.

DNA sequence The relative order of base pairs, whether in a fragment of DNA, a gene, a chromosome, or an entire genome.

dock (1) To cut off the tail. (2) The remaining portion of the tail of a sheep that has been docked. (3) To reduce or lower in value.

doe A female goat or rabbit.

dominance (1) A situation in which one gene of an allelic pair prevents the phenotypic expression of the other member of the allelic pair. (2) A type of social behavior in which an animal exerts influence over one or more other animals.

dominant gene A gene that overpowers and prevents the expression of its recessive allele when the two alleles are present in a heterozygous individual.

dorsal Of, on, or near the back of an animal.

double muscling A genetic trait in cattle where muscles are greatly enlarged rather than duplicate muscles.

down Soft, fluffy type of feather located under the contour feathers. Serves as insulating material.

drake Mature male duck.

drench To give fluid by mouth (e.g., medicated fluid is given to sheep for parasite control).

dressing percentage The percentage of the live animal weight that becomes the carcass weight at slaughter. It is determined by dividing the carcass weight by the live weight, then multiplying by 100.

drop Body parts removed at slaughter—primarily hide (pelt), head, shanks, and offal.

drop credit Value of the drop.

dry (cow, ewe, sow, mare) Refers to a nonlactating female.

dry matter Feed after water (moisture) has been removed (100% dry).

dubbing The removal of part or all of the soft tissues (comb and wattles) of chickens.

dung The feces (manure) of farm animals.

dwarfism The state of being abnormally undersized. Two kinds of dwarfs are recognized; one is proportionate and the other is disproportionate.

dysentery Severe diarrhea.

dystocia Difficult birth.

ectoderm The outermost layer of the three layers of the primitive embryo.

edema Abnormal collection of fluid in body tissues that causes soft swelling.

ejaculation Discharge of semen from the male.

emaciation Thinness; loss of flesh where bony structures (hips, ribs, and vertebrae) become prominent.

embryo Very early stage of individual development within the uterus. The embryo grows and develops into a fetus. In poultry, the embryo develops within the eggshell.

embryo transfer The transfer of fertilized eggs from a donor female to one or more recipient females.

endocrine gland A ductless gland that secretes a hormone into the bloodstream.

endoderm The innermost layer of the three layers of the primitive embryo.

enterotoxemia A disease of the intestinal tract caused by bacterial secretion of toxins. Its symptoms are characteristic of food poisoning.

entropion Turned-in eyelids.

environment The sum total of all external conditions that affect the well-being and performance of an animal.

enzyme A complex protein produced by living cells that causes changes in other substances in the cells without being changed itself and without becoming a part of the product.

EPD See *expected progeny difference*.

epididymis The long, coiled tubule leading from the testis to the vas deferens.

epididymitis An inflammation of the epididymis.

epiphysis A piece of bone separated from a long bone in early life by cartilage, which later becomes part of the larger bone.

epistasis A situation in which a gene or gene pair masks (or controls) the expression of another nonallelic pair of genes.

equine Refers to horses.

equine encephalomyelitis An inflammation of the brain of horses.

eruction (or eructation) The elimination of gas by belching.

esophageal groove A groove in the reticulum between the esophagus and omasum. Directs milk in the nursing young ruminant directly from the esophagus to the omasum.

essential nutrient A nutrient that cannot be synthesized by the body and must be supplied in the diet.

estrogen Any hormone (including estradiol, estriol, and estrone) that causes the female to come physiologically into heat and to be receptive to the male. Estrogens are produced by the follicle of the ovary and by the placenta.

estrous An adjective meaning “heat,” which modifies such words as “cycle.” The estrous cycle is the heat cycle, or time from one heat to the next.

estrous synchronization Controlling the estrous cycle so that a high percentage of the females in the herd express estrus at approximately the same time.

estrus The period of mating activity in the female mammal. Same as heat.

ET Abbreviation for *embryo transfer*.

ethology Study of animal behavior in the animal’s natural environment.

eukaryote Cell or organism with membrane-bound, structurally discrete nucleus and other well-developed subcellular compartments. Eukaryotes include all organisms except viruses, bacteria, and blue-green algae.

European breeds See *Continental breeds*.

eviscerate The removal of the internal organs during the slaughtering process.

ewe A sexually mature female sheep. A ewe lamb is a female sheep before attaining sexual maturity.

exocrine gland Gland that secretes fluid into a duct.

exotic breeds See *Continental breeds*.

expected progeny difference (EPD) One-half of the breeding value; the difference in performance to be expected from future progeny of a sire, compared with that expected from future progeny of an average bull in the same test.

family selection Selection based on performance of a family.

farrow To deliver, or give birth to, pigs.

fat Adipose tissue.

FDA See *Food and Drug Administration*.

feather picking The picking of feathers from one bird by another.

feces Bowel movements, excrement from the intestinal tract.

feed additive Ingredient (such as an antibiotic or hormone-like substance) added to a diet to perform a specific role (e.g., to improve gain or feed efficiency).

feed bunk A trough or container used to feed farm animals.

feed efficiency (1) The amount of feed required to produce a unit of weight gain or milk; for poultry, this term can also denote the amount of feed required to produce a given quantity of eggs. (2) The amount of gain made per unit of feed.

feeder Animals (e.g., cattle, lambs, pigs) that need further feeding prior to slaughter.

feeder grades Visual classifications (descriptive and/or numerical) of feeder animals. Most of these grades have been established by the USDA.

felting The process of pressing wool fibers together in conjunction with heat and moisture to produce a fabric.

femininity Well-developed secondary female sex characteristics, udder development and refinement in head and neck.

feral Domesticated animals that return to nature to survive and reproduce.

fertility The capacity to initiate, sustain, and support reproduction. With reference to poultry, the term typically refers to the percentage of eggs that, when incubated, show some degree of embryonic development.

fertilization The process in which a sperm unites with an egg to produce a zygote.

fetus Later stage of individual development within the uterus. Generally, the new individual is regarded as an embryo during the first half of pregnancy, and as a fetus during the last half.

fill The contents of the digestive tract.

filly A young female horse.

fineness A term used to describe the diameter of wool fibers.

fingerlings Small, young fish usually 1–6 inches long.

finish The degree of fatness of an animal.

Finnsheep A highly prolific breed of sheep introduced into the United States in 1968.

fistula A running sore at the top of the withers of a horse, resulting from a bruise followed by invasion of microorganisms.

flank firmness Firmness of the flank muscle in lamb carcass evaluation.

flank streaking Streaks of fat in the flank muscle of lamb carcasses.

fleece The wool shorn at one time from all parts of the sheep.

flehmen A pattern of behavior expressed in some male animals (e.g., bull, ram, stallion) during sexual activity. The upper lip curls up and the animal inhales in the vicinity of the vulva or urine.

flock A group of sheep or poultry.

flushing Placing females (typically sheep and swine) on a gaining level of nutrition before breeding to stimulate greater ovulation rates; also, a behavior in fish whereby diseased fish rub against objects in tanks or ponds.

fly strike An infestation with large numbers of blowfly maggots.

foal A young male or female horse (noun) or the act of giving birth (verb).

follicle A blisterlike, fluid-filled structure in the ovary that contains the egg.

follicle-stimulating hormone (FSH) A hormone produced and released by the anterior pituitary that stimulates the development of the follicle in the ovary.

Food and Drug Administration (FDA) A U.S. government agency responsible for protecting the public against impure and unsafe foods, drugs, veterinary products, and other products.

food-size Commercially grown fish produced for food, usually ranging from .75 to 1.0 pounds and over one foot in length.

footrot A disease of the foot in sheep and cattle. In sheep it causes rotting of tissue between the horny part of the foot and the soft tissue underneath.

forb Weedy or broadleaf plants, as contrasted to grasses, that serve as pasture for animals.

forging The striking of the heel of the front foot with the toe of the hind foot by a horse in action.

founder Nutritional ailment resulting from overeating. Lameness in front feet with excessive hoof growth usually occurs.

frame score A numerical rating of frame size.

frame size A measure of skeletal size. It can be visual or by measurement (usually taken at the hips).

freemartin A female calf born twin to a bull calf (approximately 90% will be infertile).

freshen To give birth to young and initiate milk production. This term is usually used in reference to dairy cattle.

fry Stage from hatching until fish reach one inch in length.

fryer See *broiler*.

FSH See *follicle-stimulating hormone*.

full-mouth Animal has all permanent teeth fully exposed.

full sibs Animals having the same sire and dam.

gallop A three-beat gait in which each of the two front feet and both of the hind feet strike the ground at different times.

gametes Male and female reproductive cells. The sperm and the egg.

gametogenesis The process by which sperm and eggs are produced.

gander Mature male goose.

gelding A male horse that has been castrated.

gene The fundamental physical and functional unit of heredity.

gene expression The process by which a gene's coded information is converted into the structures present and operating in the cell.

gene mapping Determination of the relative positions of genes on a DNA molecule (chromosome or plasmid) and of the distance, in linkage units or physical units, between them.

general combining ability The ability of individuals of one line or population to combine favorably or unfavorably with individuals of several other lines or populations.

generation interval Average age of the parents when offspring are born.

generation turnover Length of time from one generation of animals to the next generation.

genetic code The sequence of nucleotides, coded in triplets (codons) along the mRNA, that determines the sequence of amino acids in protein synthesis.

genetic engineering The technique of removing, modifying, or adding genes to a DNA molecule.

genome The sum total of a living organism's genetic material. The genome is divided into chromosomes, which contain genes, and genes are made of DNA.

genomics The study of genes and their function.

genotype The genetic constitution, or makeup, of an individual. For any pair of alleles, three genotypes (e.g., *AA*, *Aa*, and *aa*) are possible.

gestation The time from breeding or conception of a female until she gives birth to her young.

gilt A young female swine prior to the time that she has produced her first litter.

goiter Enlargement of the thyroid gland, usually caused by iodine-deficient diets.

gonad The testis of the male; the ovary of the female.

gonadotrophin Hormone that stimulates the gonads.

gossypol A toxic product contained in cottonseed.

grade (1) a designation of live or carcass merit (e.g., Choice grade); (2) livestock not registered with registry (e.g., breed) association.

grading up The continued use of purebred sires of the same breed in a grade herd or flock.

grass tetany A disease of cattle and sheep marked by staggering, convulsions, coma, and frequently death, caused by a mineral imbalance (magnesium) while grazing lush pasture.

grease wool Wool as it comes from the sheep and prior to cleaning. It contains the natural oils from the sheep.

gross energy The amount of heat, measured in calories, produced when a substance is completely oxidized. It does not reveal the amount of energy that an animal could derive from eating the substance.

growth The increase in protein over its loss in the animal body. Growth occurs by increases in cell numbers, cell size, or both.

habituation The gradual adaptation to a stimulus or to the environment.

half sib Animals having one common parent.

hand mating Same as hand breeding—bringing a female to a male for service (breeding), after which she is removed from the area where the male is located.

hank A measurement of the fineness of wool. A hank is 560 yards of yarn. More hanks of yarn are produced from fine wools than coarse wools.

haploid One-half of the diploid number of chromosomes for a given species, as found in the germ cells.

hatchability A term that indicates the percentage of a given number of eggs set from which viable young hatch, sometimes calculated specifically from the number of fertile eggs set.

hay Harvested forage such as alfalfa hay.

heat See *estrus*.

heat increment The increase in heat production after consumption of feed when an animal is in a thermoneutral environment. It includes additional heat generated in fermentation, digestion, and nutrient metabolism.

heaves A respiratory defect in horses during which the animal has difficulty completing the exhalation of inhaled air.

heifer A young female bovine cow before the time that she has produced her first calf.

heiferette A heifer that has calved once, after which the heifer is fed for slaughter; the calf has usually died or been weaned at an early age.

hemoglobin The iron-containing pigment of the red blood cells. It carries oxygen from the lungs to the tissues.

hen An adult female domestic fowl, such as a chicken or turkey.

herbivorous Subsisting or feeding on plants.

herd A group of animals. Used with beef, dairy, or swine.

heritability The portion of the total variation or phenotypic differences among animals that is due to heredity.

hernia The protrusion of some of the intestine through an opening in the body wall (also commonly called *rupture*). Two types of hernias, umbilical and scrotal, occur in farm animals.

heterosis Performance of offspring that is greater than the average of the parents. Usually the amount of superiority of the crossbred over the average of the parental breeds. Also referred to as *hybrid vigor*.

heterozygous A term designating an individual that possesses unlike genes for a particular trait.

hides Skins from animals such as cattle, horses, and pigs; beef hides weigh more than 30 lb each as contrasted to calf skins that weigh less.

hinny The offspring that results from crossing a stallion with a female donkey (jenny).

hobble To tie two of an animal's legs together. An animal is hobbled to prevent it from kicking or moving a long distance.

homeotherm A warm-blooded animal. An animal that maintains its characteristic body temperature even though environmental temperature varies.

homogenized Milk that has had the fat droplets broken into very small particles so that the milk fat stays in suspension in the milk fluids.

homologous Corresponding in type of structure and derived from a common primitive origin.

homologous chromosomes Chromosomes having the same size and shape that contain genes affecting the same characters. Homologous chromosomes occur in pairs in typical diploid cells.

homology Similarity in DNA or protein sequences between individuals of the same species or among different species.

homozygous A term designating an individual whose genes for a particular trait are alike.

hormone A chemical substance secreted by a ductless gland. Usually carried by the bloodstream to other places in the body where it has its specific effect on another organ.

hybrid vigor See *heterosis*.

hydrocephalus A condition characterized by an abnormal increase in the amount of cerebral fluid, accompanied by dilation of the cerebral ventricles.

hyperkalemic periodic paralysis (HYPP) An inherited muscle disorder characterized by muscle tremors, weakness and, in severe cases, collapse and death.

hypertension High blood pressure.

hypothalamus A portion of the brain found in the floor of the third ventricle. It regulates reproduction, hunger, and body temperature and has other functions.

hypoxia A condition resulting from deficient oxygenation of the blood.

ileum Distal portion of the small intestine.

immunity The ability of an animal to resist or overcome an infection.

impaction Obstructive lodging of food in the intestine.

implant To graft or insert material to intact tissues.

implantation The attachment of the fertilized egg to the uterine wall.

imprinting Learning associated with maturational readiness.

inbreeding The mating of individuals who are more closely related than the average individuals in a population. Inbreeding increases homozygosity in the population but it does not change gene frequency.

incisor A front tooth.

incubation period The time that elapses from the time an egg is placed into an incubator until the young is hatched.

independent culling level Selection method in which minimum acceptable phenotypic levels are assigned to several traits.

index (1) An overall merit rating of an animal. (2) A method of predicting the milk-producing ability that a bull will transmit to his daughters.

infection Invasion of the body tissues by microbial agents or parasites other than insects.

infectious Capable of invading and growing in living tissues. Used to describe various pathogenic microorganisms such as viruses, bacteria, protozoa, and fungi.

influenza A virus disease characterized by inflammation of the respiratory tract, high fever, and muscular pain.

ingest To eat or take anything into the stomach.

inheritance The transmission of genes from parents to offspring.

insemination Deposition of semen in the female reproductive tract.

instinct Inborn behavior.

insulin Hormone secreted by the pancreas to control blood sugar level and utilization of sugar in the body.

integration The bringing together of all segments of a livestock or poultry production program under one centrally organized unit.

intelligence The ability to learn to adjust successfully to situations.

interference The striking of the supporting leg by the foot of the striding leg by a horse in action.

interstitial cells The cells between the seminiferous tubules of the testicle that produce testosterone.

intravenous Within the vein. An intravenous injection is an injection into a vein.

in vitro Outside the living body; in a test tube or other artificial environment.

jack A male donkey.

jackass See *jack*.

jennet A female donkey.

jenny A female donkey.

Karakul A breed of fat-tailed sheep having coarse, wiry furlike hair. Used to produce Persian lambskins.

ked An external parasite that affects sheep. Although commonly called *sheep tick*, it is actually a wingless fly.

kemp Coarse, opaque, hairlike fibers in wool.

ketosis A condition (also called *acetoneemia*) that is characterized by a high concentration of ketone bodies in the body tissues and fluids.

kid Young goat.

kilocalorie (kcal, Kcal) An amount of heat equal to 1,000 calories. (See also *calorie*.)

kosher meat Meat from ruminant animals with split hooves where the animals have been slaughtered according to Jewish law.

lactalbumin A nutritive protein of milk.

lactation The secretion and production of milk.

lactose Milk sugar. When digested, it is broken down into one molecule of glucose and one of galactose.

lamb (1) A young male or female sheep, usually less than a year of age. (2) To deliver, or give birth to, a lamb.

lamb dysentery See *dysentery*.

lambling Act of giving birth. Same as parturition.

lambling jug A small pen in which a ewe is put for lambing. It is also used for containing the ewe and her lamb until the lamb is strong enough to run with other ewes and lambs.

laminitis Inflammation of the sensitive plates of soft tissue (laminae) within the horse's foot caused by physical or physiologic injury. Severe cases of laminitis may result in founder, an internal deformity of the foot. *Acute* laminitis sets in rapidly and usually responds to appropriate, intensive treatment, while *chronic* laminitis is a persistent, long-term condition that may be unresponsive to treatment.

lard The fat from pigs that has been produced through a rendering process.

layer A hen that is kept for egg production.

legume Any plant of the family *leguminosae*, such as pea, bean, alfalfa, and clover.

leucocytes White blood cells.

LH See *luteinizing hormone*.

libido Sex drive or the desire to mate on the part of the male.

lice Small, flat, wingless insect with sucking mouth parts that is parasitic on the skin of animals.

linebreeding A mild form of inbreeding that maintains a high genetic relationship to an outstanding ancestor.

line crossing The crossing of inbred lines.

linkage The proximity of two or more markers on a chromosome. The closer together the markers are, the lower the probability that they will be separated during DNA repair or replication processes and hence the greater the probability that they will be inherited together.

linkage map A map of the relative positions of genetic loci on a chromosome, determined on the basis of how often the loci are inherited together. Distance is measured in centimorgans.

lipid An organic substance that is soluble in alcohol or ether but insoluble in water; used interchangeably with the term *fat*.

litter The young produced by multiparous females such as swine. The young in a litter are called *littermates*.

liver flukes A parasitic flatworm found in the liver.

locus The place on a chromosome where a gene is located.

longevity Life span of an animal. Usually refers to a long life span.

luteinizing hormone (LH) A protein hormone, produced and released by the anterior pituitary, which stimulates the

formation and retention of the corpus luteum. It also initiates ovulation.

lymph Transparent, nutritive yellow liquid that exudes from blood vessels into tissue spaces and is drained back into the veins through lymph vessels. Lymph plays an important role in fighting infection and maintaining the body's fluid balance.

macroclimate The large, general climate in which an animal exists.

macromineral A mineral that is needed in the diet in relatively large amounts.

maintenance A condition in which the body is maintained without an increase or decrease in body weight and with no production or work being done.

mammal Warm-blooded animals that suckle their young.

mammary gland Gland in female mammals that secretes milk.

management The act, art, or manner of managing, handling, controlling, or directing a resource or integrating several resources.

marbling The distribution of fat in muscular tissue; intramuscular fat.

mare A sexually developed female horse.

marker An identifiable physical location on a chromosome whose inheritance can be monitored. Markers can be expressed regions of DNA (genes) or some segment of DNA with no known coding function but whose pattern of inheritance can be determined.

market class Animals grouped according to the use to which they will be put, such as slaughter, feeder, or stocker.

market grade Animals grouped within a market class according to their value.

masticate To chew food.

mastitis Inflammation of the mammary gland.

mean (1) Statistical term for average. (2) Term used to describe animals having bad behavior.

meat The tissues of the animal body that are used for food.

meat spots Spots in the egg that are blood spots that have changed color or tissue sloughed off from the reproductive organs of the hen.

meiosis A special type of cell nuclear division that is undergone in the production of gametes (sperm in the male, ova in the female). As a result of meiosis, each gamete carries half the number of chromosomes of a typical body cell in that species.

melengestrol acetate (MGA) A feed additive that suppresses estrus in heifers and is widely used in the feedlot industry.

mesoderm The middle layer of the three layers of the primitive embryo.

messenger RNA (mRNA) RNA that serves as a template for protein synthesis.

metabolism (1) The sum total of chemical changes in the body, including the “building up” and “breaking down” processes. (2) The transformation by which energy is made available for body uses.

metabolizable energy Gross energy in the feed minus the sum of energy in feces, gaseous products of digestion, and energy in urine. Energy that is available for metabolism by the body.

metritis Inflammation (infection) of the uterus.

MGA See *melengestrol acetate*.

microclimate A small, special climate within a macroclimate created by the use of such devices as shelters, heat lamps, and bedding.

microcomputer A small computer that has a smaller memory capacity than a larger or mainframe computer.

micromineral A mineral that is needed in the diet in relatively small amounts. The quantity needed is so small that such a mineral is often called a *trace mineral*.

milk EPD A genetic estimate of the milking ability of a beef bull's daughters when compared to the daughters of other bulls.

milk fat The fat in milk; synonymous with butterfat.

milk fever See *parturient paresis*.

milk letdown The release of milk into the teat cisterns.

Milk Only records Dairy record system similar to DHI except no milk fat samples are taken.

minimum culling level A selection method in which an animal must meet minimum standards for each trait desired in order to qualify for being retained for breeding purposes.

mites Very small arachnids that are often parasitic on animals.

mitosis A process in which a cell divides to produce two daughter cells, each of which contains the same chromosome complement as the mother cell from which they came.

modifying genes Genes that modify the expression of other genes.

mohair Fleece of the Angora goat.

monogastric Having only one stomach or only one compartment in the stomach. Examples are swine and poultry.

monoparous A term designating animals that usually produce only one offspring at each pregnancy. Horses and cattle are monoparous.

monotocous Producing a single offspring at a birth.

moon blindness Periodic blindness that occurs in horses.

morbidity Measurement of illness; morbidity rate is the number of individuals in a group that become ill during a specified time.

mortality rate Number of individuals that die from a disease during a specified time, usually one year.

mouth-brooder Fish that hold eggs or newly hatched young in their mouths.

mouthed The examination of an animal's teeth.

mule The hybrid that is produced by mating a male donkey with a female horse. They are usually sterile.

mulefoot Having one instead of the expected two toes, on one or more of the feet.

multiparous Having had two or more pregnancies that resulted in viable fetuses.

mutation A change in a gene.

mutton The meat from a sheep that is over one year old.

muzzle The nose of horse, cattle, or sheep.

myofibrils The primary component part of muscle fibers.

navel The area where the umbilical cord was formerly attached to the body of the offspring.

necropsy Perform a postmortem examination.

net energy Metabolizable energy minus heat increments. The energy available to the animal for maintenance and production.

nickings The way in which certain lines, strains, or breeds perform when mated together. When outstanding offspring result, the parents are said to have *nicked* well.

nipple See *teat*.

nodular worm An internal parasitic worm that causes the formation of nodules in the intestines.

nonruminant Simple-stomached or monogastric animal.

NPN (nonprotein nitrogen) Nitrogen in feeds from substances such as urea and amino acids, but not from preformed proteins.

nucleotide The subunit of DNA composed of a five carbon sugar, a nitrogenous base, and a phosphate group.

nutrient (1) A substance that nourishes the metabolic processes of the body. (2) The end product of digestion.

nutrient density Amount of essential nutrients relative to the number of calories in a given amount of food.

obesity An excessive accumulation of body fat.

offal All organs and tissues removed from inside the animal during the slaughtering process.

omasum One of the stomach components of ruminant animals that has many folds.

omnivorous Feeding on both animal and vegetable substances.

oogenesis The process by which eggs, or ova, are produced.

open Refers to nonpregnant females.

open-faced Face of sheep that is free from wool, particularly around the eyes.

opportunity costs Returns given up if debt-free resources (e.g., land, livestock, equipment) are used in their next-best level of employment.

optimum level of performance The level at which a trait or traits maximizes net profit. Resources are managed to achieve a combined balance of traits that sustains high levels of profitability.

osteopetrosis Abnormal thickening, hardening, and fragility of bones, making them weaker.

osteoporosis An abnormal decrease in bone mass with an increased fragility of the bones.

outbreeding The process of continuously mating females of the herd to unrelated males of the same breed.

outcrossing The mating of an individual to another in the same breed that is not related to it. Outcrossing is a specific type of outbreeding system.

ova Plural of ovum, meaning *eggs*.

ovary The female reproductive gland in which the eggs are formed and progesterone and estrogenic hormones are produced.

overeating disease A toxic condition caused by the presence of undigested carbohydrates in the intestine, which stimulates harmful bacteria to multiply. When the bacteria die, they release toxins. Called *enterotoxemia* in some animals.

overshot jaw Upper jaw is longer than lower jaw. Also called *parrot mouth*.

oviduct A duct leading from the ovary to the horn of the uterus.

ovine Refers to sheep.

ovulation The shedding, or release, of the egg from the follicle of the ovary.

ovum The egg produced by a female.

Owner-sampler record Dairy record system similar to DHI except milk weights and samples are taken by the dairy producer instead of a DHIA supervisor.

pace A lateral two-beat gait in which the right rear and front feet hit the ground at one time and the left rear and front feet strike the ground at another time.

paddling The outward swinging of the front feet of a horse that toes in.

pale, soft, exudative (PSE) A genetically predisposed condition in swine in which the pork is very light colored, soft, and watery.

palpation Feeling by hand.

parasite An organism that lives a part of its life cycle in or on, and at the expense of, another organism. Parasites of farm animals live at the expense of the farm animals.

parity Number of different times a female has had offspring.

parrot mouth Upper jaw is longer than lower jaw.

parturient paresis Partial paralysis that occurs at or near time of giving birth to young and beginning lactation. The mother mobilizes large amounts of calcium to produce milk to feed newborn, and blood calcium levels drop below the point necessary for impulse transmission along the nerve tracks. Commonly called *milk fever*.

parturition The process of giving birth.

pasteurization The process of heating milk to 161°F and holding it at that temperature for 15 seconds to destroy pathogenic microorganisms.

pasture rotation The rotation of animals from one pasture to another so that some pasture areas have no livestock on them in certain periods.

pathogen Biologic agent (e.g., bacteria, virus, protozoa, nematode) that may produce disease or illness.

paunch Another name for *rumen*.

pay weight The actual weight for which payment is made. In many cases it is the shrunk weight (actual weight minus pencil shrink).

pedigree The record of the ancestry of an animal.

pelt The natural, whole skin covering, including the wool, hair, or fur (e.g., a sheep pelt has the wool left on).

pencil shrink An arithmetic deduction (percent of liveweight) from an animal's weight to account for fill.

pendulous Hanging loosely.

penis The male organ of copulation. It serves both as a channel for passage of urine from the bladder as an extension of the urethra, and as a copulatory organ through which sperm are deposited into the female reproductive tract.

per capita Per person.

performance test The evaluation of an animal according to its performance.

pernicious anemia A chronic type of microcytic anemia caused by a deficiency of vitamin B₁₂ or a failure of intestinal absorption of vitamin B₁₂.

pharmaceuticals Medicinal products (drugs) used primarily to treat disease.

phenotype The characteristics of an animal that can be seen and/or measured (e.g., the presence or absence of horns, the color, or the weight of an animal).

pheromones Chemical substances that attract the opposite sex.

photoperiod Time period when light is present.

physiology The science that pertains to the functions of organs, organ systems, or the entire animal.

picking The removal of feathers in dressing poultry.

pigeon-toed See *toeing-in*.

pin bones In cattle, the posterior ends of the pelvic bones that appear as two raised areas on either side of the tail head.

pink tooth Congenital porphyria, teeth are pink gray and the animals tend to sunburn easily.

pinworms A small nematode worm with unsegmented body found as a parasite in the rectum and large intestine of animals.

pituitary Small endocrine gland located at the base of the brain.

placenta The vascular organ that unites the fetus to the uterus.

pneumonia Inflammation or infection of alveoli of the lungs caused by either bacteria or viruses.

poikilotherm A cold-blooded animal; one whose body temperature varies with that of the environment.

polled Naturally or genetically hornless.

poll evil An abscess behind the ears of a horse.

Polypay A synthetic breed of sheep developed in the United States by combining the Dorset, Targhee, Rambouillet, and Finnsheep breeds.

polytocous Giving birth to several offspring at one time.

porcine stress syndrome A genetic defect in swine inherited as a simple recessive. It is associated with heavily muscled animals that may suddenly die when exposed to stressful conditions. Their muscle is usually pale, soft, and exudative (PSE).

pork The meat from swine.

posterior Toward the rear end of an animal.

postgastric fermentation The fermentation of feed that occurs in the cecum, behind the area where digestion has occurred.

postnatal See *postpartum*.

postpartum After birth.

postpartum interval The length of time from parturition until the dam is pregnant again.

poult A young turkey of either sex, from hatching to approximately 10 weeks of age.

poultry This term includes chickens, turkeys, geese, pigeons, peafowls, guineas, and game birds.

predicted difference Dairy bull record based on superiority or inferiority of the bull's daughters compared to their herd mates.

predicted transmitting ability (PTA) Estimate of genetic transmitting ability (i.e., one-half of the breeding value) of dairy bulls. Estimated amount by which daughters of a bull will differ from the breed average.

pregastric fermentation Fermentation that occurs in the rumen of ruminant animals. It occurs before feed passes into the portion of the digestive tract in which digestion actually occurs.

pregnancy disease A metabolic disease in late pregnancy affecting primarily ewes carrying twins or triplets. A form of ketosis. Also called *pregnancy toxemia*.

pregnancy testing Evaluation of females for pregnancy through palpation or using an ultrasound machine.

premix A uniform mixture of one or more micro-ingredients with diluent and/or carrier. Premixes are used to facilitate uniform dispersion of the micro-ingredients in a large mix.

prenatal Prior to being born; before birth.

primiparous Bearing or having borne but one offspring.

probe A device used to measure backfat thickness in pigs and cattle.

production testing An evaluation of an animal based on its production record.

progeny testing An evaluation of an animal on the basis of performance of its offspring.

progesterone A hormone produced by the corpus luteum that stimulates progestational proliferation in the uterus of the female.

prokaryote Cell or organism lacking a membrane-bound, structurally discrete nucleus and other subcellular compartments. Bacteria are prokaryotes.

prolapsed Turned inside out.

prostaglandins Chemical mediators that control many physiological and biochemical functions in the body. One prostaglandin (PGF_{2α}) can be used to synchronize estrus.

prostate A gland of the male reproductive tract that is located just back of the bladder. It secretes a fluid that becomes part of semen at ejaculation.

protein A large molecule composed of one or more chains of amino acids in a specific order; the order is determined by the base sequence of nucleotides in the gene coding for the protein.

protein supplement Any dietary component containing a high concentration (at least 25%) of protein.

proximal Nearest. The position that is closest to the point of attachment for a limb or bone.

PSE See *pale, soft, and exudative*.

PSS See *porcine stress syndrome*.

PTA See *predicted transmitting ability*.

puberty The age at which the reproductive organs become functionally operative.

pullet Young female chicken from day of hatch through onset of egg production; sometimes the term is used through the first laying year.

purebred An animal eligible for registry with a recognized breed association.

qualitative trait A trait expressed categorically because of a sharp distinction between phenotypes (e.g., black and red). Usually only one or a few pairs of genes are involved in the expression of a qualitative trait.

quality grades Animals grouped according to value as Prime, Choice, etc., based on conformation and fatness of the animals.

quantitative trait A trait expressed on a continuous/numerical scale because of a gradual variation from one phenotype to another (e.g., weaning weight). Usually many gene pairs and environmental influences are involved in the expression of such traits.

rack (1) A rapid four-beat gait of a horse. (2) A wholesale cut of lamb located between the shoulder and loin.

ram A male sheep that is sexually mature.

ration The amount of total feed fed to an animal over a 24-hour period.

reach See *selection differential*.

realized heritability The portion obtained of what is reached for in selection.

realizer A feeder animal (usually cattle) that has serious health problems or injury. Economics dictate the animal be sold rather than continue the duration of the feeding program.

reasoning The ability of an animal to respond correctly to a stimulus the first time the animal encounters a new situation.

recessive gene A gene that has its phenotype masked by its dominant allele when the two genes are present together in an individual.

reciprocal recurrent selection The selection of breeding animals in two populations based on the performance of their offspring after animals from two populations are crossed.

recombinant DNA (rDNA) Isolated DNA molecules that can be inserted into the DNA of another cell. rDNA is used in the genetic-engineering process.

rectal prolapse Protrusion of part of large intestine through the anus.

recurrent selection Selection for general combining ability by selecting males that sire outstanding offspring when mated to females from varying genetic backgrounds.

red meat Meat from cattle, sheep, swine, and goats, as contrasted to the white meat of poultry.

registered Recorded in the herdbook of a breed.

regurgitate To cast up digested food to the mouth as is done by ruminants.

reinforcement A reward for making the proper response to a stimulus or condition.

replicate To duplicate, or make another exactly like, the original.

reproduction The production of live, normal offspring.

retained placenta Placenta remains within the reproductive tract after parturition has occurred.

reticulum One of the stomach components of ruminant animals that is lined with small compartments, giving a honeycomb appearance.

rhinitis Inflammation of the mucous membranes lining the nasal passages.

rhinopneumonitis Equine herpesvirus, type 1. It produces acute catarrh upon primary infection.

ribonucleic acid (RNA) An essential component of living cells, composed of long chains of phosphate, ribose sugar, and several bases.

rickets A bone ossification disease caused by a lack of vitamin D or unbalanced calcium:phosphorus ratio.

ridgling Another term for cryptorchid.

ringbone Osteoarthritis of the pastern joint of a horse, causing swelling and lameness.

riparian An area next to water (stream, river, or lake) where more vegetation grows compared to a greater distance from the water source because of the added moisture from the water. Grazing animals usually inhabit this area more frequently than others, thus increasing the possibility of overgrazing.

RNA (ribonucleic acid) A chemical found in the nucleus and cytoplasm of cells. RNA plays an important role in protein synthesis and other chemical activities of the cell.

roman nose A nose having a prominent bridge (e.g., a roman-nosed horse).

roughage A feed that is high in fiber, low in digestible nutrients, and low in energy. Such feeds as hay, straw, silage, and pasture are examples.

rumen The large fermentation pouch of the ruminant animal in which bacteria and protozoa break down fibrous plant material that is swallowed by the animal, sometimes referred to as the *paunch*.

ruminant A mammal whose stomach has four parts (rumen, reticulum, omasum, and abomasum). Cattle, sheep, goats, deer, and elk are ruminants.

rumination The regurgitation of undigested food and chewing it a second time, after which it is again swallowed.

sac-fry Fish with an external yolk sac.

salmonella Gram-positive, rod-shaped bacteria that cause various diseases such as food poisoning in animals.

scale (1) Size. (2) Equipment on which an animal is weighed.

scoured wool Wool that has been cleaned of grease and other foreign material.

scours Diarrhea; a profuse watery discharge from the intestines.

screwworms Larvae of several American flies that infest wounds of animals.

scrotal circumference A measurement (usually cm or in.) of the circumference of both testicles and the scrotal sac that surrounds them.

scrotum A pouch that contains the testes. It is also a thermoregulatory organ that contracts when cold and relaxes when warm, thus tending to keep the testes at a lower temperature than that of the body.

scurs Small growths of hornlike tissue attached to the skin of polled or dehorned animals.

scurvy A deficiency disease in humans that causes spongy gums and loose teeth. It is caused by a lack of vitamin C (ascorbic acid).

seedstock Breeding animals; sometimes used interchangeably with *purebred*.

selection Differentially reproducing what one wants in a herd or flock.

selection differential The difference between the average for a trait in selected animals and the average of the group from which they come; also called *reach*.

selection index Selection method in which several traits are evaluated and expressed as one total score.

semen The fluid containing the sperm that is ejaculated by the male. Secretions from the seminal vesicles, the prostate gland, the bulbourethral glands, and the urethral glands provide most of the fluid.

seminal vesicles Accessory sex glands of the male that provide a portion of the fluid of semen.

seminiferous tubules Minute tubules in the testicles in which sperm are produced. They comprise about 90% of the mass of the testes.

service To breed or mate.

settle To become pregnant.

sex-limited Existing in only one sex, such as milk production in dairy cattle.

shearing The process of removing the fleece (wool) from a sheep.

sheath rot Inflammation of the prepuce in male sheep.

sheep bot Any of a number of related flies whose larvae are parasitic in sheep. They usually are found in the sinuses.

shipping fever A widespread respiratory disease of cattle and sheep.

shoat A young pig of either sex.

shoe boil Blemish of the horse caused by the horseshoe putting pressure on the elbow when the horse lies down.

shrink Loss of weight—commonly used in the loss in live weight when animals are marketed or loss in weight from grease wool to clean wool.

sib A brother or sister.

sickle hocks Hocks that have too much set, causing the hind feet to be too far forward and too far under the animal.

side bones Ossification of the lateral cartilages of the foot of a horse.

sigmoid flexure The S-curve in the penis of boars, rams, bucks, and bulls.

silage Forage, corn fodder, or sorghum preserved by fermentation that produces acids similar to the acids that are used to make pickled foods for people.

sire Male parent.

Sire Index A dairy bull test record obtained by comparing a bull's daughters with their contemporary herd mates.

skins Skins come from smaller animals such as pigs, sheep, goats, and wild animals. A beef hide weighing less than 30 lb is called a skin.

sleeping sickness An infectious disease common in tropical Africa and transmitted by the bite of a tsetse fly.

slotted floor Floor having any kind of openings through which excreta may fall.

SNF See *solids-not-fat*.

snood The relatively long, fleshy extension at the base of the turkey's beak.

software Program instructions to make computer hardware function.

solids-non-fat Total milk solids minus fat. It includes protein, lactose, and minerals.

somatotropin The growth hormone from the anterior pituitary that stimulates nitrogen retention and growth.

soremouth A virus-caused disease affecting primarily lambs.

sow A female swine that has farrowed one litter or has reached 12 months of age.

spawn Act of fish laying eggs.

spay To remove the ovaries.

specific combining ability The ability of a line or population to exhibit superiority or inferiority when combined with other lines or populations.

spermatid The haploid germ cell prior to spermiogenesis.

spermatogenesis The process by which spermatozoa are formed.

spermiogenesis The process by which the spermatid loses most of its cytoplasm and develops a tail to become a mature sperm.

spider syndrome A recessive genetic abnormality common to black-faced sheep. The front legs are usually bent out from the knees and the hind legs typically show some deformities.

spinning count The number of hanks of yarn that can be spun from a pound of clean wool. One method of evaluating fineness of wool.

splay-footed See *toeing-out*.

spool joint The joint where the foot and pastern are removed from the front leg. Used to identify a mutton carcass.

spur A sharp projection on the back of a male bird's shank.

stags Castrated male sheep, cattle, goats, or swine that have reached sexual maturity prior to castration.

stallion A sexually mature male horse.

staple length Length of wool fibers.

steer A castrated bovine male that was castrated early in life before puberty.

sterility Inability to produce offspring.

steroid Artificially produced drug similar to the natural hormone that controls inflammation and regulates water balance.

stifle Joint of the hind leg between the femur and tibia.

stifled Injury of the stifle joint.

stillborn Offspring born dead.

stocker (cattle) Weaned cattle that are fed high-roughage diets (including grazing) before going into the feedlot.

stocker (fish) Usually 6–12 inches in length and less than .75 pounds.

stomach worms *Haemonchus contortus*, or worms of the stomach of cattle, swine, sheep, and goats.

strangles An infectious disease of horses, characterized by inflammation of the mucous membranes of the respiratory tract.

streptococcus Spherical, gram-positive bacteria that divide in only one plane and occur in chains. Some species cause serious disease.

stress An unusual or abnormal influence causing a change in an animal's function, structure, or behavior.

stringhalt A sudden and extreme flexion of the back of a horse, producing a jerking motion of the hindleg in walking.

strongyles Any of various roundworms living as parasites, especially in domestic animals.

stud Usually the same as stallion. Also a place where male animals are maintained (i.e., bull stud).

suckling gain The gain that a young animal makes from birth until it is weaned.

subcutaneous Situated beneath, or occurring beneath, the skin. A subcutaneous injection is an injection made under the skin.

sulfonamides A sulfa drug capable of killing bacteria.

superovulation The hormonally induced ovulation of a greater than normal number of eggs.

supplement A feed used with another to improve the nutritive balance of performance of the total and intended to be (1) fed undiluted as a supplement to other feeds, (2) offered free-choice with other parts of the ration separately available, or (3) further diluted and mixed to produce a complete feed.

sweeney Atrophy of muscle (typically shoulder) in horses.

sweetbread An edible by-product also known as the pancreas.

switch The tuft of long hair at the end of tail (cattle and horses).

syndactyly Union of two or more digits (e.g., in cattle, the two toes would be a solid hoof).

synthetic breeds See *composite breed*.

tagging Clipping wool from the dock, udder, and vulva regions of the ewe prior to breeding and lambing.

tags (1) Wool covered with manure. (2) Abbreviated form of ear tags, used for identification.

tallow The fat of cattle and sheep.

tandem selection Selection for one trait for a given period of time followed by selection for a second trait and continuing in this way until all important traits are selected.

TDN Total digestible nutrients; includes the total amounts of digestible protein, nitrogen-free extract, fiber, and fat (multiplied by 2.25), all summed together.

teaser ram A ram made incapable of impregnating a ewe by vasectomy or by use of an apron to prevent copulation, which is used to find ewes in heat.

teasing The stallion in the presence of the mare to see if she will mate.

teat The protuberance of the udder through which milk is drawn.

tendon Tough, fibrous connective tissue at ends of muscle bundles that attach muscle to bones or cartilage structures.

terminal sire The sire used in a terminal crossbreeding program. It is intended that all offspring from a terminal sire be sold as market animals.

testicle The male sex gland that produces sperm and testosterone.

testosterone The male sex hormone that stimulates the accessory sex glands, causes the male sex drive, and causes the development of masculine characteristics.

tetanus Rigid paralytic disease caused by *Clostridium tetani*, an anaerobic bacterium that lives in soil and feces.

tetrad A group of four similar chromatids formed by the splitting longitudinally of a pair of homologous chromosomes during meiotic prophase.

thermoneutral zone (TNZ) Range in temperature where rate and efficiency of gain is maximized. Comfort zone.

thoroughpin A hard swelling that is located between the Achilles tendon and the bone of the hock joint.

thrush Foot disease characterized by degeneration of the frog and a thick, foul-smelling discharge.

thyroid gland Two-lobed endocrine gland in the neck that controls the rate at which basic body functions proceed.

toeing-in Toes of front feet turn in. Also called *pigeon-toed*.

toeing-out Toes of front feet turn out. Also called *splayfooted*.

tom A male turkey.

TPI Total prediction index used in dairy cattle breeding. It includes the predicted differences for milk production, fat percentage, and type into one figure in a ratio of milk production \times 3:fat percentage \times 1:type \times 1.

transcription The synthesis of RNA from DNA in the nucleus by matching the sequences of the bases.

transgenic animals Animals that contain genes transferred from other animals, usually from a different species.

transmissible gastroenteritis (TGE) A serious, contagious diarrhea disease in baby pigs.

tripe Edible product from the walls of ruminant stomachs.

trot A diagonal two-beat gait in which the right front and left rear feet strike the ground in unison, and the left front and right rear feet strike the ground in unison.

twist Vertical measurement from top of the rump to point where hindlegs separate.

twitch To squeeze tightly the upper lip of a horse by means of a small rope that is twisted.

type (1) The physical conformation of an animal. (2) All those physical attributes that contribute to the value of an animal for a specific purpose.

Udder A baglike organ containing the mammary glands, characteristic of female mammals, such as cows, ewes, does, sows, and mares.

umbilical cord A flexible cordlike structure containing blood vessels that attaches a mammalian fetus to the placenta during gestation.

undershot jaw Lower jaw is longer than upper jaw.

unsoundness Any defect or injury that interferes with the usefulness of an animal.

urinary calculi Disease where mineral deposits crystallize in the urinary tract. The deposits may block the tract, causing difficulty in urination.

uterus That portion of the female reproductive tract where the young develop during pregnancy.

vaccination The act of administering a vaccine or antigens.

vaccine Suspension of attenuated or killed microbes or toxins administered to induce active immunity.

vagina The copulatory portion of the female's reproductive tract. The vestibule portion of the vagina also serves for passage of urine during urination. The vagina also serves as a canal through which young pass when born.

variety meats Edible organ by-products (e.g., liver, heart, tongue, tripe).

vas deferens Ducts that carry sperm from the epididymis to the urethra.

vasectomy The removal of a portion of the vas deferens. As a result, sperm are prevented from traveling from the testicles to become part of the semen.

veal The meat from very young cattle, under three months of age.

vein Vessel through which blood passes from various organs or parts back to the heart.

vermifuge A chemical substance given to the animals to kill internal parasitic worms.

VFA See *volatile fatty acids*.

villi Projections of the inner lining of the small intestine.

virus Ultramicroscopic bundle of genetic material capable of multiplying only in living cells. Viruses cause a wide range of diseases in plants, animals, and humans, such as rabies and measles.

viscera Internal organs and glands contained in the thoracic and abdominal cavities.

vitamin An organic catalyst, or component thereof, that facilitates specific and necessary functions.

volatile fatty acids (VFA) A group of fatty acids produced from microbial action in the rumen; examples are acetic, propionic, and butyric acids.

vulva The external genitalia of a female mammal.

walk A four-beat gait of a horse in which each foot strikes the ground at a time different from each of the other three feet.

warble The larval stage of the heel fly that burrows out through the hide of cattle in springtime.

wattle Method of identification in cattle where strips of skin (3–6 inches) long are usually cut on the nose, jaw, throat, or brisket.

weaner An animal that has been weaned or is nearing weaning age.

weaning Separating young animals from their dams so that the offspring can no longer suckle.

weaning weight EPD A genetic estimate of the weaning weight of a beef bull's calves when compared to other bulls in the sire summary.

weanling An animal of weaning age.

wet Used to describe a milking female (e.g., wet cow or wet ewe).

GLOSSARY

wether A male sheep castrated before reaching puberty.

white cells (leukocytes, white blood cells) Colorless blood cells active in the body's defense against infection or other assault. There are five types: neutrophils, lymphocytes, eosinophils, monocytes, and basophils.

white muscle disease A muscular disease caused by a deficiency of selenium or vitamin E.

winking Indication of estrus in the mare where the vulva opens and closes.

withdrawal time The time before slaughter that a drug should not be given to an animal.

withers Top of the shoulders.

wool The fibers that grow from the skin of sheep.

wool blindness Sheep cannot see, owing to wool covering their eyes.

wool top A continuous untwisted strand of combed wool in which the fibers lie parallel and the short fibers have been combed out.

woolens Cloth made from short wool fibers that are intermingled in the making of the cloth by carding.

worsted Cloth made from wool that is long enough to comb and spin into yarn. The finish of worsteds is harder than woolens, and worsted clothes hold a press better.

yearling Animals that are approximately one year old.

yearling weight Expected Progeny Difference (EPD) A breeding value that measures genetic differences in yearling weight in beef cattle.

yield Used interchangeably with *dressing percentage*.

yield grades The grouping of animals according to the estimated trimmed lean meat that their carcass would provide; cutability.

yolk (1) The yellow part of the egg. (2) The natural grease (lanolin) of wool.

yolk sac Layer of tissue encompassing the yolk of an egg.

zone of thermoneutrality The environmental temperature (about 65°F) at which heat production and heat elimination are approximately equal for most farm animals.

zygote (1) The cell formed by the union of two gametes. (2) An individual from the time of fertilization until death.

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Animal Contributions to Human Needs

Humans domesticated animals some 6,000–10,000 years ago and, thus, began a fascinating relationship that has evolved over the centuries to provide food, shelter, power, clothing, fuel, and companionship. In many ways the history of civilization is told in the application of human creativity to the task of feeding, clothing, and raising the standard of living for the world's various societies via animal agriculture.

Wide differences have developed among people in various regions of the world in using agricultural technology, management practices, and production and distribution systems to improve their standard of living. But, in all countries, domestic livestock are a source of food, clothing, by-products used for consumer goods and animal feeds, draft power, manure for fuel and fertilizer, information from research using experimental animals, sport and recreation, and pleasure for those who keep animals. Table 1 outlines the major domesticated livestock species, their approximate numbers, and their primary uses. Chickens are the most numerous (18.4 billion), followed by cattle (1.35 billion), ducks (1.11 billion), sheep (1.08 billion), and swine (941 million).

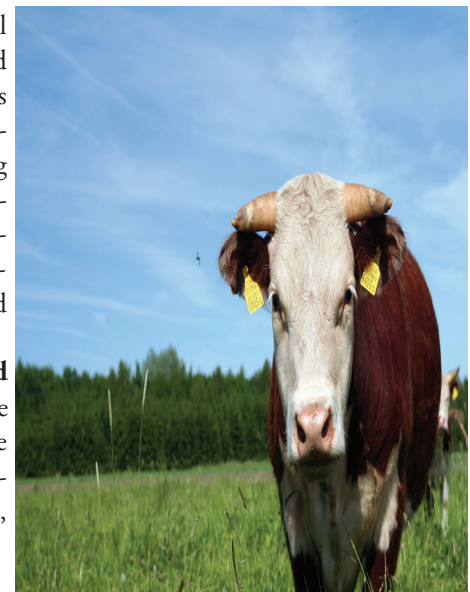
CONTRIBUTIONS TO FOOD NEEDS

When opportunity exists, most humans consume both plant and animal products (Fig. 1). Meat and dairy products are nearly always consumed in quantity when available. Animal protein availability in most countries is closely related to the economic status of the people and their agricultural technology. 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 2. Animal products constitute approximately 16% of the calories, 37% of the protein, and 45% of the fat in the total world food supply. Large differences exist between developed countries and developing countries in total daily supply of calories, protein, and fat.

learning objectives

- Describe the global distribution of livestock
- Quantify the role of animal products in the global food supply
- Evaluate differences in food production and agricultural productivity between developed and developing nations
- Compare food expenditures for at-home and away-from-home consumption in the United States
- Compare food consumption across diverse nations and cultures
- Describe changes in the U.S. agricultural productivity
- Describe the nonfood contributions of livestock



Mats Tooming - Fotolia

Table 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	1,347	India (175), Brazil (175), United States (96), China (83), Argentina (51)	Meat, milk, hides
Sheep	1,078	China (136), Australia (79), India (65), Iran (54), United States (6)	Wool, meat, milk, hides
Goats	862	China (149), India (126), Afghanistan (64), Pakistan (57), Bangladesh (56), United States (3)	Milk, meat, hair, hides
Buffalo	185	India (98), Pakistan (29), China (23)	Draft, milk, meat, hides
Camels	25	Sudan (3), Ethiopia (2), Mauritania (2), Niger (2), Pakistan (1), Mali (1)	Packing, transport, draft, meat, milk, hides
Nonruminants			
Chickens	18,398	China (4,602), United States (2,059), Indonesia (1,483), Brazil (1,200)	Meat, eggs, feathers
Swine	941	China (446), United States (66), EU (156), Russian Fed. (16)	Meat
Turkeys	482	United States (271), France (25), Italy (25), Chile (28)	Meat, eggs, feathers
Ducks	1,108	China (761), Vietnam (68), Indonesia (37), India (35), United States (7)	Meat, eggs, feathers
Horses	59	United States (9), China (7), Mexico (6), Brazil (6), Argentina (4)	Draft, riding, sport, occasionally meat
Donkeys	43	China (7), Ethiopia (5), Pakistan (4), Mexico (3), Egypt (3)	Draft, transport
Mules	11	China (3), Mexico (3), Brazil (1)	Draft, transport

^aU.S. numbers are given for comparison; may not always be among the leading countries.

Source: Adapted from USDA and FAO.

Figure 1

Animal food products such as meat, milk, and eggs are preferred foods in countries with high standards of living.

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Table 2
ANIMAL PRODUCT CONTRIBUTION TO PER-CAPITA CALORIE, PROTEIN, AND FAT SUPPLY

Country	Total Kilo Calories	Animal Products		Total Protein (g/day)	Animal Products		Total Fat	Animal Products	
		Kilo Cal	%		g/Day	%		g/Day	%
Australia	3,176	1,049	33	107	71	66	138	72	52
Bangladesh	2,103	67	3	45	6	13	22	4	18
Brazil	2,985	615	21	80	41	51	89	42	47
China	3,029	583	19	85	30	35	84	49	58
Egypt	3,346	256	8	93	18	19	60	18	30
Germany	3,451	1,035	30	95	57	60	152	82	54
India	2,428	194	8	57	10	17	48	13	27
Japan	2,762	569	21	92	51	55	83	35	42
Kenya	1,965	234	12	50	15	30	47	15	32
Mexico	3,165	583	18	88	38	43	89	4	46
Nigeria	2,850	87	3	65	8	12	68	6	7
United Kingdom	3,334	1,002	30	98	55	56	145	77	53
United States	3,772	1,043	27	114	73	64	151	71	47
Developed	3,260	857	26	99	55	55	119	62	52
Developing	2,679	348	13	69	22	29	63	26	41
World Average	2,805	459	16	76	28	37	75	34	45

Source: Adapted from USDA, FAO.

For example, consumers in developed nations derive 26% of their calories from animal products with just over one-half of their total protein and fat supply from animal products. Consumers in developing nations derive 13% of their calorie supply, 29% of their protein, and 41% of their fat from animal products. The United States ranks higher than the world average for percent of calories and protein from animal sources but about average for percent of fat from animal products.

Changes in per-capita calorie supply and protein supply during the past 40 years are shown in Figure 2. Per-capita caloric supplies of both calories and protein 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.

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. Comparing Table 3 with Table 2, note that the countries in Table 3 are listed by percentage of population involved in agriculture.

Agriculture **mechanization** (Fig. 3) (note tractor numbers in Table 3) has been largely responsible for increased food production and allowing people to turn their attention to professions other than production agriculture. This facilitates the provision of many goods and services, raises standards of living, and allows for the creation of more diverse economies. Note that 50% of the people in developing nations once engaged in agriculture while only 7% of the citizens in developed countries are active in the agricultural sector.

The tremendous increase in the productivity of U.S. agriculture (Table 4) has lowered the relative cost of food as vividly demonstrated in Table 5. Historical data show that agricultural productivity doubled in the 100-year span of 1820–1920. For example, at the turn of the century a team of horses, one handler, and a moldboard

ANIMAL CONTRIBUTIONS TO HUMAN NEEDS

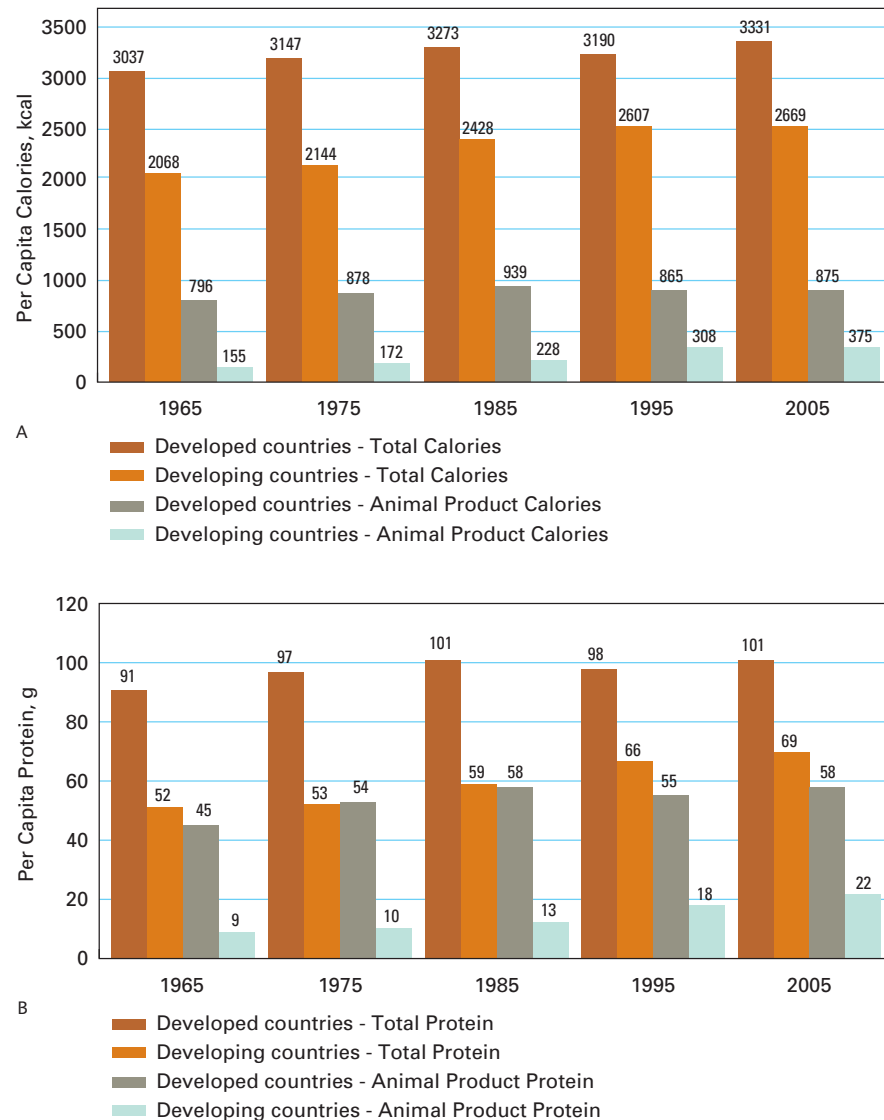


Figure 2

Caloric and protein intake from animal products. Adapted from USDA.

plow could plow two acres per day. Today, one tractor pulling three plows, each with five moldboards, plows 110 acres per day, accomplishing the work that once required 110 horses and 55 workers.

Livestock productivity since 1925 has progressively increased to extraordinary levels. The mix of animal enterprises on U.S. farms has shifted from a typical situation involving a vast number of species being raised on an average farm in the 1920s to contemporary scenarios where animal agriculture is considerably more specialized. These improvements in productivity have occurred primarily because people had an incentive to progress under a free-enterprise system.

In the United States, releasing people from producing their own food has given them the opportunity to improve their per-capita incomes. Increased per-capita income associated with an abundance of animal products has resulted in reduced relative costs of many animal products with time. United States consumers allocate a

Table 3
POPULATION INVOLVED IN AGRICULTURE IN SELECTED COUNTRIES

Country	Population (mil)	Population in Agriculture ^a (mil)	Percent of Economically Active Population in Agriculture ^b	Number of Tractors (thou)
United States	294	5.9	2	4,760
United Kingdom	59	1.0	2	500
Germany	82	21.8	2	944
Australia	19	0.8	4	315
Japan	128	4.1	3	2,028
Brazil	178	26.4	15	806
Mexico	103	22.4	22	325
Nigeria	124	37.9	31	31
China	1,312	851.0	65	995
India	1,065	556.6	52	2,528
Bangladesh	147	77.4	53	5
Kenya	32	23.7	74	13
Developed	1,329	90.9	7	19,216
Developing	4,973	2,504.0	50	8,409
World Total	6,056	2,567.0	41	27,625

^aAgricultural population is defined as all persons depending for their livelihood on agriculture. This comprises all persons actively engaged in agriculture and their nonworking dependents.

^bIncludes all economically active persons engaged principally in agriculture, forestry, hunting, or fishing.

Source: Adapted from USDA and FAO.



David R. Frazier Photolibrary, Inc./Alamy

Figure 3

The mechanization of agriculture has enabled a relatively small proportion of the human population to provide for a growing world market.

smaller share of their disposable income for food than do people in many other countries. For example, per-capita expenditures for food as a percent of household expenses in Canada, France, Mexico, South Africa, and China are 9.2, 13.7, 24.2, 20.6, and 34.9%, respectively.

Table 6 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

Table 4
PRODUCTIVITY CHANGES IN SEVERAL FARM ANIMAL SPECIES IN THE UNITED STATES

Species and Measure of Productivity	1925	1950	1975	1990	1995
Beef cattle					
Carcass weight (per year) marketed per breeding female (lb)	220.0	310.0	482.0	524.0	540.0
Sheep					
Liveweight marketed per breeding female (lb)	60.0	90.0	130.0	145.0	145.0
Dairy cattle					
Milk marketed per breeding female (lb)	4,189.0	5,313.0	10,500.0	14,000.0	16,400.0
Swine					
Liveweight marketed per breeding female (lb)	1,600.0	2,430.0	2,850.0	3,500.0	4,590.0
Broiler chickens					
Age to market weight (weeks)	15.0	12.0	7.5	7.4	7.3
Feed per pound of gain (lb)	4.0	3.3	2.1	1.9	1.8
Liveweight at marketing (lb)	2.8	3.1	3.8	4.5	5.09
Turkeys					
Age to market weight (weeks)	34.0	24.0	19.0	16.0	16.0
Feed per pound of gain (lb)	5.5	4.5	3.1	2.6	2.5
Liveweight at marketing (lb)	13.0	18.6	18.4	21.1	23.1
Laying hens					
Eggs per hen per year (no.)	112.0	174.0	232.0	250.0	254.0
Feed per dozen eggs (lb)	8.0	5.8	4.2	4.0	3.2

Source: Adapted from *Food from Animals*, CAST Report 82.

Table 5
EXPENDITURES FOR FOOD IN THE UNITED STATES (GROSS DOLLARS AND AS PERCENT OF PERSONAL DISPOSABLE INCOME)

Year	At Home		Away from Home		Total	
	(\$ bil)	(%)	(\$ bil)	(%)	(\$ bil)	(%)
1930	15.3	19.3	2.7	3.4	18.0	22.7
1940	11.8	17.9	2.5	3.7	14.3	21.5
1950	32.2	18.1	7.5	4.2	39.7	22.3
1960	50.3	15.0	11.8	3.5	62.2	18.6
1970	73.7	11.4	25.1	3.9	98.9	15.3
1980	170.8	10.4	81.1	4.9	251.9	15.4
1985	221.1	8.9	123.5	5.0	344.5	13.9
1990	291.9	8.1	184.5	5.1	476.5	13.2
1995	320.0	7.1	221.4	4.9	541.7	12.1
2000	420.0	5.8	290.1	4.0	710.2	9.9
2005	524.3	5.8	369.8	4.1	894.1	9.9
2008	553.9	6.7	411.7	4.9	965.6	11.6

Source: USDA.

developing countries (as a group; there are exceptions) as in developed countries. Table 6 also illustrates 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, swine, sheep, goats, chickens, and turkeys. There are, however, 20 or more additional species that collectively contribute about 6.5 billion pounds of edible protein per year or approximately 10% of

Table 6
CONTRIBUTIONS OF VARIOUS FOOD GROUPS TO THE WORLD FOOD SUPPLY

Food Group	Calories (%)	Protein (%)
Cereals	50	45
Roots, tubers, pulses	8	7
Nuts, oils, vegetable fats	11	4
Sugar and sugar products	8	2
Vegetables and fruits	7	5
All animal products	16	37
Meat	7	16
Eggs	1	3
Fish	1	7
Milk and dairy	5	10
Other	2	1

Source: Adapted from USDA and FAO.

the estimated total protein from all meats. These include the alpaca, llama, yak, horse, 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 Russian Federation cans more than 110 million pounds of reindeer meat per year, and in West Germany the annual per-capita consumption of venison exceeds three pounds. 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 protein. The second is that vitamin B₁₂, which is required in human nutrition, may be obtained in adequate quantities from consumption of meat or other animal products but not from consumption of plants.

Milk is one of the largest single sources of food from animals. In the United States, 99% of the milk supply comes from cattle, but on a worldwide basis, milk from other species is important. Domestic buffalo, sheep, goat, alpaca, camel, reindeer, and yak supply significant amounts of milk in some countries. Milk and products made from milk contribute protein, energy, vitamins, and minerals for humans.

Besides the nutritional advantages, a major reason for human use of animals for food is that most countries have land areas unsuitable for growing cultivated crops. Approximately two-thirds of the world's agricultural land is permanent pasture, range, and meadow; of this, about 60% is unsuitable for producing cultivated crops that would be consumed directly by humans. This land, however, can produce feed in the form of grass and other vegetation that is digestible by grazing ruminant animals, the most important of which are cattle and sheep (Fig. 4). These animals can harvest and convert the vegetation, which is for the most part indigestible by humans, to high-quality protein food. In the United States, about 385 million acres of rangeland and forest, representing 44% of the total land area, are used for grazing. Although this acreage now supports only about 40% of the total cattle population, it could carry twice this amount if developed and managed intensively.

Ruminant **animal agriculture** therefore does not compete with human use for production of most land used as permanent pasture, range, and meadow. On the contrary, the use of animals as intermediaries provides a means by which land that is otherwise unproductive for humans can be made productive (Fig. 5).



A



B



C



D

Figure 4

Ruminant animals produce food for humans by utilizing grass, crop residues, and other forages from land that cannot produce crops to be consumed directly by humans. (A) Cattle grazing stubble in New South Wales, Australia. (B) Cattle grazing hillsides in Georgia. (C) Cattle grazing native range in Arizona. (D) Sheep grazing native range. Source: American Sheep Industry Association.

People are concerned about energy, protein, population pressures (Fig. 6), and land resources as they relate to animal agriculture. Quantities of energy and protein present in foods from animals are smaller than quantities consumed by animals in their feed because animals are inefficient in the ratio of nutrients used to nutrients produced. More acres of cropland are required per person for diets high in foods from animals than for diets including only plant products. As a consequence, animal agriculture has been criticized for wasting food and land resources that could otherwise be used to provide persons with adequate diets. Consideration must be given to economic systems and consumer preferences to understand why agriculture perpetuates what critics perceive as resource-inefficient practices. These practices relate primarily to providing food-producing animals with feed that could be eaten by humans and using land resources to produce crops specifically for animals instead of producing crops that could be consumed by humans.

Hunger continues to be a challenge in some regions of the world. The factors that contribute to the hunger problem are varied and complex. Hunger takes two

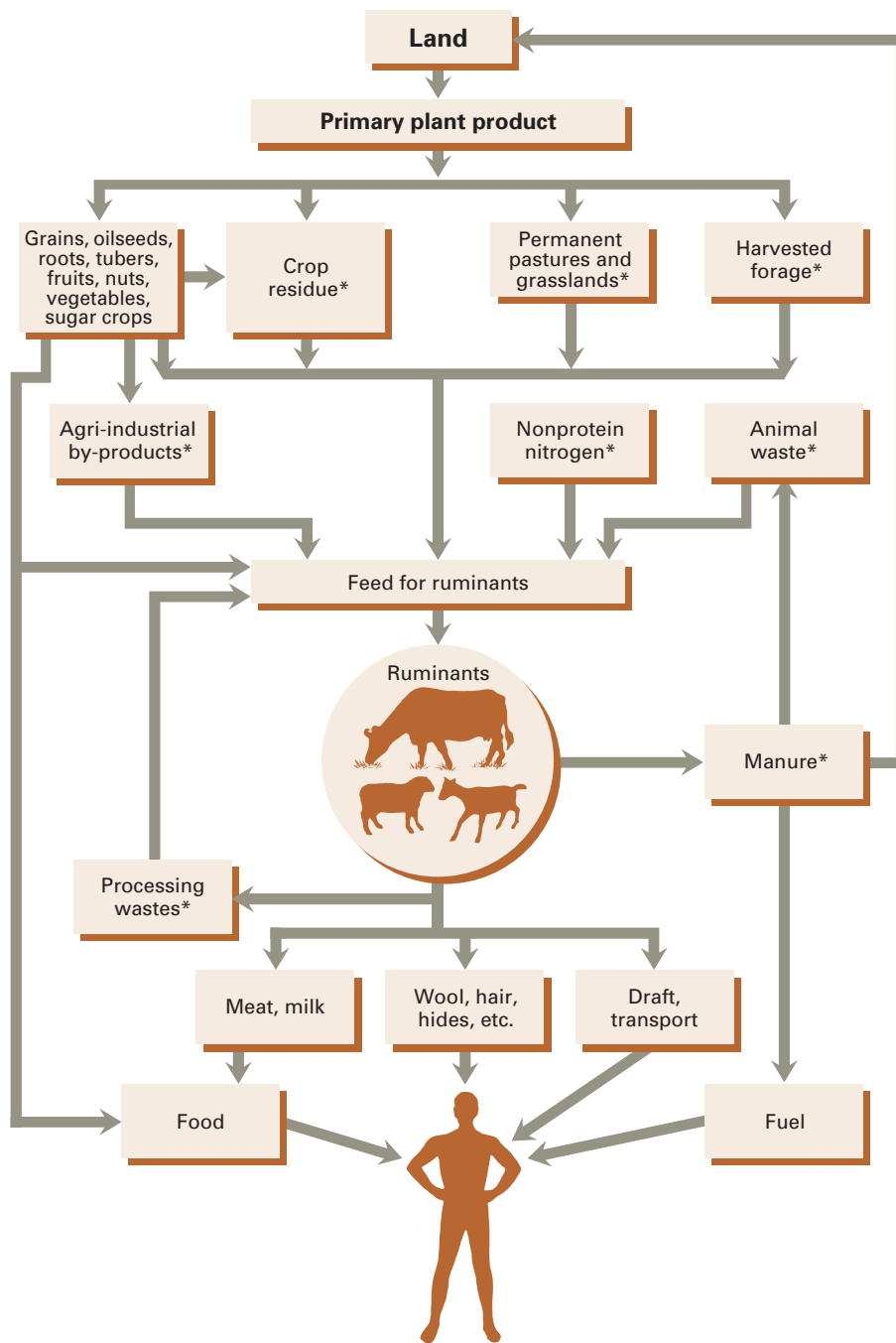
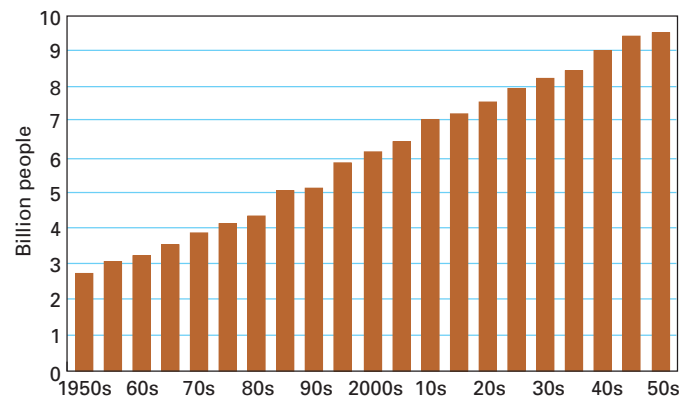


Figure 5

A graphic illustration of the land-plant-ruminant-animal-human relationship. Products marked with an asterisk (*) are not normally consumed by humans, but ruminants convert many of these products into useful products for humans. Source: Winrock International.

forms—chronic persistent hunger and famine. **Chronic persistent hunger (CPH)** results from a combination of poverty, climatic change, political instability, water shortages, loss of soil fertility, poor infrastructure (transportation, storage facilities, banking services, etc.), and illiteracy. Note that food scarcity is not a significant

Figure 6
Past, present, and projected world population. Source: U.S. Census Bureau.



contributing factor to CPH. In fact, global food production has exceeded the population growth rate. **Famine**, unlike CPH, is typically a relatively short period of crisis resulting from the breakdown in food production and distribution infrastructure resulting from catastrophic events such as hurricanes, drought, or civil war. The international community is relatively adept at reacting to and minimizing the effects of famine.

The International Food Policy Research Institute suggests that while the number of malnourished children will decline from 1993–2020, there will still be 150 million babies and toddlers who will be insufficiently fed in 2020. An additional 500 million people will also suffer from hunger. Africa, Latin America, the Caribbean, and West Asia are the regions most likely to bear the brunt of the problem in the future. Of the 11 countries with daily per-capita consumption of less than 2,000 calories, 10 of these are located in Africa.

Per-capita food availability is estimated to increase by nearly 7% by 2020, with China and East Asia experiencing the greatest increase. Evidence of a decline in global population increases is becoming apparent. However, slowing population increases is a gradual process, and for the next several decades approximately 80 million people will be added to the global population annually. Over 90% of this increase will occur in developing nations in or near urban areas. The 70 most susceptible countries to the effects of hunger are also the world's poorest nations. Sub-Saharan African nations have a per-capita income of approximately \$380 per year.

Conquering hunger in developing nations involves a multifaceted strategy that includes increasing literacy rates, particularly in women; reducing poverty; improving health care; enhancing agricultural production; and improving the total food system infrastructure. As demand for food increases, some regions of the world will become more import dependent while others will become more export focused.

Even developed nations are not immune to the effects of hunger for part of the population. For example, 85% of U.S. households are **food secure**, where all members of the household have access to enough food for a healthy lifestyle and sufficient financial resources to acquire food, as it is needed. Households deemed **food insecure** (15%) are further divided into categories of without hunger (9%) or with hunger (6%). Food insecure households without hunger are able to gain access to groceries via food assistance programs or community outreach programs. Fortunately, only 0.7% of children in the United States live in food insecure environments coupled with periods of hunger. Those households considered food insecure typically have incomes below the poverty line of \$19,000, and are comprised of single adults or single parents with children.

There will be annual demand increases of 1–1.5% for cereal grains, while world-wide demand for meat is expected to approach 2% per annum. Demand for meat will increase at the highest rate in developing countries (approximately 3%) with developed nations only accounting for less than 1% of annual demand growth. In the final analysis, the ability to pay will dictate food distribution. The need for economic growth in developing regions is of paramount importance.

Agriculture producers generate what consumers want to eat as reflected in the prices consumers are able and willing to pay. Eighty-five percent of the world's population desires food of animal origin in its diets, perhaps because foods of animal origin are considered more palatable than foods from plants. In most countries, as per-capita income rises, consumers tend to increase their consumption of meat and animal products.

If many consumers in countries where animal products are consumed at a high rate were to decide to eat only food of plant origin, consumption and price of foods from plants would increase, and consumption and price of foods from animals would decrease. Agriculture would then adjust to produce greater quantities of food from plants and lesser quantities of food from animals. Ruminant animals can produce large amounts of meat without grain feeding. The amount of grain feeding in the future will be determined by cost of grain and the price consumers are willing to pay for meat.

Some people advocate shifting from the consumption of foods from animals to foods from plants. They see this primarily as a moral issue, believing it is unethical to let people elsewhere in the world starve when our own food needs could be met by eating foods from plants rather than feeding plants to animals. The balance of plant-derived foods could then be sent abroad. These people believe that grain can be shipped with comparative ease because a surplus of grain exists in many developed nations and because any surplus should be provided at no cost. Providing free food to other countries has met with limited success in the past. In some situations, it upsets their own agricultural production, and in many cases the food cannot be adequately distributed in the recipient country because transportation and marketing systems are poorly developed.

There are strong feelings that the United States has a moral obligation to share its abundance with other people in the world, particularly those in developing countries. It appears that sharing our time and basic—but not necessarily advanced—technology can best do this. People need to have self-motivation to improve, access to knowledge and appropriate technology, and sufficient resources to develop agricultural productivity and infrastructure appropriate to their own culture.

Advances in agricultural production and related topics must be shared to minimize the effects of hunger on civilization. These achievements have been built on knowledge gained through experience and research, the extension of knowledge to producers, and the development of an industry to provide transportation, processing, and marketing in addition to production. Dwindling dollars currently being spent to support agricultural research and extension of knowledge may not provide the technology needed for future food demands. The next generation of agricultural leaders should view the decline in resources allocated to agricultural research, extension, and education as an emerging crisis.

About 20% of the world human population and 32% of the ruminant animal population live in developed regions of the world, but ruminants of these same regions produce two-thirds of the world's meat and 80% of the world's milk. In developed regions, a higher percentage of animals are used as food producers, and these animals are more productive on a per-animal basis than animals in developing regions. This is the primary reason for the higher level of human nutrition in developed countries of the world.

Possibly many developing regions of the world could achieve levels of plant and animal food productivity similar to those of developed regions. Except perhaps in India, abundant world supplies of animal feed resources that do not compete with production of food for people are available to support expansion of animal populations and production. It has been estimated that through changes in resource allocation, an additional 8 billion acres of arable land (twice what is now being used) and 9.2 billion acres of permanent pasture and meadow (23% more than is now being used) could be put into production in the world. These estimates, plus the potential increase in productivity per acre and per animal in developed countries, demonstrate the magnitude of world food-production potential. This potential cannot be realized, however, without coordinated planning and increased incentive to individual producers.

Fortunately progress can be made in reducing hunger. For example, Asia has reduced hunger (percent of population consuming less than 2,100 calories per day) by 30% in the 10-year period from 1994–2004. During the same time, Bangladesh reduced the number of hungry people by 70% by making significant strides in food production and distribution. This is particularly impressive given that Bangladesh was once considered the epicenter of famine and chronic persistent hunger. Interestingly, significant changes in governmental policy focused not only on increasing food production but also on enhancing exports as a means to infuse foreign exchange into the economy. Furthermore, government policy focused on private-sector investment in irrigation systems, seeds, and fertilizer to stimulate food production. These policies increased irrigated acreage by 50% from 1994–2004.

In the long run, each nation must assume the responsibility of producing its own food supply by efficient production, barter, or purchase and by keeping future food-production technology ahead of population increases and demand. Extensive untapped resources that can greatly enhance food production exist throughout the world, including an ample supply of animal products. The greatest resource is the human being, who can, through self-motivation, become more productive and self-reliant.

CONTRIBUTIONS TO CLOTHING AND OTHER NONFOOD PRODUCTS

Products other than food from ruminants include wool, hair, hides, and pelts. Synthetic materials have made significant inroads into markets for these products. For example, the world's production of wool peaked in 1990 but since has declined to 40-year lows. It is important to note that in more than 100 countries, ruminant fibers are used in domestic production and cottage industries for clothing, bedding, housing, and carpets.

Annual production of animal wastes from ruminants contains millions of tons of nitrogen, phosphorus, and potassium. The annual value of these wastes for fertilizer is estimated at more than \$1 billion.

Inedible tallow and greases are animal **by-products** used primarily in soaps and animal feeds and as sources of fatty acids for lubricants and industrial use. Additional tallow and grease by-products are used in the manufacture of pharmaceuticals, candles, cosmetics, leather goods, woolen fabrics, and tin plating. The individual fatty acids can be used to produce synthetic rubber, food emulsifiers, plasticizers, floor waxes, candles, paints, varnishes, printing inks, and pharmaceuticals.

Gelatin is obtained from hides, skins, and bones and can be used in foods, films, and glues. Collagen, obtained primarily from hides, is used to make sausage casings.

CONTRIBUTIONS TO WORK AND POWER NEEDS

The early history of the developed world abounds with examples of the importance of animals as a source of work energy through draft work, packing, and human transport. The horse made significant contributions to winning wars and exploration of the unknown regions of the world.

In the United States during the 1920s, approximately 25 million horses and mules were used, primarily for **draft purposes**. The tractor has replaced all but a few of these draft animals. In parts of the developing world, however, animals provide as much as 99% of the power for agriculture even today.

In more than half the countries of the world, animals—mostly buffalo and cattle, but also horses, mules, camels, and llamas—are kept primarily for work and draft purposes (Fig. 7). About 20% of the world's human population depends largely or entirely on animals for moving goods. According to the Food and Agriculture Organization of the United Nations, in developing countries animals provide 52% of the cultivation power, with an additional 26% derived from human labor. Developed countries, in contrast, use tractors for 82% of the cultivation, with animals and humans providing 11% and 7% of the power, respectively. There are more than three times as many tractors and harvesting machines and twice as many milking machines in use in developed nations as compared to developing countries. It is estimated that India alone would have to spend more than \$1 billion annually for gasoline to replace the animal energy it uses in agriculture.



A



B

Figure 7

Animals provide significant contributions to the draft and transportation needs of countries lacking mechanization in their agricultural technology. In developed countries, the use of draft animals is more oriented to recreation than necessity. (A) Donkeys being used to thresh barley.

Source: FAO. Photo by J. Bravo.

(B) Carriage horses being used for show purposes.

Figure 8

(A) Many people enjoy riding horses as part of a back-country experience. (B) Traditional use of the horse and dog in simulated hunts continues to be popular in some parts of the world. (C) Polo is an action-packed sport enjoyed by many. (D) The use of the stock dog is prevalent on many farms and ranches. (E) The cutting horse event is founded on stock handling skills on the open range. Photo courtesy of Fred Field. (F) Team roping is a popular sport with increasing participation on the amateur and professional levels. Photo courtesy of Professional Rodeo Cowboys Association.



A



B



C



D



E



F

ANIMALS FOR COMPANIONSHIP, RECREATION, AND CREATIVITY

Estimates of the number of **companion animals** in the world are unavailable. There are an estimated 59 million family-owned dogs and 75 million family-owned cats in the United States, in addition to the animals identified in Table 1. Approximately one-half of all U.S. households have at least one pet dog or cat. The U.S. pet food industry annually processes more than three million tons of cat and dog food valued at more than \$1 billion. Many species of animals would qualify as companions where people derive pleasure from them. The contribution of animals as companions, especially to the young and elderly, is meaningful, even though it is difficult to quantify the emotional value.

Animals used in rodeos, bullfighting, and other sports provide income for thousands of people and recreational entertainment for millions (Fig. 8). Numerous people who have made money from nonagricultural businesses have invested in land and animals for recreational and emotional fulfillment away from the urban environment.

Our livestock heritage involves the interactions of humans with animals over the centuries. Historically, animals have been highly respected, revered, and even worshiped by humans. Early humans expressed the sacred, mysterious qualities of some animals through art on cave walls between 15,000 and 30,000 B.C. Thus, through these early paintings and sculptures, animals found their way into an expression of the things of humans—the humanities. Several historians have noted that an extremely high form of art is the intelligent manipulation of animal life—the modeling and molding of different types through the application of breeding principles.

ADDITIONAL ANIMAL CONTRIBUTIONS

The use of livestock species in human health research is also of significance. Most human health research involving livestock is focused on smaller animals such as miniature pigs, swine, and sheep. Biomedical research using these species has focused on such topics as human aging, diabetes, arteriosclerosis, and development of replacement joints. This research is conducted under strict federal guidelines governing the care and use of animals in laboratory settings.

Transgenic technologies also offer significant potential in terms of utilizing livestock to produce specialized proteins for use in the creation of therapeutic drugs and other medical applications. This approach is often referred to as “pharming” or the use of agricultural animals to produce pharmaceuticals. Transgenic dairy cows and goats have been utilized to produce hepatitis B antigens, tissue plasminogen activator for treatment of heart disease, and the clotting agent antithrombin III for example.

CHAPTER SUMMARY

- Domesticated animals (>16 billion) contribute to the well-being of 5.6 billion humans throughout the world by providing food, clothing, shelter, power, recreation, and companionship.
- Animal products contribute significantly to the world’s human protein needs and energy supply.
- As people increase their standard of living, the per-capita consumption of animal products also increases.
- Human health is improved via the continuing research utilizing domestic animals.

KEY WEBSITES

Food and Agricultural Organization of the United Nations

www.fao.org

- Publications (State of Food and Agriculture, State of Food Insecurity, State of Commodity Markets)
- Statistics

Economic Research Service

www.ers.usda.gov

- Publications (research reports, outlook reports, *Amber Waves*)
- Data sets

KEY WORDS

per-capita calorie supply

per-capita protein supply

mechanization

animal agriculture

chronic persistent hunger (CPH)

famine

food secure

food insecure

by-products

gelatin

draft purposes

companion animals

REVIEW QUESTIONS

1. *True or False:* Developed nations have less of their population economically involved in agriculture than do developing nations.
2. *True or False:* People in developed nations consume more of their daily supply of protein and calories from animal products than do people from developing nations.
3. Compare the United States to other countries for percent of income spent on food.
4. What are the two scientifically based reasons why meat is important food for humans?
5. What was the single most important reason for increased food production in the mid-1900s?
6. What percentage of the world's agricultural land is unsuitable for cultivation of crops and is therefore used to pasture or graze livestock?
7. What are the basic human needs to which animals and animal products contribute?
8. Compare and contrast developed versus developing nations relative to agricultural productivity, management practices, and consumer diets.

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An Overview of the Livestock and Poultry Industries

It is important to see the broad picture of the livestock and poultry industries before studying the specific biological and economic principles that explain animal function and production. These industries are typically described with numbers of animals, pounds produced, production systems, prices, products, people (producers and consumers), and profitability. Products and consumers are covered in the next several chapters.

An understanding of the animal industries begins with basic terminology, especially the various species and sex classifications. Refer to the glossary for definitions of many commonly used animal terms.

U.S. ANIMAL INDUSTRIES: AN OVERVIEW

Historically, farms in the United States were highly diversified in both crop and livestock enterprises. For example, during the depression most Iowa farms had cattle, chickens, hogs, and horses (Fig. 1). Over time, however, as fewer people chose to work in production agriculture, the industry had to develop more specialization in order to create the productivity required to meet consumer demand. The livestock and poultry industries in the United States must generate large volumes of output to meet the high animal product preference of more than 307 million U.S. consumers and also to supply the growing export market. Table 1 shows the number of livestock and poultry producers, the inventory number, and value of animals at one point in time during the year.

Cash Receipts

An evaluation of farm **cash receipts** from the sale of animals and animal products provides another perspective of U.S. animal industries. Table 2 shows the cash receipts for animal commodities ranked against all agricultural commodities. The top five states for each commodity are also shown in this table. Note the cash receipts for all livestock products comprise 44% of all agricultural commodities in the United States. Prior to government subsidization of corn-based ethanol, livestock and poultry accounted for approximately 50% of agricultural farmgate receipts.

Figure 2 shows the farm cash receipts from livestock and poultry products for each state. Note that 24 states each have annual cash receipts exceeding \$2 billion.

learning objectives

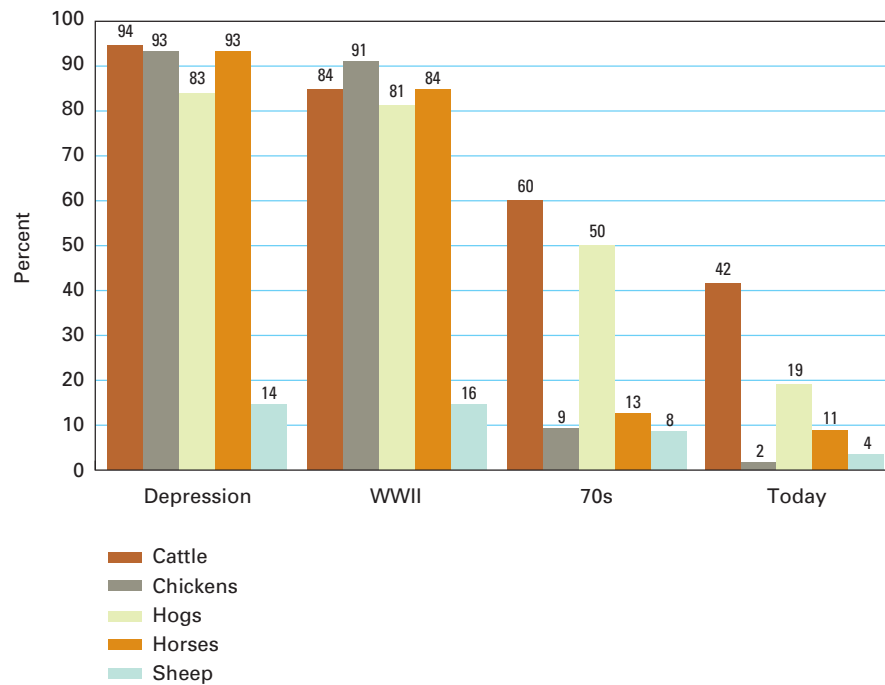
- Quantify the economic impact of the U.S. livestock industry
- Describe the role of international trade in livestock and livestock products
- Overview the international and domestic beef, dairy, horse, poultry, sheep, goat, and swine industries
- Overview nontraditional livestock enterprises



Mats Tooming - Fotolia

Figure 1

Percent of Iowa farms raising livestock species. Source: Adapted from Carolan, 2002.

**Table 1**

NUMBERS OF PRODUCERS AND ANIMALS IN THE U.S. LIVESTOCK AND POULTRY INDUSTRIES, 2008

Species	Number of Producers (1,000)	Number of Animals (mil head)	Cash Receipts (\$ bil)
Beef cows	757.9	32.5	49.2
Swine	65.6	65.1	14.1
Dairy cattle	71.5	9.1	23.4 ^a
Broilers	NA	8.9	18.8
Layers	NA	NA	NA
Breeding Ewes	70.5	4.5	0.5
Turkeys	NA	262.5	3.5
Goats—meat/milk/fiber	108.0	3.1 ^b	NA

^aValue of fluid milk sales

^b85% are meat-type

Source: Adapted from USDA.

World Trade

World trade influences profitability of U.S. animal industries. Table 3 shows the export and import markets for several animal commodities. While world trade for all U.S. products shows a deficit, agricultural and animal products show a positive trade balance. The economics of the U.S. export market for animal products is significantly influenced by cattle hides, meat (beef), fat/tallow, and dairy products. The highest import expenditures are for beef, dairy products, pork, and live cattle.

Commodity Prices

The profitability of U.S. animal industries is partly influenced by the prices paid to producers for animals and animal products. Prices can fluctuate monthly, weekly, even daily. These price changes are influenced primarily by supply and demand.

Table 2
LEADING U.S. STATES FOR FARM CASH RECEIPTS, 2008

Commodity	Rank ^a	Value (\$ mil)	Five Leading States (\$ mil)				
			1	2	3	4	5
All commodities		324,186	CA	IA	TX	NE	IL
			\$36,186	\$24,743	\$19,172	\$17,316	\$16,357
Livestock/poultry/products	—	141,090	TX	CA	IA	NE	KS
			11,030	10,632	9,868	8,320	7,213
Cattle and calves	2	48,189	NE	TX	KS	CO	IA
			7,068	6,896	6,240	3,058	2,882
Dairy products	3	34,773	CA	WI	NY	PA	ID
			6,924	4,571	2,306	2,102	2,101
Broilers	5	23,112	GA	AR	NC	AL	MS
			3,361	2,807	2,692	2,631	2,194
Hogs	8	16,077	IA	NC	MN	IL	IN
			4,759	2,171	2,047	971	923
Chicken eggs	9	8,225	IA	OH	GA	IN	PA
			1,118	585	564	535	487
Turkeys	12	4,478	MN	NC	MO	AR	IN
			744	652	371	348	306
Horses	25	1,165	KY	NJ	NA	NA	NA
			1,080	85	NA	NA	NA

^aRanking is in comparison to all agricultural commodities.
Source: Adapted from USDA.

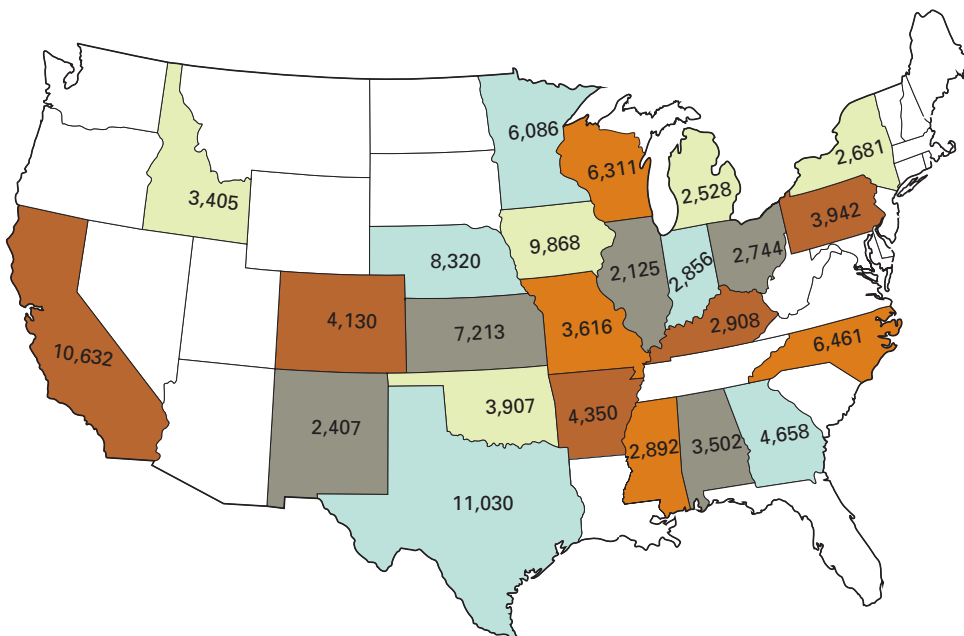


Figure 2
Cash receipts for livestock and products, 2008 (\$ mil). Source: Adapted from USDA.

Those individuals interested in animal profitability should know the average prices of animal products. In addition, an understanding of the prices for specific classes and grades of animals, of what causes prices to fluctuate, and of how high prices are obtained is also necessary. Figure 3 compares market prices of several

Table 3
U.S. EXPORTS AND IMPORTS OF MAJOR ANIMAL PRODUCTS, 2008

Commodity	Exports	Imports
	Value (\$ mil)	Value (\$ mil)
Live animals	761	2,603
Red meat and products	8,786	4,831
Poultry meat and products	4,881	NA
Dairy products	3,820	3,138
Hides and skin	2,064	157
Animal feeds and oil meal	8,204	459
Total for Agricultural Products	96,632	73,418

Source: Adapted from USDA.

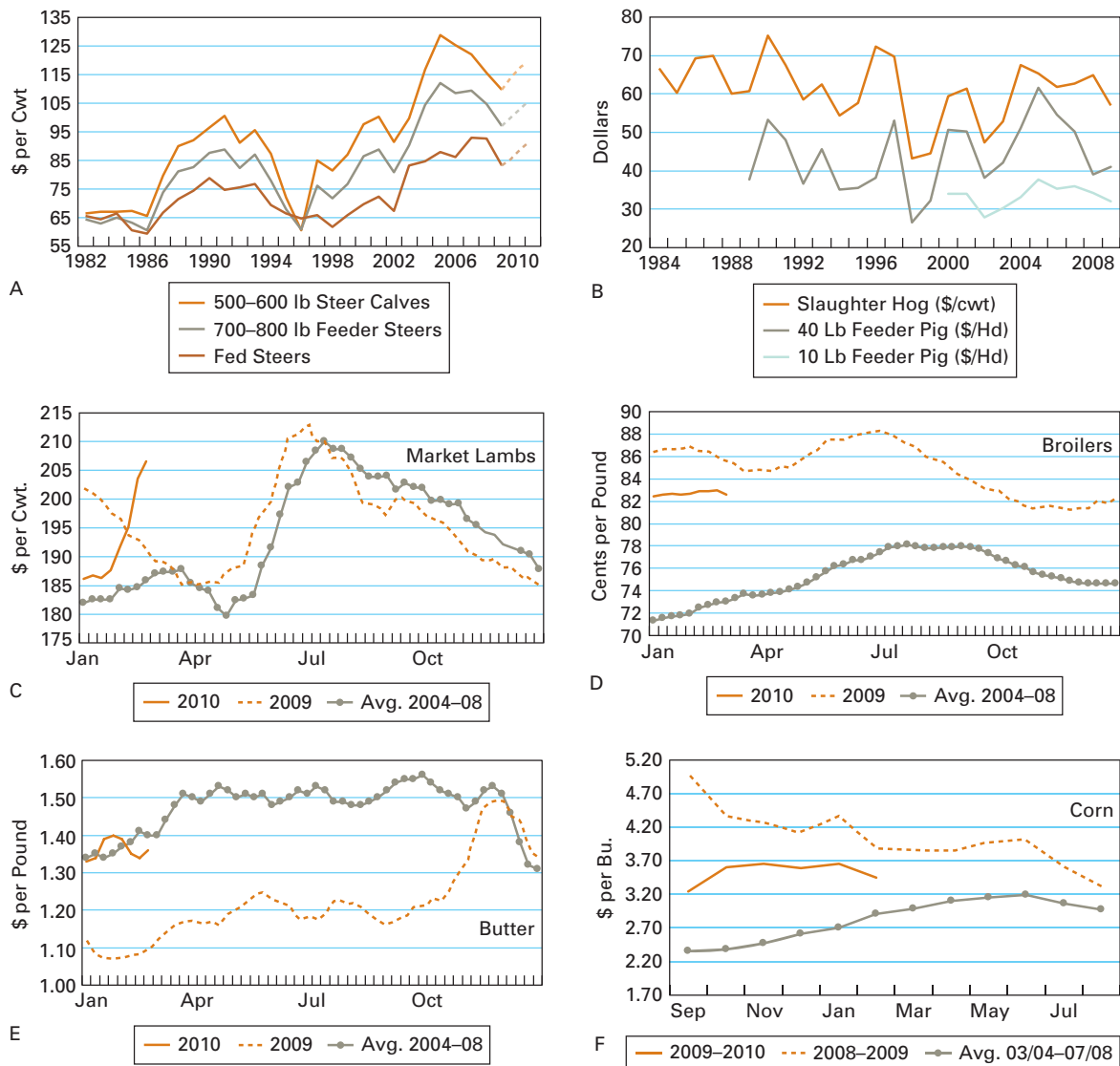


Figure 3

Livestock and product commodity prices are cyclic over time and contribute significantly to the economic challenges faced by agricultural producers. Source: Livestock Marketing Information Center

livestock and poultry commodities. This overview shows average prices and variability in prices producers receive for the animals and products they sell. Details of how some factors influence prices are discussed in later chapters.

Biological Differences in Meeting Market Demand

Changes in consumer demand, feed prices, weather, and other factors dictate the need to increase or decrease animal numbers and amount of product produced. Figure 4 shows the large differences between some farm animal species and how quickly or slowly numbers can change. Broiler numbers can be increased or decreased in a couple of months, while several years are needed to make significant changes in cattle numbers.

THE BEEF INDUSTRY

Global Perspective

Cattle were probably domesticated in Asia and Europe during the New Stone Age. Humped cattle (*Bos indicus*) were developed in tropical countries; the *Bos taurus* cattle were developed in more temperate zones.

Cattle, including the domestic water buffalo, contribute food, fiber, fuel, and draft animal power to the 6.8 billion people of the world. For most developed countries, beef (meat) is a primary product. For developing countries, beef is a secondary product as draft animal power and milk are the primary products. In some countries, cattle are still a mode of currency or a focus of religious beliefs and customs.

Table 4 shows the leading countries for cattle numbers, beef production, and beef consumption. India and Brazil have the largest cattle population; however, India's per-capita consumption is low because religious customs forbid cattle (considered

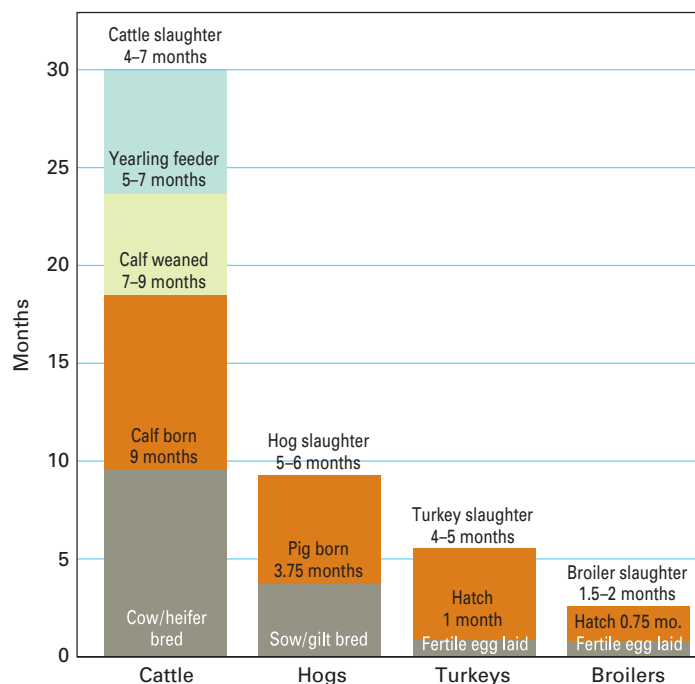


Figure 4

Biological time lag in changing numbers of several species of farm animals.

Source: USDA.

Table 4
WORLD CATTLE NUMBERS, PRODUCTION, AND CONSUMPTION

Country	No. Cattle (mil head)	Country	Production (bil lb) ^{a,b}	Country	Per-Capita Supply (lb)
1. India	175	1. United States	26.9	1. Argentina	123
2. Brazil	175	2. Brazil	19.9	2. United States	94
3. United States	97	3. China	12.9	3. Australia	94
4. China	83	4. Argentina	6.2	4. Uruguay	85
5. Argentina	51	5. Australia	5.1	5. Brazil	79
World Total	1,347	World Total	137	World Average^b	21

^aDoes not include buffalo meat.

^bCarcass weight.

Source: Adapted from USDA.

sacred) from being slaughtered. The United States produces the most beef tonnage, while Argentina has the highest per-capita consumption.

Countries with a high cattle population relative to their human population typically have a high per-capita consumption of beef and high export tonnage. For example, the cattle versus human population in Australia is 27.5 million versus 19 million, and in Argentina it is 51 million versus 37 million. Both countries rank high in per-capita consumption of beef. Japan, with its 4.5 million cattle, 127 million people, and rapidly expanding economy, has an increasing demand for beef (Table 5).

United States

The U.S. **beef industry** is made up of a series of producing, processing, and consuming segments that relate to each other but that operate independently. Table 6 identifies the various segments and the products they produce.

Figure 5 shows total cattle and amount of carcass beef produced in the United States from 1977 through 2008. Interestingly, 93.7 million head of cattle currently produce more carcass beef than 110 million head produced in 1985. There are several

Table 5
U.S. BEEF TRADE, 2008

Exports		Imports	
Country	(\$ mil)	Country	(\$ mil)
1. Mexico	\$1,399	1. Canada	\$895
2. Canada	716	2. Australia	880
3. Japan ^a	383	3. New Zealand	601
4. South Korea	294	4. Brazil	296
5. Taiwan	128	5. Mexico	118
World Total	3,619	World Total	3,062

^aDue to loss of international markets at the end of 2003, the United States lost significant market share. The United States exported \$1.4 billion worth of beef to Japan in 2003.

Source: Adapted from USDA and FAS.

Table 6
AN OVERVIEW OF THE BEEF INDUSTRY SEGMENTS IN THE UNITED STATES

Segment of the Beef Industry	Products Produced or Utilized	Approximate Number
Seedstock Producers ↓ ↑ a↓ ↑b	Breeding stock—primarily bulls (14–30 months old) and some heifers and cows. Some steers and heifers for feeding. Slaughter cows and bulls.	65,000 breeders, 5 major AI studs
Commercial Cow-Calf Producers ↓ ↑ ↓ ↑ ↓ ↑	Calves (6–10 months old), weighing 300–700 lb. Slaughter cows and bulls with majority over 5 years of age, weighing 800–1,500 lb (cows) and 1,000–2,500 lb (bulls).	757,900 producers ^c
Yearling or Stocker Operator ↓ ↑ ↓ ↑	Feeder steers and heifers (most of them 12–20 months old, weighing 500–900 lb).	
Feeders ↓ ↑ ↓ ↑ ↓ ↑	Market steers, heifers, cows, and bulls (mostly steers and heifers 16–30 months old, weighing 900–1,400 lb).	142 feeding companies with capacity >1,000 head
Packers ↓ ↑ ↓ ↑	Carcasses (approx. 600–800 lb). Boxed beef (carcasses into subprimal cuts).	706 packing plants
Retailers ↓ ↑	Retail cuts. By-products.	35,400 grocery stores with sales of \$2 million or more per year
Consumers	Cooked products. By-products (leather, pharmaceuticals, variety meats, etc.).	308 million consumers (U.S.); 6.8 billion consumers (world)

^aAnimal and/or product flow.

^bDemands and expectations.

^cIn addition, there are approximately 72,000 dairy farms that produce about 20% of U.S. beef.

Source: Field and Taylor, 2007.

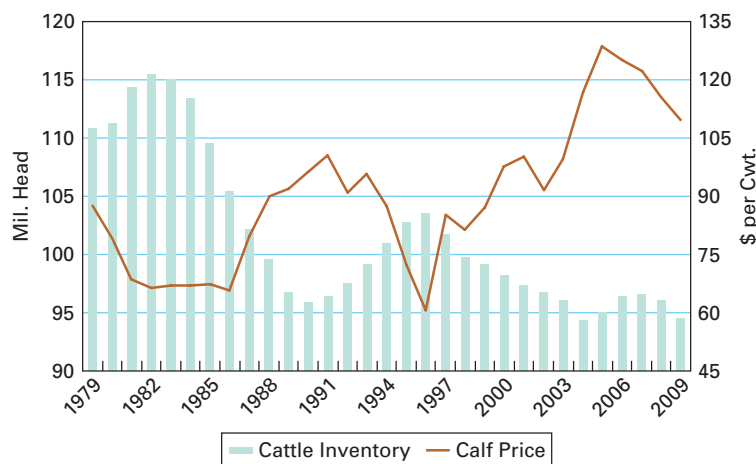


Figure 5
Total U.S. cattle inventory versus commercial beef production. Source: Livestock Marketing Information Center.

reasons for this relatively high production of beef from fewer numbers of cattle: (1) the average carcass weight has increased from 579 lb in 1975 to 776 lb in 2007, (2) an increased number of cattle are fed per feedlot (2.4 times the feedlot capacity), (3) the market age of fed cattle has decreased, (4) more crossbreeding and faster-gaining

European breeds (e.g., Simmental, Limousin, and Charolais) are being used in commercial breeding programs, and (5) more Canadian and Mexican calves are imported and fed in the United States when market conditions are favorable.

Cattle Production

Most commercial beef cattle production occurs in three phases: the **cow-calf**, **stocker-yearling**, and **feedlot** operations. The cow-calf operator raises the young calf from birth to 6–10 months of age (400–650 lb). The stocker-yearling operator then grows the calf to 600–850 lb, primarily on roughage. Finally, the feedlot operator uses high-energy rations to finish the cattle to a desirable slaughter weight, approximately 900–1,300 lb. Most fed steers and slaughter heifers are between 15 and 24 months of age when marketed.

However, there are alternatives to the typical three-phase operation. In an integrated operation, for instance, the cattle may have a single owner from cow-calf to feedlot, or ownership may change several times before the cattle are ready for slaughter. Alternative production and marketing strategies are diagrammed in Figure 6.

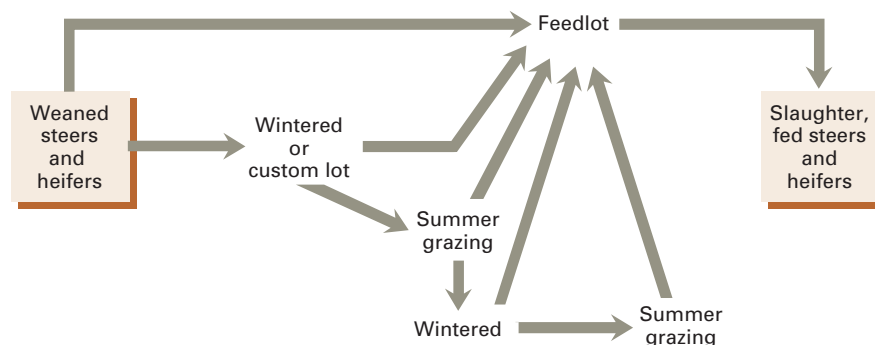
Cow-Calf Production U.S. cow-calf production involves some 32.5 million head of beef cows that are distributed throughout the country. Most of the cows are concentrated in areas where forage is abundant. As Figure 7 shows, 14 states each have over 700,000 head of cows (75% of the U.S. total), most of them located in the Plains, Corn Belt, and southeastern states. Approximately 77% of the 757,900 beef cow operations have less than 50 cows per operation. However, more than 54% of the beef cow inventory is in operations with more than 100 cows (Table 7). Cow numbers fluctuate over the years, depending on drought, beef prices, and land prices.

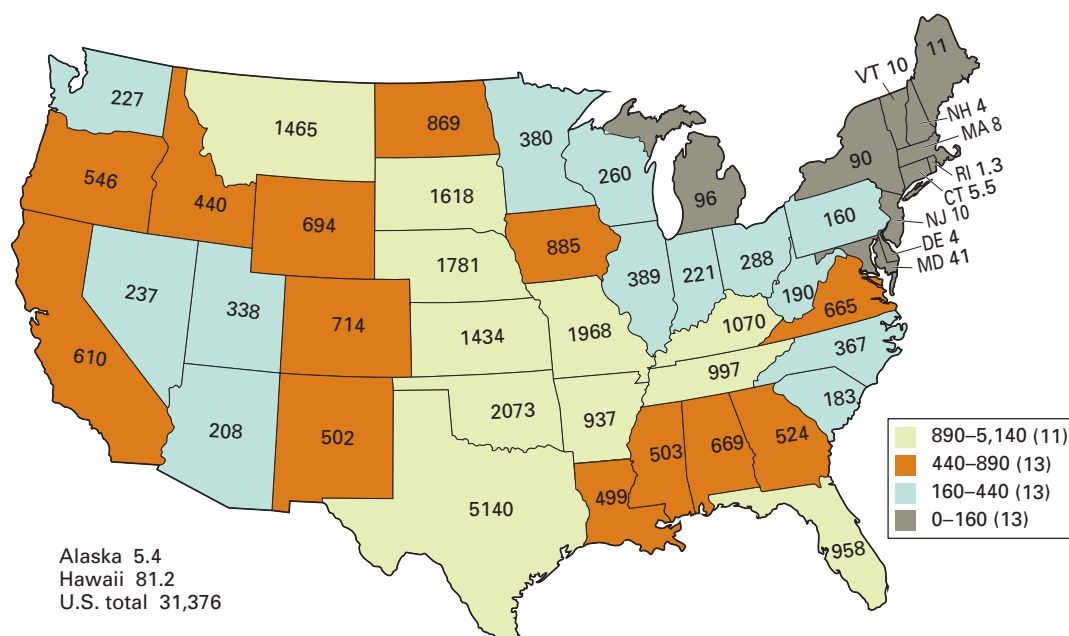
There are two kinds of cow-calf producers. Commercial cow-calf producers raise most of the potential slaughter steers and heifers. Seedstock breeders—specialized cow-calf producers—produce primarily breeding cattle and semen.

Stocker-Yearling Production Stocker-yearling producers feed cattle for growth prior to their going into a feedlot for finishing. Replacement heifers intended for the breeding herd are typically included in the stocker-yearling category. Our focus here, however, is on steers and heifers grown for later feedlot finishing.

Several alternate stocker-yearling production programs are identified in Figure 6. In some programs, a single producer owns the calves from birth through the feedlot-finishing phase, and the cattle are raised on the same farm or ranch. In other programs, one operator retains ownership, but the cattle are custom-fed during the growth and finishing phases. In still other programs, the cattle are bought and sold once or several times.

Figure 6
Alternative production and marketing strategies in the U.S. beef industry.



**Figure 7**

Beef cows that have calved January 1, 2010 (1,000 head). Source: Livestock Marketing Information Center.

Table 7
U.S. BEEF COW OPERATIONS AND INVENTORY

Herd Size (No. Cows)	Operations	Inventory
	Percent of Total	Percent of Total
1–49	77	28
50–99	12	18
100–499	10	39
500+	1	15

Source: Adapted from USDA.

The primary basis of the stocker-yearling operation is to market available forage and high-roughage feeds, such as grass, crop residues (e.g., corn stalks, grain stubble, and beet tops), wheat pasture, and silage. Stocker-yearling operations also make use of summer-only grazing areas that are not suitable for the production of supplemental winter feed.

Stocker-yearling operations are desirable for early-maturing cattle. These cattle need slower gains to achieve heavier slaughter weights without being excessively finished. Larger-framed, later-maturing cattle usually are more efficient and profitable if they go directly to the feedlot after weaning.

Feedlot Cattle Production Feedlot cattle are fed in small pens or fenced areas, where harvested feed is brought to them. Some cattle are finished for market on pasture, but they represent only 10–15% of the slaughter steers and heifers. They are sometimes referred to as *nonfed cattle* because they are fed little, if any, grain or concentrate feeds. The cattle-feeding areas in the United States (Fig. 8) correspond to the primary feed-producing areas where cultivated grains and roughage are grown.

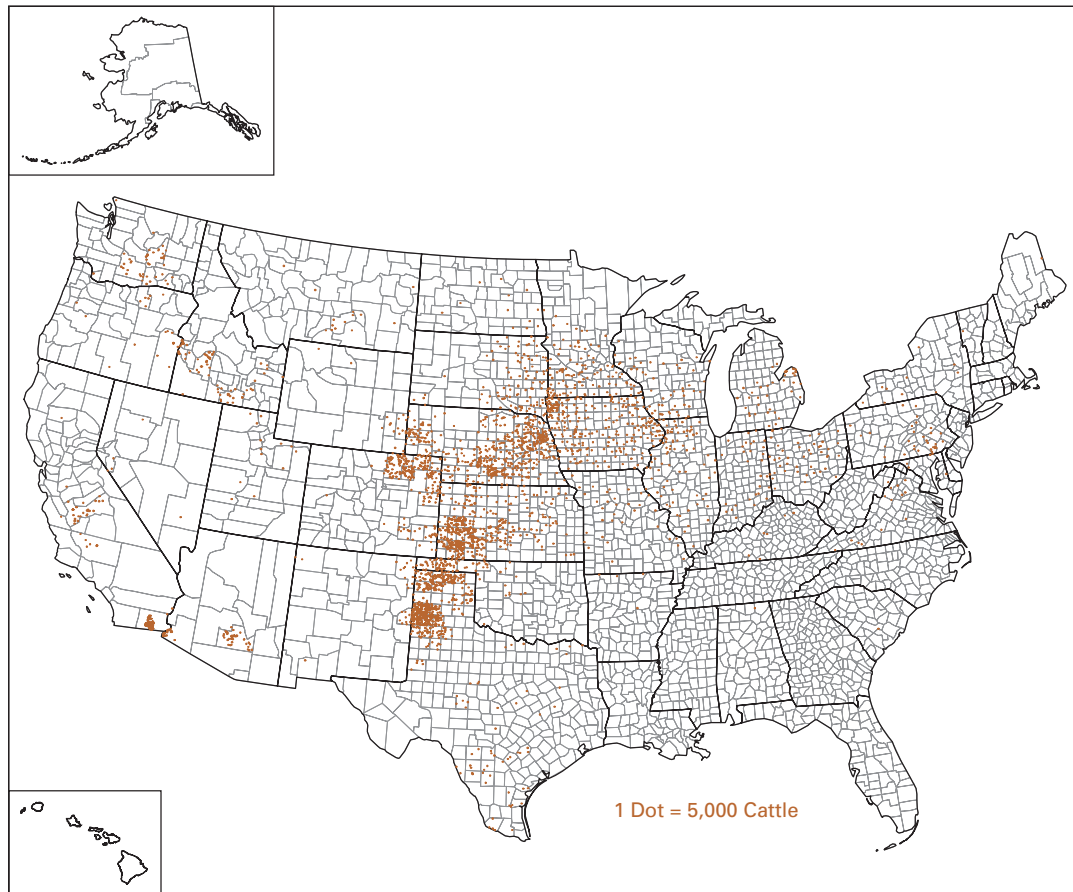


Figure 8

Cattle-feeding areas in the United States. Note that cattle feeding is concentrated in the southern and central region of the Great Plains. Source: USDA.

These locations are determined primarily by soil type, growing season, and amount of rainfall or irrigation water. Figure 9 shows where the approximately 22.5 million feedlot cattle are fed in the various states. The total number of fed cattle marketed in the leading states is shown in Figure 10. The 21.8 million head marketing by the leading states represent 95% of the 22.5 million head of fed cattle in all states. By contrasting Figures 9 and 10, the number of cattle marketed for each state is considerably higher than the number on feed. This is because most commercial feedlots feed more than 1.5 times their one-time capacity in a given year.

Cattle Feeding

The two basic types of cattle-feeding operations are (1) **commercial feeders** and (2) **farmer-feeders**. The two operations are distinguished by type of ownership and size of feedlot (Figs. 11 and 12).

The farmer-feeder operation is usually owned and operated by an individual or a family and has a feedlot capacity of fewer than 1,000 head. An individual or partnership sometimes owns the commercial feedlot, but more often a corporation owns it, especially as feedlot size increases. It has a feedlot capacity of more than 1,000 head. Approximately 95% of fed cattle are fed in feedlots with more than 1,000-head capacity. A number of U.S. commercial feedlots have capacities of 40,000 head or higher, and a few have capacities of more than 100,000 head. Some commercial

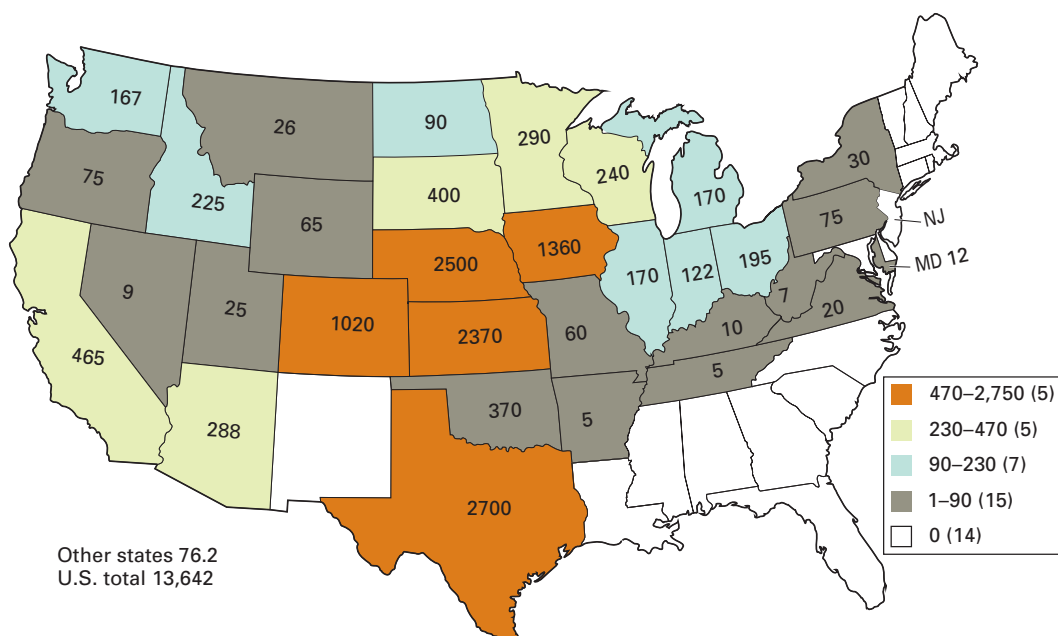


Figure 9

Cattle on feed January 1, 2010 (1,000 head). Source: Livestock Marketing Information Center.

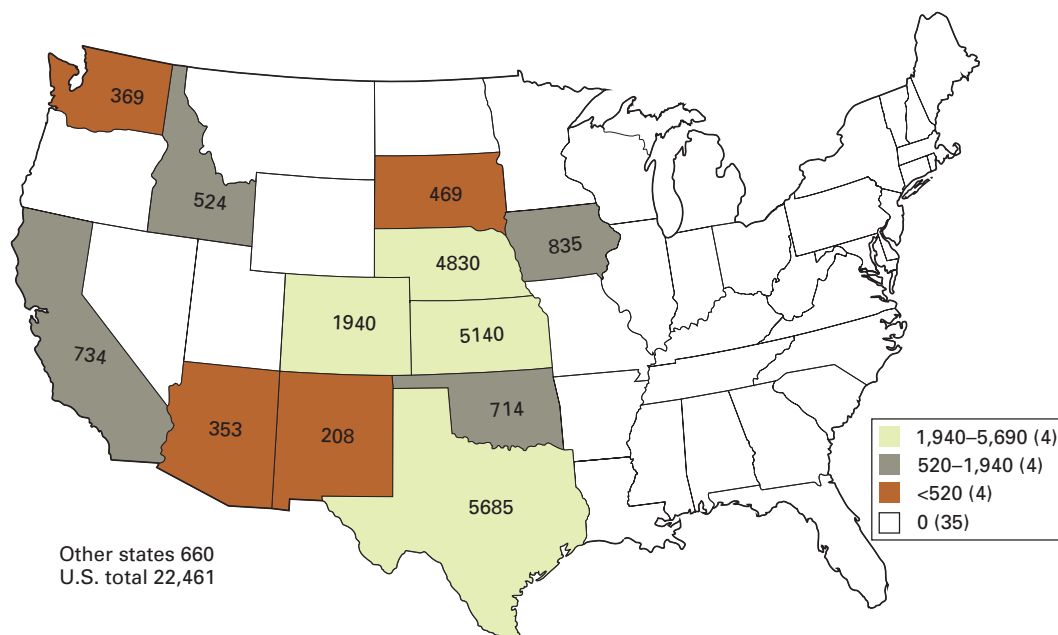


Figure 10

Fed cattle marketings 1,000+ head feedlots 2005 (1,000 head). Source: Livestock Marketing Information Center.

feedlots custom-feed cattle; that is, the commercial feedlot provides the feed and feeding service to the cattle owner.

Each type of feeding operation has its advantages and disadvantages. What is an advantage to one type of feedlot is usually a disadvantage to the other type. The large commercial feedlot usually enjoys economic advantages associated with its size as well as professional expertise in nutrition, health, marketing, and financing. The farmer-feeder

Figure 11

The feed mill associated with a large commercial cattle-feeding enterprise. Rations can be formulated and delivered to meet the needs of thousands of head of cattle.



Figure 12

Cattle on feed at a small farmer-feeder enterprise. The feed being consumed was raised on site and fed to cattle to add value to these crops. JL Creative Captures - Fotolia



has the advantages of distributing labor over several enterprises by using high-roughage feeds effectively, creating a market of homegrown feeds through cattle, and more easily closing down the feeding operation during times of unprofitable returns.

THE DAIRY CATTLE INDUSTRY

Global Perspective

Milk and milk products are produced and consumed by most countries of the world. Although buffalo, goat, and other types of milk are important in some areas, our focus here is on cow's milk and its products.

Table 8 shows world dairy cattle numbers, fluid milk production, and per-capita consumption of milk. Of the 247 million dairy cows in the world, India leads all other countries with its 38 million. The European Union has the highest total fluid milk production. The average annual world production per cow is 5,165 lb, with production in Israel the highest at over 22,000 lb. Countries with high milk-production levels per cow have excellent breeding, feeding, and health-management programs.

World butter production is 21.1 billion pounds. The European Union, India, the United States, and Pakistan are the leaders in total butter production, while New Zealand, the European Union, and Switzerland have the highest per-capita consumption of butter.

The leaders in cheese production are the European Union and the United States, accounting for 70% of the world's 42 billion pounds of cheese production.

Table 8
WORLD DAIRY CATTLE NUMBERS, MILK PRODUCTION, AND CONSUMPTION

Country	No. Dairy Cattle (mil head)	Country	Fluid Milk Production (mil ton)	Country	Production Per Cow ^a (lb)
1. India	38	1. EU	165	1. Israel	22,283
2. EU	24	2. United States	95	2. United States	20,597
3. Brazil	21	3. India	48	3. Canada	18,246
4. Russian Fed.	9	4. China	39	4. Japan	16,279
5. United States	9	5. Russian Fed.	35	5. EU	13,464
World Total	247	World Total	637	World Average	5,165

^aWhole and skim milk.

Source: Adapted from USDA and FAO.

Table 9
VALUE OF U.S. DAIRY PRODUCT IMPORTS AND EXPORTS, 2008

Exports		Imports	
Commodity	(\$ mil)	Commodity	(\$ mil)
Nonfat dry milk	1,379	Cheese	1,171
Cheese and curd	530	Casein	758
Whey	367		
Total	3,753	Total	3,074

Source: Adapted from USDA.

Iceland, the European Union, Switzerland, and the United States have the highest per-capita consumption of cheese.

Milk is produced worldwide, but manufactured dairy products dominate dairy trade. Dairy products traded internationally account for about 5% of the global milk production on a milk-equivalent basis. Trade restrictions keep trade volume and prices lower than if trade was more liberalized. Most developed countries, including the United States, extensively regulate their dairy industries by subsidizing production and often exportation.

Table 9 shows the U.S. import and export trade in dairy products. Cheese and nonfat dry milk are the most significant export items with cheese going to the Pacific Rim and NAFTA partners and dry milk to countries with minimal dairy production. Cheese and milk components are imported from countries in Europe and Oceania.

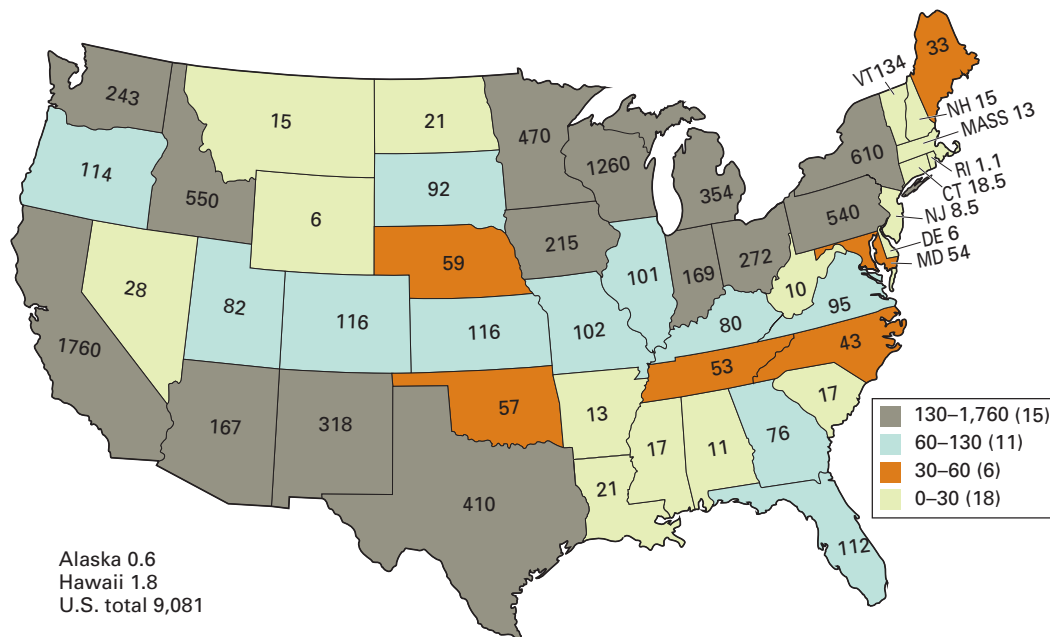
United States

The U.S. **dairy industry** has changed dramatically since the days of the family milk cow. Today it is a highly specialized industry that includes the production, processing, and distribution of milk. A large investment is required in cows, machinery, barns, and milking parlors where cows are milked. Dairy operators who produce their own feed need additional money for land on which to grow the feed. They also require machinery to produce, harvest, and process the crops.

Although the size of a dairy operation can vary from less than 30 milking cows to more than 5,000 milking cows (Fig. 13), the average U.S. dairy has approximately 135 mature milking cows. Average dairy producers farm 200–300 acres of land, raise much of the forage, and market the milk through cooperatives, of which they are members. The producers sell about 4,100 lb of milk daily, or about 1.5 million lb

Figure 13

Dairies in the United States continue to increase in herd size. Many dairy cow herds are intensively managed in excellent facilities. Photo by Justin Field.

**Figure 14**

U.S. milk cow numbers, 2010 (1,000 head). Source: Livestock Marketing Information Center.

annually, valued at about \$200,000. Their average total capital investment may exceed \$500,000. The average dairy producer has a partnership (with a family member or another person) to make the management of time and resources easier.

Nearly 80% of the U.S. dairy herd was concentrated in large dairy farms (with 100 or more milk cows) in 2009. These large dairies represented just 13% of all U.S. farms with milk cows. New technologies have required extensive capital investment that is most feasible for large dairy operations. Since 1977, farms with fewer than 30 milk cows have declined continuously as a share of all farms with milk cows. The share of farms having 100 or more milk cows is increasing in both number and share of all farms with milk cows. The largest farms are typically found in the West and Southwest. The traditional milk-producing states of the Northeast and Great Lakes states have seen their share of milk production become stable and then decline in recent years.

One way to stress the importance of dairying in the United States is to examine the number of cows in the states (Figure 14). The five leading states in thousands of dairy cows are, respectively, California (1,760), Wisconsin (1,260), New York (610),

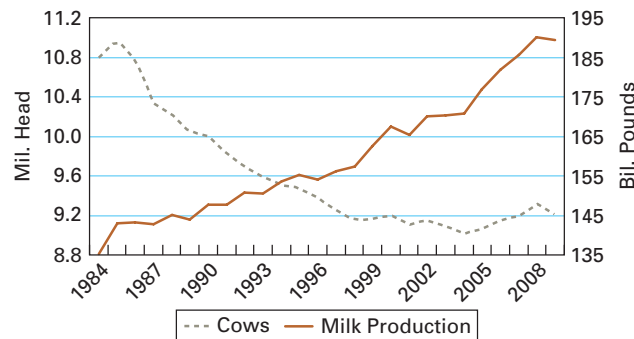


Figure 15
Trends in milk cow numbers
and milk production. Source:
Livestock Marketing Information
Center.

Idaho (550), and Pennsylvania (540). The five leading states in milk production per cow are, respectively, Washington (23,270 lb), Arizona (22,679 lb), Colorado (22,577 lb), Idaho (22,332 lb), and Nevada (21,680 lb). And the five leading states in total pounds of fluid milk produced (given in million pounds) are, respectively, California (37.5), Wisconsin (22.8), New York (12.1), Pennsylvania (10.5), and Idaho (10.1).

As Figure 15 shows, today's nine million dairy cows are approximately one-third the number of cows 50 years ago, yet total milk production continues to increase due to increased production per cow, which is currently 19,565 pounds of milk per cow. This marked improvement is the result of effective breeding, feeding, health, and management programs.

THE HORSE INDUSTRY

Global Perspective

The horse was domesticated about 5,000 years ago. It was one of the last farm animals to be domesticated. Horses were first used as food, then for war and sports, and also for draft purposes. They were used for transporting people swiftly and for moving heavy loads. In addition, horses became important in farming, mining, and forestry.

The donkey, descended from the wild ass of Africa, was domesticated in Egypt prior to the domestication of the horse. Donkeys and zebras are in the same genus (*Equus*), but are different species from horses. Horses mate with donkeys and zebras but the offspring produced are sterile.

Table 10 shows the world numbers of horses (59 million), donkeys (43 million), and mules (11 million). The five leading countries are given for each of the three species, with the United States leading in horse numbers while China leads in inventory of donkeys and mules.

Horses have been companions for people since their domestication. Once important in wars, mail delivery, farming, forest harvesting, and mining, the horse today is used in shows, in racing, in the handling of livestock, and for companionship, recreation, and exercise.

United States

There were no horses on the North American continent when Columbus arrived. However, there is fossil evidence that the early ancestor of the horse was here some 50–60 million years ago. The **Eohippus** (or dawn horse), a four-toed animal less than a foot high, is believed to be the oldest relative of the horse. Through evolutionary changes, the **Mesohippus** (about the size of a collie dog) was believed to have foraged on the prairies of the Great Plains.

The early ancestors of the horse disappeared in pre-Columbian times, supposedly by crossing from Alaska into Siberia. It is from these animals that horses

Table 10
WORLD HORSE, DONKEY, AND MULE NUMBERS

Horses		Donkeys		Mules	
Country	(mil head)	Country	(mil head)	Country	(mil head)
1. United States	9.0	1. China	7.0	1. China	3.0
2. China	7.0	2. Ethiopia	5.0	2. Mexico	3.0
3. Brazil	6.0	3. Pakistan	4.0	3. Brazil	1.0
4. Mexico	6.0	4. Mexico	3.0	4. Colombia	0.6
5. Argentina	4.0	5. Egypt	3.0	5. Morocco	0.5
World Total	59	World Total	43	World Total	11

Source: Adapted from FAO.

may have evolved in Asia and Europe. The draft horses and Shetland ponies developed in Europe, whereas the lighter, more agile horses developed in Asia and the Middle East. The Spaniards and colonists introduced modern horses to the Americas.

In the early 1900s, there were approximately 25 million horses and mules in the United States. Shortly after World War I, however, horse numbers began a rapid decline. The war stimulated the development and use of motor-powered equipment, such as automobiles, trucks, tractors, and bulldozers. Railroads were heavily used for transporting people and for moving freight long distances. By the early 1960s, horses and mules had declined to a mere three million in the United States.

With the shorter work week and greater affluence of the working class, there has been more time and money available for recreation. An estimated two million American horse owners and an additional estimated five million people acting as service providers, employees, and volunteers are involved in the industry. Approximately 3.5% of consumer expenditures for recreation are spent in the **horse industry**. The U.S. horse business generates more than \$25 billion in goods and services annually.

The American Horse Council estimates that there were 9.2 million horses in the United States in 2005, with about 43% utilized in recreational activities, 29% as show animals, 10% involved in racing, and the remainder utilized in rodeo, polo, ranch work, or other activities. The leading states for horse numbers are identified in Table 11. The export of horses generated more than \$513 million in 2008, with imports valued at \$323 million.

Table 11
HORSE POPULATION IN SELECTED STATES AND PRIMARY USE

State	Horses 1,000 (N)	Racing (%)	Showing (%)	Recreation (%)	Other ^a (%)
Texas	979	11	19	27	44
California	698	11	30	43	17
Florida	500	12	52	18	14
Oklahoma	326	20	34	10	36
Colorado	256	10	26	29	35
Ohio	326	21	34	35	9
Kentucky	320	45	21	25	10
New York	202	18	27	37	18
U.S. Total	1,200	10	29	43	18

^aIncludes agricultural, other sports, nonspecific breeding, etc.

Source: Adapted from American Horse Council.

Horse owners tend to be well-educated, upper-middle income (median income of \$60,000), and middle-aged. However, approximately one-third of horse owners have an annual income of less than \$50,000. The annual cost of horse maintenance ranges widely from \$1,000–\$15,000 per horse depending on region and use. Monthly boarding costs (stall space, bedding, and feed) are typically \$150–\$250 per head. Training and riding lessons would typically run from \$300–\$600 per month and \$20–\$50 per hour, respectively. Horse owners typically pay \$48–\$75 per horse for farrier service (horseshoeing and hoof care). The average cost of participating in a horse show ranges from \$100–\$540 per show.

Horse numbers in the United States increased rapidly from 1960–1976, with slower growth after that time period. Horse numbers declined in the mid-1980s when applicable tax laws (that removed some of the advantages of horse ownership) were passed by Congress. Horse numbers are slowly rebuilding at the present time. Interest in diverse horse activities has risen as evidenced by increases in membership of the American Driving Society, the U.S. Combined Training Association, and the U.S. Dressage Federation by 4%, 14%, and 23%, respectively, over the past half-decade.

THE POULTRY INDUSTRY

Global Perspective

The term *poultry* applies to chickens, turkeys, geese, ducks, pigeons, peafowls, and guineas. Chickens, ducks, and turkeys dominate the world **poultry industry**. In parts of Asia, ducks are commercially more important than broilers (young chickens), and in areas of Europe, there are more geese than other poultry because they are more economically important.

Chickens originated in Southeast Asia and were kept in China as early as 1400 B.C. Charles Darwin concluded in 1868 that domestic chickens originated from the Red Junglefowl, although three other Junglefowl species were known to exist.

Tables 12 and 13 show the leading countries in world poultry production and consumption.

World governments influence world poultry trade by controlling production and pricing and by placing **tariffs** on incoming goods—all barriers to free international trade. Trade liberalization by countries with industrial market economies would likely increase the trade of and decrease the price of poultry meat. Countries with efficient producers (such as the United States, Brazil, and Thailand), combined with consumers from countries with considerable trade protection (such as Japan, Canada, and the European Union), would benefit most from liberalized trade.

Table 12
POULTRY AND EGG PRODUCTION

Broiler	(mil ton)	Turkey	(mil ton)	Eggs	(bil eggs)
U.S.	18.4	U.S.	3.7	China	454.9
China	12.2	EU	1.8	EU	112.1
Brazil	11.3	Brazil	0.5	U.S.	90.1
EU	9.7	Canada	0.2	India	49.8
Mexico	2.8			Mexico	46.7
World	87.5	World	6.7	World	1,144.3

Source: Adapted from USDA, FAO.

Table 13
POULTRY AND EGG CONSUMPTION

All Poultry ^a	Per capita (lbs)	Eggs	Per capita (lbs)
Kuwait	158	Japan	42
Israel	158	China	37
Netherlands Antilles	140	Mexico	37
St. Lucia	130	Paraguay	35
Bahamas	123	Hungary	35
World	28	World	27

^aUnited States is 6th at 119.

Source: Adapted from USDA and FAO.

Table 14
POULTRY AND EGG IMPORTS-EXPORTS FOR THE UNITED STATES

Commodity	Exports (mil \$)	Imports (mil \$)
Chicken	3,514	618 ^a
Turkey	482	—
Eggs	323	22
World	5,052	917

^aAll poultry meat combined.

Source: Adapted from USDA.

Poultry is the fastest-growing source of meat for people. The industrialized countries produce and export more than 50% of the poultry meat in the world. Poultry exports account for more than five billion dollars (Table 14).

United States

The annual U.S. income from broilers, turkeys, and eggs exceeds \$30 billion (broilers, \$18.8 billion; eggs, \$8.2 billion; and turkeys, \$3.5 billion). Figure 16 shows the leading 10 states in broiler, turkey, and egg production. The U.S. poultry industry is concentrated primarily in the southeastern area of the country.

From 1900–1940, the primary concerns of the U.S. poultry industry were egg production by chickens and meat production by turkeys and waterfowl. Meat production by chickens was largely a by-product of the egg-producing enterprises. The **broiler** industry, as it is known today, was not yet established. Egg production was well established near large population centers, but the quality of eggs was often low because of seasonal production, poor storage, and the absence of laws to control grading standards.

Before 1940, large numbers of small farm flocks existed in the United States, but the management practices applied today were practically unknown. The modern mechanized poultry industry of the United States emerged during the late 1950s as the number of poultry farms and hatcheries decreased and the number of birds per installation dramatically increased. Larger cage-type layer operations appeared, and egg-production units grew, with production geared to provide consumers with eggs of uniform size and high quality. Large broiler farms that provided consumers with fresh meat throughout the year were established, and large dressing plants capable of dressing 50,000 or more broilers daily were built. The U.S. poultry industry was thus revolutionized.

AN OVERVIEW OF THE LIVESTOCK AND POULTRY INDUSTRIES

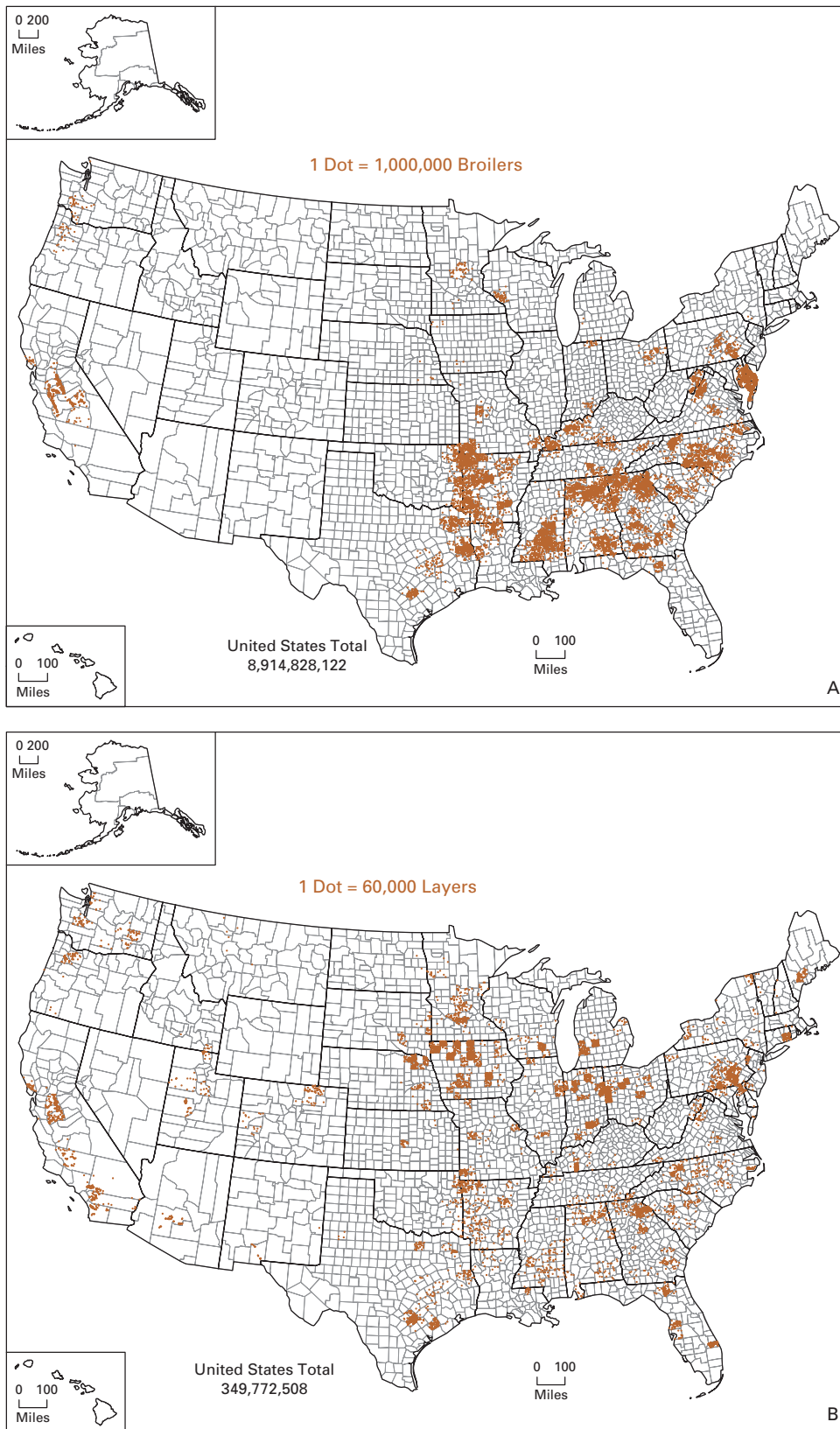


Figure 16

Concentration of broiler (A), egg (B), and turkey (C) production in the United States (million).

Source: Adapted from USDA.

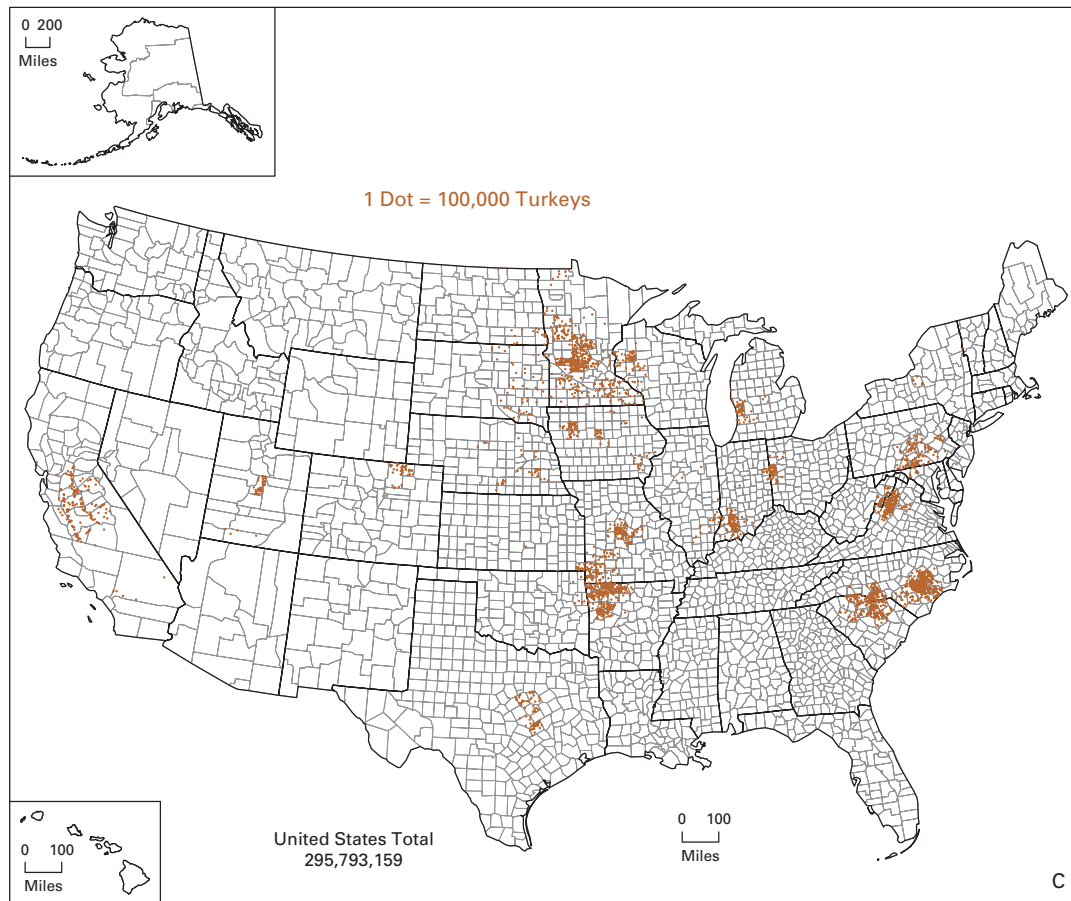


Figure 16 (CON'D)

One of the most striking achievements of the poultry industry is its increased production of eggs and meat per hour of labor. Poultry operations with one million birds at one location are not uncommon. Automatic feeding, watering, egg collecting, egg packing, and manure removal have accomplished significant labor reduction.

Dramatic changes came between 1955 and 1975 with the introduction of integration. It began in the broiler industry and is applied to a lesser degree in egg and turkey operations. Integration brings all phases of an enterprise under the control of one head, frequently the corporate ownership of breeding flocks, hatcheries, feed mills, raising, dressing plants, services, and marketing and distribution of products (Fig. 17). After 1975, poultry entered a new period of consolidation, in which vertically integrated companies purchased, acquired, or merged with each other, creating a small number of superintegrated companies.

The actual raising of broilers is sometimes accomplished on a contract basis between the person who owns the houses and equipment and furnishes the necessary labor, and the corporation that furnishes the birds, feed, field service, dressing, and marketing. Payment for raising birds is generally based on a certain price for each bird reared to market age. Bonuses are usually paid to those who do a commendable job of raising birds. An important advantage to the integration system is that all phases are synchronized to ensure the utmost efficiency.

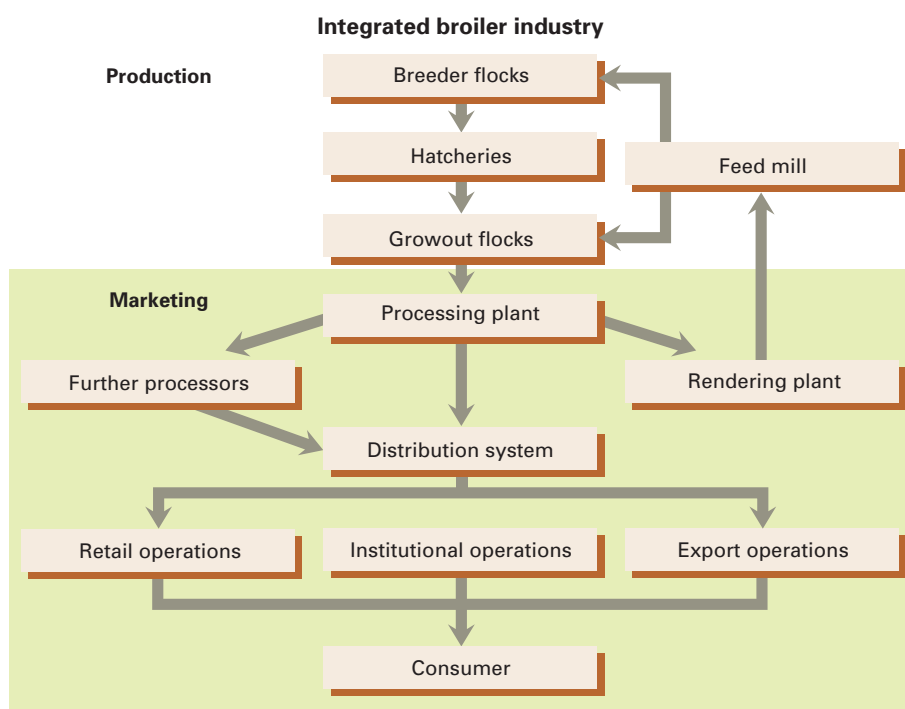


Figure 17
Structure of the integrated
broiler industry.

Broiler production is concentrated in the southern and southeastern states. California and Texas are the only states with large production located outside the “broiler belt.” The “broiler belt” includes Alabama, Arkansas, Georgia, Mississippi, North Carolina, and Virginia. This region produces two-thirds of U.S. broilers.

Broiler production has increased tremendously over the past three decades, from 3.7 million pounds of ready-to-cook broilers in 1960 to 48.8 million pounds in 2007. The U.S. broiler industry is concentrating its growout operations into fewer but larger farms.

Although the number of laying hens in the United States has declined over the years, egg production is higher because of improved performance of the individual hen. In 1880, for example, the average laying hen produced 100 eggs per year; in 1950, the average was 175; in 1986, it increased to 250; and in 2007, it was 263 eggs.

The USDA estimates that 85% of the market eggs produced in the United States are from large commercial producers (those that maintain 1–11 million birds). The 45 largest egg-producing companies in the United States have more than 97 million layers, which is 35.5% of the nation’s total.

Important changes have also occurred in U.S. turkey production. Fifty years ago, turkeys were raised in small numbers on many farms; today, they are raised in larger numbers on fewer farms. The average turkey farmer is producing well over 50,000 turkeys per year. The leading turkey-producing states are North Carolina, Minnesota, Virginia, and California.

Most of the turkeys produced today are the heavy or large, broad-breasted white type. At one time, the fryer-roaster-type turkey (5–9 lb) was popular; it bridged the gap between the turkey and the broiler chicken. Today, the broiler industry has taken over the fryer-roaster market because it can produce fryer-roaster chickens at a much lower price.

It takes 16 weeks for turkey hens and 19 weeks for turkey toms to reach market size. Because there is a heavy demand for turkey meat in November and December, turkey eggs are set in large numbers in April, May, and June. However, eggs are set year-round because there is a constant, though lower, demand for fresh turkey meat throughout the year. The normal incubation period for turkey eggs is 28 days.

In the recent past, most consumers considered turkey a seasonal product, with consumption occurring primarily at Thanksgiving. Increasingly, turkey is consumed throughout the year, and consumers have available to them a large variety of turkey products. The greater demand for turkey has meant that approximately one billion pounds more of ready-to-cook turkey is produced today than was produced in the early 1980s.

The export market has become increasingly important to the poultry industry with 20% of broiler production, 9% of turkey, and 2% of eggs sold to customers outside of the United States. However, disruptions in foreign markets can have significant impact on the industry. For example, when Russian buyers stopped purchasing U.S. chicken in 2001 and 2009, not only did broiler prices go down but the competing meats also experienced price slippage as the supply of animal protein overwhelmed short-term demand.

THE SHEEP AND GOAT INDUSTRY

Global Perspective

Sheep and goats are closely related, with both originating in Europe and the cooler regions of Asia. Sheep are distinguished from goats by the absence of a beard, less odor (males only), and glands in all four feet. The horns are spiral in different directions; goat horns spiral to the left, while sheep horns spiral to the right (like a corkscrew).

Sheep and goats are important ruminants in temperate and tropical agriculture. They provide fibers, milk, hides, and meat, making them versatile and efficient, especially for developing countries. Sheep and goats are better adapted than cattle to arid tropics, probably because of their superior water and nitrogen economy. Cattle, sheep, and goats often are grazed together because they utilize different plants. Goats graze **browse** (shrubs) and some **forbs** (broad-leaved plants), cattle graze tall grasses and some forbs, and sheep graze short grasses and some forbs. Many of the forbs in grazing areas are broadleaf weeds.

More than 60% of all sheep are in temperate zones and fewer than 40% are in tropical zones. Goats, though, are mostly (80%) in the tropical or subtropical zones (0–40°N). Temperature and type of vegetation are the primary factors encouraging sheep production in temperate zones and goat production in tropical zones.

Sheep originated in the dry, alternately hot-and-cold climate of Southwest Asia. To succeed in tropical areas, then, sheep had to adapt the abilities to lose body heat, resist diseases, and survive in an adverse nutritional environment. For sheep to lose heat easily, they require a large body surface-to-mass ratio. Such a sheep is a small, long-legged animal. In addition, a hairy coat allows ventilation and protects the skin from the sun and abrasions. In temperate areas, sheep with large, compact bodies, a heavy fleece covering, and storage of subcutaneous fat have an advantage. Sheep can also constrict or relax blood vessels to the face, legs, and ears for control of heat loss.

The productivity of sheep is much greater in temperate areas than it is in tropical environments. This difference is the result not only of a more favorable environment (temperature and feed supply) but also of a greater selection emphasis on growth rate, milk production, lambing percentage, and fleece weight. Sheep from

temperate environments do not adapt well to tropical environments; therefore, it may be more effective to select sheep in the production environment, rather than introduce sheep from different environments.

World sheep numbers of nearly 1.1 billion head in 2009 are the highest on record. China, Australia, India, and Iran are the leading sheep-producing countries (Table 15). Mongolia, Iceland, and New Zealand have the highest per-capita consumption of mutton, lamb, and goat meat.

The United States exports a relatively small amount of lamb and mutton with most of its export in the form of mutton from cull ewes (Table 16). However, Australia and New Zealand provide a significant amount of lamb to the U.S. market. The importation of lamb from Oceania is a point of contention in the U.S. **sheep industry**.

The 862 million head of goats in the world are concentrated primarily in India and China, with Pakistan, Afghanistan, and Bangladesh also having large goat populations (Table 17). In many countries, goats are important for both milk and meat production. Table 17 shows the leading countries in goat meat and milk production.

Table 15
WORLD SHEEP NUMBERS, PRODUCTION, AND CONSUMPTION

Country	No. Sheep (mil head)	Country	Production (bil lb) ^a	Country	Per capita Consumption ^b (lb)
1. China	136.0	1. China	2.2	1. Mongolia	87.0
2. Australia	79.0	2. EU	1.0	2. Iceland	54.0
3. India	65.0	3. Australia	0.8	3. New Zealand	52.0
4. Iran	54.0	4. New Zealand	0.6	4. Turkmenistan	42.0
5. Sudan	51.0	5. Iran	0.4	5. Kuwait	35.0
6. U.S.	6.0	6. U.S.	0.09	6. U.S.	1.0
World Total	1,078.0	World Total	9.1	World Average	4.0

^aCarcass weight of lamb and mutton.

^bSheep and goat meat combined.

Sources: Adapted from USDA and FAO.

Table 16
AVERAGE EWE FLOCK SIZE IN SELECTED STATES IN THE UNITED STATES

Range Flocks		Farm Flocks	
State	Ewes (N)	State	Ewes (N)
Wyoming	380	Minnesota	38
Arizona	280	Nebraska	45
Utah	167	Michigan	28
New Mexico	137	Pennsylvania	22
Nevada	193	New England	18

Source: USDA.