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National University of Life and Environmental Sciences
Department of Genetics, Breeding and Biotechnology of Animals

Breeding of agricultural animals

Poultry breeding

Methodical instructions for laboratory works on section «Breeding of agricultural animals »

To students of educational-qualification level «Bachelor»

Specialty - veterinary medicine

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from following themes: Special animal science. Poultry breeding.

For students of a specialty «Veterinary medicine of veterinary faculty» with the profound studying of English language.

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to students of educational-qualification level «Bachelor»
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CONTENTS

The modern poultry industry has seen remarkable growth over the past 50 years. Three major factors played a role in helping the poultry industry become the billion dollar industry it is today.

1. Scientific research: Since the early beginning of the poultry industry, **scientific research** has played a major role in helping the industry produce poultry eggs and meat more efficiently. Some important findings include the following:

a. Nutritional discoveries like Vitamin D, B12, feeding high-energy diets and the importance of amino acids and other essential nutrients.

b. Disease control like Pullorum, Marek's and the development of vaccines to help control disease.

c. Genetic improvements started by the "Chicken of Tomorrow Contest" help focus attention to a better meat-type chicken. Later, the 4-way cross helped develop extremely efficient and uniform birds.

d. Development of various technologies helped create automation and equipment to make incubation, production, and processing more efficient.

e. Knowledge related to managing the birds for optimum growth and improving management techniques resulted in better efficiency and high quality products.

2. Integration of the various segments of the industry and adopting industrial-like methods for the production, slaughter, and marketing of poultry meat and eggs. Integration will be discussed in more detail later.

3. The industry has also been innovative in developing new, convenient, further-processed, value added products that have replaced whole and cut-up chicken and whole egg sales. The percentage of whole and cut-up chicken sales has dropped from nearly 100% in 1960 to around 60% today. Products like breast tenders, cooked breast rolls, boneless wings, deli meats, ground turkey meat, liquid pasteurized eggs and an assortment of frozen pre-cooked meals has aided in the overall industries growth. Chicken has also become a mainstay of the fast food menus over the past 20 years.

Learning Objectives:

In this module you will learn to:

- identify trends in poultry meat and egg consumption
- locate centers of commercial layer, broiler, and turkey production
- chart trends in feed efficiency and growth rate of the meat bird industry
- list at least two reasons for the success of the poultry industry

- identify milestones in the life cycle of layers, broilers, and turkeys
- compare and contrast production models used in the poultry industry
- explain the role of crossbreeding in the commercial poultry industry

Definitions:

Vertical Integration: A business model that combines related marketing functions and decisions under a single company's control.

Economy of scale: Achieving higher production levels with fewer resources.

Contract production system: An agreement between an integrated company and an independent producer to coordinate production.

International primary breeder company: A company that develops genetic strains of chickens or turkeys with superior traits to help the integrator produce efficient birds for their specific product lines. It takes these companies about 5 to 7 years to develop a new line of hybrids for the market.

4-way hybrid cross: The commercial cross used in the poultry industry for the purpose of maximizing efficiency as well as protecting genetic stocks. Each line brings in separate traits in aid in breeding efficiency, growing efficiency or maximum carcass yield and efficiency. The 4-way cross in obtained by mating the cross of two male lines and two female lines.

Stunned: Process in which electric or gas is used to render the bird unconscious prior to it being killed. This process aids in proper bleed-out and keeps the bird from damaging the carcass and in loosing feathers for removal.

Offal: Inedible waste products composed of blood, feathers, heads, feet, viscera, as well as any condemned parts or whole birds. Offal is cooked, ground and dried at rendering plants where it is used in pet and animal foods or other by-products.

Statistics

1. This chart demonstrates changes in meat bird performance over the years. As you can see, the rate of efficiency has grown a great deal since 1950.

Change in Broiler Performance Over Time

Year	Live market weight (kg)	Feed efficiency (lbs. feed/kg of meat)	Percent Mortality	Age marketed (weeks)
1923	2.2	4.7	18%	16

1950	3.2	4.4	14%	14
1970	3.9	2.6	3%	10
1990	5.0	2.2	3%	8
2010	5.5	1.8	3%	5

2. Per capita consumption of poultry has also grown since 1960. Most noteworthy is the upward trend in the broiler consumption. During the period of 1950s-1970s, integration became the main business model, production efficiency improved, and transportation of grain and product became easier. This accounted for the gradual increase in broiler consumption over this period. From the 1970s to 2000 the growth has been marketing related. The poultry industry built on the movement toward a more healthy diet and the development of further processed convenience items. Turkey meat consumption has seen the same trends. However, without a main dish-type item for the restaurant market, turkey consumption has leveled off. Egg consumption dropped off due to the initial concerns with cholesterol consumption in the 1970s and 1980s. Future growth will likely be driven by global strategic alliances.

Per Capita Consumption of Poultry Meat and Eggs

Year	**Broiler Annual Consumption(kg. carcass weight)**	**Turkey Annual Consumption (kg. carcass weight)**	**Eggs Annual Consumption (eggs)**
1940	14.6	2.9	318.8
1950	20.8	4.2	391.4
1960	28.0	6.2	333.8
1970	40.1	8.1	308.9
1980	48.5	10.2	271.1
1990	70.3	17.5	234.1
2000	90.1	17.3	251.0

2008*	97.6	17.6	247.3

'Source: USDA/Economic Research Service. Data last updated Feb. 1, 2010.

Commercial Production Statistics

The production of poultry has become very concentrated within regions.

Most of the broiler production has become concentrated across the south and southeastern United States. This is due to the advantages of low cost land, labor, and transportation services. The egg industry has become concentrated across the mid-west grain belt on large multimillion bird complexes. This is mainly due to the fact that the egg industry is not as labor intensive and is located closer to the feed grain production and large consumer population areas. The turkey industry is located in a mix of lower cost areas and closer to feed sources. Turkeys also are not as heat tolerant and thus are not raised in the deep south.

The following three graphics show you the top ten producing states for turkeys, broilers and eggs in the United States. They show the total production and Pennsylvania production levels as of 2010.

The final graphic shows the change in the value of production for broilers, eggs, turkeys, and other chickens in the United States during the past ten years. Note the continued growth of the value of poultry meat over the past ten years.

Other Poultry Industries

While the three largest poultry industries (egg, broiler, and turkey production) are the most visible, there are a number of other prominent poultry industries.

The game bird industry raises pheasants, bob white quail, chukars and other species for hunting preserves and food. Most are raised in large flight pens as in the Photo A. These operations vary greatly in size from less than 100 birds to over 100,000 birds annually.

The duck industry is very similar to the broiler industry. However, there are only four major integrated companies that produce a majority of the ducks in the United States. Most waterfowl producers are small independent farms.

Photo A

The live bird market is active near large cities with diverse populations. This is an industry based on a way of marketing. Live bird marketers buy and gather poultry from various sources such as auctions and independent producers, then transport the birds to a hub or distribution center. The live birds are then sorted and distributed to a store in the city. In these stores, the live birds are then held in cages until a customer selects and buys the bird. The customer then pays on a price per kg basis and pays for the bird to be slaughtered according to their cultural standard. Birds for this market are often produced as part of an integrated company without the processing plant. See Photo B to the right.

Segway

You now have an idea of the location of and value generated by the commercial poultry industry. You've also had a brief glimpse of some less common poultry industry segments. On the next page you'll take a closer look at the unique business model that has helped the industry grow into a multi-billion dollar industry.

The Modern Poultry Industries - Vertical Integration of the Poultry Industry

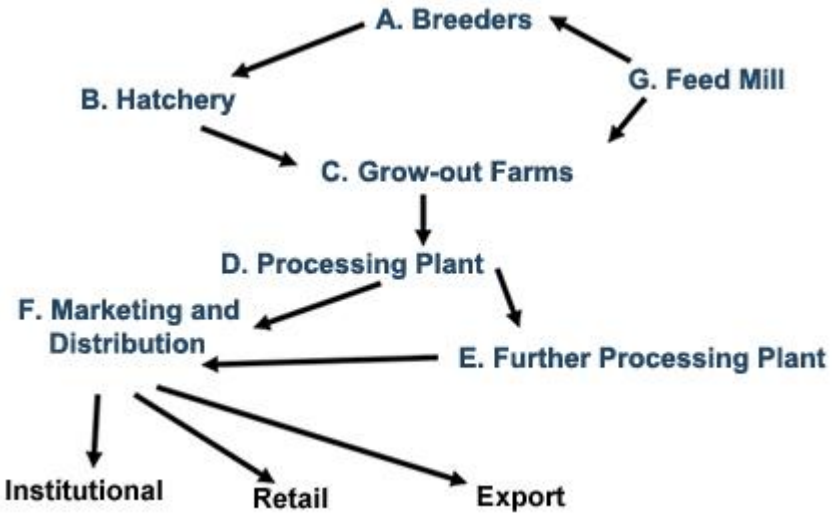
One of the reasons the commercial poultry industry has been able to produce meat in such an economic manner is vertical integration. This means one company owns and controls multiple stages of production like the breeder flocks, hatchery, grow-out flocks, processing plant, feed mill, transportation, and marketing. Vertical integration allows the company to control costs, to better utilize barn space, feed production capacity, gives them better control over product quality and consistency, and allows the company to use economy of scale to their advantage. The main cost advantages come from having control of the production capacity, elimination of individual profit centers, and buying feed and supplies in very large volumes.

As part of this model, the poultry industry also uses a contract production system. Under this system, an independent producer (farmer) provides the land, buildings, equipment, utilities, and daily care and management of the birds. The company supplies the birds, feed, and any necessary health or technical assistance. The company coordinates and provides delivery of chicks from the hatchery and catching crews and transportation at the time of harvest. The independent producer is then paid so much per kg of meat or per egg produced based on efficiency standards. The best producers are rewarded with bonus payments based on their relative performance. The growers that achieve better feed efficiency, lower mortality, and other cost and quality standards earn a premium. The system rewards efficiency and optimal bird care.

****A common misconception**: Some people refer to integrated production as factory farming due to the overall scale of production. A common misconception is that this model puts the family farm out of business. However, under the contract system the ability to build two or more poultry houses on a farm and have a guaranteed source of income has kept many family farms profitable and allows future generations to continue producing food by diversifying the farm income stream and reducing financial risk.

What follows is a more detailed discussion on how the vertical integration model works in the modern poultry meat industry. The egg industry is very similar with slight differences in who owns the breeders and feed mill or degree of integration.

Vertical Integration



Breeds

History

Domestication of the chicken dates back to at least 2000 B.C. The domestic chickens' ancestry can be traced back to four species of wild jungle fowl from Southeast Asia. However, the Red Jungle Fowl *(Gallus gallus* or *Gallus bankiva)* is the most commonly found wild species in the world today and is considered the main ancestor of the domestic chicken. The chicken belongs to the genus *Gallus* of the family *Phasianidae*. Domestic chickens are simply classified as *Gallus domesticus*.

Caption: Gallus Gallus wild chickens.

The sport of cockfighting had tremendous influence not only in the domestication of the chicken but also on the distribution of fowl throughout the world. After centuries of selection and breeding for numerous extremes, chickens now exist in many colors, sizes, and shapes. There are more than 350 combinations of physical features known today. In 1873, the American Poultry Association was organized for the purposes of adopting standards of excellence and establishing a way of classifying the various breeds.

Although the purebred poultry industry served as the foundation for the development of the commercial industry, the two industries soon developed very different types of domestic fowl. While the purebred exhibition industry continued to select and breed fowl for standard conformations and plumage colors, the commercial industry developed specialized hybrids for meat and egg production. Today, the two industries are very different. The purebred fowl of today are basically the same as they were 100 years ago and are mainly raised as a hobby, whereas the commercial poultry industry has developed into a science that produces highly nutritious meat and eggs with extreme efficiency.

Breeds and Varieties

The breeds and varieties of chickens are so numerous that it would be impossible to discuss all of them in detail at this time. However, a basic knowledge of how to identify and classify fowl may be helpful. Domestic fowl are divided into classes, breeds, and varieties.

Class: A grouping of breeds according to the geographic area of their origin or to similar characteristics.

Breed*:* An established group of individuals with similar physical features (i.e., body shape or type, skin color, number of toes, feathered or non-feathered legs) that when mated with others of its own kind produce offspring that have the same characteristics. The Plymouth Rock breed is a good example.

Variety: A sub-division of a breed. Differentiating characteristics including plumage color and pattern, comb type, and the presence of beards or muffs. For example, the Plymouth Rock breed is available in many colors - Barred, White, Buff, Partridge, Silver Penciled, etc. In each, the physical shape and features are the same, but the feather color and pattern differ, which constitutes each as a separate variety.

Some of the more common breeds and varieties of domestic chickens include:

1. **New Hampshire Red** (shown on the right) have yellow skin, lay brown-shelled eggs and have orange-red adult plumage. This is a dual-purpose breed which means it has been selected for both a meaty body and to produce eggs.

2. **Rhode Island Red** are similar to New Hampshire Reds except they are usually better layers and Rhode Island Reds have deep-red adult plumage. The chicks of Rhode Island Reds are brown in color.

3. **Barred Plymouth Rock** are dual-purpose chickens that have gray and white striped plumage. The black fluff with a white spot on the tops of their head easily identifies the chicks. This breed was developed in America during the 19th century.

4. **Cochin** are mainly raised as ornamental fowl, but the females are frequently used to naturally incubate and brood the chicks of other fowl. The Cochin's origin is traced to China but the big, fluffy balls of feathers as we know them today were further developed in America. Cochins have feathered shanks and have extremely loose, soft feathers that give them their fluffy appearance.

5. **Cornish** were developed as the ultimate meat bird and have contributed to build the vast broiler industry of the world. The Cornish originated in England.

6. **Leghorn** are grandparents of our modern white-egg industry. Originating in Italy, the Leghorn has a large single comb and is flighty by nature.

Some of the more unusual breeds and varieties of domestic chickens include the following:

1. **Polish**is another unusual and beautiful breed. They have a crested or hat of feathers on top of their heads.

2. **Frizzle** (as shown on the right) have a genetic modification that causes the feathers to curl back towards the bird's head instead of lying naturally.

3. **Naked Neck** have a bare neck totally absent of feathers. This single gene trait affects the arrangement and number of feathers over the chicken's body.

4. **Silkie**is a blue skinned chicken used for ornamental purposes. Some hybrids have been developed for the live bird market. This breed of chicken appears to have hair instead of feathers. This is a genetic trait that causes abnormal texture and appearance of the feathers.

5. **Ameraucana**were discovered in South America and are nicknamed Easter egg chickens because of the blue and green eggs they lay. This is again a genetic modification in which a blue cuticle is applied to the egg. When introduced to brown egg layers, the result is an olive-green shell; introduced to white egg layers, the result is a blue shell.

Bantams are the miniatures of the poultry world. The word "Bantam" is the term used to classify the over 350 breeds and varieties of true-breeding miniature chickens. There are bantams of almost every breed of large chicken, but there are some types of which there is no large counterpart. Bantams are purebreds raised for exhibition and hobby. Their small size and numerous shapes, colors, and personalities give them a broad appeal to people who live in urban areas. This illustration shows two males that were hatched on the same day. Both are White Wyandotte's. The one on the left you see a large fowl and on the left a bantam. The only difference between them is the size. The bantam is about 1/5th scale.

Commercial Poultry

Over the years, traditional breeds have lost their commercial importance since they are not as efficient at producing meat and eggs. Crossbreeds and hybrid strains have been developed into the modern chickens and turkeys used by today's industry.

All meat and egg poultry raised commercially have been developed by an international primary breeder company. These birds have been selected to produce an extremely efficient hybrid line specific for the company's product lines.

Egg Cycle

In the modern *egg industry*, most laying hens are hybrid White Leghorns (white egg producers) or sex-linked hybrids that resemble New Hampshire Reds and Barred Plymouth Rocks (brown egg producers). Sex-linking is where a plumage trait, like slow feathering or a certain color pattern, is linked to the sex chromosome so that there is a distinct physical difference between the sexes of day-old chicks. This saves time and money separating the females for egg production. Today's egg producing hens can produce over 300 eggs per year; this is over twice the average of 150 eggs per year in 1947.

Primary Breeders

The primary breeders and multiplier flocks are owned by an international breeder company.

Breeders are raised in a slatted floor house with automatic watering, feeding, and egg collection systems. The slatted floors allow the birds to actively function on a floor surface while allowing the manure to fall through the slats into a manure pit. This keeps the birds and eggs cleaner.

Males and females are allowed to mate naturally. Females begin producing eggs around 20 weeks of age and will lay efficiently until about 85 weeks of age. Both white-shelled and brown-shelled egg lines are produced depending on the desired egg market. The only difference is the color of the egg shell and the breed of bird that we use to produce the egg. Brown egg birds are slightly less efficient at egg production per kg of feed than are white egg producers, mainly because the brown egg laying breeds are larger bodied and require more feed for body maintenance.

Poultry Timeline

Hatching eggs

It takes a female between 23 and 32 hours to produce a fertile egg. The eggs are automatically collected daily, transported to the hatchery and stored at 13-18° C and 70% humidity until they are set in the incubator. The eggs are held here for about three to seven days prior to placing in an incubator. One fertile hatching egg is worth $.28 and weighs around 60g.

Further processing changes the product into something more convenient or useful in another form. Liquid and dried eggs are used in a wide array of consumer products. Convenient pre-cooked egg products are also more common at food stores and restaurants. This also adds more value to the final product.

Broiler Life Cycle

The modern *broiler industry* has developed a hybrid that is unlike any other breed. The initial breeds used in modern broiler hybrids were Cornish and Plymouth Rocks. Today's broiler can achieve a 2,25-kg market weight in five weeks. Forty years ago, it took 10 weeks to achieve a 1,81kg market weight. These advances are the result of scientific progress in genetic, nutritional, and environmental research.

Primary Breeders

The primary breeder flocks are owned by an international breeder company. These flocks produce highly efficient breeding lines (parent lines) that are sold to the integrated broiler companies. Chicks

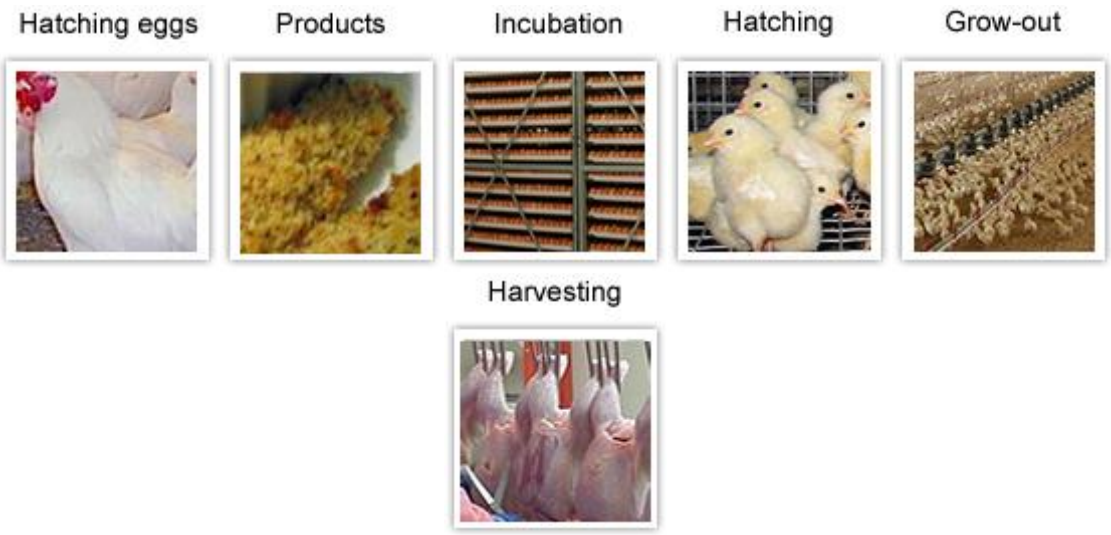
are hatched at the breeder's hatchery and then sold and delivered to the integrated companies' parent breeding farms.

Parent Stock Breeders

Once the chicks arrive at the integrated company's breeder growing farm, the birds are raised to 20 weeks of age under environmentally controlled conditions. Controlling the length of daylight is extremely important. Breeders do not receive more than 10 hours of light daily as they are growing so they are not prematurely stimulated to lay eggs. During the 20 weeks of the grow-out, each bird will eat 30-35 kg of feed and will grow to 6-8 kg. Once they reach 20 weeks of age, they are transported to the breeder farm.

The parent breeders are the birds that produce the fertile eggs that will become the broiler chickens that are harvested for meat. Breeders are raised in open floor houses with automatic watering, feeding, and egg collection systems. Males and females are allowed to mate naturally. Females begin producing eggs around 24 weeks of age and will lay efficiently for 40 weeks per cycle. An average broiler breeder female will lay 150-180 eggs in a year.

Broiler Timeline



Hatching eggs

When the broiler breeder female reaches 24 weeks of age, she will be laying. It takes a female between 24 and 32 hours to produce a fertile egg. The eggs are automatically collected daily, transported to the hatchery, and stored at 55-18° C and 70% humidity until they are set in the incubator. The eggs are held here for about three to 10 days prior to being placed in an incubator. One fertile hatching egg is worth $.28 each and weighs around 65g.

This is where we make the product more convenient as well as add value to the product. In the meat industry, further processing means something is done to the whole carcass such as cut-up, deboning, and fabricating poultry meat into value-added products. The cut-up operation is often done at the processing plant. However, some companies ship the whole carcasses to the further processing plant for specialized cut-up. Cut-up is where machines cut the whole carcass into individual parts. Deboning is where the bones are removed from specific parts to produce items like breast filets or other boneless products.

Value added refers to fabricating the carcass into consumer-ready products that requires additional time or labor. These products usually involve seasoning, breading, sauces, and marinating, as well as special packaging to meet market demands for convenient products. The added value result in higher margins and profits while providing a large product choice for the consumer.

Turkey Life Cycle

The modern ***turkey industry*** has developed a hybrid white turkey that is larger and faster growing than purebred or wild turkeys. The modern hybrid turkeys are so large they can no longer naturally breed efficiently. All modern turkeys are artificial insemination. Artificial insemination allows selective breeding of the sexes so breeders can raise fewer males and achieve higher rates of hatchability.

Primary Breeders

The primary breeder flocks are owned by an international breeder company. They produce highly efficient breeding lines (parent lines) that they sell to integrated turkey production companies. Poults are hatched at the breeder's hatchery and then sold and delivered to the integrated companies' parent breeding farms.

Parent Stock Breeders

Once the poults arrive at the integrated company's breeder grow-out farm, the birds are raised to 28 weeks of age under environmentally controlled conditions. Controlling the length of daylight is extremely important. Breeder turkeys are never allowed more than 10 hours of light daily as they are growing so they are not prematurely stimulated to lay eggs. During the 28 weeks of grow-out, hens will grow to 11-13,6kg and eat about 46kg of feed. Males will grow to 23-32kg and eat over 90kg of feed. Once they reach 28 weeks of age, parent breeding stock are transported to the breeder farm.

The parent breeders produce fertile eggs that will become turkeys harvested for meat. Female breeders are raised in open floor houses with automatic watering, feeding and egg collection systems. Males are raised in floor pens at separate facilities. Since natural mating puts the female at risk of injury commercial meat turkeys are all bred artificially. This is unique in the poultry industry. Toms are raised separate from the hens, semen is collected from the toms, and hens are artificialy inseminated once every seven days depending on fertility rates. Females begin producing eggs around 28 weeks of age and will lay efficiently for 26 weeks. An average turkey breeder female will lay 100-130 eggs per laying cycle.

Turkey Timeline

Products

Hatching eggs

Once the turkey breeder female reaches 28 weeks of age they will start laying. It takes a female between 24 and 32 hours to produce a fertile egg. The eggs are automatically collected daily, transported to the hatchery, and stored at 13-18°C and 70% humidity until they are set in the incubator. The eggs are held here for about three to 10 days prior to being placed in an incubator. One fertile hatching egg is worth $.88 each and weighs around 86g.

Activities

- **Animal Welfare**Learn how the turkey industry ensures the health and well-being of its flocks.
- **Antibiotics**Hear about the importance of animal antibiotics and how they have been used for more than 50 years to maintain the well-being of turkey flocks and to ensure safe products
- **Animal Health**See how the turkey industry is working to protect its flocks –and your food supply - by following strict farming policies and protocols.

Management of Poultry

Incubation

Incubation means maintaining conditions favorable for developing and hatching fertile eggs.

In nature, the female bird (hen) picks the nest site and lays a group, or clutch, of eggs (usually 8 to 13 eggs), one egg per day. Once she has a clutch of eggs, she begins sitting on the eggs all the time, leaving only for food and water. This time is called the incubation period. The hen's body temperature is 40–42C°. When she sits on the eggs, the center of the egg heats to 37.5-38°C. The hen turns the eggs on a regular basis by using her beak to scoop under the egg and roll it towards her. The humidity (moisture) comes from the environment, the hen's body, and any moisture the hen brings back to the nest on her feathers.

We have replaced the hen with a machine called an **incubator**. The incubator adds warmth and moisture. We turn the eggs, but everything else needed to nourish and protect the growing embryo is self-contained in the fertile egg.

Four factors are of major importance in incubating eggs artificially: temperature, humidity, ventilation and turning. Extensive research has shown that the optimum incubator temperature is around 99° F when relative humidity is 60%, concentrations of oxygen 21%, carbon dioxide 0.5%, and air movement past the egg is at 12 cubic feet per minute.

Hatching times for various species of poultry **(days required to hatch):**

Chicken (21)
Bobwhite quail (23-24)
Pheasants (24-26)
Guinea(27-28)
Turkey (28)
Most domestic ducks and geese (28)
Muscovy ducks (35)

Feeding poultry has become a science in itself, yet feeding poultry has been made very simple. All poultry diets are based on a mixture of corn and soybean meal with supplemental vitamins, minerals

and amino acids to meet the bird's needs. Most small poultry producers buy bagged feed for a specific type and age of bird. Large companies have their own feed mills that produce many tons of feed daily.

For layer and breeding stock

- 0 to 6 weeks - Starter (20% protein)
- 6-18 weeks - Grower (14-16% protein)
- 18 weeks - Laying (16-18% protein)
- Supplement Oyster shells to laying birds for added calcium

For meat type birds

- 0 to 4 weeks - Starter
- Chickens (20-24%)
- Turkeys and game birds (24-28%)
- 4 weeks to market age – Grower/Finisher (18-22% protein)
- Chickens (18-20%)
- Turkeys and game birds (20-22%)
- Increase floor, feeder, and water as birds grow

Rearing Poultry

Most poultry are raised in confinement facilities where the birds' environment and lighting can be controlled. Each type of bird has its own challenges and needs throughout production. Managing the birds properly is important to the birds' well-being and efficiency.

Temperature and brooding area layout is key to success in brooding poultry for the first week. Layers and purebred fowl need to be started at 33-35C°, while broilers and turkeys should be started at 31-

33 C. In all cases temperature requirements decrease –15C° per week until the temperature reaches 21°C or the environmental temperature.

Placement of the feed, water, and heat is an important part of brooding. Feed and water equipment should be positioned so the birds have a direct path to and from the heat. Water and feed should be available in each direction from the heat source. Brooding turkeys requires special precautions. If corners and low spots are present, poults will pile up and suffocate themselves.

Lighting is an important management tool. Two factors that need to be managed are light intensity and the length of the lighting period. Birds see at a different light spectrum than humans and thus require lower levels of light. During the first week of life, birds receive about 5 foot-candles of light. However, after the first week, light levels are reduced to between .5 and 1 foot-candles. This seems like very dim light to the human eye, but more intense light can be stressful for poultry and create management issues.

Lighting period changes with the age of the bird. Young chicks and poults are usually started with full light (24 hours of light) for the first week. After the first week, lighting programs change with the birds needs. Meat birds will usually have at least 18 hours light daily until harvest. Length of lighting for layers and breeders will decrease to 10 hours light daily from 10 - 18 weeks of age. The lighting period is then increased to bring the birds into production. Initially, light is increased to 12 hours at 18 weeks of age then increased by 15 minutes a day to a maximum of 16 hours.

Layers must have 16 hours of light daily to produce eggs efficiently.

Health and bio-security for food safety

The three major components of bio-security are isolation, traffic control, and sanitation.

Isolation refers to keeping birds from contact with other birds that may carry a disease. The most common form of isolation is the confinement of animals within a controlled environment. An enclosed or fenced area keeps birds in, but it also keeps other birds and animals out. Other good isolation practices include separating birds by species and age group. For large poultry operations, all-in/all-out management requires depopulation of the entire facility between flocks and allow times for cleaning and disinfection to break the cycle of disease.

Traffic control refers to not allowing traffic onto your farm and not allowing workers on your farm to visit other poultry farms.

Sanitation requires that all vehicles, equipment, and people entering the farm are properly cleaned and disinfected prior to having access to the farm. Farm labor must practice general sanitation guidelines before entering a production facility. Proper cleaning and disinfection of all buildings and equipment between flocks is also important to break disease cycles.

Infectious diseases can be spread from farm to farm in the following ways:

- Introduction of diseased birds or animals

- Introduction of healthy birds who have recovered from disease but are capable of carrying the disease to other birds
- Shoes and clothing of visitors or caretakers who move from flock to flock
- Contaminated vehicles that travel between farms
- Carcasses of dead birds that have not been disposed of properly
- Rodents, insects, cats, wild animals, and free-flying birds
- Contaminated feed

Past disease outbreaks almost always have been caused by the introduction of new birds to an existing flock and the movement of people and vehicles between farms without proper cleaning and sanitation. Proper management of the flow of people, equipment, and birds should be a top priority of the farm bio-security plan to limit the risk to bird health.

Manure management

Poultry produce a large amount of manure. Fortunately most poultry manure is rather dry and can be easily and economically transported to distant cropland where the nutrients can be effectively utilized by growing plants. However, poultry manure is high in nitrogen and when composted make a highly valued soil amendment. All poultry farms are required to have a waste management plan to properly use the manure it produces. These pictures show two types of manure composting facilities commonly used in the modern industry.

Marketing

A large part of the poultry industry's success has been company branding or labeling. When poultry companies started to integrate, they quickly realized the need to promote and distribute poultry products that customers demanded. Product and brand name promotion enabled companies to increase market share.

Another important strategy was developing convenient products that the consumer wanted to buy. These value-added products have also improved sales and increased market share.

Today, you can walk into any supermarket and be confronted with a wide range of poultry products sold by multiple poultry brands. Additionally, most restaurants have multiple poultry items on the menu. Effective marketing combined with the efficient cost of production is why the per capita consumption of poultry has increased over the past 20 years.

Production Models

Housing (Production models)

The poultry industry is very diverse and ranges from small backyard production to very large integrated self-contained complexes that raise millions of birds on one farm. A "production model" is a fancy way of differentiating among types of facilities.

Regardless of the production model, a good poultry house needs to provide for the birds' needs. A poultry house should provide;

Protection from:

- Temperature, draft, and moisture
- Injury
- Predators

A poultry house should provide appropriate space for the type of production model used. For small backyard coops with manual watering and feedering; plan on 1 sq m of bird inside space and 10 sq mbird for outside runs. For floor houses with automatic water and feeders plan for the following:

White egg layers	1 to 1.5sq m/bird
Brown egg layers	1.2 to1.5 sq m/bird
Broiler chickens	0.75 to 1.5 sq m/bird
Turkeys	
0-8 weeks Hens	1.0 sq m/bird
Toms	1.5 sq m/bird
After that Hens	2.0 sq m/bird
Toms	3.5 sq m/bird
For cage production	67 to 86 sm per laying hen

There should be continuous access to feed and water with good ventilation. The poultry house should be easy to clean and allow birds to be separate from manure with an appropriate lighting program and a well-kept appearance.

The model used to raise poultry does not always indicate the size or scale of production. There are examples of very small and very large scale production under each of these models. Today, a majority of poultry meat and egg production falls under one of the following four production or housing models. Most industry organizations have developed standards for human production practices, as well.

Range (Pasture)

With this production model, birds are raised on the ground in open fields or pastures much like we did 70 years ago. These pictures are of a few mobile coops that can be moved around a pasture. The idea is for the birds to always have access to fresh greens and the outdoors. The birds must still be in a fenced area for protection and still must be fed a supplemental diet, since chickens and turkeys are not able to survive and be productive on nutrients they consume from the pasture alone. Some semi-automatic systems have been adopted to decrease labor. However, this type of production model requires more labor and land per kg of product produced. Other issues include the birds being exposed to more parasites, diseases, and predation. Picture A shows a very small mobile layer coop with a temporary mobile fence. Picture B is a more permanent chicken coop in a permanent fenced pasture area.

Photo A

Photo B

Confinement house (Cage free)

All commercial meat chickens and most cage free eggs are produced using this model. This model confines the birds to a large indoor area and usually provides automatic water, feed, and egg collection. The biggest technological change over the past ten years has been the type of ventilation used to better control the environmental conditions in the large poultry houses.

Picture C, pictured below on the left, is of a modern tunnel ventilation broiler house. Notice the automatic water and feed lines.

Photo C

Photo D

Picture D, pictured above to the right, is of a cage free layer house called an aviary. Birds are allowed to roam free in areas of the house. All feed, water, and egg collection is automated.

Cage

A majority of modern egg production is currently using this production model. In this environment, the birds are raised in a cage with a wire floor so that the manure falls to a wide belt that removes it from the house. The eggs roll out of the cage immediately, and a belt collects the eggs at least daily. The main advantage is the egg is not allowed direct contact with the manure and the hen is never

exposed to earth-borne parasites or disease. Water, feed, amount of light, and all aspects of the environment are automatically controlled. A complex like the one in Picture I can hold 4.5 million hens and produce over 4 million eggs daily. In this picture notice the feed mill is located in the middle so the feed is automatically delivered to the hens to eliminate feed transportation costs. At the far left side of the picture you can see the tanks that hold the liquid eggs processed from eggs produced at this facility.

Photo E

Picture E shows how the facility looks inside. Notice the multiple story cage system. This system allows for very high egg production on less land area. There has been a great deal of discussion from humane groups as to which production model is best. We will discuss this in the next section.

Organic

To sell organic products, the poultry must have outdoor access, must have all certified organic inputs, and the operation has to be certified organic. Most organic operations use a range/pasture or combination of a large indoor coop with an outside fenced area for the birds to access.

Modern Breeding Practices

When the poultry industry started, poultry was produced locally for home meat and egg consumption. So farmers bred dual-purpose chickens, because they produced both eggs and meat from the same flock. Once the industry started, mature birds were selected to specifically produce either eggs or meat.

The modern poultry industry has developed very specialized genetic lines of birds to produce eggs and meat in an efficient manner. International primary breeder companies have developed extremely efficient hybrid lines specifically for the products the industry is trying to produce. All the parent stock these international companies produce are 4-way hybrid cross chicks that are then grown to produce the meat or eggs we consume.

The following content will discusses the basics of the modern breeding and selection for the layer, broiler, and turkey industries in more detail.

Commercial Breeding Design

The 4-way cross used in the commercial poultry industry protects genetic lines while allowing commercial companies to harness the best production qualities found in the grandparent lines. Each grandparent line excels in one or more economically important trait. Crossing of the grandparent lines infuses these traits into a multi-trait parent line. When parental lines are crossed, the offspring have all the economically important traits needed for the birds to efficiently produce meat or eggs. In addition, the 4-way cross maximizes heterosis. It takes between five and nine years to develop and introduce a new line of birds to the market.

	Male Lines		Female Lines	
Pedigree	A	B	C	D
Great-grandparents	A x A	B x B	C x C	D x D
Grandparents	A	B	C	D
Parent	AB		CD	
Commercial Meat or Egg bird	ABCD			

Primary Breeder - Layers

Today, there are only three major genetic breeding companies that supply birds to the commercial layer industry. Hy-Line supplies a majority of the birds raised for egg production in the United States. The Hendrix group has purchased a large number of smaller companies over the past few years and supplies most laying chickens in other countries.

The modern breeding company goal is simple. They are always trying to develop a bird that lays more high quality eggs at a lower cost.

Selection Factors in Layers

Genetic companies develop genetic lines used for international egg production. The modern genetic companies use computer-assisted selection to analyze data sets using breeding value estimations. They then make selections that will improve as many traits as possible for each breeding line they develop.

Production-related traits like temperament aid in the management of the birds and their overall livability. The overall goal is to improve the production traits to get more eggs from each hen using less feed. However, none of the production improvements can be done at the cost of egg size or quality. It is a balancing act to develop the best bird for the job.

Primary Breeders - Broilers

Today there are only two major genetic breeding companies that supply a majority of the birds to the commercial broiler industry. Cobb supplies a majority of the birds raised by Tyson. The Aviagen group is also a major player of the number of the birds used in the broiler industry in the U.S. and worldwide. Perdue has developed its own genetic lines to supply their company's needs.

Today's Broilers

Today's broiler is very different than the one produced when the industry was beginning in the 1950s.

This photo is courtesy of Dr. Havenstein, past department head at North Carolina State University.

Here is cross section of the breast of a 1957 model (left side) at 42 days of age (0,59 kg.) compared to a 2001 model (right side) at 43 days of age (2,905 kg). Most of the obvious differences result from genetic selection. However, nutrition and management improvements also play a role in the efficiency with which the poultry industry produces meat today.

Difficult as it may be to believe, the drastic changes represented in these photos are a result only three tools: conventional breeding methods, better nutrition, better housing and management.

Here's how the genetic part worked. Rapid genetic change can be made for animals that have a short reproductive span. This is called a "generation interval". Chickens can turn two generations per year. And one hen might lay 160 eggs in that 6-month period and could potentially have 160 offspring. Say we take all the offspring from a pair of chickens and keep only the fastest growing ones (or the ones with the most breast meat) to use for breeding stock for the next generation, then keep doing the same thing for 5 years (10 generations), we can end up with a bird that gains weight extremely rapidly (or has an awful lot of breast meat). Compare this to the rapid domestication of the Russian foxes we discussed earlier in the course. It's the same concept.

Notice that the word "hormones" is not included in the list of tools. **There are no hormones used in the poultry industry.** Even so, the word "hormone" is not a dirty word. There are hormones in every bite of food you consume. They have to be there because without hormones, both plant and animal life would cease to exist. There are two types of hormones. Protein hormones, if consumed, are digested (and reduced to their individual amino acids) the same as any other protein. Steroid hormones are the ones you typically think of – such as estrogen and testosterone. Both estrogen and testosterone are required for reproduction in people and animals. Actually, green leafy vegetables have much more

estrogen in them than any animal product you might eat. And both estrogen and testosterone arise from that other dirty word – cholesterol. It's beyond the scope of this course to explain the physiology of meat producing animals, but scientists with expertise in the hormonal control of growth understand that hormones are part of life. The only place hormones are used in the meat animal industry is in finishing beef cattle. We will discuss this more in the beef cattle module.

Antibiotics

What about antibiotics in the poultry industry? There are certain large-scale production systems that market antibiotic-free poultry. It usually costs a little bit more to raise poultry without antibiotics because more birds die or get sick during grow-out. In addition, litter in the barn floors must be completely cleaned out and replaced for each antibiotic-free flock, which adds additional expense. Nevertheless, consumers have shown they are willing to pay more for birds raised without antibiotics.

I asked Mike Hulet, Penn State's meat bird extension specialist to comment on feed additives used in the meat bird industry. Here was his reply:

"All additives that are used in broiler feed can be categorized in the following areas:

1. Antibiotics: used for growth promotion and disease treatment in conventional production. Not used for Natural, ABF (Antibiotic Free production), or Organic Production.
2. Anticoccidials: Control coccidiosis (an intestinal parasite) and increase growth rate. Used in conventional and natural production.
3. Probiotics and Prebiotics: "Good" bacteria and essential oils that improve gut health. These are used mostly for antibiotic-free and organic production.
4. Organic acids: Used to acidify gut to prevent pathogenic (bad) bacteria from flourishing.
5. Feed grade vaccines are used to build resistance against disease challenges.

Depending on the market, production system, and specific health challenges to the birds, these can be used in varying combinations - usually only one or two will be used at a time.

When antibiotics are used, the antibiotic is eliminated from feed for a period of time prior to slaughter so that the antibiotics have a chance to clear the birds' system. Random samples are taken prior to slaughter to ensure that no residues remain."

You'll learn a lot more about the inspection and the quality control process in a later module.

Selection Factors

The modern genetic companies use a great deal of computer capability to analyze data sets to create breeding value estimations. They then make selections that will improve as many of these factors as possible for each breeding line they develop. The broiler breeding companies now select for a wide

array of factors such as the following, that are important to optimize efficiency of production of broiler meat.

- skeletal integrity
- cardiovascular fitness
- feed conversion
- immune response
- growth profiles
- egg production
- hatchability
- live weight
- breast yield
- meat quality

Broiler Sizes by Product Type

Broiler companies also raise very different genetic lines of birds to meet specific product lines the company supplies to the consumer. Birds raised to a lighter harvest weight can be a very fast growing bird to a 4 kg target weight. Alternately, larger birds used for deboned breast filets and other further processed products may grow a bit slower initially to assure a sound structure before the final fleshing (meat) develops on the bird.

A.*Fast food parts 1,82 kg*

B.*Tray pack 2,49 kg*

C.*Deboning 1,90-2,63kg*

Primary Breeders - Turkeys

Today there are only two major international genetic breeding companies that supply birds to the commercial turkey industry. There are some small heritage or purebred breeders of turkeys for small scale producers. However, the commercial large breasted whites raised today come from one of two main genetic companies.

Commercial Turkeys

The genetic variation of every white turkey raised in the commercial industry is very small. All commercial turkeys can be traced to 12 white birds, and only two large commercial breeding companies exist.

Selection for meat turkeys is very similar to that of meat chickens. Traits like structure, meat yields, efficiency, and livability are very important. However, egg production and the hens' tendency toward broodiness (hens want to incubate the eggs) create special challenges to the turkey breeding industry.

Another major challenge when breeding meat turkeys is the overall size of the breeding toms. Toms (male turkeys) can weigh over 70 kgs. Since natural mating puts the female at risk of injury, commercial meat turkeys are all bred artificially. Turkeys are the only poultry species that utilizes artificial insemination. Toms are raised separately from the hens, semen is collected from the toms, and hens are artificially inseminated once every seven days depending on fertility rates.

Poultry Organizations

The following are a list of major poultry organizations and links to the web sites.

Support Resosurces

- Penn State Poultry Extension Resource Page Excellent site to find any and all types of poultry information.

Career Options

The tremendous growth of the poultry industry has created a high demand for motivated, innovative, educated, and caring employees. Job placement for college graduates with training in the poultry sciences continues to be virtually 100%. Graduates with the poultry minor typically receive multiple job offers and have had an average starting salary between $36,000 and $42,000 upon graduation from college.

If you are interested in science, biology, management, nutrition, product development, technology, or health the poultry industry has opportunities available for you. The poultry industry needs people in the following fields of interest:

1. Hatchery management
2. Production management
3. Research and development
4. Byproduct utilization
5. Ventilation and engineering
6. Processing
7. Veterinary science
8. Independent auditors
9. Quality assurance of inputs and products
10. Food science
11. Nutrition
12. Genetics
13. Feed mill management
14. Microbiology
15. Product development
16. Marketing
17. Sales
18. Economics

19. Nutrient management

Discussion Forum

Popular press article critique #1

Society has a great interest in animals.. Journalists earn a living by taking stances on topics, but often stances on animal stories are poorly researched. One-sided articles are used as a source for the next one-sided article. One of the goals for this course is to give you enough information about animal husbandry practices so that you can identify popular press articles that inaccurately represent realities of the animal industries.

1. Instructor will assign you to a group of four students. (Groups will remain intact for both critiques).

2. Each group is responsible for identifying an article or story that criticizes an animal use in the Ukraine, Europe, world. This may include animal housing methods, animal management techniques, animal impacts on the environment, etc.

3. Groups should work together to highlight **at least two areas** in the article where the facts or industry understanding are accurately represented **and at least two areas** where the facts or industry understanding are misrepresented. In addition, **papers must address the issue in light of inexpensively feeding a higher world population on the same or dwindling land area, if applicable**.

4. Information to confirm or refute article statements can originate from class materials or independent on-line investigation. Citations of factual information must be provided.

Paper Format:

Paper should be 2-3 pages in length, Times 12 font, and 1.5 line spacing. Paper should also include the following:

a. Introductory paragraph explaining the context of the article or story including where (website, newspaper, magazine, etc.) it was published. An accurate URL must be included so the instructor can view the article.

b. Paragraph(s) on article accuracies

c. Paragraph(s) on article inaccuracies

d. Concluding paragraph summarizing your group's assessment of the author's viewpoint, goals for writing the article, and thoroughness of the author's background research.

e. Citations

Helpful websites:

1. http://www.feedstuffsfoodlink.com/ME2/Default.asp
2. http://www.soundagscience.org/
3. http://www.das.psu.edu/
4. http://www.fao.org/
5. http://www.grandin.com/welfare/intro.welfare.html

View grading Rubrics.

https://www.youtube.com/watch?v=CzjeI_05UNw&feature=player_embedded

https://www.youtube.com/watch?v=yS56hUODH0w&feature=player_embedded