Section 2
Poultry Genetics
Notes

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Prior to the 1950s, poultry grown in the US was primarily dual purpose birds, meaning they were used for both meat and eggs. Primarily, they were used for eggs and occasionally for meat. However, during the 1950s chickens began to be bred for specific purposes, specifically for meat production and egg production. In the commercial industry the birds used for meat are termed broilers. The broiler is generally considered to be the genetic cross of the Cornish breed and the White Plymouth Rock breed. In the commercial industry most white eggs are produced by the White Leghorn breed. In recent years, several strains have become commercially available that will lay brown eggs, these breeds have increasing popularity in response to consumer demand for brown eggs.

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The decision to select specifically for meat and egg production was very important because these to production factors are negatively correlated. This negative correlation means birds that are good meat producing chickens typically have low egg laying potential while chickens that lay a lot of eggs typically don't have the muscling required for efficient meat production.

Genetic progress throughout the 60s, 70s and 80s focused on growth rate, feed conversion and white meat yield because this is the most valuable cut on the carcass.

During the 90s and 2000s geneticists began to focus on specialized genetics to meet market demands. The two primary markets that birds are selected for are the small bird market, also known as the fast food market, and the big bird market or big bird deboning market. Birds grown for the fast food market are grown to approximately 40 days of age and reach approximately 5 lb. Birds grown for the big bird market will be 55-60 d at market age and will reach 8+ pounds.

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In addition to selecting for purpose, and market in the development of commercial strains specific traits were emphasized for each gender. The traits emphasized for males include… The traits emphasized for females include… Also, in recent years selecting for reproductive performance has been a point of emphasis in male lines also.

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Heritability has a great impact on genetic selection. Heritability is defined as the ability of measurable… So this means that traits with high heritability as passed well from parent to offspring. A trait that is a highly heritable trait also provides for rapid genetic progress to be made from generation to generation. In contrast, a trait with low heritability will take more generations to make the same amount of genetic progress.

For the commercial poultry meat industries geneticists have traditionally focused on improving broiler breast meat yield because it was the most domestically demanded cut, but also because it is a highly heritable trait. Many traits could have been chosen as a point of emphasis for selection that would have had the same impact on profitability however many of them were not as heritable as breast meat yield.

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Selection pressure also has a big impact on the success of a breeding program. Selection pressure is defined as the amount of pressure applied to a certain selection criteria. To increase selection pressure is to select fewer birds to be bred for the next generation. By increasing selection pressure and selecting fewer birds more genetic progress can be made with each generation. In the example presented here, which flock would have greater genetic progress with the next generation? Greater selection pressure was applied to flock B. Fewer birds, with higher body weight, were selected to breed for the next generation. Therefore Flock B would have increased body weight with the next generation compared to Flock A

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In poultry, heritability and selection pressure have played a huge role in the improvement of the genetics for production characteristics. Two natural attributes of poultry have also attributed to the genetic improvement of poultry. These traits are hens produce a large number of eggs in a productive life and a short generation interval. Because one hen will produce a large number of eggs there are more offspring to choose from and therefore more opportunity for genetic progress within one generation. A short generation interval has played a significant role in rapid genetic improvement of poultry. At 20-25 weeks a hen will begin to lay eggs therefore the time from generation to generation is very short. This short generation interval also means risk in selection is lower, if wrong choice is made can be corrected comparatively quickly, and opportunity for improvement is high.

Compare a breeding program of poultry to that of cattle. One cow will produce few offspring over a long period of time. Of the few offspring produced the best would be selected and bred for genetic improvement. At least another 2 years and finally genetic progress will be made however risk is high (what if the wrong choice was made in selection) and the opportunity or great genetic improvement in one generation is low.

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Two important innovations have also led to the success of commercial poultry breeding programs. The first is trap-nests. In breeder houses hens are provided with nests where they can go lay their eggs however, a trap-nest keeps the hen with her egg until a care-taker releases her. This allows egg production for each hen to be monitored, accurate records to be taken for each bird and allows the hens which produce the best to be kept for continued breeding. The second innovation is the artificial incubator. Incubators have allowed for large numbers of offspring to be hatched at one time. Incubators are precisely controlled environments and maximize the number of eggs hatched, allowing for more offspring for selection.

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In the commercial poultry industry the primary breeder company provides the commercial meat producers with parent-stock chicks. Primary breeder companies employ geneticists who are responsible for making the decisions on genetic selection. Therefore the main goal of the primary breeder company is to improve genetics and meet market demands for parent-stock chicks. The organization of a primary breeder company designed to meet these needs and can best be described as a pyramid. At the top of the pyramid are the pedigree level birds. At the pedigree level is where genetic selection occurs. Geneticists will keep only the birds that meet specific selection criteria (remember selection pressure). Selected birds are bred back to make the next generation of pedigree stock and unselected pedigree will move down the pyramid to the Great-Grandparent level. Great-Grandparent birds are mated to produce Grand-parent birds. Grand-parent birds are a step down the pyramid and are mated to produce parent birds. All birds prior to parent birds are owned by the primary breeder company. At the parent level the primary breeder company sells chicks to the integrated company, and parent birds are mated to produce the commercial meat producing birds which are also owned by the integrator.

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The second reason that primary breeder companies are set up as a pyramid is for multiplication to meet market demands. At the pedigree level, 1 male pedigree is kept for every 10 female pedigree birds the price of a pedigree bird is approximately $1,500 per chick. From every 1:10 male: female pedigree birds approximately 150 GGP birds will be produced with a value of approximately $150/chick; From those 150 GGP chicks 6,000 GP chicks will be produced at approximately $15/chick; From those 6,000 chicks, 240,000 parent chicks will be produced at approximately $1.50/chick; From those 240,000 chicks, 28,800,000 chicks will be produced at approximately $0.15/chick. You can see how multiplication is a critical role of the primary breeder company pyramid, if solely for reducing chick cost.

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From the previous slide you can appreciate how valuable the pedigree birds are to the primary breeder company. There are separate male and female pedigree lines; before mentioned separate selection emphasis for gender. Male and female pedigree lines are crossed at the grandparent level to produce the commercial stock. Crossing the pedigree lines results in hybrid vigor. Hybrid vigor is important because it produces genetic heterosis. This means that specific traits in the offspring (GPs) are improved related to the sire and dam (GGP). This is because this heterosis prevents recessive genes from affecting offspring*. Another major advantage of crossing the pedigree lines is protection of the pedigree. By doing this, companies purchasing parent birds would not be able to recreate the pedigree line.

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Let’s take a closer look at primary breeder programs, as previously mentioned protecting the pedigree line is critical to the success of a primary breeder company not only because of the value of the birds but because of the success of future breeding programs. A four way crossing system is commonly used by primary breeder companies. This is when four pedigree lines are used to produce the commercial level

progeny. The four lines include two lines for producing the male parent birds and two lines for producing the female parent birds. As previously mentioned each line is bred for specific traits to be passed onto the offspring. At the grandparent level only one gender from each of the four lines is kept and crossed to produce the parent level birds.

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So in detail… At the pedigree level are two male lines and two female lines. The unselected pedigree of all four lines is used as GGP birds to produce the GP birds. At the GP level only one gender is kept and (in this example) the male from male-line A is crossed with the female from male-line B resulting in Male AxB. On the female line side, the male from female-line C is crossed with the female from female-line D resulting in female CxD. These two lines are crossed to produce the commercial broiler (AxBxCxD)