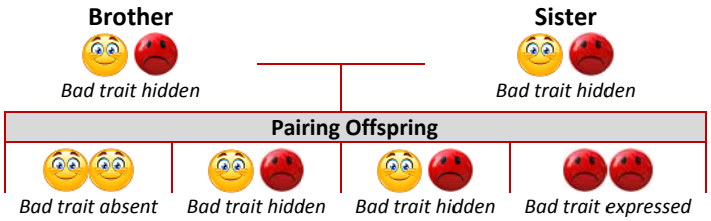
Genetics: Inbreeding

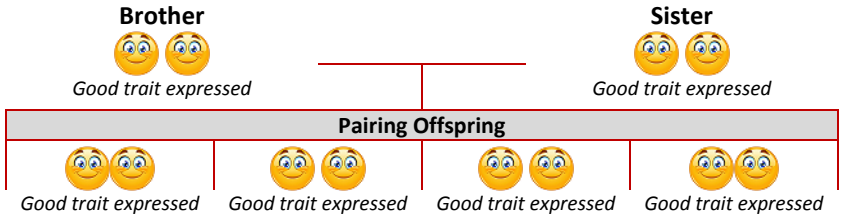
The term "inbreeding" is frequently considered taboo… something repulsive, forbidden, particularly offensive… an act that creates horribly disfigured monsters. Yet, 20% of marriages around the world are between first cousins – Charles Darwin and Albert Einstein both married first cousins.[1] In poultry, line-breeding (organized inbreeding) has long been used in husbandry to create new breeds, improve exhibition qualities, and improve livestock uniformity, vigor, and productivity.[2] When used haphazardly, inbreeding can have undesirable results; however, when used cautiously, it can be beneficial.

- **A FEW STATISTICS**:
  1. Some 90% of the genetic diversity in chickens has been lost since domestication. Loss of diversity means that modern chickens are less able to adapt to environmental changes and disease evolution. This is not a significant problem in managed flocks with adequate care and housing.
  2. Some 10% of the genetic material within modern chicken breeds is identical and this percent increases to 15% within commercial breeding industry… they are more closely related than aunts and nieces in a typical human population – 12.5%.[3] In simple terms, finding breeding stock that is completely unrelated is not possible.
  3. Many believe that mating siblings (brother and sister) is much more intense that parent-child (father-daughter or mother-son); however, the inbreeding coefficient (F1 25%) and the cumulative effect (F5 67.19%) are the identical.[4]
  4. Experiments of the early 20th century frequently demonstrated rapid inbreeding resulted in a significant loss in hatchability, viability, and productivity. However, those experiments were flawed because "they were developed primarily to illuminate the process of inbreeding and not for the express purpose of obtaining viable highly inbred lines." Other experiments resulted in viable lines for up to 22 generations at levels up to 95%.[5]
- **GENETIC DIVERSITY**: In sexual reproduction, two parents contribute genetic information to produce unique offspring allowing a species to adapt to changes in weather, disease, parasites, and food supply. Through the blending of genetic material, the chance that an offspring will inherit an unfavorable trait is reduced by half; and of those unfavorable traits inherited, many are masked by a more dominant gene. Unfortunately, diversity is the adversary to poultry breeders… diversity dilutes desirable traits such as uniformity, body type, and color.
- **DRAWBACKS**: The act of inbreeding does not create bad genes or bad traits – the genes themselves do not mutate (transform). Rather, since closely related birds share many of the same genetic alleles (markers), inbreeding increases the odds that two undesirable, recessive (hidden) alleles will be paired allowing the undesirable trait to be expressed (unmasked)…. traits such as micromelia, dwarfism, crossed beak, crooked toes, and others. Considering the thousands of alleles involved, managing these possible flaws can be difficult.



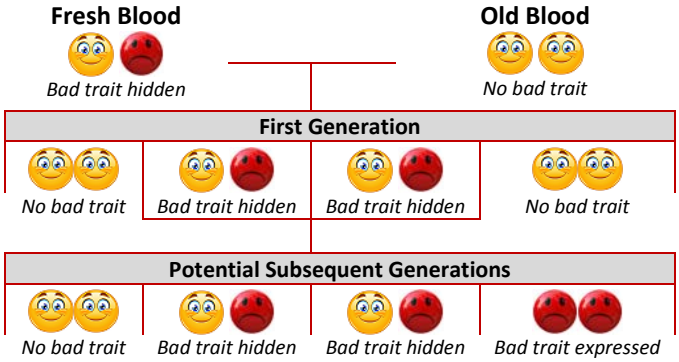
- **BENEFITS**: Conversely, desirable traits are also controlled primarily through genetic selection. The best way to replicate desirable traits is to pass the genes responsible for those traits down to the offspring. Naturally, if both parents share the same traits, odds are great that the offspring will also possess those traits.

[1] *William Saletan,"What's wrong with marrying your cousin?," Slate, Apr. 10, 2002.*
[2] *L.E. Keyser, "Standard Poultry and the Making of the Breeds," Poultry Success, 1950, page 12*
[3] *Debora MacKenzie, "Chicken genome plucked bare by inbreeding," New Scientists, 4 November 2008.*
[4] *Douglas Tave, "Inbreeding and brood stock management," Food and Agriculture Organization of the United Nations, Rome, 1999*
[5] *Dr. Hans Abplanalp, et. al. "Inbreeding For The Genetic Analysis And Improvement Of Poultry Populations," University of California, Poultry Science, 1973*



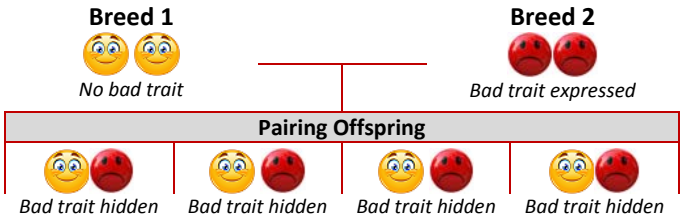
Utilizing a closed flock system with standard Bronze turkeys over a four year period, I was able to increase the hatch rate for all eggs set from 82.4% to 91.0% while concurrently reducing the cull rate from 8.4% to 0.7% and the juvenile loss from 20% to 0%.

- **OUTCROSSING**: Outcrossing involves bringing in "fresh blood" in order to improve genetic diversity and avoid the effects of inbreeding. Outcrossing may be necessary if there becomes a problem inbreeding depression. However, bringing in "fresh blood" can also be problematic. Since many genetic traits are recessive (hidden), the "perfect" appearing male may very well introduce a number of undesirable, hidden traits into the flock… many of those traits may not physically appear until the second generation and may be especially difficult to eliminate completely once they enter a flock.



Fearing inbreeding depression, I once introduced new drakes to my mallard flock to "freshen" the blood. Unfortunately, one of those drakes possessed a recessive crested gene and 10% of the ducklings hatched during the subsequent year were crested. Apparently, one or more of my hens also had the recessive gene. While some love crested ducks, it's an undesirable trait in ranch pond ducks – my target customer base.

- **HYBRID VIGOR**: A hybrid is the offspring of two plants or animals of different species, varieties, or breeds. The hybrid vigor phenomenon has been used in both plants and animals to increase fertility, hatchability, offspring vigor, and both quantity and quality of production (meat or eggs). Technically, breeding two genetically dissimilar parents greatly increases the odds that an undesirable, recessive (hidden) allele will be paired with a more desirable, dominant allele causing the undesirable trait to be masked (concealed). Since this can occur across multiple systems, the production results can be significant. Within the backyard poultry world, the sex-link is the most common hybrid that can be sexed at hatch as well as demonstrate increased productivity.

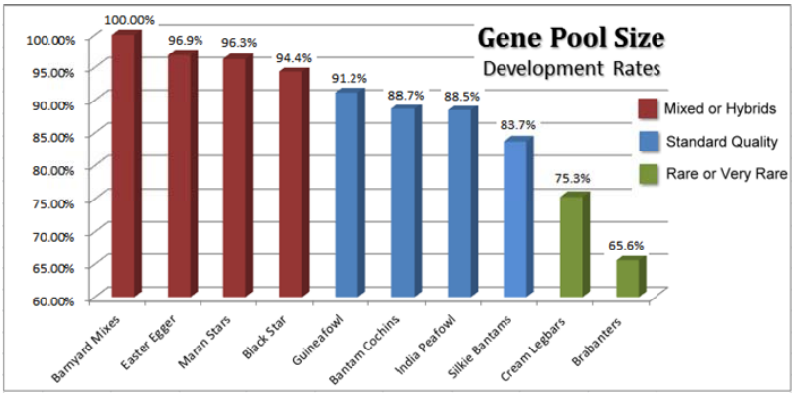


- **INBREEDING DEPRESSION**: Inbreeding depression is similar in nature to hybrid vigor but with opposite effects. It occurs primarily in "exhibition quality" stock or rare breeds with an extremely small genetic pool. Inbreeding depression results in an increase in chick deformities and a decrease in fertility, hatchability, vigor, and both quantity and quality of production.

How much inbreeding is too much? Opinions vary with much depending on the size of the breed gene pool, relationship of the original breeding stock, intensity of inbreeding, and the diligence of culling efforts. Careful monitoring of fertility rates, hatch rates, chick quality, instances of defects, and adult productivity will reveal when the intensity reaches unacceptable levels. With a carefully considered, systemic approach, close breeding has been effective to multiple generations.

Inbreeding Coefficient for Related Pair Matings[1]	
Full siblings, Parent-child, Double first cousins	25%
Half siblings, Grandparent-grandchild, Uncle-niece, Double first cousins	12.5%
First cousins	6.25%
Half cousins	3.13%
Second cousins	1.56%
Half-Second cousins	0.78%
Third cousins	0.39%
Shoffner, 1948, found that for every 10% increase in the inbreeding coefficient, chickens lost an average of 4.36% in egg hatchability and a 9.26 eggs per year decrease in production.	

Cumulative Inbreeding Coefficient[2]				
Generation	Parent-offspring	Full-siblings	Half-siblings	Double first cousin
0	0.00	0.00	0.00	0.00
1	25.00	25.00	12.50	12.50
2	37.50	37.50	25.00	18.75
3	50.00	50.00	34.38	25.00
4	59.38	59.38	42.97	31.25
5	67.19	67.19	50.39	36.72
6	73.44	73.44	56.84	41.80
7	78.52	78.52	62.45	46.48
8	82.62	82.62	67.23	50.78
9	85.94	85.94	71.58	54.74
10	88.62	88.62	75.28	58.37
∞	100	100	100	100



- **FURTHER READING**:
  1. "Line Breeding, Inbreeding & Outcrossing," *The Classroom @ The Coop,* http://www.the-coop.org/forums/ubbthreads.php?ubb=showflat&Number= 28027
  2. "Line Breeding via a Spiral Breeding Program," *Iowa Blue Chicken Club*, http://www.iowabluechickenclub.com/line-breeding-via-spiral-breeding-program.html
  3. Heather Nicholson, "GMS6: Sex-Linkage," scratch cradle, August 5, 2012.https://scratchcradle.wordpress.com/2012/08/05/gms6-sex-linkage/

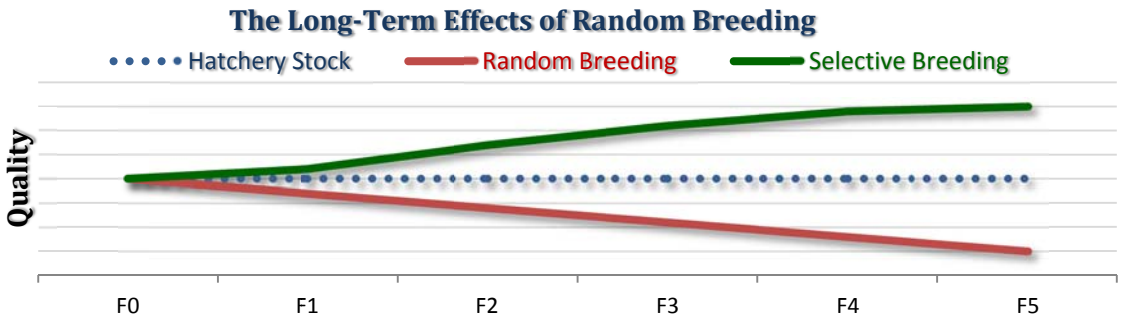
[1] *F. M. Lancaster, "The Coefficient Of Inbreeding (F) and Its Applications," Genetic and Quantitative Aspects of Genealogy, February 2015*
[2] *Douglas Tave, "Inbreeding and brood stock management," Food and Agriculture Organization of the United Nations, Rome, 1999*

Genetics: Selective Breeding

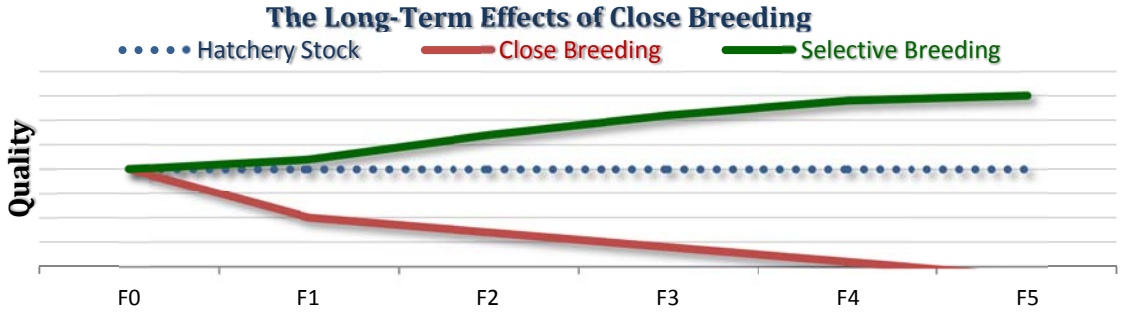
Your fowl are either improving or degenerating with each passing generation. Selective breeding is the only means whereby a flock can be improved… if not, then they are multipliers and not breeders.

-- Dr. Charles R.H. Everett[1]

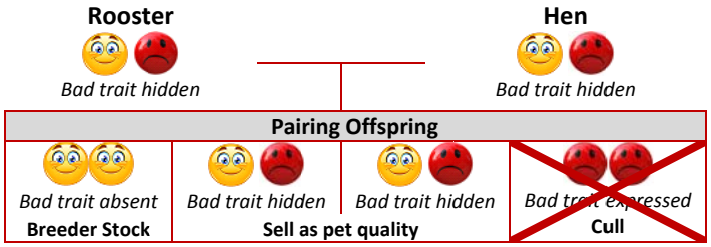
RANDOM BREEDING: Each of us has an inherent instinct to cultivate crops and husband livestock. It's in our nature… it's what separates us from the animals… it's what permitted us to establish permanent settlements and civilizations. Yet, advances in agricultural practices have removed most of us from the land. For those of who have discovered (or rediscovered) the joys of raising poultry, incubating and hatching eggs helps fulfill this natural inclination. However, city folk turned country folk are not privy to poultry breeding secrets once handed down from generation to generation; but rather, must acquire those secrets through books and personal experience. While our nurturing nature encourages us to save every chick we hatch, doing so is an unhealthy practice that leads to a decline in our flock quality:



SMALL GENE POOLS: If our original stock originate from small genetic pools or we allow unrestrained breeding of close relatives, then flock decline will proceed at a more rapid pace. This sharp quality reduction probably accounts for the reluctance of many to incorporate line breeding into their breeding programs:



WHAT IS SELECTIVE BREEDING? Selective breeding (artificial selection) is the process by which humans use animal breeding and plant breeding to selectively develop particular phenotypic (displayed) traits by choosing which typically animal or plant males and females will sexually reproduce and have offspring together.[2] Within a commercial setting, selective breeding involves a great of money, time, and science. Within the backyard setting, selective breeding involves simply producing offspring from the best of one's flock. For the hobbyist, selective breeding means focusing on quality rather than quantity.

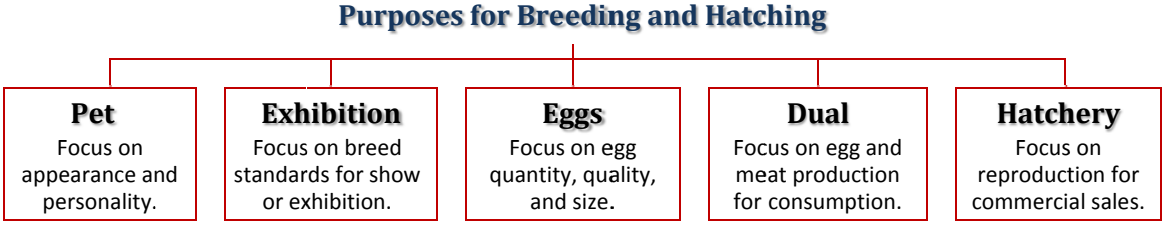


[1] *Dr. Charles R.H. Everett, Selective Breeding: How to Breed Chickens," Countryside Daily, December 5, 2016*
[2] *"Selective breeding," Wikipedia, 16 October 2017, https://en.wikipedia.org/wiki/Selective_breeding*

STEP 1: DETERMINE YOUR PURPOSE FOR BREEDING:

Once we realize that placing eggs in the incubator results baby hatchlings, then we realize that we'll need to do something with all those hatchlings… some will hatch to show their birds, others to make a little money, others to replenish their flock, and still others just to give them away. Since everybody will have a different focus, there is no single "best" way of doing things.

Personally, I don't care to leave our little farm so breeding birds for exhibition is not for me. I also do not cook and my wife doesn't care for home grown meat so meat production is simply not a consideration. I do enjoy a bold, pretty bird pecking around in the yard. I also like producing eggs for the lowest possible cost, and I need a way to pay the feed bill so my three main points of focus are (1) pets, (2) eggs, and (3) hatchery stock. Determining your purpose will determine which path will work best for you.



STEP 2: SOURCE YOUR ORIGINAL FLOCK:

- **AUCTIONS**: In my opinion, a person should never purchase birds from an auction. There is rarely an opportunity to view the parent stock or evaluate flock health issues and auction birds can be a dangerous source of parasites and disease. Birds sold in auction are rarely of high quality and are usually rejects or extras. Additionally, unscrupulous dealers frequently travel about the countryside buying birds from various sources with the purpose of a profit…. quality or sanitation is not a priority When obtaining birds from an auction, use extreme care and isolate them for no less than 30 days.

- **HATCHERIES**: Acquiring your original flock from a large hatchery is advantageous because chicks are relatively cheap and usually have a great deal of genetic diversity. Unfortunately, hatcheries focus on production rather than quality. Some hatcheries claim to offer "show or "4-H" quality birds but the actual quality of these birds is questionable. Hatchery birds are unlikely ever to produce exhibition quality offspring even after several generations of selective breeding. They can, however, result in good quality pet and production flocks through selective breeding.
- **RECOGNIZED BREEDERS**: Acquiring your original flock from nationally recognized breeders is advantageous because chicks are likely to be of high quality and conform to American Poultry Association or American Bantam Association standards. Unfortunately, they are likely to be expensive, especially those of exhibition quality. Additionally, birds from recognized breeders more than likely closely related and originate from small gene pools. For best results, either ask specifically for unrelated birds or use two or more sources.
- **LOCAL BREEDERS**: Acquiring your original flock from local breeders is advantageous because you can physically view the parents, assess quality, tour facilities, and visit with the breeder giving you a source of information should questions arise. Unfortunately, although there are some excellent local breeders, many are focused on making a quick dollar and not quality – use great caution and isolate birds for no less than 30 days. Remember, the stock you acquire from local breeders will likely be related and unlikely to be their very best; spend time talking with the breeder so you'll understand how they the select birds they sell… ask for unrelated birds or acquire your flock from two or more sources.
- **SHIPPED EGGS**: Acquiring your original flock from shipped eggs is advantageous because you have access to just about any breed. Unfortunately, you have no control over quality, health, or genetic lines. Seller reviews may be helpful but are not always accurate. I ordered eggs from an on-line seller with a 100% rating, but the eggs sent were old and genetically mixed. Additionally, shipped eggs do not always perform well in the incubator. A friend in Oklahoma sent a dozen Icelandic eggs through the mail, they were packed extremely well, but none developed when incubated. Buying eggs through the mail can be fun but it's not a route that I would take in adding a line to my flock.

STEP 3: SELECTING YOUR BREED STOCK:

- **INITIAL QUANTITIES**: Regardless of the route used to acquire your original stock, always buy several more hatchlings than you intend to keep. As a general rule, I keep about 15-25% of the hatchlings purchased. Of the remaining balance, defective birds are culled and the rest sold as "pet" quality. Many are reluctant to reduce their flock so drastically because of their financial investment. However, it is one of those "Pay me now or pay me later" scenarios… the more selective you are at the start, the fewer culls you will have in the future.

For those with limited funds and who are not focused on exhibition, hatcheries place specific breeds on sale towards mid-summer and into the fall. At the time of this writing, Ideal Poultry has straight-run Buff Orpingtons on sale for $1.20 each with the purchase of 25 or more. For $48.00 and $7.00 shipping, you'd get 40 chicks that should give you a decent start – two good cockerels and six good pullets. By selling the "pet quality" birds you'll recover most of your original investment and perhaps earn a few extra dollars. Again, you'll not get exhibition quality chicks from a hatchery, but hatcheries can provide an avenue for starting a decent production or pet quality program.

Wouldn't it be easier and cheaper in the long-term to simply buy from a reputable breeder? Yes, probably but not necessarily. First, breeders are unlikely to sell the best of their best. You're more likely to get chicks straight out of the hatcher so not all the chicks are select quality. Second, unless the breeder is exceptionally large, the chicks likely have a small gene pool and may experience inbreeding depression. Ultimately, you'll need to purchase from two different breeders or, at minimum, two different lines… both avenues require purchasing extra birds. Third, birds from recognized breeders are usually 10 times more expensive than those from a hatchery. This additional cost may be prohibitive to a person with limited financial resources especially where potential predator problems add to the financial risk.

- **SELECTION CRITERIA**:

1. **QUALITY #1: EGG QUALITY**: To produce healthy, vigorous chicks we not only need good genetics, we also need high quality eggs… the quality of an egg's content directly impacts the quality of the chick hatched. Egg shape, color, texture, and size help indicate which eggs are suitable for incubation and which are not. Discolored, misshaped, roughly textured, and unusually large or small eggs all indicate that something is not quit right and that perhaps the egg would be more suitable for eating. Additionally, eggs laid on the ground, in dirty nests, or otherwise potentially contaminated should be avoided as infections may not necessarily kill the chick but will certainly compromise its quality.
2. **QUALITY #2: VIGOR & DEVELOPMENT**: Many backyard hobbyist form an emotional attachment to their chicks and adopt will attempt to "save" chicks that are struggling. Many claim that these weak chicks grow up to be just as "good" as those that don't display a problem. This approach, I believe, is a mistake. Lack of vigor and development are signs that there is heredity, immunity, or developmental issues that should not be passed on to future generations. Some people set these chicks aside and sell them as "pet quality." Personally, I'm reluctant to less vigorous chicks because I wouldn't want someone selling me a "defective" chick.

    - **ASSISTING HATCHLINGS**: I do not assist hatchling hatch. Once you've established a solid incubation protocol – temperature, humidity, and turning – then chicks that do not hatch under their own strength demonstrate a heredity, immunity, or developmental issue.

    > *A chick's failure to progress normally at hatching stage can be caused by genetic problems resulting in malpositioning, deformities or weakness, in which case assistance may promote the survival of birds with deleterious genes.*[1] *Debra Bourne MA VetMB PhD MRCVS*

[1] *Debra Bourne MA VetMB PhD MRCVS, Senior Veterinary Editor, Wildlife Information Network, "Management of Hatching Bird Eggs," Wildpro, NDA.*

- **21 DAYS OF INCUBATION**: I end my hatches at the end of day 21. Once you've established a solid incubation protocol – temperature, humidity, and turning – chicks should begin to hatch at the start of Day 21 and finish hatching no later than the end of Day 21. There are exceptions… some breeds, such as Marans and game fowl, may require an additional 6-12 hours of incubation. In such cases, I'll add the specific number of hours to the end of Day 21. Chicks that do not hatch within set limits possess heredity, immunity, or developmental issues and should be culled.
- **BROODER VIGOR**: Hatchlings should be up, running around, eating and drinking 24 hours after hatch – turkeys and a few other species may take 48 hours. With careful observation, chicks that are weak or slow to start can be identified and removed – quality over quantity.

> *The constitutional vigor or vitality of a chick determines its capacity for growth... the majority of evidence indicates that constitution is fundamentally a matter of inheritance and initial selection is, therefore, of considerable importance.*[1] *L. E. Card and W. F. Kirkpatrick, 1919*

- **PHYSICAL DEFECTS**: When moving chicks from the hatcher to the brooder, they should be carefully checked for physical defects such as splayed legs, crooked toe, wry neck, abnormal size, scissor or parrot beak, exposed organs including the yolk sac, or other defects. Some of these defects are not noticeable at first but will become more readily apparent as the chick grows. Again, some people are tempted to "save" or "fix" chicks with physical defects. Within any selective breeding program, we need to remember that there is a reason that these defects occur and keeping these chicks in our flock is an unhealthy practice.

> *Most malformed chicks have a poor chance of becoming healthy, productive members of a backyard flock. Many, but not all chick malformations can be inherited traits, so malformed chicks who survive should not be used for breeding because they can pass on the trait to future generations. For these reasons, euthanizing a malformed chick is justifiable, if done humanely.*[2]
>
> *Julie Gauthier and Rob Ludlow, Raising Chickens*

- **ILLNESS**: A sick bird indicates either poor management practices by the breeder or a weak immunity system within the bird. If an illness is caused by poor management, then correct the problem. If an illness is caused by a weak immunity system, then do not use the bird forbreeding. This criterion is especially important when the original stock comes from a different geographical location… the genetics of a bird may be well suited for the bugs in the Northeast United States but unsuitable for the Southwest. Use of antibiotics and home remedies may cure the individual bird but it does not fix a less than perfect immune system. Selecting only those birds that demonstrate resistance to the bugs in your area should be of primary importance.

> *Here in East Texas, young turkey poults have a high mortality rate when placed on ground where older birds reside. Raising poults in raised pens or fresh ground allows their immune system to mature before they face the onslaught of microbes hiding in the ground… but such management practices are only partially effective. Mortality among juvenile birds remains significant. But by using only birds that demonstrate a strong resistance to local microbes, subsequent generations display greater resistance and lower mortality than the original flock.*

3. **QUALITY #3: DEVELOPMENT & PRODUCTIVITY**: The Livestock Conservancy produces the publication *The Heritage Chicken Manual* that outlines recommendations desirable production traits in chickens and provides more information than can reasonably be presented here. Digital copies are available on-line at: https://livestockconservancy.org/index.php/heritage/internal/chicken-manual.
   - ✓ Chapter 1. Selecting for Meat Qualities and Rate of Growth
   - ✓ Chapter 2. Selecting for Egg Production
   - ✓ Chapter 3. Ongoing Selection of Breeding Stock

[1] *L. E. Card and W. F. Kirkpatrick, "Improved, Profitable rearing Methods," Poultry Herald, Volumes 31-32, page 207, 1919*
[2] *Julie Gauthier, Rob Ludlow, "How To Spot Problems Of Newly Hatched Chicks," Raising Chickens, NDA, http://www.dummies.com/home-garden/hobby-farming/raising-chickens/how-to-spot-problems-of-newly-hatched-chicks/*

4. **QUALITY #4: CONFORMITY TO APA BREED STANDARDS**: While not all breeders chose to exhibit their birds, established breed standards provide an excellent source as to each breed's expected appearance. These standards can be found in The American Poultry Association's *Standard of Perfection* and American Bantam Association's *Bantam Standard*.

STEP 4: DETERMINING YOUR BREEDING METHOD: Please remember that I keep a total of about 150 adult birds but that number consists of several different breeds and species. My practices discussed in the *text boxes* below do ***NOT*** reflect best practices but illustrate compromises a backyard hobbyist with limited resources may adopt.

- **FLOCK**: (Closed Flock) All breeding birds are located in a single pen and allowed to mate freely. Each cycle the best males and females are selected as replacements. No new birds are introduced into the system. This method is the simplest to maintain. The number of generations a flock is able to attain without experiencing inbreeding depression depends on the flock size – most sources tend to recommend a flock of no less than 100 for reasonable sustainability. Flock breeding is generally used for flock maintenance rather than improvement and is probably the method most used by hatcheries. Flock breeding can be used for flock improvement with smaller number but should not be continued for more than three or four generations to avoid inbreeding depression.

  I use this method with my "Tinks" bantams – a Serama and Old English mix. I basically keep four roosters and ten hens, allow all birds to free range, and am currently on my third generation (F2). Replacements are selected primarily on size (super small) and color (variety). Breeding stock is replaced every three to four years. Despite having far fewer birds than recommended, this methods works for me because (1) the original birds were unrelated, (2) the F1 generation were hybrids, (3) they have a replacement cycle of only 3-4 years, and (4) I'm not breeding to APA Standards. Eventually, I'll probably divide the flock into two groups of females, place Serama roosters with one group, and place Rankin roosters with the other.

- **OUT AND OUT**: Outcrossing or out-breeding is the practice of introducing unrelated genetic material into a breeding flock, usually "fresh" males. It increases genetic diversity and reduces the chances of inbreeding depression. Outcrossing can be used to improve a flock if the new males are of better quality than the existing flock and the preferred method for the hobbyist because it does not require a large number of birds. Unfortunately, this method can also cause problems as it can introduce undesirable recessive genes that may not be noticeable for two or three generations.

  I've had negative experiences in the past with outcrossing with fresh males bring in undesirable recessive traits. Therefore, I'm outcross as rarely as reasonably possible. Generally, I'll breed any new males to a new batch of my own pullets. If the results are positive, then I'll breed that same male to his daughters in the next generation. I use males for outcrossing primarily because males are generally more available and cheaper. When acquiring new males, I'll buy at least six males for every one that I need for breeding – keeping the best for breeding and selling the remainder as pet quality.

- **SPIRAL**: (Clan Mating) Spiral mating requires setting up and labeling three or more separate breeding pens. Each cycle, the best of the females are selected and placed in their original pen – pullets from pen A go into pen A, pullets from pen B go into pen B, and so forth. The best of the males are selected and rotated to the next pen – males from pen A go into pen B, males from pen B go into pen C, and so forth. Over time, selective breeding will result in an overall improvement in the flock. This system can be maintained for several generations before experiencing inbreeding depression or the need for new stock.

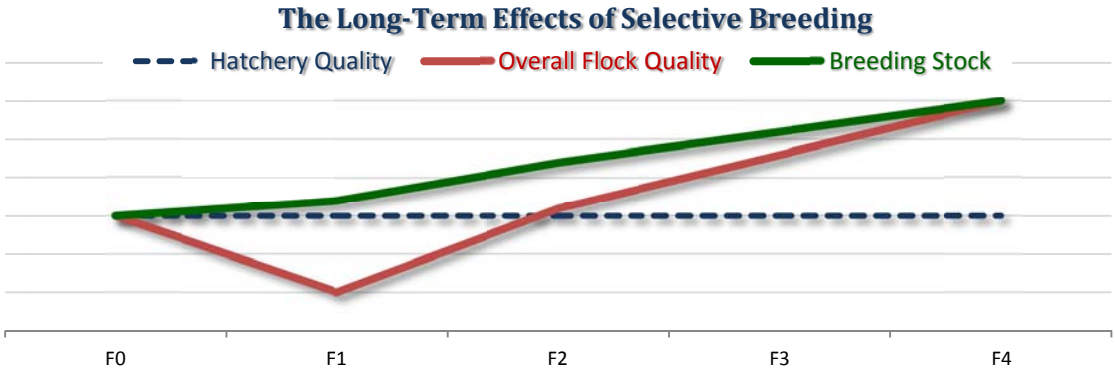
  Spiral breeding enables fairly rapid results with a minimum investment and is probably best method for backyard hobbyist who desires to breed a specific breed for exhibition. It is also suitable for individuals who sell enough hatchlings and/or hatching eggs to financially justify the cost of maintaining several pens.

  Since my goal is to maintain a sustainable flock of peafowl for my lifetime without the need to outcross, this is the method that I use with peafowl. Initially, I acquired my original birds from five different sources, grew them out, and then selected the three males and nine females that I wanted to keep for breeding. The three males were placed in three separate flight pens and then for each pen three unrelated females were chosen. The excess males and females were sold. Peafowl mature at only 1/6th the rate of chickens and their replacement cycle is 8-9 years instead of the usual 2 years for chickens. I've not yet had a need to rotate replacement. I did replace one hen using a young female from an unrelated pen.

- **LINE**: (Pedigree) Line breeding usually involves breeding closely related birds such as daughter to father. Such mating systems require great care and much more research than can be presented here.

> *In East Texas, the winters rarely get cold enough to kill off bacteria and parasites in the ground. Thus, poultry need to have a strong, natural resistance to the bugs in the area. This isn't the case with heritage turkeys brought in from outside the area. Mortality from Blackhead in turkeys can be over 70% for turkeys placed on the ground where older birds have been… something that I experienced firsthand. To combat the problem, I took the best of my surviving F1 turkeys and breed them to each other despite them being full or half siblings. Ultimately, I was able to produce a line with up to 100% survivability.*

INITIAL DECLINE: From personal experience, selective close breeding results in a drop in the ***overall*** flock quality in the first generation (red line). This is probably the result of undesirable, hidden recessive genes pairing off in the offspring. However, a number of individuals (10-15%) demonstrate good or excellent qualities. By only using the best of the flock and culling (removal) lesser quality birds, the overall flock quality eventually catches up with the breeding stock (green line). This year in my F4 Bronze turkeys, there was no significant difference between the juveniles that I kept for breeding and those that I sold as extras.



SELECTIVE BREEDING EXAMPLES: I am a very small producer who focuses on "pet" and "production" rather than "exhibition" qualities. The primary purpose of my Dominique flock is to produce high quality black sex-link laying pullets so egg quantity and size are of primary importance. Within my geographical area, turkey poults tend to have a high mortality rate when placed on the ground so survivability became my primary focus with my Bronze turkeys.

Dominique Flock						
	Cull Rate	**Flock Quality**	**Egg Quantity**	**Egg Size**	**Egg Quality**	**Hatch Rate**
F0	23.0%	★★☆☆☆	72%	Medium	★★★★★	79.3%
F1	12.0%	★★★☆☆	76%	Medium-Large	★★★★☆	62.2%
F2	2.6%	★★★☆☆	80%	Medium-Large	★★★★☆	78.2%
F3	1.4%	★★★★☆	85%	Large	★★★★☆	--

Standard Bronze Turkey Flock					
	Cull Rate	**Mortality Rate**	**Flock Quality**	**Egg Quality**	**Hatch Rate**
F0	20.0%	10%	★★★★☆	★★★★☆	82.4%
F1	14.3%	70%	★★★★☆	★★★★☆	87.9%
F2	10.9%	30%	★★★★☆	★★★★★	86.3%
F3	4.1%	10%	★★★★☆	★★★★★	91.0%
F4	1.0%	0%	★★★★★	--	--

ADDITIONAL READING:

- "Poultry Farming For Beginners and Breeding the Home Flock," *Countryside Daily*, February 7, 2013: http://countrysidenetwork.com/daily/poultry/chickens-101/poultry-farming-for-beginners-and-breeding-the-home-flock/
- "Using the Clan Mating System," *The Modern Homestead*, August 2016, http://www.themodernhomestead.us/article/Clan+Mating.html
- Farhan Sheikh, "Breeding of Poultry," *The Poultry Guide*, October 14, 2012, http://thepoultryguide.com/breeding-of-poultry/