Chapter 15
Selection of Breeding Stock

Swine Breeding Projects

A swine breeding project is one of the most challenging, but also one of the most rewarding. The knowledge, capital and time the project requires is much more than found in a market animal project. The member should start by visiting with an owner-operator of a swine production farrow to finish operation. Their advice and insight will help answer questions and provide the project member a clearer picture of what this project entails.

The member should start with obtaining an open gilt, a bred gilt or sow. Two or more sows offer a greater challenge and may be considered as the member gains more experience. A swine breeding project requires top management which starts with good record keeping. Breeding, feed, health, financial, performance and environmental records are all very important requirements of a swine enterprise. The project member should realize up front that these records **must** be filled out on a day to day basis. This is true for both seedstock producers and those in commercial pork production operations.

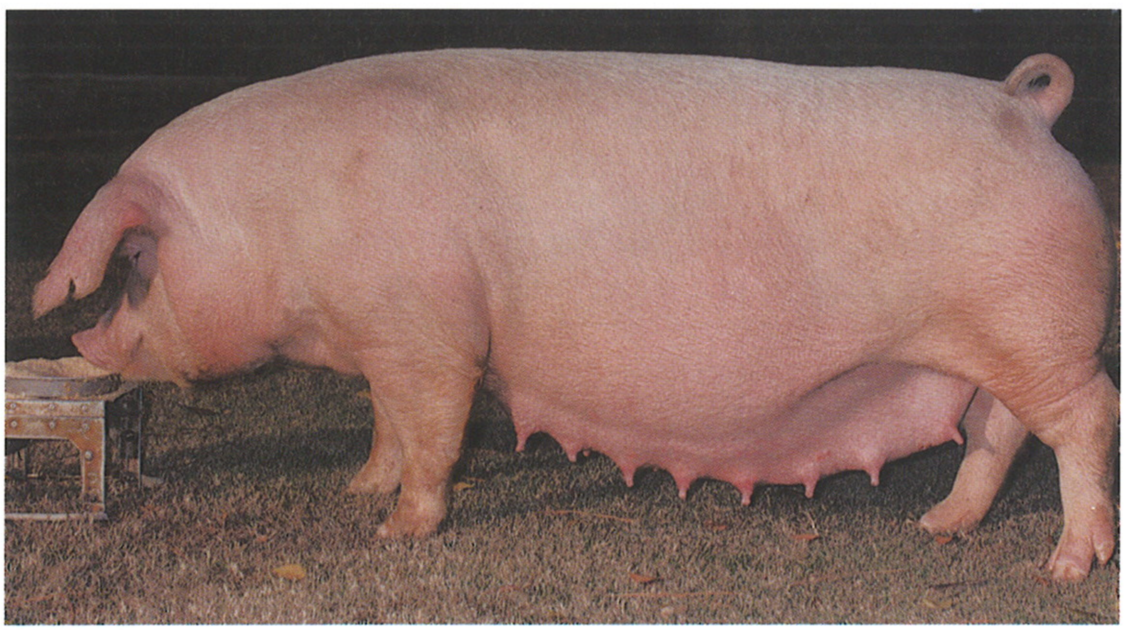


Figure 15.1
Ideal bred sow

Production Options

Begin a swine project with the number of pigs you can adequately handle. Increase the size of your project each year as you gain experience and have available space. Again, it is very important to keep records on all pigs for project evaluation.

Advantages of becoming involved in the raising and breeding of swine include the following:

1. Initial investment can be modest.
2. The swine project can be adapted to a wide variety of management situations and resources.
3. The enterprise can have a rapid turnover and a steady cash flow. For example:
   (a) Two litters per sow per year (12 to 20 pigs per sow per year)
   (b) Feeder pigs for sale at 10 to 12 weeks
   (c) Market hogs for sale at five to six months
   (d) High market salvage value on culled breeding animals
4. Hogs are efficient converters of feed, making it possible to market home-produced grains through hogs for more money.
5. Types of enterprises to consider depend on the project member's workload, the kind of shelter available and the financial resources available.

   Enterprises to consider may include:
   (a) Feeder pig to finish (easiest to manage, requires considerable operating capital)
   (b) Feeder pig production (requires less operating capital and more careful management)
   (c) Farrow to finish (a combination of a & b, which reduces market fluctuation risk)

To start your swine breeding project, you need to consider several management factors that are essential to developing a successful program. First, you need to decide whether you want to develop a purebred or commercial production system and then select animals to meet your goals. Once you have decided what your goals are in this project, you must manage your breeding herd by providing the proper nutrition, health program and environment.

Choosing a Production System

The swine breeding project will involve several decisions that need to be made prior to the purchase of your first gilt or sow. Purebred or commercial? Confinement or pasture? Feeder pig production or farrow to finish? Closed herd or open? Once these questions have been answered it's time to go shopping.

Purebred

Purebred: A breed or line of swine that have been selected for a specific purpose over a period of time: Purebred breeders identify and select animals that meet desired production and physical qualities and try to fix these traits in their animals. A purebred is often associated with a formal registration procedure requiring extensive pedigree (history) information. Involvement in the purebred swine business can be highly rewarding as you form and mold highly predictable genetic packages into superior animals. Self satisfaction comes through the accomplishment of producing genetically superior animals which you make possible through wise breeding decisions. To top it all off, there is satisfaction in working with other swine breeders who have similar interests, ambitions and goals. Being involved in a Jr. breed association will open many doors to information and opportunities to which many livestock youth would never otherwise be exposed. Please refer back to chapter 2 for a listing of Breed Associations for further information.

Crossbred

Crossbreeding is mating animals from different breeds or lines. Pork producers use crossbreeding to produce hybrid vigor (heterosis) and to combine the attributes of various breeds for commercial production of pigs.

The crossbred female is the basis for more than 95 percent of commercial swine produced in the United States. This is because the crossbred, compared to the purebred, female will normally produce more pigs at birth with greater livability and produce more milk, which equals heavier weaning weights. Crossbred offspring also grow faster to market weight as a result of heterosis. The percentage improvement obtained by crossbreeding is shown in table 1. Heterosis exists when crossbred offspring perform better than the average of the parental breeds or lines. The performance of a cross between breeds may be more or less than the best parental breed, so it is very important that the correct breeds are chosen for the trait in which improvement is desired.

Table 1. Average percent heterosis advantage for various swine traits.*

Trait	First cross using purebred females as parents	Multiple cross using crossbred females as parents
	%Advantage of offspring over parents	
Number pigs born alive	0.5	8.0
Number pigs at 21 days	9.0	23.0
21 day litter weight	10.0	27.0
Days to 220 lb.	7.5	7.0
Feed per pound gain	2.0	1.0
Backfat	-2.0	-2.0
Loineye area	1.0	2.0

*Ahlschwede, W.T. et al. 1988. Crossbreeding systems for commercial pork production. PIH-39, Pork Industry Handbook.

Selection of Breeding Stock

Gilts

The success of a swine project is based on a sound foundation, the sow herd. The sow herd contributes half of the genetic makeup of growing-finishing pigs. This factor makes it very important that careful selection of females be placed as a priority of the herd. Gilts should be selected based on both their genetic (genotypic) background and on their visual (phenotypical) appraisal. Emphasis should be placed on:

- Growth rate
- Litter size
- Leanness
- Soundness (structural and reproductive)
- Disposition (attitude with people & other pigs)
- Records—sow's, expected progeny differences (EPD's), breeding values (BV's)

Visual appraisal is very important! The best records on a gilt mean very little if she cannot pass a **soundness evaluation.** Soundness means being free from flaws or defects. There are three areas of particular concern: 1) reproductive, 2) mammary and 3) skeletal.

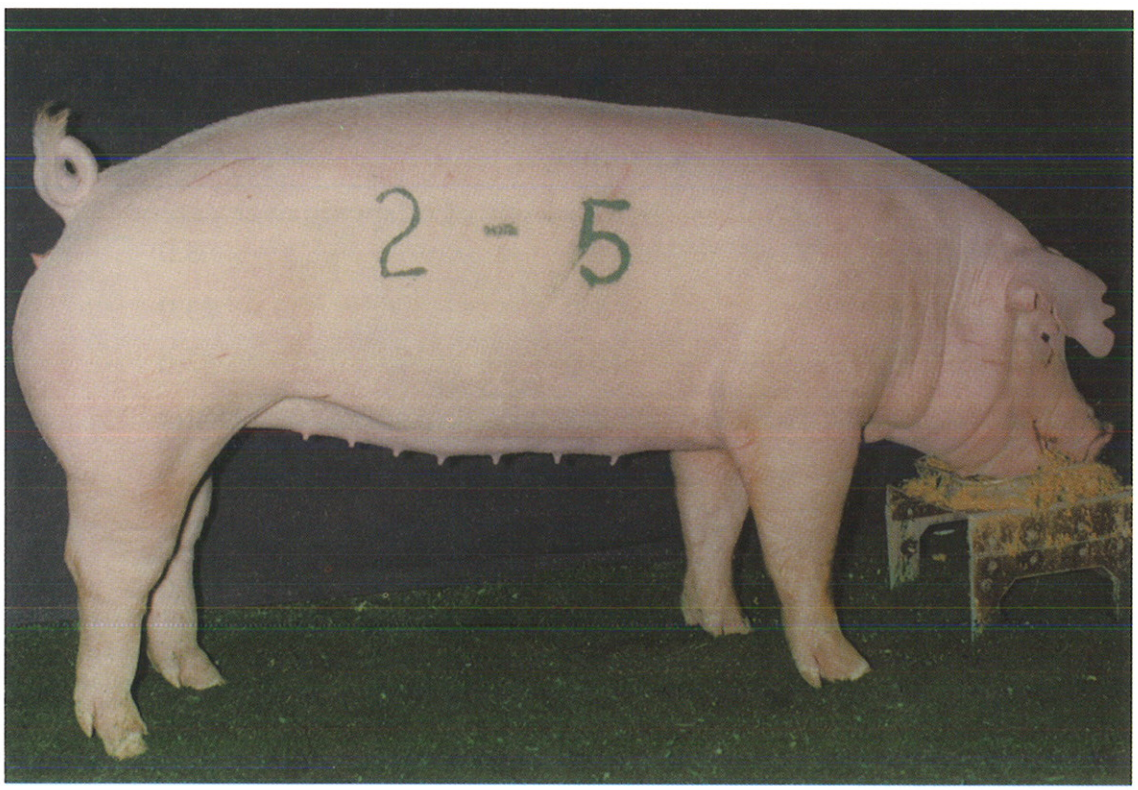


Figure 15.2
Desirable gilt

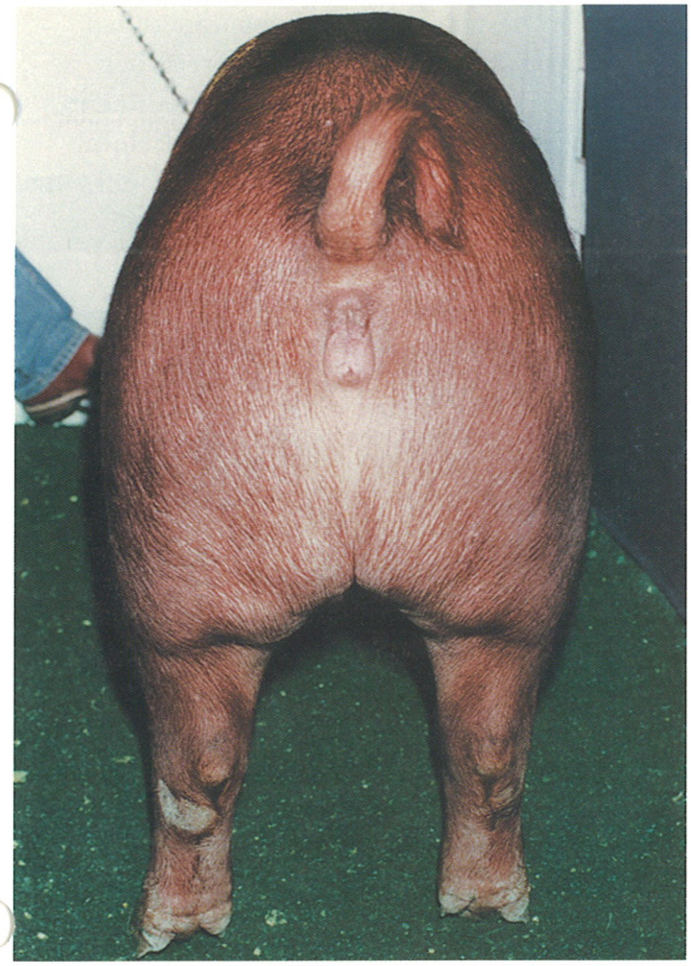


Figure 15.3
Desirable/normal vulva

Figure 15.4
Small vulva

Reproductive soundness. Gilts should exhibit normal reproductive development, both anatomically and behaviorally. The external genitalia (vulva) should be normally developed.

Most anatomical defects of the reproductive system are internal and not visable. Gilts with small vulvas (figure 15.4) are indicative of infantile reproductive tracts (not fully developed) and should not be kept. Replacement gilts should begin to show signs of puberty at least a month prior to anticipated breeding. Sows which have difficulty farrowing, are slow farrowing, or have damaged reproductive tracts (uterine prolapse, or uterine infection) should be culled. Reproductive failure is the number one reason for removal from the herd.

Mammary soundness. Gilts should possess a sufficient number of functional teats to nurse a large litter of pigs. There should be at least six, well-spaced, functional teats to a side. Gilts with inverted or scarred nipples should not be saved. (New concrete, rough floors and corrosive chemical compounds on the floors of farrowing houses can cause abrasions to gilts' underlines which result in nonfunctional teats.) As a gilt approaches puberty, her underline should become more prominent, indicating normal development. **Skeletal soundness.** Gilts with feet and leg problems which will interfere with normal breeding, farrowing and nursing functions **should not be saved.** (Chapter 3 figures 3–10, 3–11).

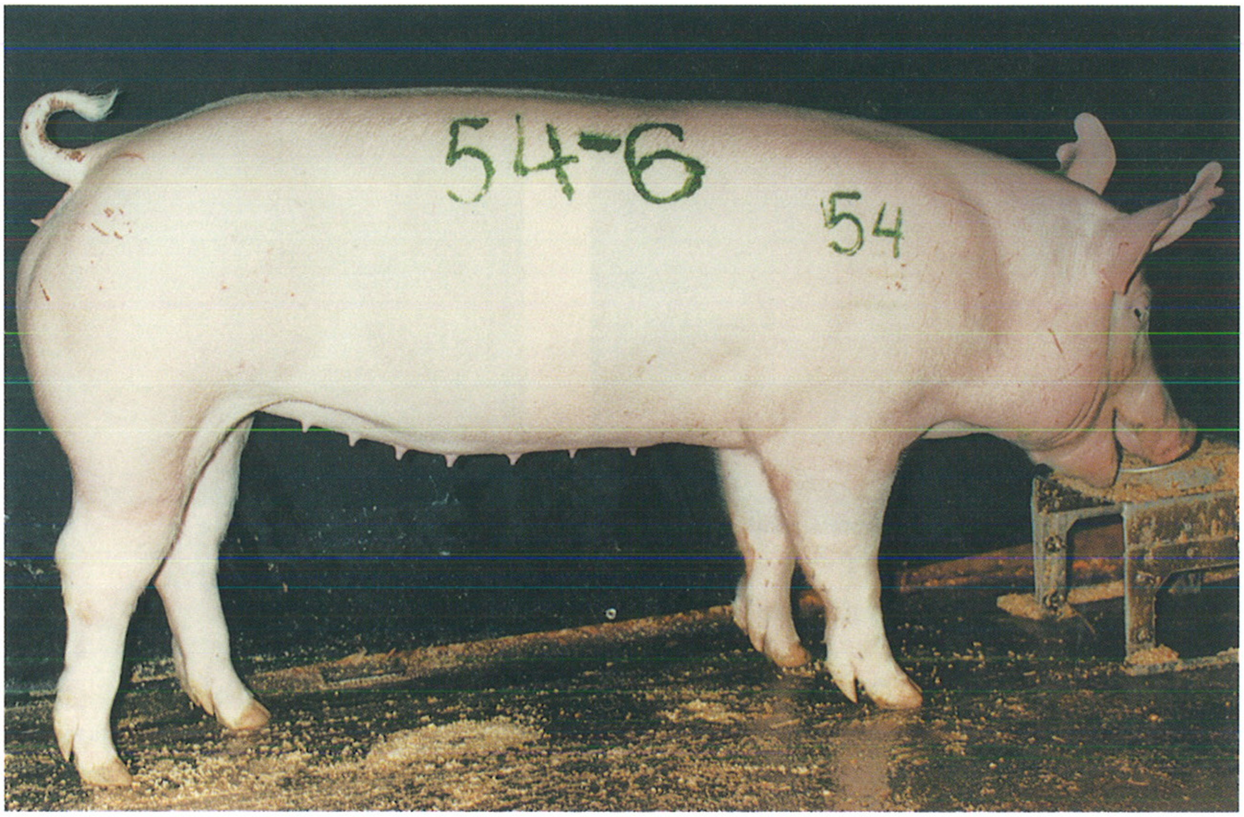


Figure 15.5
Prominent underline

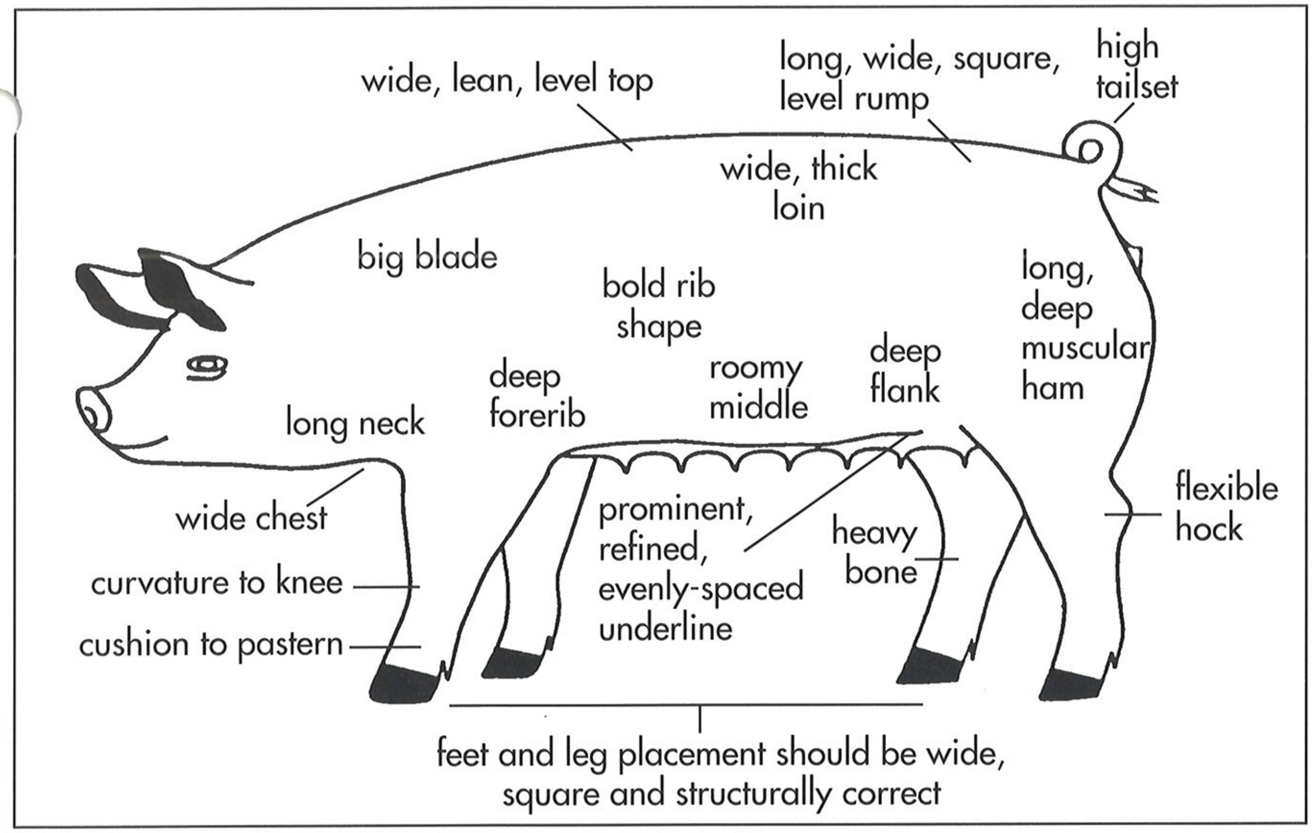


Figure 15.6
Characteristics of an ideal breeding gilt

The Components of the Female Reproductive Tract

1. Brain

- Senses the external and internal environment of the female and regulates behavior and the reproductive process.
- Controls learning
- Is the ultimate control center for reproduction.

Hypothalamus

- Sorts the signals from the boar: smell via the nose, sight via the eyes, touch, and sound. With the appropriate signals, the hypothalamus activates, controls, and integrates the nervous and hormone systems.
- Secretes gonadotrophic releasing hormone (GnRH) that regulates luteinizing hormone (LH) and follicle stimulating hormone (FSH) secretion from the anterior pituitary gland.
- Secretes other hormones that influence growth, metabolism and the animal's response to stress.

Pituitary glands

- Glandular anterior lobe - Secretes LH (which matures follicles and induces ovulation) and FSH (functions in follicle selection and growth).

Neuronal posterior lobe

- Secretes oxytocin, which stimulates milk letdown and contractions of the smooth muscles of the uterus.

2. Ovaries

- The female gonad.
- Produce estrogen and progesterone, the principal female hormones.
- Produce ova (eggs).
- Undergo cyclical changes in hormone production and anatomy.

Corpora lutea

- Ovarian structures that produce progesterone during diestrus and pregnancy.
- Formed by luteinization of ovulated follicles.
- Maintained if the female becomes pregnant; in the cycling, nonpregnant female degenerate to form the corpora albicantia (CA).

Follicles

- Each follicle usually contains one ovum (egg).
- Produce estrogen.

3. Oviducts (Fallopian tubes)

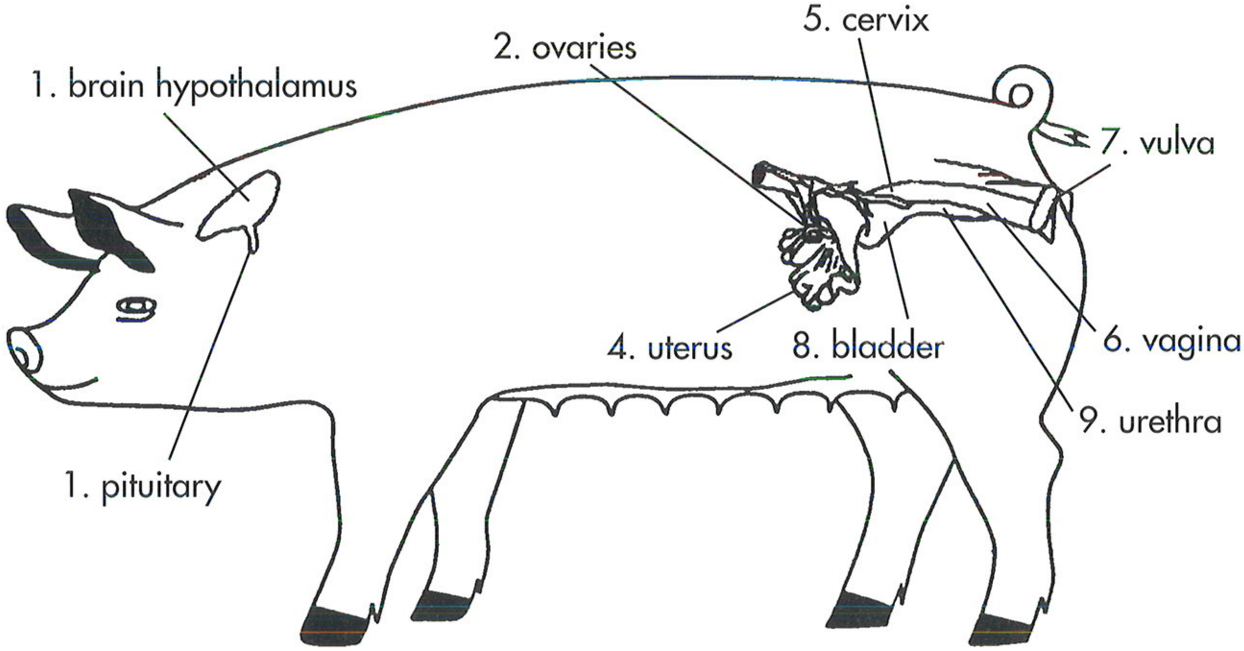
- The ovarian end is funnel-shaped.
- Tubular structure that permits passage of the egg to the uterus.
- Site for fertilization of eggs by sperm.
- Provides a "protected" environment for the egg and early embryos.

4. Uterus

- Paired tubes or horns connected to the oviducts.
- Glandular lining (endometrium) nourishes the embryo and developing fetuses.
- Controlled by reproductive hormones.
- Enlarges at sexual maturity and during estrus; shrinks during diestrus.
- Contracts during farrowing to expel piglets and placentae.

- Source of Prostaglandin: plays a role in the regression of corpora lutea.

5. **Cervix**
   - Contains numerous glands that supply mucus to the vagina.
   - Has many ridge-like folds that lock the boar's corkscrew penis or AI rod.
   - Tight and constricted during diestrus and pregnancy; slackens during estrus and opens during farrowing.
6. **Vagina**
   - Connects the cervix with exterior via a short vestibule; guides the boar's penis during mating.
   - Nonglandular; undergoes cyclical changes with the estrous cycle, has numerous cell layers during estrus but less than six during diestrus or pregnancy.
   - Forms birth tract during farrowing.
7. **Vulva**
   - External genital organ of the female pig.
   - Reddens and swells in response to estrogen associated with estrus.
8. **Urinary bladder**
   - Sac for urine storage; connects to the kidneys via ureters.
9. **Urethra**
   - Discharges urine from the body.
   - Can be traumatized by the boar's penis during mating.
   - Discharges urine from bladder, connects bladder and vagina.
10. **Infundibulam**
    - The fimbriated end of the infundibulam surrounds the ovary and "captures" the egg at ovulation.
11. **Ampulla**
    - Thin-walled portion of the oviduct, aids in ova transport to the site of fertilization.
12. **Ampulla-isthmus junction**
    - Junction in the oviduct where fertilization of the ova by sperm occurs.
13. **Isthmus**
    - Tubular section of the oviduct that facilitates sperm transport from the uterus and fertilized egg (zygote) transport to the uterus.
14. **Uterotubal junction**
    - Regulates the movement of sperm into the oviduct and movement of the zygote into the uterus.
    - Obstructs movement of bacteria from the uterus into the oviduct and body cavity.



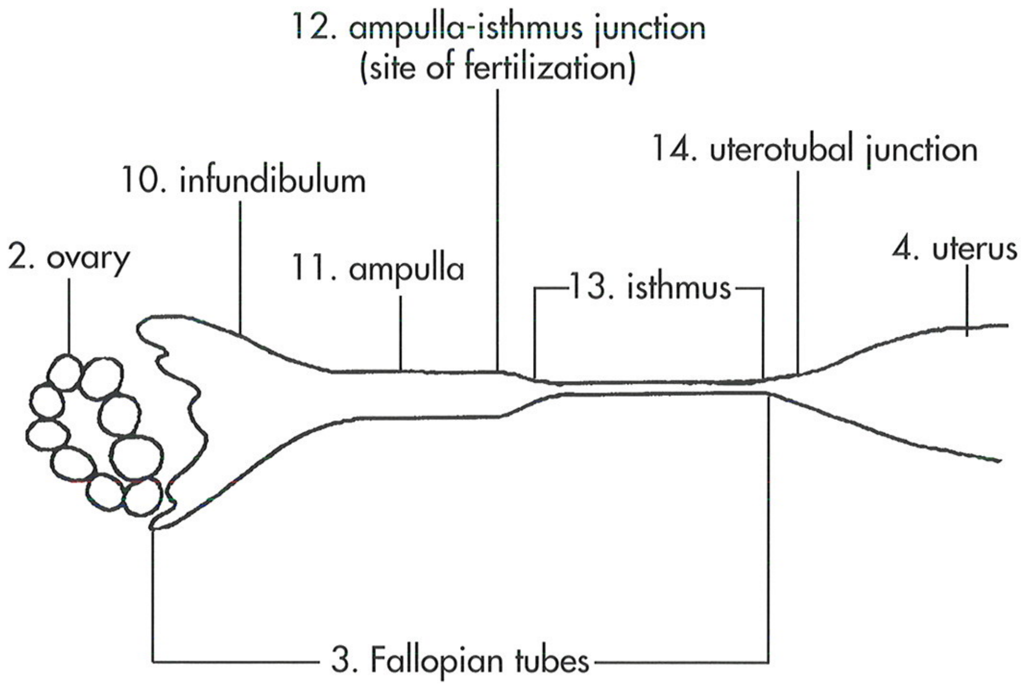


Figure 15.7
The reproductive tract of the female pig

Gilt Selection Calendar

When	What
Birth	• Identify gilts born in large litters. Hernias, cryptorchids and other abnormalities should disqualify all gilts in a litter for replacements. • Record birth dates, litter size, breed composition and identification. • Equalize litter size by moving pigs from large litters to sows with small litters. Pigs should nurse before moving. • Keep notes on sow behavior at time of farrowing and check: (a) disposition, (b) length of farrowing, (c) any drugs such as oxytocin administered, (d) condition of udder, and (e) extended fever.
2–5 weeks	• Wean litters. Feed balanced, well-fortified diets designed to optimize growth and development. • Screen gilts identified at birth by examining underlines, and reject those with fewer than 12 well spaced teats. If possible, at this time select and identify as replacement gilt candidates about 2–3 times the number needed for replacement.
180–250 lbs.	• Evaluate gilts for growth, leanness, and soundness. • Select for replacements the fastest growing, leanest gilts that are sound and from large litters. Save 25–30% more than needed for breeding. • Remove selected gilts from market hogs. Place on restricted feed. Increase mineral fortification levels. • Give fenceline contact with boar. (When gilts are 150 to 170 days of age). • Observe gilts for sexual maturity. If puberty records are kept, give advantage to those gilts that have cycled most frequently when final culling is made.
Breeding	• Make final selection when the breeding season begins and keep sufficient extra gilts to offset the percentage of nonconception. • Make sure all sows and gilts are ear-tagged or identified. • Start breeding at second or third estrus (6–8 months of age)

Boar Selection

The performance level of a swine herd is determined by two things: genetics and environment. The genetic contribution is determined by the boars and gilts selected and the breeding scheme involved. The environment, (weather, housing, feeding management, etc.) will enhance or hinder the performance traits.

It is every bit as important to focus on the health and genetic background of the boar as it is the gilts. The boar will actually have more effect on the herd as a whole than the gilts. A boar will contribute 50% of his genetics for every pig that is sired by him.

When selecting your new boar or ordering semen for Artificial Insemination (AI) follow a genetic improvement program that balances the traits you desire. Keep in mind that visual appeal is important but must co-exist with performance, carcass and quality traits.

A sound genetic improvement program should include four features:

1. Accurate, complete performance records including individual animal identification.
2. A history of the boar and preferably his ancestors genetic merit in these traits: growth rate, feed efficiency, carcass merit and reproductive performance.
3. An index value indicating the boars rank compared to his herd of origin and also within his breed or lineage.
4. Structural and breeding soundness evaluation. The best records in the world won't mean anything if the boar is not capable of breeding. (Refer to chapter 2 on structural evaluation).

The breeding program used will likely dictate the breed, crossbred or composite boar needed. Boars or semen can be purchased from purebreed breeders and commercial breeding organizations. Both can be good sources of genetics.

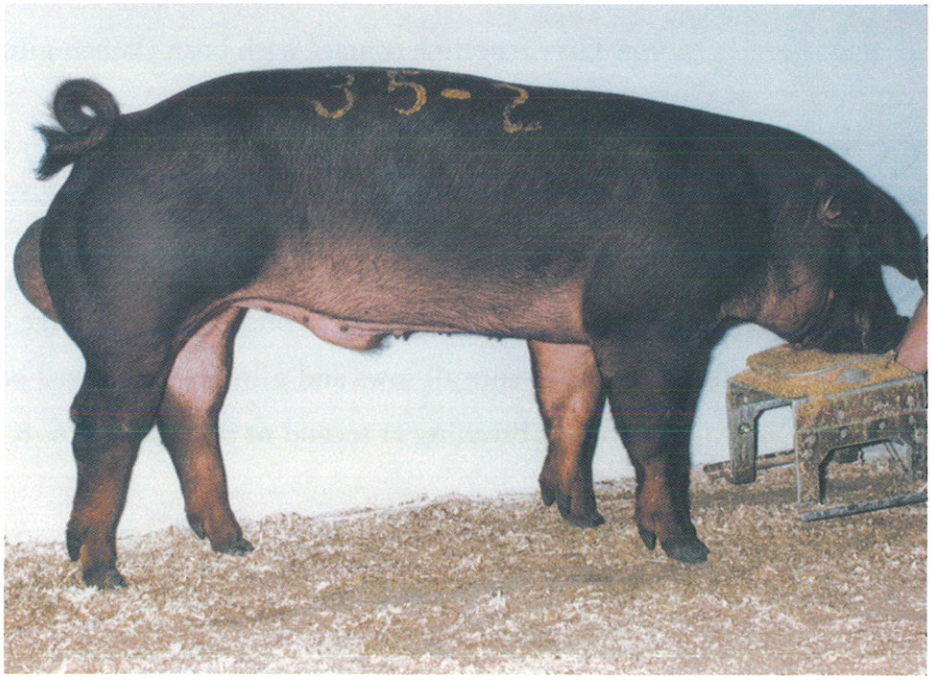


Figure 15.8
Ideal boar

Age of boar - Select and purchase boars at 6 to 7 months of age. Don't use young boars just because they appear to be large enough. Boars should be purchased at least 2 months prior to intended breeding. This will provide you time to isolate and check for health concerns. This is also a good opportunity to test mate boars to gilts and evaluate for breeding performance.

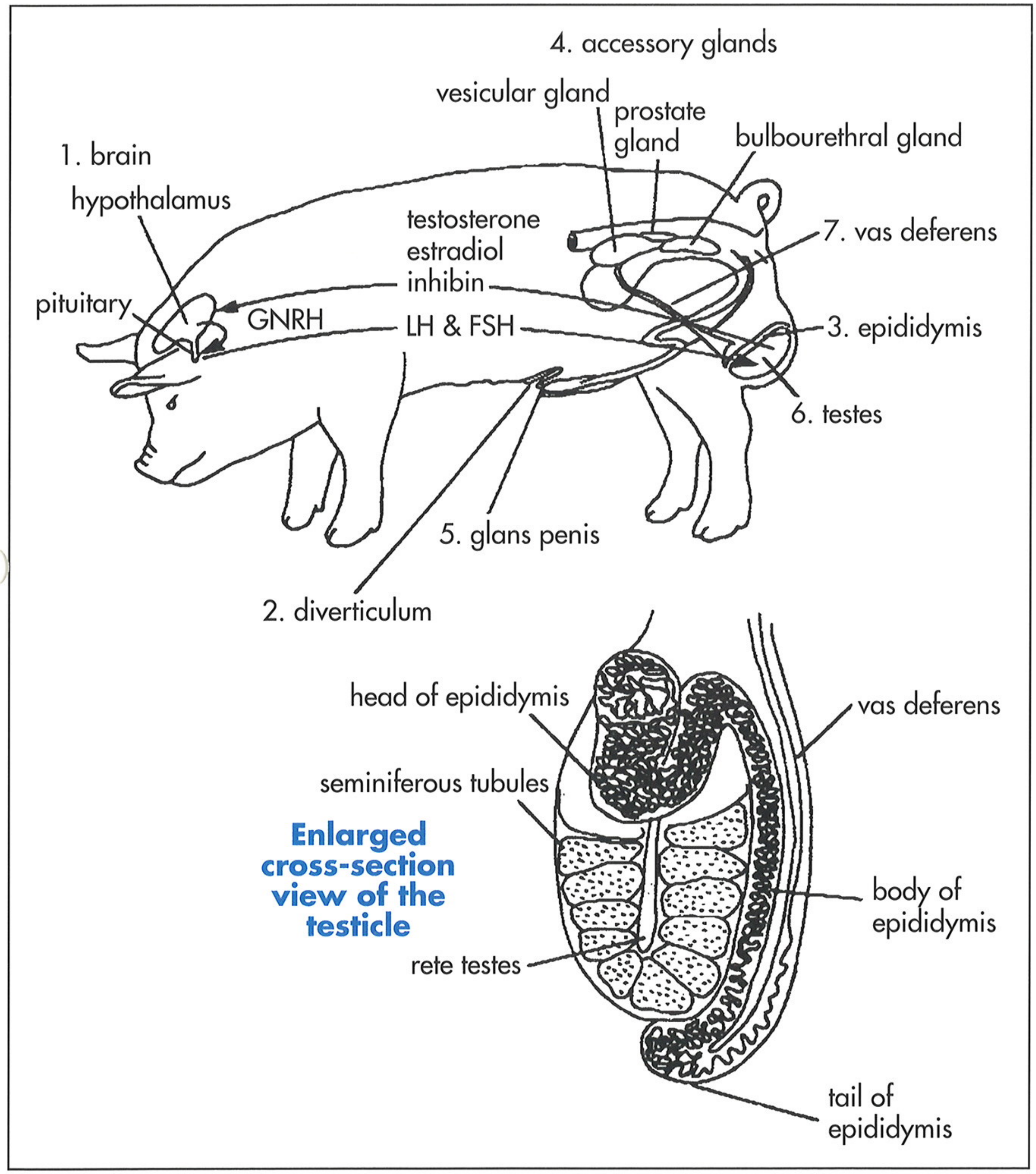


Figure 15.9
Top: the reproductive system of a boar. Bottom: boar testes

The Components of the Male Reproductive Tract

Keys to Figure 15.9

1. Brain

- Senses the external and internal environment of the boar and regulates behavior and the reproductive process.
- Controls learning in the boar.
- Primary hormonal organ that controls reproductive processes by secreting hormones that stimulate and regulate sperm production.

Hypothalamus

- Receives signals from the nose (e.g., odors of breeding females in heat) and signals from the eyes (e.g., sight of females in heat) that cause the boar to respond immediately with changes in his sexual behavior.
- Secretes gonadotropin releasing hormone (GnRH) that regulates secretion of luteinizing hormone (LH) and follicle stimulating hormone (FSH) from the anterior pituitary.
- Secretes corticotropin releasing factor (CRF), which controls secretion of adrenal corticoids. Secretion of high amounts of CRF increases during some forms of stress, and may reduce sperm output and inhibit secretion of GnRH.

Pituitary gland

- Glandular anterior lobe -Secretes luteinizing hormone (LH) and follicle stimulating hormone (FSH), which stimulate the Leydig cells of the testes.

Neuronal posterior lobe

- Secretes oxytocin, which causes smooth muscle to contract and propel semen through the penis at ejaculation.

2.) Diverticulum

- Appears to serve no useful purpose.
- Can become filled with urine, semen, and secreted fluid, which can kill sperm.

3.) Epididymis

- Formed by the merging of the efferent ducts.
- Carries sperm out of the body.
- Secretes chemicals that mature the sperm cells.
- Sperm are concentrated in the head of the epididymis.
- Sperm are stored in the tail of the epididymis until ejaculation.

4.) Accessory glands

- Secrete the fluid and gel that comprises about 90% of the volume of ejaculate, which:
  -maintains appropriate pH and salt balance.
  -provides nutrients for the sperm.
  -provides a transport medium for the sperm.

Vesicular glands

- One of three accessory glands that secrete fluid in semen, the vesicular gland secretes the largest amount of the three glands.

Prostate gland

- One of three accessory glands that secrete fluid in semen. The prostate gland secretes the least amount of the three glands.

Bulbourethral glands

- Larger in the boar than in other livestock species.
- The source of the gel fraction in semen.

5.) Glans penis

- Contains many nerves and is very sensitive.
- Responds to the pressure and temperature of the female reproductive tract.
- Must be properly stimulated for a normal ejaculation.
- Retracts into the prepuce or sheath when the boar is not sexually active.

Penile urethra

- The tube or duct that carries semen from the site of production through the middle of the penis to the tip where it is ejaculated. This duct also carries urine from the bladder.

6.) Testes

- Produce hormones, including testosterone, which is the principle hormone that stimulates sperm production and male behavior.
- Produce sperm

Seminiferous tubules

- Where sperm originate through meiosis.

Rete testes

- Transport sperm out of the testes.

Scrotum

- Contains the testes.
- Hangs outside the body to keep the testes cool.

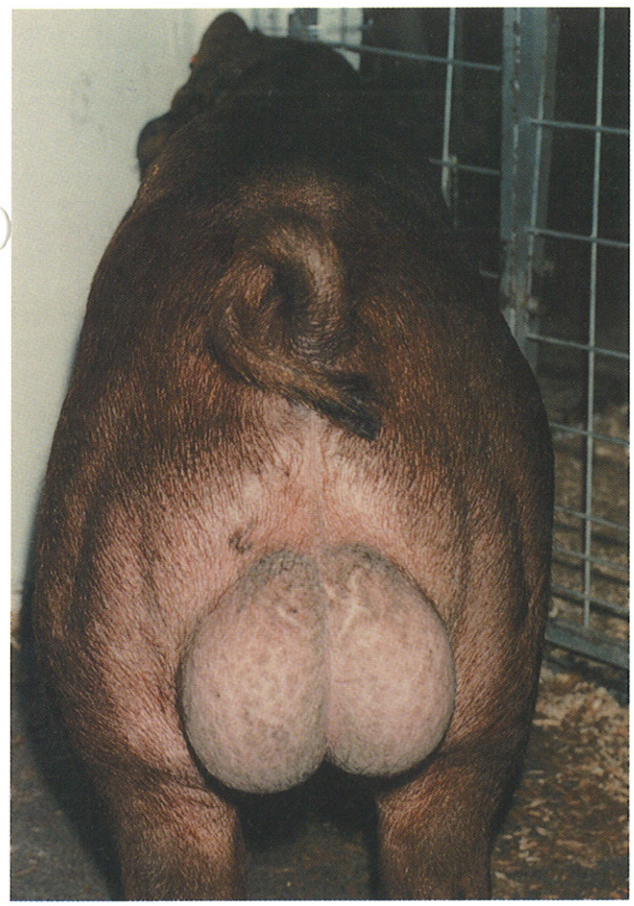


Figure 15.10
Desirable testicles

Figure 15.11
Small, undesirable testicles

7.) Vas deferens

- Heavily muscled tube through which sperm move rapidly as they are being ejaculated.
- Contracts vigorously in response to hormones (oxytocin and prostaglandin Fα) during ejaculation.
- A vasectomy involves cutting and tying each vas deferens so that no sperm can be transported out of the body.

Bladder

- Empties into the urethra near the junction with the vas deferens.
- Collects and stores urine.

Chapter 17
Genetics

Genetics are very important to understand since they will help determine how that animal will perform under different types of management and environmental situations. Let's look at developing a base understanding of some genetic principles.

Genetics influence economically important traits such as litter size, litter weights, growth rate, feed efficiency, backfat thickness, pork quality and structural correctness. Project members need to know how genetics work in order to properly mate and improve their herds.

How does inheritance work? Let's start at the beginning!

A body cell in your pig contains 38 **chromosomes.** Chromosomes are thread like structures that contain **genes,** the basic unit of inheritance. Genes are responsible for affecting body development and function. For normal body development and function, genes must occur in pairs. Genes are part of the chromosomes that reside in the nucleus of body cells. The chromosomes in the cells of a pig's tail are exact copies of the chromosomes in the pig's heart. However, the genes on the chromosomes know their function in specific body tissues.

Chromosomes occur in distinct pairs. Pigs have 19 pairs for a total of 38 chromosomes. Humans have 23 pairs for a total of 46 chromosomes. Since chromosomes occur in pairs, genes also exist in pairs.

If there are more or less than two chromosomes in a pair, an abnormality will occur. An example of this is Down's Syndrome in humans. A person with Down's Syndrome has three members in a particular set of chromosomes instead of the normal two.

During the process of reproductive cell division (meiosis), only one member of a chromosome pair is passed on to sperm (boar) and egg cells (sow). During fertilization, a sperm cell unites with the egg cell to form a zygote which develops into the pig fetus.

Because chromosomes contain genes, the offspring will receive half of its genes from each parent. However, each individual in the litter will receive a different sample of its parents' genes. So even though they are in the same litter, littermates will only have about 50% of the same genes.

The location of a gene on a chromosome is called the locus. At the same locus on **homologous** chromosomes are genes that affect the same trait. These corresponding genes are referred to as a gene pair. For a given pair, the genes can be identified as **like** (homozygous) or **different** (heterozygous). See the following example:

B = symbol for the gene causing black hair
b = symbol for the gene causing red hair

Animal	Genotype	Phenotype
1	BB	black
2	Bb	black
3	bb	red

Animal #1 is homozygous at this locus because it has the same genes whereas individual #2 is heterozygous. A particular gene combination is referred to as the genotype while the physical appearance (what is seen or measured) is called the phenotype.

Based on these phenotypes, **B** is referred to as the dominant gene, and **b** is the recessive. For these two genes, complete dominance exists since B covers the effect of b. However, different degrees of dominance, or a lack of dominance, can occur for other genes.

Hair color is an example of a qualitative trait because the phenotypes fit into distinct categories or classes. Qualitative traits are controlled by one or a few pairs of genes. Genotypes for qualitative traits are often predicted based on mating tests. Laboratory analyses of blood samples have been used to predict genotypes of qualitative traits such as porcine stress syndrome (PSS). See Chapter 4 (Quality).

Quantitative traits generally do not fit into distinct classes for phenotypes. Examples of quantitative traits are backfat thickness, feed efficiency, days to market, 21-day litter weight, and number of pigs born alive. These traits are controlled by many pairs of genes. The expression of these traits (phenotype) is influenced by the animal's genes (genotype) and the environment. With uniform care, feeding, and housing, pigs within a group will express less variation in performance from environmental effects, which results in more accurate genetic evaluations.

An individual's genetic value for a trait is affected by an additive component and a non-additive component. The additive genetic component is due to the effects of the genes, independent of their interaction with other genes. Since individual genes are passed from parent to offspring, this component is inherited and can be improved through proper selection.

The trait's non-additive genetic value is due to the interaction of genes. Since gene combinations are not passed from parent to offspring, a trait's non-additive value is not inherited, but can be improved through **crossbreeding** or **outcrossing.** This improvement in non-additive value is referred to as **heterosis** or **hybrid vigor.** The opposite of heterosis is inbreeding depression. Inbreeding depression is the drop in performance due to a decrease in non-additive value resulting from mating related animals.

The additive genetic component is commonly referred to as the **breeding value.** Animals that excel in this component produce offspring with high breeding values. This would be expected since an animal passes one-half of its breeding value on to the progeny. Because of this, one-half of the individual's breeding value is the **expected progeny difference (EPD).** The EPD is the difference between the average performance of the individual's offspring and the average performance of all progeny in the population.

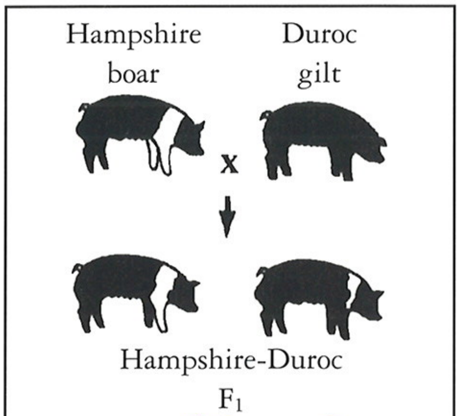
Heritability Estimates for Swine Traits

Trait	Heritability
Litter size born alive	.20
Litter birth weight	.30
21-day litter weight	.20
Average daily gain	.40
Days to 250 lb.	.40
Feed conversion	.30
Soundness	.40
Backfat thickness	.50
Loin eye area	.50
Carcass length	.55
Carcass quality	.15–.50

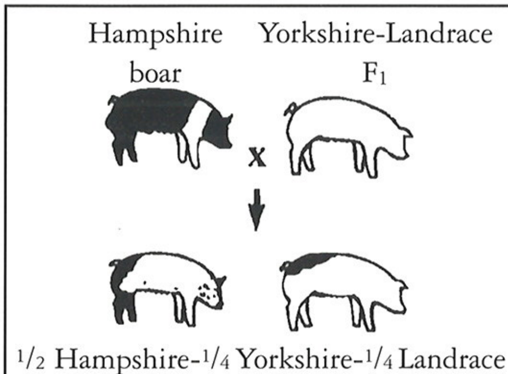
Percentage of the Maximum Heterosis Obtained from Various Crossbreeding Systems

System	% Heterosis Individual	% Heterosis Maternal
F_1 (initial cross, A x B)	100	0
Backcross (A x A-B)	50	100
2-breed rotation	67	67
3-breed rotation	86	86
4-breed rotation	93	93
Terminal cross using F_1 sows	100	100
Rotaterminal using a 2-breed rotation	100	67
Rotaterminal using a 3-breed rotation	100	86

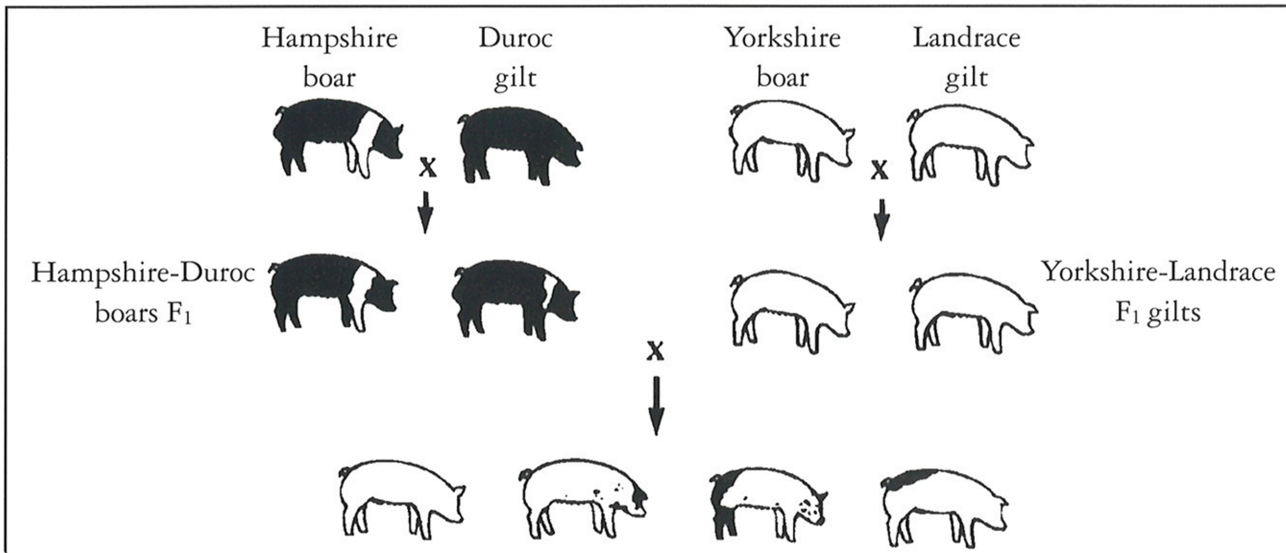
Examples of Crossbreeding Systems



Two Breed Cross System



Three Breed Cross System



Four Breed Terminal Crossbreeding System

Abnormalities

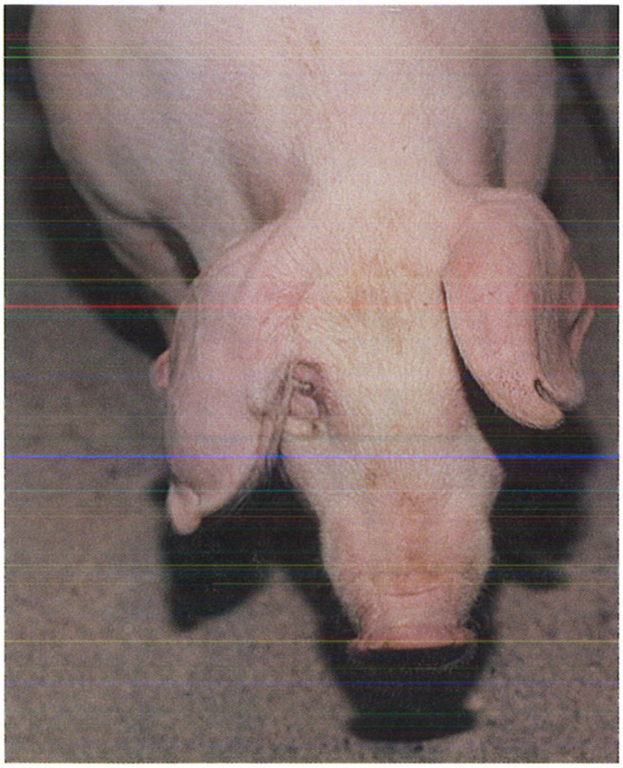


Figure 17.1
The hematoma on the pig's right ear was caused by environmental conditions

Anatomical abnormalities or defects occur in at least 1% of newborn pigs. These defects may be caused by genetic or environmental factors. Although the frequency of these defects is low, they can be frequent enough in an individual herd to cause substantial economic loss.

Traditionally, producers have assumed all such abnormalities were of genetic origin since the defects are often dramatic and congenital.

Congenital defects only imply that they are visible at birth and not that they have a genetic cause. We now recognize that environmental factors such as viral infections, dietary deficiencies, and ingestion of certain drugs, chemicals, and pesticides during pregnancy may alter normal prenatal development of the pig. In fact, some cases of an abnormality may result from genetic factors while other cases of the same abnormality may result solely from environmental factors.

Umbilical Hernia—A weakened supportive muscle in the navel area results in the intestines protruding through the belly wall. Also known as a belly bust. This condition is primarily caused by infection in the navel area. Research studies have shown no genetic influence on the incidence rate of umbilical hernias.

Important Genetic Abnormalities

Porcine Stress Syndrome (PSS)—(refer to Chapter 4)

Rendement Napole Gene—(refer to Chapter 4)

Scrotal Hernia—Results from a weakness of the muscles that surround the inguinal canal, permitting the intestines to drop into the scrotum.

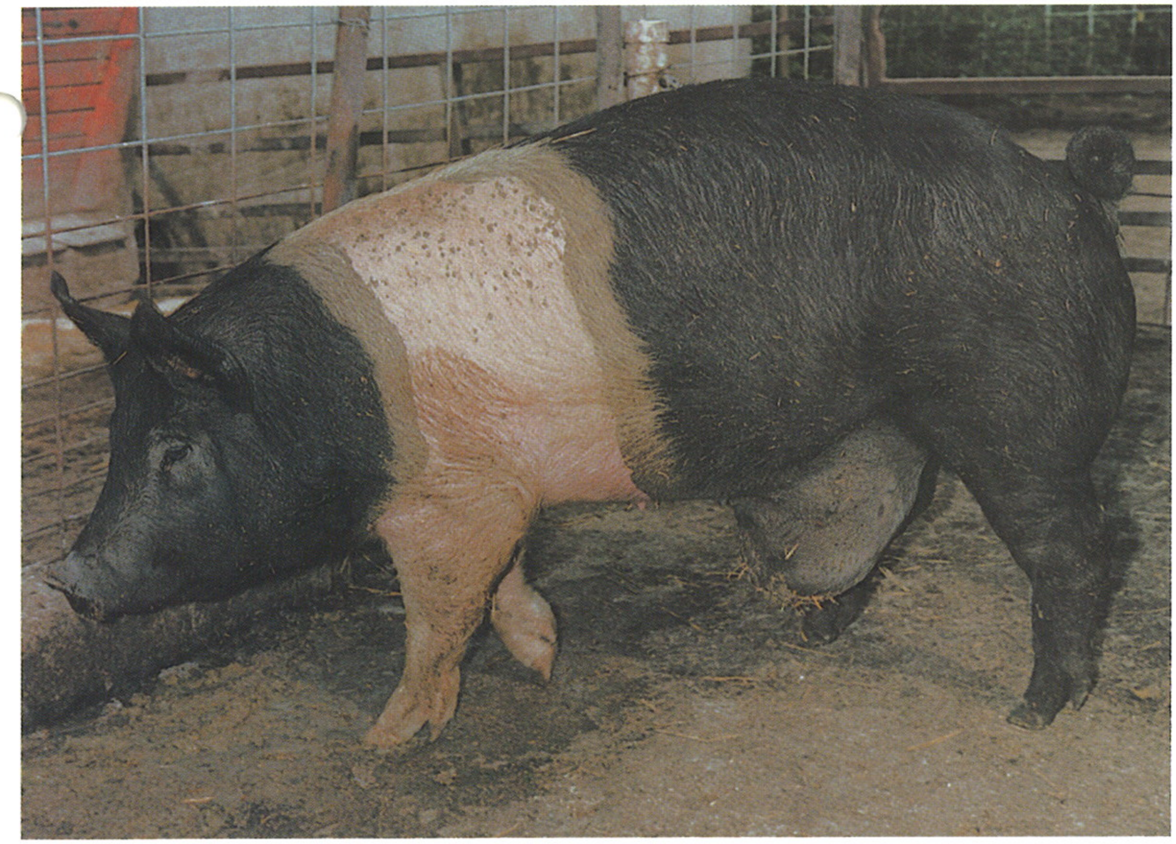


Figure 17.2
Umbilical hernia

Figure 17.3
Scrotal hernia

Atresia Ani—This condition is characterized by a pig being born without a rectal opening. Boar pigs die within a few weeks unless an opening is made surgically to permit him to defecate. Females with no anal opening can commonly defecate through the vulva and grow normally.

Cryptorchidism—Are male pigs with one or more testicles retained up in the body cavity.

Hermaphrodites—Are pigs that carry both male and female sex organs. Example: vulva and testicles are both present.

Other genetic abnormalities include: rectal prolapse, swirls (hair whorls), screw tail, blood warts, brain hernias, cleft palate, gastric ulcers, hemophilia (bleeders), humpback, hydrocephalis, leukemia, spraddle (splay) legs, tremors, polydactyly (extra toes), syndactyly (mule foot). Refer to Pork Industry Handbook, PIH-97 for more information.

Figure 17.4
Spraddle (splay) legs—genetic defect

Figure 17.5
Masking tape is used to aid the piglet in movement and to strengthen the legs