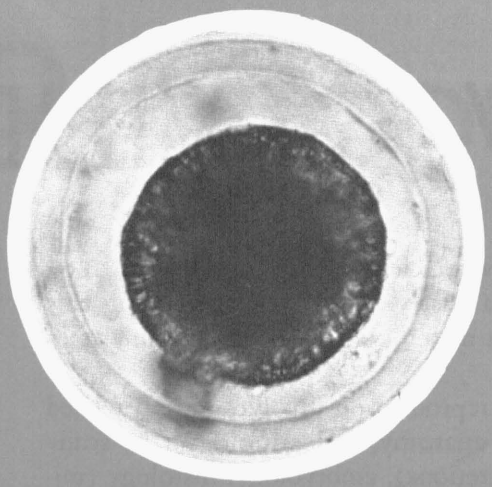
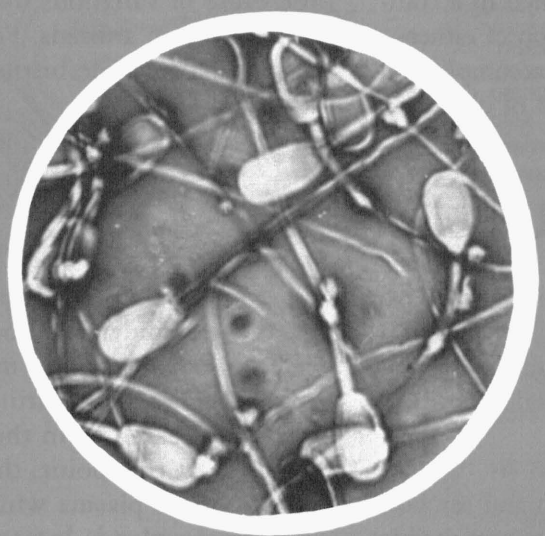
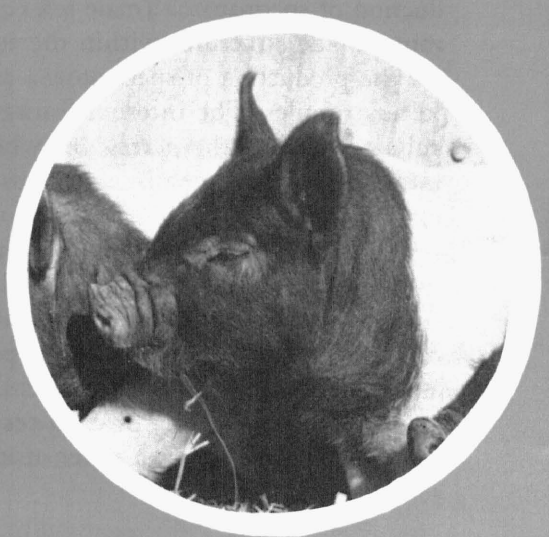


How Swine Reproduce





B 756 AUGUST, 1960
UNIVERSITY OF MISSOURI
AGRICULTURAL EXPERIMENT STATION

For More Pigs Per Litter Learn --

HOW SWINE

The basic processes of reproduction are essentially the same in all farm animals: (1) production of mature eggs by the female, (2) production of viable sperm by the male, and (3) a means of successfully joining the two for the production of new individuals. But the way these processes are carried out varies in the different species. Thus it is important that we consider many of the details of reproduction on the basis of a specific group, such as swine.

The reproductive mechanism is uniquely set apart from other body systems by the fact that two systems, male and female, must be joined in a compatible union before the primary function of either—the production of an offspring—can be accomplished. Naturally, this complicates the problem of obtaining high reproductive efficiency in a breeding herd. You may have had a costly experience illustrating this point when you mated a group of fertile females to a sterile male.

A study of reproduction involves several related scientific areas: anatomy, endocrinology (the study of hormonal secretions), embryology, histology (microscopial anatomy), and genetics. Knowledge from these fields helps us explain the development, function, and purpose of the reproductive processes.

This understanding, in turn, helps us establish the cause of variations in the reproductive cycles of different farm animals. For example, why do cows usually have single births whereas sows give birth to several young?

Male Reproductive System

The male reproductive system consists of two testes, three accessory sex glands and a series of tubules through which the spermatozoa are transported from the site of production to the female reproductive tract.

The primary functions of the testes are the production of spermatozoa (male sex cells) and sex hormones. The structures within the testes responsible for the production of spermatozoa are called seminiferous tubules. The internal lining of these coiled tubules contains the germ cells which develop into immature spermatozoa by a process known as spermatogensis.

Growth pressure forces the immature spermatozoa through several small tubules into another structure called the *epididymis* where storage and further maturation occurs. The epididymis of the boar consists of a single tightly coiled tube located on the external surface of each testis and is about 400 to 500 feet in length when unraveled.

At the time of service, the spermatozoa pass from the epididymis through the *vas deferens* which empties into the *urethra* in the region of the bladder. (The urethra is the urinary tract extending from bladder to exterior; in the male it also conveys the semen.) At this point, the spermatozoa are mixed with seminal plasma which is produced by the accessory sex glands located near the urethra. The combination of seminal plasma and spermatozoa is called semen and it is this mixture that is deposited in the female reproductive tract at the time of service.

The accessory sex glands found in the boar are the *seminal vesicles, prostate* and *Cowper's gland.* The paired seminal vesicles and Cowper's glands are 5 to 6 inches long and 1 to 2 inches wide in the mature boar whereas the prostate is considerably smaller, being a 1-inch band of glandular tissue located around the neck of the bladder.

The penis is the male organ for mating and the sheath, which contains and covers the free portion

REPRODUCE

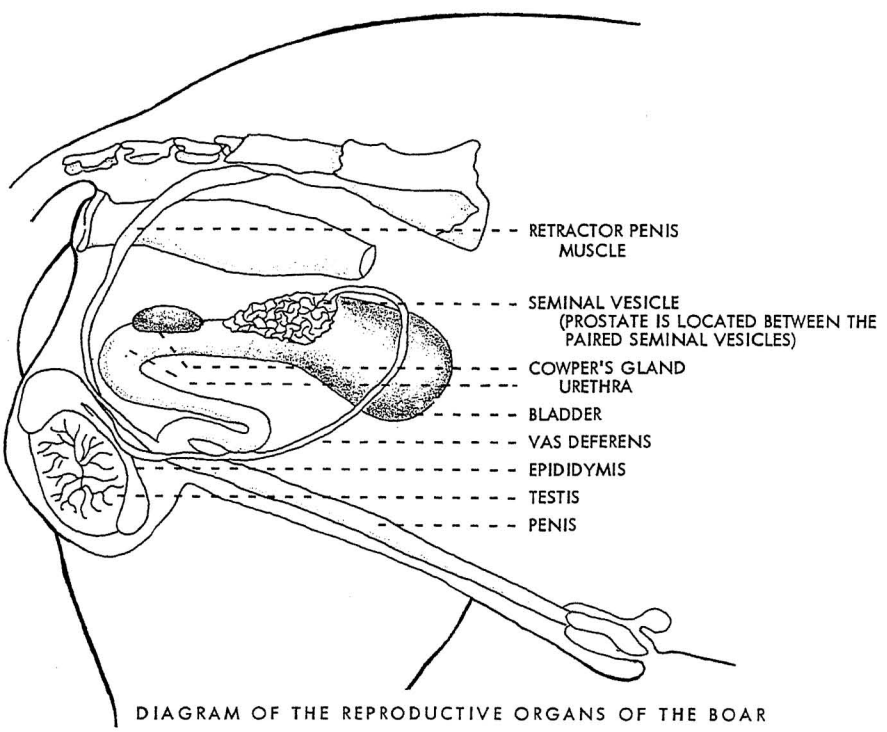


DIAGRAM OF THE REPRODUCTIVE ORGANS OF THE BOAR

of penis when it is not erect, is called the *prepuce.* A pouch is found in the upper wall of the prepuce of the boar which accumulates urine and, in turn, is partially responsible for the strong odor associated with mature boars.

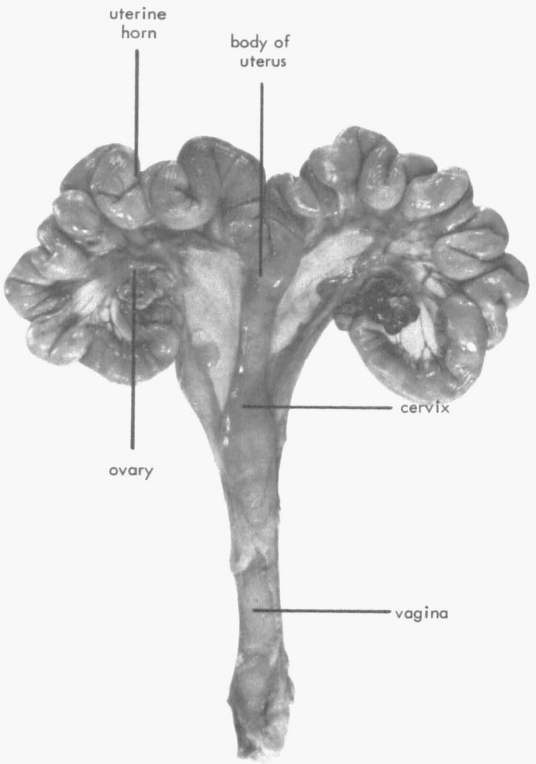
The second major function of the testes is the production of the male sex hormone. Specialized cells (cells of Leydig) located in the testicular tissue between the seminiferous tubules secrete testosterone, which is transported to other parts of the body by the circulatory system. Some of the functions of testosterone are: the inducement of libido (sex drive), the development of secondary sex characteristics such as tusks on boars, the maintenance of the accessory sex glands, and increased nitrogen retention by the body tissues. It also seems apparent that the rate of fat deposition in swine is at least partially under the control of testosterone. This is best demonstrated by the wide difference found in the backfat thickness of barrows and boars.

Female Reproductive System

The reproductive tract of the sow consists of the ovaries and a tubular portion which is modified in structure to perform widely different functions.

The ovaries are the site of production of the ovum, or egg, and female sex hormones. The ovum carries a sample half of the genetic make-up of the dam and the sperm cell a sample half of the genes of the male. The successful union of the ovum and spermatozoon results in a new individual having the full complement of genetic particles, half from each parent.

Each ovum develops in a fluid-filled *follicle* which protrudes from the surface of the ovary when ma-



Right, reproductive organs of a non-pregnant, sexually mature gilt. Eggs produced by the ovaries enter the small Fallopian tubes (refer to diagram) where fertilization by male sperm occurs. The fertilized ova then pass into the uterine horns and develop into embryo pigs. Membranes of the embryos attach to the wall of the uterus and the developing pigs get their nourishment from the blood system of the dam.

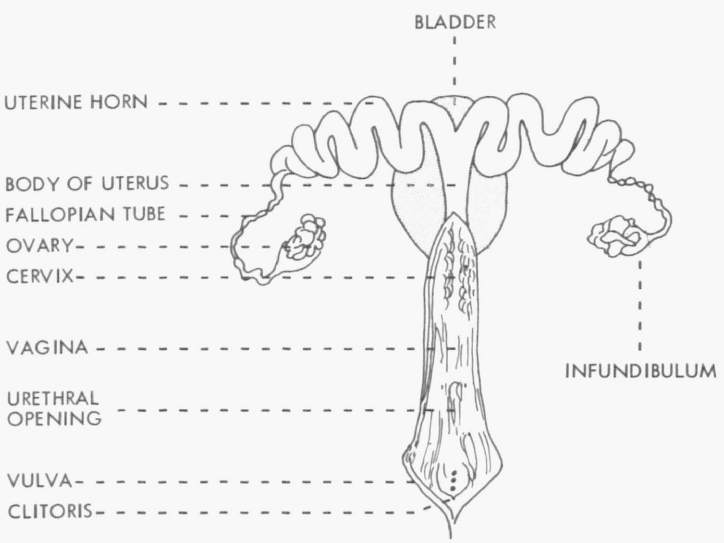
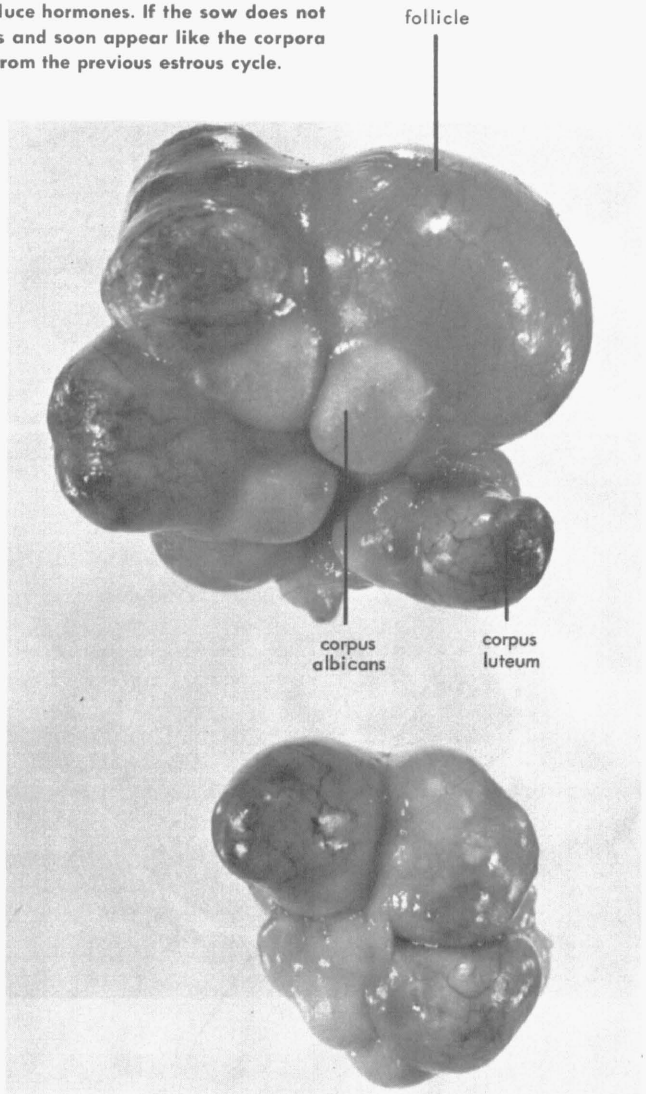


DIAGRAM OF THE REPRODUCTIVE ORGANS OF THE SOW

Ovaries of a non-pregnant gilt, magnified about 3¼ times. Nine developing copora lutea are on the ovaries. The large follicle on the upper ovary has not yet ruptured. When it ruptures and releases the enclosed egg to the Fallopian tube, it will become a corpus luteum like the one below it and produce hormones. If the sow does not become pregnant, the copora lutea will regress and soon appear like the corpora albicantia (center of upper pic), which are left from the previous estrous cycle.

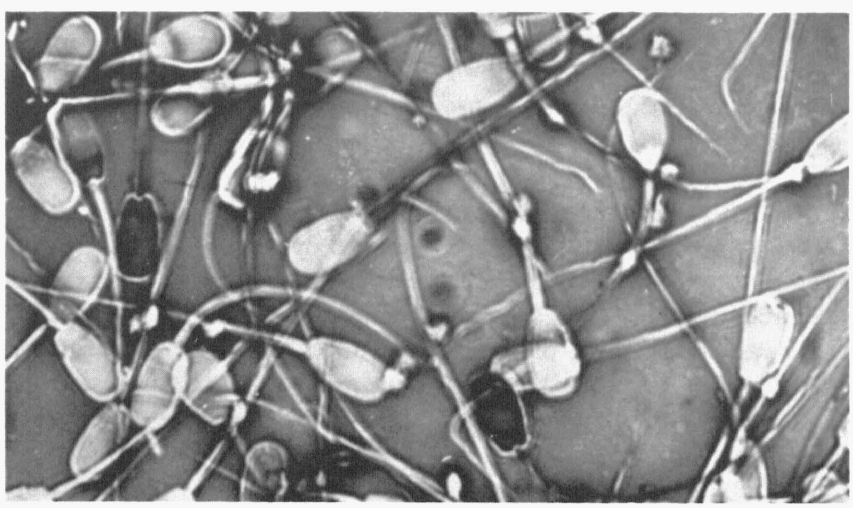


ture.. The mature follicle is about 0.4 of an inch in diameter. The wall of the follicle ruptures at the time of ovulation, releasing the enclosed egg and surrounding fluid to the tubular part of the reproductive tract.

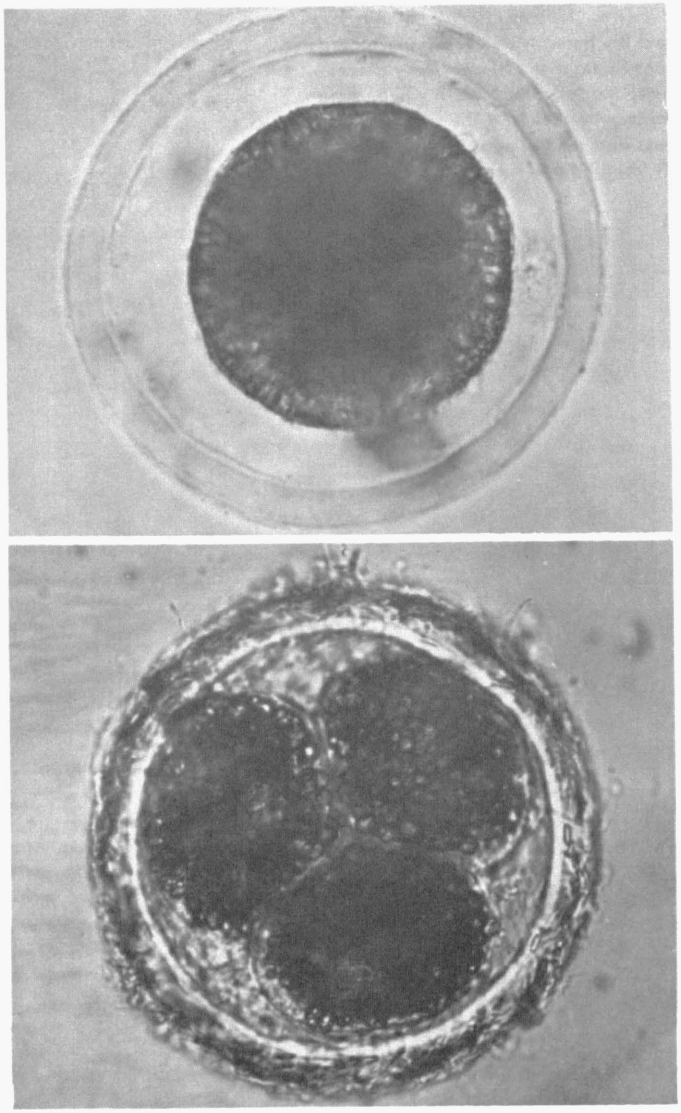
Ovulation in the sow is a gradual process that occurs over a matter of hours. It is generally considered that, in swine, more eggs are released from the ovary 30 to 36 hours after the beginning of heat than at any other time during the heat period.

The tubular portion of the sow's reproductive tract has a continuous opening from the area of the ovary to the outside of the animal's body. Differences in size, function and appearance clearly separate the reproductive tract into the following parts: *Fallopian tubes, uterine horns, body of the uterus, cervix, vagina* and *vulva* (listed in the order that the egg and embryo pass from the time the egg is released from the ovary to the birth of the offspring).

The Fallopian tubes and uterine horns are paired and the cervix and vagina are single structures. The average lengths of these structures in the sow are: Fallopian tube, 6 to 12 inches; uterine horn, 3 to 5 feet; uterine body, 2 inches; cervix, about 4 inches; and vagina, 4 to 5 inches.



These are boar spermatozoa magnified about 1000 times. Around 20 billion spermatozoa are ejaculated at each service by the boar. A single sperm unites with one egg to form the new individual. Sperm are considerably smaller than the egg but each contributes equally to genetic make-up of the offspring.

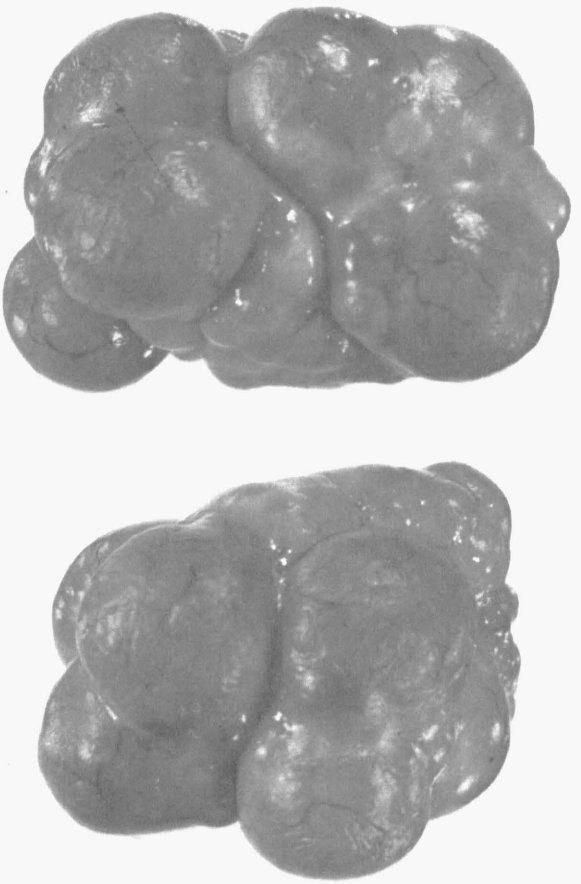


After the ovum or egg (1) is fertilized it begins to divide, reaching the 4-celled stage pictured (2) after about 48 hours (one cell is hidden in Figure 2). This "cleavage" of cells of cells continues until formation of the pigs is completed. This prenatal development is complete in about 114 days in the sow. (Pictures 1 and 2 magnified 340 times. Generally only 55 to 60% of the ova are farrowed as living pigs, though each is potentially a new individual.
Figure 3 shows the reproductive tract of a gilt pregnant for 28 days.

Fertilization, or union of an egg and sperm, occurs in the Fallopian tube. The fertilized ova reach the uterine horn approximately 2 days after ovulation and it is here in the horns of the uterus that the development of the pig embryo occurs. Nourishment for the developing young is supplied by the blood system of the dam to the embryonic membranes which are attached to the uterine wall. The nutrients are then transported to the body of the embryo by the umbilical vein.

The cervix, which is located between the uterus and vagina, opens into the body of the uterus in non-pregnant sows but is closed during pregnancy. The walls of the cervix relax when the sow farrows which permits the offspring to pass from the uterine horns into the vagina.

Estrogen and progesterone are the female sex hormones produced by the ovary. In general, estrogens induce estrus (heat) in the female whereas progesterone suppresses the onset of estrus. A decrease



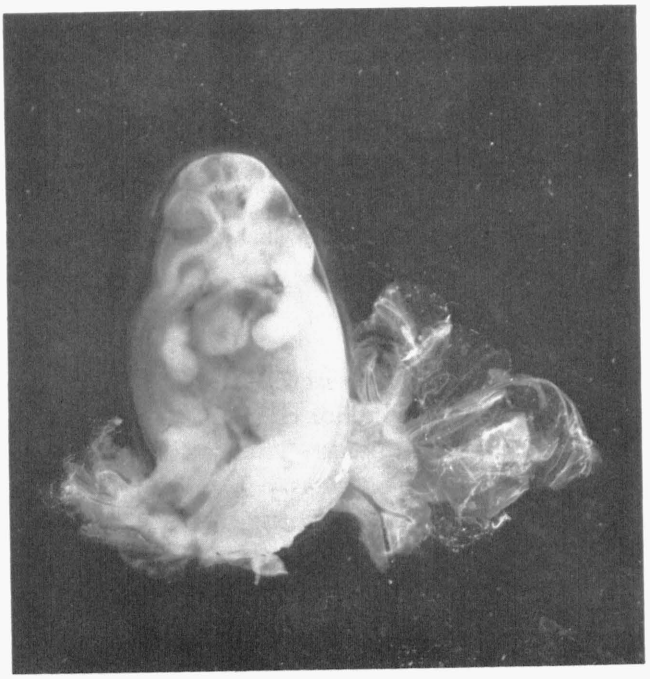
(Approx one-fourth actual size.) Enlargement in the uterine horns and an increase in blood supply to the uterus have occurred. Embryos usually space themselves evenly, as the 9 shown.
Figure 4 shows ovaries of a pregnant gilt. Eggs have left the ruptured follicles, which are now called corpora lutea. Throughout pregnancy these corpora lutea produce the hormone, progesterone, which prevents the onset of heat during pregnancy. Regression of the corpora lutea in non-pregnant gilts allows them to come back in heat about every 21 days.

in the secretion of progesterone and an increase in estrogen production induce estrus in the sow at the same time ovulation occurs. The synchronization of heat and ovulation is necessary to make the sow receptive to the boar so that spermatozoa and ova will be present in the Fallopian tubes at the same time. Otherwise, fertilization would not occur since the fertilizable life of the egg is probably less than one day and the spermatozoa would not be expected to remain viable for more than 1 to 2 days.

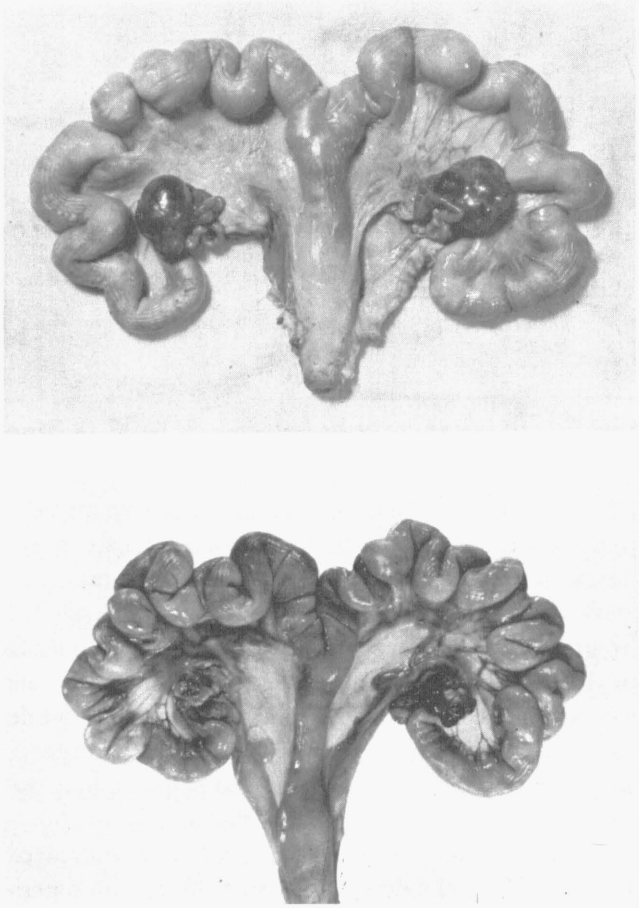
Periodic changes in the female's hormonal balance control the 21-day estrous cycle that is exhibited by open sows. In pregnant sows, progesterone is maintained at a high level which prevents ovulation and estrus. Occasionally, the usual hormonal balance is interrupted and a pregnant animal will show estrus.

In even more rare cases, it appears that both estrus and ovulation have occurred during pregnancy and, following a fertile mating at the latter estrus,

Above are pig embryos 28 days after fertilization. The major portion of the embryonic death loss occurs prior to this stage of the gestation period. Most critical time for embryonic survival is between fertilization and the 25th day of pregnancy.



Right, identical twin embryos with incomplete division into separate individuals (joined at head and abdomen). Unfavorable uterine environment is considered the major cause of embryonic death but many others, such as this abnormal embryonic development, contribute to prenatal loss.



The top reproductive tract has a pair of cystic ovaries. Compare with normal ones in the lower picture. Note the cystic follicles are several times normal size. They fill with a watery fluid. Females with cystic ovaries frequently show an abnormally long heat period and their estrous cycle is often irregular in length. About 5 to 10% of all gilts reaching breeding age are sterile because of anatomical and endocrine defects.

young of widely different ages have developed in the uterus at the same time and were farrowed on different dates. This phenomenon is called superfetation.

The average length of the gestation period in gilts and sows is 114 days. Why pregnancy terminates after this period of time and farrowing occurs has not been fully explained. Undoubtedly, changes in hormonal ratios contribute to the termination of pregnancy but the causes of these changes and the direct action they exert on the reproductive system is not clearly understood at present.

Questions and Answers

When should gilts be bred during the heat period?

When one service is being used, gilts and sows should be bred during the latter part of the first day of heat. By breeding at this time, chances are improved of having viable sperm present at the site of fertilization throughout the period of time that ovulation occurs.

Two services at each heat period should be practiced if a sufficient number of boars are available. Matings should be made on the first and second days of heat. Two services increase the proportion of gilts that settle and may also tend to increase the average litter size.

How many spermatozoa are usually ejaculated at each service?

An average of about one-half pint of semen is ejaculated by the mature boar at each service. The average number of spermatozoa per cubic millimeter of boar semen is about 100,000 which makes the average number of sperm ejaculated at each service approximately 20 billion.

Should gilts be bred during the first heat period?

No. The maximum litter size possible at farrowing is controlled by the number of eggs produced at the heat period when the gilt is bred. For example, if the number of eggs shed by the ovaries of a particular gilt is only 5, litter size at farrowing cannot be more than 5 and probably will be less than 5. The number of eggs produced increases markedly from the first to the third or fourth heat. Therefore, breeding should be postponed until at least the second heat period.

Questions and Answers on

How does the number of eggs produced compare with litter size at farrowing?

Only about 55 to 60 percent of the eggs are represented by living pigs at farrowing. But the losses due to *non-fertilization* of eggs in gilts or sows that settle appear to be minor. Several studies have shown that, on the average, 95 percent of the eggs recovered 3 to 4 days after breeding are fertilized. Therefore, fertilization is essentially an all or none process.

The amount of embryonic death that occurs up to the 25th day of pregnancy is a major controlling factor of litter size at farrowing. Approximately one-third of the eggs are missing by the 25th day of gestation and, although some of the embryos will be lost after the 25th day, the rate is considerably less.

What feeding practices can be used to improve litter size?

Don't overfeed during the early stages of pregnancy. This also applies from the time replacement gilts are 150 to 175 pounds of weight to two to three weeks before breeding. Reducing the energy level in the ration to about 75 percent of a full-fed level has been demonstrated to hasten sexual maturity in gilts. In addition, fewer reproductive disorders appear in gilts that are not excessively fat at breeding time.

"Flushing" or increasing the feed intake two to three weeks before breeding is recommended. This has been found to increase the number of eggs available for fertilization and, in turn, to increase the maximum litter size possible at farrowing.

After breeding, the energy intake of gilts and sows should be limited during the first third of pregnancy to promote embryonic survival. A bulky, low-energy ration may be self-fed or hand feeding may be used to control the feed intake.

It is also important that gilts receive an adequate amount of protein for growth during pregnancy. Therefore, precautions should be taken to prevent restricting this and other nutrients needed for growth too severely. The substitution of alfalfa meal for corn in a complete-mixed ration offers one way of successfully limiting the energy intake while maintaining protein needs. Also, if you hand-feed, the protein supplement may be fed separately at the desired level.

Feed intake should be gradually increased throughout the last 60 to 70 days of the gestation period, but still not to the point that the sows become too fat. The growth rate of the fetus during the last half of pregnancy is more rapid than during the earlier stages of development which, in turn, puts a greater demand on the sow for nutrients.

Should sows be bred at the first heat period exhibited a few days after farrowing?

No. There appears to be little reason for breeding at this time because conception rarely occurs. This has been found to be at least partially due to the fact that sows do not usually ovulate during this heat period and, in turn, no eggs are available for fertilization.

To what degree is litter size inherited?

The heritability of litter size at farrowing is estimated to be around 10 to 15 percent, which is rather low. This simply means that only a limited amount of progress can be expected from the selection for increased litter size at farrowing and that most variations in litter size are due to environmental effects such as nutritional level, infections, and the general management of the breeding herd.

Your Breeding Problems

What effect does the boar have on litter size?

A boar of normal fertility has very little influence on the size of the litters he produces. However, some genetic superiority for the production of large litters may be transmitted from the boar to his daughters.

What are the major defects of the reproductive tract that may cause sterility or impair fertility in swine?

Cystic ovaries is one of the major disorders of the reproductive system in gilts and sows. This condition involves the development of large follicles on the ovaries which do not ovulate to free the enclosed egg. Frequently gilts and sows with cystic follicles show heat continuously for a period of a week or longer. However, in some cases they may fail to exhibit heat regularly.

Although the success in correcting this condition is usually rather limited, the administration of hormonal preparations is generally the most effective treatment available.

Probably the most common defect of the male reproductive tract is a condition known as *cryptorchidism.* The testicles of the male embryo are located in the body cavity in the area where the ovaries are found in the female. Normally, they descend into the scrotum before birth but sometimes this fails to happen. When both testes are retained in the body cavity, the animal is sterile due to the failure of sperm production but male sex hormones are produced by the undescended testes. These animals, frequently called ridglings, show normal sexual desire.

In other instances one testis may be descended and one retained within the body cavity; a condition called *monorchidism.* Fertility is usually normal in these animals although the concentration of spermatozoa in the semen is lower. If the descended testicle is removed, the animal will be sterile but sexual desire may still be exhibited due to the secretion of testosterone by the undescended testicle.

Cryptorchidism is an inherited defect. Therefore, a boar with an undescended testicle or animals from a line in which cryptorchidism is common should not be used for breeding purposes.

Other abnormalities that have been observed in the reproductive tracts of swine include: missing segments of the uterus, blocked Fallopian tubes, missing cervix or vagina, and infantile reproductive organs.

Are transmissible genital diseases found in swine?

Yes, brucellosis may be a major cause of sterility in the swine herd. It has been observed that in herds containing this infection many of the sows failed to settle. Abortions may occur in the infected animals that do settle but the incidence of abortions varies considerably. Small litter size and a large number of weak and dead pigs at birth are also indications of the presence of the disease. The brucellosis status of the herd should be determined when sterility is a major problem since other infections of the reproductive tract that cause sterility are apparently not too common.

Leptospirosis may also be a cause of abortions in sows and gilts. In most cases, abortions due to leptospirosis occur during the last three weeks of gestation but they may occur at any stage of pregnancy.

WEANING AND GESTATION TABLE*

Date	56 days	114 days	Date	56 days	114 days
Jan 1	Feb 26	Apr 25	July 5	Aug 30	Oct 27
Jan 6	Mar 3	Apr 30	July 10	Sept 4	Nov 1
Jan 11	Mar 8	May 5	July 15	Sept 9	Nov 6
Jan 16	Mar 13	May 10	July 20	Sept 14	Nov 11
Jan 21	Mar 18	May 15	July 25	Sept 19	Nov 16
Jan 26	Mar 23	May 20	July 30	Sept 24	Nov 21
Jan 31	Mar 28	May 25	Aug 4	Sept 29	Nov 26
Feb 5	Apr 2	May 30	Aug 9	Oct 4	Dec 1
Feb 10	Apr 7	June 4	Aug 14	Oct 9	Dec 6
Feb 15	Apr 12	June 9	Aug 19	Oct 14	Dec 11
Feb 20	Apr 17	June 14	Aug 24	Oct 19	Dec 16
Feb 25	Apr 22	June 19	Aug 29	Oct 24	Dec 21
Mar 2	Apr 27	June 24	Sept 3	Oct 29	Dec 26
Mar 7	May 2	June 29	Sept 8	Nov 3	Dec 31
Mar 12	May 7	July 4	Sept 13	Nov 8	Jan 5
Mar 17	May 12	July 9	Sept 18	Nov 13	Jan 10
Mar 22	May 17	July 14	Sept 23	Nov 18	Jan 15
Mar 27	May 22	July 19	Sept 28	Nov 23	Jan 20
Apr 1	May 27	July 24	Oct 3	Nov 28	Jan 25
Apr 6	June 1	July 29	Oct 8	Dec 3	Jan 30
Apr 11	June 6	Aug 3	Oct 13	Dec 8	Feb 4
Apr 16	June 11	Aug 8	Oct 18	Dec 13	Feb 9
Apr 21	June 16	Aug 13	Oct 23	Dec 18	Feb 14
Apr 26	June 21	Aug 18	Oct 28	Dec 23	Feb 19
May 1	June 26	Aug 23	Nov 2	Dec 28	Feb 24
May 6	July 1	Aug 28	Nov 7	Jan 2	Mar 1
May 11	July 6	Sept 2	Nov 12	Jan 7	Mar 6
May 16	July 11	Sept 7	Nov 17	Jan 12	Mar 11
May 21	July 16	Sept 12	Nov 22	Jan 17	Mar 16
May 26	July 21	Sept 17	Nov 27	Jan 22	Mar 21
May 31	July 26	Sept 22	Dec 2	Jan 27	Mar 26
June 5	July 31	Sept 27	Dec 7	Feb 1	Mar 31
June 10	Aug 5	Oct 2	Dec 12	Feb 6	Apr 5
June 15	Aug 10	Oct 7	Dec 17	Feb 11	Apr 10
June 20	Aug 15	Oct 12	Dec 22	Feb 16	Apr 15
June 25	Aug 20	Oct 17	Dec 27	Feb 21	Apr 20
June 30	Aug 25	Oct 22	Jan 1	Feb 26	Apr 25

*For leap year, one day must be subtracted from each weaning and farrowing date computed for the period from January 1 to February 28 with the exception of the weaning dates for January 1, 2, and 3.