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Donald G. Levis

University of Nebraska-Lincoln, donlevis@hotmail.com

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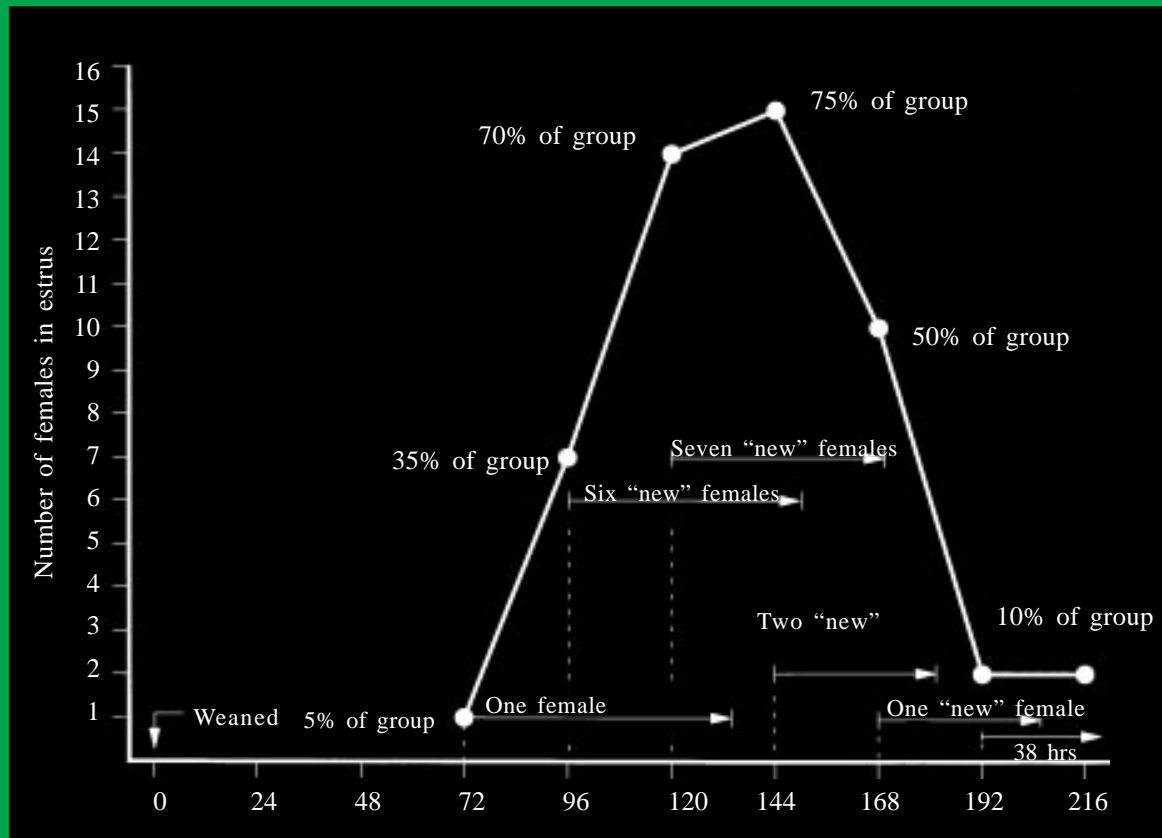
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Management Strategies for Pen-mating Female Pigs



by Donald G. Levis
Extension Swine Specialist



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Summary

The master control switch of a pork production enterprise is weaning day. Pork production managers have little or no control concerning when a weaned female will cycle or how long she will be in estrus after weaning. When females are pen-mated, the producer needs to use management procedures to prevent an excessive number of estrous females from expressing the standing response at the same time, try to manage estrous females so that they are bred at the proper time, try to manage boars so they maintain an adequate level of fertility, evaluate boars for level of sexual behavior before and during the mating period and heat-check gestating females. Regardless of the boar-to-female ratio used or the management procedures implemented, there is no guarantee all females will be satisfactorily serviced during their first estrus after weaning.

Pen-mating is the process of putting boars and females in the same pen for a designated period (usually 21 to 42 days) with an unsupervised copulatory process. Very few scientific experiments have evaluated the influence of pen-mating on reproductive performance. Although pen-mating is utilized as a labor-saving strategy for breeding management, the farrowing rate (number of females farrowed per number of females exposed) of females pen-mated at first estrus after weaning varies substantially (Table I). In Table I, a comparison can not be made between breeding pens due to boar age differences, number of boars per pen and number of sows in each pen.

It is important to have a high farrowing rate because farrowing rate is significantly correlated with number of live pigs born per bred female per year. Data compiled from North Carolina State University

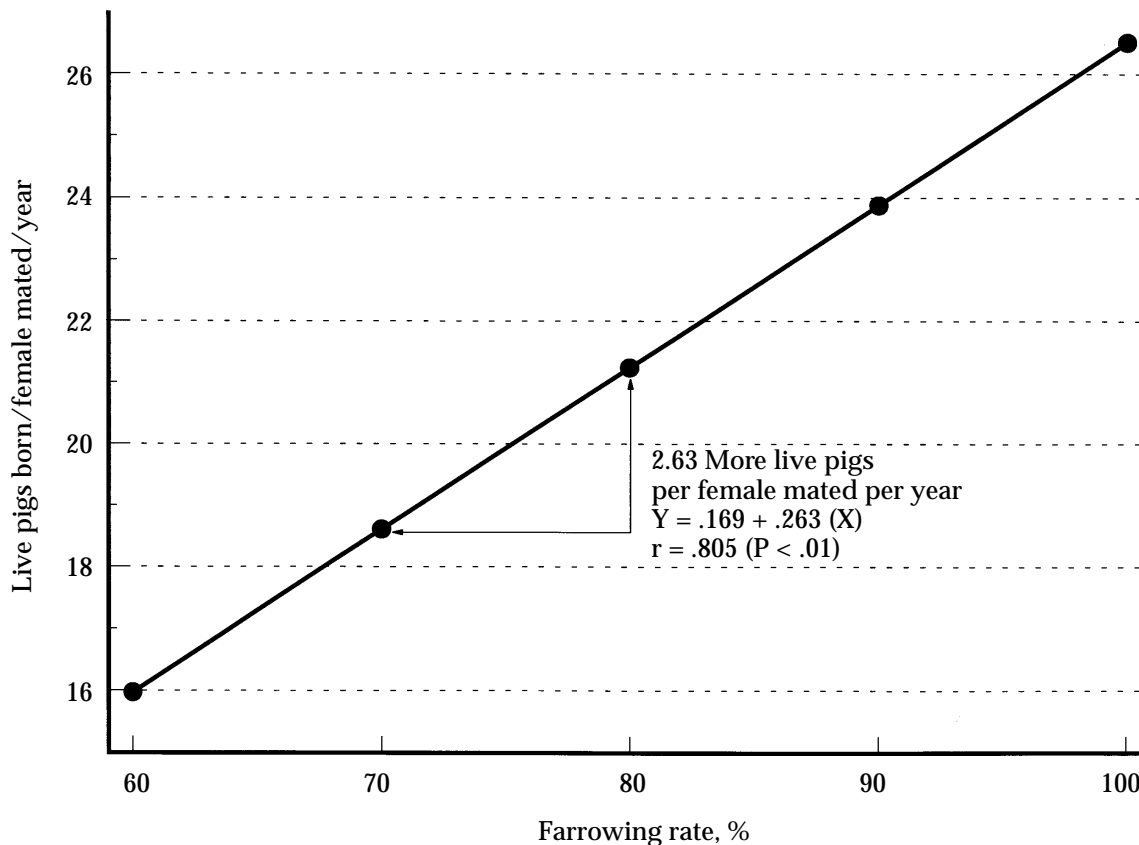


Figure 1. Relationship between farrowing rate and live pigs born per female mated per year.

Table I. Farrowing rate from first estrus after weaning when pen-mating on a commercial farm.^a

Date weaned	Pen One Two Duroc Boars (Mature age)			Pen Two Two Crossbred Boars (Young age)			Pen Three Three Crossbred Boars (Mature age)		
	Number of females		Percent Farrow	Number of females		Percent Farrow	Number of females		Percent Farrow
	Weaned	Farrowed		Weaned	Farrowed		Weaned	Farrowed	
Sep 30	8	5	62.5	7	4	57.1	7	5	71.4
Nov 6	9	4	44.4	6	5	83.3	6	4	66.7
Dec 12	7	3	42.9	6	5	83.3	4	2	50.0
Jan 18	6	4	66.7	5	3	60.0	4	4	100.0
Feb 23	8	4	50.0	5	3	60.0	6	5	83.3
Apr 1	6	5	83.3	6	4	66.7	8	4	50.0
May 7	8	7	87.5	5	3	60.0	7	5	71.4
Jun 13	6	5	83.3	7	6	85.7	5	4	80.0
Jul 19	9	3	33.3	6	4	66.7	7	4	57.1
Aug 21	7	4	57.1	5	2	40.0	5	3	60.0
Totals	74	44	59.5	58	39	67.2	59	40	67.8

^aAll females were weaned into a boar pen and remained in the pen with the boar until farrowing.

Table II. Reproductive performance on a commercial farm that changed from pen-mating to hand-mating.

Year	Method of mating	Avg. number of females	Number females farrowed	Litters per female per year	Number of pigs		Pigs per female per year
					Farrowed	Weaned	
1	Pen-mated 12 months	140	219	1.56	2061	1849	14.39
2	Hand-mated four months	140	246	1.76	2587	2145	16.69
3	Hand-mated 12 months	111	259	2.33	2809	2412	21.72

indicates the number of live pigs born per bred female per year increased 2.63 pigs per each 10% increase in farrowing rate (Figure 1). Many times, a decrease in farrowing rate and/or litter size born live occurs because various biological and sociological events in the pen-mating environment can not be adequately controlled or managed.

Pork producers who change from pen-mating to hand-mating find the time spent hand-mating more than pays for itself. Reproductive performance of a farm that changed from pen-mating to hand-mating is shown in Table II. This farm experienced the benefit from hand-mating because during a 12-month period they had pen-mated the first four months, hand-mated the middle four months and pen-mated the last four months (Year 2 in Table II). When the reproductive data was analyzed, the farrowing rate and litter size was lower for pen-mating compared to hand-mating. When a 12-month period of hand-mating

(Year 3 in Table II) was compared to an earlier 12-month period of pen-mating (Year 1 in Table II), reproductive performance improved as follows: (1) 20.7% decrease in average number of females on inventory, (2) 10.2% increase in pigs weaned per litter, (3) 15% increase in pigs born live per litter, (4) 30.5% increase in total number of pigs weaned, (5) 36.3% increase in total number of pigs born live, (6) 49.4% increase in litters per female per year and (7) 51% increase in pigs weaned per female per year. Some factors that improved reproductive performance were: better control of boar fertility; a tighter production schedule due to knowledge of exact breeding dates; bred females were regularly heat-checked to identify open females; and females not returning to estrus after their second mating were culled. This Extension Circular discusses various pen-mating problems and their possible solutions.

Accumulation of Estrous Females

As previously stated, the “**master control switch**” for a swine operation is weaning day. After a group of females is weaned, management has essentially no control over the cycling pattern of the female group. The following two factors have major influence on the number of females in estrus on each day after weaning: (1) the accumulated frequency for the number of days from weaning-to-estrus and (2) the accumulated frequency for number of hours estrous females are receptive to boar stimuli.

Weaning-to-estrus interval. The majority of recently weaned females should cycle four to six days after weaning; however, the distribution of females first detected in estrus on each day after weaning can be quite variable (*Figure 2*). The following factors can influence the weaning-to-estrus interval: genetics, parity, feed intake during lactation, season, length of lactation, body condition at weaning and mycotoxins.

Duration of estrus. The duration of time an estrous female is receptive to boar stimuli averaged 50.1 ± 21.0 hours (range: eight to 136 hrs) and 59.6 ± 14.8 hours (range: 32 to 153 hrs) in two studies. *Figure 3* depicts the frequency distribution for the percentage of females standing for 8 to more than 96 hours in the two studies.

Onset of estrus to ovulation. Research has shown that as the weaning-to-estrus interval increases the duration of estrus decreases and the time from onset of estrus to ovulation decreases (*Figure 4*). Optimal fertilization of ova results when females are mated 0 to 24 hours before ovulation. When females are mated outside this range, as can easily occur when pen-mating females, fertilization rate of the ova decreases, reducing litter size.

By combining the weaning-to-estrus interval with the duration of estrus, it is easy to see how pen-mating allows the number of females in estrus to accumulate on each day. *Figure 5* illustrates how the number of females in estrus accumulates on each day when 20 females are weaned on the same day and placed in one breeding pen. It is possible to have 75% of the weaned females in estrus on Day 6 after weaning. This pattern will vary, both for each group weaned and between farms, but the principles shown can be applied to any weaning system to estimate the number of females in estrus on each day.

One way to reduce the excessive number of estrous females accumulating when pen-mating is to use two or three breeding pens or wean sub-groups every two to three days into two breeding pens. The problems of weaning a group of females every two days are: (1) the farrowing house is utilized over an extended period of time making an all-in-all-out system more difficult to accomplish and

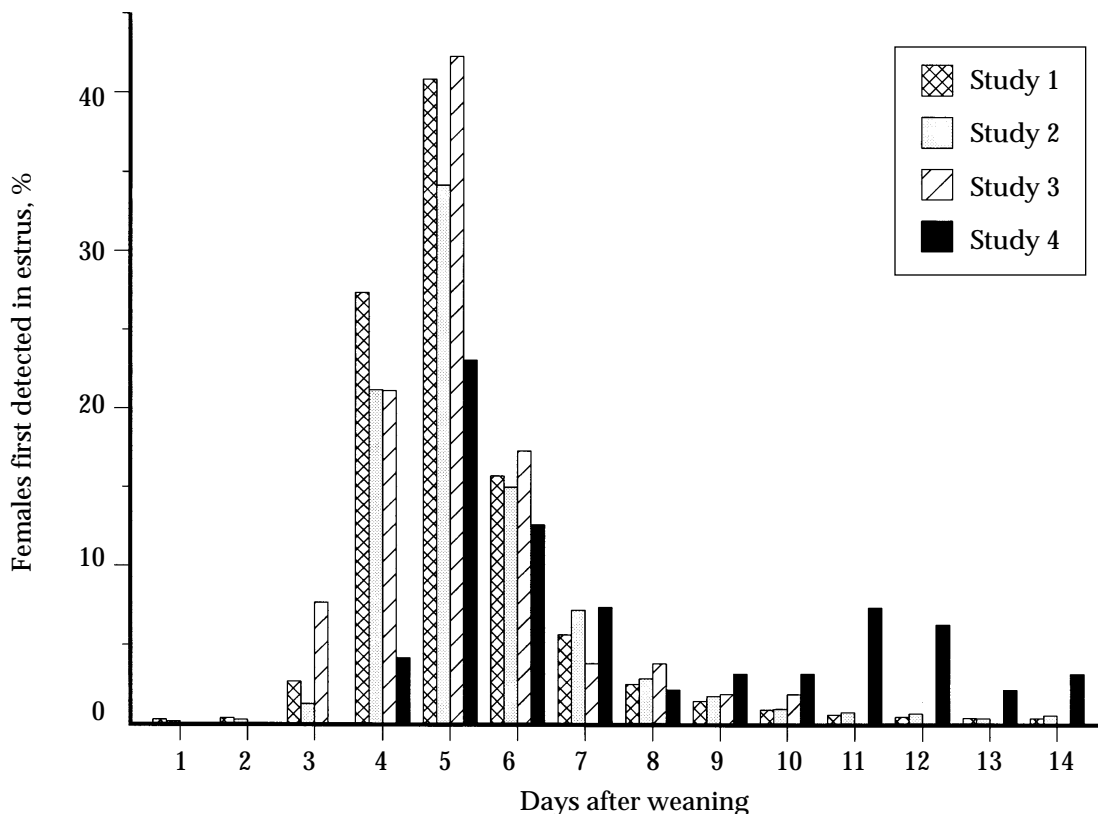


Figure 2. Distribution of females first detected in estrus by day after weaning.

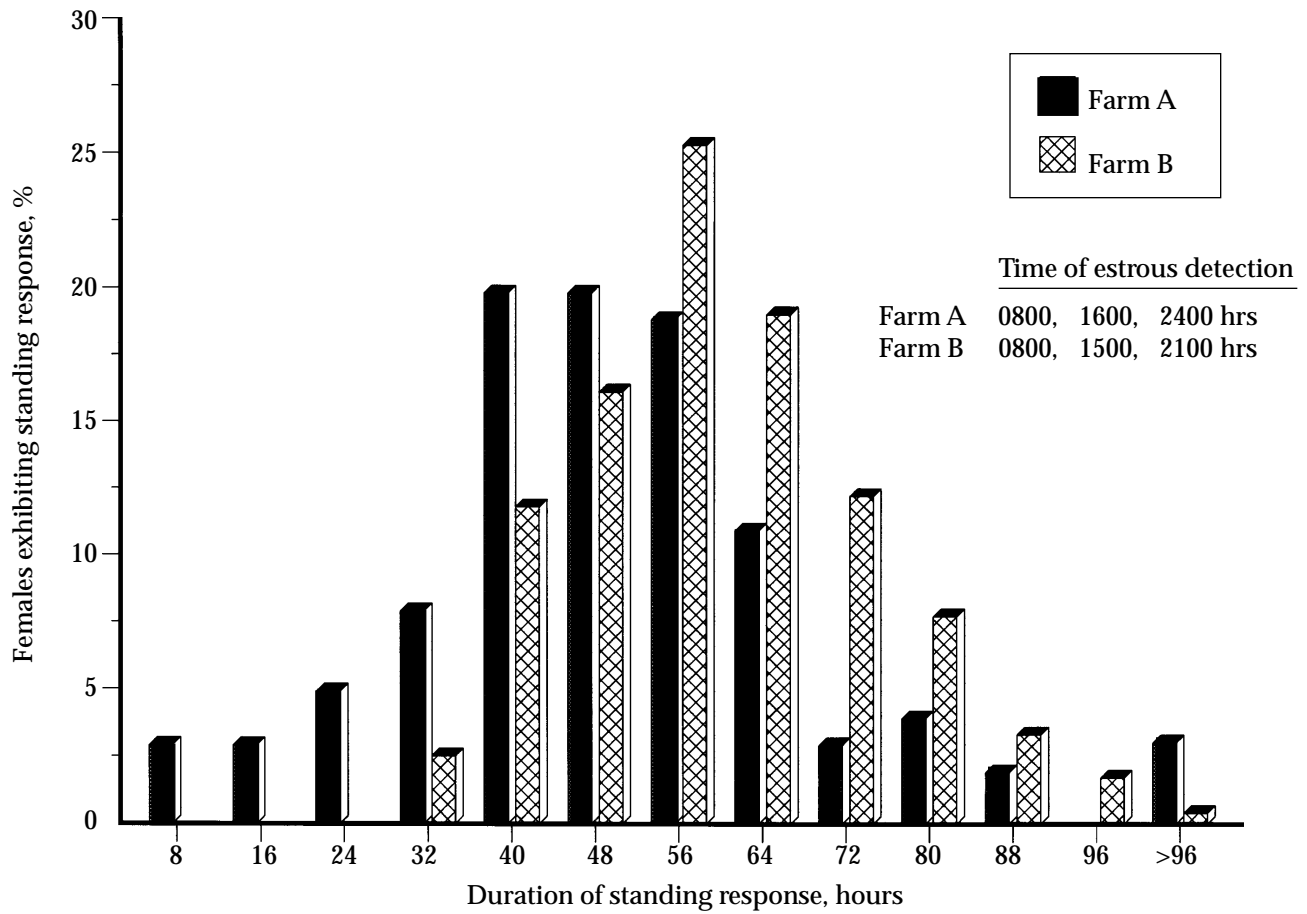


Figure 3. Frequency distribution of females exhibiting a standing response.

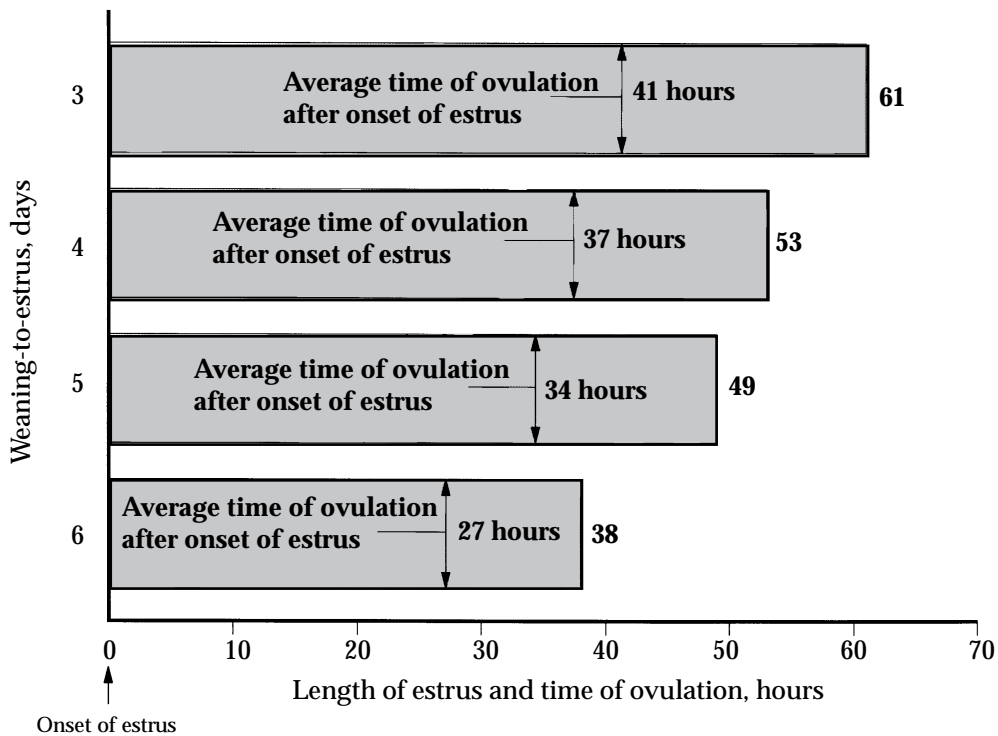


Figure 4. Schematic relationship between weaning-to-estrus, duration of estrus and time of ovulation.

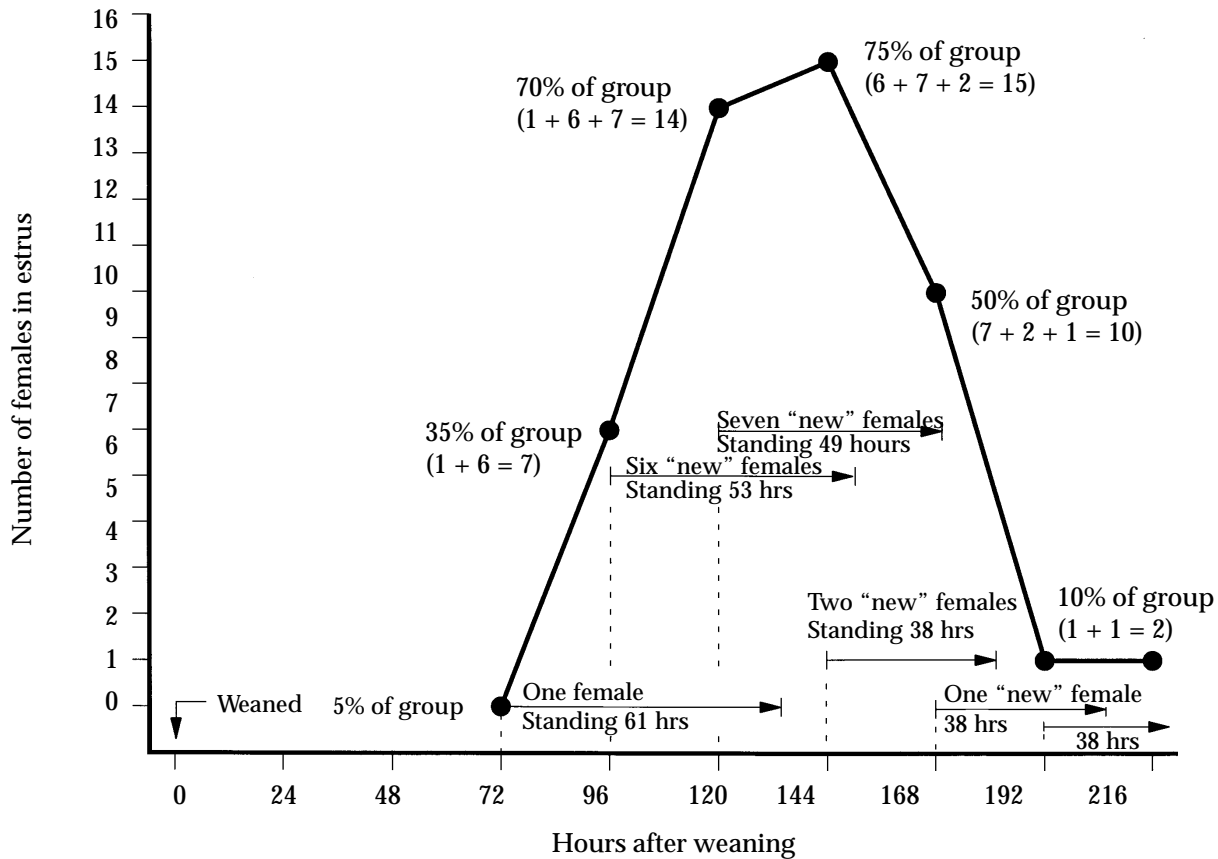


Figure 5. Estimated number of females in estrus on each day when pen-mated in one breeding pen. Twenty females are weaned the same day and 90% cycle within eight days after weaning.

(2) management of the nursery facility can be more difficult due to the wider age range of piglets. In addition, the normal biological variation of length of gestation, which can range from 108 to 123 days, extends the period of time a farrowing house is used (Figure 6).

Figure 7 illustrates the estimated number of females in estrus on each day when 20 females are weaned on the same day and pen-mated in one, two, three or four breeding pens. The number of females in estrus still accumulates; however, there are fewer estrus females per pen on each day. A possible advantage to having fewer estrus females per pen per day is that it reduces the number of social interactions between females and boars. This may result in the boar(s) being able to identify and breed different females. Figures 8 and 9 illustrate an estimated distribution pattern for number of females in estrus on each day when a group of 20 females is weaned in four subgroups of five females every two days into either one breeding or two breeding pens. Duration of estrus is assumed to be 61, 53, 49 and 38 hours for females first expressing estrus on days three, four, five and six after weaning, respectively. The example for the two breeding pens weans all five females on the same day and places all females into one of the two breeding pens on an alternating basis (Figure 9). While

the number of females in estrus still accumulates; there are fewer females per pen in estrus on days five and six after weaning.

All types of physical and environmental stress should be minimized for 28 days after mating. There are many reasons to reduce stress including: (1) After mating the fertilized eggs are retained within the oviduct for about two days before they are released into the uterus. If stress causes the eggs to be released into the uterus too early, they will die as the uterus is a hostile environment prior to the normal time the eggs enter the uterus. (2) About 10 to 12 days after mating, the blastocysts start to define their space in the uterus by developing a 100 cm (39 inches) long, extensively folded structure, which signals the female to maintain pregnancy. (3) Attachment of the blastocyst to the uterine wall starts around 12 to 14 days after mating and continues until about 28 days after mating.

When 20 females are weaned in four subgroups of five females every two days and alternately weaned into two breeding pens, the detrimental effects on reproduction from fighting at mixing would be minimal. The majority of the fighting by females within and between the two groups will have passed by the time the first subgroup of females start cycling (Figure 9).

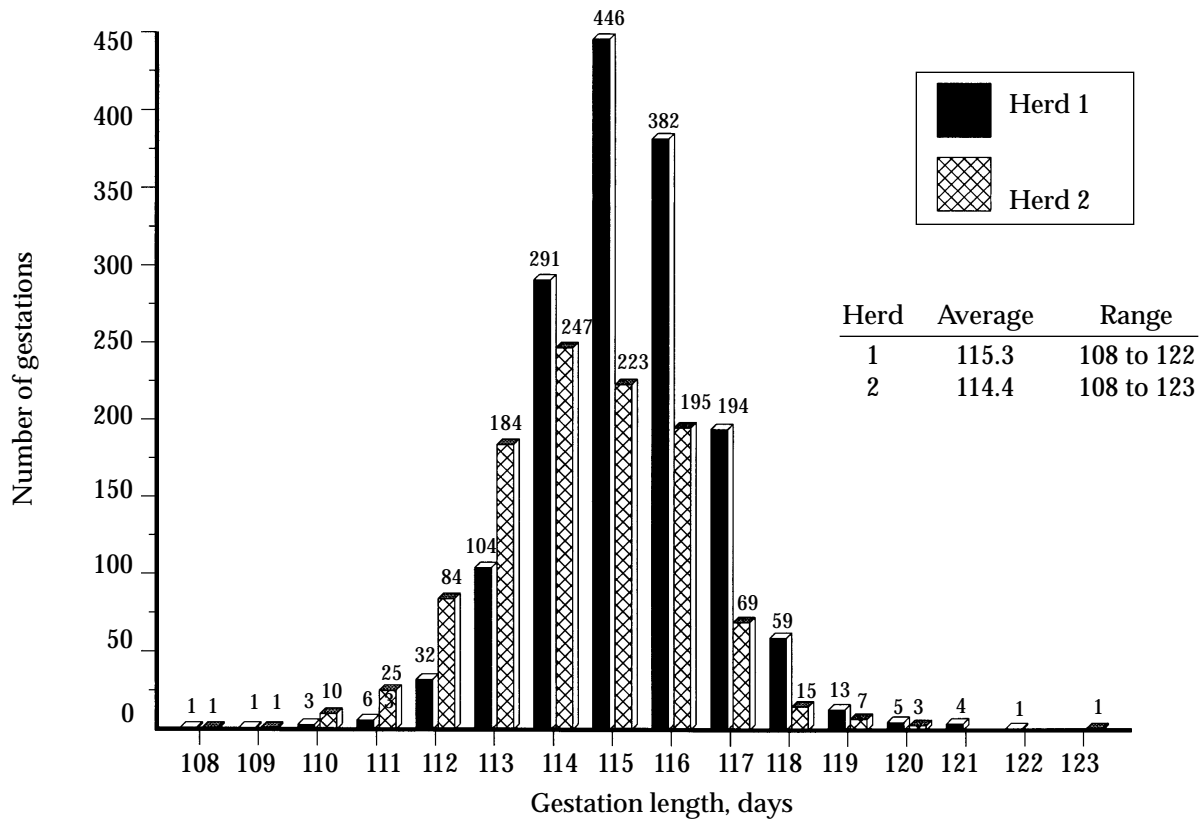


Figure 6. Frequency distribution for length of gestation.

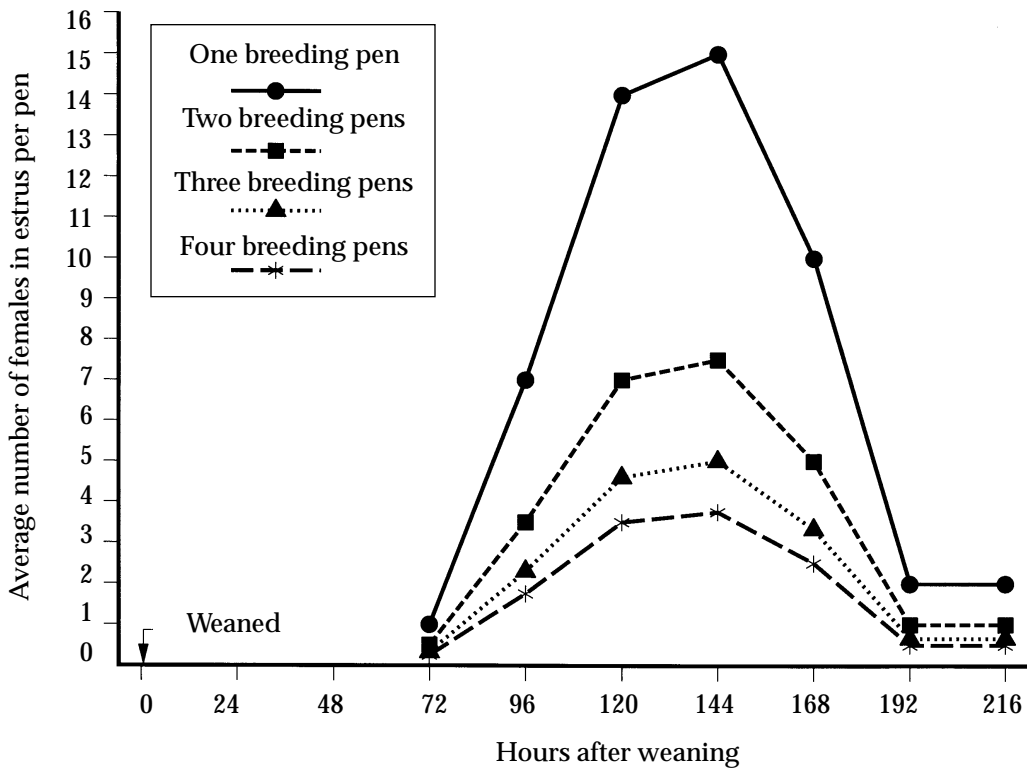


Figure 7. Estimated average number of females in estrus on each day when pen-mated in one, two, three or four breeding pens. Twenty females are weaned the same day and 90% cycle within eight days after weaning.

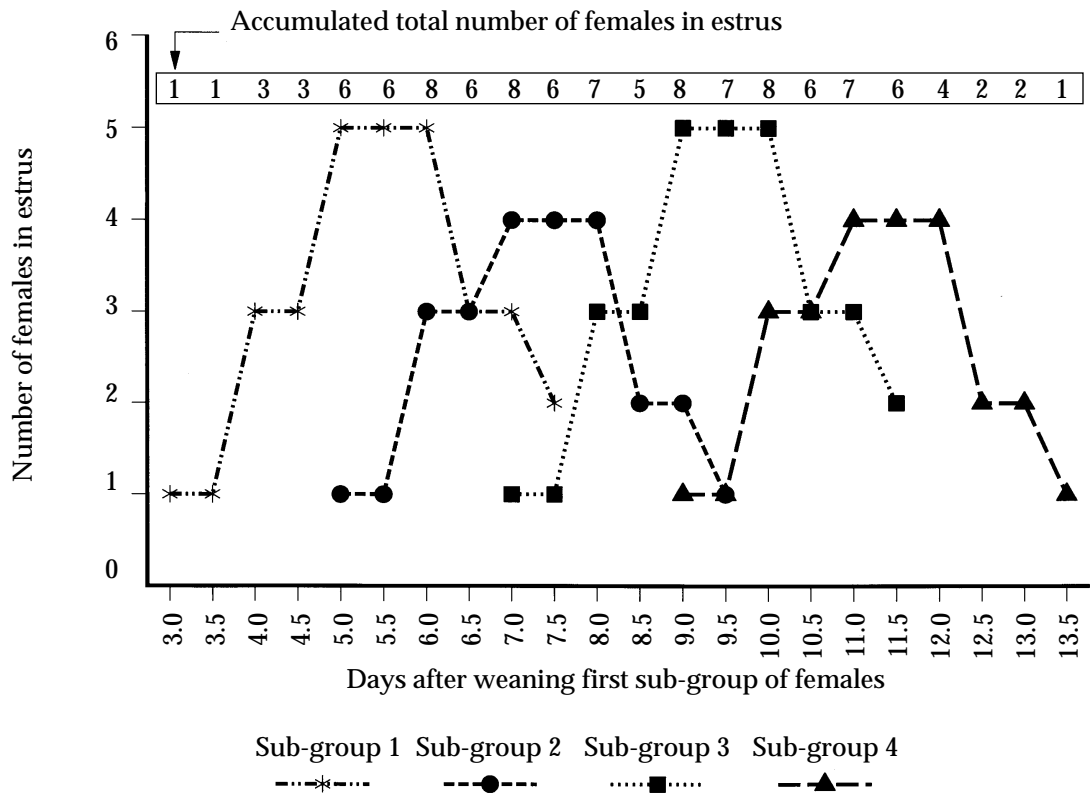


Figure 8. Estimated number of females in estrus on each day when five females are weaned every two days into one breeding pen (four sub-groups of five females equal 20 females weaned).

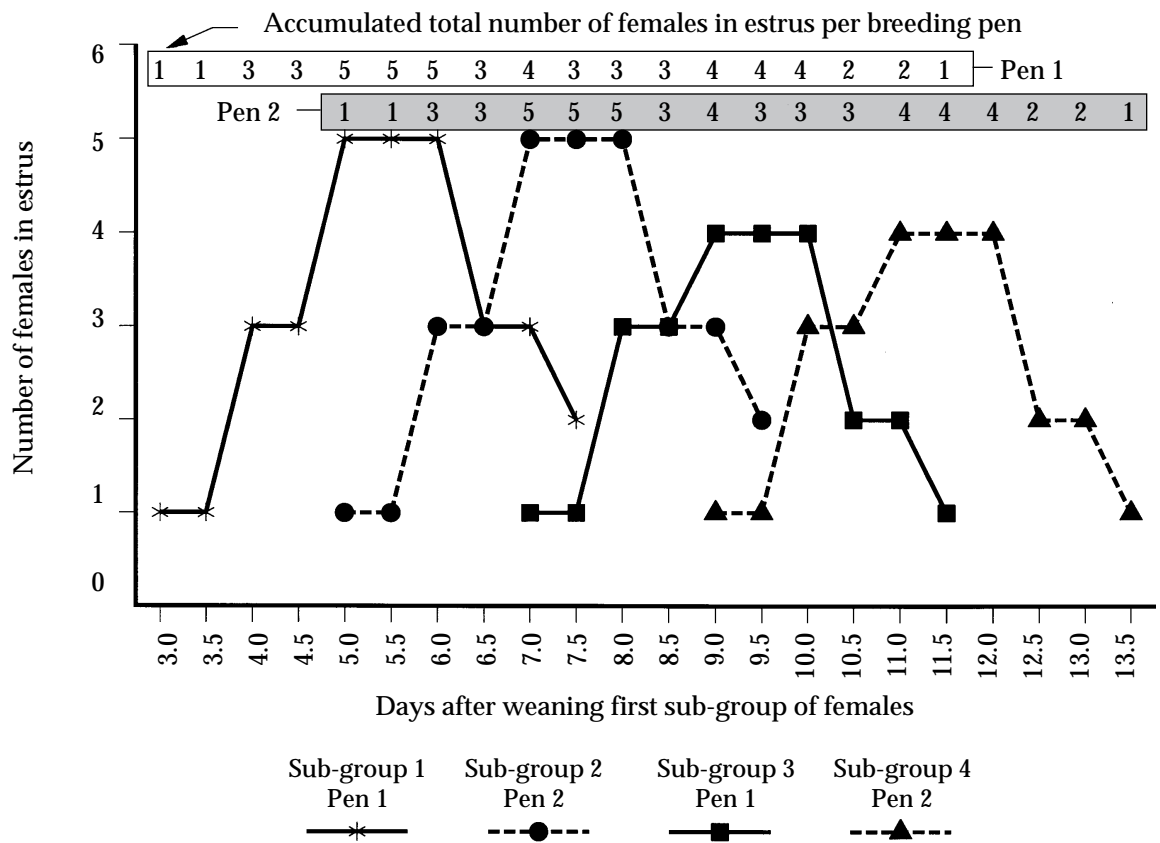


Figure 9. Estimated number of females in estrus on each day when five females are weaned every two days into two breeding pens. (The breeding pen all females enter is alternated every two days).

Boar Fertility

When the number of estrous females are allowed to accumulate as shown in *Figure 5*, overworked boars may result in a boar fertility problem. Some overworked boars have a decrease in sexual behavior and do not breed many different females. Another possibility is that an aggressive boar may continue to breed females after his sperm supply is substantially reduced or depleted. Boars need sexual rest for sperm replenishment, as sperm output decreases rapidly. A research study indicated that after five days of sexual rest, a second ejaculation contained 46.9% less, the third ejaculation 51.7% less, the fourth ejaculation 55.8% less, the fifth ejaculation 67.9% less and the sixth ejaculation 80.2% less sperm than the first ejaculation on a collection interval of 24 hours (*Figure 10*). Generally, when on a 12- or 24-hour mating interval, the sperm output number tends to stabilize after five matings. The important question is, "What level of sperm output is being reached at stabilization—fertile, subfertile or infertile?" It is believed 3 to 6 billion motile sperm are needed for adequate fertilization of ova. However, the number of motile sperm required for good fertility varies from boar to boar.

The major problem with pen-mating is that boars do not pace themselves to mate females on a 12- to 24-hour interval. For example, an aggressive boar may mate the first estrus female five times during the first 24 hours he is in the weaned female pen. Obviously, a boar that has mated five times the first day will have a substantial reduction in sperm count for the remaining females he will mate (*Figure 11*). The pen-mating example (*Figure 11*) weans four females on the same day and houses the females with one boar that is not rotated for sexual rest. It is assumed that onset of estrus occurs on Monday (one female), Tuesday (two females) and Wednesday (one female) after being weaned the previous Thursday. The assumed duration of estrus is the same as shown in *Figure 4*. If the boar only mates once every 24 hours after the first five matings, there is risk some females will: (1) not be mated because there is more than one female in estrus on Tuesday, Wednesday and Thursday, (2) only be mated once, (3) be mated at the wrong time with respect to time of ovulation, especially if only mated once and (4) be mated more frequently than other females. If the boar maintains a high level of sexual activity and mates each female numerous times, his fertility will be substantially diminished.

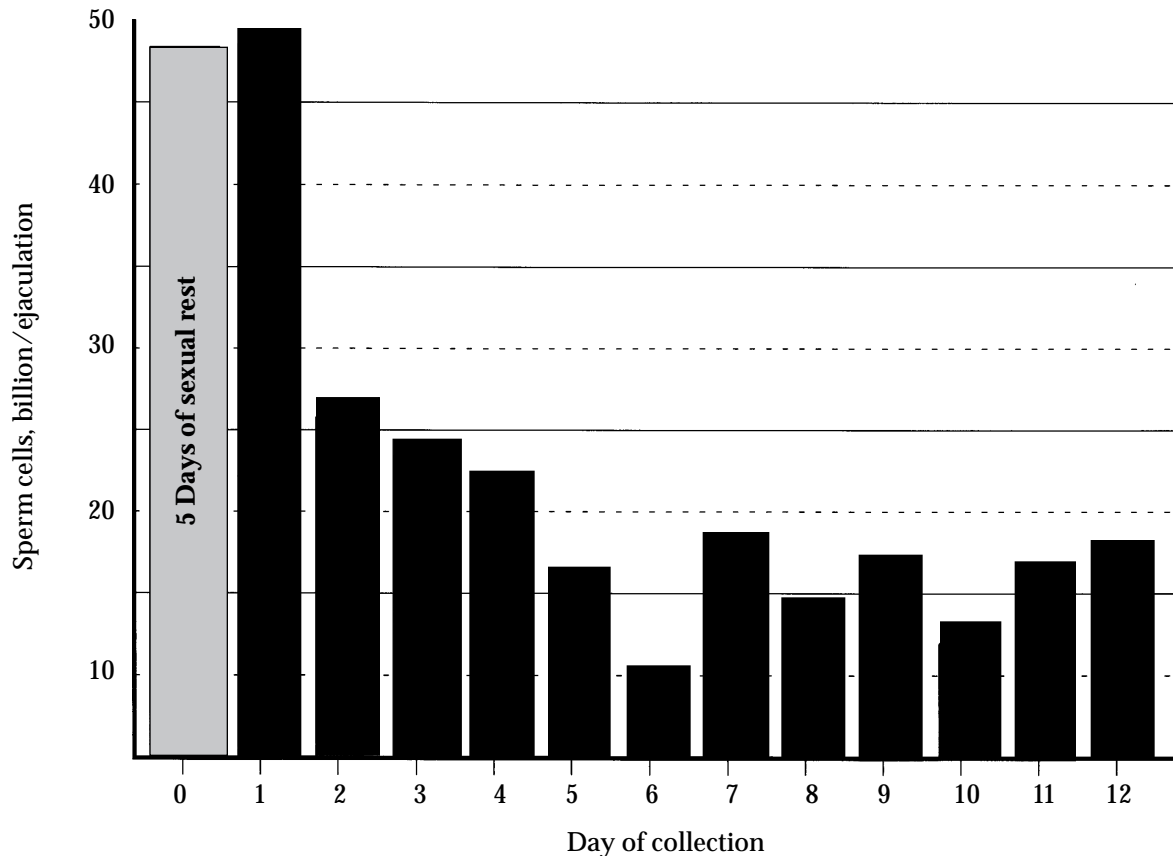


Figure 10. The effect of boars ejaculating every 24 hours on sperm output.

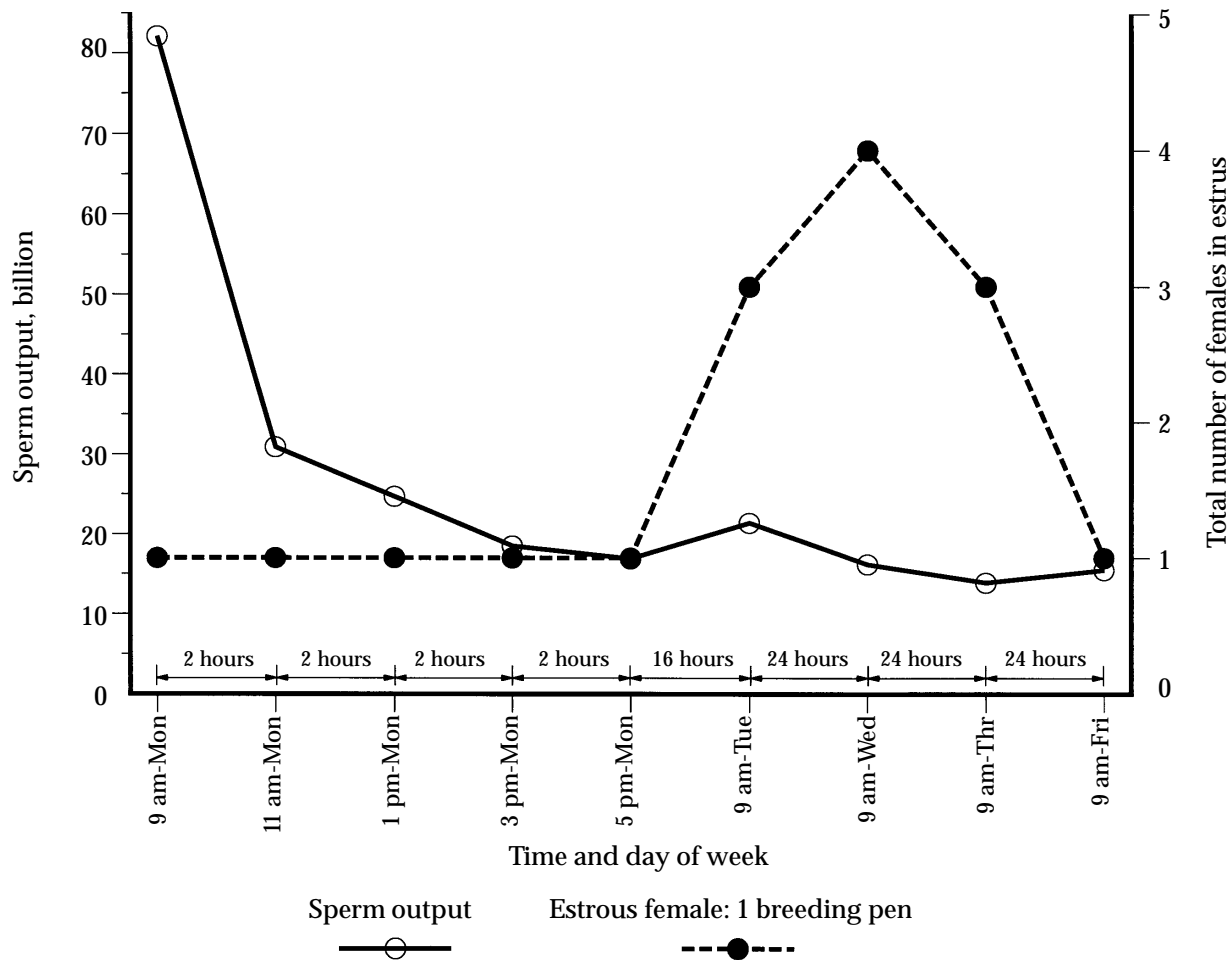


Figure 11. Relationship between sperm output and accumulation of estrous females when pen-mating in one breeding pen (Four females are all weaned on the same day and housed continuously with the same boar).

The solution generally recommended to enhance boar fertility is rotating boars for sexual rest. Boars are easily trained to a daily rotation system: withhold feed until the boar has moved from a breeding pen to a pen for sexual rest or has moved from a sexual resting pen to breeding pen. Group-housed boars should be sexually rested out of sight and sound of estrous females and working boars. This procedure substantially reduces homosexual activity, which can also deplete sperm reserves during the resting period. Ideally, boars should be housed individually; however, this requires they be used individually in the breeding pen.

Boar Mounting Efficiency

The number of successful copulations is very low when compared to the large number of mounts performed by a boar in a single-sire or multi-sire pen-mating environment. The number of mounts, number of copulations, number of mounts per copulation and number of copulations per mount by boars (~ one year old) used to pen-mate four females per pen is shown in *Table III*. Boars in each breeding pen were

full siblings from the same litter and had been reared and used for natural mating together. The number of matings per mount for boars in a multi-sire breeding pen ranged from 1.4% (2 copulations per 138 mounts) to 57.1% (4 copulations per 7 mounts). Mounting efficiency is substantially reduced when large differences exist in body size between a boar and female. In *Table IV*, female numbers XB12 and XB15 were mounted 72 and 59 times, respectively, but copulation did not occur with any boar in the pen. The body weight of these two females were, respectively, 139 and 86 lb heavier than the average body weight of the boars in the pen.

Inadequate Sexual Behavior of Boars

Inadequate sex drive in boars, such as lack of willingness or eagerness to pursue, mount and attempt service of females when pen-mating, can be influenced by high environmental temperatures, domination by other boars or larger females, bad past breeding experiences (psychological), over-use (sexual fatigue), sickness, inexperience, immaturity, excessive body condition and old age.

Table III. The number of mounts, number of copulations, number of mounts per copulation, and number of copulations per mount by boars when pen-mating four females per pen.

Observation period	Mating Pen Number	Boar Number	Sexual activity ^a			
			Number of mounts	Number of matings	Mounts per mating	Matings per mount
Jul 8 to Jul 11	One (four females)	LW1	58	2	29.0	3.4%
		LW2	61	5	12.2	8.2%
		LW3	35	7	5.0	20.0%
		LW4	39	7	5.6	17.9%
	Two (four females)	H1	7	4	1.8	57.1%
		H2	14	1	14.0	7.1%
Jul 28 to Jul 31	One (four females)	D1	20	2	10.0	10.0%
		D2	88	4	22.0	4.5%
		D3	138	2	69.0	1.4%
	Two (four females)	LR1	51	3	17.0	5.9%
		LR2	87	4	21.8	4.6%
		LR3	54	4	13.5	7.4%
		LR4	37	2	18.5	5.4%

^aMating behavior was observed for 72 continuous hours.

The first objective when attempting to solve a boar's sexual behavior problem is to determine whether the boar is truly sexually inactive. Because the highest level of courtship behavior occurs immediately after a sexually rested boar comes in contact with females, a suspect boar should be housed overnight out of the sight and sound of estrous females. The following morning, after the boars and females have eaten, the suspect boar should be evaluated for sexual behavior with an estrous female of similar body size for 15 minutes. The boar should be evaluated on his ability to pursue and mount a female, obtain an erection, gain entry into the vagina and successfully copulate for more than three minutes. A less-effective method to evaluate male sexual behavior is to move a boar from his current breeding pen to another breeding pen. This method of evaluation is less effective because the boar may have recently completed an unobserved copulation, diminishing his sexual desire to mate.

It is best to observe boars for sexual behavior early in the morning, especially during hot weather.

When the ambient temperature exceeds 86°F, boar sexual behavior starts to diminish. During extremely hot weather, some boars will cease to mate about mid-morning and will not resume sexual activity until dark. The majority of courtship behavior and mating occurs between 2:00 am and 11:00 am (*Table V*).

Domination of one boar in courtship and mounting behavior in multi-sire breeding pens (two to four boars per pen) may or may not be a problem. Domination by one boar in a multi-sire breeding pen has been shown to be less of a problem when boars are reared together as littermates. However, from a practical point of view, littermates of equal quality are rarely available for use on a commercial operation. When domination is not a problem in a multi-sire breeding pen, sexual activity in the breeding pen is enhanced. It appears social facilitation of courtship behavior occurs because when one boar starts sexual activity the other boars commence sexual activity. Social facilitation can, however, create a problem when there are either not enough estrous females available for all boars or all boars prefer the same female.

Table IV. The number of mounts and number of copulations received per female during a 72-hour period of pen-mating.

<i>Observation period</i>	<i>Mating Pen Number</i>	<i>Estrous female number</i>	<i>Sexual activity</i>		<i>Proportion of females mated</i>
			<i>Number of mounts</i>	<i>Number of matings</i>	
Jul 8 to Jul 11	One (4 boars)	XB1	61	3	100.0% (4 of 4)
		XB2	30	6	
		XB3	75	8	
		XB4	27	4	
	Two (2 boars)	XB5	0	0	50.0% (2 of 4)
		XB6	1	0	
		XB7	8	3	
		XB8	12	2	
Jul 28 to Jul 31	One (3 boars)	XB9	46	2	75.0% (3 of 4)
		XB10	65	4	
		XB11	63	2	
		XB12	72	0	
	Two (4 boars)	XB13	57	7	75.0% (3 of 4)
		XB14	79	4	
		XB15	59	0	
		XB16	34	2	

Table V. Courtship behavior time and number of matings by 18 boars within each 60-min period of a 24-h day.^a

<i>Time of day</i>	<i>Sexual activity when not mounted, min</i>	<i>Duration of time mounted, min</i>	<i>Number of matings</i>	<i>Time of day</i>	<i>Sexual activity when not mounted, min</i>	<i>Duration of time mounted, min</i>	<i>Number of matings</i>
2400 to 0100	14.6	11.4	1	1200 to 1300	4.9	1.6	0
0100 to 0200	28.7	17.8	2	1300 to 1400	14.7	9.7	1
0200 to 0300	64.2	56.1	2	1400 to 1500	6.4	1.6	0
0300 to 0400	58.0	43.5	5	1500 to 1600	16.4	1.5	0
0400 to 0500	82.2	57.3	7	1600 to 1700	27.8	19.4	2
0500 to 0600	96.1	50.2	2	1700 to 1800	6.9	1.3	0
0600 to 0700	51.1	28.4	2	1800 to 1900	9.0	13.4	0
0700 to 0800	69.8	52.2	5	1900 to 2000	0	0	0
0800 to 0900	56.6	38.5	2	2000 to 2100	5.4	2.7	0
0900 to 1000	46.8	55.2	6	2100 to 2200	5.6	7.4	1
1000 to 1100	48.6	32.8	2	2200 to 2300	0	0	0
1100 to 1200	6.4	8.3	1	2300 to 2400	3	4.7	0

^aThe observations were taken for 113 continuous hours when females were coming into estrus, were in estrus, and going out of estrus.

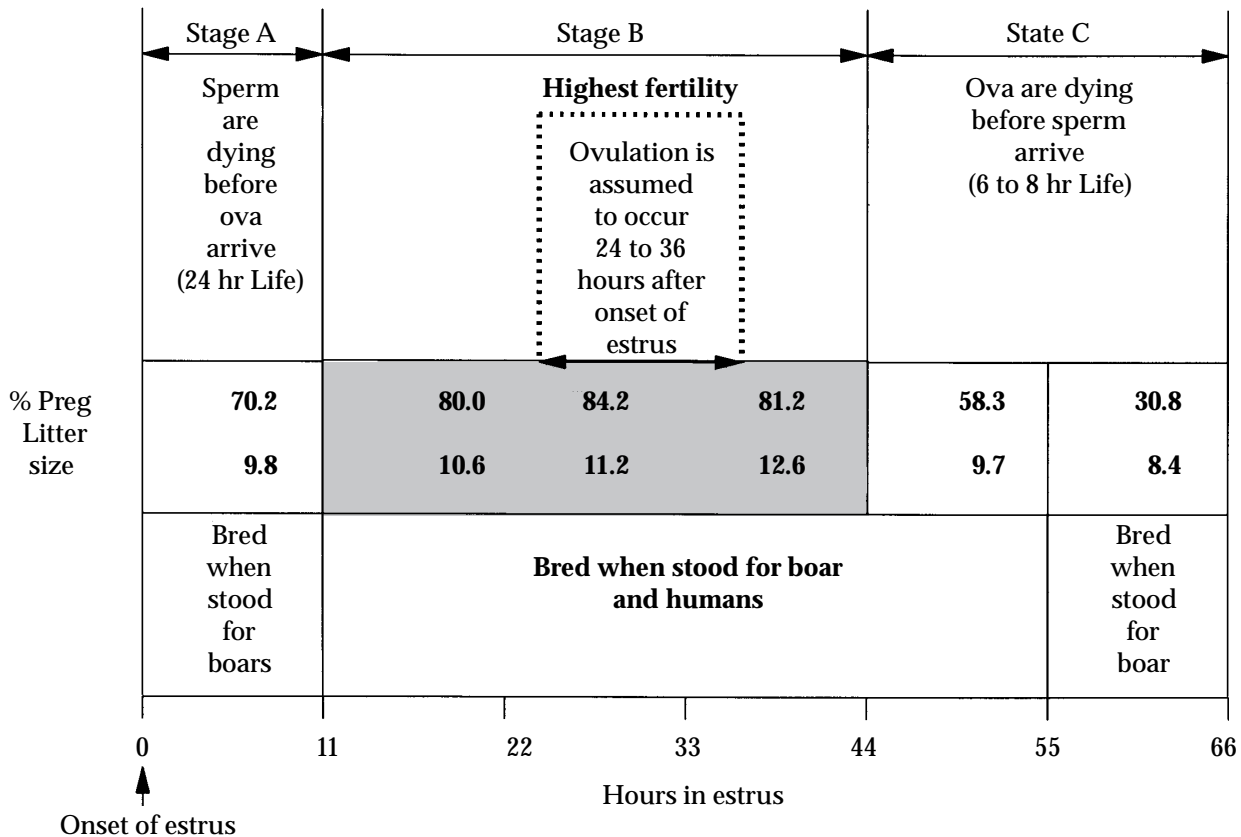


Figure 12. Relationship between time of a single mating and reproductive rate in gilts.

Improper Time Mated

Figure 12 shows that for optimum farrowing rate and litter size, gilts should be bred during Stage B (11 to 44 hours after standing estrus starts). When too many estrous females are in the same pen, they may be bred in Stage A, C or not at all. The lower conception rate and litter size in Stage A occurs because sperm cells start to die before ovulation takes place. The sharp decrease in pregnancy rate and litter size in Stage C occurs because ova have died before the arrival of sperm cells or polyspermy (more than one sperm fertilized the ova) occurred, which results in cellular problems in the development of fertilized ova.

Rotating sexually rested boars among female pens may or may not increase the probability of all estrous females being bred at the proper time. Often the new boar in the pen mates the same female the previous boar mated, increasing the probability of that female being bred at the proper time. On the other hand, other estrous females may not be mated.

Females Not Being Mated

There has been no research conducted to evaluate the influence of various boar-to-weaned female ratios when pen mating, on the percentage of estrous females mated or number of copulations received per female. When two to four boars were placed in a breeding pen with four estrous females, the overall

percentage of females mated was 75% (12 of 16 females), with the number of copulations per female ranging from zero to eight (Table IV).

Some pork producers have tried pen-mating by putting one boar in a pen with two weaned females. However, the farrowing rate to first service with this method rarely exceeds 70 to 75%. Results from a research trial in which one boar was placed in a pen with three females (two estrous females, one anestrus female) showed the percentage of females mated was 61.1% (Table VI). Only three of the nine boars, each of which were known to have a moderate to high level of sexual behavior, mated both females in estrus. The other six boars also mated females but they mated the same female many times. Other research has also shown some boars select a particular female with whom they spend a preponderance of courtship time. It appears there is no simple way to pen-mate females to be absolutely sure all females are bred during the same estrus period.

“Downer” Females

Pen mating can result in a “downer female” because too many boars are in the pen when the first female stands for mating. This problem can be prevented by not placing the boars in the breeding pen until the afternoon of the fourth day after weaning. This practice increases the number of estrous females available for boars to court and mate.

Table VI. Number of matings per boar and number of different estrous females mated by each boar during pen-mating.^a

Boar identification	Number of times boar mated	Number of females mated	Number of females in estrus	Females mated (%)
A	9	2	2	100
B	4	1	2	50
C	5	1	2	50
D	4	2	2	100
E	1	1	2	50
F	5	1	2	50
G	0	0	2	0
H	7	2	2	100
I	5	1	2	50
Total:	40	11	18	61.1

^aThe boar was placed in a pen for 4.7 days that contained two females in heat and one female not in heat.

Estrous Detection

Pork producers who pen-mate females can easily increase reproductive efficiency (pigs sold/female maintained) by checking for returns to estrus in gestating females. Nonproductive females need to be identified and culled. Research data for hand-mated females indicates the farrowing rate for females rebred at their first post-breeding return to estrus is 65.6% and 51.0% for females rebred at their second post-breeding return to estrus. The farrowing rate of females mated at first estrus after weaning was 83.6%.

If a group of females is weaned on the same day, bred at first post-weaning estrus and their estrous activity is “normal”, they can be checked for estrus at two-day intervals from 18 to 24 days and 39 to 45 days after weaning. The key point to remember: do not let females receive boar stimuli (sight, sound or smell) for one hour before checking for estrus. It has been demonstrated that estrous females become refractory (will not stand in presence of a boar) to boar stimuli within five to 10 minutes after exhibiting a standing response (*Figure 13*).

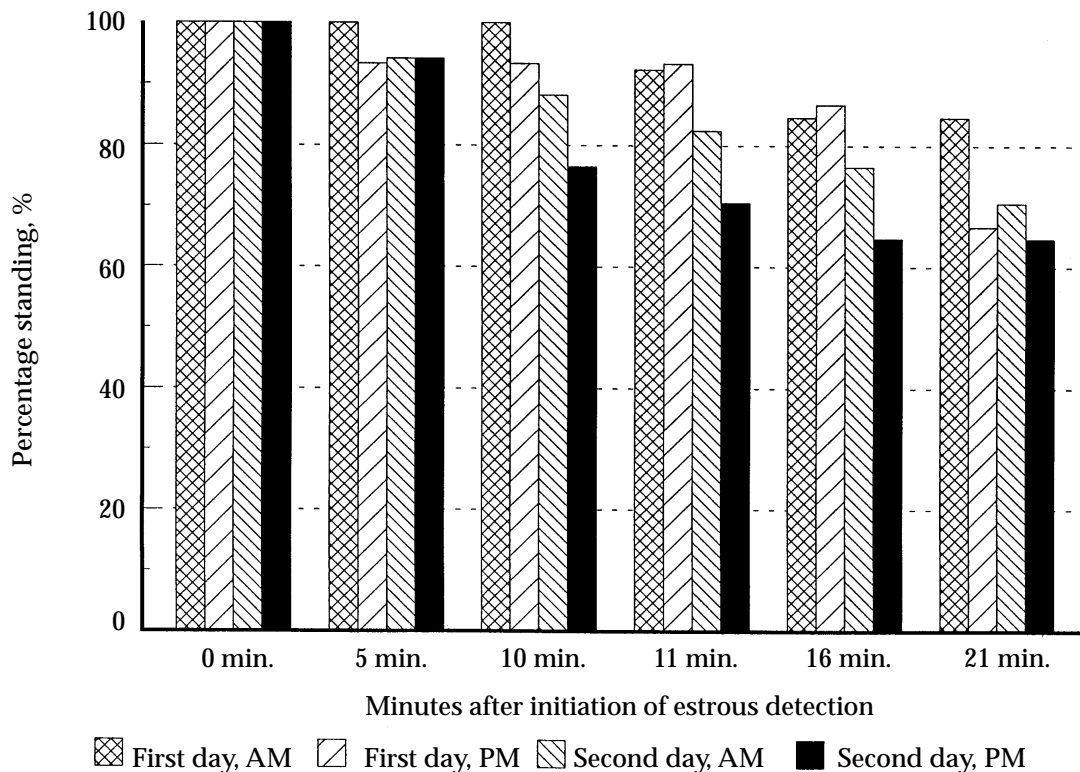


Figure 13. Proportion of gilts in standing estrus after exhibiting standing response.

Table VII. An example of calculating number of boars when pen-mating females that are all weaned the same day.

Total number of females to breed (B)	Ratio Being Used: 1 boar per 2 females bred (A = .5)				
	Total numbers of boars (C = Ax B)	Number of breeding pens (D)	Number of boars assigned each pen (E = C ÷ D)	Number of boars in each subgroup of boars	
				Days to sexual rest	
				1 Day (E ÷ 2)	2 Days (E ÷ 3)
10	5	1	Pen 1 = 5	Grp 1 = 2 Grp 2 = 3	Grp 1 = 2 Grp 2 = 2 Grp 3 = 1
10	5	2	Pen 1 = 2 ----- Pen 2 = 3	Grp 1 = 1 Grp 2 = 1 ----- Grp 1 = 1 Grp 2 = 2	Not possible to use 2 days sexual rest ----- Grp 1 = 1 Grp 2 = 1 Grp 3 = 1
20	10	1	Pen 1 = 10	Grp 1 = 5 Grp 2 = 5	Grp 1 = 3 Grp 2 = 3 Grp 3 = 4
20	10	2	Pen 1 = 5 ----- Pen 2 = 5	Grp 1 = 2 Grp 2 = 3 ----- Grp 1 = 2 Grp 2 = 3	Grp 1 = 2 Grp 2 = 2 Grp 3 = 1 ----- Grp 1 = 2 Grp 2 = 2 Grp 3 = 1
20	10	4	Pen 1 = 2 ----- Pen 2 = 2 ----- Pen 3 = 3 ----- Pen 4 = 3	Grp 1 = 1 Grp 2 = 1 ----- Grp 1 = 1 Grp 2 = 1 ----- Grp 1 = 1 Grp 2 = 1 ----- Grp 1 = 1 Grp 2 = 1	Not possible to use 2 days of sexual rest

Estimating Number of Boars Needed

It is difficult to make an absolute recommendation for boar requirements when pen-mating. Generally, the number of females cycling and receptive to the boar on each day of the breeding period and the number of ejaculations by each boar per day are unknown. Percentage of females pregnant at 30 to 35 days after mating has been reported to be 92% for females bred by boars ejaculating once per day for five days and 58% for females bred by boars that ejaculated four times per day for five days. It is not uncommon for boars to ejaculate four or more times per day when pen-mating. Therefore, a conservative approach must be taken for estimating number of boars to use when pen-mating, especially when it is

important that farrowing rate and litter size born live remains high. The following suggestions will help in determining boar requirements when pen mating:

All Females are Weaned the Same Day. Since the number of females in estrus accumulates over time (Figure 5), it is important to answer the following questions: (1) How many females are being weaned? (2) How many pens are being used for breeding? (3) How many weaned females are being placed in each breeding pen? (4) Are some boars going to be moved out of the female pen for a short period while other boars take their place? and (5) How much time are the boars given for sexual rest? An example of calculating the number of boars needed when pen-mating females all weaned the same day is shown in Table VII

Table VIII. An example of calculating number of boars when pen-mating females that are all weaned the same day.

Total number of females to breed (B)	Ratio Being Used: 1 boar per 4 females bred (A = .25)				
	Total number of boars (C = Ax B)	Number of breeding pens (D)	Number of boars assigned each pen (E = C ÷ D)	Number of boars in each sub-group of boars	
				Days of sexual rest	
				1 Day (E ÷ 2)	2 Days (E ÷ 3)
10	3	1	Pen 1 = 3	Grp 1 = 2 Grp 2 = 1	Grp 1 = 1 Grp 2 = 1 Grp 3 = 1
10	3	2	Pen 1 = 2 ----- Pen 2 = 1	Grp 1 = 2 Grp 2 = 1 Not possible to use one day of sexual rest	Not possible to use 2 days sexual rest Not possible to use 2 days sexual rest
20	5	1	Pen 1 = 5	Grp 1 = 2 Grp 2 = 3	Grp 1 = 2 Grp 2 = 2 Grp 3 = 1
20	5	2	Pen 1 = 2 ----- Pen 2 = 3	Grp 1 = 1 Grp 2 = 1 Grp 1 = 1 Grp 2 = 2	Not possible to use 2 days sexual rest Grp 1 = 1 Grp 2 = 1 Grp 3 = 1
20	5	4	Pen 1 = 1 ----- Pen 2 = 1 ----- Pen 3 = 1 ----- Pen 4 = 2	Not possible to use 1 day of sexual rest Not possible to use 1 day of sexual rest Not possible to use 1 day of sexual rest Grp 1 = 1 Grp 2 = 1	Not possible to use 2 days of sexual rest for all boars

(one boar per two females bred) and *Table VIII* (one boar per four females bred). Regardless of the boar-to-female ratio used, there is no guarantee all females will be satisfactorily mated during their first estrus after weaning.

Female Group is Split-Weaned. The most sensible method for estimating the number of boars needed when pen-mating a group of split-weaned females is to estimate the accumulated number of females in estrus on each day during the breeding period. The factors to consider are: (1) number of days between weaning each sub-group of females, (2) number of females per sub-group, (3) number of

breeding pens, (4) distribution of weaned females among breeding pens, (5) rotation of boars for sexual rest, (6) length of sexual rest for boars, (7) percentage of females first found in estrus on each day and (8) the length of time a female is in estrus.

A minimum of five boars would be needed to breed the distribution of 20 females shown in *Figure 7* when using the following assumptions: (1) Boar-to-female ratio is one boar to four females (*Table VIII*), (2) two breeding pens are used and (3) the boars are rested one day. Because of pen-mating variables, however, there is no guarantee that all 20 females will be mated during the first estrus after weaning.

Indoor Pen-mating Facility

Indoor pen-mating facilities should be carefully designed and constructed to provide animal comfort and enhance reproductive performance.

Boar Housing

Ideally, boars should be housed individually to reduce injuries from fighting and riding, to stimulate their sexual behavior, to simplify moving them in and out of the pen, to eliminate homosexual activity and to adjust feed intake to maintain proper body condition. These benefits extend the useful life of the boars, reducing costs due to the need for fewer replacement boars.

Floor space and surface. The amount of floor space allowed per boar is generally 35 to 50 square feet. The floor should be partially or totally slatted to prevent a mucky environment. When using a partially slatted floor, the boars are fed on the floor. The alley is raised four inches to prevent the boars from blowing feed into the alley.

Pen dimensions and gate latch. The minimum width of the pen is five feet, however, six feet is preferred. The pen partitions should be 46 to 48 inches high and constructed of vertical pipe to prevent climbing. Vertical pipe should be spaced four to five

inches apart. The bottom horizontal pipe should be no more than eight inches off the floor between adjacent pens and only six inches off the floor next to the feed alley. Boar pens should have a gate latch that can be opened and shut quickly yet not be opened by the boar.

Ventilation, heating and cooling The resting area for individually housed boars should be totally enclosed as there is not enough body mass to generate heat. The boar resting area is not large, therefore, the cost of installing and operating a mechanical ventilation system is reasonable. During warm seasons, boars are generally cooled with an intermittent spraying system combined with fans.

Sow Housing

When pen-mating indoors, the number of weaned females per pen should be kept small, about four to 10. The floor plan shown in *Figure 14* houses seven females with one boar (18 square feet per animal).

Floor space and surface. The floor space allowed per female is generally 18 to 20 square feet in the breeding pen and 16 square feet in gestation (14 square feet for gilts). Normally, females are pen-mated on a partially slatted floor. Imprinting a diamond pattern (4- to 5-inch o.c., one-half inch deep) in the breeding pen floor helps prevent injuries when

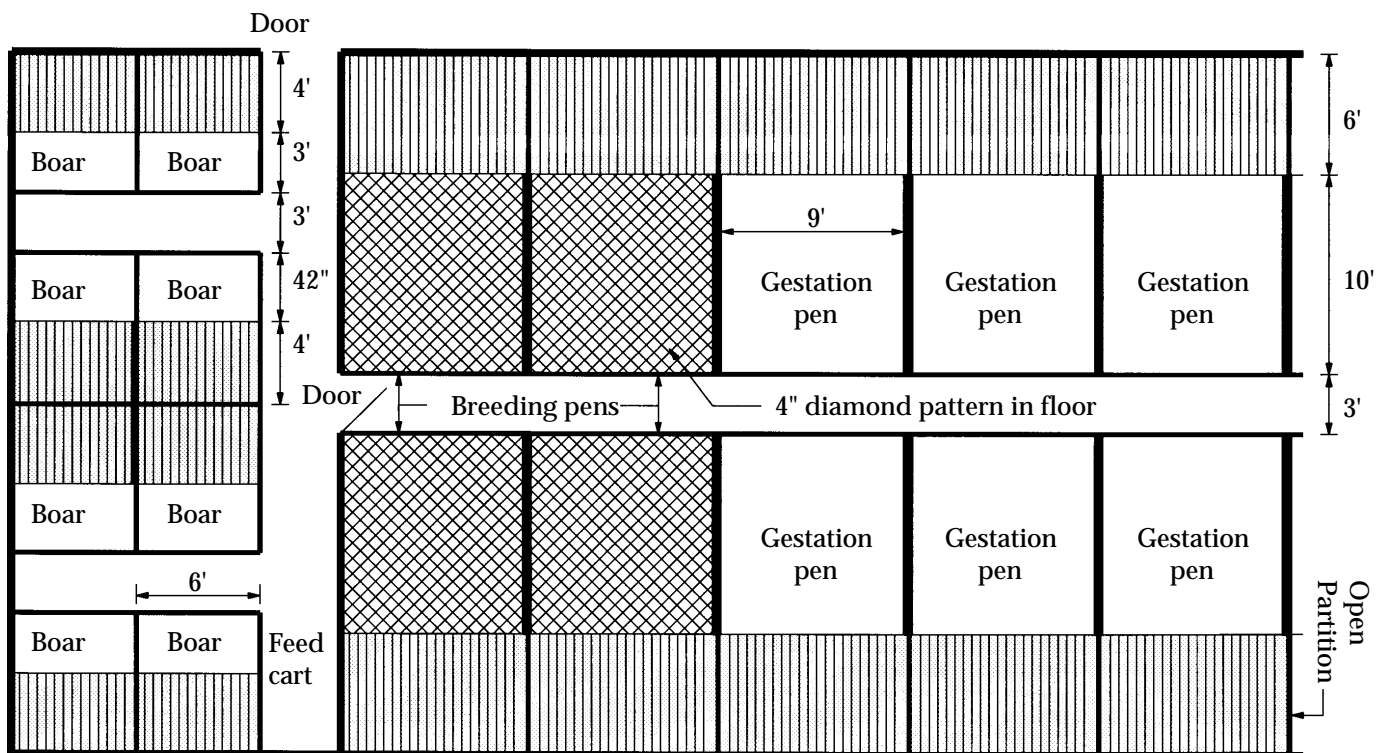


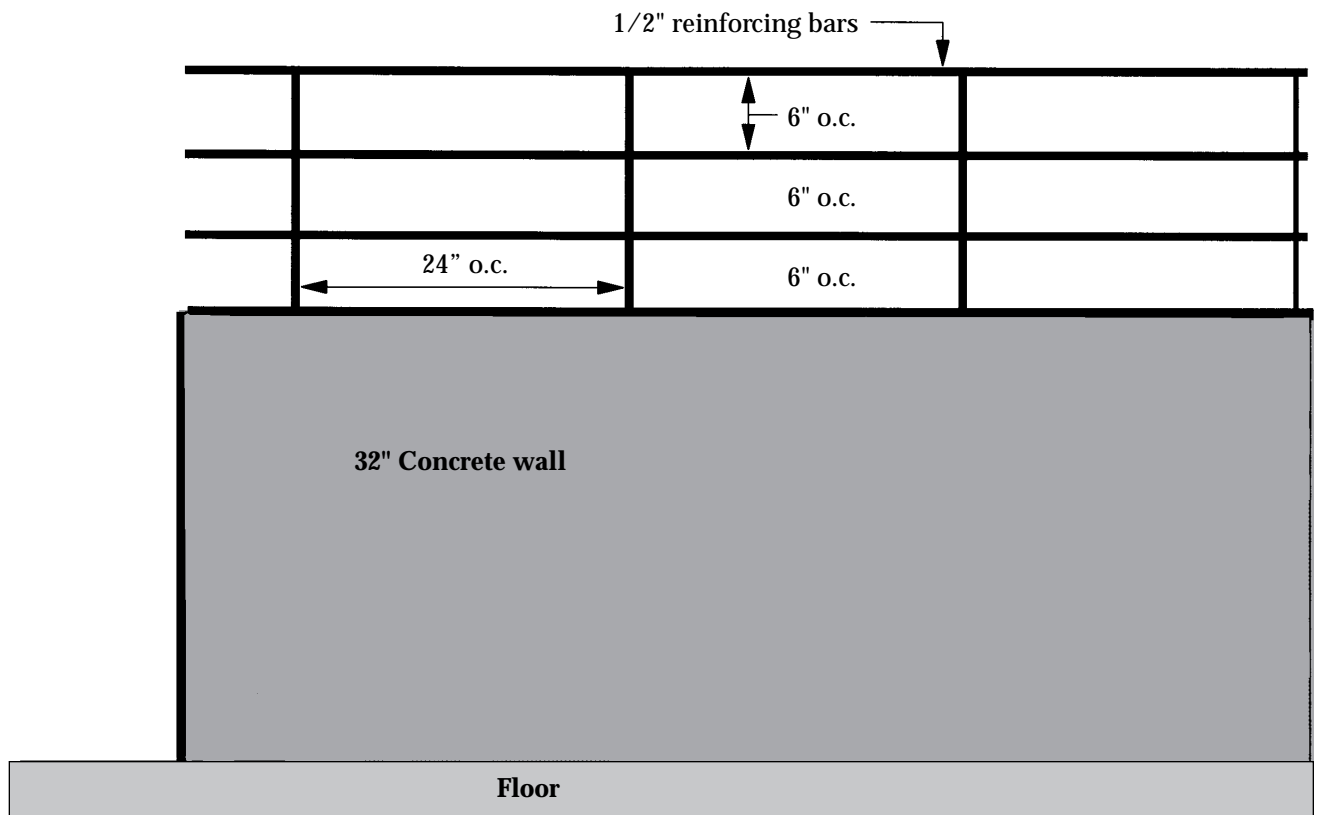
Figure 14. Example of an indoor pen-mating facility.

females are mounting or being mounted by other females or a boar. Feeding females on the floor helps keep it clean and dry. Raising the alley four inches above the breeding pen floor prevents the females from blowing feed back into the alley.

Pen partition and gate latch. Normally, a 48" high pen partition is used to prevent females and boars from getting into an adjacent pen. In a partially slatted facility, a solid pen partition is used on the solid portion of the floor to enhance a good dunging pattern. However, a solid pen partition interferes with air flow. To enhance air flow and still have an effective

48" high partition, set a pipe or steel rod panel on top of a 32" concrete wall (*Figure 15*). Breeding and gestation pens also should have a gate latch that can be opened and shut quickly and yet can not be opened by animals. Open partition gates are used along the alley, so estrus detection can be easily accomplished during the gestation phase.

Ventilation, heating and cooling. The facility shown in *Figure 14* is a gable or "A" roof building. The building is operated as non-mechanically ventilated modified-open-front facility.



Drawn by D. G. Levis

Figure 15. Example of a pen partition to allow air movement.