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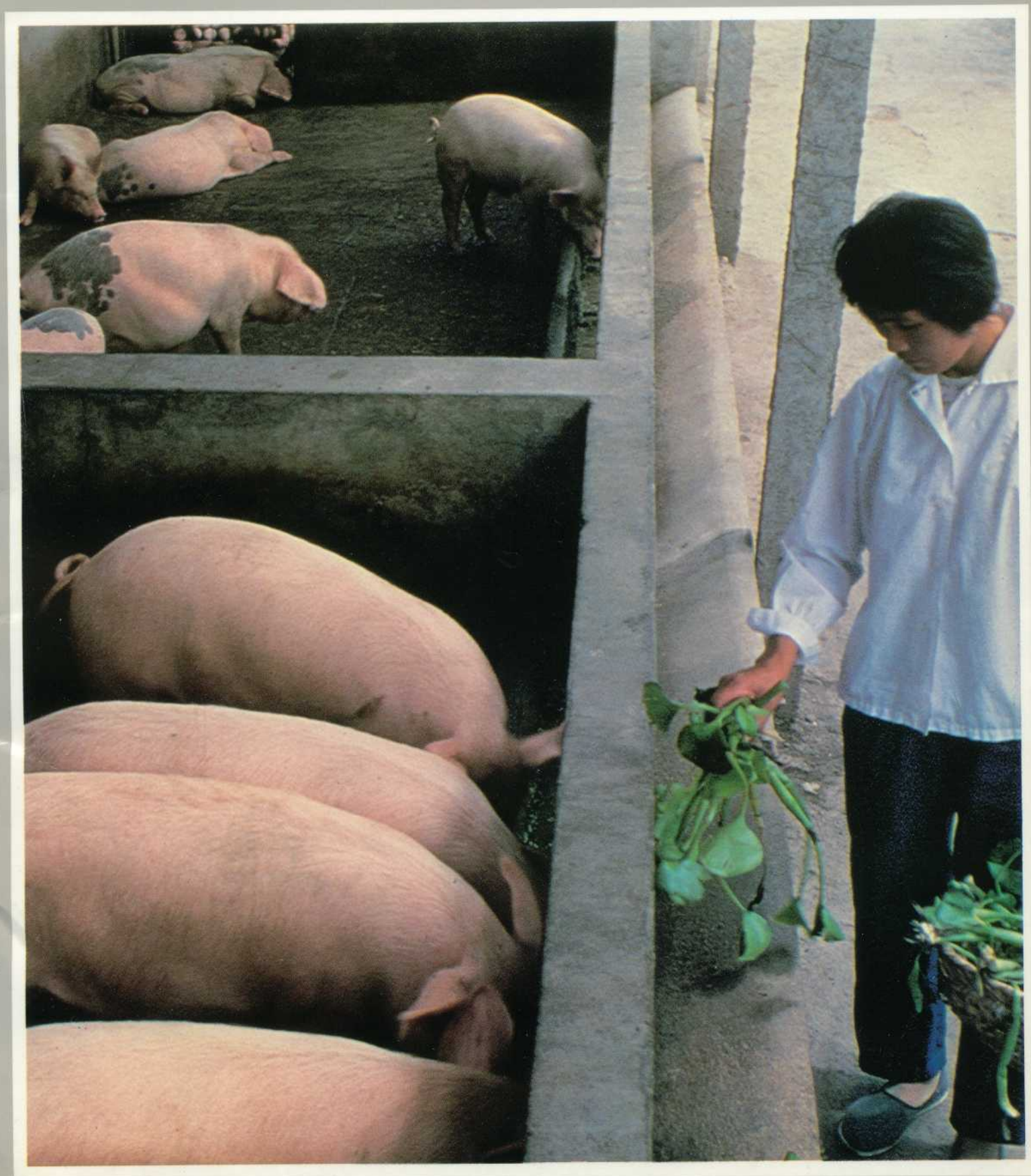

Factors Influencing the Weaning to Oestrus Interval in Swine: A Review*

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Introduction

The productive lifespan of the sow in the herd can be divided roughly into four distinctive intervals:

1. from birth to 90 kg (200 lb) liveweight (or market weight)
2. from 90 kg to first farrowing
3. period of successive reproductive cycles
4. interval from last weaning to culling

Under good management and appropriate economic conditions, raising the sow up to the assigned market weight should be a profitable operation in the sense that if this female is marketed for meat, it should be comparable in most aspects to other males or females assigned originally as slaughter animals.

The intervals between 90 kg and first farrowing and from weaning of the last litter to culling, are two unproductive and rather expensive periods of the life of a sow. If we consider the former as a necessary preparatory phase for the reproductive interval which follows, no useful function can be attributed to the latter.

The period of successive reproductive cycles is the most important interval for the producer since it is the period which pays for all his expenses in raising the sow to that phase and provides the margin of profit for the whole operation. The optimum operation would then be:

optimize the first interval (birth to 90 kg)
reduce the second interval (90 kg to lst farrowing)
maximize the third interval (period of reproductive cycles), and
eliminate the fourth interval (weaning of last litter to culling).

Looking closely into the third interval, the one that concerns us most, we find that it cannot be prolonged beyond a certain level (age or parity) after which the productivity of the sow decreases drasticly, so, maximizing production would be by improving its efficiency, which means increasing the number of cycles in a given period of time (the whole reproductive interval or per unit of time, usually per year).

The potential and extent of this maximization can be done by examining a typical cycle which is composed

of four distinctive periods:
1. Period of gestation
2. Period of lactation
3. Interval from weaning to first-oestrus
4. Interval from first oestrus to conception

There is very little the producer can do to reduce the length of the gestation period, since nature fixed it at about 115 days. Although some breeds may have shorter or longer gestation periods the difference is usually a few days which may not mean much in the cycle as a whole.

All efforts should be made to eliminate the fourth interval, that is between first oestrus after weaning and conception, which means making the first mating after weaning *the fertilized mating*. Usually under normal management, over 90% of the sows would conceive from the first time and higher percentages up to 98% may be encountered in well-managed well-run operations. This can be achieved by considering many factors among them, better detection of heat, optimum time for mating, consistant availability of boar power, and using boars with superior semen quality and high libido.

Reducing the interval from weaning to oestrus together with lowering the weaning age of the piglets to reduce the lactation period are the two main steps towards increasing the number of reproductive cycles of the sow and hence improve its reproductive interval.

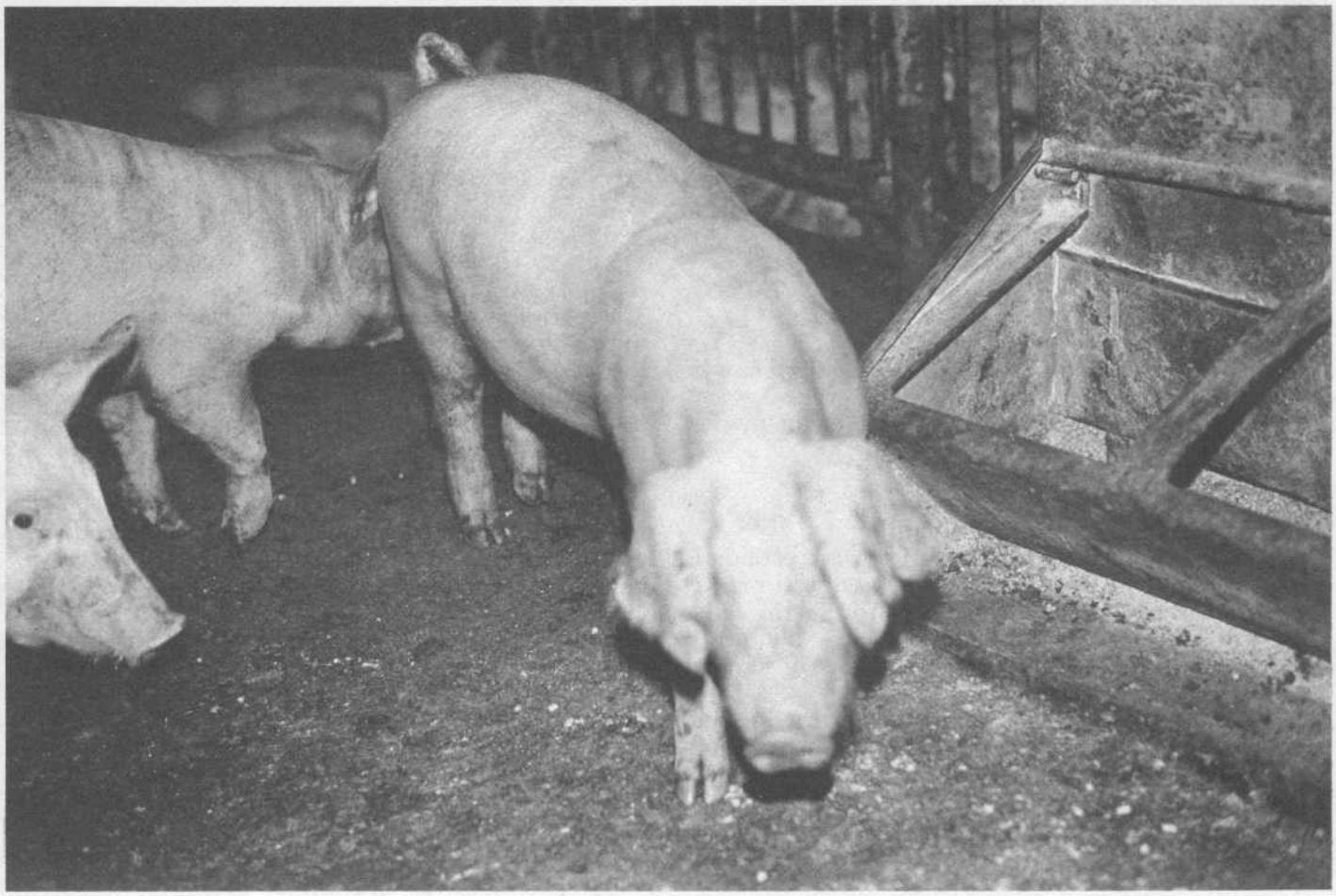
Research on the effect of early weaning on sow productivity is well documented and the application of the findings is evident from the adoption of weaning at 21 to 35 days in most present day operations instead of the traditional 56-day lactations.

In spite of the evident economic importance (Table 1) and although the interval weaning to oestrus has been reported in many experiments and the effects of various factors on this trait have been demonstrated, to the authors knowledge, no work has yet been undertaken to summarize the existing knowledge or to try to draw conclusions from it. This makes the objective of this review article.

TABLE 1 - The number of farrowings per year according to length of lactation and the interval weaning to conception.

Interval weaning-conception (days)	115 days of gestation plus lactation of: 21 day	35 day	56 day
28	2.2	2.0	1.8
21	2.3	2.1	1.9
14	2.4	2.2	2.0
7	2.5	2.3	2.1

Housing in small or large groups has an adverse effect on weaning to oestrus interval.



Oestrus and ovulation mechanism after farrowing and during lactation

Many sows exhibit oestrus few days after farrowing, this oestrus is often without ovulation and is believed to result from hormonal unbalance following parturation. Lactation acts as an inhebitor of follicular development and thus in most cases no oestrus can be observed while the sow is lactating. Weaning or the sudden (or even gradual) removal of the piglets acts as a stimulus for the secretion of the FSH hormone which is responsible for the development of the follicules. The development of the follicules is very fast (Day 1973) and within 3 to 5 days the small follicules of about 3 mm or less can develop to the ovulating size of 8 mm or more (Figure 1). Accordingly, under normal conditions and with the proper balance of hormones the sows are expected to return to oestrus within a week after weaning provided that lactation lasts at least 15 days. The sows that fail to return to estrus are probably those which either fail to respond to the weaning stimulus or those unable to produce the necessary hormones. This was shown by the work of te Brake *et al.* (1976) and Aherne *et al.* (1976) which are presented in Figures 2 & 3 respectively. Both experiments showed that there is a marked difference in hormone concentration in the blood, between the early and late returning sows. The reason for this difference is not fully understood and could be the result of the interaction between the individual sow and its environment.

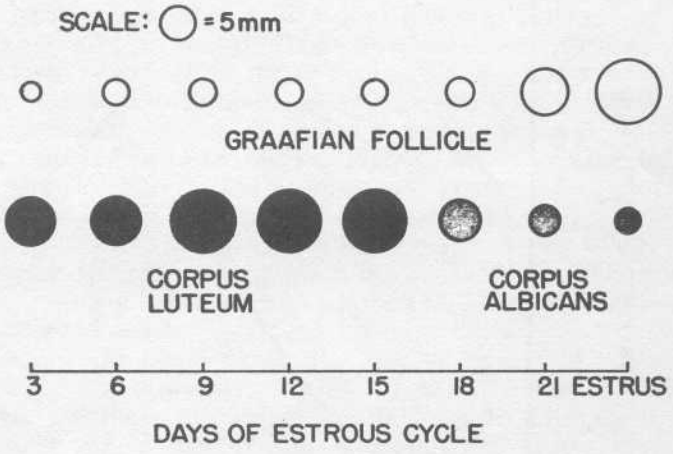
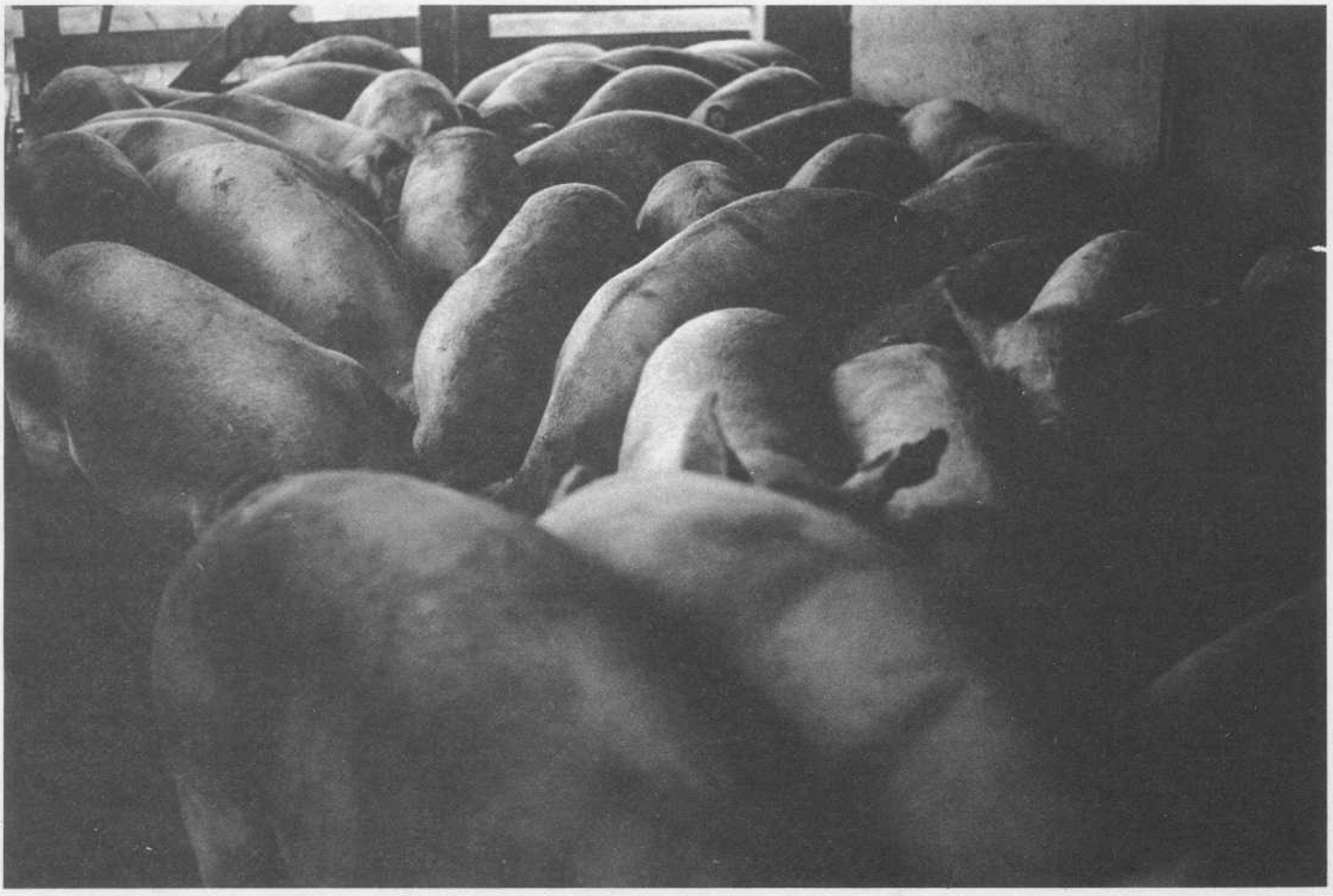


Fig. 1 - Growth of ovarian follicules during the oestrous cycle (Day, 1962).



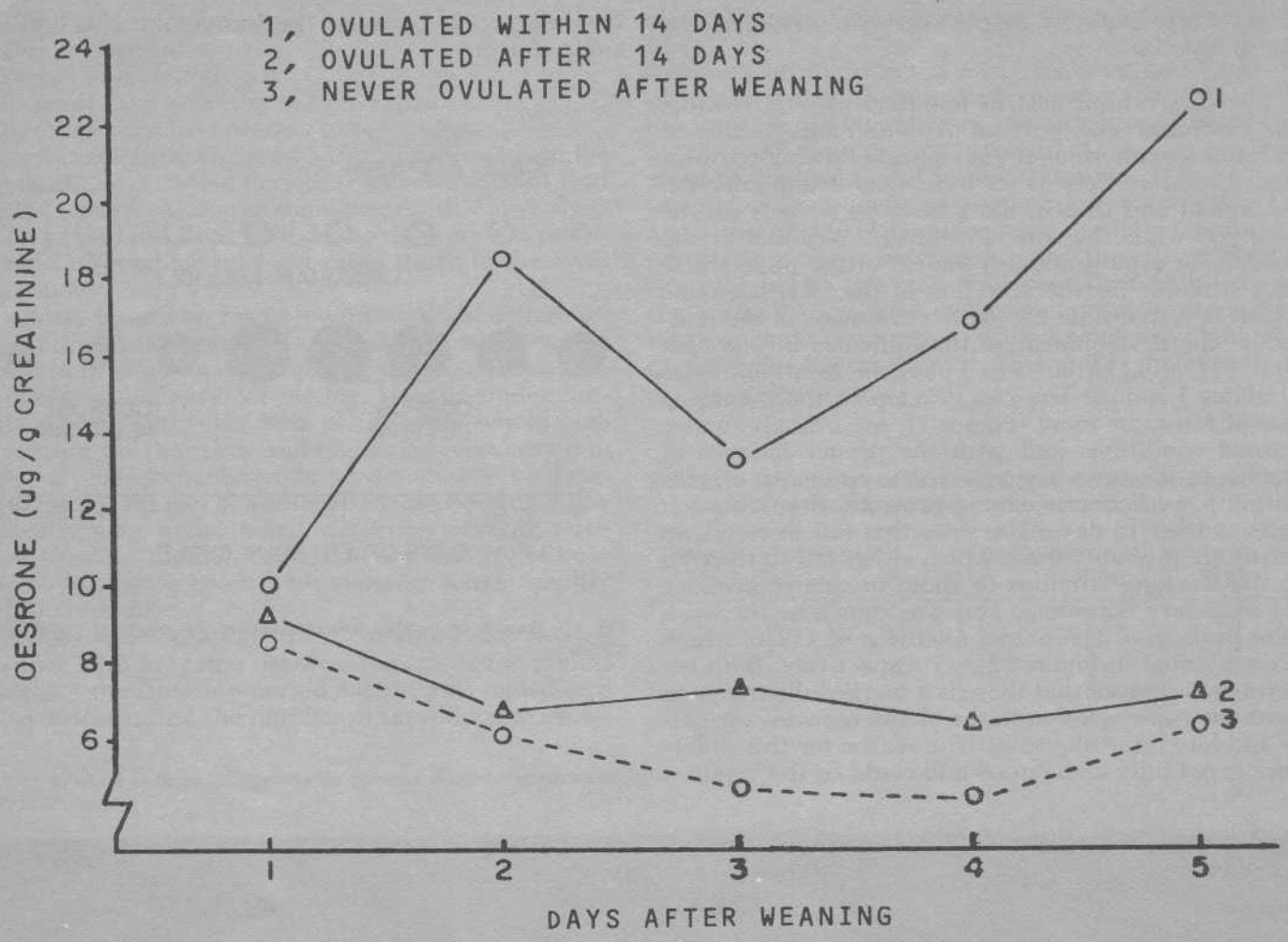


Fig. 2 - Oesrone concentration during the first 5 days after weaning in sows showing oestrus: 1, within 14 days, 2, after 14 days of weaning and 3, of those never showing oestrus (from te Brake et al, 1976).

Weaning to oestrus (conception) interval in practice and its causes of variation

Table 2 presents the average weaning to oestrus (or conception) interval of various studies or surveys carried out in different parts of the world. The table shows that the interval increases as the number of animals observed increases. Many explanations could be given for that, the most probable is that with few animals the exception ones are seldom reported and under experimentation those animals are the first to disappear, not to interfere with the objectives of the experiments which are often studying some other traits, factors or treatments. Also in some experiments the observations are taken for only a certain period after weaning 3 or 4 weeks for example. Under most commercial or large scale operations, often, not more than 75% of the sows would return to oestrus and successfully conceive within 14 days after weaning (Table 3).

The causes of variation in the length of the weaning to oestrus interval can be classified into three major areas: genetics, nutrition and management.

1. Genetics:

Differences among breeds and crosses are the main genetic cause of difference in weaning to oestrus interval. In spite of the many studies in which more than one genetic group was involved, often the genetic groups were pooled together and treated as one group, assuming that they would react to the treatments similarly. In the few studies where efforts were made to compare different genetic groups the results always indicated differences which were often significant (Table 4). Aumaitre *et al.* (1976) were able to demonstrate that crossbreeding was responsible for a marked reduction in the interval and found the heterotic effect to be significant (Fig. 4).

In comparing 28 crosses from eight breeds Fahmy *et al.* (1979) showed that significant differences among crosses and breeds involved in producing these crosses exist. (Fig. 5).

This implies that using the genetic tools available can result in modifying the interval. However, since the weaning to oestrus interval, like other reproductive traits, is controlled less by the action of genes than by

environment, the extent by which selection can succeed in reducing the interval is questionable and if it occurs it would be rather slow. Very few genetic parameters were reported for this trait and they were as follows:

a. repeatability (the correlation between successive observation)

0.19 by Van der Heyde *et al.* (1974)
0.28 by Fahmy *et al.* (1979)

b. heritability (the fraction of the trait controlled by the action of additive genes)

0.25 by Fahmy *et al.* (1979)

TABLE 4 - Differences between breeds and crosses in the interval weaning to oestrus.

Genetic groups and Means					Reference
Large White		Large Black			Burger (1952)
7.9		16.1			
Landrace		Saddleback			MacLean (1968)
9.5		11.7			
Yorkshire		Lacombe			
4.3		5.2			Dyck (1972)
5.5		14.3			Dyck (1971)
Ld x Y	D x Y	LB x Lc	D x Lc	LB x Ld	Fahmy & Dufour
10.6	18.9	13.4	13.3	13.2	(1976)

Ld: Landrance, Y: Yorkshire, D: Duroc, LB: Large Black, Lc: Lacombe

TABLE 5 - Effect of energy intake on the interval weaning-oestrus (days)

	Ad Lib	High	Medium	Low	References
Last 7 days of lactation		5.0		5.4	Brooks & Cole (1973)
After weaning	6.1	6.5	7.0	5.4	Brooks et al. (1975)
		4.3	4.9		Dyck (1972)
		9.3	12.0	21.6	Brooks & Cole (1972)
	5.0	5.2	7.9	4.9	Brooks & Cole (UP)*
	13.5		14.3		Fahmy & Dufour (1976)

* Unpublished

2. Nutrition:

Good management and actual need for feed necessitate changes in the feeding practice of the sow during the reproductive cycle. Many studies have demonstrated the effect of varying quantities and qualities of energy and protein on traits of economic importance in swine production such as litter size, piglet preweaning growth and the weaning to oestrus interval. Almost all the studies showed that increasing feed intake results in shortening the interval whether that increase occured during pregnancy, during lactation or after weaning. The results of these studies are summarized in Table 5, and in a particular study where the treatments were imposed during lactation and after weaning (Shearer and Adam, 1973) the results are presented separately in Table 6.

Since feeding is not only the level of energy but also the level (and quality) of protein, various experiments were conducted to study the effect of protein. These results are shown in Table 7. They also show that

TABLE 2 - Interval weaning-oestrus (conception) in different studies.

Country	Number	Mean	Reference
France	142 333	(22.4)	Aumaître et al. (1976)
Belgium	2 207	11.4	Van der Heyde et al. (1974)
Bulgaria	1 021	13.6	Radev et al. (1976)
Russia	821	14.0	Benkov (1973)
France	677	12.5 (21.6)	Aumaître & Le Pan (1976)
Canada	502	10.4	Dyck (1971)
UK	400	11.4	MacLean (1969)
USA	201	5.9	Soma & Speer (1975)
USA	177	7.5	Myers & Speer (1973)
UK	176	6.6	Brooks et al. (1975)
Canada	123	13.9	Fahmy & Dufour (1976)
Australia	110	11.4	Webster (1978)
South Africa	89	12.5	Burger (1952)
USA	77	7.0	Svajgr et al. (1974)
UK	47	9.9	Pay (1973)
USA	24	5.1	Self & Grummer (1958)
USA	17	4.5	Svajgr et al. (1972)
UK	15	5.3	Brooks & Cole (1973)
NZ	15	14.1	Adam (1972)

TABLE 3 - Percent of sows returning to oestrus after weaning in different studies.

No. of animals	Weaning age (days)	Returning to oestrus (%)	Interval after weaning (days)	References
13049	40	41.5	9	Mesnil du Buisson & Signoret (1968)
156	19.8	74.4	1-15	Moody et al. (1969)
169	—	64	1-7	Rasbech (1969)
45	56	95.4	4-7	Alzabe & Wilde (1972)
821	36	83.6	21	Benkov (1973)
1421	40-45	71.1	12	Yakimchuk (1976)
1077	55-60	67.4	12	Yakimchuk (1976)
54116	21-35	69.8	1-15	Aumaître et al. (1976)
203	30	45.3	3-10	Andreev (1976)
177	35	65.5	1-14	Fahmy & Dufour (1976)
549	21-35	54.5	17	Fahmy et al. (1979)

diets poor in protein are responsible for the delay in return to oestrus, and in some extreme cases can cause complete failure to return to oestrus (Exp. 2, Svajgr *et al.* 1972).
Other research extended to the effect of other components of the diet. In an experiment reported by Yakimchuc (1976), the effect of vitamin A was investigated and the results are presented in Table 7. They showed that high level of vitamin A reduced by about 2 days the length of the interval. Other studies on the effect of other vitamins and minerals on reproduction in general were conducted, they showed that the effect on the weaning to oestrus interval was not important.

3. Management:

a) *Length of lactation*

Weaning had been practiced for a long time at 56 days or later after farrowing. After extensive research on the effects of early weaning, weaning age was reduced to 21 to 35 days. Many other studies were conducted to study the effect of reducing the weaning age even further, (6 to 10 days or at birth, Marx and Hoepfner, 1976; Pay, 1973; Baker *et al.*, 1953). The difficulties observed come from two sources, the size of the following litters was markedly smaller and the weaning to oestrus interval was markedly longer as shown in Figure 6. It seems that the interval starts to level µp after 21 days of lactation which is presently the recommended lactation period. A particular survey study conducted in France (Aumaître *et al.* 1976) on a large sample confirm this last statement (Fig. 7).

b) *Parity*

The interval weaning-oestrus decreases drasticly after the second parity as shown in Table 9. It remains almost unchanged after the third parity (See Fig. 4).

c) *Health condition of the sow*

That sick sows returning to oestrus later than healthy ones should be considered normal. It is possible that sows late in returning to oestrus are in effect sick without manifesting any symptoms. Four studies were carried out to study the effect of administring antibiotics to find out if the treatment has an effect on reducing the interval. The results are summarized in Table 10 and show that antibiotics had very little effect on reducing weaning to oestrus interval.

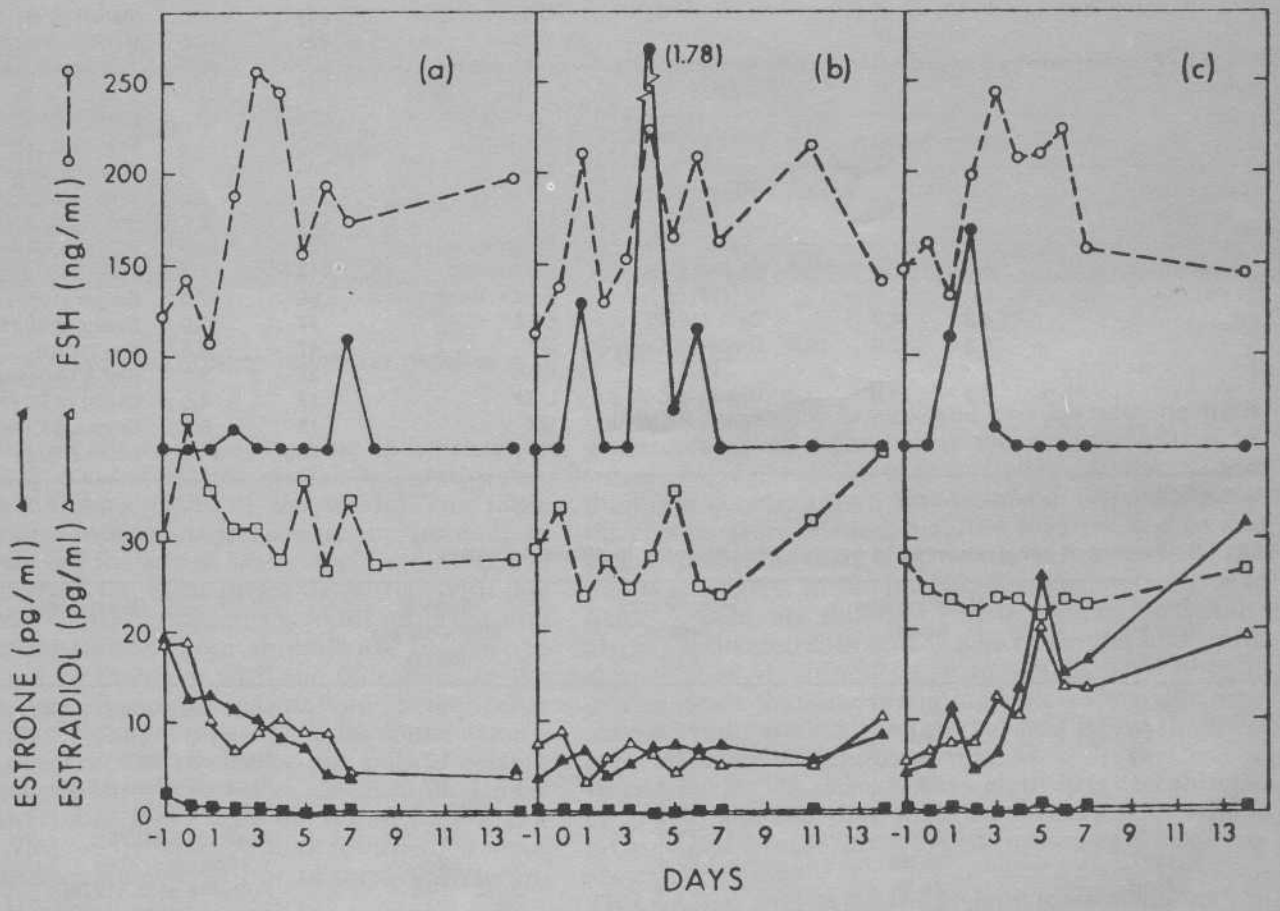


Fig. 3 - Hormonal profile in sows which did not return to oestrus (a, b, c) and those ovulated (d, e, f) within 14 days after weaning (at 7,5 and 10 days respectively) (Aherne et al 1976).

TABLE 6 - Effect of energy intake during lactation and after weaning on the interval weaning-oestrus (days).

During lactation	Control 2.7 kg	After weaning 2.7 kg *	3.6 kg **	Mean
Low	11.2	11.8	7.6	10.4
Medium	8.6	10.8	14.5	11.2
High	6.0	16.7	24.7	15.3
Mean	8.5	13.1	16.1	

* Complete fasting for 24 h after weaning

** Complete fasting for 24 h after weaning followed by 3.6 kg of feed for 3 days followed by 2.7 kg/day for the rest of the period.
Shearer & Adam (1973).

d) *Feeding management at weaning*

In 1969, MacLean (1969) published results which showed that sows deprived of food 24 hours after weaning returned to oestrus 10 days earlier than those fed normally after weaning, and depriving the sows from food and water for 24 hours reduced the interval even further (19 days). The practice of depriving the sows

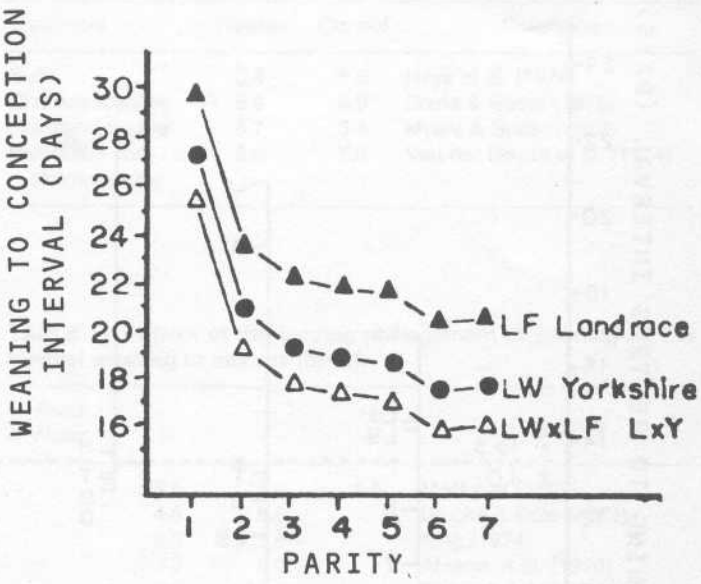
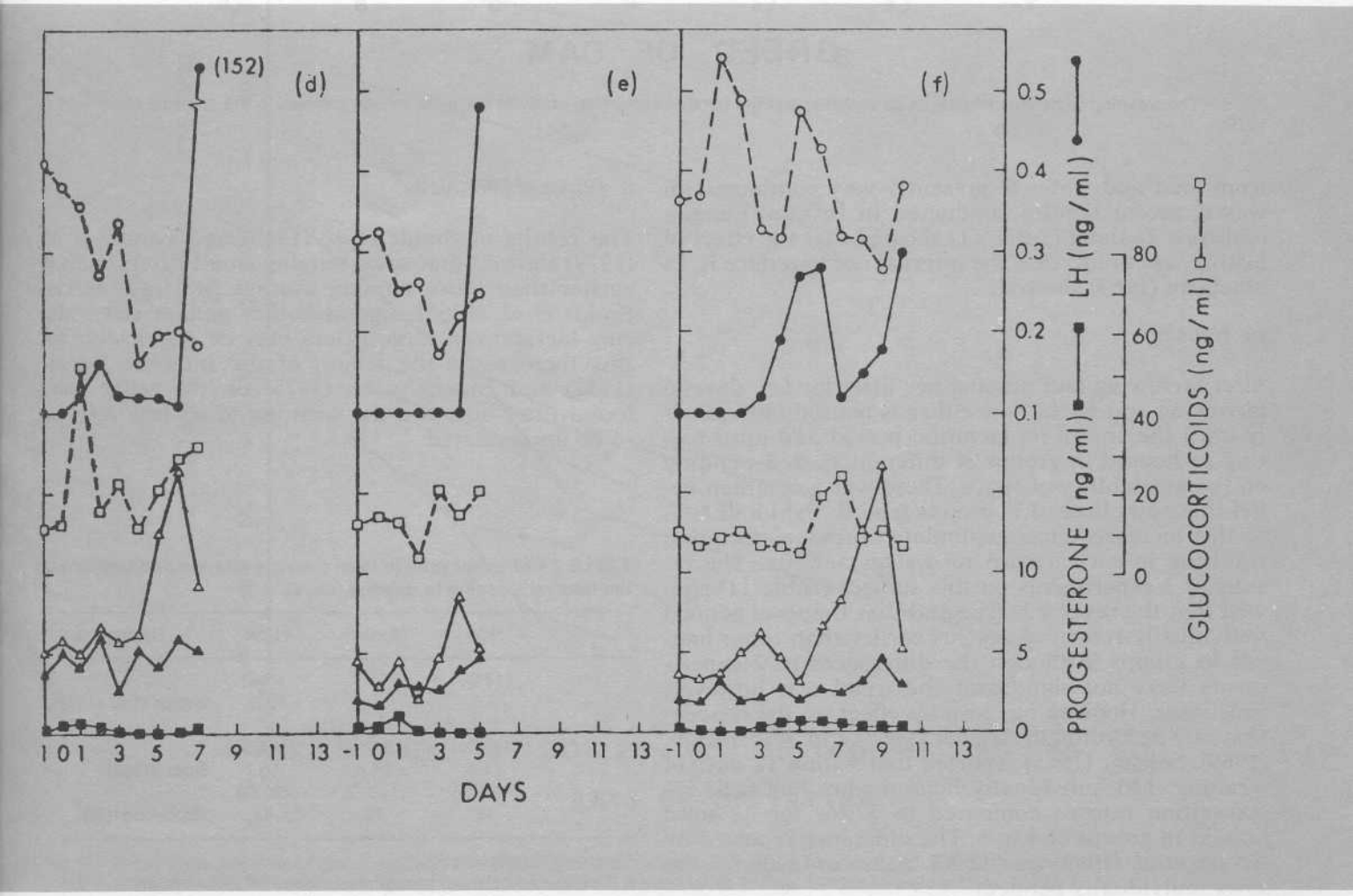


Fig. 4 - The relation between parity and weaning to conception interval in purebred and crossbred sows (Aumaitre et al 1976).



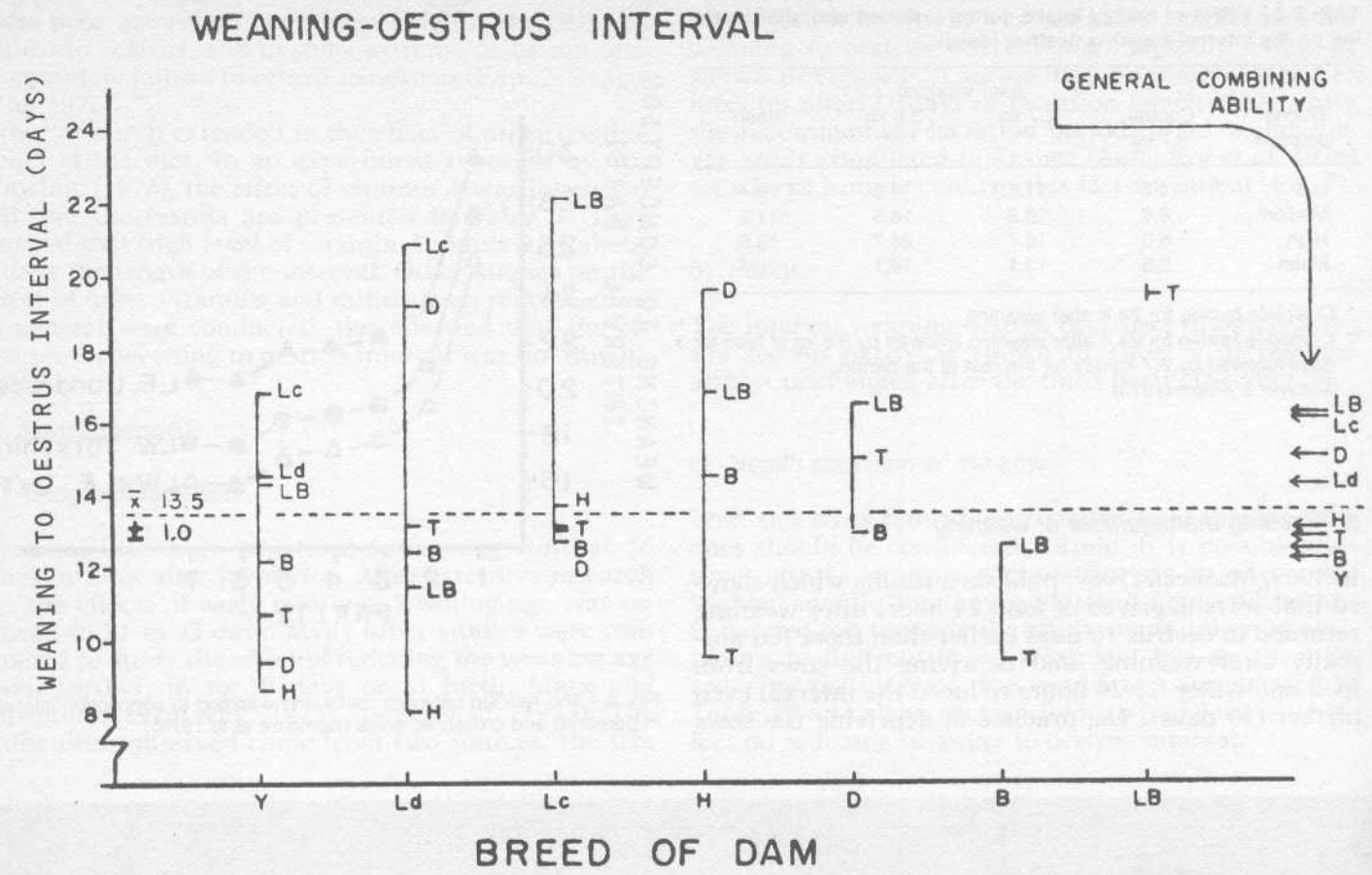


Fig. 5 - The weaning to oestrus interval in 28 crosses, and the general combining ability of the eight breeds involved in the crossing (Fahmy et al, 1979).

from food and water is presently very common. However, recent studies conducted in Britain, Canada and New Zealand (Table 11) showed that the effect of fasting was to increase the interval not to reduce it, as MacLean (1969) showed.

e) *Housing*

After farrowing and nursing her litter for few days in farrowing crates, the sow either is housed individually until the end of its lactation period and until mating or housed in groups of different sizes depending on the availability of space. There was a common belief that sows housed in groups tend to fight and hense this increased stress stimulate hormonal secretion resulting in early return to oestrus activity. The results of 3 experiments on this subject (Table 11) showed that the reverse is true and that the sows penned individually return to oestrus earlier than those housed in groups. Although the differences in 2 experiments were not significant the trend was however, consistant. Housing has also an effect on the conception rate according to Salehar (1965) and Sviben *et al.* (1969). Salehar (1965) reported that within 12 days of weaning, 120 individually housed sows had a 83.6% conception rate as compared to 57.6% for 42 sows housed in groups of 4 to 6. The difference reported by Sviben *et al.* (1969) was 12.3%, again in favour of the sows individually penned.

f) *Effect of litter size*

The results of Smidt *et al.* (1965) and Fahmy *et al.* (1979) showed that sows nursing small litters recycle earlier than those nursing average or larger litters. Smidt *et al.* (1965) suggested that greater stress during lactation in large litters may be responsible for this increase in the length of the interval. Burger (1952) and Brooks *et al.* (1975) on the other hand found litter size and the weaning to oestrus interval to be uncorrelated.

TABLE 7 - Effect of protein level during gestation and lactation on the interval weaning to oestrus (days).

	High	Medium	Low	References
	(17%)		(5%)	
1 —	4.5		9.5	Svajgr et al. (1972)
2 —	5.2		*	
	(19.6%)	15.3%)	(10.8%)	
	11.8	11.4	16.7	Boaz (1962)
	(130 G)	(110 G)	(90 G)	
	16	25	44	Rasbech (1965)

* no oestrus observed
The figures between parenthesis represent protein levels.

TABLE 8 - Effect of vitamins on the interval weaning to oestrus (days).

Carotene IU vit A	40 mg 0	75 mg 0	100 mg 0	75 mg 25 000	100 mg 25 000	Reference
	8.6	8.2	8.2	6.6	6.4	Yakimchuk (1976)

TABLE 9 - Effect of parity on the interval weaning to oestrus (days).

Parity 1	2	3	Reference
24	13	10	Rasbech (1969)
19	11	10	Boaz (1962)
23	8	11	Adam (1972)
17	10	6	O'Grady & Harnahan (1975)
15	13		O'Grady et al. (1973)
6.5	6.4		Adam & Shearer (1971)

TABLE 10 - Effect of antibiotics on the weaning to oestrus interval (days).

Treatment	Treated	Control	Reference
Sulfa	5.6	5.6	Hays et al. (1978)
Chlortetracycline	5.9	5.9	Soma & Speer (1975)
Chlortetracycline	5.7	5.4	Myers & Speer (1973)
Penicilline and streptomycine	8.6	7.6	Van der Heyde et al. (1974)

TABLE 11 - Effect of the feeding management at weaning on the interval weaning to oestrus (days).

Feed	+	—	—	Reference
Water	+	+	—	
	25.5	15.0	6.5	MacLean (1969)
	4.8	5.5		Brooks & Cole (1973)
	5.5	5.6		King (1974)
	7.3	9.0		Aherne et al. (1976)
	8.5	13.1		Shearer & Adam (1973)

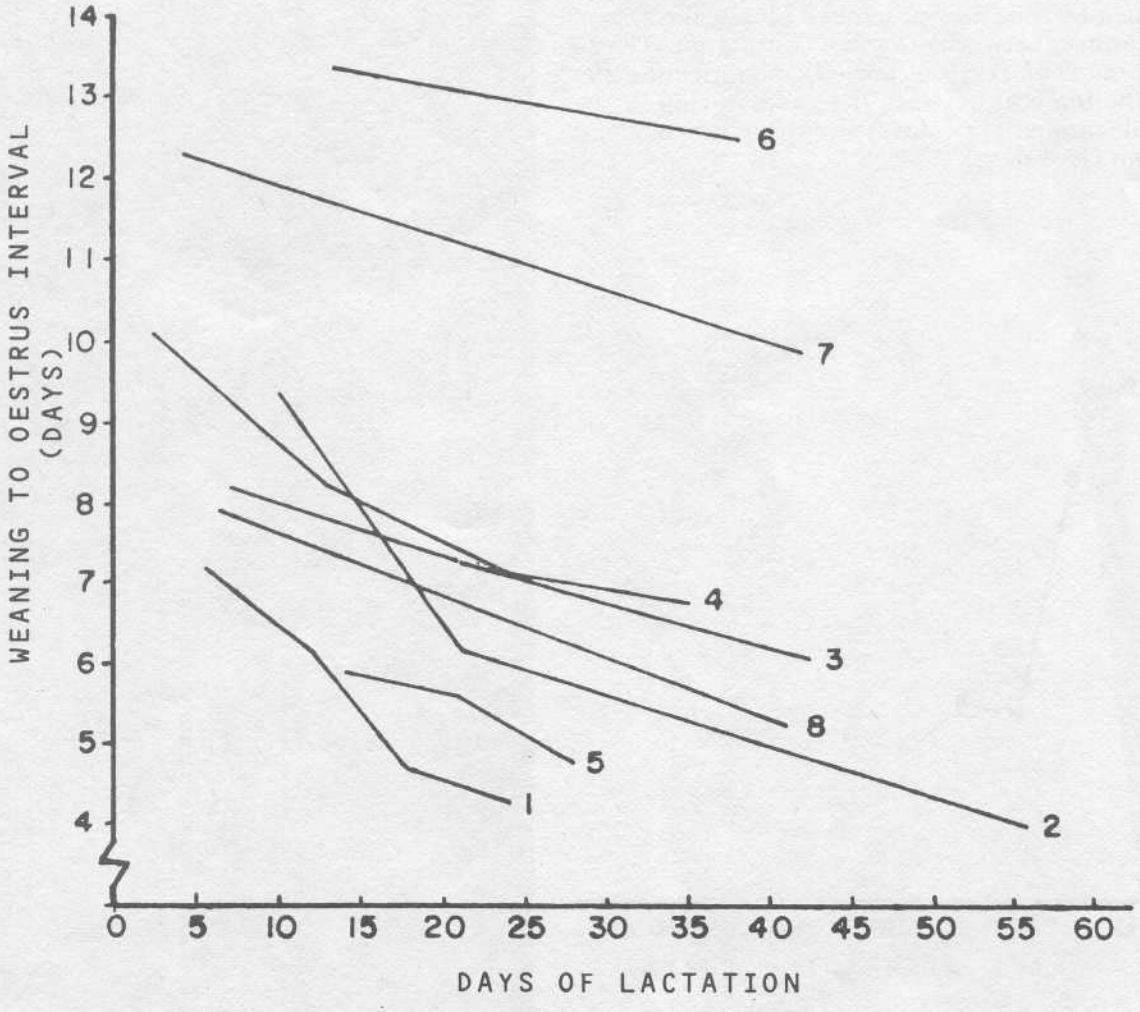


Fig. 6 - The relation between length of lactation and weaning to oestrus interval (1, Hays et al, 1978; 2, Self & Grummer, 1958; 3, Varley & Cole, 1976; 4, Svajgr et al 1974; 5, Moody & Speer, 1971; 6, Aumaitre & Le Pan, 1976; 7. Pay, 1973; 8, Varely & Cole, 1978).

g) *Season of farrowing*

The studies of Moody *et al.* (1969), Adam and Shearer (1971), Myers and Speer (1973), Aumaître *et al.* (1976), Love (1978) and Fahmy *et. al.* (1979) extended over a long period of time and thus differences among seasons could be identified. In all the studies, summer months were found to be the least advantageous for the interval weaning to oestrus.

TABLE 12 - Effect of housing on the interval weaning to oestrus (days).

Individual	Group	Reference
9.0	11.5	MacLean (1969)
12.3	15.4	Fahmy & Dufour (1976)
8.2	9.6	Petchey et al. (1978)

Myers and Speer (1973) reported that 41% of the sows not exhibiting detected heat had weaned from June to September. The corresponding figure in the study of Moody *et al.* (1979) was 65%. Aumaître *et al.* (1976) found a difference of about 11 days in the length of the weaning to oestrus interval between sows weaning from mid-June to September (26-30 days) and those weaning between October and June (15-20 days). Fahmy *et al.* (1979) reported a significant difference in the interval between litters farrowing in the spring and summer (15.1 days) and those farrowing in the autumn (11.4 days).

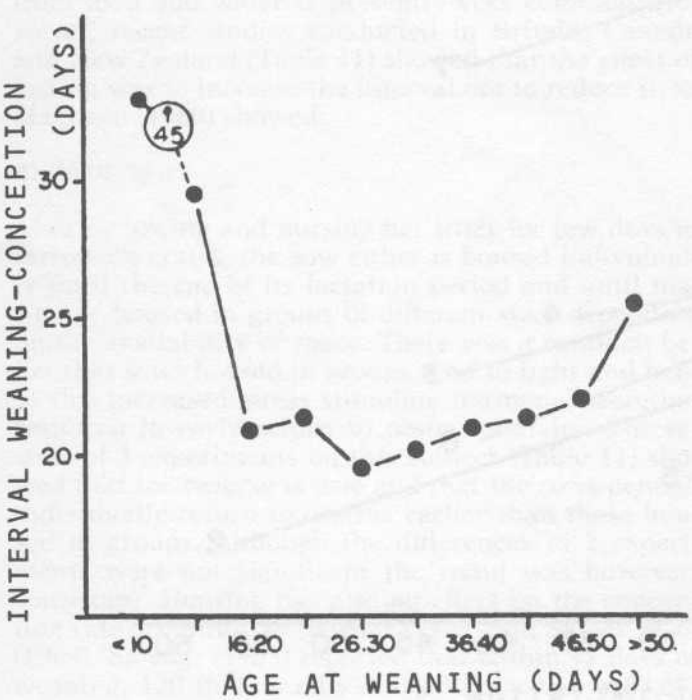
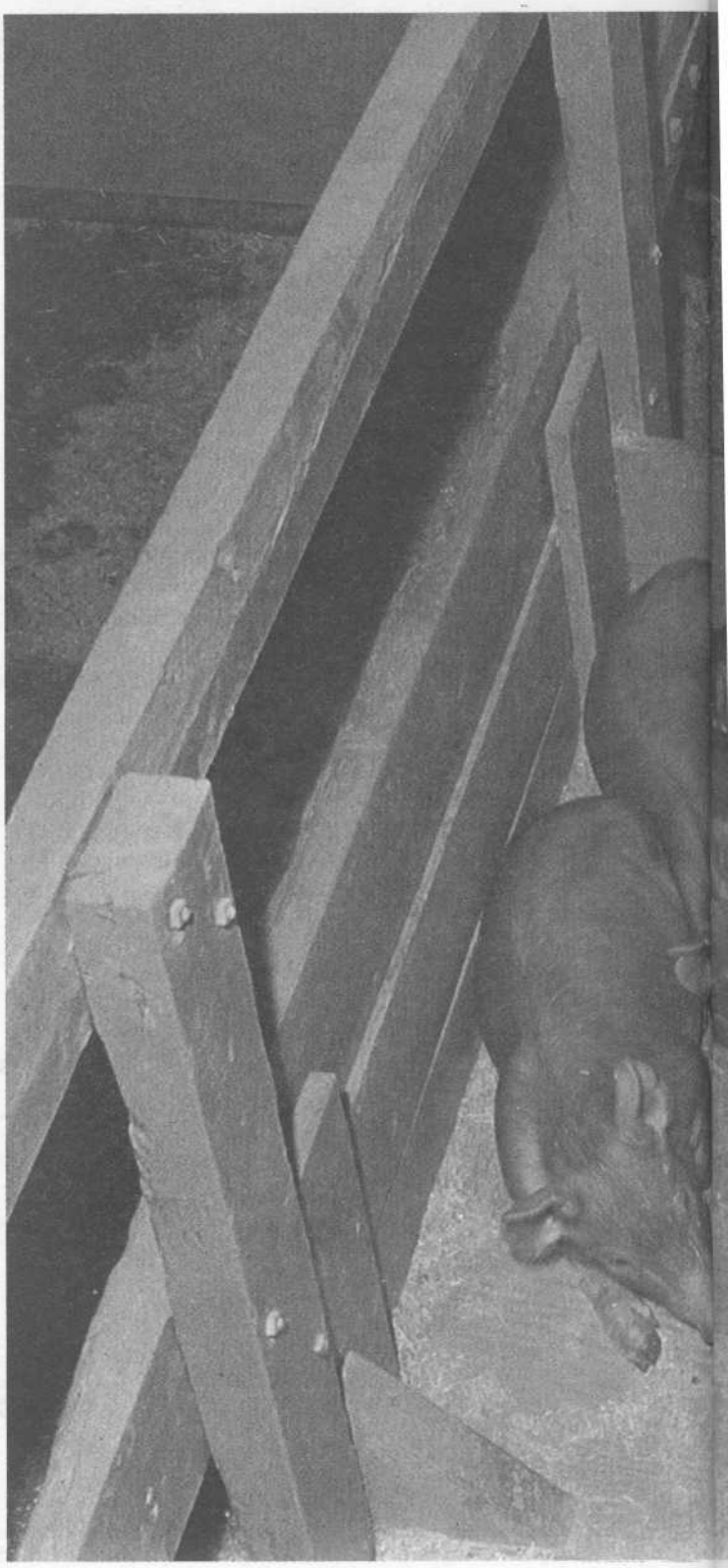


Fig. 7 - The interval weaning-conception in relation to age at weaning (Aumaitre et al 1976).



Removal of the piglets at weaning is a stimulous for returning to oestrus and ovulation.

Love (1978) divided the sows in a production unit into two groups according to weaning to oestrus interval, those with interval greater than or lesser than 18 days. He found that the sows which took more than 18 days to express a detectable oestrus were not significantly affected by summer infertility problem, whereas the group taking less than 18 days to show a detectable oestrus following weaning were affected by summer infertility.

h) *The presence of boars*

Šipilov (1965) found that when a teaser boar was put with 20 sows for 1½ - 2 hours daily for 15 days before weaning, 30% of the sows showed signs of being in oestrus and were mated before weaning, and the remaining sows within the 5 days following weaning. In 20 control sows, non came to oestrus before weaning and only 40% within the 5 days following weaning. Similar findings were also reported by Petchey and English (1980) who found that when sows and their litters were grouped 21 days after farrowing, the introduction of a boar 4 days later reduced the weaning to conception interval significantly. The interval was 5.80 days for sows exposed to the boar and 11.8 days for control sows. None of the sows exposed to the boar had a weaning to oestrus interval exceeding 9 days whereas in the control gorup 7 of the 21 sows had an interval exceeding 10 days.

i) *The effect of exercise*

The effect of exercise on the interval weaning oestrus is not definitely established. According to Tomov (1973) the effect of exercise was different in sows of different parities (Table 13).

TABLE 13 - Effect of excercise on the weaning to oestrus interval (days).

Parity	Forced exercise 2 hr per day	Free exercise	No exercise
1 & 2	8.4	6.6	8.9
2 & 3	17.2	19.3	12.5
3 & 4	8.8	15.7	18.8

Feeding is an important factor influencing the weaning to oestrus interval in sows.

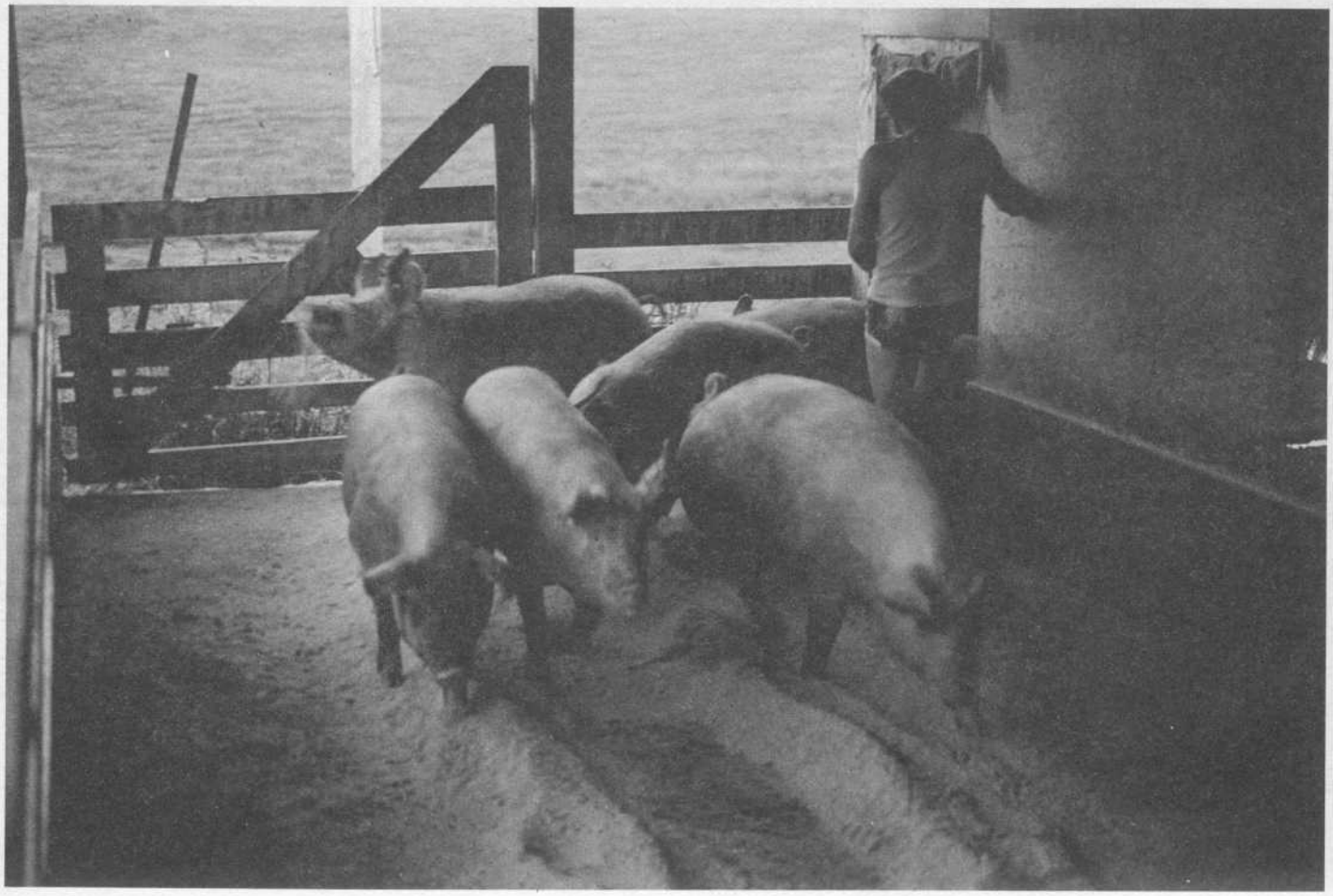


TABLE 14 - Effect of hormones on the weaning to oestrus interval.

Treatment	Treated sows	Un-treated sows	Reference
1500 UI PMS	5.2*	7.0	Day (1973)
1000 UI PMS			
500 UI HCG	3.4*	5.0	Christenson et al. (1972)
1200 UI PMS	4.8*	5.4	Longenbecker & Day (1968)
750 UI PMS	5.4**	6.3	Soma & Speer (1975)
1000 UI PMSG	5.4	5.6	King (1974)
400 UI gonadotropine, 200 UI HCG	4.8	13.6	Badev & Andreev (1974)
1100 UI PMS	7.7	13.6	Badev & Andreev (1974)
400 UI PMS + 200 HCG	7.9	15.9	Webster (1978)

* Significant 5%
** Significant 1%

4. Special management:

Treatment with hormones, often PMS, resulted in significant reduction in the weaning to oestrus interval (Table 14). What is not determined however, is the lasting effect of the treatment or its economic advantage. The important question which was not answered from these experiments is the effect of the treatment on the problem sows rather than on the normal ones which would return eventually within a normal interval.

Conclusion

The conclusion drawn from this review of literature is that in most of the studies reported, the causes of differences among sows in the weaning to oestrus interval were not fully understood. In very few studies, the main objective was only to study the problem as such, in most cases the interval was reported as additional results. As it presently stands, it seems that improving the weaning to oestrus interval could be made mainly thorugh improving the feeding and management of the sows. Care should also be taken in choosing the breeds, crosses among breeds, which are known to have shorter intervals. Eliminating the sows with long interval as early as possible, and their progeny if feasible, would greatly improve herd averages.

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