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THE EFFECTS OF FEED INTAKE LEVEL DURING THE LAST 7 DAYS OF LACTATION AND THE FIRST 3 DAYS FOLLOWING WEANING ON REPRODUCTION OF PRIMIPAROUS SOWS

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THE EFFECTS OF FEED INTAKE LEVEL DURING THE LAST SEVEN DAYS OF LACTATION AND THE FIRST THREE DAYS FOLLOWING WEANING ON REPRODUCTION OF PRIMIPAROUS SOWS

By

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ABSTRACT

THE EFFECTS OF FEED INTAKE LEVEL DURING THE LAST SEVEN DAYS OF LACTATION AND THE FIRST THREE DAYS FOLLOWING WEANING ON REPRODUCTION OF PRIMPAROUS SOWS

By

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The reproductive performance of the sow is affected by many factors including age, breed, environment, lactation length, nutrition, parity and season. For primiparous sows, decreasing feed intake from full feed to 2.2 kilograms per day in the final week of lactation did not affect the number of days from weaning to rebreeding, subsequent gestation length or litter size and only tended to decrease conception rate. Starving primiparous sows for three days after weaning, as opposed to feeding 2.2 kilograms per day, tended to increase the number of days from weaning to rebreeding and conception rate but did not affect gestation length or litter size.

Fatter sows at weaning tended to require fewer days to return to estrus than leaner sows. Sows weaned in the spring and summer required more days to return to estrus after weaning than sows weaned in the fall or winter.

Full feeding sows throughout lactation and feeding 2.2 kilograms per day after weaning appeared to result in optimum reproductive performance.

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INTRODUCTION

A major cause of economic loss in the swine industry is reproductive failure of the sow. Reproductive failure can occur at first estrus, during gestation, at parturition, during lactation and after weaning. Total reproductive capacity is influenced by a multitude of factors including diseases, nutrition, management, environment, breed and many others.

Sows failing to exhibit normal ovulatory estrus and failing to conceive following parturition and weaning represent a major proportion of the sows culled from herds (Rasbeck, 1969). Nutritional influences, during gestation and lactation, on the post-weaning to estrus interval have been studied by Elsley *et al*. (1969), Hardy *et al*. (1969), MacPherson *et al*. (1969), O'Grady *et al*. (1973), Baker *et al*. (1976). Studies by Maclean (1969), Brooks *et al*. (1972), Dyck (1972) ahd Brooks *et al*. (1975) have shown an effect of energy intake immediately following weaning on the weaning-to-breeding interval. Manipulation of energy intake during both lactation and the post-weaning interval to estrus should help elucidate the total management scheme resulting in improved reproductive performance of the sow.

REVIEW OF LITERATURE

NUTRITIONAL INFLUENCES ON ESTRUS

Inadequate nutrition delays sexual maturity in both males and females. Deficiency in energy intake alone results in delayed sexual maturity and irregularity or complete cessation of the estrous cycle due to ovarian inactivity (Sutton, 1941). Wiltbank *et al*. (1962, 1964) demonstrated that decreasing the energy intake of beef cows before and after parturition resulted in an increase in the interval from calving to first estrus. There were also more cows failing to return to estrus within 150 days of calving when energy intake was reduced to 50% of normal.

While delays in puberty and anestrus result from inadequate energy intake, excess energy prior to estrus in cycling gilts enhances reproductive activity. Corman and Zimmerman (1972) found an increase in the number of ova ovulated in gilts fed high energy levels for the entire period between two periods of estrus. Naber and Zimmerman (1972) demonstrated that the optimum time to increase energy intake is 16 to 18 days after the previous estrus (approximately three to five days prior to ovulation) to obtain the maximum number of ovulations in gilts.

The effects of various energy levels during gestation and lactation have a limited influence on reproductive performance following weaning. Lodge *et al*. (1966b) and Lodge (1969) observed significantly higher weight gains by sows during gestation coupled with greater weight loss in lactation for sows fed increased energy levels during pregnancy and lactation. There were no significant effects on weight change from weaning to first estrus or the length of the interval from weaning to breeding. Elsley et al. (1969) obtained similar results feeding sows high, medium or low energy levels in gestation and high or medium levels in lactation. No difference in the number of days from weaning to estrus was observed between treatments. These data support previous findings by Lodge et al. (1966a) that increasing the energy level fed to sows in pregnancy is not beneficial in enhancing return to estrus following weaning of the piglets. Elsley et al. (1968) did observe an increase in piglet weight at eight weeks of age with sows fed high energy levels in both gestation and lactation. Sows receiving equal energy intake throughout an entire reproductive cycle, however, had equal performance after three parities regardless of distribution of intake (i.e. high in gestation and low in lactation or low in gestation and high in lactation). When sows were underfed through three successive gestations and not allowed to gain weight from parturition to rebreeding, a significant amount of weight was lost compared to sows fed normally. By the fourth parity, sows on the reduced intake in gestation were described as very thin and a reduction in litter size and piglet birth weight was noted (Elsley and MacPherson, 1970). No other effects on sow reproductive performance were observed to this point. Elsley et al. (1968) noted a significant reduction in fat content of the carcasses of sows on a low energy intake for four successive gestation periods compared to sows on normal levels of intake. Although severe energy restriction through four parities appears to have little effect on reproductive performance, continuation of this depletion may result in decreased reproductive efficiency.

Manipulation of energy intake during lactation has resulted in conflicting reports. Lodge (1959) found no difference in reproductive performance of sows following weaning when fed on a high or low plane of nutrition in lactation. He did, however, measure a significant decrease in milk production (19% lower) in sows on reduced intake. As milk production decreased with decreased feed intake of sows, the percent of solids in the milk, including percent fat, tended to increase. This increase was not significant, except for percent protein, and lactose content tended to decrease. Piglet weights were not significantly different at any stage of the 8 week lactation for sows on the high or low lactation intake. O'Grady et al. (1973) reported similar results after feeding sows one of four energy levels during a 42 day lactation through three successive parities. Litter size, piglet growth during lactation and interval from weaning to conception were not affected by treatments. Sows were slaughtered after weaning the third litter and it was determined by dissection that those on the highest lactation energy level lost 20% of their body reserves of fat while those on the lowest level lost nearly 80%. Carrying the treatments through several more gestations may have resulted in a significant decrease in reproductive performance. deLange et al. (1980) determined that sows in a very thin condition in their third lactation produce less energy in their milk than sows in normal condition, but effects on reproductive performance were not recorded. Severe weight loss in lactation may be replenished with adequate nutrition in gestation as noted previously by Elsley et al. (1968). Hughes and Calder (1979) demonstrated, with a limited number of sows, a decrease in the interval from weaning to breeding with increased lactational feed intake. They also observed significant correlations between sow weight change, backfat thickness and subsequent reproductive performance. As the interval from weaning to remating increased, subsequent litter size also increased. Maclean (1968, 1969) reported that emaciated sows experienced a higher incidence of failure to return to estrus following weaning or an increase in the interval from weaning to first estrus, as compared to normal condition sows, regardless of the length of lactation. Up to 50% of the emaciated sows had a significantly greater number of days from weaning to estrus than normal sows. When the emaciated sows did show estrus and conceive when bred, subsequent litter size and piglet birth weights were normal. These sows failed to regain sufficient weight during gestation to be classified as being of normal body composition at the next farrowing. As high as 26% of all sows and 36% of first-litter gilts, from herds considered to be normal, were classified as nonfertile due to failure to recycle within 14 days following weaning. Maclean (1969) also observed that sows gaining less than 141 g per day from weaning to 30 days post-weaning were likely to be infertile (become anestrus or have a delayed return to estrus).

Hardy and Lodge (1969) found that the greater the weight loss in lactation, the fewer ovulations there would be at the first post-weaning esturs. Weight loss or gain between weaning and estrus, however, was not correlated with number of ovulations at first estrus. These reports indicate that full feeding sows in lactation should result in optimum reproductive performance and litter growth.

The practice of depriving sows of food and water for one day following weaning is felt by some to aid in the cessation of milk production. Several researchers have combined this practice with manipulation of feed intake during the final days of lactation to determine their effects on reproductive performance. Brooks and Cole (1973) demonstrated that reducing feed intake the final week of a 6 week lactation, with or without depriving food and water for one day following weaning, had no effect on the interval from weaning to estrus. Lactation treatment may have been negated, however, by a higher energy intake in early lactation by the "reduced" group to give the same total feed intake between the two treatments. Varley and Cole (1976) obtained similar results by feeding two or four kg per day during a 10 day lactation and after weaning. Further investigation is warranted in these areas as the results obtained may have been confounded by lactation length, total energy intake and condition of the sow at farrowing, weaning and breeding.

Attempts to identify a single management scheme following weaning resulting in optimum reproductive performance have reached varying conclusions. Sows showed no response to food and water restriction for 24 hours following weaning (King, 1974). This agrees with Brooks and Cole (1973). Maclean (1969), however, observed a reduction in the interval from weaning to remating when he withheld both feed and water for 24 hours following weaning. The herds utilized in this study were known to have abnormally long delays in return to postweaning estrus, confirmed by a lack of ovarian follicular activity at autopsy. Sows failing to rebreed normally were characterized by lower weight gains between weaning and remating than those cycling normally (64 g per day versus 141 g per day, respectively). These figures represent sows weaned after a three week lactation. Nearly identical results were obtained following an eight week lactation, with sows gaining 159 and 86 g per day for fertile and infertile groups, respectively. One can conclude from these results that the effect of postweaning treatments on reproductive performance is highly dependent upon the condition of the sow at weaning.

High levels of feed intake immediately following weaning have had varied effects on subsequent reproductive performance. Brooks and Cole (1972) obtained a beneficial effect on reproductive performance by increased feed intake following weaning. Feeding 2.7 and 3.6 kg per day resulted in a shortened interval from weaning to remating, a higher conception rate and fewer anestrous sows than feeding 1.8 kg per day. Cooper et al. (1975) observed no effect of feeding 1.8 kg or 3.6 kg of feed per day from weaning to breeding on the length of that interval as did Dyck (1972), feeding 2.25 versus 3.75 kg per day. These findings are similar to those of Fahmy and Dufour (1976) who showed no advantage to flushing sows with full feed from one day after weaning to rebreeding versus feeding 2.7 kg per day on the length of this interval. Conception rate of the high intake group was 10% below that of the low intake group in the trial by Cooper et al. (1975). This negative effect of increased intake is supported by Dyck, who reported in 1974 that first litter gilts fed 3.6 kg per day from weaning to remating had fewer fetuses than gilts fed 1.8 kg per day when bred on the first estrus following weaning. Myers and Speer (1973) observed no advantage in conception rate or number of pigs farrowed by doubling intake to sows for one day immediately following mating, but did improve performance with the addition of 1.0 g chlortetracycline daily to the diet from weaning to 15 days postmating. The contradictions in the above trials clearly show that the wide variation in response may be influenced by many other factors, some of which will be outlined below.

The effects of a protein deficient diet (below 12% crude protein) fed during gestation are limited when considering reproductive performance of the sow and piglet growth rate in lactation (Lodge et al., 1966a; Holden et al., 1968, MacPherson et al., 1969, Mahan and Mangan, 1975 and Mahan, 1979). Feeding the lactating sow a diet below 14% crude protein may result in lower piglet weaning weights compared to sows fed 14% or 16% crude protein (Baker and Jensen, 1976). Feeding a 9% crude protein diet in gestation and a 12% crude protein diet in lactation resulted in fewer piglets born in the next farrowing (Mahan, 1979). Svajgr et al. (1972) reported that a diet containing two percent crude protein fed in gestation and five percent crude protein fed in lactation resulted in an increase in the interval from weaning to estrus and a decrease in the number of embryos present 28 days postmating for first litter gilts. This diet sequence was compared to feeding diets containing 17% crude protein in both gestation and lactation. These results indicate that a diet containing 13% crude protein fed in gestation at 1.82 kg per day and a diet of 16% crude protein fed ad libitum in lactation will allow optimum performance of sows to be realized.

PARITY: FIRST LACTATION VERSUS SUBSEQUENT LACTATIONS

The work by MacPherson (1969) and by Baker and Jensen (1976) indicates that the sow is more susceptible to adverse handling during the first parity than subsequent parities. This is supported by data from Aumaitre et al. (1976) who found the interval from weaning to first estrus to be greatest for sows following their first and second lactations and decreasing thereafter. Lodge et al. (1966a) indicated that the number of pigs born increases with successive parities. Large White sows were reported to have a higher incidence of infertility following weaning of their first litter than Landrace or Saddleback sows (Maclean, 1969). No difference between breeds was observed after subsequent litters. Michel et al. (1980) demonstrated that feeding gilts every third day in gestation instead of every day resulted in fewer piglets born at farrowing. This effect was not observed in sows farrowing their second or subsequent litters. Gilts which become infertile following weaning after a three week lactation, were characterized as having gained less weight in gestation, farrowed smaller litters, lost more weight during lactation and gained less weight following weaning (73 g versus 327 g per day) than gilts rebreeding and conceiving normally following weaning (Maclean, 1969). For first litter gilts weaned at eight weeks postpartum, those which were infertile (failed to return to estrus or failed to conceive following breeding) had gained less weight during gestation and also lost more weight in lactation than fertile gilts. No record was kept of weight change following weaning or subsequent litter size.

O'Grady et al. (1973), however, showed that decreasing energy intake in lacation decreased milk yield (as measured by piglet gain to 21 days) in the second and third lactation but not in the first lactation. There was also a significant decrease in the number of piglets born at the second parturition to sows receiving high energy intake during the first lactation as compared to sows receiving a low energy intake in the first lactation. Thompson et al. (1975) reported that gilts farrowing their first litter from 319 days of age to 471 days of age had equal performance across all ages. The total number of piglets born, number born alive and number weaned were not different. The average length of the interval from one farrowing to the next was not different between age groups and the number of pigs born per sow per year were equal, as was the culling rate. The number of piglets born increased with subsequent farrowings across all age groups also. It is evident that the reproductive efficiency of gilts improves with subsequent farrowings, as manifested by increased litter size and shorter intervals from weaning to remating.

GENETIC BACKGROUND OF THE SOW

The genetic background of the sow has an influence on reproductive performance. Burger (1952) reported that Large White sows returned to estrus sooner following weaning than Large Black sows (7.9 versus 16.1 days respectively). Dyck (1971, 1972) found that significantly fewer days are required for Yorkshire sows to return to estrus after weaning than Lacombe sows. Fahmy et al. (1979) reported that crossbred sows involving eight breeds differed in reproductive performance depending on their genetic background. Sows sired by Yorkshire and Large Black boars had a shorter interval from weaning to remating than sows of Duroc ancestry. Crossbred gilts (Large White X Landrace and the reciprocal) are characterized by fewer days from weaning to estrus than either purebred Large White or Landrace gilts. As stated earlier, Maclean (1969) found that Large White gilts had a higher incidence of infertility following weaning of the first litter than Landrace or Saddleback sows. This difference was not apparent after weaning subsequent litters. Inbreeding also delays the onset of first estrus in prepuberal gilts by several weeks (Warnick, 1951). Difference in the genetic effect on reproductive performance has been well documented both across and within breeds, therefore, one must be very careful when extrapolating data from a small subpopulation to fit an entire population.

LITTER SIZE AND LENGTH OF THE SUCKLING PERIOD

A limited amount of information is available concerning the effects of litter size at weaning on the sow's reproductive performance. Burger (1952) found no effect of litter size at weaning or lactation length on the length of the period from weaning to remating in Large Black sows. Dyck (1972) also reported that litter weaning weight does not effect the interval from weaning to rebreeding. Many workers have reported that as lactation length increases, the interval from weaning to estrus decreases (Self and Grummer, 1958; Maclean, 1969; Kurg et al., 1974; Svajgr et al., 1974; Krug et al., 1975 and Allrich et al., 1979). Other reproductive parameters are also affected by lactation length. Conception rate of the mating on the first postweaning estrus increases as lactation length increases (Svajgr et al., 1974 and Krug et al., 1974). The number of sows failing to cycle following weaning due to cystic ovaries decreased as lactation length increased (Svajgr et al., 1974). The number of embryos alive 28 days after breeding increased linearly as the previous lactation length increased (Svajgr et al., 1974). This information agreed with that of Krug et al. (1975), who reported a significant linear increase in the total number of pigs born and number of pigs born alive as the previous lactation length increased. Sows were mated on the first estrus following weaning. Cole et al. (1975) found that sows weaned after a lactation of four to 21 days in length had 3.1 fewer pigs at the following farrowing than sows weaned after a lactation of 21 to 42 days in duration. Aumaitre et al. (1976) estimated the optimum age to wean piglets for maximum reproductive performance of the sow to be between 21 and 35 days (data from over 142,000 litters in France). These data agree with those of Speer (1974) who compiled data on 982 sows. Lactation lengths greater than 20 days and less than 45 days resulted in optimum performance of the sow.

SEASON OF THE YEAR WHEN WEANED

Horses, sheep and goats are well known to normally exhibit sexual activity during particular seasons of the year (Hafez, 1974). Cattle and swine are less pronounced in their seasonal influence of reproductive phenomena. Aumaitre *et al*. (1976) have determined, from over 142,000 farrowings in France, that the length of the interval from weaning to breeding is significantly greater for sows weaned from July to September than when weaned at any other time of the year (26 to 30 days versus 15 to 20 days, respectively). This difference of 10 days decreases after the second parity.

MANAGEMENT OF THE SOW FOLLOWING WEANING

Maclean (1969) reported that sows placed in individual stalls and fed individually following weaning had a shorter return time to breeding than sows group housed and individually fed from weaning to breeding (9.0 versus 11.5 days respectively). This observation, however, may have been confounded by breed differences. This did agree, however, with data compiled by Krivec and Bohm (1964) who reported 58% of sows penned in groups of up to eight were served within 12 days of weaning, whereas 84% of individually penned sows were served during the same period of time. Space allotment of the grouped sows may be an important factor. Moody and Speer (1971) reported no difference in farrowing rate between sows individually stalled after weaning and sows group-penned in large outside lots. Environment may also be a factor in these studies.

ESTRUS DURING LACTATION

It is well known that sows exhibit a nonfertile estrus within a few days of parturition (Burger, 1952). Shearer *et al*. (1972) attributed the rise in circulating estrogen at the time of this estrus to be from a source other than the ovaries. This observation is supported by Crighton and Lamming (1969) who demonstrated that follicular growth and uterine development are suppressed during lactation. Burger (1952) also observed that five percent of lactating sows exhibited estrus from 18 to 27 days following the nonovulatory, postpartum estrus. Sows were not mated but were checked daily for estus and three of the four continued to exhibit estrus at approximate 21 day intervals until mated on the first estrus following weaning at 56 days postpartum. The one sow which failed to cycle a third time in lactation was in heat four days after weaning. Rowlinson et al. (1975) found that by grouping from two to eight sows and litters three weeks after farrowing and introducing a boar 24 hours after grouping (left in continuously thereafter) 100% of 180 sows showed estrus during lactation. When bred during this lactational estrus, 85% of the sows conceived. This falls in the range of normal conception rates for sows bred after weaning (Holtmann et al., 1975; Johnson and Omtvedt, 1975 and Drewry, 1980). Petherick et al. (1977) found 77.5% of grouped lactating sows in estrus before weaning. Petchey et al. (1978) determined that 28 day weights and 42 day weaning weights were significantly lower for piglets of grouped sows and litters compared to nongrouped controls. Litter size at the subsequent farrowing was also reduced for sows grouped during lactation compared to nongrouped sows. A mature boar was not present in the grouped pens in this study and only three of 156 sows displayed lactational estrus. When a boar was given fence-line contact with grouped sows, results similar to those of Petherick et al. (1977) were obtained (49% of grouped sows exhibited lactational estrus, Petchey and Jolly, 1979). Sows nursing small litters and sows farrowing from September to December displayed a higher incidence of lactational estrus than those nursing large litters or farrowing from January through August (Petchey and Jolly, 1979). A considerable amount of evidence has been accumulated to demonstrate that treatment of lactating sows with gonadotrophins will result in fertile estrus prior to weaning (Cole and Hughes, 1946; Heitman and Cole, 1956; Epstein and Kadman, 1969; Crighton, 1970; Guthrie et al., 1978; Hausler et al., 1980).

ESTRUS IN THE SOW FOLLOWING WEANING

Many factors influence the length of the interval from weaning to first estrus in the sow. Burger (1952) reported that this interval was usually eight to 16 days. Dyck (1971) observed that on the average, estrus occurred from 5.5 to 14.3 days following weaning. Aumaitre et al. (1976), however, stated that the average number of days from weaning to remating was 22.4 days. The reports by Burger and Dyck above were from highly controlled and well observed groups of sows while Aumaitre's information represented a large number of commercial herds utilizing varying management practices throughout France over a period of several years. Although this information may be less accurate or reliable, the conditions under which it was collected may better represent those of the commercial swine industry. Some sows may have been bred on the second estrus instead of the first postweaning estrus in the data collected by Aumaitre et al. (1976).

MATERIALS AND METHODS

Eighty-four primiparous Duroc, Yorkshire and crossbred (Duroc, Hampshire, Landrace and Yorkshire) sows were allotted to treatments of a 2 x 2 factorial experiment as follows:

Preweaning treatment: Full feed to weaning or 2.2 kg per day.

Postweaning treatment: 2.2 kg per sow per day or no feed.

Preweaning treatment was begun seven days prior to weaning. Postweaning treatment began the day of weaning and lasted three successive days. Water was available at all times ad libitum. Farrowing occurred from November 1978 to April 1980 during all months of the year except February, May, and December.

During gestation, gilts received 2.2 kg per day of a 13.5% crude protein, corn-soybean meal diet fortified with vitamins and minerals (Table 1). Gilts were dewormed 30 days prior to farrowing with dichlorvos (Atguard[1]).

The lactation diet was a 15.6% crude protein, corn-soybean diet fortified with vitamins and minerals (Table 1). Approximately 108 days after breeding, first litter gilts were washed, treated for mange and placed into individual farrowing crates. The farrowing room contained 32 farrowing crates with either total or partially slotted flooring over a deep pit. Room temperature was maintained at

[1]Shell Chemical Company - Division of Shell Oil Company Animal Health Houston, Texas 77001

22^{o} C during the cold months and supplemental heat was provided the piglets in a creep area. Heat mats and 250 watt heat lamp bulbs were utilized to provide supplemental heat for the piglets. Creep feed was made available to piglets at 10 days of age. The south wall of the farrowing room contained large windows which permitted natural lighting. Supplemental lighting was utilized from 0800 to 1700 hours to supplement light emitted by the heat lamp bulbs.

Feed was withheld from sows the day of farrowing and increased gradually thereafter from 2.2 kg per sow per day to full feed within a week. Sows were weighed within 24 hours after farrowing and piglets were weighed, identified, and needle teeth and tails were clipped. An injection of 200 mg of iron as iron dextran[2] was given intramuscularly to all piglets three days after birth. Male pigs were castrated at 21 days of age and weights of all piglets were recorded at this time.

In mid-lactation, first litter gilts were randomly allotted, according to breed and number of pigs nursing, to one of the treatment combinations described above. Average lactation length was 31 days. Sows were weighed and treatments started seven days prior to weaning. Sows were again weighed at weaning and average backfat depth was determined with a steel probe. Measurements were taken at the first rib, last rib and last lumbar vertebra, five centimeters from the midline, over the longissimus dorsi muscle. At weaning, sows were moved to individual stalls of the breeding-gestation building. This barn was a totally enclosed, environmentally regulated facility with partial slats at the rear of the stall floor. Lighting was provided by

[2] Armidexan[R] - 100 mg/cc Iron dextran; Chromalloy, Animal Health Division, Omaha, Nebraska 68103

fluorescent bulbs from 0700 to 1700 hours daily. Supplemental heat was provided in cold weather to maintain room temperature at 18^{o} C. Three days after weaning, sows were reweighed and checked daily for estrus. Boars of known high libido, housed in the same room, were utilized to detect estrus and mating occurred as soon as the sow would permit. A second mating occurred 24 hours later. The number of days from weaning to mating were recorded.

Sows were individually stalled and fed until the next farrowing. Open sows were returned to breeding pens. Beginning on the fourth day following weaning, all sows received 2.2 kg of the gestation diet until farrowing. Length of gestation and subsequent litter size at parturition were recorded.

Data were compared by analysis of variance for least square differences of means.

Table 1. Sow Diets

Ingredient	Int. ref. no.	Gestation	Lactation
Ground shelled corn	4-02-935	82.42	78.30
Soybean meal (49%)	5-04-612	12.50	17.50
Calcium carbonate		1.30	1.10
Dicalcium phosphate		2.00	1.50
MSU VTM premix		0.60	0.50
Salt		0.50	0.50
Vit E-Se premix		0.50	0.50
50% Choline chloride		0.18	-
Aureo -10		-	0.10[a]

[a]Supplies 20 grams per ton of chlortetracycline.

Table 2. Calculated Analysis of Sow Diets

	Gestation	Lactation
Metab. Energy (kcal/kg)	3180	3213
% Crude Protein	13.50	15.60
% Lysine	0.58	0.72
% Calcium	0.78	0.74
% Phosphorus	0.70	0.62

RESULTS AND DISCUSSION

ANESTROUS SOWS

Of the 84 primiparous sows nine, (10.7%) failed to show estrus within 21 days of weaning and were termed anestrous. The distribution of anestrous sows was not different across treatment groups (Table 3). This value for anestrous sows falls within the normally expected range of from seven percent to 36% (Maclean, 1969; Dyck, 1971; King, 1974 and Fahmy *et al.*, 1979).

Table 3. Distribution of Anestrous Sows Across Treatment Combinations

		Preweaning treatment		
		Full feed	2.2 kg per day	Total
Postweaning treatment	2.2 kg per day	2	3	5
	No feed	2	2	4
	Total	4	5	

INTERVAL FROM WEANING TO REMATING

Reducing feed intake from full feed (5.5 kg/day) to 2.2 kg per day for the last seven days of lactation did not affect the number of days from weaning to first estrus for the remaining 75 sows (Table 4). The mean number of days for the full fed sows was 6.22 and for the sows fed 2.2 kg per day was 6.24 days. Likewise, withholding feed for 3 days following weaning had no effect on the interval from weaning to remating when compared to feeding 2.2 kg daily (Table 5). The mean number of days from weaning to remating was 5.76 for sows fed 2.2 kg per day after weaning and 6.69 days for sows not fed for three days immediately after weaning. Although the effect of post-weaning feed intake level was not significant on the rebreeding interval, there was a trend for sows fed 2.2 kg per day to have a shorter interval than sows not fed for three days (P<.20). No interaction between preweaning feed level and postweaning feed level was observed.

Table 4. Main Treatment Effects on the Number of Days from Weaning to First Estrus.

	Number of observations	Days
Preweaning treatment		
Full feed	40	6.22 ± 0.12
2.2 kg per day	35	6.24 ± 0.12
Postweaning treatment		
2.2 kg per day	39	5.76 ± 0.12
no feed	36	6.69 ± 0.12

Numbersindicate mean ± standard error.

These interval lengths from weaning to estrus are much shorter than the average reproted by Aumaitre *et al*. (1976) on a large population (22.4 days). Others, however, have reported similar interval lengths for small populations of sows (Self and Grummer, 1958; Lodge, 1969; Dyck, 1972; Brooks and Cole, 1973; King *et al.*, 1974; Svajgr *et al.*, 1974; Varley and Cole, 1976 and Fahmey, 1979). The trend observed for the interval length to increase when feed is withheld is in partial agreement with the findings of Brooks and Cole (1972) who reported a decrease in the interval from weaning to remating as the daily postweaning feed intake was increased from 1.8 kg to 3.6 kg per sow per day until mating. There was a low negative correlation between the length of the interval from weaning to remating and backfat depth at weaning (- 0.25). This observation, that the number of days from weaning to remating increases as sows get thinner, is supported by Maclean (1968, 1969) who found that emaciated sows had poorer reproductive performance than sows in normal flesh. The weaning to remating interval also was somewhat correlated with the month weaned (r = - 0.18). This effect of season will be discussed further after treatment effects.

CONCEPTION RATE

Reducing feed intake from full feed to 2.2 kg per day for the last seven days of lactation did not effect the conception rate of the 75 sows mated on the first estrus after weaning. The conception rates for the full fed sows and sows reduced to 2.2 kg intake per day were 82.1% and 71.6%, respectively. Withholding feed for the first 3 days after weaning did not produce conception rates different from sows fed 2.2 kg daily (72.2% and 81.4%, respectively, for the two treatments). There was no interaction between preweaning and postweaning treatment. Brooks and Cole (1973), Myers and Speer (1973), Cooper *et al.* (1975) and Varley and Cole (1976) also reported that increasing or decreasing the sow's feed intake just prior to and after weaning did not affect conception rates when sows were bred on the first postweaning estrus.

A low negative correlation was observed between conception rate and the length of the interval from weaning to estrus (r = - 0.23). This trend for conception rate to increase as the weaning to estrus interval decreases is not supported by the literature. Cooper et al. (1975), Fahmy and Dufour (1976) and Drewry (1980) found no correlation between conception rate and the number of days from weaning to remating.

Table 5. Main Treatment Effects on Conception Rate of Sows Bred on the First Estrus Following Weaning.

	Number of observations	Conception rate
Preweaning treatment		
Full feed	40	82.1% ± 11.2
2.2 kg per day	35	71.6% ± 11.2
Postweaning treatment		
2.2 kg per day	39	81.4% ± 11.6
No feed	36	72.2% ± 11.6

Numbers indicate means ± standard errors.

LITTER SIZE

The total number of pigs born in the next farrowing was not affected by decreasing feed intake to 2.2 kg per day the final week of lactation compared to full feeding to weaning. The mean number of pigs born to sows full fed to weaning was 10.1 and for sows on reduced intake was 9.2. Although nonsignificant, a trend was observed whereby decreasing the sow's feed intake the final week of lactation also decreased the subsequent litter size when sows were bred on the first post-weaning estrus ($P<.23$). This trend is supported by O'Grady et al. (1973) who reported that increased dietary intake level in lactation resulted in more pigs born in the next litter.

There was no difference in the number of pigs born in the subsequent farrowing between sows fed 2.2 kg per day after weaning and sows not fed for three days immediately after weaning. The average number of piglets born for the fed and starved sows were 10.0 and 9.4 respectively. There was no interaction between preweaning and postweaning feed intake levels. No significant correlations were observed between the number of pigs born in the next farrowing and any of the parameters measured.

The number of pigs nursing the sows at weaning of the first litter had no affect on reproductive performance. Sows were grouped into those nursing from one to four, five to seven and eight to twelve pigs at weaning. The average number of pigs weaned in the first litter was 6.1 and the range was from one to eleven.

Table 6. Main Treatments Effects on the Number of Pigs Born in the Next Farrowing

	Number of observations	Number of pigs
Preweaning treatment		
Full feed	32	10.1 ± 0.13
2.2 kg per day	24	9.2 ± 0.13
Postweaning treatment		
2.2 kg per day	32	10.0 ± 0.13
No feed	24	9.4 ± 0.13

LACTATION LENGTH

Mean lactation lengths were not different for the different treatments imposed, either before or after weaning. No significant correlations were observed between lactation length and any of the reproductive parameters measured. There was a trend for sows to lose more weight between farrowing and weaning and in the first three days after weaning as lactation length increased. Lactation length ranged from 19 to 47 days with an overall mean of 31 days. Burger (1952), Speer (1974), Cole et al. (1975) and Aumaitre et al. (1976) all reported that lactation lengths greater than 21 days and less than 45 days result in optimum performance of the sow. These and other workers have shown that shorter and longer lactation lengths (21 and 45 days respectively) result in an increase in the number of days from weaning to estrus. The correlation of lactation length with the weaning to breeding interval was very low in this study ($r = -0.10$).

Table 7. Main Treatment Effects on Mean Lactation Length

	Number of observations	Mean lactation length (days)
Preweaning treatment		
Full feed	44	30.2 ± 0.11
2.2 kg per day	40	31.9 ± 0.11
Postweaning treatment		
2.2 kg per day	44	30.3 ± 0.11
No feed	40	31.8 ± 0.11

Numbers indicate mean ± standard error.

Table 8. Mean Age at Farrowing of Sows for Main Treatment Effects

	Number of observations	Age at farrowing (days)
Preweaning treatment		
Full feed	44	397.6 ± 7.29
2.2 kg per day	40	395.8 ± 7.24
Postweaning treatment		
2.2 kg per day	44	396.2 ± 7.02
No feed	40	399.4 ± 7.72

Numbers indicate mean ± standard error.

Table 9. Main Treatment Effects on Average Backfat Depth at Weaning

	Number of observations	Average backfat depth (cm)
Preweaning treatment		
Full feed	44	2.50 ± 0.11
2.2 kg per day	39	2.29 ± 0.11
Postweaning treatment		
2.2 kg per day	43	2.34 ± 0.11
No feed	40	2.45 ± 0.11

Numbers indicate mean ± standard error.

AGE AT FARROWING

The age of the gilts at farrowing was moderately correlated with weight at farrowing (0.38), weight one week before weaning (0.40), weight at weaning (0.36), weight three days after weaning (0.30) and the change in weight in the first three days after weaning (0.34). No other significant correlations were observed with age at farrowing. The gilts ranged from 349 to 567 days of age with an overall mean of 398 days. These findings of no age effect agree with those of Thompson et al. (1975). The correlation between age at farrowing and the number of days from weaning to remating was not significant at - 0.06.

BACKFAT DEPTH

Heavier sows tended to have a greater average backfat depth at weaning than lighter sows. The correlations between backfat at weaning and weight after farrowing, weight one week before weaning, weight at weaning and weight three days after weaning were 0.23, 0.51, 0.50 and 0.44, respectively. Sows that lost more weight in lactation tended to be leaner at weaning. Correlations between backfat depth and weight loss in lactation and backfat depth and weight loss in the last week of lactation were -0.26 and - 0.22 respectively. Fatter sows at weaning tended to lose more weight the first three days after weaning than thin sows. The correlations between backfat depth at weaning and weight loss after weaning was 0.25. Fatter sows also tended to have fewer days from weaning to first estrus than thin sows. The correlation between these two parameters was - 0.25. Fatter sows also tended to have longer gestation lengths (r = 0.33).

Decreasing feed intake from full feed to 2.2 kg per day the last

Table 10. Main Effects of Treatments Prior to Weaning on Weights and Weight Changes From Farrowing to 3 Days After Weaning

Parameter	Full feed	2.2 kg per day
Weight at farrowing	192.52 ± 2.60(35)	196.68 ± 2.60(34)
Weight 7 days before weaning	186.05 ± 2.24(35)	190.02 ± 2.24(40)
Weight at weaning	182.68 ± 2.21(44)	179.11 ± 2.21(40)
Weight 3 days after weaning	173.02 ± 2.03(43)	172.77 ± 2.03(39)
Weight change in lactation	-9.84^{a} ± 1.69(35)	-17.56^{b} ± 1.69(34)
Weight change the last week of lactation	-3.37^{c} ± 0.70(35)	-10.91^{d} ± 0.70(40)
Weight change the first 3 days after weaning	-9.66^{e} ± 0.79(43)	-6.34^{f} ± 0.79(39)

Numbers represent mean ± standard error.
Number in brackets represents number of observations.
Numbers within rows with different subscripts are significantly different.
a vs b = ($P < .03$)
c vs d = ($P < .0005$)
e vs f = ($P < .02$)

week of lactation did not significantly affect backfat depth at weaning. Average backfat depth was not different for feed-restricted sows (after weaning) and sows fed 2.2 kg per day. No sows were considered to be abnormally thin at the end of lactation and no effects were expected on condition of the sow and her reproductive performance.

SOW WEIGHT CHANGES BEFORE AND AFTER WEANING

As expected, treatments significantly affected weight changes in lactation and in the first three days after weaning. Weight loss between farrowing and weaning was much greater ($P<.03$) for sows fed 2.2 kg per day the last week of weaning than sows full fed to weaning. The weight loss in the last seven days of lactation was also significantly greater ($P<.0005$) for sows on reduced intake in that period than sows full fed. Sows fed 2.2 kg per day the last seven days of lactation also lost more weight in the first three days after weaning than sows full fed to weaning ($P<.02$). Farrowing weights, weights one week before weaning, weaning weights and weights three days after weaning were not different for the different treatment groups. Sows heavier at farrowing tended to lose more weight in lactation ($r = 0.43$).

Sows starved for three days after weaning lost more weight ($P<.0005$) in that period than sows fed 2.2 kg per day. No interactions between preweaning and postweaning feed intake levels were evident for any of the weight changes discussed. Weight changes before and after weaning were not significantly correlated with any of the reproductive parameters measured. Fatter sows at weaning tended to lose more weight in the three day period immediately after weaning ($r = 0.25$). Older sows also tended to lose more weight in the three day period after

Table 11. Main Effects of Treatments After Weaning on Weights and Weight Changes From Farrowing to 3 Days After Weaning.

Parameter	Postweaning treatment: 2.2 kg per day	Postweaning treatment: No feed
Weight at farrowing	194.95 ± 2.60(36)	194.25 ± 2.60(33)
Weight 7 days before weaning	186.03 ± 2.24(38)	190.05 ± 2.24(37)
Weight at weaning	177.72 ± 2.21(44)	184.08 ± 2.21(40)
Weight 3 days after weaning[1]	174.34 ± 2.03(42)	171.45 ± 2.07(40)
Weight change in lactation	-17.23^{a} ± 1.69(36)	-10.17^{b} ± 1.69(33)
Weight change the last week of lactation	-8.31^{c} ± 0.70(38)	-5.97^{d} ± 0.70(37)
Weight change the first 3 days after weaning	-3.38^{e} ± 0.79(42)	-12.62^{f} ± 0.79(40)

Numbers represent mean ± standard error.
Number in brackets represents number of observations.
Numbers within rows with different subscripts are significantly different.
a vs b = ($P<.05$)
c vs d = ($P<.06$)
e vs f = ($P<.0005$)

[1]There was a significant interaction ($P<.064$) between treatment before and after weaning on weight 3 days after weaning (Table 12).

weaning than younger sows (r = 0.34). Sows losing less weight during lactation tended to be fatter at weaning (r = -0.25).

BREEDS

No effect of breed was observed on any of the parameters measured. and there was no interaction between these parameters and breeds. These results conflict with reports by Burger (1952), Maclean (1969), Dyck (1971, 1972) and Fahmy et al. (1979). However, the low number of Duroc and Yorkshire sows compared to crossbred sows and allotment across treatment groups prevented a breed effect from being measured.

Table 12. Interaction of Main Treatments on Sow Weight 3 Days After Weaning[1].

		Preweaning treatment		
		Full Feed	2.2 kg per day	Mean
Postweaning treatment	2.2 kg per day	178.5 ± 3.52	170.9 ± 4.25	174.3
	No feed	169.3 ± 4.23	171.9 ± 4.00	171.5
	Mean	173.0	172.8	

[1]Interaction between preweaning and postweaning treatments was significant at P<.064.

SEASON AT WEANING

The season of the year when sows were weaned had a significant effect on their reproductive performance. The length of the interval from weaning to remating was lower (P<.035) for sows weaned in the fall and winter months than for sows weaned in the spring or summer. There was a significant interaction (P<.03) between the level of

Table 13. Breed Distribution Across Treatment Groups

	Breed distribution		
Preweaning treatment	Crossbred	Duroc	Yorkshire
Full feed	33	6	5
2.2 kg per day	31	5	4
Postweaning treatment			
2.2 kg per day	34	4	6
No feed	30	7	3

Table 14. Main Effects of Season of the Year at Weaning on Reproductive Performance of Sows

	Season of the year at weaning			
Parameter	Spring	Summer	Fall	Winter
Number of days from weaning to first estrus	7.4^{a}(22)	7.12^{a}(13)	5.2^{b}(14)	5.3^{b}(26)
Conception rate of breeding at first estrus after weaning (%)	72.7^{c}(22)	71.5^{c}(13)	92.9^{d}(14)	72.0^{c}(26)
Number of pigs farrowed in the subsequent litter	10.5 (14)	8.9 (11)	10.2 (13)	9.6 (18)

Number in brackets represents number of observations.
Numbers within rows with different subscripts are significantly different.

[1]Seasons indicated include sows weaned during the following months:

- Spring - April, May
- Summer - July, September
- Fall - October, November
- Winter - December, February

dietary intake during the last week of lactation and the season of the year at weaning. When dietary intake was reduced from full feed to 2.2 kg per day for the last seven days of lactation in the spring, the interval from weaning to estrus decreased in length. However, when the level of dietary intake was decreased for the final week of lactation in the summer months, the length of the interval from weaning to estrus increased. These trends may be due to a higher variation in the interval from weaning to estrus for the full fed sows in the spring and for the sows reduced in feed intake in the summer. The overall effect of season on the length of the weaning to remating period agrees with findings by Aumaitre _et al_. (1976). The season of the year at weaning did not affect conception rate or the subsequent litter size and there was no interaction of these parameters and dietary treatments with seasons.

CONCLUSIONS

1. Decreasing dietary intake from full feed to 2.2 kg per day for the final week of a 31 day lactation in primiparous sows did not affect the sow's weaning to remating interval length, conception rate, gestation length, subsequent litter size or the number of sows anestrus after weaning.

2. Withholding feed for the first 3 days after weaning did not affect the length of the interval from weaning to remating, conception rate, gestation length, subsequent litter size or number of sows anestrus after weaning the first litter compared to feeding 2.2 kg per day.

3. Sows in good condition (more backfat) tend to have a shorter interval from weaning to remating than very thin sows.

4. Contrary to other reports, as the length of the interval from weaning to remating decreased, conception rate tended to increase.

5. As lactation length increased, sows tended to lose more weight during lactation and in the first 3 days following weaning.

6. As the age of gilts increased at farrowing, weight after farrowing, weight 7 days before weaning, weight at weaning and weight 3 days after weaning increased.

7. The following parameters tended to be associated with sows having the greatest backfat depth at weaning: sows weighed more throughout lactation and after weaning, lost less weight in lactation, lost more weight after weaning and had a shorter interval from weaning to estrus.

8. Decreasing feed intake from full feed to 2.2 kg per day in the last week before weaning did not affect backfat depth at weaning.

9. Decreasing feed intake from full feed to 2.2 kg per day in the last week of lactation resulted in a greater weight loss in lactation and in the first 3 days after weaning than maintaining sows on full feed to weaning.

10. Sows starved for 3 days immediately after weaning lost more weight than sows fed 2.2 kg per day in this period.

11. Sows weighing more after farrowing tended to lose more weight during lactation than lighter weight sows.

12. Older sows tended to lose more weight in the 3 day period after weaning than younger sows.

13. Yorkshire, Duroc and crossbred sows had equal reproductive performance and weight changes in lactation and after weaning.

14. Sows weaned in spring and summer months required more days to return to estrus after weaning than sows weaned in the fall and winter.

15. Reducing feed intake from full feed to 2.2 kg per day in the final week of lactation resulted in a shorter interval from weaning to remating for sows weaned in the spring but a longer interval for sows weaned in the summer.

16. Season of the year at weaning did not affect any parameters measured except the number of days from weaning to remating.

17. The number of pigs weaned in the first litter did not affect any of the reproductive parameters measured.

Table 16. CORRELATIONS

	Treatment	Breed	Age at farrowing	Mo. farrowing	Wt. at farrowing	Wt. preweaning	Mo. wean	Wt. at wean	Back fat	Wt. post-weaning	Mo. bred	No. pigs	Conception	Lact. wt. ch.	Post-weaning wt. ch.	Pre-weaning wt. ch.	Lact. length	Interval wean to bred
Breed	.03	1.00																
Age at farrowing	.07	.30	1.00															
Month farrowed	.04	-.24	-.04	1.00														
Wt. at farrowing	-.17	.14	.38	-.29	1.00													
Wt. 1 week preweaning	-.10	.20	.40	-.28	.85	1.00												
Month weaned	.05	-.27	-.06	.99	-.29	-.29	1.00											
Wt. at weaning	.09	.22	.36	-.22	.77	.95	-.22	1.00										
Backfat at weaning	.21	.10	.16	.10	.23	.51	.09	.50	1.00									
Wt. 3 days after weaning	.02	.20	.30	-.28	.82	.93	-.29	.94	.44	1.00								
Month bred	.07	-.27	.07	.78	-.12	-.13	.75	-.09	.08	-.15	1.00							
No pigs born	.10	-.12	-.04	.15	-.09	-.02	.14	.00	-.13	.00	.16	1.00						
Conception rate	.12	-.14	-.02	.02	-.02	.00	.01	-.02	.16	.01	.02	.00	1.00					
Lactation wt. change	-.29	-.15	.05	-.09	.43	-.06	-.08	-.24	-.27	-.09	-.02	.00	.04	1.00				
Post-wean wt. change	.20	.16	.34	.06	.10	.28	.06	.40	.25	.06	.11	.01	-.11	-.47	1.00			
Prewean wt. change	-.54	-.17	.07	-.26	.30	.13	-.27	-.17	-.22	-.01	-.18	-.13	.00	.60	-.36	1.00		
Lactation length	-.11	-.24	-.15	.04	-.08	-.19	.10	-.18	.02	-.19	-.04	.06	-.05	.15	-.08	.00	1.00	
Days from wean to bred	-.04	-.06	-.06	-.19	.13	.01	-.18	.08	-.25	.07	-.16	-.09	-.23	.02	.04	.13	-.10	1.00
Gestation length	.04	.09	.16	.31	-.19	-.06	.29	.06	.33	.09	-.26	-.25	.00	-.25	-.07	-.25	-.18	-.25

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APPENDIX

Table 16. Analysis of Variance for Main Effects of Treatments on Backfat Depth at Weaning and Reproductive Performance.

	Mean square	
	Treatments	Experimental error
Length of lactation	40.215 (3)	36.191 (80)
Backfat depth at weaning	0.062 (3)	0.053 (79)
Number of days from weaning to estrus	6.507 (3)	9.459 (71)
Conception rate	0.129 (3)	0.180 (71)
Gestation length	0.916 (3)	1.520 (49)
Number of pigs born in the next litter	9.525 (3)	7.736 (52)

Number in brackets represents degrees of freedom.

Table 17. Analysis of Variance for Main Effects of Treatments on Weights at Farrowing, 1 Week Prior to Weaning, at Weaning and 3 Days After Weaning and Weight Changes During Lactation and After Weaning.

	Mean square	
	Treatments	Experimental error
Weight at farrowing	3183.667 (3)	2215.957 (56)
Weight 7 days prior to weaning	2653.765 (3)	2015.352 (56)
Weight at weaning	3644.873 (3)	1896.642 (56)
Weight 3 days after weaning	2037.439 (3)	1628.619 (56)
Weight change from farrowing to weaning	2743.910[a] (3)	858.219 (56)
Weight change in the final week of lactation	1547.108[b] (3)	107.948 (56)
Weight change in the 1st 3 days after weaning	2400.746[b] (3)	131.562 (56)

[a]Significant at $P<.03$.

[b]Significant at $P<.0005$.

Number in brackets represents degrees of freedom.

Table 18. Analysis of Variance for Main Effects of Treatments and Season of the Year When Weaned on Subsequent Reproductive Performance.

	Mean square		
Source of variation	Number of days from weaning to estrus	Conception rate	Number of pigs born in the next litter
Treatment last week of lactation	18.50 (1)	804.00 (1)	18.10 (1)
Treatment 1st 3 days after weaning	15.80 (1)	29.10 (1)	62.10 (1)
Season of the year at weaning	25.30[a] (3)	17.20 (3)	6.28 (3)
Preweaning diet x postweaning diet	27.30 (1)	386.00 (1)	14.00 (1)
Preweaning diet x season at weaning	27.00[b] (3)	489.00 (3)	5.90 (3)
Postweaning diet x season at weaning	72.00 (3)	588.00 (3)	18.40 (3)
Experimental error	8.29 (60)	19.60 (60)	7.26 (41)

Number in brackets represents degrees of freedom.

[a] $P<.04$

[b] $P<.03$