FEEDING AND REPRODUCTION IN GILTS AND SOWS

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SUMMARY

With modern lean gilts there is considerable evidence to suggest that such gilts should be fed ad libitum from the time of selection until they are bred at their second or third estrus. Pregnant gilts should not be fed high levels (in excess of 2.5 kg/day) in early gestation. For sows that have lost considerable weight (in excess of 15 kg) during lactation, high levels of feeding in early gestation will increase weight gain but will not reduce embryo survival. Under good housing and management conditions a constant level of feeding throughout gestation is preferred. Increasing feed intake during the last 10 to 14 days of gestation will increase piglet birthweights slightly but in most cases this increased birthweight is not economical nor will it increase survival rates of normal sized pigs. It is recommended to feed sows to appetite throughout lactation. After weaning, first litter gilts and sows in poor condition will benefit from ad libitum feeding but sows in normal condition will perform optimally when fed approximately 2 kg feed/day from weaning to breeding.

INTRODUCTION

It is frequently suggested that production efficiency and profitability of a farrow to finish unit is determined to a large extent by the average number of pigs weaned per sow per year. Maybe so. But profit is the difference between costs and returns. Therefore if input costs are allowed to become excessive in order to maximize production efficiency then a lower production level maybe more profitable if input costs are reduced. Each unit manager therefore must define his own objectives and know the breakeven point between production efficiency and costs of production. For the purposes of this paper we will assume that maximum production efficiency, as measured by number of pigs weaned per sow per year or per lifetime, is the objective of each swine producer.

Most survey data shows that the average sow produces four to five litters before being culled. Sows produce larger litters than gilts so keeping the number of gilt replacements to a minimum will improve production efficiency. Most commercial producers replace 30 to 40% of their herd each year. Therefore, the selection of nutrition and management of gilts is an important consideration in maximizing reproductive efficiency. This paper will deal only with the effects of nutrition on gilt and sow reproductive performance.

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The gilt

It is now widely accepted that:

1. ovulation rate in the gilt increases from puberty through the third estrus (Archibong et al. 1987).

2. puberty can be induced in gilts by exposure to a mature boar, relocation and mixing (Kirkwood and Hughes 1980; 1981).

Age at puberty

There have been several reviews on the effect of nutrition on age at puberty (Anderson and Melampy 1972; Brooks and Cole 1974, Den Hartog and Van Kempen 1980). A common conclusion is that restricted energy intake (60 to 70% of ad libitum) will delay the onset of puberty by about 9 days (Table 1). This nine day delay in onset of puberty represents a reduction in sow productivity of about 0.2 pigs per year (Regault and Dagorn 1973).

Table 1. Influence of energy intake during rearing on age and weight at puberty.

	Low	High
Number of trials	22	19
Mean starting age (d)	86.7	85.8
Mean starting weight (kg)	36.2	34.8
Mean energy intake ($MJ.d^{-1}$)	22.3	34.4
Age at puberty (d)	211	202
Weight at puberty (kg)	80	99***

From Den Hartog and van Kempen (1980).
***P<0.001.

There is general agreement in the literature that severe protein restriction during the growing-finishing period will delay the onset of puberty but a 25-30% restriction will not (Den Hartog and Van Kempen 1980, Cunningham et al. 1974; Friend 1973).

Table 2. Influence of premating dietary energy intake on ovulation rate (data in parenthesis are from Anderson and Melampy 1972).

	Period of feeding			
	Rearing		Estrous cycle	
	Low	High	Low	High
No. of trials	21 (7)	21 (7)	30 (24)	36 (24)
Energy intake (MJ ME/d)	21.2 (17.6)	33.8 (36.9)	22.5 (24.1)	41.1 (42.1)
Ovulation rate	11.8 (13.8)	13.2 (15.4)***	11.8 (11.6)	13.7 (13.4)***

Adapted from Den Hartog and van Kempen (1980)
*** $P<0.001$

Table 3. Effect of high energy intake on ovulation rate.

No. of trials	No. days high energy diet fed	Increased ovulation
6	0-1	1.35
6	2-7	0.86
8	10	1.58
14	11-14	2.23
2	21	3.10

Adapted from Anderson and Melampy (1972).

Table 4. The difference in energy intake between gilts fed high or low levels of energy.

No. of trials	Increased energy (MJ ME/d)	Increase in ovulation
6	24.3 - 32.2	2.15
17	14.2 - 23.4	1.47
10	7.1 - 13.0	1.60

Anderson and Melampy (1972).

Table 5. The influence of feed intake on age and weight at puberty.

	Maximum prepubertal feed intake (kg/d)		
	2.0	2.4	Ad libitum
Pubertal age (d)	194.0 ± 4.9a	196.8 ± 5.1b	180.4 ± 3.8ab
Pubertal wt. (kg)	96.2 ± 2.0	100.1 ± 0.2	102.8 ± 2.5

Means with same letters differ, P<0.05.

Table 6. Conception rate for gilts fed high (H) or low (L) levels of feed during the prepubertal and premating periods.

Feed level combination	Number of experiments	Mean conception rate (%)
LL	12	82.6
LH	6	88.0
HH	8	80.5

From Den Hartog and van Kempen (1980).

Table 7. Influence of feeding level on embryo survival in gilts.

Period	Number of trials	Energy intake (MJ ME/d)	Number of embryos	Embryo survival (%)
Prepubertal	19	35.7	9.8	69.7**
	46	22.8	10.0	77.5
Premating	36	38.5	10.1	73.2*
	31	21.6	9.7	78.3

Adapted from Den Hartog and van Kempen (1980).
*P<0.04, **P<0.01.

Table 8. Changes in midbackfat depth (BF) for conventional and early mated gilts.

	Early mated	Conventionally mated
Mean mating age (d)	198	237
BF postpartum (litter 1)	18.8	25.0
BF weaning (litter 1)	16.8	18.2
BF remating		
Parity 2	18.2	18.0
Parity 3	14.6	15.3
Parity 4	14.0	15.1

From Brooks (1982).

Table 9. Correlation coefficient (r) or feed intake during pregnancy and sow performance.

Trait	Correlation coefficient
Sow weight gain, kg	0.71
Number born	0.14
Pig birth weight, kg	0.46

From Elsley (1973).

Table 10. Influence of gestation feed level on sow performance (mean of five parities).

	Pregnancy feed level		
	H	M	L
P2 - Parturition (mm)	15.5	14.4	13.6
P2 - Weaning (mm)	12.7	12.1	12.0
Pigs born alive	10.8	10.4	11.1
Sow survival (%)	65.0	55.0	40.0

Feed level 2.3, 2.0, 1.7 kg/d.
From Whittemore et al. (1984).

Ovulation rate

It is generally accepted that for restricted fed animals an increase in feed or energy intake prior to mating will increase ovulation rate (Anderson and Melampy 1972; Brooks and Cole 1974; Den Hartog and Van Kempen 1980) (Table-2) The optimum period of increased intake appears to be in excess of 11 days and the maximum response to supplementation is about 25 to 30 MJ DE equivalent to going from 50% of ad libitum intake to ad libitum intake (Tables 3 and 4). However) we have a considerable amount of evidence that increasing feed or energy intake (flushing) of gilts before mating will only increase ovulation rate to the levels obtained with gilts maintained on ad libitum feeding throughout their entire growing-finishing period (Table 5). At protein levels between 12 and 16% source or level of protein appears to have little effect on ovulation rate (Anderson and Melampy 1972).

Conception rate

There is no clear evidence that nutrition of gilts during the growing-finishing will affect conception rate at first service. The results of 26 experiments reviewed by Den Hartog and Van Kempen (1980) suggest that there is no significant difference in conception rate between gilts fed ad libitum or restricted levels. However, the best conception rates were obtained with gilts fed restricted levels during the growing-finishing period and flushed prior to mating (Table 6).

Embryo survival

High level feeding during rearing or in the premating period is associated with an increased embryo mortality (Table 7) probably due to an increased ovulation rate. Den Hartog and Van Kempen (1980) suggest that increased ovulation rates results in increased embryo mortality.

Long-term performance

Currently , a major issue regarding the replacement gilt is the influence of weight and backfat thickness at selection and mating on both short and long term prolif icacy. Limited survey data suggests that early breeding or extreme leanness at time of mating does increase culling rate and reduce prolificacy (Gueblez et al. 1985). In contrast some research suggests that with good nutrition and management early breeding or extreme leanness does not reduce prolificacy or result in an increased culling rate (Table 8). It appears that as yet an undetermined minimum level of body fat is required for successful reproduction and breeding very lean gilts allows little margin for error in nutrition or management over the entire breeding cycle (Aherne and Kirkwood 1985).

Therefore, for genetically lean gilts that are being bred before they reach 120 kg liveweight it is recommended that they be fed a grower diet ad libitum from 20 to 100 kg and up to the time they are bred. Such a feeding regimen will maximize body weight and body condition and may result in increased ovulation rate, litter size and lifetime in the herd (King et al. 1984a).

Table 11. Daily energy and feed requirements of pregnant gilts and sows.

	Bred gilts and sows[a]		
Weight at mating (kg)	120	140	160
Mean gestation weight (kg)[b]	142.5	162.5	182.5
Energy required, Mcal DE/d			
Maintenance[c]	4.53	5.00	5.47
Gestation weight gain [d]	1.33	1.33	1.33
Total required	5.86	6.33	6.80
Feed required/day (kg)	1.80[e]	1.90	2.00
	1.95[f]	2.11	2.27
Protein required/day (g)	216	228	240

[a]Assume 25 kg maternal weight gain plus 20 kg increase in weight due to products of conception, total 45 kg.
[b]Weight at mating plus $\frac{\text{total weight gain}}{2}$
[c]Animal maintenance requirement: 110 kcal DE/kg$^{.75}$
[d]1.10 Mcal DE/d for maternal weight gain plus 0.23 Mcal DE/d for conceptus gain.
[e]Corn-soybean meal diet containing 3.34 Mcal DE/kg.
[f]Barley-soybean meal diet containing 3.0 Mcal DE/kg.

Table 12. Effect of temperature and sow condition on feed required daily for maintenance of individually housed pregnant sows (grams)[a,b].

	Degrees (C) below lower critical temperature			
Sow condition	0	5	10	15
Fat	0	170	340	510
Thin	0	295	590	885

[a]Lower critical temperature, 19°C.
[b]Assumes a feed containing 12 MJ ME/kg.
Adapted from NRC (1981).

Table 13. Effect of level of protein during pregnancy on sow performance.

	Protein level, %		
Item	9	13	17
Number of sows	29	33	31
Pregnancy wt gain, kg	33	42	42
Pigs born/litter			
Total	10.3	9.7	9.6
Live	10.1	9.4	9.2
Pig birth wt., kg			
Live	1.23	1.23	1.27

Mahan and Mangan (1975).

Table 14. Effect of level of protein during pregnancy on sow performance.

	Protein level, %			
Item	9	11	13	15
Pregnancy wt gain, kg	12.8	18.7	21.0	21.7
Pigs born/litter				
Total	10.1	10.7	10.9	11.0
Live	9.7	10.1	10.3	10.4
Pig birth wt, kg				
Live	1.35	1.34	1.30	1.29

Greenhalgh et al. (1977).

Table 15. Calcium and phosphorus requirements of pregnant and lactating sows (% of the diet)[a].

	Bred gilts or sows	Lactating gilts or sows
Calcium	0.75	0.75
Phosphorus	0.60	0.60

[a]Based on minimum feed intakes of 1.8 kg in gestation and 4.4 kg in lactation.

Pregnancy

From an analysis of 20 experiments Elsley (1973) calculated that feed intake in pregnancy was highly correlated with liveweight gains of sows (0.71), reasonably correlated with piglet weight (0.46) but poorly correlated with litter size (0.46) (Table 9).

In general, energy and/or feed consumption by pregnant sows affects mainly maternal weight gain, to a lesser extent piglet birth weights and has little effect on number of pigs born (ARC 1981, Whittemore et al. 1984; Lewis and Reese 1986) (Table 10). It should be noted from the data in Table 10 that it takes 114 kg of feed for a pregnant gilt or sow to increase average birth weight by 20 or 50 g. This increase would not be economical, especially if average birth weight is over 1.3 kg and does not influence piglet mortality. Low level feeding (1.7 kg/d or less) during gestation may result in a higher culling rate (Table 10).

It is now generally recommended that pregnant sows be fed to allow an increase in maternal weight gain during pregnancy of 25 kg (Aherne and Kirkwood 1985). An estimate of the feed intake required to allow a 25 kg increase in maternal weight during pregnancy is shown in Table 11. It can be seen that for sows of different weights, feed intake during pregnancy should range from 1.95 to 2.27 kg per day of a barley-soybean meal diet. Thus a 120 kg gilt or sow would require a minimum of 5.9 Mcal DE (approx. 25 MJ) and 216 g protein per day for optimum performance. These recommendations assume individual feeding and a thermoneutral environment. Table 12 demonstrates how feed requirements vary with sow condition and environmental temperature.

Protein intake

Although weight gain will respond to increased protein intake in gestation up to levels of 300 g per day, no improvement in reproductive performance is apparent beyond a daily intake of approximately 140 g of protein supplying 8 to 10 g lysine and 7 to 8 g threonine (Cole 1982). Lewis and Reese (1986) suggest that only four research papers have sufficiently evaluated the effects of various protein levels during pregnancy and lactation and their effects on performance and protein requirements during lactation (Mahan and Mangan 1975; Greenhalgh et al. 1977, 1980; NRC-42 1978). From these studies (Tables 13 and 14) we can conclude that 11 to 13% protein of either barley based or corn-soy based diets will optimize sow weight gain in gestation, litter size and average birth weight.

Calcium and phosphorus

The calcium and phosphorus requirements of sows are less well defined than those of growing animals. In general, attempts to demonstrate improved performance of sows from increases in calcium and phosphorus levels above those listed in Table 15 have not been successful (Arthur et al. 1983a,b: Grandhi and Strain 1983; Kornegay and Kite 1983).

Biotin

In studies where sows were subjectively scored, biotin supplementation has improved hoof hardness, compressive strength and reduced foot pad lesions (Grandhi and Strain 1980; Bryant et al. 1984a,b; Webb et al. 1984). However, no improvements were recorded in other studies (Hamilton and Veum 1984; Tribble et al. 1984). Reproductive performance, including pigs farrowed and weaned) litter weaning weight, and number of days from weaning to estrus have been improved, but not always significantly, by biotin supplementation of sow diets (Brooks et al. 1977; Easter et al. 1979; Penny et al. 1981; Bryant et al. 1984c; Hamilton and Veum 1984; Misir and Blair 1984; Tribble et al. 1984). These experiments were conducted using a variety of grain sources (barley, wheat, sorghum and corn). A lack of consistency among these experiments for the individual reproductive criteria or no response for any reproductive criterion and the wide range of biotin supplementation (100 to 550 µg/kg diet), makes it difficult-to provide a firm recommendation or the need for routine supplementation of biot in in sow diets.

Choline and folacin

Supplementation of grain-soybean diets. for pregnant gilts and sows with 434 to 880 mg/kg of choline has generally resulted in an increase in the number of live pigs born, and in some experiments, the number of pigs weaned (Kornegay and Meacham 1973; Stockland and Blaylock 1974; NRC-42 1976; Grandhi and Strain 1981). Improved conception rate with choline supplementation was reported by Stockland and Blaylock (1974) in a long-term reproductive study. During lactation choline supplementation of diets containing 8 to 10% fat or oil did not improve lactation performance (Searley et al. 1981; Boyd et al. 1982). In general the supplementation of folacin to sow diets has not improved reproductive performance (Easter et al. 1979).

. Patterns of feed intake in gestation

Early pregnancy When sows lose excessive weight and backfat during the lactation and postweaning periods it may be desirable to feed such sows very well (3 kg/day) in early gestation in order to improve their body condition. However , the review data of Den Hartog and Van Kempen (1980) suggest that high levels of feed intake in early gestation will decrease embryo survival (Table 16). Similar suggestions have been made by Dyck and Strain (1983). It has been speculated that it is only when high level feeding at the time of mating increases ovulation rate that increased embryo mortality will occur. Toplis et al. (1983) demonstrated that feeding 4 kg per day rather than 2 kg per day in early gestation did not increase embryo mortality in sows when the feeding regimen was introduced on day three of gestation (Table 17). Reducing feed intake below normal levels (1.8 to 2.0 kg/d) does not influence embryo survival in gilts (Dyck and Cole 1986).

It has been suggested that in trials where a detrimental effect of nutrition on early embryo survival has been. demonstrated, the experimental animals were gilts (Toplis et al. 1983). This apparent difference between gilts and sows may be explained by the fact that in sows after weaning major hormonal and metabolic adjustments continue and the sow is in a weight or fat loss phase. With gilts they are usually in a weight gain phase before mating and have not lactated thus feed intake in early gestation may have a greater effect on hormonal status-than it would with sows. The effects of feed intake in early gestation is likely mediated through its influence on plasma progesterone levels and clearance.

Table 16. Influence of energy level during rearing, the estrus cycle and postmating on ovulation rate, number of embryos and embryonic survival.

Sequence of treatments	LLL	LHL	HHH
Number of trials	26	14	15
Number of ova shed (calculated)	12.6	13.9	14.0
Number of embryos	9.90	10.75	9.84
Embryonic survival (%)	78.7a	77.6a	70.3b

Den Hartog and van Kempen (1980).

It should also be considered that data on early embryonic mortality measured at day 25 to 30 of gestation may be misleading. Levels of embryo mortality of 18.8 to 33% were reported by Etienne et al. (1983) for gilts on various prepubertal feeding regimes. However, these differences were reversed for fetal mortality (assessed at 105 d of gestation) which lead to no difference in actual fetal numbers.

Late gestation Theoretically, the nutrient requirements of sows increase with advance in pregnancy following the pattern of fetal development. Fetal weight is doubled over the last month of pregnancy, with' the most rapid fetal growth occurring in the last 10 days of gestation. It has been frequently suggested, therefore that increasing feed intake in late gestation will increase piglet birth weights. Cromwell et al. (1982) using 848 sows increased sow feed intake by 1.36 kg daily for the last 23 d of pregnancy and noted a significant increase (50 g) in piglet birth weight. However, Hillyer and Phillips (1980) using 304 sows reported that increasing feed intake in late gestation did not significantly increase birth weights (Table 18). An increase in birth weight through increased feed intake of the sow is only likely to be of economic value where the birth rate is low and is contributing to an increased preweaning mortality. The increased feed intake in late gestation does not appear to influence ease of farrowing or lactation feed intake. Elsley et al. (1971) demonstrated that when sows were fed the same amount of feed throughout gestation, the pattern of feed intake, did not influence piglet birth weights. Therefore, in general a constant level of daily feed throughout gestation is recommended.

Role of fat in sow diets

Moser and Lewis (1980), Pettigrew (1981) and Searley (1984) from reviews of the literature concluded that increasing the energy density of the sows diet in late gestation by adding fat (optimum level 7.5%) increases the fat content of' sows milk and increases the survival of light weight (<0.9 kg) piglets. In general, the addition of lipid to the diet of sows in late gestation has not increased the fat or glycogen content of the newborn pig (Seerley 1984). There is some evidence that fat supplementation of the diet

Table 17. Reproductive performance of sows given low or high food levels for 30 days after mating.

	Low (2 kg/day)	High (4 kg/day)
Number of sows	16.0	18.0
Remating interval (days)	4.2	4.4
Ovulation rate	23.4	23.9
Number of embryos	17.6	16.8
Embryo survival (%)	74.8	72.0

From Toplis et al. (1983).

Table 18. Influence of increased feed level in late gestation on sow and piglet performance.

	Feed level	
	Basal	High
Sow gestation weight change (kg)	39.8	48.9
Piglet birth weight (kg)	1.41 (1.36)	1.46* (1.39)

Data from Cromwell et al. (1982) (and Hillyer and Phillips 1980).

Table 19. Daily energy and feed requirements of lactating gilts and sows.

	Lactating gilts and sows		
Weight at farrowing (kg)	145	165	185
Milk yield (kg)	5.0	6.25	7.5
Energy required (Mcal DE/kg)			
Maintenance[a]	4.5	5.0	5.5
Milk yield[b]	10.0	12.5	15.0
Total	14.5	17.5	20.5
Feed required/day (kg)	4.4[c]	5.3	6.1
	4.8[d]	5.8	6.8
Protein required/day (g)	572	689	793

[a]Animal maintenance requirement: 110 kcal DE/kg.
[b]2.0 Mcal DE/kg milk.
[c]Corn-soybean meal diet containing 3.34 Mcal DE/kg.
[d]Barley-soybean meal diet containing 3.0 Mcal DE/kg.

Table 20. Summary of effect of energy intake during lactation on litter size at weaning[a,b].

Energy intake MJ of ME/day	kg corn-soy/day	Litter size weaned
<50	<3.7	8.5
50-58	3.7-4.3	8.6
>58	>4.3	8.7

[a]Parity ranged from 1 to 4.

[b]Lactation length ranged from 4 to 8 weeks.

Elsley et al. (1968), Hitchcock et al. (1971), O'Grady et al. (1973), Adam and Shearer (1975), Reese et al. (1982a), Nelssen (1983), King and Williams (1984a).

of the peripartal sow can reduce the weaning to mating interval in sows (Seerley 1984; Brit 1986).

Interval feeding

A practical method of limiting the feed intake of sows during pregnancy is interval feeding. With interval feeding sows are allowed to consume two or three days of feed in one day, then wait two or three days before provided access to feed again. This system allows every sow in the pen to eat her fill even if she is a slow eater. Adjustments in average daily intake are made by altering either the time on the feeder (2 to 12 hours) or the time off the feeder (2 or 3 days). If time on the feeder is restricted, one feeder hole per sow is needed. Recent research has shown that interval feeding does not significantly influence birth weights or number of pigs weaned per litter (Michel and Easter 1985).

Lactation

The energy and protein requirements of the lactating sow will depend on the weight of the sow, her milk yield and its composition. Estimates of the energy and protein requirements of lactating sows of different weights are shown in Table 19. For a sow weighing 165 kg and producing 6.25 kg milk daily, an intake of 17.5 Mcal DE and 689 g crude protein per day should suffice. However, for various reasons (breed, strain, environmental temperature, level of feed fed in gestation, palatability of diet) a sow may eat less than the required 5.8 kg per day. Our records of feed intake of lactating sows has shown feed intakes of 4.1, 5.5, 5.9 and 5.6 for 1st, 2nd, 3rd and 4th parity sows. Others have also reported very low feed intakes for lactating sows fed ad libitum (King and Dunkin 1986; Brit 1986; Armstrong et al. 1986). Sows that consume less energy and protein than is needed for milk production will therefore lose weight, which consist of 25% fat and 15% protein (Shields et al. 1985). This energy and protein loss will contribute towards milk synthesis but with a lower efficiency than that from feed.

Feed intake in lactation is intimately related to feed consumption during pregnancy. It has been demonstrated that the more the sow eats during gestation the less she will eat during lactation (Harker and Cole 1985). It is now very well established that level of feed, energy or protein intake during lactation can influence body weight change, milk yield and composition (ARC 1981, Reese et al. 1982a,b; 1984; King and Williams 1984a,b; Hughes et al. 1984; King and Dunkin 1986; Lewis and Reese 1986).

In this paper we are concerned primarily with the effects of feeding on reproduction. A summary of seven experiments in Table 20 indicates that energy intake during lactation may have a slight effect on litter size at weaning .

The data of King and Dunkin (1986) suggest that a reduced protein intake during lactation (508 to 511 g/day) will increase sow weight loss, and significantly decrease the percentage sows in estrus by day eight after weaning. Though percentage protein in a diet is only meaningful in relation to an expected feed intake the results of Mahan and Mangan (1975) and Greenhalgh et al. (1977; 1980) suggest that a 13% protein diet is satisfactory for lactating sows fed either barley or corn based diets. This recommendation is in agreement with that of NRC (1979).

Table 21. Summary of effects of energy intake during lactation on percentage of sows in estrus by various time periods after weaning[a].

Item	Energy intake, MJ of ME/day				
	33	42	50	59	67
No. sows	59	49	49	49	58
Percent in estrus					
by 7 d	58	82	88	88	95
by 14 d	69	90	92	94	97
by 21 d	69	92	92	98	99
Lactation wt change (0-28 days), kg	-23	-19	-12	-5	-2

[a]Corresponds to 2.5, 3.1, 3.8, 4.4 and 5.0 kg of corn-soybean meal diet daily.
Reese et al. (1982a), Nelssen (1983).

Table 22. Lactation energy intake and postweaning performance (28 day lactation).

Lactation energy intake MJ DE/day	35		70
Percentage in estrus by day 14 postweaning	41.9		92.9
Sows returning to estrus	Yes	No	Yes
Sow wt loss, kg	35.2	37.6	14.7
Backfat loss, mm	8.3	10.1	2.1
Body fat, %	13.1	10.7	17.5

Reese et al. (1984).

Days to postweaning estrus (heat)

Several recent experiments have firmly established that sows that lose excessive amounts of weight or body condition will have extended remating intervals and an increased incidence of anestrus (King et al. 1982; 1984a; Reese et al. 1982a,b; 1984; King and Williams 1984a,b; Hughes et al. 1984; King and Dunkin 1986).

A summary by Lewis and Reese (1986) of the data (Table 21) suggests that energy intakes of less than 50 MJ of ME/day are detrimental to sow return to estrus. Increasing energy intake beyond 50 MJ ME/d will not influence return to service but will reduce sow weight and fat loss (Reese et al. 1982a).

Reese et al. (1984) subdivided their low energy group into those that did and those that did not return to estrus. They noted that the lactation weight loss and postweaning weighty gain were very similar, indicating that weight change per se had little or no influence on the time taken to achieve estrus. However) they did note that the lactation backfat loss was larger for those sows that remained anestrus and the calculated percentage body fat was lower (Table 22). They suggested as did Kirkwood and Aherne (1986) that the fat loss was a major contributing factor in the delay in return to estrus. Thus a physiological function for adipose tissue is indicated. Reese et al. (1984) did observe some muscle wasting in the energy restricted sows as judged by creatine concentrations but this was considered not to be related to expression of estrus. In contrast King and Dunkin (1986) concluded that though reduced energy intake will increase sow weight and backfat loss, protein intake during lactation is the major nutritional factor influencing interval from weaning to estrus (Table 23). They suggested that when protein intake is adequate, energy intake can be reduced to 45 MJ DE without affecting postweaning performance.

Table 23. Energy and protein intake in lactation and gilt performance.

Feed/day, kg	3.5	3.5	4.0	5.0	
Protein/d, g	511	703	508	815	
DE MJ/d	45	45	60	63	
Wt. loss, kg	21.8	20.8	17.8	9.6	**
Backfat loss, mm	5.5	7.9	3.2	4.0	**
Pig wt./d, g	180	204	193	202	*
Weaning to estrus, d	16	13	14	11	NS
# in estrus by d 8, %	23	64	41	59	*
Ovulation rate	12.3	11.9	12.6	13.3	NS

King and Dunkin (1986).

Inadequate protein intake during lactation will delay return to estrus (O'Grady and Hanrahan 1975; King and Williams 1984b; Brendemuhl 1985).

Ovulation rate

Hardy and Lodge (1969) reported that ovulation rate at the first postweaning estrus was significantly influenced by weight changes in the previous lactation. Brooks (1982) suggests that gilts that become catabolic during lactation may remain so after weaning and as a consequence have reduced ovulation rates. However, studies have failed to detect an effect of weight loss in lactation on ovulation rate (Pike and Boaz 1972; King et al. 1982; King and Williams 1984a,b; Hughes et al. 1984; King and Dunkin 1986). The adverse affects of large live weight changes on conception rate reported by Hardy and Lodge (1969) have not been confirmed by other reports (Hitchcock et al. 1971; Reese et al. 1982b; King et al. 1984b; King and Williams 1984a) and may be a result of poor oestrus detection in sows having uncharacteristic weaning to remat ing intervals.

Embryo survival

While there is general agreement that low level feeding in lactation adversely influences the weaning to remating interval, whilst not affecting subsequent ovulation rate, the influence of lactation feed level on subsequent embryo survival is not clear. Thus, King and Williams (1984a,b) report no influence of low lactation dietary energy or protein intakes on embryo survival, while others do note an adverse effect of low level feeding (King and Williams 1984; Hughes et al. 1984). (Table 24'). It is obvious that insufficient work has been done in this area. An obvious question is whether a minimum backfat level must be achieved, rather than a minimum backfat depletion, before embryo survival is compounded (i.e. will poor lactation nutrition only adversely affect those sows already relatively thin). If condition loss in lactation does affect embryo survival, the mechanism of action remains unclear.

Table 24. The effects of lactation feed level on postweaning reproductive performance of sows.

	Lactation feed level (kg/day)	
	3	7
Remating interval	8.0	5.5
Ovulation rate	19.0	18.5
Embryo survival (%)	63.4	75.3

After Hughes et al. (1984) and Baidoo et al. (unpublished).

Post weaning

The major objectives of nutrition during this period are to shorten the interval to effective service, synchronize the onset of estrus and maximize the ovulation and conception rates. Previous recommendations have included a "drying off'" period for at least 24 h postweaning during which the sow received no food or water. It has been suggested that this is an effective means of shortening and synchronizing the interval to estrus (MacLean 1969). More recent evidence indicates no beneficial value of this practice when conception rates are greater than 80% (Allrich et al. 1979; Tribble and Orr 1982) and may even be detrimental with some management systems (Allrich et al. 1979). However) this does not mean that this system of management would not be effective where conception rates are less than 70% as was the case in the study of MacLean (1969).

Remat ing interval Of greater interest is the influence of postweaning plane of nutrition on the remating interval of sows. Increasing the level of feed postweaning has been reported to shorten the interval to service in primiparous sows (Brooks and Cole 1972; King and Williams 1984a), increase the number of sows exhibiting estrus within 10 days of weaning (Brooks and Cole 1972; Fahmy and Dufour 1976; King and Williams 1984a) and increase the synchronization of estrus (Dyck 1972). Other reports fail to confirm an effect of nutrition on the length of the weaning to service interval (Dyck 1972; 1974; Fahmy and Dufour 1976; Den Hartog and van der Steen 1981; Tribble and Orr 1982). It is possible that the results of the study of Brooks and Cole (1972) are due to the use of gilts which may respond differently to postweaning feed intake than do multiparous sows. However, Den Hartog and van der Steen (1981) also used primiparous sows and observed no response to variations in postweaning feed intake. Brooks et al. (1975) stated that all animals in their trial were subjected to an excellent standard of management and overall there was no loss of body weight during lactation. Whilst not measured, these authors estimate that in their earlier work (Brooks and Cole 1972), the primiparous sows lost about 20 kg liveweight during lactation. It therefore seems possible that a further indirect nutritional effect exists, i.e. lactation feed level (and thus weight change pattern) may affect the response of sows to the postweaning feed level.

Ovulation rate The available information on the influence of postweaning nutrition on ovulation rate at the first estrus and subsequent litter size is also contentious. The normal remating interval for a sow can vary but may be as low as 4 to 5 days and as such, appears to correspond to the follicular phase of a normal estrous cycle. Therefore it may be expected that sows will respond to nutritional changes in this period in a similar manner to that seen in gilts. However , there is little evidence to support a claim for high level feeding during the remating interval affecting either the ovulation rate or subsequent litter size of sows. This may in part to be due to the relatively short time span involved since Dyck (1974) reports that increasing feed level will not affect the first postweaning ovulation rate, but does increase ovulation rate at the second postweaning estrus. Lodge and Hardy (1968) did report an increased litter size in flushed sows (9 vs 10.8) although this may be the result of control sows having a low mean litter size. The flushing therefore seems to have brought low litter size back to "normal" rather than cause an increase above what was to be expected. Indeed, with larger litter sizes in the control groups, various authors have failed to confirm a stimulatory effect of increased feed intake on ovulation rate (Fahmy and Dufour

1976; Tribble and Orr 1982).

Conception rate Increasing postweaning feed levels for primiparous sows has been reported to improve conception rates (Brooks and Cole 1972), although this is not confirmed by results from older sows (Dyck 1972; Brooks et al. 1975; Fahmy and Dufour 1986; Tribble and Orr 1982). However, the possibility of an interaction between lactation and postweaning feed levels remains to be adequately investigated. It is concluded that level of feeding in the remating interval is unlikely to improve reproductive performance unless it is to reverse the reduction in performance due to poor nutrition management in lactation (Pike and Boaz 1972).

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