Feeding pregnant and lactating sows

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The literature on sow nutrition and feeding has been well reviewed up to the beginning of the present decade (ARC, 1981; O'Grady, 1980). In this paper, therefore, I propose to examine only literature published since 1980 with the aim of identifying those areas where new data allow a better understanding of feeding or modify existing concepts.

The period under review is noteworthy in that it coincided with dramatic improvements in sow productivity at the farm level. This in turn resulted in new demands for information to ensure that productivity is not hindered by inadequate feeding. It must be stated that these improvements in productivity were mostly the result of changes in management systems. For example, the widespread change to crossbred and hybrid sows; the reduction in weaning age and the improvement in fertility through controlled mating management (O'Grady, Lynch and Kearney, 1983; Tilton and Cole, 1982). The consequences were, for example, a 33% increase in sow output in Ireland from 1974 to 1982 (Tuite, 1983) and a 42% increase in national sow output in Denmark from 1976 to 1984 (Anon., 1985).

This changed situation had an effect on the approach to sow experimentation. Aspects such as weaning to mating interval, ignored in the earlier experiments, took on a new importance. Other areas such as the importance of culling rate were identified (Kroes and van Male, 1979) although to date little has been achieved in solving the enormous losses from culling after the first litter. Sow body condition has been identified as a factor separate from feeding level and is likely to yield interesting information with further study.

I - Sow body conditions and fat reserves

Whittemore, Franklin and Pearse (1980) measured backfat in sows fed a standard diet considered adequate during two cycle breed comparisons. Although the sows gained 22 kg from first mating to second weaning, they lost 6.8 mm of backfat. This led these authors to question the adequacy of the feed level and to undertake an experiment of five parity duration (Whittemore *et al.*, 1984). The planned difference in backfat did not materialise as sows used lactation to compensate for differences induced by pregnancy. Additionally, culling was higher where attempts were made to reduce backfat. More detailed conclusions are not possible on the basis of the preliminary report.

Fat stores at mating had earlier been emphasised by Elsley and Gilchrist-Shirlaw (1976) and the effects of selection for leanness are highlighted by Aherne and Kirkwood (1985) who show that average backfat in 90 kg gilts, in Alberta, dropped from 19.6 mm to 15.4 mm from 1973 to 1984.

Fowler (1984) has set targets for backfat thickness at the P2 position as follows:

Time	Backfat thickness (mm)
First mating	20
First farrowing	25
Second mating	15
Second farrowing	20
Third mating	15
Third farrowing	20

Reese *et al.* (1984) examined the effects of weight and backfat loss in lactation and concluded that catabolism of bodyfat was more deleterious to a rapid return to oestrus than catabolism of muscle. They also showed that sows not returning to oestrus after weaning had less backfat although they had little differences in weight loss. King, Williams and Barker (1982) reported that backfat loss in lactation was positively correlated with the length of the subsequent interval between weaning and mating.

1. Climate

Body fat stores are of course influenced by feed quantity and composition but also by the climatic conditions under which the animals are maintained. ARC (1981) deviated from other "nutrient requirements" in that it related sow energy requirements to temperature and to bodyweight as seen in **Table 1**.

Geuyen, Verhagen and Verstegen (1984) expanded on this concept and demonstrated that heat loss was related to the system of housing as well as temperature. Heat loss increased below 20°C in individually housed sows but only when the temperature dropped below 14°C where sows were housed in groups of three.

2. Energy

Walker (1983) produced very interesting data on the effects of feed level over four pregnancies in early weaned sows where the lactation length was 14 days. Feed levels examined ranged from 1.5 to 2.5 kg/day in gestation. The diet had 12.7 MJ/kg DE. The number of pigs per litter was not affected and sow weight responded as expected. Piglet birth weight was significantly influenced in parities 2,3 and 4 and postnatal liveweight gain in parities 2 and 4 by sow energy intakes. There were clear indications that culling rate and weaning to conception was least on the highest feed level.

A number of experiments has recently examined feed intake in lactation. King and Williams (1984a, 1984b) showed increases in weaning to ovulation, mating and conception times among first litter sows fed 2 kg *versus* 4.5 kg per day over 32 day lactations. On the other hand, feed level post weaning was without effect possibly due to the shortness of the period. In the second experiment these same authors showed that severe restriction of energy (26 MJ DE/day) or protein (315 g/day) in lactation increased the culling rate and the interval to ovulation and oestrus. The proportion of sows exhibiting oestrus within eight days of weaning was 88 on HEHP *versus* 53 on other treatments HELP, LEHP, LELP. Nelssen *et al.* (1985) showed that 10 Mcal DE/day in lactation delayed the onset of oestrus. Reese *et al.* (1984) showed .93 in oestrus following 16 Mcal ME/days *versus* .42 on 8 Mcal. Earlier Reese *et al.* (1982) showed fewer sows receiving 8 Mcal ME/day in lactation in oestrus by 7, 14, 21 and 70 days after weaning in three experiments. In another paper (Reese *et al.*, 1982b) showed that 8 Mcal ME/day in lactation increased the incidence of silent heats whereas 12 or 16 Mcal ME/day were little different.

It must therefore be concluded that recent evidence implicates low energy intake in lactation as a major factor in delayed oestrus, lower ovulation rates and silent heats. This problem is clearly magnified in high performance herds. Verstegen *et al.* (1985) showed that while the sow is 62 to 68% efficient in converting feed energy to milk energy, it nevertheless requires 0.5 to 0.6 kg/day of additional feed to meet the needs of an additional piglet being suckled. O'Grady *et al.* (1985) in an analysis of records from 3,328 lactations showed that voluntary feed intake increases by less than half this requirement for each extra pig suckled.

Although it is common commercial practice to feed lactating sows close to appetite, modern systems put many restrictions on feed intake. These have been listed by O'Grady *et al.* (1985) and include energy density of the diet, feeding system, breed, parity and house temperature. In addition to the effects on mean intakes there is wide variation in intakes between individual sows maintained under fairly standard conditions. Lynch (1985) has extracted data relating to 1,297 lactations in the Moorepark herd in 1983 and 1985. His data are presented in **Table 2** and demonstrate a year to year variation as well as an increase up to the 4th parity. The major issue arising from the table is the proportion of sows with less than 4 kg per day intakes. According to the data of Reese *et al.* (1982 b) these may be at risk of increased weaning to oestrous intervals.

II - Fat supplementation of sow diets

In an attempt to reduce piglet mortality many researchers considered the possibility of boosting piglet energy stores at birth by feeding high levels of fat in the last days of pregnancy and in lactation. Considerable literature on the topic accumulated from 1974 onwards and the data up to 1981 were reviewed by Moser (1985). He concluded that there was an average advantage of 0.3 piglet per litter from fat feeding, although this has not been observed in all experiments. Two papers published since (Cieslak *et al.*, 1983 and Cox *et al.*, 1983) support this conclusion. The survival rate of piglets was most improved where birthweights were between 700 and 1,100 g. The data from Cox *et al.* further show that fat fed in lactation in summer reduced the weaning to oestrus period from 20.9 ± 2.1 to 12.6 ± 2.1 days. It also increased the percentage of sows in oestrus by 10 days after weaning from 34 to 59. In winter the effects were much smaller and reversed. Whether these effects of fat are due to fat *per se* or to energy intake is not clear.

III - Feeding after weaning

The earlier suggestion that feeding in the immediate post-weaning period had a major influence on weaning to mating interval, conception rate and litter size (Brooks and Cole, 1972) has not been confirmed in more recent experiments (Den Hartog and van der Steen, 1981; Tribble and Orr, 1982). One is left to conclude that the emphasis should be placed on preventing excessive weight loss in lactation and that post weaning feeding is ineffective with the possible exception of first litter sows that had large weight losses in lactation.

IV - Protein and amino acids

Greenhalgh *et al.* published their second coordinated experiment in 1980 and concluded that 11-12% protein in diets for gestation will give the maximum output of weaned pigs in almost any circumstances. Lower levels (e.g., 9-10% from cereals alone) are often satisfactory but many incur a penalty in numbers born or in the weights of the piglets at birth and subsequently. They placed the lysine requirement at under 0.45-0.5%.

In relation to protein in lactation these same authors state that "sows respond linearly to increased protein intake by producing more milk and increasing the weaning weight of their litter". Taking economic circumstances into account, however, they opted for a recommendation of 15% crude protein in lactation diets.

Since 1980 a number of other reports have been published that add to our appreciation of protein and amino acid nutrition. Filipovich (1984) confirms no response in gestation beyond 0.5% lysine. Carley *et al.* (1983) show that the supplementation of maize based diets with 0.25% lysine and 0.02% trytophan enhanced antibody development. Haye *et al.* (1981) showed no difference in performance between sows given pregnancy/lactation levels of crude protein of 14/14, 12/16 or 9/18%. Wilkinson *et al.* (1984) showed that with diets based on barley/soya and fishmeal the second limiting amino acid after lysine was threonine.

Wilkinson *et al.* (1982) examined the lysine requirements of multiparous sows in mid-lactation using metabolic techniques. They showed that urinary urea nitrogen was the best indicator of requirement and on the basis of this test placed the daily requirement for lysine at 48.5g. **Table 3** shows the contrast between this finding and previous estimates.

V - Feedstuffs

The widespread use of least cost techniques in feed formulation has increased the demand for nutritional information on the lesser used feed ingredients and some information has become available in recent years. Hanrahan and O'Grady (1985) have shown that winter wheat can constitute up to 77% of pelleted diets for growing finishing pigs and 66% in weaner diets. One would feel confident that very high levels can also be used in sow diets.

Crenshaw and Danielsen (1985) found no problems but higher birth weights and milk fat when raw soybean meal was fed to supply all the supplementary protein in sow diets fed for three pregnancies.

Waterworth and Heath (1981) fed pruteen (a single cell protein) at 8% inclusion in diets in a multigeneration breeding programme. Although over 5,000 piglets were born to sows in the study, no differences were apparent in any parameter measured between control and pruteen fed sows.

Kepler *et al.* (1982) included 25-50% ground sunflower seeds in diets from day 100 of gestation and during 14 day lactations. As expected, fat in milk was increased but no reproductive parameter was affected. Palatability was an initial problem at the 50% inclusion rate.

A more exotic protein feed, processed house fly larvae, was fed by Bayadina and Inkina (1980) with excellent results.

VI - Vitamins

Biotin has received considerable emphasis in feed compounding since the report of Brooks *et al.* (1977) showed supplementation to reduce the incidence of foot lesions and dry skin and result in shorter weaning to mating intervals. Since that time, emphasis has been placed on the availability of biotin from different feed ingredients. Frigg (1984) produced a table of availability values from 17 ingredients and showed ranges from zero in rye to 100% in whey powder. Of the most common ingredients, wheat (41% available) and tapioca (6% available) create concern while barley biotin is listed as 21.6% available. Earlier, biotin was considered more available in corn (Anderson *et al.*, 1978). Bryant *et al.* (1985) fed wheat or corn based diets with or without 440µg of supplemental biotin per kg diet to sows through four parities.

While biotin supplementation improved conception rate and weaning to oestrus interval and there were differences in favour of the corn based diets, the expected grain x biotin interaction was not recorded.

Indications of other unexpected responses to vitamins are seen in a recent report from Matte *et al.* (1984) who show 12.0 liveborn pigs per litter from 51 sows that had received folic acid and been flushed in the weaning to mating interval compared to 10.5, 10.7 and 10.9 in other treatments. This is obviously a topic that deserves further study.

In summary, recently published studies emphasise the importance of climate in determining feed requirements of intensively managed pregnant sows. Increased output puts greater emphasis on lactation feeding. This is under pressure due to litter size and intake of feed. Very low intakes in lactation are clearly implicated in delayed onset of post weaning oestrus. Biotin is likely to be inadequate in many diets while there is an indication that post weaning flushing, when combined with folic acid supplementation, may increase fertility.

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Table 1: Daily feed requirement of pregnant sows (ARC, 1981)

Liveweight at mating kg	120	140kg/day*	160
Within thermal neutrality	2.0	2.2	2.4
5°C below critical temp.	2.4	2.6	2.8

* Assumed (a) Feed contains 12.5 MJDE/kg
(b) Net wt. gain in pregnancy 20 kg

Table 2: Feed intakes of lactating sows fed to appetite 4-5 week lactations

% of sows within parity	parity				
	1	2	3	4	5
1983 - Mean litter size 8.7 Feed/day kg					
<3	4	2	0	0	0
3.1 to 4	44	15	8	14	8
4.1 to 5	48	61	45	38	36
5.1 to 6	5	23	47	42	53
>6	0	0	0	5	2
No. of sows	110	101	76	73	257
Mean intake kg : 4.7±0.75	3.98	4.55	4.88	4.95	4.94
1985 - Mean litter size 9.1 Feed/day kg					
<3	2	2	6	1	0
3.1 to 4	11	3	2	1	2
4.1 to 5	51	24	17	15	11
5.1 to 6	33	60	55	63	61
>6	3	10	21	20	26
No. of sows	106	98	112	103	261
Mean intake kg: 5.3±0.7	4.73	5.21	5.36	5,35	5.62

Source: Data from Lynch P.B., unpublished

Table 3: Estimates of lysine requirements of the lactating sow

Reference	Requirement g/day
Boomgaardt, 1972	20.0
Salmon Legagneur and Duee, 1972	37.2
Lewis and Speer, 1973	30.0
McDougal and Fowler, 1974	26.4
O'Grady and Hanrahan, 1975	33.0
Chen *et al.*, 1978	33.6
Sohail *et al.*, 1978	38.5
Wilkinson *et al.*, 1982	35.0