Precision nutrition for modern sow genotypes

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The objective of modern pig production is to maximise the quantity and quality of pig meat produced per sow per year – or per lifetime – at minimal costs. A first step is to ensure that the sow produces an adequate number of piglets per year, or per lifetime; and over this past decade we have seen in many countries an improvement in productivity from 20-25 to 30+ piglets reared per sow per year.

The feeding of the sow is a key element in achieving these objectives, and a question often asked is: 'What are the nutritional requirements of the modern, hyperprolific sow and what feed management practices need to be adopted to ensure that these requirements are met?'

Energy and amino acids

During gestation, the objective should be to feed the sow for a specific body gain and increase in backfat thickness and to achieve a body condition score of 3.5 at parturition (scale 1-5). Table 1 provides the mean energy and lysine requirements during gestation for sows of different body weight (mid gestation) and rates of maternal gain and are based on the requirement for maintenance (body weight), maternal body weight gain and conceptus tissue. The latter is small compared with the requirements for maintenance and body gain.

As litter size increases, today's producer needs to know by how much the increase in litter size in the modern hyperprolific sow increase these requirements? Table 2 shows that as litter size increases from 10 to 16, the mean requirement throughout gestation increases by 0.4 MJ/day and, for a typical gestation diet, requires a 30g/day increase in feed requirement.

However, much of the increase in foetal growth occurs over the last six weeks of gestation and thus it may be calculated that the energy requirement for conceptus tissue development increases from 2.90 to 3.60 MJ/kg, that is 0.23 to 0.29kg feed/day.

For lysine, the increase in requirement is 0.8 to 1.0kg/day. Failure to provide this additional feed will result in reduced piglet birth weight or sow body condition. Thus, feeding to a condition score of 3.5, regardless of expected litter size, not only safeguards the sow, but is the key to ensuring good piglet birth weight.

Table 1. The energy and lysine requirements of sows of different body weight and maternal body weight gain during gestation (BSAS, 2003).

	Maternal gain (kg)	Energy (MJ/day) NE	DE	Lysine (g/day) SIDL*	Total	Feed intake+ (kg/day)
150kg sow	20	18.3	24.9	8.5	10.1	1.9
	40	20.9	29.4	11.7	13.9	2.2
	60	23.5	33.8	14.8	17.6	2.5
225kg sow	15	22.9	32.1	8.0	9.5	2.4
	27.5	25.0	35.5	9.6	11.4	2.7
	37.5	26.3	37.7	11.1	13.2	2.8
	50	28.5	41.1	12.7	15.1	3.0
300 kg sow	0	23.5	34.0	7.4	8.8	2.5
	5	25.2	36.4	7.8	9.4	2.7
	15	26.0	38.6	8.9	10.6	2.8

** Standardised ileal digestible lysine. + Based on diet containing 13.2 MJ DE or 9.4 MJ NE/kg*

Litter size	Piglet birth weight (kg)	Total piglet weight (kg)	Total conceptus weight (kg)	Total energy (MJ)	Energy/day (MJ/day)
10	1.6	16.0	21.3	18.2	1.60
12	1.5	18.0	24.0	20.0	1.75
14	1.4	19.6	26.1	21.5	1.90
16	1.3	20.8	27.7	22.6	2.00

Table 2. The effect of increasing litter size on energy requirements for conceptus.

Body weight loss in lactation and post weaning (kg)	Condition score at mating (scale 1-5)	Increase in feed requirement (kg/d)	Feed intake (kg/day)
<5	3.0	0	2.4
10-15	2.5	0.3	2.7
>20	2.0	0.5	3.0

Table 3. Suggested feed allowance for a 200kg sow in early gestation, depending on condition score and extent of body weight loss during the previous lactation and post weaning (Close, 2006).

Three phase programme

The feeding strategy must ensure that the nutrient needs of the sow are met at all times and a three phase programme is recommended – Phase 1: mating to 28 days; Phase 2: 28-80 days and Phase 3: day 80 to farrowing, with feed intakes being increased, especially in Phase 3, to take account of the increasing metabolic needs during gestation.

In mature sows that have lost considerable body weight and body condition during lactation/post-weaning, it is advisable to increase feed intake in early gestation.

The amount to be given depends on the extent of the loss, as indicated in Table 3.

Continued on page 8

Continued from page 7

Once these losses have been restored, normal feed levels can be provided.

During lactation, the objective should be to maximise the weaning weight of the piglets, regardless of litter size, with minimal loss of body weight and body condition of the sow. Some idea of the requirements for sows of different body weight and litter growth rates are presented in Table 4.

The most effective feeding strategy is to follow the milk yield of the sow, that is to control the amount of feed provided for the first few days after parturition (increasing the quantity of feed provided by 0.5kg each day until the sow consumes 4-5kg/day) and then to feed to appetite, that is several times per day. To achieve the high intakes necessary to meet the need of the modern hyperprolific sow it is important to provide good quality diets, as well as uninterrupted access to good quality water, and if nipple drinkers are provided, then the flow rate must be at least two litres/minute.

	Litter growth rate (kg/d)	Energy (MJ/day) NE	Energy (MJ/day) DE	Lysine (g/day) SIDL*	Lysine (g/day) Total	Feed intake+ (kg/day)
150kg sow	1.5	40.7	57.5	33.1	39.4	4.10
	2.0	51.5	73.6	43.2	51.4	5.25
	2.5	62.3	89.7	53.3	63.5	6.40
225kg sow	2.25	61.5	89.4	49.2	58.5	6.38
	2.75	72.3	105.4	59.4	70.7	7.53
	3.25	83.1	121.5	69.5	82.7	8.67
300 kg sow	2.50	70.9	104.5	54.3	64.6	7.46
	3.20	81.7	120.6	64.4	76.6	8.61
	3.50	92.5	136.7	74.5	88.7	9.76

** Standardised ileal digestible lysine. + Based on diet containing 14.0 MJ DE or 10.0 MJ NE/kg*

Table 4. Energy and lysine requirements of lactating sows of different body weight and at different litter growth rates (after BSAS, 2003).

It is also important to provide creep or pre-starter diets to the piglets from day seven onwards, as this will reduce the metabolic demand on the sow and hence minimise loss of body weight and body condition. It also ensures a good piglet weaning weight.

In terms of energy and lysine: the following dietary specifications are suggested:

- Gilt rearer:
  13.5 MJ DE and 8.0g lysine/kg.
- Pregnancy:
  13.0 MJ DE and 6.0g lysine/kg.
- Lactation (general):
  14.0 MJ DE and 10.0g lysine/kg.
- Lactation (gilts: low intake):
  14.5 MJ DE and 12.0g lysine/kg.
- Lactation (sows: high intake):
  13.5 MJ DE and 9.0g lysine/kg.

Minerals and vitamins

Compared with energy and amino acids, there is less information on the mineral and vitamin requirements of the modern sow (Table 5). Indeed, much of the information on which current recommendations are made are based on work carried out 20-30 years ago, when the productivity of the sow was much lower than today. The consequence of this is illustrated by the work of Mahan and Newton (1995) who reported that the analysed body mineral content of sows after weaning their third litter of piglets was 15-20% lower than that of control non-bred animals of similar age when fed according to NRC (1998) standard.

Close (2006) has suggested that to overcome these losses from the body the mineral content of the diet of the modern sow would need to be increased by 5% with parity. However, a better way to meet the need of the modern, hyperprolific sow is to provide more available sources of minerals, that is organic rather than inorganic minerals.

	Suggested allowances (per kg diet)
Calcium (%)	0.72-0.80
Phosphorus (digestible %)	2.3-3.2
Sodium (%)	0.17-0.20
Chloride (%)	0.14-0.18
Potassium (%)	0.25
Magnesium (%)	0.04
Copper (ppm)	6-15
Iodine (ppm)	0.2-2.0
Iron (ppm)	80-100
Manganese (ppm)	20-40
Zinc (ppm)	80-100
Selenium (ppm)	0.2-0.25
Cobalt (ppb)	0.2-0.5

** Higher values are for lactating sows*

Table 5. Suggested mineral allowances for the breeding sow* (BSAS, 2003; BPEX/MLC, 2004).

With this in mind, Fehse and Close (2000) supplemented the diet of sows with a special combination of organic minerals (Bioplex Sow-Pak: Se, Fe, Zn, Cu, Mn and Cr, Alltech Inc) and reported an extra 0.5 piglets weaned per litter for sows weaning 26.5 piglets per sow per year. Sow longevity was also increased.

Since this original trial, a number of commercial and field trials have been conducted in which Bioplex Sow-Pak (with or without Cr) partially replaced or was added on top of the standard inorganic mineral supplement in the diet of the sow during gestation and lactation. Performance was measured over a single or multiple parities for sows of different breeds in several countries throughout the world .

Supplementation of the diet with Bioplex Sow-Pak increased the number of piglets weaned by 0.52 ±0.14 (n=15), with the response varying between 0.3 and 0.8 extra piglets per litter.

Assuming 2.3 litters per sow per year this equates to an extra 1.2 weaned piglets per sow per year. It was interesting to observe that the size of the litter had no effect on the number of additional piglets weaned. The response was very cost effective with a calculated ROI value of 4.5:1.

More recently, Mahan and Peters (2008) compared the form (organic or inorganic) and level of trace minerals (NRC, 1988 or 'industry') in the diet of sows over six parities.

When NRC levels were fed, there was little difference in the number of live piglets born per litter. However, when industry levels were used, there was an extra piglet born per litter when organic minerals were provided compared with inorganic minerals.

They concluded that feeding sows organic minerals may improve sow reproductive performance, possibly due to a reduction in the accumulation of free radicals which may impair reproductive performance.

Table 6. Suggested vitamin allowances for the breeding sow to be added per kg diet* (BSAS, 2003; BPEX, 2004).

Vitamin	Suggested allowances (per kg diet)
A (IU) (Retinol)	7,500-12,000
D (IU) (Calciferol)	800-2,000
E (IU) (Tocopherol)	50
K (mg) Menadione)	1.5-2.0
B1 (mg) (Thiamin)	2
B2 (mg) (Riboflavin)	5
Niacin (mg) (Nicotinic acid)	20-25
B6 (mg) (Pyridoxine)	3-4
B12 (mg) (Cyanocobalamine)	0.03
Pantothenic acid (mg)	15-20
Biotin (mg)	0.2-0.25
Folic acid (mg)	3
Choline (mg)	300
C (Ascorbic acid)	-
Essential fatty acids (g)	
linoleic acid	7
arachidonic acid	5

** Higher values are for lactating sows*

Vitamin requirements

Although vitamins are needed for the normal functioning of the body, several play a specific role in reproduction; for example: vitamins A and B, biotin, folic acid and choline. The requirements for these and the other fat and water soluble vitamins are presented in Table 6.

Recently, Matte et al. (2006) have calculated in relation to B vitamins, that there is a greater need for updating information, considering the 'dietary fine-tuning' that is required for high producing pigs.

Conclusion

To achieve a high level of productivity in the modern sow, it is not sufficient to consider just the nutritional needs of the sow per se in terms of changes in body weight and body condition. It is equally crucial to apply nutritional and management strategies that reduce the loss of breeding potential, which is currently about 40% of the genetic potential of the modern hyper-prolific sow.

Thus, it is important not only to supply sufficient energy and amino acids in the diet, but also minerals and vitamins in adequate quantities and in the most bio-available form.

Similarly, good management practices must be applied to ensure the best health, welfare and well being of the sow throughout her reproductive life. ■

References are available from the author on request.