How important is feed intake?

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Introduction

Over the past 10 to 15 years there have been very significant changes in pig performance due to selection. The result has been an increase in maximum protein deposition, a shift in the distribution of energy towards more protein and less lipid deposition, an increase in maintenance requirements and a decrease in voluntary feed intake (Knap, 2000). Using national UK data, Walters (2000) estimated that actual annual percentage changes in key production traits were:

Growth rate	+0.41
Lean growth	+0.79
Feed conversion	-0.69
Backfat	-1.66
Feed intake	-0.32

Note that while growth, lean growth, feed conversion and backfat have all shown improvements, there was a significant decline in appetite.

In markets, like that currently in Australia, where feed costs are high some producers may feel that low feed intakes are a benefit as they reduce costs. Typically, average feed costs account for some 60% of breeding-herd costs and some 35% of grow-out costs (Whittemore, 2000):

Breeding-herd production of 30kg weaner		**Grow-out unit, 30-100 kg**	
Expenditure as percentage of total:			
Feed for sows and boars	30	Weaner purchase	50
Feed for piglets	30	Feed	35
Veterinary	4	Veterinary	1
Power	4	Power	2
Other variable costs	2	Other variable costs	2
Fixed costs	30	Fixed costs	10

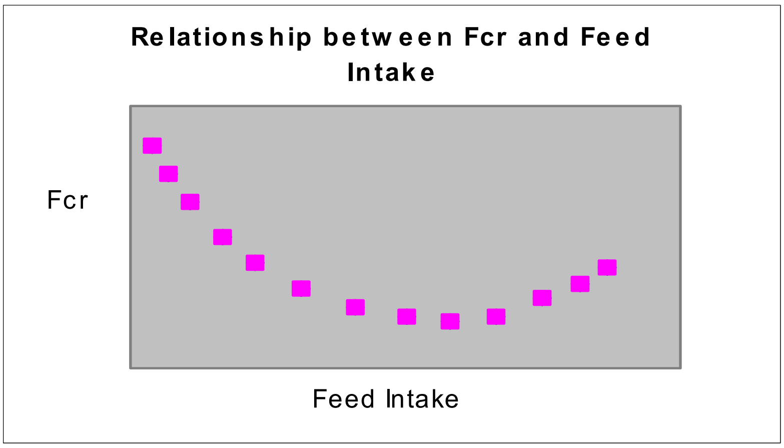
The latest UK data from the Meat and Livestock Commission (MLC, 2002) show that the feed costs for a breeder/finisher were 56.5% of total costs:

Feed Costs	Percentage
Sow	13.4
Piglet/grower/finisher	43.1
Total Feed Costs	**56.5**
Other Variable Costs	
Veterinary/Medicines	4.0
Transport	3.4
Power	3.2
Water	1.2
Straw/Bedding	1.8
Miscellaneous	1.6
Total Variable Costs	**15.0**
Fixed Costs	
Labour	17.1
Buildings	4.7
Equipment	3.7
Other	3.0
Total Fixed Costs	**28.5**

However, despite the importance of feed costs in financial terms, the trait is often ignored in breeding objectives (e.g. Luxford, 1999) or given a very low or negative economic value in selection indices (e.g. De Vries, 1989). Part of the reason is the dynamic biological effects where changes in feed intake affect other key traits – for example, feed intake is the major determinant of growth. Thus, when feed intake increases the usual result is an increase in growth. Growth models typically give general 'rules of thumb' for the effect of increasing intake by 0.1kg:

Feed conversion increases by 0.05
Growth increases by 35 grams per day (gpd)
Backfat (P_2) increases by 0.45 mm
Killing-out increases by 0.25%

However, this is a tremendous simplification as the response is usually not linear between traits. For example, there is a curvo-linear relationship between feed intake and feed conversion ratio (FCR):



Note that there is a large range of feed allowances over which there is very little change in feed conversion ratio.

Even this 'standard' relationship is a major simplification of reality because it ignores other important factors such as sex, genotype, stocking density/feeder space, environment, health status and dietary composition. Because of these factors, feed intake relationships are highly farm specific. For this reason, the knowledge of actual on-farm feed intake is a prerequisite for the effective application of nutritional standards in any particular production circumstance (De Lange, Marty, Birkett, Morel and Szkotnicki, 2001). Also, it is important to remember that, when feed intakes are being estimated from feed usage on-farm then wastage should be taken into account. The typical 'normal' range for wastage is 2 to 10%.

Practical Aspects of Feed Intake – The Sow

Just as there have been significant genetic changes in the grower/finisher there have been changes in the sow resulting in higher milk yield and maintenance costs (leading to increased energy requirements), reduced body fat reserves and reduced appetite.
As a result, the future potential for increasing litter size will require both improved management and higher feed intake capacity of the sow. For example, Eissen (2000) published data showing that modern gilts could 'cope' with up to 11 piglets – however, larger litter sizes resulted in high weight loss, large backfat loss and poorer litter growth due to inadequate feed intake:

	11 pigs	**14 pigs**
Feed intake (kg/day)	5.0	4.7
Backfat loss (mm) day10-28	2.5	3.8
Weight loss (kg) 10-28	18.8	24.0
Litter growth (kg) 10-28	42.4	44.8
Piglet growth (kg) 10-28	3.85	3.20

These results clearly indicate that future genetic increases in litter size will require an in-built increase in feed intake capacity. As a result, Eissen, Kanis and Kemp (2000) argued that sow appetite in lactation should be included in all dam-line breeding programmes. Even the feed intake of the sow in the week prior to farrowing as well as during lactation has a significant effect on the numbers weaned, the litter weight at weaning and piglet growth rates (e.g. Wahner, Scholz and Kammerer, 2001).

First results from a major co-ordinated trial in the Netherlands (Appeldoorn, 1999) reported that gilts with high feed intakes on performance test go on to have high feed intakes in subsequent lactation. This helps to explain why animals bred for low intakes have a poor record for longevity.

Karsten, Rohe, Schulze, Looft and Kalm (2000) estimated the genetic correlations between performance test traits measured in boars and the reproductive traits in their offspring. The correlations between feed intake and reproductive traits ranged between 0.12 to 0.27, suggesting that appetite is a limiting factor on sow performance and that the antagonism between production and reproduction increases with reduced feed intake.

Whittemore (2000) suggested that:

- Lactation weight loss may be largely prevented at feed intakes above 5 kg per day, but that fat loss will cease when intakes are above 8 kg.

- An extra 1 kg of feed per day over a 28-day lactation will save about 10 kg of maternal body weight loss and about 1.4 mm of P_2 backfat.

Mavromichaelis (2001) cited research that sows with minimal losses of body fat and protein during lactation take less time to return to oestrus after weaning and that the subsequent litter size tends to be higher. Simple 'rules of thumb' suggest that each extra kg of lactation feed per day will result in 1 kg extra of milk. This in turn will support about 250 g extra daily growth by the litter, resulting in higher weaning weights. Pigs that are heavier at weaning achieve market weight faster and are more efficient so that each additional kg at weaning reduces slaughter age by some 5 days.

Cameron, Kerr, Garth, Fenty and Peacock (2002) showed in a comparison of different selection lines that selection strategies that result in reduced feed intake during lactation must be avoided if lipid mobilisation is then required to attain energy balance, otherwise the result will be reduced reproductive performance.

One of the greatest problems facing global pig production is to maximise the performance of the breeding sow in hot climates. This subject was recently reviewed by Farmer and Prunier (2002). Some of their conclusions were:

- Under elevated ambient temperatures, sows decrease heat production and increase heat loss. This strategy involves reducing feed intake. In 13 trials the mean reduction in feed intake was 3.53% per ºC.

- As a result of the reduced intake there was a concomitant reduction in milk production. The reduction in lactation production in 7 trials averaged 2.37% per ºC.

- The reduction in litter growth averaged 1.77% per ºC in 7 trials.

Based on the above, it would appear that feed intake is very important for the maximisation of sow performance.

Practical Aspects of Feed Intake – The Young Pig

Many classic experiments (e.g. Campbell and Dunkin, 1983) have shown that young pigs fail to maximise protein deposition because of low appetite. Tullis, Henderson and Whittemore (1980) proved that by feeding expensive dense diets, performance could be improved such that feeding costs can actually be reduced. Furthermore, it was shown that faster growing pigs produced better carcase quality and showed less variation in the time taken to reach 25 kg. More recent data (e.g. Lawlor, Lynch, Caffrey and Doherty, 2002) have shown in 'modern genotypes' that pigs with the fastest early growth potential continue to have a growth advantage through to slaughter – each 50gpd increase in the post-weaning growth period equates to a 10 day reduction in the days to slaughter. The commercial message is clear – the feeding level in the young pig should be as high as possible to ensure that pigs are grown as close to their genetic potential as possible.

Suggested target intakes for young pigs are to be published shortly (Whittemore, in press):

Live Weight (kg)	'Standard-plus'	'Standard'	'Standard-minus'
10	0.60	0.55	0.50
20	1.11	1.01	0.92
30	1.52	1.39	1.26

Assumes healthy pigs in a thermoneutral environment fed a 13.5 plus MJ DE diet.
Standard-plus pigs have high lean growth while standard-minus tend to be slower growing and fatty.
Standard-plus intakes should be achieved in units with good post-weaning management

Based on the above, it would appear that maximisation of feed intake in the young pig is very important.

Practical Aspects of Feed Intake – Grower/Finishers

A key goal in pig production is to improve efficiency by changing the shape of the feed intake curve, particularly around 20 to 40 kg when the pig is most efficient. Improved management systems are essential in order to achieve this within batches of pigs – for example, feeder type and space allowances have a significant effect on performance and within-batch variation. Weatherup, Beattie and Walker (1998) reported that a 3kg spread at 11 weeks (35 kg) resulted in a spread of 15 kg at slaughter – this has serious commercial implications if pigs are raised in an all in-all out system and the contract weight band is financially important.

The inter-relation between immune status and feed intake has been reported by several authors. For example, Williams, Stahly and Zimmerman (1997) showed that some 6%

of net energy intake was diverted from 'growth' during immune challenge. They also showed that pigs with high feed intakes also tended to have higher immune status.

Several trials have shown that modern lean genotypes have high lean potential through to 120 kg liveweight (e.g. Chadd, Cole and Walters, 1993). Lees (1998) quoted data on entire boars and gilts grown from 80 to 120 kg that showed that limiting energy intake will significantly reduce lean deposition:

	28.5 MJ/DE	**31.0 MJ/DE**	**Ad libitum**
Feed Intake	2.19	2.37	3.08
Daily gain	675	851	1208
Feed conversion	3.25	2.82	2.58
Protein deposition gpd	109	138	176
Fat deposition gpd	102	131	268

One question that has been posed is whether the rapid lean growth of modern genotypes means that diets have become a limiting factor even at ad libitum intakes. Cameron and Macleod (1997) showed that this is the case, with high merit selection lines responding more in terms of improved growth rate to increased dietary energy, but also being much more sensitive to changing dietary protein levels. Thus, at high energy levels, the growth rate of low merit animals was little changed by altering the level of protein whereas a high merit line requires the optimum level of protein to maximise its lean growth.

Because a large percentage of the world's pigs are kept in hot climates it is important to understand the influence of such environments. Several authors have shown that high temperatures and humidity result in significantly reduced growth because of lower feed intakes. For example, Rinaldo, Le Dividich and Noblet (2000) measured performance from 15 to 90 kg in three environments:

	Temperature °C	**Relative Humidity**
Control	20.0	75
Cool Tropics	24.6	84
Warm Tropics	27.3	82

There were no significant differences between the control and the cool tropics for growth, intake, feed conversion ratio or carcase traits. However there were highly significant differences between the control and the warm tropics – growth rate was reduced by 13% as a result of a 13% decrease in feed intake. Interestingly, due to a reduction in the weight of internal organs this led to a significantly higher (+1.8%) killing-out percentage.

As for the young pig, suggested target intakes for grower/finishers are to be published shortly (Whittemore, in press):

Live Weight (kg)	'Standard-plus'	'Standard'	'Standard-minus'
30	1.52	1.39	1.26
40	1.86	1.70	1.54
50	2.15	1.96	1.78
60	2.38	2.18	1.97
70	2.57	2.35	2.13
80	2.73	2.50	2.27
90	2.87	2.62	2.38
100	2.98	2.72	2.47
110	3.07	2.80	2.54
120	3.14	2.87	2.60

Assumes healthy pigs in a thermoneutral environment fed a 13.5 plus MJ DE diet.
Standard-plus pigs have high lean growth while standard-minus tend to be slower growing and fatty.
Entire males may tend toward the high lean growth type, while castrates may tend toward the fatty type.
Farms with standard feed intake at lighter weights may find lower intakes in later stages due to negative stocking density.

The future importance of intake in the grower/finisher has been high-lighted by the use of growth modelling which allows the forecasting of future requirements with continuing genetic progress. For example, Walters (2001) projected the performance of pigs growing from 40 - 110kg at 950gm per day with an annual increase of 15gm per day over fifteen years:

Year	Growth	Lean Growth	Fat
2002	950	431	11.9
2007	1025	471	11.3
2012	1100	513	10.7
2017	1175	554	10.1

Note the increase in lean growth and the reduction in fat. The model predicted that animals would be leaner at a given weight and less mature at that weight. In combination with the increased growth the result was an increase in mature size and a resulting change in the nutrient requirements:

Year	Energy MJ DE/day	Lysine g/day	FCR*	Feed Intake*
2002	31.2	26.2	2.50	2.37
2007	32.1	28.1	2.38	2.44
2012	32.9	30.1	2.28	2.51
2017	33.7	32.1	2.18	2.57

* Assumes 5% wastage ; 13.89 MJ/DE diet

Note that the model predicted an increase in daily energy and lysine to support the genetic potential for lean growth. The result was an on-going requirement for increased daily feed intake. currently a considerable shortfall between genetic potential and commercial performance in this trait there is growing awareness that this is an area requiring considerable emphasis for the immediate future.

Based on the above, it would appear that feed intake is very important in the grower/finisher.

Summary

There is evidence of declining intake in pig populations. Although feed is the largest cost in pig production, the complex relationships between the key production traits suggest that the decline in intake will adversely affect performance. The presented data suggest that in the sow, the young pig and the grower/finisher the maximisation of feed intake must be achieved. If the current decline in feed intake is not reversed it is likely that performance and profitability will be reduced in the future. Thus, the optimisation of feed intake is very important for the global industry.

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