TECHNOLOGIES TO MAXIMISE THE GROWTH PERFORMANCE OF PIGS UNDER COMMERCIAL CONDITIONS

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I. INTRODUCTION

Pigs have the potential to produce lean meat more effeciently than all other mammalian and most animal species, and to form the basis of very efficient and profitable large scale feed production businesses. However, with few exceptions, the biological potential of the animal is rarely realised and the business opportunities offered by the animal and the technology surrounding it is rarely if ever fully exploited.

The present paper attempts to establish potential and realistic performance figures for "modern" pig production, and to illustrate how current and developing technologies, if appropriately applied and combined, can lead to production effeciencies previously considered unachievable for any other domestic animal species.

II. FACTORS AFFECTING PERFORMANCE AND COMMERCIAL REALITIES

We know from the results of thousands of research projects that modern genotypes are capable of growing at 1000 g/d from 25 to 125 kg such that it is relatively easy for scientists to grow pigs from 25 to 100 kg in only 75 days. However, experimental pigs are generally housed in individual pens where feed intake can be 20 to 30% higher than in group penning situations. Nevertheless, providing we know the constraints to improved performance we can do something about them, and in Table 1 I have summarized the potential growth rates of pigs during the various commercial phases of production, performance levels achieved under continuous flow type production systems, and realistic targets for the same systems.

Apart from trying to reduce the growth gap which exists in pigs from 25 kg onwards, the sow imposes a tremendous constraint on growth rate up to weaning and even under ideal situations pigs from weaning to 25 kg generally do not grow much faster than 500 g/d. Consequently a realistic age-for-weight target would be 65 days at 25 kg. The latter is readily achieved in the BMI systems. The major constraints to achieving this target are the piglet's weight at weaning, and feed intake and growth rate in the first 10-14 days after weaning.

Table 1. The potential, commercial and realistic weights (kg) of pigs at different stages of production.

	Potential		Commercial		Realistic Targets	
Age (days)	Weight (kg)	Growth (g/d)	Weight (kg)	Growth (g/d)	Weight (kg)	Growth (g/d)
0	1.5		1.5		1.5	
25	10.2	350	7.5	240	7.0	220
45	22.7	625	13.0	275	14.2	360
65	38.7	800	25.0	600	27.8	680
110	87.7	1000	56.5	700	63.8	800
145	122.7	1000	86.3	850	95.3	950
Growth rate from birth (g/d)		835		584		658

The figures in Table 1 are in line with the PRDC publication Pig Stats (Table 2) which provides performance and financial information for some 26,000 sows. Similarly, the realistic targets given in Table 1 are being achieved by numerous producers under continuous flow production systems. The latter is also illustrated in Table 2 which shows the growth rates achieved by the Bunge commercial herd in NSW which includes some 2,500 pure bred sows.

Table 2. Changes in commercial growth rates (g/day) over the last five years.

Year	90/91	91/92	92/93	93/94	94/95
Pig Stats	537	545	552	565	575
Bunge Meat Industies (Corowa)	539	547	563	585	610

The results in Table 2 demonstrate that growth rate certainly can be altered and that it has improved considerably over the last five years. This improvement is due in part to the industries move towards heavier carcass weights which takes advantage of the fact that pigs grow faster towards the end of the production cycle than they do at lighter body weights. Genetic improvement on the other hand has probably had little or no positive effect on growth rate over the same period, but because of better management, better nutrition and disease control, the gap between the pigs potential for growth and that achieved commercially has been reduced.

The questions which remain are: Can performance be further increased, and what are the consequences?

III. MEANS OF IMPROVING GROWTH PERFORMANCE IN TRADITIONAL HOUSING SYSTEMS

It is evident from Table 1 that the biggest gaps between the pigs inherent potential for growth rate and what is achieved commercially lie in the periods to weaning, the first 10 to 14 days after weaning, and in the "grower" phases (65 to 110 days) of production.

Apart from using quite sophisticated and not necessarily cost effective means of increasing birth weight and sow milk production, marked improvements in growth rate up to weaning are unlikely to be achieved and providing the targets given in Table 1 are being reached, efforts should be concentrated in the post weaning periods.

In the periods immediately after weaning, and from 65 to 110 days of age, feed and nutrient intake is the single biggest factor constraining growth rate. Providing the "problem" is related to the rate and not the efficiency of growth, improvements can be achieved in many ways.

1. Reducing down time. This simply means reducing the time pens are empty by minimizing the time pens are "rested" between batches of pigs either by reducing the time pens are cleaned and left to dry, or by doing the cleaning outside normal working hours.

2. Addition of additional grow out facilities/space. The addition of extra grow out facilities is generally the most expensive option. However, the advent of deep litter systems within the Australian industry can allow extra "penning" to be provided at relatively low capital cost and it is an option that should not be discarded.

3. Improving nutritional management. Growth rate can be improved at any stage of development by ensuring the diet offered the pig at the time is designed to meet the animals specific nutrient "requirements", and to overcome specific constraints on growth performance. The latter change as the pig grows, and diets should be altered accordingly, and the following techniques should be kept in mind when designing nutritional strategies to improve growth rate.

a) Phase feeding - the pigs tissue requirements, and the intrinsic constraints on performance, change rapidly in the period from weaning to 15 weeks of age, and the use of as many as five diets during this period can often be justified on the basis of cost effectiveness and improved growth rate. For example, the use of three diets declining in nutrient content and "complexity" with age and/or weight from weaning to 63 days of age ensures near maximal growth performance and flexibility, since the duration over which the various diets are fed can (and should be) altered depending on season, and the weight and age of pigs at weaning. For example the smaller pigs at weaning can be offered the first stage diet for a week longer than their heavier counterparts. The latter effect is shown in Table 3 which presents the results of an on farm experiment in which light and heavy pigs at weaning were offered a second stage weaner diet for 14 (conventional) or 19 days after weaning on growth rate. By simply increasing the time the second stage weaner is offered to lighter pigs in particular, the manager of this production unit has increased weaner growth rate (23 to 63 days) from 470 to 525 g/d.

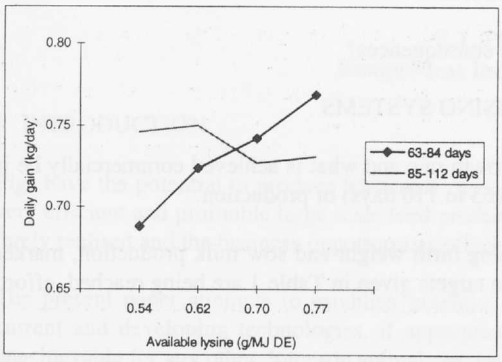
Table 3. The effect of extending the use of a second stage weaner diet for five days on the growth rate of pigs from 14 to 40 days after weaning at 23 days of age (Charlton and Williams 1996)[1].

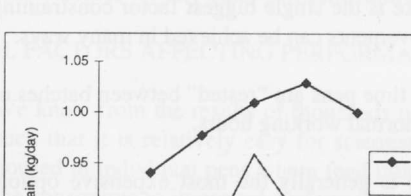
Piglet weight at 47 days (kg)	Diet	Growth rate (g/d)	
		14 - 19 days	15 - 40 days
Light			
	FSW	497	588
	SSW	368	510
Heavy			
	FSW	680	670
	SSW	545	645

[1] Pigs normally offered a superstarter diet for five days, the first stage weaner diet (FSW) for nine days and the second stage weaner diet (SSW) for 26 days.

Similar and even greater economic advantages can be achieved by phase feeding during the grower period of production. The transition period from weaner to grower in continuous flow type production units is almost as crucial to overall performance as the immediate post weaning period. This is because the pig is generally made to adjust firstly to a change in housing and environmental conditions, and secondly to the diet it is offered. In most cases the weight or variation in the weight of the pig with season, previous disease episodes or changes in mating and weaning management, are not taken into account when formulating/designing diets for this transition period. Recent research by Brewster (1995) has demonstrated that the lysine content of the diet required to support near maximal growth performance in this period is considerably higher than that currently recommended or used within Australian industry. Brewster (1995) also found that the pigs' requirement for amino acids change very rapidly in the period from 13 to 110 days of age, and that dietary lysine levels required to support near maximal growth performance in the period 63 to 84 day of age actually depress growth rate in the period 85 to 112 days of age. The latter is demonstrated in Figure 1 which shows the growth rate responses of male pigs to dietary lysine in the periods 63 to 84 and 85 to 112 days of age. These results demonstrate that phase feeding is almost essential during this period. The results also question the appropriateness of diets offered by commercial mills and recommended by industry consultants during this period.

Figure 1. The effect of dietary lysine on the daily gain of pigs between 63 and 115 days of age





Similar questions could be raised about the responses of commercial "grower" pigs to dietary energy concentration, particularly as current "recommendations" are based on the results of research conducted in the early 1980's. More recent research by Henman (1985) has demonstrated that the growing pigs responses to dietary energy content are very much dependent on the conditions under which the pig is grown (Table 4).

Table 4. The responses of male pigs to dietary energy content when housed in individual pens (IP) or commercially in groups of 20 (CP)[1]

	Dietary DE (MJ/kg)					
	12.5	13.0	13.5	14.0	14.5	15.0
Feed intake (kg/d)						
IP	2.11	2.20	2.20	2.07	1.92	1.92
CP		1.68		1.65		1.59
Daily gain (g)						
IP	975	1008	973	1009	1011	1020
CP		730		810		860
Feed:gain						
IP	2.17	2.18	2.27	2.06	1.90	1.95
CP		2.30		2.03		1.84

[1] Only three diets tested in commercial conditions.

For example Henman (1985) reported that when housed in individual pens, pigs between 63 and 98 days of age showed no response in terms of growth rate to dietary DE concentration ranging from 12.5 to 15.0 MJ/kg. However, when housed in commercial conditions growth rate improved with each increase in dietary DE content from 13.0 to 15.0 MJ/kg.

The results further demonstrate that feed intake is the major reason pigs housed commercially grow slower than those housed under more ideal conditions. They also question the appropriateness of current recommendations and strategies employed by commercial nutritionists, since the energy content of first stage grower diets is unlikely to exceed 14 MJ DE/kg. Indeed, it is obvious that the pigs development from weaning to 112 days of age is continuous, with crucial periods occurring in the first 7 to 10 days after weaning and in the first two weeks of the grower phase of production. Current diet and management changes during these periods are much more abrupt, and considerable improvement in both growth rate and cost effectiveness could be achieved, firstly by marginally extending the use of diets during these crucial periods of growth, and secondly by reassessing current nutrient requirements for pigs to 112 days of age.

The gap between the animals potential growth rate and that expressed commercially tends to decline with age and weight, and the efficiency of growth tends to become a larger constraint on profitability. Nevertheless, we know that the principles of phase feeding are equally applicable to the heavier pig, albeit not quite as spectacular since the animals' tissue requirements for amino acids change more gradually from 70 to 110 kg than they do at lighter body weights. However, the oversupply of amino acids will depress growth rate and dietary nutrient specifications need to be adjusted relative to the genetic capacity of the pig for protein deposition.

The effects of ingredients and nutrient specifications on carcass yield should also be considered when developing programmes for finisher pigs, since it is carcass weight rather than growth rate *per se* that we are trying to achieve. The current mentality however, is to use low energy diets and fibrous high N ingredients such as lupins as major sources of essential amino acids. Both strategies may have an adverse effect on carcass yield and whole herd profitability. The latter is demonstrated to some extent in Table 5 which shows the results of an experiment conducted to investigate the responses of pigs from 54 to 112 kg live weight to five levels of digestible energy under ideal commercial conditions.

Table 5. The effect of dietary energy content on the performance of pigs from 54 to 112 kg live weight.

	Dietary DE (MJ/kg)				
	11.8	12.6	13.4	14.3	15.3
Daily gain (g)	872	931	1006	1038	1017
Feed intake (kg/d)	3.31	3.23	3.36	3.28	3.00
Feed:gain	3.04	3.44	3.33	3.12	2.81
Carcass weight (kg)	81.7	83.5	83.4	85.3	86.5
Dressing Percentage	73.4	74.0	74.6	75.0	76.0

Based on these results there would seem to be considerable scope for cost effectively improving the growth rate and lean meat output from commercial production facilities by using higher energy diets for finisher pigs. Similar improvements in dressing percentage and overall growth are likely to be achieved by using low protein diets during the finisher period of production, and both aspects warrant further consideration and investigation.

4. Other factors - There are numerous other techniques/technologies proven and/or claimed to improve the growth rate of pigs under "conventional" housing systems. These include:

Exogenous enzymes such as phytase and xylanases for pigs from weaning to 42 days of age.
Zinc oxide (3000 ppm) for pigs from weaning to 42 days of age.
Spray cooling for grower-finisher pigs during summer.
Exogenous PST administration for pigs from 70 to 110 kg live weight.
Alleviation and/or removal of disease entities such as mycoplasma pneumonia, swine dysentery, ileitis, and sub clinical disease challenges.
Growth promotants such as $CuSO_4$ and products such as BMD, Virginiamycin, Posistac and others.
An adequate supply of clean/fresh drinking water.

The success or otherwise of any or all of these techniques/technologies will depend on individual circumstances, but we know from experience (most of it bad) that it is difficult if not impossible to achieve anywhere near maximal growth performance in herds affected by (infected with) mycoplasma pneumonia. The latter, I would think, remains a major constraint on the competitiveness of the Australian pig industry and emphasis should be placed on vaccine development/importation and/or cost effective medication programmes.

Alternatively and probably more sensibly, we need to think about changing current production systems and techniques which often perpetuate these problems and in turn prevent the successful implementation of new technologies including improved genetics.

5. New production and housing systems. The potential to reduce the impact of disease on the efficiency of production has led to the development of segregated production systems. Although not fully understood the technology which has been developed in the USA tends to result in quite marked improvements in growth rate. The latter is thought to be associated with the immune system and the fact that it is not activated to the same extent under these systems as it is under more conventional production systems. In Australia the concept has been combined with deep litter housing systems in which pigs are kept in groups of 200 or more from weaning through to slaughter at 100-110 kg live weight.

Both systems have enabled pigs to grow at near their maximal biological limits which in turn has served to demonstrate the consequences of very rapid growth. The latter is demonstrated in Table 6 which shows the growth performance of pigs from weaning to approximately 100 kg grown under conventional and segregated early weaning systems.

Table 6. The comparative performance of pigs from 4.5 to 104 kg live weight under conventional and segregated early weaning (SEW) systems.

	Production System	
	Conventional	SEW
Starting weight (kg)	6.2	4.5
Final weight (kg)	105.5	106.7
Age (days)	160	150
Daily gain (g)	659	711
Feed:gain	2.23	2.45
P2 (mm)	12.3	15.6

The results show it is possible with these newer systems to achieve a growth rate of 700 g/d from birth. However, the decline in feed conversion efficiency and increase in carcass fat content indicated by the increase in P2 fat thickness questions the ability of current commercial genotypes to handle these new systems or removal of the constraints which exist on feed intake and growth rate within current production systems. The "problem" is most pronounced in female pigs and is particularly evident in deep litter systems where even in groups of 200 pigs consume 20 to 25% more feed than their counterparts kept in groups of 15 to 30 in conventional housing systems.

Indeed, within deep litter systems it is possible to grow pigs at 950 g/d from 25 kg to slaughter at 110 kg live weight which is equivalent to 759 g/d from birth. However, the economics favour slower growth, particularly, from 70-75 kg onwards for female pigs because they are simply too inefficient and too fat when grown at these rates.

Consequently, growth rates of 700 g/d and above are achievable at present. The economics of attaining such growth rates are questionable and the advent of the newer production and housing systems are highlighting serious deficiencies in modern genotypes. However genotypes are now available which are capable of extremely high feed intakes without deterioration in feed effeciency or any marked increase in body or carcass fatness.

*Problems with efficiency and "fatness" are associated with new systems and/or current genotypes. Genotype problems can also be overcome immediately by using technologies such as exogenous pST administration during the last 21-28 days of production. The effects of both technologies (developing genotypes and pST) are illustrated in Table 7. The table summarises the results of a recently completed experiment to establish the potential of a commercial genotype developed using "unique biological" selection techniques for growth performance under varying feed/energy intake conditions from 80 to 120 kg, and the extent the relationships for females might be affected by pST.

Table 7. Effects of feed intake and pST administration (8mg/pig/day) on the performance of male (M) and female (F) pigs from 80 to 120 kg

		Feed intake (kg/d)		
		2.20	2.35	Adlibitum①
Daily gain (g)	M	751	898	1376
	F	598	802	1040
	Fp	862	1043	1211
Feed:gain	M	2.96	2.67	2.41
	F	3.53	3.00	2.76
	Fp	2.63	2.27	2.21
P2 (mm)②	M	9.9	11.9	12.8
	F	12.6	13.0	13.1
	Fp	8.6	10.8	10.5

Fp Female pigs treated with pST
① Adlibitum daily intakes: 3.31 kg for males, 2.84 kg for females and 2.67 kg for pST treated females.
② Ultrasonic P2

The growth rate and feed efficiency of both sexes responded positively to each increase in energy intake and when feed was offered adlibitum entire males grew at 1376 g/d and had a feed:gain of only 2.4. These performance levels have never been reported previously for "commercial" pigs of such heavy weight.

Exogenous pST administration further improved the growth rate and feed efficiency of females by 16 to 30 % and 26 to 40 % respectively.

Both technologies are currently available and when combined with the newer housing and production systems, lean meat may be produced at levels and efficiencies not previously thought biologically possible.

IV. CONCLUSIONS

There is a lot of slack within current production systems and our knowledge base, particularly as the latter applies to nutrition, disease control, genetics, and growth manipulation.

Indeed, in some of these areas Australian and New Zealand industries have not advanced much in the last five to six years.

Industry consultants, commercial feed and live stock suppliers and researchers need to be aware of these constraints and set more adventurous goals for improvements that they have in the past.

The future is both brighter and exciting. It is likely that only those with a vision, knowledge and a willingness to move away from traditional systems and thoughts will be participants in food industries based on pigs in the future.