COMMERCIAL VALIDATION OF A SINGLE DIET VERSES PHASE FEEDING IN GROWER – FINISHER PIGS

2G-109

Report prepared for the
Co-operative Research Centre for an Internationally Competitive Pork Industry

By

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January 2011

Established and supported under the Australian Government's Cooperative Research Centres Program

Executive Summary

In 2009 Karen Moore and Bruce Mullan reported on a CRC project which involved a comparison of 3 different feeding strategies for female Grower/Finisher pigs namely a conventional 3 phase programme, a blend feeding programme with the diets changing weekly and a single diet from 20 – 100 kg. L. Wt. pitched at 60 kg requirement for female pigs nominated by AusPig. The surprising outcome of this trial was that there were no significant differences between any of these treatments in terms of growth rate, feed efficiency or final carcass characteristics. Further to this, the single diet treatment resulted in a lower cost per kilogram liveweight gain by about 3c/kg. The current trial undertook to validate these findings under commercial conditions.

This trial attempted to mimic the previous study as closely as was practicable (same three treatments using the same dietary specifications) but with greater numbers (960), both male and female pigs housed at commercial stocking densities, and a fourth treatment of a standard commercial feeding programme. Overall performance was quite respectable for commercially housed pigs with an average daily gain and FCR of 893 g/d and 2.43 respectively for the 25 – 103 kg liveweight range.

Up to 60 kg liveweight the pigs on the Single Diet exhibited retarded growth due to the obvious shortfalls in amino acid supply (0.58 gm Avail. Lysine/MJ DE). In this same period the best performance was recorded on the highest lysine treatment (3 PHASE programme involved 0.75 gm Avail. Lysine/MJ DE up to 50 kg and then 0.60 gm/MJ DE to 80 kg liveweight). In the second half of the trial (60 – 103 kg. L. Wt.) the Single Diet programme delivered the best performance, and was also the highest lysine treatment in this phase. The feeding programmes involving the lowest lysine levels in this latter period (3 PHASE treatment at 0.5 gm Avail. Lysine/MJ DE and the blend feeding treatment 0.50 – 0.48 gm Avail. Lysine/MJ DE) not only recorded the poorest growth but showed a marked deterioration in feed conversion efficiency.

Although the Single Diet fed pigs were able to catch up some of their initial growth retardation, there was no evidence of compensatory growth. The growth rate, feed intake and energetic efficiency in the latter phases were similar to the treatments with comparable dietary specifications. The apparent compensation was due to the retardation of the other treatments due to amino acid under supply rather than extraordinary performance on the Single Diet. Hence the apparent respectable performance of the Single Diet approach is more an artefact of the experimental design than it is a clear endorsement of the concept.

This trial confirms the findings of Moore and Mullan (2010) that the lysine requirements of modern pig genotypes in Australia maybe higher than is currently recognised in commercial diets. This trial demonstrates that grower/finisher pigs are quite sensitive to amino acid supply and the apparent elevation of requirements extends well into the current finisher phase before easing. The validity of the Single Diet approach cannot be tested until it can be compared to a reference programme in which the pig's nutrient requirements are fully met across the entire growing period.

The results suggest that the "minimal" available lysine levels (g/MJ DE) required to support the performance of modern genetic during the live weight phases 25-40 ,40-60,60-80 and 80-105 kg are 0.75 ,0.65 ,0.58 and 0.55 respectively for males. The corresponding "requirements" of females are 0.72, 0.58, 0.58 and 0.52 respectively. These levels are similar to those reported previously for modern genetics by Moore and Mullan

The results of this project are of interest and importance to Nutritionists and commercial feed millers formulating for pigs, Production managers administering feeding programmes

and pig researchers formulating base diets for production experiments to avoid the confounding effects of nutrient shortfalls.

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1. Introduction

In January 2009, Karen Moore and Dr Bruce Mullan reported on Pork CRC Project 2A-104 conducted at Medina Research Centre, Western Australia, investigating various feeding strategies for grower-finisher pigs. This study compared 3 treatments namely:

1. a conventional phase feeding programme (20-50, 50-80, 80-100 kg)
2. a blend feeding strategy involving weekly changes to the diet to closely match the nominated nutrient requirements of the average liveweight of the pigs in the pen
3. a Single Diet from 20-100 kg liveweight.

The surprising outcome of this trial was that there were no significant differences between any of the treatments in terms of growth rate or feed conversion efficiency despite a high level of performance being achieved (Av. ADG = 955 gm/day, Av. FCR = 2.22 from 20-100 kg. LWt).

Pigs on the Single Diet programme exhibited the expected retardation of performance initially due to the obvious deficiency of amino acid supply but appeared to achieve a degree of compensatory growth in the latter stages to record a similar result overall. The Single Diet recorded a lower feed cost per kilogram liveweight gain of the order of 3c/kg and although the backfat was slightly higher numerically (11.1 compared to 10.7mm for the conventional treatment) the difference was not statistically significant.

If this Single Diet approach could be shown to be valid under commercial conditions it would have profound significance for commercial production, not only simplifying the feeding of pigs but offering a means to counter the feed efficiency drift commonly observed in the late finishing phase.

However the Medina trial was conducted in a high health research facility environment with small groups of pigs, held at a generous stocking density and with very uniform starting weights within groups. These features are not characteristic of commercial production and the potential for compensatory growth in commercial conditions is questionable.

Consequently the purpose of the current project was to validate the concept of using a Single Diet as a means to reduce feed costs without compromising performance under commercial conditions.

The APFG research unit at Brinkley is essentially a commercial grow out unit accommodating 1200 pigs/shed in 60 pens of 20 pigs. The unit has been retrofitted with a Big Dutchman computerised feed dispensing unit which can draw feed from multiple silos and dispense any nominated blend to a specific pen as programmed. Hence it has the capacity to reproduce the Medina trial under commercial conditions.

2. Methodology

This experiment was conducted at the APFG Brinkley Research Facility and the protocol was approved by the Pork CRC Research Committee and the SARDI Animal Ethics Committee. The animals were handled according to the Australian Code of Practice for the care and use of animals for scientific purposes (NHMRC, 2004).

The protocol adopted mimicked that of the Medina study as close as was practicable, but with more pigs, two sexes (male, female) and an extra treatment (commercial programme).

Treatments and Diets

A total of 960 commercial weaners [(Large White x Landrace) x Terminal Sire] were allocated to one of 4 treatments with pigs housed in groups of 20, but with each pair of pens sharing a common feeder. This yielded 6 replicates for growth rate, and 3 replicates for feed conversion for each treatment x sex combination.

The treatments applied were:

1. A Single Diet from 25-100kg liveweight with the same nutrient specification of the Medina study (13.7 MJ DE/kg and 0.58 g Avail. Lys/MJ DE).
2. A conventional 3 phase programme as employed in the Medina study with diets changing at 50 and 80 kg live weight.
3. A 4 diet programme of standard commercial diets, involving differentiation in the finisher phase only (65-100kg). The normal PAYLEAN application from 75kg LWt was omitted to reduce any confounding effects.
4. A full blend feeding programme which involved changing the proportion of the 2 extreme diets on a weekly basis to closely match the nominated AUSPIG requirements of the pigs, as used in the Medina Study.

Diets

Details of the 4 base diets from which all combinations were derived are presented in Appendix 1.

These were basically 4 standard commercial diets being Weaner, Grower 1, Finisher 1 and Presale.

Table 1 - Blending proportions and the resultant nutrient specifications of the diets

	Weaner %	Grower %	Finisher %	Presale %	Specifications		Diet Cost $/tonne*
					DE (MJ/kg)	Av. Lys/ MJ DE	
Treatment 1 - Single Diet	40			60	13.7	0.58	290
Treatment 2 - 3 Phase Feeding							
25-50	100			-	14.5	0.75	369
50-80	50			50	13.8	0.60	317
80-100	16			84	13.4	0.50	281
Treatment 3 - Commercial Diets							
Weaner	100				14.5	0.75	369
Grower 1		100			14.0	0.68	328
Grower 2		65	35		13.8	0.62	296
Finisher 1			100		13.6	0.56	283
Finisher 2	27.5		38	34.5	13.3	0.52	273

	Weaner %	Grower %	Finisher %	Presale %	Specifications		Diet Cost $/tonne*
					DE (MJ/kg)	Av. Lys/ MJ DE	
Treatment 4 - Blend Feeding	100			0	14.5	0.75	369
	90			10	14.3	0.72	359
	80			20	14.2	0.69	348
	70			30	14.1	0.67	338
	60			40	14.0	0.64	327
	50			50	13.9	0.61	317
	45			55	13.8	0.59	311
	40			60	13.7	0.58	306
	30			70	13.6	0.55	296
	25			75	13.5	0.53	291
	20			80	13.5	0.52	285
	15			85	13.4	0.50	280
	10			90	13.3	0.48	275
	0			100	13.2	0.45	264

* Diet costs are based on material costs plus manufacturing and delivery.

The Average Lysine/MJ Digestible Energy (DE) specifications for each treatment at each stage, relative to the nominated AUSPIG female requirements, have been presented in Table 2.

Table 2 - The lysine specifications (g Available Lysine/MJ DE) for each treatment relative to AUSPIG estimated requirement (females)

Approximate Liveweight (Kg)	AUSPIG Requirement	1 Single Diet	2 3 Phase	3M Commercial Male	3F Commercial Female	4 Blend
25	0.74	0.58	0.75	0.75	0.75	0.75
30	0.71	0.58	0.75	0.75	0.75(wean)	0.72
35	0.68	0.58	0.75	0.68	0.68	0.69
40	0.65	0.58	0.75	0.68	0.68(Gro1)	0.67
45	0.62	0.58	0.75	0.68	0.62	0.64
50	0.59	0.58	0.60	0.62	0.62(Gro2)	0.61
55	0.58	0.58	0.60	0.62	0.62	0.59
60	0.57	0.58	0.60	0.62	0.62	0.58
65	0.54	0.58	0.60	0.56(Fin1)	0.52(Fin2)	0.55
70	0.52	0.58	0.60	0.56	0.52	0.53
75	0.51	0.58	0.60	0.56	0.52	0.52
80	0.49	0.58	0.50	0.56	0.52	0.50
85	0.49	0.58	0.50	0.56	0.52	0.50
90	0.48	058	0.50	0.56	0.52	0.48
95	0.45	0.58	0.50	0.56	0.52	0.48
100	0.45	0.58	0.50	0.56	0.52	0.45

Animals and measurements

The pigs employed were part of the normal weekly consignment of pigs from a commercial APFG piggery. The pigs were sorted on arrival with any underweight or physically compromised pigs being excluded. The 960 pigs chosen were graded into large, medium and small liveweight range with double pens of each and each treatment was represented within each liveweight range. These weight categories essentially represent the replicates within the experiment.

The pigs in each of the paired pens shared a MAXIMAT feeder, with water attached plus 2 independent drinker nipples. The pens measured 4.7 m x 3.0 m and had partially slatted floors. The shed was naturally ventilated.

Diet change points were then programmed based on the average weight within each weight class.

The pigs were identified by a unique colour combination of ear tags for each pen to track any unplanned pig movements during the trial, but these were not required as all pigs remained within their allocated pens.

The pigs were allowed 2 days to acclimatise to the new surroundings before the initial weigh. The pigs were weighed at a common point in time every 3 weeks for the first 3 periods but the final period was staggered to ensure the large, mediums, and small sub-groups reached a similar final weight at slaughter.

Feed changes were made independent of the weigh days, in line with the average projected weight within each weight sub-group.

The three weight sub-groups were slaughtered in a staggered manner, over 3 consecutive weeks but all pigs within each group were processed at the same time and each treatment was equally represented within each weight group.

Prior to slaughter the pigs were tattooed with their pen number for easy identification at the abattoir. The pigs were processed in the standard commercial manner.

Statistics

All statistical analysis was conducted using the One-way analysis of variance (ANOVA) procedure in Statgraphics Plus 5.1 (Statistical Graphics Corp. Warrenton, VA). The growth performance and slaughter data characteristics for males and females were assessed both independently and in combination. Pen was used as the experimental unit for average daily gain and body weight analysis. Feeder was used as the experimental unit for feed conversion. For slaughter data the individual carcass was used as the experimental unit. Differences between means were identified by the least significant difference (LSD) and reported when $P \leq 0.10$ and considered significant when $P \leq 0.05$.

3. Outcomes

The male pigs averaged 23.27 kg at the start and 60 days of age (average of the large, medium, small groups were 25.83, 23.14 and 21.14 kg respectively).

The female pigs averaged 26.62 kg at the start and 66 days of age (average of the large, medium and small groups were 27.93, 27.48 and 24.45 kg respectively).

Overall the pigs averaged 25.02kg liveweight at the start of the experiment and there were no significant differences in start weight between treatments (Table 1). The results have been presented as 4 x 21 day periods for the females and 3 x 21 + 27 days for the males (3 x 21 + 24 days overall).

A summary of liveweight, feed intake, daily gain, and FCR data is presented in Tables 3, 4 and 5 for mixed sexes, females and males respectively. Carcass data (carcass weight, P2 backfat and dressing percentage) are presented in Table 6. An overview of economic outcomes and energetic efficiency of each of the dietary regimes is presented in Table7.

Table 3 - Liveweight (LW), average daily gain (ADG), voluntary feed intake (VFI), feed conversion ratio (FCR) and days on experiment for all pigs (combined sexes) fed the 4 treatments

	Treatment					
	1	2	3	4	SE	P =
	Single Diet	3 Phase	Commercial	Blend		
n =	12 (6)*	12 (6)	12 (6)	12 (6)		
No pigs/treat - Initial	240	240	240	240		
- Final	218	234	230	229		
Days on Experiment	87	87	87	87		
Live weight (kg)						
Day 0	25.27	25.19	24.65	24.98	0.373	0.971
Day 21	39.20	43.32	41.13	41.24	0.596	0.321
Day 42	56.30 a	61.46 b	59.72 ab	58.91 ab	0.714	0.075
Day 63	77.48	82.37	79.55	78.85	0.797	0.166
Slaughter (Day 87)	101.02	103.56	103.56	102.67	0.554	0.331
Voluntary Feed Intake (kg/d)						
0-21 days	1.440	1.485	1.454	1.456		
21-42 days	1.943	1.999	1.991	1.980		
42-63 days	2.440	2.467	2.470	2.419		
63-87 days	2.732	2.739	2.793	2.802		
Overall	2.159	2.173	2.177	2.164		
Average Daily Gain (g)						
0-21 days	676 a	816 b	785 b	777 b	13.8	0.001
21-42 days	818 a	910 c	885 bc	860 ab	9.7	0.004
42-63 days	1007 b	996 b	945 a	930 a	9.3	0.003
63-87 days	994 b	881 a	1011 b	995 b	16.8	0.019
Overall	871	901	907	893		
Feed Conversion Ratio						
0-21 days	2.132 b	1.779 a	1.853 a	1.872 a	0.031	0.001
21-42 days	2.377	2.195	2.245	2.302	0.033	0.251
42-63 days	2.422 a	2.473 ab	2.611 b	2.602 b	0.031	0.068
63-87 days	2.748	3.138	2.764	2.854	0.069	0.183
Overall	2.479	2.412	2.400	2.429	0.024	0.749
*n = 12 for ADG						
n = 6 for VFI, FCR						

Table 4 - Liveweight (LW) average daily gain (ADG), voluntary feed intake (VFI), feed conversion ratio (FCR) and days on experiment for female pigs fed the 4 treatments

	Treatment				
	1	2	3	4	P Value
	Single Diet	3 Phase	Commercial	Blend	
n =	6 (3)*	6 (3)	6 (3)	6 (3)	
No pigs/treat - Initial	120	120	120	120	
- Final	117	119	114	117	
Days on Experiment	84	84	84	84	
Live weight (kg)					
Day 0	26.48	26.90	26.39	26.91	0.971
Day 21	41.62	44.93	44.38	44.78	0.321
Day 42	59.00 a	64.43 b	63.42 b	62.80 ab	0.075
Day 63	80.71	85.92	83.63	82.51	0.166
Slaughter (Day 84)	100.00	103.60	104.57	101.51	0.331
Voluntary Feed Intake (kg/d)					
0-21 days	1.546	1.616	1.581	1.614	
21-42 days	2.001	2.131	2.143	2.111	
42-63 days	2.567	2.630	2.628	2.576	
63-84 days	2.719	2.837	2.896	2.830	
Overall	**2.208**	**2.304**	**2.380**	**2.283**	
Average Daily Gain (g)					
0-21 days	721 a	859 b	858 b	860 b	0.001
21-42 days	835 a	929 c	906 bc	856 ab	0.004
42-63 days	1030 b	1023 b	963 a	940 a	0.003
63-84 days	945 b	834 a	1003 b	922 b	0.019
Overall	875	913	931	888	0.165
Feed Conversion Ratio					
0-21 days	2.146 b	1.820 a	1.842 a	1.875 a	0.001
21-42 days	2.395	2.296	2.367	2.465	0.251
42-63 days	2.489 a	2.569 ab	2.729 b	2.742 b	0.068
63-84 days	2.889	3.410	2.892	3.116	0.183
Overall	2.523	2.524	2.483	2.571	0.749
*n= 6 for ADG					
n= 3 for VFI, FCR					

Table 5 - Liveweight (LW), average daily gain (ADG), voluntary feed intake (VFI), feed conversion ratio (FCR) and days on experiment for male pigs fed the 4 treatments

	Treatment				
	1	2	3	4	P Value
	Single Diet	3 Phase	Commercial	Blend	
n =	6 (3)*	6 (3)	6 (3)	6 (3)	
No pigs/treat - Initial	120	120	120	120	
- Final	101	115	116	112	
Days on Experiment	90	90	90	90	
Live weight (kg)					
Day 0	23.55	23.47	22.93	23.14	0.967
Day 21	36.78	38.70	37.88	37.70	0.162
Day 42	53.60 a	58.48 b	56.02 b	55.02 ab	0.063
Day 63	74.24 a	78.82 b	75.47 ab	75.18 ab	0.104
Slaughter (Day 90)	102.04	103.52	102.54	103.82	0.189
Voluntary Feed Intake(kg/d)					
0-21 days	1.334	1.353	1.326	1.298	
21-42 days	1.885	1.867	1.839	1.848	
42-63 days	2.313	2.304	2.311	2.262	
63-90 days	2.756	2.641	2.689	2.774	
Overall	**2.118**	**2.081**	**2.084**	**2.094**	
Average Daily Gain (g)					
0-21 days	630 a	773 b	712 b	693 b	0.000
21-42 days	801 ab	891 c	863 bc	864 ab	0.031
42-63 days	983 b	969 b	927 a	920 a	0.004
63-90 days	1041 ab	928 a	1018 b	1068 ab	0.037
Overall	872 a	890 bc	885 c	896 ab	0.026
Feed Conversion Ratio					
0-21 days	2.117 b	1.737 a	1.863 a	1.868 a	0.000
21-42 days	2.353 ab	2.094 a	2.123 ab	2.139 b	0.044
42-63 days	2.354 a	2.377 ab	2.492 b	2.461 b	0.032
63-90 days	2.662 a	2.865 b	2.636 a	2.592 ab	0.081
Overall	2.429	2.338	2.355	2.337	0.492
*n= 6 for ADG					
n= 3 for VFI, FCR					

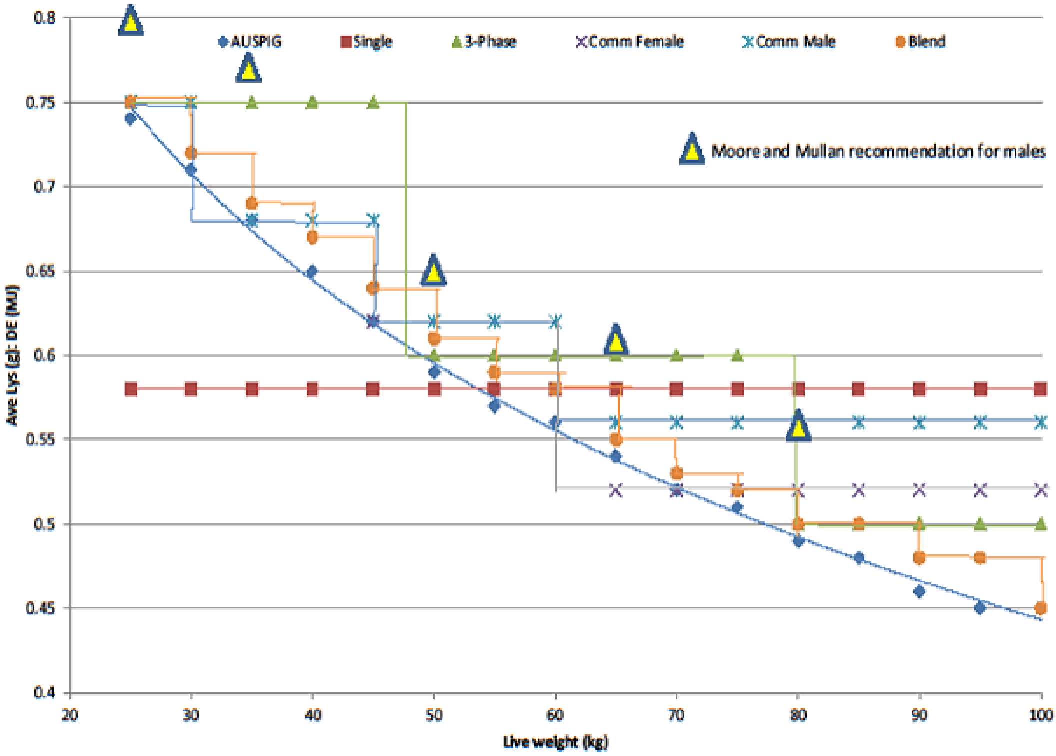
During the first two, 21 day periods (approximately 25-60 kg L.Wt) pigs on the Single Diet programme exhibited retarded growth due to the amino acid shortfall. This was most marked in the first period (17.2% and 10.1% lower ADG compared to the 3 Phase treatment in period 1 and 2 respectively).

As feed intake was similar between treatments in these two periods the FCR differences were of the same order. A part of this effect can be explained by the energy density differences (13.7 MJ DE/kg in the Single Diet verses 14.5 MJ DE/kg in the first stage of the 3 Phase programme). This would account for 5.6%

difference in FCR so most of it was due to the amino acid shortfall in the first period, but declining in the second period as the apparent requirement moved closer to the Single Diet lysine content.

The responses in the first 2 periods to the Commercial programme and the Blend Feeding programme were intermediate between the Single Diet and 3 Phase programme and in line with their amino acid contributions (see Figure 1).

Figure 1 - Schematic of treatments applied relative to the assumed AUSPIG requirement curve



In period 3, (approximately 60-80 kg L. Wt) the Single Diet and 3 Phase programme produced similar ADG and FCR responses in line with their similar lysine concentrations (0.58 and 0.60 gm Av. Lys/MJ DE respectively). The Commercial programme and the Blend Feeding programme recorded lower ADG and poorer FCR values due to their lower lysine concentrations, suggesting they were now moving below the apparent requirement.

In the final phase (approximately 80-100 kg) the Single Diet and Commercial programmes recorded similar values (at similar lysine concentrations 0.58 gm Av. Lys/MJ DE for the Single Diet, 0.56 gm Av. Lys/MJ DE for the male and 0.52 gm Av Lysine for the females in the Commercial programme).

The 3 Phase programme recorded the poorest ADG and FCR in this phase due to its lower lysine contribution. The female pigs on the Blend Feeding programme demonstrated a similar reduction in ADG and FCR in proportion to the lysine inputs provided, but the males produced an anomalous result performing similarly to the Single Diet treatment.

Overall the full grow out period there was no significant differentiation between the 3 Phase, Commercial programme or Blend Feed treatments in terms of ADG, VFI and FCR.

The Single Diet group fell behind initially but recorded "normal" performance in the second half of the trial to end up approximately 2 kg liveweight lighter than the other treatments at the end (3.5% lower ADG overall) suggesting there was no compensatory growth in the final stages to offset the initial retardation. The Single diet group achieved the same or similar FCR values over the entire study as pigs on the other three treatments.

As dressing percentage was not affected by treatment the carcass weights were in line with the live weight differences between treatments. Carcass weights did not differ between treatments for entire male pigs. For females, pigs from the single diet treatment produced a significantly lighter carcass than those from the 3 phase and commercial programs (Table 6).

Table 6 Carcass Weight (kg), Backfat (mm) and Dressing %

Sex	Weight Categor	Days on Test	Treatment												SE	P Value
			1 (Single Diet)			2 (3 Phase Program)			3 (Commercial Program)			4 (Blend Feeding)				
			Carcass Wt	P2	Dress %	Carcass Wt	P2	Dress %	Carcass Wt	P2	Dress %	Carcass Wt	P2	Dress %		
Males	Heavy	83	75.67	10.21	74.32	76.17	10.4	74.26	74	10.4	73.82	75.29	9.	73.75		
	Medium	91	70.95	10.95	74.09	78.1	10.83	75.31	77.65	10.7	73.67	78.25	11.74	73.93		
	Light	96	81.4	11.78	74.96	77.84	70.08	74.63	75.72	10.61	74.24	76.75	10.43	74.11		
	Average		76.01			77.37			75.79			76.76				0.665
	Average			10.98			10.27			10.72			10.62			0.182
	Average				74.46			74.73			73.91			73.93		
Females	Heavy	77	73.51	11.25	75.39	76.96	10.98	77.15	74.73	11.51	75.37	74.48	11.2	75.52		
	Medium	85	81.2	12.55	77.44	80.98	13.45	77.41	83.13	13.85	76.83	78.42	11.8	76.69		
	Light	90	74.85	11.14	76.67	82.54	12.21	77.54	79.77	12.52	75	79.19	12.85	76.38		
	Average		76.52 a			80.16 c			79.21 bc			77.36 ab				0.007
	Average			11.65			12.21			12.63			11.95			0.173
	Average				76.5			77.37			75.73			76.2		
	Overall		76.26 a			78.77 b			77.5 ab			77.06 a			0.282	0.047
	Overall			11.32			11.24			11.68			11.29		0.098	0.417
	Overall				75.48			76.05			74.82			75.07		

The different growth patterns induced by the various treatments did not produce any significant differences in P2 backfat values, between the treatments (Table 6).

4. Application of Research

The principle tenet of blend or phase feeding is that feed conversion efficiency will be optimised if the steps in nutrient supply closely match the animal's changing requirements.

Recent lysine requirement titration studies (Moore and Mullan, 2010) suggest that the requirements at each liveweight stage assumed for this study (and the Moore and Mullan, 2009 project it emulated) were understated. Consequently the comparison of a Single Diet verses phase or blend feeding strategies was compromised to the extent that the latter deviated from the animal's actual requirement.

In the first 2 periods (approximately 25 – 60 kg Lwt) the Single Diet was clearly deficient in lysine, resulting in slower growth and poorer feed efficiency. The highest lysine treatment in this period (the 3 Phase Programme) supported the best growth and feed efficiency, and values not dissimilar to Moore and Mullan, 2009, 2010, considering the weight range difference and commercial conditions. (Table 7)

Table 7 - Current results are compared with those of Moore and Mullan for 25-60kg Lwt.

	Moore & Mullan, 2009 (22-55 kg)		Moore & Mullan, 2010 (22-53 kg)		This Study (25-60 kg)	
	Male	Female	Male	Female	Male	Female
ADG (g/d)	-	910	890	900	832	894
FCR	-	1.89	1.65	1.80	1.92	2.06

The Blend Feeding and Commercial treatments recorded lower growth rates and poorer FCR than the 3 Phase treatments in this period, implying that the reduction in lysine levels was premature.

Beyond 60 kg liveweight the Single Diet had the highest lysine content and supported superior growth and feed efficiency.

In the original trial (Moore and Mullan, 2009) a similar phenomenon was observed and reported as compensatory growth following the initial retardation. However, in the current trial there does not appear to be any compensatory growth but merely a return to normal growth as the requirement is satisfied. The apparent compensatory effect is more to do with the other treatments falling off in performance due to their lysine contributions falling below actual requirements, rather than any extraordinary response to the Single Diet.

In the 60 – 100 kg liveweight range the performance on the Single Diet treatment was similar to the Commercial treatment (which was the closest in terms of lysine specifications).

Table 8 - Summary of results in 60-100kg Lwt

	Single Diet (0.58 gm Av. Lys/MJ DE)		Commercial Programme (0.62/0.56, 0.62/0.52 gm Av. Lys/MJ DE)	
	Male	Female	Male	Female
ADG gm/day	1012	988	973	983
FCR*	2.51	2.69	2.54	2.73

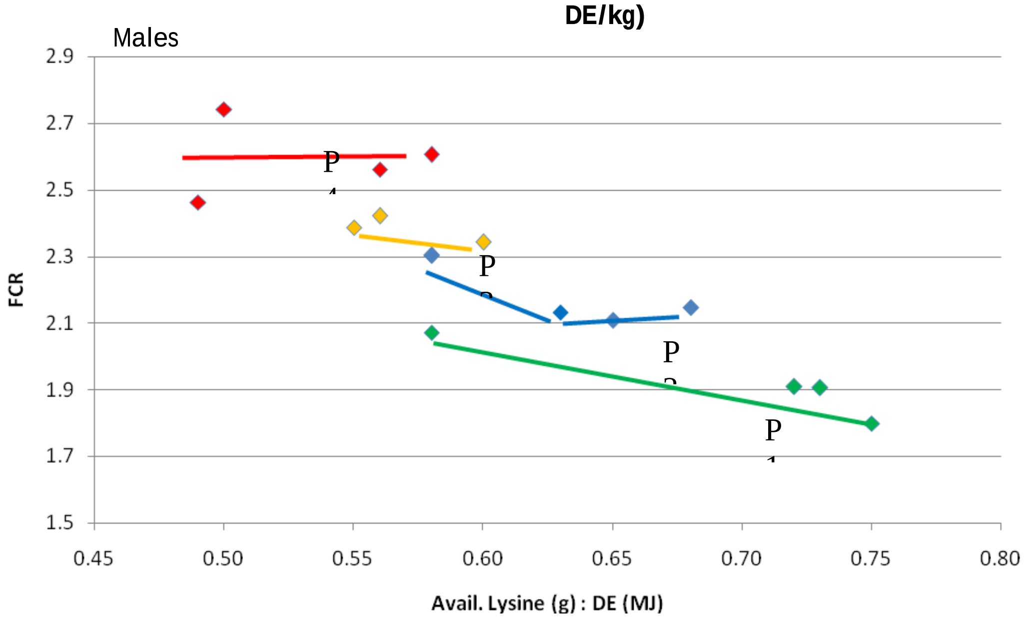
(* Corrected to a common 13.7 MJ DE/kg)

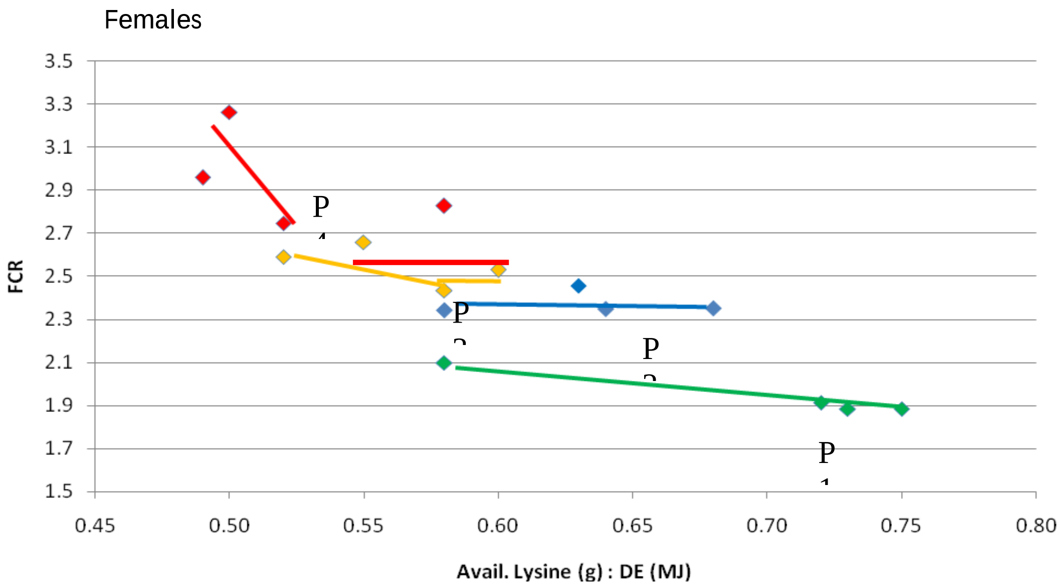
Feed conversion ratios corrected to a common 14.0 MJ DE/kg energy level, for each treatment in each of the four periods, are presented in Figure 2. Although this trial was not designed as a lysine requirement titration, estimates of apparent requirement can be made from this data and are shown in the table below.

Table 9 - Comparison of estimated lysine levels required to support near maximal performance (g Avail Lysine/MJ DE)

	This Study		Moore and Mullan (2010)		AUSPIG
Liveweight	Males	Females	Males	Females	Female
25-40	0.75	0.72	0.77	0.76	0.68
40-60	0.65	0.58	0.65	0.60	0.59
60-80	0.58	0.58	0.60	0.55	0.52
80-100	0.55	0.52	0.53	0.50	0.48

Figure 2 - FCR Response X Period (P) (Corrected to 14.0 MJ DE/kg)





In Table 10, a comparison of the cost of feed in each dietary regime and the subsequent feed cost per kilogram of liveweight gain or carcass gain, revealed that the single diet and commercial programmes were very similar, and considerably more cost effective than the 3 Phase or Blend Feeding programmes, particularly for females. For females the single diet program was $7.23/pig lower cost than the 3 phase program and the lowest cost of the four programs investigated.

Table 10 - Economic Comparison and Energetic Efficiency

	Treatment			
	1	**2**	**3**	**4**
	Single Diet	**3 Phase**	**Commercial**	**Blend**
Males				
Δ L. Wt. (kg)	78.49	80.05	79.61	80.68
Δ Carcass Wt. (kg)*	58.11	58.23	58.50	59.17

	Treatment			
	1	2	3	4
	Single Diet	3 Phase	Commercial	Blend
Total cost of feed/pig ($)	55.28	59.56	56.44	57.92
Feed cost/ Kg L. Wt. ($)	.704	.744	.709	.718
Feed cost/kg Carcass ($)	.951	1.023	.965	.979
Total MJ DE/pig	2611	2593	2586	2586
MJ DE/kg L. Wt. Gain	33.3	32.4	32.5	32.1
MJ DE/kg Carcass Gain	44.9	44.5	44.2	43.7
Females				
Δ L. Wt. (kg)	73.52	76.7	78.18	74.6
Δ Carcass Wt. (kg)	56.4	59.72	59.15	56.91
Total cost of feed/pig ($)	53.79	61.02	56.29	55.16
Feed cost/kg L. Wt. ($)	.732	.796	.720	.739
Feed cost/kg Carcass ($)	.954	1.022	.952	.969
Total MJ DE/pig	**2541**	**2672**	**2634**	**2631**
MJ DE/kg L. Wt. Gain	34.6	34.8	33.7	35.3
MJ DE/kg Carcass Gain	45.1	44.7	44.5	46.2

This does not necessarily endorse the Single Diet concept as a cost effective strategy as the commercial programme was also likely to be lysine deficient particularly in the latter stages and differences in carcass weight and income also need to be considered. However it does confirm that this approach may reduce the cost of feeding and warrants further investigation.

The energy consumption was quite common across most of the dietary treatments with males being marginally more efficient on a live weight basis, but similar and not statistically different from females on a carcass basis.

The average energy cost per kilogram of liveweight gain of 33.6 MJ DE is still somewhat short of the Pork CRC target of 28.0 MJ DE. This can be partly explained by a mortality rate of 5.1% during the trial mainly due to APP. With this level of mortality the immune challenge on the surviving pigs would be substantial and no doubt would have drained a proportion of feed energy that would have otherwise gone to growth. It may e coincidental but the greatest losses were recorded in the Single Diet males (see Tables 3 & 4 above). One of the downsides to protein restriction in the early grower stage could be that it compromises immune development and leaves the pig more vulnerable to disease challenges.

Energetic Efficiency

The energy cost per kilogram of liveweight gain for each period is presented in Table 11. The results indicate that energetic efficiency declines as the pigs mature. The latter is expected, but the movement in the final period is quite marked particularly in those treatments obviously deficient in lysine. The analysis also reveals no indication of any improved energetic efficiency associated with the single diet treatment, confirming the point that there was no compensatory growth.

Table 11 - Energetic efficiency x weight range (MJ DE/kg L.Wt. Gain)

		Treatment							
		1		2		3		4	
		Single Diet		3 Phase		Commercial		Blend	
Period	**Approx L.WT. (kg)**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
1	25 – 40	29.01	29.40	25.19	26.39	26.68	26.39	26.71	26.81
2	40 – 60	32.24	32.82	30.04	32.94	29.51	32.90	29.83	34.38
3	60 – 80	32.26	34.10	32.80	35.45	33.89	36.29	33.42	37.24
4	80 – 103	36.47	39.72	38.39	45.75	35.85	38.46	34.47	41.44

5. Conclusion

This trial confirms the findings of the Medina study (Moore and Mullan, 2009) in that the Single Diet treatment performs similarly overall as the various phase feeding treatments. However the current results suggest this is more an artefact of the experimental design than it is a confirmation of the validity of the Single Diet approach.

The lysine requirement assumptions adopted for this experiment appear to have been understated. As such, all of the treatments involve sub-optimal lysine supply at some stage of the experiment (either early or late).

As a consequence the full growth and feed efficiency potential of the stock was not realised and hence we have not established a valid base line to compare the Single Diet approach against.

It is clear that feeding a single 0.58 gm Av. Lysine/MJ DE diet below 60 kg liveweight results in a marked retardation of growth. Beyond 60 kg liveweight the pigs on this diet grew normally with no evidence of any compensatory growth, so the weight gain foregone prior to 60 kg liveweight is unlikely to be recovered in the subsequent growth phases.

6. Limitations/Risks

However, we have still not witnessed the full potential growth response facilitated by a dietary programme that met the amino acid requirements in each phase. It may well be that the current concept of a smooth declining requirement curve is too simplistic.

The lysine titration of Moore and Mullan (2010) demonstrates that the apparent female Av. Lysine/DE requirement (gm Av. Lys/MJ DE) varied from 0.77 in the 30 – 50 kg range, down to 0.60 in the 50 – 65 kg range, rising to 0.70 in the 65 – 80 kg range and falling markedly to 0.50 in the 80 – 95 kg range. These bumps or plateaus in the requirement curve may be quite real corresponding to possible pre-pubertal growth spurts and, as such, need to be considered in the development of feeding strategies aimed at optimising feed efficiency or minimising the cost of liveweight gain.

7. Recommendations

Whatever the explanation, it would appear that amino acid requirements in modern genotypes are not only elevated relative to previous estimates, but the animals appear very sensitive to amino acid supply and the higher requirements persist well into the current finisher phase before easing.

Pig fed diets containing 0.50 gm Avail. Lysine/MJ DE or less in the finisher phases are likely to be lysine deficient which could provide a part of the explanation for the upward drift in FCR in the late finisher phase of commercial pig production.

8. References

MOORE, K and MULLAN, B (2009) Evaluation of feeding strategies and measurement of feed consumption using the FEED LOGIC System. CRC Internal Report Feb, 2009.

MOORE, K and MULLAN, B (2010) Lysine requirements of pigs from 20 to 100 kgs live weight. Pork CRC Project 2A-104: Expts 2+3.

Appendix 1: Base diets employed (kg/3 tonne)

	Weaner	Grower 1	Finisher 2	Presale
Wheat	1703	1248	300	300
Barley	450	900	1946	1945
Peas	150	300	240	150
Millmix	-	-	90	270
Canola	180	250	240	150
Soybean meal	120	-	-	-
Meat meal	145	165	60	60
Fish meal	60	-	-	-
Blood meal	55	40	-	-
Molasses	30	-	-	-
Tallow	58	42	53	60
Salt	6	6	6	6
Limestone	19	28	44	42
BIOFOS	-	-	8	6
Lysine SO4	13.6	11.8	6.6	4.5
Alimet	1.6	1.6	-	-
Threonine	1.3	1.5	-	-
Avizyme	1.2	0.6	0.6	0.6
Phyzyme	0.3	0.3	0.3	0.3
Vitamin/ min premix*	6	6	6	6
Nutrient Composition				
DE (MJ/kg)	14.5	14.0	13.3	13.2
Crude protein %	20.9	19.3	15.8	15
Avail. Lysine %	1.09	0.95	0.69	0.59
gm. Av. Lys/ MJ DE	0.75	0.68	0.52	0.45