EVALUATION OF PHASE FEEDING COMPARED TO A SINGLE DIET STRATEGY FOR GROWING-FINISHING PIGS

PROJECT ID A3A-105

Final Report prepared for the Australasian Pork Research Institute Limited (APRIL)

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Executive Summary

Previous APRIL funded research - APRIL project A3A-103 - indicated advantages in feeding a single diet throughout the growing-finishing period, compared to a traditional phase feeding approach. The APRIL project 3A-103 was conducted in Western Australia using female pigs of a Large White × Landrace × Duroc cross. The experimental results showed no significant effects of feeding strategy [i.e., Phase: four separate diets over grower/finishing period compared to three single diet strategies- Single 50: (0.67 g SID Lys/MJ DE); Single 60: (0.65 g SID Lys/MJ DE) and; Single 70: (0.60 g SID Lys/MJ DE)] on growth performance, carcass weight or backfat at slaughter. There was a trend for pigs who received the Single 60 or Single 70 diet to have an improved feed conversion ratio compared to those fed the Phase or Single 50 diet (P=0.062). It was cheaper to feed pigs the Single 70 diet than the Single 60 diet, which in turn was cheaper than both the Single 50 and Phase diets (P<0.001).

The current experiment was commissioned by APRIL to further investigate the potential of a single diet strategy, in a large commercial environment, using pigs from a different genetic background (i.e. PrimeGro™ Genetics).

The current experiment compared growth performance, carcass measurements and profitability of a three-diet phase-feeding program compared to three single-diet feeding programs in both immunocastrated male and female pigs. The phase feeding program used an early grower diet from 10 to 13 weeks of age (EG; 14.0 MJ DE and 0.75 g SID Lysine per MJ DE), a late grower diet from 14 to 16 weeks of age (LG; 13.8 MJ DE and 0.65 g SID lysine per MJ DE), and a finisher diet from 16 weeks of age to sale (FIN; 13.5 MJ DE and 0.62 g SID lysine per MJ DE). The average age for sale was similar among the treatments. The pigs in the other three feeding programs received a single diet (either EG, LG or FIN) from 10 weeks age until slaughter. There were 10 male pens (49 pigs per pen) and 10 female pens (45 pigs per pen) in each feeding program.

The feeding programs significantly affected average daily gain (ADG) (P=0.004) and FCR (feed conversion ratio) (P=0.022) but not average daily feed intake (ADFI) (P=0.080). Specifically, pigs in the EG group and phase-feeding group both had greater ADG than pigs in the FIN group. The ADG of EG, LG and phase-feeding groups were not significantly different. The pigs in the EG group had a better (all P<0.05) FCR than the other groups (that were not different in FCR).

The feeding programs affected the hot standard carcass weight (HSCW; P=0.053), such that pigs in the EG group and phase-feeding group had a greater HSCW than the FIN group (both P<0.05). Carcass backfat thickness at the P2 site was not affected by the feeding programs unless HSCW (75.0 kg) was used as a covariate, such that pigs in the EG group had a lower backfat thickness than the phase feeding and LG groups (both P<0.05).

Feeding programs impacted profitability. Over all pigs (combined immunocastrated males and females), use of a single diet finisher feed (FIN) had the lowest feed cost/kg liveweight gain ($0.85/kg) followed by the phase feeding ($0.86/kg), single diet late grower (LG) and single diet early grower (EG) ($0.88 and $0.91/kg liveweight) diets.

For immunocastrated male pigs, the single diet FIN had the lowest feed cost/kg liveweight gain ($0.83/kg) followed by the single LG, phase feeding and single EG ($0.84, $0.85 and $0.88/kg) diets.

For female pigs, the single diet FIN and phase feeding diets had the lowest feed cost/kg liveweight gain ($0.88/kg) followed by the single LG and single EG ($0.92 and $0.95/kg) diets.

However, when calculated as net profit/pig over the entire experimental cohort, for combined sexes and female pigs, use of a phase-feeding program was most profitable. However, for immunocastrated male pigs, use of a single EG diet was most profitable.

In summary, the current research provides large scale, commercial data that:

- Supports the use of phase feeding three diets to female pigs between 25 and 100 kg liveweight and where split sex feeding is not practical.
- Supports the use of a single grower specification diet (specification targeting between 14 MJ DE and 0.75 g SID lysine/MJ DE and 13.75 MJ DE and 0.65 g SID lysine/MJ DE) being fed to immunocastrated male pigs.

However, the economic evaluation conducted in this study depends on two factors that change over time:

1. Feed ingredient prices – particularly the cost of dietary energy and protein.
2. Prevailing carcass grids and price penalties for being outside weight and backfat depth specifications.

This research suggests that using an appropriately formulated and fed single diet in the grow-finish phase can be practically applied by the Australian pork industry. However, it is critical for each producer to consider the abovementioned factors when assessing the feasibility of adopting the use of such a feeding strategy.

Furthermore, this research was conducted in commercial/conventional shedding, and it is recommended that a similar study is conducted in deep-litter/eco-shed housing where intakes are higher and carcasses grade fatter.

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1. Introduction

Traditionally pigs are fed multiple diets between weaning and sale to:

- Cater for the developing/maturing digestive system of the young pig;
- Gradually increase use of lower value, less digestible ingredients;
- Match the changing needs of the pig for dietary nutrients (especially energy and amino acids) to meet maintenance and growth requirements as the pig matures;
- Reduce/optimize feed costs;
- Maximise carcass returns under prevailing sales grids.

Under some circumstances, feeding a single diet to growing-finishing pigs may be a practical alternative to phase feeding. A single diet over the grower and finisher period would improve and simplify feed manufacture, storage and delivery. However, critically, use of a single diet must be shown to be comparable to phase feeding in terms of the key profit drivers - feed cost, carcass weight and carcass fat measures.

Previous studies, including APRIL project 3A-103, suggested there may be no difference in growth performance and carcass characteristics, but an economic advantage, to feeding a single diet formulated to a specific SID Lys/DE ratio throughout the growing-finishing period, compared to a traditional phase feeding approach. Results from APRIL-funded project 3A-103 (*Feeding a single diet to pigs in the grower/finisher stage to reduce feed costs and improve feed efficiency*) conducted in Western Australia using female pigs of a Large White×Landrace×Duroc cross showed no significant effects of feeding strategy [i.e., Phase feeding: diets changed when the average LW of pigs reached 23 kg (0.84 g standardised ileal digestible lysine (SID Lys/MJ DE), 50 (0.67 g SID Lys/MJ DE), 70 kg (0.60 g SID Lys/MJ DE) or 90 kg (0.52 g SID Lys/MJ DE); Single 50: the same diet fed throughout (met Lys requirements 50 kg LW; 0.67 g SID Lys/MJ DE); Single 60: the same diet fed throughout (met Lys requirements at 60 kg LW; 0.65 g SID Lys/MJ DE) and; Single 70: the same diet fed throughout (met Lys requirements at 70 kg LW; 0.60 g SID Lys/MJ DE] on growth performance, carcass weight or backfat at slaughter. There was a trend for pigs who received the Single 60 or Single 70 diet to have an improved feed conversion ratio compared to those fed the Phase or Single 50 diet ($P=0.062$). It was cheaper to feed pigs the Single 70 diet than the Single 60 diet, which in turn was cheaper than both the Single 50 and Phase diets ($P<0.001$).

The experimental outcomes were derived under the conditions of this genotype using their estimated amino acid and energy requirements, and under the farm's specific management and feeding conditions. Responses may therefore be different, or of a different magnitude, using other genotypes that might have different amino acid and energy requirements and (or) be kept under different management and feeding conditions.

2. Methodology

Animals husbandry and experimental design

The procedures that involved animals in the current study were in accordance with the Australian Code for the Care and Use of Animals for Scientific Purposes (8th edition) (National Health and Medical Research Council 2013) and approved (Protocol ID 20N010C) by the Animal Ethics Committee of Rivalea Pty Ltd, Corowa, NSW, Australia.

The experiment followed a 4×2 factorial arrangement of treatments (n=10 pens per treatment) to study the effects of feeding programs (phase feeding, early grower phase diet, late grower phase diet and finisher phase diet), sex (immunocastrated male pigs vs female pigs), and their interactions, on growth performance and commercial carcass traits. A total of 80 pens was allocated into the treatments based on the four feeding programs and two sexes, resulting in 10 male pens and 10 female pens in each feeding program. The live animal phase of the experiment was conducted in group pens fitted with an automatic feeding system at the Research and Innovation Unit of Rivalea Australia Pty Ltd (Corowa, NSW, Australia) between 18 May and 18 August 2020. Pigs were housed in pens (49 pigs per pen for immunocastrated male and 45 pigs per pen for female) with a solid concrete floor and walls, and partially slatted areas. Landrace × Large White × Duroc male and female pigs (Primegro™ Genetics, Corowa, NSW) were selected into the experiment at 10 weeks of age with an average body weight of 27.0 ± 4.25 kg (mean ± standard deviation), and randomly allocated into the 4×2 arrangement. The early grower phase (EG; 14.0 MJ DE and 0.75 g SID Lysine per MJ DE), late grower phase (LG; 13.8 MJ DE and 0.65 g SID lysine per MJ DE), and finisher phase (FIN; 13.5 MJ DE and 0.62 g SID lysine per MJ DE) diets were formulated to contain similar or excess nutrients levels recommended by NRC 2012 (Table 1). Diets were manufactured multiple times over the 3-month trial period.

In the phase feeding program, pigs received the EG diet from 10-13 weeks of age, the LG diet from 14-16 weeks age, and the FIN diet from 16 weeks until slaughter (av. 22 weeks age). The pigs in the other three feeding programs received a single diet (either EG, LG or FIN) from 10 weeks of age until slaughter. The pigs had *ad libitum* access to feed and free access to water via nipple drinkers. Male pigs received the second vaccination dose of Improvac™ (Zoetis) during the experiment at 18 weeks age. Pigs were sold by pen over 14 days on 5 day points targeting a 95 to 100 kg target weight, and one female and one immunocastrated male pen from each treatment were sold on each market day point. On average pigs were sold at an average of 22 weeks of age. One pen of female pigs that received the phase feeding program was excluded from the data analysis due to a reported error in its feed delivery system.

Growth performance and carcass traits

Growth performance was evaluated between 10-16 weeks age, 10 weeks to sale, and 16 weeks to sale. The total body weight and number of pigs in each pen were recorded at 10 weeks of age, 16 weeks of age and the day before slaughter. The average daily feed intake (ADFI), average daily gain (ADG) and feed conversion ratio

(FCR; feed consumed: live weight gained) were calculated based on the total weight of pigs in the pen, total feed allocation, and the number of pigs in the pen. The hot standard carcass weight (HSCW; head on, visceral tissue off, trotters on), backfat thickness at the P2 site (65 mm from the midline over the last rib; Hennessy Chong fat depth probe measurement), and loin depth (at P2 site) from each individual pig were measured in the abattoir (Rivalea Australia Pty Ltd, Corowa, NSW, Australia). Average dressing percentage for each pen was calculated by the ratio between average HSCW and average live weight of the pen.

Statistical analysis

Data on growth performance and carcass traits (using the average of each pen as an experimental unit) were analysed using the UNIVARIATE procedure for the effect of feeding programs (phase feeding, EG, LG and FIN) and sex (immunocastrated male vs female). The entry body weight was used as a covariate for analyzing all the variables. Hot standard carcass weight was used as an additional covariate for analyzing carcass backfat and loin depth. A probability of $P \leq 0.05$ was regarded as statistically significant. The interaction between sex and feeding programs was not significant for any of the measurements, thus the results were presented as the marginal mean from the main effect of the feeding program and the main effect of sex. The Least Significant Difference (LSD) method was used for *post-hoc* pair-wise comparison when the main effect of the feeding program was significant. All the statistical analyses were conducted in SPSS (IBM SPSS Statistics for Windows, v25, Armonk, NY).

Economic analysis

The market value of each carcass was graded based on $3.25 per kg HSCW weight for carcass backfat (P2) < 14 mm and $2.90 per kg HSCW weight for carcass backfat (P2) ≥ 14 mm. The cost of production consists of cost of feed consumed (mean values of each treatment group) and a fixed amount of other costs (eg: pigs values at the start of the experiment). The profit was calculated using the mean carcass values from each treatment group substrating the average cost of production of the treatment group. The changes of profit in relative to the phase feeding program were reported for each treatment group.

Table 1 Diet formulations.

Ingredient %	Early grower (EG) (25-45 kg) $382/t	Late grower (LG) (45-65 kg) $359/t	Finisher (FIN) (65-105 kg) $347/t
Wheat	43.1	44.5	40.5
Barley	25.0	30.0	35.0
Millrun	5.0	7.5	10.0
Canola meal	15.0	11.0	9.7
Soybean meal	3.0	0	0
Meat meal	4.0	2.0	0
Tallow	2.0	1.5	0.83
Limestone	0.67	0.83	1.0
Dicalcium Phosphate	0	0.40	0.67
Lysine-HCL	0.50	0.50	0.50
DL-Methionine	0.05	0.05	0.06
Threonine	0.13	0.14	0.15
Mineral premix[1]	0.13	0.13	0.13
Vitamin premix[2]	0.06	0.06	0.06
Feed enzymes[3]	0.025	0.025	0.025
Salt	0.33	0.33	0.33
Calculated energy and nutrients			
Digestible energy, MJ/kg	14.0	13.75	13.5
Protein, %	19.5	16.7	15.4
Fat, %	4.1	3.4	2.7
Fibre, %	5.0	4.9	5.0
Calcium, %	0.78	0.80	0.80
Available phosphorus, %	0.43	0.43	0.43
Total Lysine, %	1.23	1.03	0.96
SID lysine, %	1.05	0.89	0.84
SID lysine g/MJ DE	0.75	0.65	0.62
Met:Lys	0.30	0.30	0.32
Thr:Lys	0.67	0.68	0.70
Try:Lys	0.20	0.20	0.20
Iso:Lys	0.58	0.57	0.56

[1] Supplied per kg of grower diets: copper, 101 mg; manganese, 46.8 mg; zinc, 73.0 mg; iron, 56.0 mg; iodine, 0.675 mg; selenium, 0.30 mg; chromium 0.16 mg. Supplied per kg of finisher diets: copper, 100 mg; manganese, 28.0 mg; zinc, 50.0 mg; iron, 70.0 mg; iodine, 0.50 mg; selenium, 0.20 mg; chromium 0.20 mg.

[2] Supplied per kg of grower diets: vitamin A, 5000 IU; vitamin D3, 1000 IU; vitamin K, 0.66 mg; vitamin B-1, 1.0 mg; vitamin B-2, 3.3 mg; vitamin B-6, 2.0 mg; vitamin B-12, 6.7 µg; niacin, 20 mg; pantothenic acid, 10.0 mg, Vitamin E 31.7 IU. Supplied per kg of finisher diets: vitamin A, 3000 IU; vitamin D3, 600 IU; vitamin K, 0.40 mg; vitamin B-1, 0.6 mg; vitamin B-2, 2.0 mg; vitamin B-6, 1.2 mg; vitamin B-12, 4.0 µg; niacin, 12 mg; pantothenic acid, 6.0 mg, Vitamin E 19 IU.

[3] Supplied per kg of grower and finisher diets: phytase, 500 FTU mg; xylanase, 150 mg.

3. Outcomes

3.1 Growth performance

Pigs were allocated into the four feeding programs with a similar entry body weight (P=1.00) (Table 2). Female and male pigs had a similar (P=0.52) body weight at entry.

By 42 d after the start of the study, at 16 weeks of age, pigs in the EG group were heavier (both P<0.05) than those in LG and FIN groups, but similar to those that received the phase feeding program. During 10-16 weeks of age, the feeding programs affected ADG (P=0.001) and FCR (P=0.051) although ADFI was not affected (P>0.05). Specifically, pigs in the EG group had the greatest ADG compared to those in LG and FIN groups (both P<0.05), but similar to those in the phase feeding group (P>0.05). Feed conversion ratio was lower better in pigs in the EG group than LG and FIN groups (both P<0.05), but similar (P>0.05) to those in the phase feeding group. Female pigs had greater ADFI (P<0.05), similar ADG (P>0.05), and a higher FCR (P<0.05) than male pigs during the 10-16 week age period. The interaction between feeding program and sex was not significant in any measurement.

By slaughter age, pigs in the EG group had a greater body weight than pigs in LG and FIN groups (both P<0.05) but similar (P>0.05) to those in the phase feeding group. The phase feeding group had a similar body weight (P>0.05) as the LG and FIN groups. The feeding programs affected the ADFI and FCR (both P<0.05) but not ADG (P>0.05) in the 16 weeks of age to slaughter period. Specifically, ADFI (16 weeks of age-slaughter) of pigs in the phase feeding group was greater (P<0.05) than all the three other groups (that had statistically similar ADFI). The EG and LG group pigs had lower FCR (16 weeks of age-slaughter) than the phase feeding group (both P<0.05) but similar (P>0.05) to the FIN group. Female pigs had a higher ADFI, lower ADG and higher FCR than castrated male pigs during the d 42 to slaughter period (all P<0.001). The interaction between feeding program and sex was not significant in any measurement.

When evaluating the whole experimental period (10 weeks of age to slaughter), the feeding programs significantly affected ADG (P=0.004) and FCR (P=0.022) but not ADFI (P=0.080). Specifically, pigs in the EG group and phase feeding group both had greater ADG than pigs in the FIN group. The ADG of the EG, LG and phase feeding groups were not significantly different. The pigs in the EG group had lower (all P<0.05) FCR than the other groups (that were not significantly different in FCR). Female pigs had a higher ADFI, lower ADG and higher FCR than castrated male pigs during the 10 weeks of age to slaughter period (all P<0.001). The interaction between feeding program and sex was not significant in any measurements.

3.2 Commercial carcass traits

The feeding programs affected (P=0.053) the HSCW, such that pigs in the the EG group and phase feeding group had a greater HSCW than FIN group (both P<0.05) (Table 3). Carcass backfat thickness at P2 site was not significantly affected by the feeding programs unless HSCW (75.0 kg) was used as a covariate (to remove the effect of carcass weight on P2), such that the pigs in the EG group had a lower backfat thickness than the phase feeding and the LG groups (both P<0.05). Loin depth was not affected (P>0.05) by the feeding programs regardless of using HSCW as a covariate or not. Dressing percentage was not affected (P>0.05) by the feeding programs. Female pigs had similar HSCW (P>0.05), greater dressing percentage (P<0.001), backfat thickness (P=0.011 and P<0.001 for without and with HSCW as a covariate respectively) and loin depth (P<0.001, regardless of using HSCW as co-variate) than the immunocastrated male pigs.

3.3 Feed costs of programs

The feed costs and feed cost/kg of liveweight gain are presented in Table 4. The raw material feed costs of each diet were $382, $359 and $347 for EG, LG and FIN, respectively (Table 1).

Over all pigs (combined immunocastrated males and females), and over the entire feeding duration period, use of a single diet FIN feed had the lowest feed cost/kg LW gain ($0.85/kg) followed by phase feeding ($0.86/kg), single diet LG, and single diet EG ($ 0.88 and $0.91/kg LW) diets.

For immunocastrated male pigs, the single diet FIN feed had the lowest feed cost/kg liveweight gain ($0.83/kg) followed by the single LG diet, phase feeding, and the single EG diet ($0.84, $0.85 and $0.88/kg, respectively).

For female pigs, the single diet FIN feed and phase feeding had the lowest feed cost/kg liveweight gain ($0.88/kg) followed by the single LG diet and the single EG diet ($0.92 and $0.95/kg, respectively).

3.4 Relative profitability of feeding programs

The net profitability of treatments was calculated using all the pigs sold into a grid based on $3.25/kg for carcasses under 14 mm P2 and $2.90/kg for carcasses over 14 mm P2. The average feed costs for each treatment were deducted from the carcass returns to calculate a margin over feed and this was compared as a change in profit relative to the phase feeding program (Table 4). For combined sex and female pigs, phase feeding was the most profitable program, whereas for immunocastrated male pigs the single diet EG program was the most profitable.

Importantly, the analysis of profitability is specific for the ingredient costs and sales grids. Changes in ingredient costs and sales grids can greatly impact the outcome of this financial comparison.

Table 2. Growth performance of pigs received a phase-feeding program vs single-diet feeding programs.

Variables	Feeding programs				SEM	Sex		SEM	P-values		
	Phase feeding (n=19 pens)	Early grower (n=20 pens)	Late grower (n=20 pens)	Finisher (n=20 pens)		Immunocastrated male (n=40 pens)	Female (n=39 pens)		Feeding	Sex	Interaction
BW, 10 weeks, kg	27.0	27.0	26.9	27.0	0.99	27.3	26.6	0.20	1.00	0.52	1.00
BW, 16 weeks, kg	61.6^{abc}	62.3^{c}	60.7^{a}	61.2^{ab}	0.28	61.4	61.5	0.20	**<0.001**	0.51	0.63
BW, sale, kg	99.5^{ab}	100.6^{b}	98.5^{a}	97.9^{a}	0.67	100.7	97.6	0.56	**0.039**	**<0.001**	0.74
Grower phase, 10-16 weeks											
ADFI, g	1796	1792	1776	1795	18.8	1727	1853	13.3	0.87	**0.032**	0.90
ADG, g	826^{b}	841^{bc}	803^{a}	814^{ab}	6.7	819	823	4.7	**0.001**	0.51	0.63
FCR	2.17^{ab}	2.13^{a}	2.21^{b}	2.20^{b}	0.022	2.10	2.26	0.015	**0.051**	**<0.001**	0.79
Finisher phase, 16 weeks-sale											
ADFI, g	2596^{b}	2488^{a}	2509^{a}	2468^{a}	25.2	2464	2566	17.6	**0.003**	**<0.001**	0.09
ADG, g	935	946	938	910	13.5	957	907	9.3	0.24	**<0.001**	0.23
FCR	2.79^{b}	2.64^{a}	2.68^{a}	2.72^{ab}	0.034	2.58	2.83	0.023	**0.017**	**<0.001**	0.30
Overall, 10 weeks-sale											
ADFI, g	2177	2126	2127	2118	17.6	2082	2191	12.3	0.080	**<0.001**	0.29
ADG, g	880^{b}	893^{bc}	870^{ab}	862^{a}	6.1	890	863	4.3	**0.004**	**<0.001**	0.42
FCR	2.48^{b}	2.39^{a}	2.45^{b}	2.46^{b}	0.021	2.34	2.54	0.015	**0.022**	**<0.001**	0.39

Average entry body weight=27.0 kg was used as a covariate for all variables; means with different superscript letters differ ($P<0.05$; LSD pair-wise comparison); pigs were sold at an average of 22 weeks age.

Table 3. Commercial carcass traits of pigs received a phase-feeding program vs single-diet feeding programs.

Variables	Feeding programs				SEM	Sex		SEM	P-values		
	Phase feeding (n=19 pens)	Early grower (n=20 pens)	Late grower (n=20 pens)	Finisher (n=20 pens)		Immunocastrated male (n=40 pens)	Female (n=39 pens)		Feeding	Sex	Interaction
HSCW, kg	75.3[b]	76.0[b]	74.7[ab]	74.0[a]	0.53	75.3	74.8	0.37	**0.053**	0.36	0.86
Dressing, %	75.7	75.6	75.8	75.5	0.16	74.8	76.5	0.12	0.62	**<0.001**	0.63
Backfat, P2, mm	9.56	9.41	9.62	9.28	0.114	9.32	9.62	0.081	0.15	**0.011**	0.70
Backfat, P2, mm*	9.52[b]	9.27[a]	9.66[b]	9.43[ab]	0.088	9.28	9.65	0.061	**0.016**	**<0.001**	0.53
Loin depth, P2, mm	53.1	52.9	52.9	52.3	0.45	51.5	54.1	0.32	0.57	**<0.001**	0.34
Loin depth, P2, mm*	52.9	52.4	53.1	52.8	0.36	51.4	54.2	0.26	0.60	**<0.001**	0.29

Average entry body weight=27.0 kg was used as a covariate for all carcass traits; *HSCW=75.0 kg was used as an additional covariate; means with different superscript letters differ (P<0.05; LSD pair-wise comparison). Pigs were sold at an average of 22 weeks age.

Table 4. Profitability comparison between phase feeding v single diet program between 25 kg and slaughter[1, 2.]

	Feed cost, $/pig	Feed cost, $/kg live weight gain	Carcass value $/pig	Net profit relative to phase feed $/pig
Combined sex				
Phase feed	62.7	0.86	243.90	0.00
Early grower	67.1	0.91	246.53	-1.77
Late grower	63.0	0.88	242.15	-2.05
Finisher	60.7	0.85	240.13	-1.77
Immunocastrated males				
Phase feed	62.7	0.85	244.31	0.00
Early grower	66.1	0.88	248.44	0.73
Late grower	61.5	0.84	243.65	0.54
Finisher	59.8	0.83	240.95	-0.46
Females				
Phase feed	62.8	0.88	243.47	0.00
Early grower	68.1	0.95	244.37	-4.40
Late grower	64.5	0.92	240.57	-4.60
Finisher	61.6	0.88	239.31	-2.96

[1] Pigs were sold over 14 days in 5 cuts targeting a 95 to 100 kg target weight; pigs were slaughtered on the 22 weeks age (average).

[2] Price grid based on $3.25/kg carcasss weight for < 14 mm P2, and $2.90 kg carcass weight for P2 > 14 mm.

3.5 Summary of major results

The results present a "classical" pig growth and carcass response to dietary nutrient supply. Pig growth rate and feed efficiency were improved by using diets/programs with higher energy and amino acid levels. In the grower phase (10-16 weeks of age), pigs fed the single early grower diet (EG) had significantly better feed efficiency (reduced FCR) than those fed either of the two lower density programs (the FCR of the phase-feeding program was statistically similar to the other three feeding programs during the grower phase). This improved feed efficiency in pigs fed the EG diet was extended over the entire experimental period (10 weeks age to sale) compared to all other programs (including phase feeding).

Interestingly, the only significant response of the various feeding programs on ADFI was for the phase-fed pigs in the finisher period to have higher feed intakes than the three single diet programs. This increase in feed intake resulted in significantly poorer feed use efficiency than the single-fed early (EG) and late grower (LG) pigs. Given that the phase-fed pigs and the single diet FIN-fed pigs were being fed the exact same ration over the finisher period, this suggests that one possible advantage of a single diet program is that digestibility is improved when diet changes are reduced/eliminated. However, this would require further examination.

The carcass value analysis was based on a sales strategy to target a 75 kg carcass. Pigs were sold over 2 weeks in five cuts. Considering the sales strategy, the single FIN diet program produced carcasses with a lower carcass weight than the phase and single EG diets. When carcass weight was used as a covariate the pigs fed the single EG diet were leaner than the phase-fed and single LG programs. The single FIN diet pigs were intermediate. There were no differences between feeding programs on dressing percentage, indicating that digestive viscera weights were not influenced by the feeding program.

4. Application of Research

The current research provides large scale, commercial data that:

- Supports the use of phase feeding 3 diets to female pigs between 25 and 105 kg liveweight and where split sex feeding is not practical.
- Supports the use of a single grower specification diet (specification targeting between 14 MJ DE and 0.75 g SID lysine/MJ DE and 13.75 MJ DE and 0.65 g SID lysine/MJ DE) being fed to immunocastrated male pigs.

However, the economic evaluation conducted in this study depends on two factors that change over time:

- Feed ingredient prices – particularly the cost of dietary energy and protein.
- Prevailing carcass grids and price penalties for being outside weight and fat depth specifications.

This research suggests that using an appropriately formulated and fed single diet in the grow-finish phase can be practically applied by the Australian pork industry.

However, it is critical for each producer to consider the abovementioned factors when assessing the feasibility of adopting the use of such a feeding strategy.

Furthermore, this research was conducted in commercial/conventional shedding, and it is recommended that a similar study is conducted in deep-litter/eco-shed housing where intakes are higher and carcasses grade fatter.

5. Conclusion

The decision to utilize phase feeding or a single diet program for grow/finish pigs will be predicated by a number of factors including:

- Individual farm factors (eg: genetics, silo/feedline infrastructure, sorter technology, etc),
- Raw material pricing,
- Sales grids.

The current research identifies that use a single diet program is beneficial for immunocastrated male pigs but not for females.

It is recommended that a similar study be conducted using pigs reared in eco-shed facilities where the ability to sort and manage carcass fat depth is more difficult.

6. Limitations/Risks

Farm owners and manager will be required to evaluate the suitability of a single diet program on their own farms and regularly review this as feed ingredients and sales grids change.

The profitability may be also affected by facility size and capital cost (eg: silo management) which have not been taken into consideration in the current profit analysis.

7. Recommendations

It is recommended that a similar study be conducted using pigs reared in eco-shed facilities where the ability to sort and manage carcass fat depth is more difficult.

8. References

Appendix 1 - Notes

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Appendices

Supplementary Tables

Supplementary Table 1. Growth performance by sex by dietary treatments.

Variables	Immunocastrated male				Female				SEM	P-values		
	Phase feeding (n= 10 pens)	Early grower (n=10 pens)	Late grower (n=10 pens)	Finisher (n=10 pens)	Phase feeding (n= 9 pens)	Early grower (n=10 pens)	Late grower (n=10 pens)	Finisher (n=10 pens)		Feeding	Sex	Interaction
BW, 10 weeks, kg	27.3	27.2	27.3	27.2	26.6	26.7	26.6	26.6	1.40	1.00	0.52	1.00
BW, 16 weeks, kg	61.6	62.2	60.7	61.6	61.7	62.4	60.6	60.7	0.40	**<0.001**	0.51	0.63
BW, sale, kg	100.6	102.5	100.19	99	98.44	98.6	96.9	96.8	0.95	**0.039**	**<0.001**	0.74
Grower phase, 10-16 weeks												
ADFI, g	1729	1723	1698	1759	1864	1861	1855	1831	26.6	0.87	**0.032**	0.90
ADG, g	826	839	805	824	826	843	802	805	9.4	**0.001**	0.51	0.63
FCR	2.10	2.05	2.11	2.13	2.25	2.21	2.31	2.27	0.03	**0.051**	**<0.001**	0.79
Finisher phase, 16 weeks-sale												
ADFI, g	2495	2475	2469	2419	2698	2500	2548	2518	3.4	**0.003**	**<0.001**	0.09
ADG, g	954	992	966	917	915	900	910	902	18.5	0.24	**<0.001**	0.23
FCR	2.63	2.50	2.56	2.65	2.95	2.78	2.80	2.80	0.05	**0.017**	**<0.001**	0.30
Overall, 10 weeks-sale												
ADFI, g	2096	2087	2068	2079	2257	2165	2186	2157	2.4	0.080	**<0.001**	0.29
ADG, g	890	914	885	871	871	872	855	854	8.6	**0.004**	**<0.001**	0.42
FCR	2.36	2.28	2.34	2.39	2.59	2.49	2.55	2.53	0.03	**0.022**	**<0.001**	0.39

Average entry body weight=27.0 kg was used as a covariate for all variables. Pigs were sold at an average of 22 weeks age.

Supplementary Table 2. Carcass traits by sex by dietary treatments.

Variables	Immunocastrated male				Female				SEM	P-values		
	Phase feeding (n= 10 pens)	Early grower (n=10 pens)	Late grower (n=10 pens)	Finisher (n=10 pens)	Phase feeding (n= 9 pens)	Early grower (n=10 pens)	Late grower (n=10 pens)	Finisher (n=10 pens)		Feeding	Sex	Interaction
HSCW, kg	75.3	76.5	75.0	74.2	75.4	75.5	74.3	73.8	0.75	0.053	0.36	0.86
Dressing, %	74.9	74.7	74.9	74.9	76.6	76.5	76.8	76.2	0.23	0.62	<0.001	0.63
Backfat, P2, mm	9.35	9.30	9.40	9.22	9.78	9.51	9.83	9.341	0.16	0.15	0.011	0.70
Backfat, P2, mm*	9.31	9.08	9.40	9.34	9.72	9.45	9.92	9.51	0.12	**0.016**	<0.001	0.53
Loin depth, P2, mm	51.7	52.4	51.3	50.8	54.5	53.5	54.63	53.71	0.64	0.57	<0.001	0.34
Loin depth, P2, mm*	51.6	51.6	51.2	51.3	54.3	53.3	54.96	54.33	0.51	0.60	<0.001	0.29

*HSCW=75.0 kg was used as an additional covariate.
Average entry body weight=27.0 kg was used as a covariate for all carcass traits.
Pigs were sold at an average of 22 weeks age.