Agri-Food and Biosciences Institute

AFBI Hillsborough

The effect of 'Transition' and 'Jetmix' feeders on pig performance

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TABLE OF CONTENTS

INDEX OF TABLES

1. Executive summary

Efficient pig production involves maintaining good growth rates throughout the pig's lifetime. However, it is well known that a 'growth check' normally occurs at weaning and this can increase the time taken to reach a target live weight at slaughter. Recently, new feeder designs, the Transition and Jetmix feeders have been developed to improve the feed intake of pigs post weaning and hence minimise the growth check. The manufacturer recommended that meal should be offered via the Transition feeder for 11 days post weaning, after which meal or pellets should be offered via the Jetmix feeder for the remainder of the growing period. The objective of this study was to compare the performance of post-weaned pigs offered feed (meal or pellets) via a Transition and/or Jetmix feeder or a dry multi-space feeder. Six hundred Large White/Landrace pigs were weaned at 4 weeks of age and, in groups of 20, allocated to one of 5 treatments.

Although feed usage increased during the growing period when feed was offered through the Transition and Jetmix feeders (813 and 844 vs 737 g/day respectively), feed efficiency was poorer (1.53 and 1.58 vs 1.43) than when pigs were offered pellets via the dry multi-space feeders. Although similar growth rates were observed over the growing period, the use of the pellets via the dry multi-space feeder was the most economically efficient (35 p food/kg gain). The performance of pigs was poorer when they were offered meal via the dry multi-space feeder as opposed to pellets. In addition, similar pig performance was attained when only the Jetmix feeder was used instead of both the Transition and Jetmix feeders as recommended by the manufacturer suggesting that the additional cost of installing a Transition feeder was not justified in terms of improved pig performance.

In this study the weight of pigs within a group of 20 varied from approximately 7 to 11 kg at 4 weeks of age. Although, no difference in pig performance between treatments was noted when only small pigs were compared separately to medium and large pigs, it is possible that if the small pigs were physically separated from the group and offered feed via a Transition or Jetmix feeder, benefits may be attained.

Overall, offering pellets through a dry multi-space feeder resulted in similar pig performance, but more efficient use of feed in the growing accommodation compared to the use of the Transition and/or Jetmix feeders. A difference of £4400 per year in feed costs for a 200 sow herd rearing 22 pigs/sow/year was observed between the use of the Jetmix feeder compared to offering pellets via a dry multi-space feeder in the growing accommodation.

2. Introduction

Piglets undergo dramatic changes in their environment and diet when they are weaned and during this time a growth check occurs. Research by Geary and Brooks (1998) has shown that each 50 g/day increase in dry matter intake in the week following weaning increased 28 day post-weaning weight by 870 g. In addition dry matter intake in the week after weaning accounted for as much variation in the 28 day post-weaning weight as any combination of weaning weight, weaning age, sex and dietary treatment (Geary and Brooks, 1998). Among the many methods being employed to improve feed intake, the use of liquid feeding is attracting much

attention. Numerous studies have been carried out on the effects of wet feed, acidified and fermented, on the growth performance of post-weaned and growing pigs (Lawlor, 1999; Lawlor *et al*., 2002; Brooks *et al*., 2003; Walton, 2003). Nevertheless, results of studies have been inconsistent. For example, Lawlor *et al*., (2002) reported no significant production benefits from wet feeding, Walton (2003) observed an improvement in lifetime feed efficiency and performance and Chae (2000) noted that liquid feeding with milk replacer increased feed intake, improved growth rate and reduced mortality, especially in early-weaned or light weight weaning piglets. Brooks *et al*. (2003) suggested that the method of wet feeding and the source of the liquid could be manipulated to improve performance, although there were considerable problems in maintaining the hygienic quality of liquid diets offered *ad libitum*. Liquid feeding, however, has also been reported to contribute to increased feed wastage through spoilage when not removed from troughs (O'Connell *et al*., 2002). Newly developed feeders (Transition and Jetmix) have been designed to overcome many of the problems associated with liquid feeding. The experiment undertaken here aimed to investigate the effect of liquid feeding using a Transition (Pic 1) and Jetmix feeder (Pic 2) on feed intake and performance of post weaned pigs.

Pic 1 Transition Feeder

Pic 2 Jetmix Feeder

3. Materials and Methods

3.1 Experimental design and animals

A total of 600 ¾ Landrace x ¼ Large white pigs were weaned at 4 weeks of age and balanced for weight, gender and sire into groups of 20 which were randomly allocated to one of five treatments over 6 replicates (Table 1).

Table 1 Experimental treatments

	Age : 28 – 39 days		Age : 39 – 70 days	
Treatment	**Feeder**	**Feed form**	**Feeder**	**Feed form**
1	Transition	Meal	Jetmix	Pellets
2	Transition	Meal	Multi-space	Pellets
3	Multi-space	Meal	Multi-space	Pellets
4	Multi-space	Pellets	Multi-space	Pellets
5	Jetmix	Pellets	Jetmix	Pellets

The Transition and Jetmix feeders were both manufactured by G.E. Baker (UK). It was recommended that the Transition feeder should offer feed to pigs only during the first 11 days after weaning, after which the Jetmix feeder should be used. Meal was the only feed form which could be used through the Transition feeder, whereas pellets or meal could be used in the Jetmix feeder. Prior to dispensing feed, the Transition feeder mixed the meal with a fixed proportion of water, feed was therefore dispensed as a wet gruel into a circular communal trough (Diameter 36 cm, maximum depth 5 cm, width of trough at feeding place 12 cm). In contrast the Jetmix feeder dispensed pelleted feed into the circular communal trough (Diameter 42 cm, maximum depth 8 cm, width of trough at feeding place 16 cm) after which a fixed proportion of water was sprayed onto the pellets. Both feeders were programmed to offer feed within fixed time intervals throughout the growing period (4-10 weeks of age). When pigs were 4 weeks of age, feed was offered for 30 minutes per hour. An alarm sounded when feed was available, however pigs had to nudge a bar above the trough area to receive feed. Dispension of feed was therefore restricted for 30 minutes per hour in order for feed to be cleared. This time interval was gradually decreased through the growing period according to the length of time pigs took to clear the trough. Allowance time reached a maximum of 50 minutes per hour when pigs were seven weeks old. Square wooden trays (45 cm^2 for Transition and 55 cm^2 for Jetmix) were placed under the troughs of the feeders in order to retrieve feed that was spilled over the edge. However, pigs consumed this feed in the trays and therefore no 'wasted feed' weigh backs were available.

One Transition and one Jetmix feeder were used per 20 pigs. Water was also offered from 2 Bowl drinkers per 20 pigs. The feeder type was compared with the "dry" multi-space feeder (Etra Feeders, Northern Ireland) of traditional design with the feed hopper connected directly to the trough with an adjustable aperture to regulate feed flow. The dry multi-space feeder offers feed in pelleted or meal form from four separated compartments (dimension of each compartment – 20 cm wide. 16.4 cm long and 12.5 cm deep) within the entire trough space. Two dry multi-space feeders were used per 20 pigs.

After weaning, pigs were housed in combined stage 1/stage 2 accommodation (0.38 m^2/pig) with plastic slatted floors. Temperature was 28ºC on the first day of

treatment which was reduced by 0.5ºC/day to 18ºC, with this temperature maintained for the rest of the treatment period. The pigs were exposed to natural lighting through windows and artificial lighting (6250 lux) during feeding. Commercial diets were offered between 4 and 8 weeks of age after which pelleted diets formulated at AFBI, Hillsborough were offered to finish.

3.2 Production performance measurements

Pigs were individually weighed and growth rates were established at 38, 49 and 70 days of age. Pigs were also weighed at 15 weeks of age and finish (21 weeks + 5 days) to investigate any carry over effects. Feed intakes and water usage were also recorded at these stages. Pen average daily gains (ADG g/d), average daily feed intakes (ADFI g/d) and feed conversion ratios (FCR) were subsequently calculated. The coefficient of variation of growth rate in the growing period was also calculated.

3.3 Economic evaluation

The economic efficiency of each treatment was calculated using the feed costs of (period of offering in brackets): Creep 1 (3 kg/pig in stage 1) - £550/tonne, Creep 2 (3 kg/pig in stage 1) - £420/tonne, Link (6 kg/pig in stage 1/2) - £280/tonne, Grower (to 10 weeks of age in stage 2) - £190/tonne. Returns only take into account difference in performance, i.e. growth rate, feed intake and feed conversion efficiency and do not include overheads, e.g. housing, labour, capital etc.

3.4 Statistics

The data were analysed using Genstat, Version 5 (Lawes Agricultural Trust, 1989). The influence of treatment factors on performance parameters were analysed by analysis of variance (blocked for replicate). The within-group coefficient of variation was calculated for body live weight and growth rate by dividing within-group standard deviation values by group mean values.

4. Results

4.1 Effect of treatment on pig performance

The weight of pigs at 39 days of age (11 days post weaning) was significantly ($P<0.001$) lower when they were offered meal via a multi-space feeder compared to pigs offered feed through the other feeder designs (Table 2). The weight of pigs at 42 days of age (7 weeks) also differed significantly ($P<0.05$). At 42 days of age pigs which were offered feed using the Transition + Multi-space feeder and the Jetmix feeder tended to be heavier than pigs offered pellets from the multi-space feeder with pigs being offered feed through the Transition + Jetmix feeders being the heaviest and pigs offered meal through the multi-space feeder being the lightest. There was no significant treatment effect on the weight of pigs at 70 days of age (10 weeks of age) or through the finishing period.

Average daily gain of pigs differed significantly between 28 and 39 days of age ($P<0.001$), and as a result overall from 28 to 42 days of age (wean – 7 weeks of age) (Table 2). Pigs offered feed through the Transition and Jetmix feeders tended to have higher average daily gains than pigs offered pellets or meal from the multi-space feeder with pigs being offered feed at the respective time period through both the Transition and Jetmix feeder having the highest average daily gain and pigs offered meal through the multi-space feeder having the lowest. The average daily

gain of the pigs from 42 to 70 days of age (7-10 weeks of age) did not differ significantly, nor did the overall average daily gain from weaning to 10 weeks of age (28-70 days of age). Pigs offered meal through multi-space feeders in the growing accommodation tended to have significantly ($P<0.05$) higher average daily gain from 70-105 days of age (10-15 weeks of age) than pigs offered feed from the Transition + Jetmix or just the Jetmix in the growing accommodation.

Average daily feed intake (usage) (ADFI) was significantly higher ($P<0.01$) from 28-39 days of age when feed was offered via the Transition or Jetmix feeders (Table 2). When pigs were 39-42 days of age a significantly higher ADFI was attained when pigs continued to be offered feed from the Jetmix feeder. ADFI was similar for all other treatments. When pigs were 42-70 days of age, ADFI was significantly higher ($P<0.001$) when feed was offered through the Jetmix feeder than when meal or pellets were offered through the multi-space feeder. There was no significant difference in ADFI through the finishing period.

There was a significant difference in the feed conversion ratio (FCR) from 28 to 70 days of age (wean to 10 weeks of age) between treatments (Table 2). Pigs offered meal through a multi-space feeder had the poorest FCR, while pigs offered pellets through a multi-space feeder had the best FCR between 28 and 39 days of age. The FCR of pigs from 28-39 days of age, offered feed through the Transition and Jetmix feeders was similar. When pigs were 39-42 days of age FCR was poorest for pigs offered feed through the Jetmix feeder and was similar for pigs on all other treatments. FCR from 42-70 days tended to be poorer for pigs offered feed through either the Transition or Jetmix feeders in the growing accommodation.

Table 2 Pig performance from weaning to finish as a result of offering feed through different feeder designs

		Treatment					Statistical Significance	
	Age (days)	**Trans + Jetmix**	**Jetmix**	**Trans + Multi**	**Multi + Pellets**	**Multi + Meal**	**SEM**	**P**
Weight (kg)	28	8.91	8.93	8.94	8.92	8.95	0.024	NS
	39	12.08^{b}	11.92^{b}	11.94^{b}	11.83^{b}	11.02^{a}	0.157	<0.001
	42	16.62^{c}	16.31^{bc}	16.11^{bc}	15.83^{ab}	15.32^{a}	0.235	<0.05
	70	30.75	30.86	29.51	30.04	29.29	0.444	NS
	105	53.64	52.66	53.25	53.61	53.67	0.754	NS
	152	99.64	97.62	97.97	99.49	97.55	1.291	NS
Average daily gain (g/day)	28-39	288^{b}	272^{b}	273^{b}	264^{b}	188^{a}	13.75	<0.001
	39-42	505	488	464	444	477	17.38	NS
	28-42	385^{c}	369^{bc}	359^{bc}	345^{ab}	318^{a}	11.58	<0.01
	42-70	673	693	638	677	666	12.47	NS
	28-70	533	535	502	515	496	10.77	NS
	70-105	657^{ab}	626^{a}	682^{bc}	677^{bc}	700^{c}	13.59	<0.05
	105-152	975	953	948	973	930	16.56	NS
Average daily feed usage (g/day)	28-39	353^{b}	351^{b}	355^{b}	280^{a}	261^{a}	20.25	<0.01
	39-42	611^{a}	678^{b}	555^{a}	558^{a}	555^{a}	19.44	<0.001
	28-42	470^{bc}	498^{c}	445^{b}	405^{ab}	393^{a}	17.20	<0.01
	42-70	1140^{b}	1177^{b}	1058^{a}	1052^{a}	1055^{a}	25.20	<0.01
	28-70	813^{b}	844^{b}	759^{a}	737^{a}	731^{a}	17.63	<0.001
	70-105	1533	1512	1585	1607	1603	34.4	NS
	105-152	2513	2436	2415	2481	2428	45.1	NS
Feed conversion ratio (kg feed/kg gain)	28-39	1.23^{b}	1.31^{bc}	1.32^{bc}	1.06^{a}	1.42^{c}	0.051	<0.01
	39-42	1.22^{a}	1.39^{b}	1.20^{a}	1.26^{a}	1.17^{a}	0.039	<0.01
	28-42	1.22^{a}	1.35^{b}	1.24^{a}	1.18^{a}	1.24^{a}	0.027	<0.01
	42-70	1.69^{c}	1.70^{c}	1.66^{bc}	1.56^{a}	1.59^{ab}	0.033	<0.05
	28-70	1.53^{bc}	1.58^{c}	1.51^{b}	1.43^{a}	1.47^{ab}	0.022	<0.01
	70-105	2.34	2.42	2.33	2.38	2.29	0.055	NS
	105-152	2.58	2.56	2.55	2.55	2.61	0.054	NS

[a, b, c,] Means with the same superscript are not significantly different
NS Not significant

4.2 Effect of treatment on carcass performance

Treatment had no significant effect on the cold weight, kill out percentage, back fat depth, lean meat % or total lean meat of the carcass (Table 3).

Table 3 Carcass performance of pigs offered feed through different feeder designs in stage 1/stage 2

	Treatment					Statistical Significance	
	Trans + Jetmix	Jetmix	Trans + Multi	Multi + Pellets	Multi + Meal	SEM	P
Cold weight (kg)	75.1	73.8	75.2	75.0	74.4	1.01	NS
Kill out %	75.5	75.6	76.2	75.5	76.2	0.30	NS
Back fat depth (mm)	12.0	11.3	11.6	12.2	11.7	0.27	NS
Lean meat (%)	61.3	61.9	61.6	61.1	61.5	0.23	NS
Total lean meat in carcass (kg)	45.9	45.7	46.2	45.7	45.7	0.52	NS

NS Not significant

4.3 Effect of treatment on the variation in growth rate between pigs

Treatment had no significant effect on the coefficient of variation for average daily gain at any stage of growth (Table 4). When pigs were 39 days old, the coefficient of variation of weight was lowest when pigs were offered pellets through a multi-space feeder and was highest when pigs were offered feed through the Transition feeder ($P<0.05$) (Table 4).

Table 4 The coefficient of variation for weight and average daily gain of pigs from weaning to finish when offered feed from different feeder designs

		Treatment					Statistical Significance	
	Age	Trans + Jetmix	Jetmix	Trans + Multi	Multi + Pellets	Multi + Meal	SEM	P
Weight	28	0.044	0.046	0.047	0.042	0.044	0.0032	NS
	39	0.109^{c}	0.095^{abc}	0.100^{bc}	0.079^{a}	0.082^{ab}	0.0070	<0.05
	42	0.119	0.120	0.105	0.099	0.117	0.0078	NS
	70	0.106	0.109	0.098	0.107	0.111	0.0077	NS
	105	0.107	0.094	0.099	0.124	0.109	0.0096	NS
	152	0.099	0.077	0.095	0.096	0.097	0.0083	NS
Average daily gain	28-39	0.401	0.323	0.369	0.303	0.384	0.0267	NS
	39-42	0.238	0.276	0.237	0.263	0.263	0.0222	NS
	28-42	0.252	0.248	0.219	0.226	0.272	0.0176	NS
	42-70	0.126	0.142	0.126	0.143	0.143	0.0121	NS
	28-70	0.147	0.146	0.135	0.151	0.160	0.0111	NS
	70-105	0.156	0.140	0.137	0.199	0.165	0.0169	NS
	105-152	0.132	0.110	0.132	0.113	0.121	0.0117	NS

[a, b, c,] Means with the same superscript are not significantly different
NS Not significant

4.4 Effect of treatment on the weight and average daily gain of small, medium and large pigs separately

The effect of treatment on weight of pigs at 39 days of age was similar for small, medium and large pigs (Table 5) and reflected the trends highlighted when small, medium and large pigs were considered together (Table 2). Although treatment had a significant effect on the weight of pigs at 42 days of age (Table 2), treatment only had a significant effect on the weight of large pigs at 42 days of age with large pigs being offered meal through the multi-space feeder being lightest and large pigs offered feed through the Transition + Jetmix feeder being the heaviest (Table 5). When pigs were 70 days of age treatment had no significant effect on the weight of small or medium weight pigs but the weight of large pigs differed significantly, with large pigs being offered meal through the multi-space feeder being lightest and large pigs offered feed through the Transition + Jetmix feeder being the heaviest (Table 5). No significant differences were found in the weight of small, medium or large pigs across treatments through the finishing stage.

Table 5 The effect of treatment on the weight (kg) of small, medium and large pigs from weaning to finish, offered feed from the different feeder designs in the growing stage

		Treatment					Statistical Significance	
Age	**Grade**	**Trans + Jetmix**	**Jetmix**	**Trans + Multi**	**Multi + Pellets**	**Multi + Meal**	**SEM**	**P**
28	Small	7.83	7.82	7.92	7.85	7.83	0.040	NS
	Medium	8.86	8.83	8.85	8.87	8.86	0.023	NS
	Large	10.0	10.0	10.0	10.0	10.1	0.034	NS
39	Small	10.7[b]	10.6[b]	10.7[b]	10.8[b]	9.9[a]	0.152	<0.01
	Medium	12.0[b]	11.8[b]	11.8[b]	11.7[b]	10.9[a]	0.239	<0.05
	Large	13.5[b]	13.2[b]	13.3[b]	12.9[b]	12.2[a]	0.194	<0.01
42	Small	15.0	15.0	14.6	14.7	14.0	0.272	NS
	Medium	16.4	16.2	15.9	15.6	15.2	0.332	NS
	Large	18.3[c]	17.5[abc]	17.7[bc]	17.0[ab]	16.6[a]	0.314	<0.05
70	Small	28.4	28.6	27.6	28.5	27.8	0.525	NS
	Medium	29.9	30.9	29.0	29.7	29.3	0.533	NS
	Large	33.6[c]	32.7[bc]	31.9[abc]	31.7[ab]	30.7[a]	0.639	<0.05
105	Small	50.9	49.5	51.6	52.4	52.2	0.932	NS
	Medium	52.7	53.7	51.7	52.9	53.4	1.091	NS
	Large	57.6	54.4	57.0	55.0	55.6	1.113	NS
152	Small	97.7	93.2	94.9	98.2	95.5	1.529	NS
	Medium	99.3	98.9	96.8	98.4	97.5	2.085	NS
	Large	102.5	99.4	102.6	101.3	99.7	2.048	NS

[a, b, c,] Means with the same superscript are not significantly different
NS Not significant

The average daily gain from 28-39 days of age of small and medium pigs differed significantly (Table 6) in a similar manner to that reported in Table 2. The average daily gain of large pigs also differed significantly from 28-39 days of age but although large pigs offered meal through a multi-space feeder still had the lowest average daily gain, large pigs offered feed through the Transition + Jetmix feeder tended to

have a higher average daily gain than large pigs on other treatments (Table 6). As observed when all pigs were grouped together (Table 2), there was no significant difference in the average daily gain of small, medium or large pigs from 39-42 days of age when they were considered separately (Table 6). Overall from 28-42 days of age, and also 28-70 days of age, large pigs had a significantly higher average daily gain when they were offered feed from the Transition + Jetmix feeder compared to pigs offered meal via the multi-space feeder, while no significant difference in the average daily gain of small or medium pigs was observed between treatments.

Table 6 The effect of treatment on the average daily gain (g/day) of small, medium and large pigs from weaning to finish, offered feed from the different feeder designs in the growing stage

		Treatment					Statistical Significance	
Age	**Grade**	**Trans + Jetmix**	**Jetmix**	**Trans + Multi**	**Multi + Pellets**	**Multi + Meal**	**SEM**	**P**
28-39	Small	266^{b}	261^{b}	249^{b}	271^{b}	184^{a}	13.99	<0.01
	Medium	281^{b}	273^{b}	266^{b}	256^{b}	190^{a}	21.78	<0.05
	Large	317^{c}	285^{bc}	296^{bc}	266^{b}	196^{a}	16.55	<0.001
39-42	Small	467	480	427	443	460	22.7	NS
	Medium	489	484	467	435	505	23.30	NS
	Large	543	492	487	456	508	21.41	NS
28-42	Small	360	360	330	348	308	14.15	NS
	Medium	375	368	353	337	319	16.36	NS
	Large	414^{c}	371^{bc}	382^{bc}	352^{ab}	325^{a}	14.95	<0.01
28-70	Small	503	508	479	504	486	13.02	NS
	Medium	514	539	492	507	498	12.97	NS
	Large	575^{c}	553^{bc}	533^{abc}	528^{ab}	503^{a}	15.44	<0.05
42-70	Small	639	649	627	652	656	19.12	NS
	Medium	646^{ab}	702^{c}	624^{a}	667^{bc}	677^{bc}	13.68	<0.01
	Large	729	724	677	697	671	19.54	NS
70-105	Small	647^{ab}	608^{a}	684^{b}	688^{b}	696^{b}	18.98	<0.05
	Medium	648	642	651	660	692	22.70	NS
	Large	682^{ab}	609^{a}	714^{b}	668^{ab}	719^{b}	24.90	<0.05
105-152	Small	992^{b}	927^{a}	921^{a}	971^{ab}	919^{a}	18.34	<0.05
	Medium	976	955	953	963	931	25.30	NS
	Large	953	955	965	972	936	27.30	NS

$^{a, b, c,}$ Means with the same superscript are not significantly different
NS Not significant

The average daily gain of medium weight pigs, from 42-70 days of age differed significantly with medium weight pigs offered feed via the Transition + Multi having the lowest ADG and pigs offered feed through the Jetmix feeder had the highest ADG (Table 6).

When all pigs were considered together (Table 2) there was no difference in the growth rate of pigs in the finishing stage. However when considered separately, small and large pigs from 70-105 days of age had the lowest ADG when offered feed in stage 1/stage 2 through the Jetmix feeder (Table 6). During 105-152 days of age

the average daily gain of small pigs differed significantly also, with small pigs offered feed through the Transition + Jetmix feeder in stage 1/stage 2 having the highest ADG and similar to small pigs offered pellets through the multi-space feeder in stage 1/stage 2.

Overall, there was no significant interaction between the grade (small, medium or large) of pig and the treatment at any stage of growth.

4.5 Effect of treatment on the coefficient of variation for weight and average daily gain of small, medium and large pigs separately

The was no significant effect of treatment on the coefficient of weight (Table 7) or average daily gain (Table 8), at any stage of growth, for small, medium or large pigs when they were considered separately. There was no significant interaction between grade of pig (small, medium or large) and treatment at any stage of growth for the coefficient of variation for weight and average daily gain.

Table 7 The effect of treatment on the coefficient of variation for weight of small, medium and large pigs from weaning to finish, offered feed from the different feeder designs in the growing stage

		Treatment					Statistical Significance	
Age	**Grade**	**Trans + Jetmix**	**Jetmix**	**Trans + Multi**	**Multi + Pellets**	**Multi + Meal**	**Sem**	**Sig**
28	Small	0.047	0.050	0.057	0.044	0.045	0.0059	NS
	Medium	0.039	0.038	0.037	0.037	0.035	0.0022	NS
	Large	0.047	0.049	0.048	0.045	0.052	0.0037	NS
39	Small	0.116	0.094	0.100	0.088	0.076	0.0120	NS
	Medium	0.099	0.093	0.112	0.076	0.073	0.0105	NS
	Large	0.113	0.097	0.089	0.072	0.096	0.0144	NS
49	Small	0.120	0.120	0.107	0.111	0.123	0.0146	NS
	Medium	0.113	0.117	0.111	0.100	0.106	0.0132	NS
	Large	0.125	0.121	0.098	0.086	0.122	0.0122	NS
70	Small	0.103	0.106	0.094	0.118	0.108	0.0110	NS
	Medium	0.110	0.107	0.107	0.119	0.112	0.0151	NS
	Large	0.106	0.114	0.094	0.085	0.112	0.0117	NS
105	Small	0.108	0.089	0.082	0.098	0.114	0.0144	NS
	Medium	0.100	0.087	0.117	0.149	0.104	0.0205	NS
	Large	0.113	0.105	0.099	0.124	0.109	0.0164	NS
152	Small	0.099	0.070	0.077	0.070	0.098	0.0118	NS
	Medium	0.105	0.076	0.122	0.105	0.089	0.0135	NS
	Large	0.093	0.085	0.085	0.112	0.105	0.0181	NS

NS Not significant

Table 8 The effect of treatment on the coefficient of variation for average daily gain of small, medium and large pigs from weaning to finish, offered feed from the different feeder designs in the growing stage

		Treatment					Statistical Significance	
Age	**Grade**	**Trans + Jetmix**	**Jetmix**	**Trans + Multi**	**Multi + Pellets**	**Multi + Meal**	**SEM**	**P**
28-39	Small	0.397	0.326	0.333	0.279	0.330	0.0503	NS
	Medium	0.380	0.305	0.418	0.328	0.376	0.0389	NS
	Large	0.427	0.338	0.357	0.302	0.446	0.0551	NS
39-42	Small	0.234	0.291	0.215	0.285	0.277	0.0468	NS
	Medium	0.217	0.266	0.229	0.284	0.250	0.0387	NS
	Large	0.263	0.272	0.267	0.220	0.263	0.0276	NS
28-42	Small	0.234	0.245	0.206	0.219	0.264	0.0292	NS
	Medium	0.251	0.242	0.238	0.253	0.263	0.0345	NS
	Large	0.272	0.257	0.214	0.206	0.288	0.0280	NS
42-70	Small	0.124	0.146	0.111	0.165	0.131	0.0168	NS
	Medium	0.137	0.133	0.143	0.161	0.126	0.0166	NS
	Large	0.118	0.146	0.124	0.104	0.174	0.0231	NS
70-105	Small	0.153	0.137	0.102	0.152	0.165	0.0207	NS
	Medium	0.142	0.130	0.174	0.216	0.137	0.0302	NS
	Large	0.172	0.153	0.137	0.229	0.193	0.0366	NS
105-152	Small	0.132	0.109	0.116	0.087	0.111	0.0195	NS
	Medium	0.139	0.112	0.160	0.105	0.112	0.0184	NS
	Large	0.124	0.110	0.119	0.147	0.141	0.0232	NS
10-Finish	Small	0.123	0.095	0.088	0.076	0.112	0.0140	NS
	Medium	0.123	0.092	0.147	0.116	0.104	0.0154	NS
	Large	0.118	0.103	0.102	0.155	0.136	0.0241	NS

NS Not significant

4.6 Effect of grade (small, medium and large) on pig weight and average daily gain and associated coefficients of variation from weaning to finish

At all ages, large pigs were significantly heavier than medium pigs which were significantly heavier than small pigs (Table 9). However at slaughter (152 days of age) although large pigs were significantly heavier, the weight of small and medium pigs was similar. The coefficient of variation for the weight for small, medium and large pigs was similar from 39 days of age to slaughter (152 days of age) (Table 9).

The ADG and coefficient of variation for ADG of small, medium and large pigs was similar from 28-39 days of age (Table 10). However, from 39-42 and 42-70 days of age large pigs had higher average daily gains than small or medium pigs which had similar ADG's (Table 10). There was no difference in the coefficient of variation for ADG from 39-42 or 42-70 days of age and no difference in the ADG or coefficient of variation of ADG between small, medium or large pigs in the finishing stage.

Table 9 The effect of grade (small, medium, large) on the weight (kg) and the respective coefficients of variation (Co. Var.) from weaning to finish

		Grade			Statistical Significance	
Age		**Small**	**Medium**	**Large**	**Sem**	**P**
28	Weight	7.85[a]	8.85[b]	10.0[c]	0.033	<0.001
	Co. Var.	0.049[b]	0.037[a]	0.048[b]	0.0023	<0.001
39	Weight	10.5[a]	11.6[b]	13.0[c]	0.118	<0.001
	Co. Var.	0.095	0.091	0.093	0.0056	NS
42	Weight	14.7[a]	15.9[b]	17.4[c]	0.167	<0.001
	Co. Var.	0.116	0.110	0.110	0.0063	NS
70	Weight	28.2[a]	29.8[b]	32.1[c]	0.295	<0.001
	Co. Var.	0.106	0.111	0.102	0.0061	NS
105	Weight	51.3[a]	52.9[b]	55.9[c]	0.481	<0.001
	Co. Var.	0.098	0.115	0.110	0.0076	NS
152	Weight	95.9[a]	98.2[a]	101.1[b]	0.828	<0.001
	Co. Var.	0.083	0.099	0.096	0.0064	NS

[a, b, c,] Means with the same superscript are not significantly different
NS Not significant

Table 10 The effect of grade (small, medium, large) on the average daily gain (ADG) (g/day) of pigs and the respective coefficients of variation (Co. Var.) from weaning to finish

		Grade			Statistical Significance	
Age		**Small**	**Medium**	**Large**	**SEM**	**P**
28-39	ADG	246	253	272	10.33	NS
	Co. Var.	0.333	0.361	0.374	0.0212	NS
39-42	ADG	455[a]	476[ab]	497[b]	10.68	<0.05
	Co. Var.	0.260	0.249	0.257	0.0179	NS
28-42	ADG	341	350	369	8.12	NS
	Co. Var.	0.233	0.249	0.248	0.0143	NS
42-70	ADG	644[a]	663[a]	700[b]	8.62	<0.001
	Co. Var.	0.140	0.157	0.146	0.0088	NS
28-70	ADG	496[a]	510[a]	539[b]	7.11	<0.001
	Co. Var.	0.135	0.140	0.133	0.0093	NS
70-105	ADG	665	659	679	10.82	NS
	Co. Var.	0.142	0.160	0.177	0.0131	NS
105-152	ADG	946	956	956	10.25	NS
	Co. Var.	0.111	0.126	0.128	0.0091	NS

[a, b, c,] Means with the same superscript are not significantly different
NS Not significant

4.7 The effect of treatment on water usage

Water usage per pig from 28-39 days of age was significantly higher (P<0.001) when pigs were offered feed from the Transition feeders compared to the Jetmix or multi-space feeders (Table 11). Significant differences in water usage, with a similar trend to those above, were also present between treatments when pigs were 39-42 and 42-70 days of age (P<0.01). Overall, from 28-70 days of age (wean – 10 weeks of age) water usage per pig, differed significantly (P<0.01), being highest when pigs were offered feed through the Transition + Jetmix feeder and lowest when pigs were offered meal through the multi-space feeder.

Table 11 The average water usage per pig per day (litres) in the growing accommodation when pigs were offered feed through the different feeder designs

	Treatment					Statistical Significance	
Age	**Trans + Jetmix**	**Jetmix**	**Trans + Multi**	**Multi + Pellets**	**Multi + Meal**	**SEM**	**P**
28-39	1.74^{b}	1.21^{a}	1.74^{b}	1.24^{a}	0.84^{a}	0.141	<0.001
39-42	2.69^{c}	2.43^{bc}	2.57^{c}	2.00^{ab}	1.67^{a}	0.168	<0.01
28-42	2.17^{d}	1.75^{bc}	2.11^{cd}	1.59^{ab}	1.21^{a}	0.129	<0.001
42-70	4.43^{c}	4.17^{bc}	3.91^{bc}	3.57^{ab}	3.09^{a}	0.239	<0.01
28-70	3.33^{c}	2.99^{bc}	2.89^{bc}	2.60^{ab}	2.18^{a}	0.166	<0.01

$^{a, b, c,}$ Means with the same superscript are not significantly different

4.8 Economic efficiency of treatment

Total feed costs were highest when the Transition and/or Jetmix feeders were used (Table 12). The most efficient feeder design and feed form was the use of the dry Multi-space feeder with pellets. From 4-10 weeks of age a difference of almost £1 per pig in total feed cost was observed between the use of the Jetmix and dry multi-space feeder + pellets. On a 200 sow unit, where 22 pigs per sow are being produced per year, this equates to an increased cost of £4400 per year with the Jetmix feeder.

Table 12 The performance and feed costs of pigs offered feed from different feeders from weaning to 10 weeks of age

	Treatment				
	Trans + Jetmix	**Jetmix**	**Trans + Multi**	**Multi + Pellets**	**Multi + Meal**
ADG (g/day)	533	535	502	515	496
ADFI (g/day)	813	844	759	737	731
FCR	1.53	1.58	1.51	1.43	1.47
Total feed cost/pig (£)	9.70	9.99	9.20	9.00	8.94
Feed cost/gain (p/kg)	37	38	37	35	37

5. Discussion

5.1 Transition/Jetmix vs Dry Multi-space

The Transition and Jetmix feeders were introduced to the market as tools to improve the feed intake of growing pigs. The Transition feeder in particular was designed to smooth the transition from a predominately liquid diet on the sow to a predominately solid diet in the growing accommodation. These feeders cost five times the amount of a traditional plastic dry multi-space feeder.

The Transition and Jetmix feeders offer feed in the form of a wet mash. Through the Transition feeder this wet mash is dispensed directly into the trough whereas through the Jetmix feeder, dry pellets are dispensed over which a proportionate volume of water is sprayed. Pigs then mix the water and pellets when eating and food is largely consumed as a wet mash with constant consistency.

The results of this study show that the use of the Transition and Jetmix feeders in growing accommodation increases feed usage compared with the traditional use of dry pelleted feed through multi-space feeders. This is in agreement with Kim *et al*. (2001) who found piglets offered liquid feed for 14 days after weaning improved feed intake. Also, similar to this study, Kim *et al*. (2001) found no major difference in the growth performance in the remainder of the growing/finishing period or carcass quality of pigs offered liquid diets compared to dry pelleted diets, although they claimed that the heavier weight of pigs at 14 days post weaning was reflective of heavier finish weights.

However, when the Transition and Jetmix feeders were used, a poorer feed efficiency and similar growth rates were attained when compared to dry pelleted feed through a multi-space feeder. This is in agreement with Lawlor *et al*. (2002) who found no benefit in growth performance of post weaned pigs offered liquid feed over dry feed and highlighted that feeding liquid feed was wasteful of feed since unacceptable DM gain/feed ratios were attained. The results of this study are also similar to those reported by O'Connell *et al*. (2002) who investigated the effect of offering post weaned pigs wet feed via different feeder designs. Those feeder designs did not have a time controlled mechanism like that present in the Transition and Jetmix feeders. It was thought that the time controlled mechanism may have improved feed efficiency but values for feed efficiency over the growing period in the study by O'Connell *et al*. (2002) using wet feeding were better than those found in this study using the Transition and/or Jetmix feeders.

Due to a poorer feed conversion efficiency, the total feed cost and feed cost/kg gain using the Transition + Jetmix feeders was greater than when dry pellets were offered via the multi-space feeders.

In this study wooden trays were placed under the feeding troughs of the Transition and Jetmix feeders in order to collect wasted feed which spilled over the side of the trough. However, pigs ate off these trays also and therefore no 'spilled' feed was collected. It could be hypothesised that FCR would have been even poorer if these wooden trays had not been under the troughs as the feed would have fallen directly down the slats.

5.2 Transition vs Jetmix

The manufacture of the Transition and Jetmix feeders advised that the Transition feeder should offer meal to pigs for 11 days after weaning, the Jetmix feeder should then replace the Transition feeder through which meal or pellets could be offered. Since pellets are commonly the feed form used it was decided to offer these through the Jetmix feeder.

The average daily gain (ADG), feed usage (ADFI) and feed conversion efficiency (FCR) of pigs offered feed from the Transition or Jetmix feeder in the first 11 days after weaning were similar. The Jetmix feeder was therefore equally capable of helping pigs adjust from the sow liquid diet to the 'wet gruel' in the post weaning stage. The manufacture advised that the Transition feeder should be used post weaning as opposed to the Jetmix feeder, since it's dimensions suited smaller pigs. In this study the pigs in the pens varied in weight from ~7 kg to 11 kg and when the growth performance of the small pigs within the pen was compared with that of the medium and large pigs during the first 11 days after weaning, there was no difference within or between feeder type (Transition or Jetmix).

After 11 days post weaning, (39 days of age) until pigs were 7 weeks of age (42 days) the ADFI of those pigs which changed feeder type i.e. Transition onto Jetmix or Transition onto Multi-space was lower but better feed efficiency than those pigs which stayed on the Jetmix feeder. Overall ADG was not affected. A change in feeder type has been found to significantly decrease feed intake and numerically decrease growth rates for a short period of time after transition when pigs are transferred from growing to finishing accommodation (Magowan *et al*., 2006). During the latter stages of the growing phase growth rate, feed usage and efficiency were similar for both groups of pigs offered the Jetmix feeder. Feed usage from 7-10 weeks of age of pigs offered pellets through the multi-space feeder (and which previously had been offered feed via the Transition feeder), was similar to that of pigs offered pellets via the multi-space feeder from weaning. The FCR of Transition/Multi-space pigs was however poorer and similar to that of pigs offered feed via the Jetmix feeder. Although not significant, Magowan *et al*. (2006) also observed a decrease in feed efficiency after pigs changed from a dry multi-space to a wet and dry single-space feeder. However, this effect disappeared after one week. It is possible that offering pigs feed via the Transition feeder taught them 'bad habits' regarding feed efficiency/wastage which followed through when they were offered pellets via the multi-space feeder. In addition, although there was no significant difference in ADG, the pigs which changed feeder type from Transition to multi-space had a numerically lower ADG in the latter growing stage than pigs which were on the same feeder type from weaning and even pigs that changed feeder type from a Transition to a Jetmix feeder.

A change in feeder type caused a decrease in feed intake and although there were no major effects on ADG, it was less detrimental to change to a Jetmix feeder than a dry multi-space feeder. However, overall the use of one feeder, the Jetmix produced performance results similar to the use of the twp new feeder types i.e. the Transition and Jetmix feeder.

5.3 Meal vs pellets

When meal was offered through a multi-space feeder the growth performance of pigs from wean to 7 weeks of age especially, was lower than when pellets were offered through the multi-space feeder. Although feed intake was similar, the feed conversion efficiency of pigs was poorer when meal was offered.

In agreement with historical work, offering a dry pelleted diet was found to be more efficient than offering a dry meal diet (Pond and Maner, 1984).

5.4 Variable growth

Although O'Connell *et al*. (2002) found that the use of the dry multi-space feeder minimised variation in the growth rate between pigs compared to offering feed through a wet and dry multi- or single-space feeder or communal trough, no feeder design or regime in this study reduced overall variable growth of pigs during stage 1/stage 2, although offering pellets through the dry multi-space feeder reduced the variation in growth rate, compared to the other treatments, during the first 11 days after weaning.

It is interesting to note that, although the weight of small, medium and large pigs differed, the variation in their weight did not, when considered within each stage of growth. In addition, during the first 11 days after weaning the growth rate of small, medium and large pigs was similar and variable growth was higher than at any other stage of growth. Previous studies have shown that the performance of small, medium and large pigs is similar in the first week after weaning but weaning weight was also found to be a significant predictor of subsequent piglet performance (Miller *et al*., 1999). Through the remainder of the growing stage, the ADG of small, medium and large pigs differed as expected but their variable growth did not. During the finishing stages 70-152 days, the growth rate of small, medium and large pigs was similar. This suggests that the most opportune time period to reduce variability and improve the growth performance of pigs is in the growing stages.

During the early finishing stages (70-105 days) it was also noted that treatment tended to have a carryover effect. However, unlike performance trends in the growing stage pigs, in particular small and large pigs, offered feed from the Jetmix feeder had poorer performance than pigs which had been offered pellets or meal via a multi-space feeder. Those pigs which had already coped with a change in feeder type i.e. Transition – Jetmix appeared to cope better when changed to the wet and dry single-space feeder at finishing than the pigs which were offered feed from the Jetmix throughout.

As expected pigs offered feed in the Transition + Jetmix feeders used more water than pigs offered dry feed via the multi-space feeder. This was mainly due to the fact that the Transition and Jetmix feeders used water to offer pigs feed in the form of a wet mash. In this study it is difficult to estimate the impact of the extra water used per pen on the volume of slurry produced since it would have been consumed via the wet mash and not directly wasted.

6. Conclusions

1) Although the Transition and Jetmix feeders increased feed usage, feed conversion efficiency was poorer and overall the growth rate of pigs in the growing stage was similar to pigs offered pellets via a dry multi-space feeder.
2) The use of a dry multi-space feeder was most economically efficient. A difference of approximately £1 in total feed cost per pig was observed between the use of the Jetmix feeder and the dry multi-space feeder with pellets. On a 200-sow herd, rearing 22 pigs/sow/year, this equates to £4400 per year increased feed cost with the Jetmix feeder.
3) The performance of pigs offered feed via only the Jetmix feeder was similar to the performance of pigs offered feed from both the Transition and Jetmix feeder.
4) Poorer performance, especially in the early weaning stages, was attained using meal via multi-space feeder compared with pellets.
5) There may be benefits in offering feed via the Jetmix feeder to small pigs when housed separately at weaning.

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