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## A Preliminary Look into the Effect of Feeding Frequency on the Performance Parameters of Weaner Pigs

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**Abstract** This experiment was undertaken to investigate the influence of the frequency of feeding on average daily gain, feed conversion efficiency, feed intake and the digestibility of crude protein and dry matter of weaned pigs. Eighteen, clinically healthy crossbred weaner pigs (average weight  $24 \pm 0.4$  lbs.) were used. They were randomly allocated to three treatments during a period of 60 days. Treatment (1): once daily (700g/pig), Treatment (2): Twice daily (350g/pig) and Treatment (3): Thrice daily (233g/pig) feeding. Water was provided ad libitum. Weaners demonstrated no difference ( $p > 0.05$ ) in average daily gain (ADG) (0.94-1.02 kg) across all treatment groups. Feed conversion ratio (FCR) was highest ( $p < 0.05$ ) among weaners that were fed only once per day (6.07 kg). However, there was no difference ( $p > 0.05$ ) in feed conversion efficiency among pigs fed twice (5.15 kg) and three times daily (5.13 kg). Weight gain was highest ( $p < 0.05$ ) among pigs allotted to twice a day feeding (66.2 kg). Similarly, final weight was highest ( $p < 0.05$ ) among pigs fed twice daily (108.3 kg). Dressing percentage was highest ( $p < 0.05$ ) for pigs fed three times daily (70 %) and lowest ( $p < 0.05$ ) for pigs fed two times per day. Dry matter digestibility (DMD) was highest ( $p < 0.05$ ) among pigs fed three times daily (68 %) and lowest among pigs given feed only once daily (63.5 %). Crude protein digestibility (CPD) was lowest ( $p < 0.05$ ) among pigs fed once per day (53 %) and highest ( $p < 0.05$ ) for the group allotted twice daily feeding (58 %). Fat was highest ( $p < 0.05$ ) in the ham of pigs fed twice daily (223.19 g/kg) and lowest in the ham of pigs fed only once per day (62.48 g/kg). Protein was highest ( $p < 0.05$ ) in the ham of pigs fed three times daily (110.9 g/kg). Ham moisture content was lowest ( $p < 0.05$ ) for pigs fed once daily (51.8 g/kg). Feed cost per pound gain was lowest ( $p < 0.05$ ) among pigs fed twice daily (\$5.53) and highest ( $p < 0.05$ ) among pigs fed three times daily (\$6.79). Final weights were highest ( $p < 0.05$ ) among females across all treatment groups when compared to males. It was concluded that pig producers can benefit from a restricted system of feeding.

**Keywords** Feeding Frequency, weaned pigs, carcass quality, average daily gain (ADG), Feed conversion efficiency, feed intake (FI), dry matter digestibility (DMD)

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### Introduction

Pork meat has been an integral part of the diet of meat lovers in Trinidad. Throughout the year, locals have demonstrated a high preference for pork meat but pig producers have been unable to supply the demand. It is agreeable that the major constraint to production is the cost of the feed, however, some have purported that the system of feeding influences the performance of growing pigs in a mark way. Apart from the type of feed, feeding methods have been reported to significantly enhance feed conversion ratios, weight gain, reproductive capacity and the chemical composition of swine meat [5]. Restricted feeding has been grabbing the attention of animal producers worldwide. It entails feeding fixed amounts of a ration two to three times per day [15]. Some have posited that feeding *ad lib* especially with high energy feeds can result in the synthesis of body fat which is inefficient in terms of feed conversion. In addition, carcasses with elevated fat have become unacceptable owing to threatening human health concerns. Reduced adipocyte volume, lipogenic capacity and back fat thickness



were reported in pigs with restricted feeding [11; 10; 4]. Under tropical conditions, a restricted system of feeding has been used to alleviate the effect of heat stress in breeding animals [21]. Feeding frequency is practiced with market pigs to improve carcass quality and feed efficiency while decreasing production costs [3; 5]. The authors concluded that feeding pigs twice daily would significantly enhance performance parameters when compared to once a day feeding. In Trinidad, pig producers are accustomed to feeding once daily. The world, based on scientific research is adopting a more varied approach to feeding pigs. The question on how much to feed is yet to be determined. This study is therefore designed to investigate the effect of once, twice and three times a day feeding on the performance of weaners.

## Material and Methods

### Study site

The study was conducted at the Pig Unit of the Eastern Caribbean Institute of Agriculture and Forestry (ECIAF) Farm, University of Trinidad and Tobago. The Farm is located along the Caroni North Bank Road in Centeno, approximately three (3) kilometers east of the PIARCO International Airport. Humidity is approximately 75% with an average daily temperature of 27 °C. There are two seasons experienced in Trinidad; rainy (June - November) and dry (December - May). The land is flat to undulating with a rich variety of animal species.

### Animals and Animal Management

Data for growth rate, gain and efficiency was collected over a 60 day period from 18 clinically healthy male and female crossbred weaner pigs with an average weight of 24±0.4 lbs. Weaners were randomly allocated to the three treatment groups (feeding frequency) based on body weight and sex (3 females and 3 males per group) in a completely randomized design (CRD) with each pig replicated six times (six replicates per treatment group). Weaners were housed in open ended concrete-floored pens equipped with feeding and watering troughs.

### Feeding

The trial consisted of an adaptation period of 7 days. The chemical composition of the ration is illustrated in Table 1. The feed was formulated by one of the local feed companies to meet the requirement of a growing pig. Weaners were provided with water *ad libitum*. The feeding treatments included: Treatment 1: Once daily (700 g/pig) in the morning at 0700hr. Treatment 2: Twice daily (350 g/pig) in the morning and at noon at 0700 and 1200h. Treatment 3: Thrice daily (233 g/pig) in the morning, noon and in the evening at 0700, 1200 and 1700hr. The feed offered was increased incrementally by 150-200 g/week for each treatment group. Weaners were weighed and measured weekly and weekly feed consumption was recorded. These records were used to assess weight gain, dry matter intake, feed conversion ratio and overall growth. Weekly feed samples were collected in brown paper bags and dried at 65 °C for 48 hrs. Samples were then subsampled and finely grinded through a 1-mm grinder prior to analysis. The chemical composition of the feed samples was analyzed to determine crude protein and dry matter digestibility [1]. All analyses were conducted in duplicate.

### Digestibility trial

In the last two weeks of the trial, feces from each pig was collected directly from the rectum by grab sampling during the morning, before distribution of the feed. Feces were placed in labelled polyethylene bags and dried at 65 °C for 48hrs. Samples were then separated into groups and finely grinded through a 1-mm grinder prior to analysis. The chemical composition of the feed and feces for each treatment group was analyzed to determine crude protein and dry matter digestibility [1]. Apparent Digestibility coefficients were calculated as follows:

$$\text{DM digestibility (\%)} = \frac{\text{DM in feed} - \text{DM in feces}}{\text{DM in feed}} \times 100$$

$$\text{CP digestibility (\%)} = \frac{\text{CP in feed} - \text{CP in feces}}{\text{CP in feed}} \times 100.$$

### Carcass evaluation

Two pigs each per group (male and female) were randomly selected and slaughtered to determine dressing percentage and the ham meat was analyzed for protein and fat according to [1].

### Statistical Analysis

A two-factorial design with factor treatment and sex was used in the statistical analysis of the data, using analysis of variance (ANOVA) following the general linear model as outlined in the Minitab 17 software. The main effects of feed frequency and their interaction on ADG, FCR, FI, dressing percentage and fat% in ham



meat were analysed using the General Linear Models (GLM) procedure of MINITAB (MINITAB Version 17). Differences among means were determined by Tukey's test.

### Results/Discussion

The nutritive value of the commercial feed used throughout the study is presented in Table 1. The analyses were done on samples collected over the 8 week period so as to observe any major changes in the chemical content. There were no significant changes in nutritive content over the study period.

**Table 1:** Chemical composition of feed fed to weaners (g/kg DM)

Feed	Week	DM	OM	CP	EE	ASH	CF	NFE
Pig grower	1	877.0	816.0	156	73.5	48.0	54.1	567
Pig grower	2	872.3	811.4	154	84.0	43.0	63.4	585
Pig grower	3	868.4	810.8	150	73.0	43.9	50.0	582
Pig grower	4	873.0	822.2	148	75.0	45.3	54.6	526
Pig grower	5	880.4	819.0	153	85.0	50.5	55.0	549
Pig grower	6	875.5	817.7	147	77.0	54.3	52.2	539
Pig grower	7	880.0	812.3	154	81.2	57.7	53.0	543
Pig grower	8	873.0	815.0	152	76.3	43.0	51.5	552
SD		4.09	3.95	3.15	4.68	5.53	4.07	19.1

DM: Dry matter, OM: Organic matter, CP: Crude protein, EE: Ether extract, CF: Crude fibre, NFE: Nitrogen free extract, SD: Standard deviation

Calculated according (AOAC 1995)

The nutritive value of the feed fell within the manufacturers specifications for a growing pig (NRC 1998). This suggest that the performance of the pigs should not be limited by the nutritive content of the feed except for nutrient bioavailability.

The effect of feeding frequency on the performance parameters of weaner pigs over an eight week period is presented in Table 2. There was no difference ( $p>0.05$ ) in length (39.3-40.1 inches) and height (22-23.7 inches) of pigs across all feeding frequencies. Similarly, weaners across all treatment groups demonstrated no difference ( $p>0.05$ ) in average daily gain (ADG) (0.94-1.02 kg) (Table 2). This does not support the work of Schneider et al (2014) who reported increases in average daily gain (ADG) with increase feeding frequency. This may be due to poor nutrient utilization among the treatment groups or low bioavailability of nutrients influencing gain. Feed conversion ratio (FCR) was highest ( $p<0.05$ ) among weaners that were fed only once per day (6.07 kg). This can be attributed to less time spent feeding, poor feed utilization or the environment. However, there was no difference ( $p>0.05$ ) in feed conversion efficiency among pigs fed twice (5.15 kg) and three times daily (5.13 kg). These findings agree with [23] and [6] who did not discover any difference in digestibility or performance when pigs received the same total amount of feed in large meals or distributed over small meals. Feed to gain ratio in this study was higher than those reported in the literature. This may be explained in part by possible feed wastage, competition for feed among the groups and harsh environmental temperatures. Pigs have a tendency to reduce intake in response high ambient temperatures so as to better cope with heat stress.

**Table 2:** The effect of feeding frequency on performance parameters of weaner pigs

Treatment	Length (inches)	Height (inches)	ADG (kg)	FCR (kg)	Weight Gain (kg)	Final Weight (kg)	Dress percentage	Mortality (%)
Feeding Freq. 1	40 <sup>a</sup>	22 <sup>a</sup>	1.01 <sup>a</sup>	6.07 <sup>a</sup>	56.3 <sup>a</sup>	99.33 <sup>a</sup>	66 <sup>a</sup>	0 <sup>a</sup>
Feeding Freq. 2	40.1 <sup>a</sup>	23.7 <sup>a</sup>	0.94 <sup>a</sup>	5.15 <sup>b</sup>	66.2 <sup>b</sup>	108.3 <sup>b</sup>	60 <sup>b</sup>	16 <sup>b</sup>
Feeding Freq. 3	39.3 <sup>a</sup>	22.7 <sup>a</sup>	1.02 <sup>a</sup>	5.13 <sup>b</sup>	56.8 <sup>a</sup>	97.67 <sup>a</sup>	70 <sup>c</sup>	0 <sup>a</sup>
SEM	1.56	0.559	0.123	0.279	4.99	6.55	3.22	0.786

<sup>abc</sup>Means in the same column within a parameter with different superscripts differ significantly;  $p<0.05$ . ADG: Average daily gain, Freq.: frequency, FCR: Feed conversion ratio, SEM: Standard error of mean



Weight gain was highest ( $p < 0.05$ ) among pigs allotted to twice a day feeding (66.2 kg). Similarly, final weight was highest ( $p < 0.05$ ) among pigs fed twice daily (108.3 kg). This is in agreement with [5] who reported improvements in gain with twice a day feeding when compared to once. These results suggest that there may have been a change in basal metabolism among pigs fed twice daily hence improving nutrient utilization [19]. Increased performance can also be due to the second-meal phenomenon [8]. The phenomenon indicates that the insulin response is reduced (due to increased frequency of feeding) by distributing the nutrient load over a longer period. This creates a more efficient utilization of nutrients. Dressing percentage was highest ( $p < 0.05$ ) for pigs fed three times daily (70 %) and lowest ( $p < 0.05$ ) for pigs fed two times per day. Pigs fed twice daily exhibited the highest ( $p < 0.05$ ) mortality (16 %).

The effect of feeding frequency on digestibility and meat characteristics of weaner pigs is presented in Table 3. Dry matter digestibility (DMD) was highest ( $p < 0.05$ ) among pigs fed three times daily (68 %) and lowest among pigs given feed only once daily (63.5 %). This is in contrast to the work by [9] who illustrated that dry matter digestibility was better for animals fed twice daily and that there was no significant difference between twice and three times daily feeding. These results are in line with [13] who indicated that feeding frequency has the potential to increase digestibility in pigs. This increase in digestibility is associated with the increase flow of digestive enzyme in the small intestine [22; 20; 23] and increases in pancreatic secretions which is positively correlated with digestibility [7; 2]. Crude protein digestibility (CPD) was lowest ( $p < 0.05$ ) among pigs fed once per day (53 %) and highest ( $p < 0.05$ ) for the group allotted twice daily feedings (58 %). This supports the work of [9] who illustrated better crude protein digestibility among pigs fed twice daily. Improved performance of the twice daily fed pigs can be attributed to their higher crude protein utilization/digestibility. Fat was highest ( $p < 0.05$ ) in the ham of pigs fed twice daily (223.19 g/kg) and lowest in the ham of pigs fed only once per day (62.48 g/kg) (Table 3) suggesting that pigs fed twice daily have not been able to efficiently utilize fat in the diet [19]. Additionally, pigs with higher ham fat may be due to the animals spending more time lying than involved in increase activity. During the finishing period the pig's ability to consume feed outweighs its ability to deposit protein. As a consequence, a high percentage of energy and protein ingested at this time may be deposited as carcass fat [24].

**Table 3:** The effect of feeding frequency on digestibility and meat characteristics of weaner pigs

Treatment	DMD (%)	CPD (%)	Ham fat (g/kg)	Ham protein (g/kg)	Ham Ash (g/kg)	Ham Moisture content (g/kg)	Feed cost/lb gain (TTD)
<b>Feeding Freq. 1</b>	63.5 <sup>a</sup>	53 <sup>a</sup>	62.48 <sup>a</sup>	83.3 <sup>a</sup>	39.95 <sup>a</sup>	51.8 <sup>a</sup>	6.32 <sup>a</sup>
<b>Feeding Freq. 2</b>	65.0 <sup>b</sup>	58 <sup>b</sup>	223.19 <sup>b</sup>	85.4 <sup>a</sup>	58.83 <sup>b</sup>	74.1 <sup>b</sup>	5.53 <sup>b</sup>
<b>Feeding Freq. 3</b>	68 <sup>c</sup>	55 <sup>c</sup>	192.16 <sup>c</sup>	110.9 <sup>b</sup>	53.4 <sup>bc</sup>	74.3 <sup>b</sup>	6.79 <sup>c</sup>
<b>SEM</b>	0.00	0.00	26.3	4.33	3.92	0.890	0.702

<sup>abc</sup>Means in the same column within a parameter with different superscripts differ significantly;  $p < 0.05$ . ADG: Average daily gain, DMD: dry matter digestibility, CPD: crude protein digestibility, FCR: Feed conversion ratio, SEM: Standard error of mean

Protein was highest ( $p < 0.05$ ) in the ham of pigs fed three times daily (110.9 g/kg). This corroborates the findings of [25] who observed that protein output increased with increasing the number of daily meals. However, there was no difference ( $p > 0.05$ ) in ham protein among pigs fed once (83.3 g/kg) and twice daily (85.4 g/kg). This can be explained in part by the tendency for protein to decrease as pigs increase in weight. Ash was lowest ( $p < 0.05$ ) in the ham of pigs fed once daily (39.95 g/kg). There was no difference ( $p > 0.05$ ) in ham moisture content for pigs fed twice (74.1 g/kg) and three times daily (74.3 g/kg). However, ham moisture content was lowest ( $p < 0.05$ ) for pigs fed once daily (51.8 g/kg). Feed cost per pound gain was lowest ( $p < 0.05$ ) among pigs fed twice daily (\$5.53) and highest ( $p < 0.05$ ) among pigs fed three times daily (\$6.79) (Table 3). This supports the work of English et al (1988) who indicated that increased feeding frequency can decrease production cost.



The interaction between feeding frequency and sex on the performance parameters of weaner pigs is presented in Table 4. Females were significantly longer than males among pigs fed twice (34.68 & 31.11 in) and three times daily (35.11 & 32.00 in). Similarly, females were significantly taller ( $p < 0.05$ ) than males among pigs fed twice (19.79 & 17.8 in) and three times daily (20.25 & 18.5 in). There was no difference ( $p > 0.05$ ) in average daily gain (ADG) between male and female pigs fed three times daily. However, average daily gain (ADG) was lowest ( $p < 0.05$ ) among males (0.284 & 0.326 kg) fed once and twice daily when compared to females (0.300 & 0.406 kg) fed once and twice daily (Table 4).

**Table 4:** Treatment and sex interaction on the performance parameters of weaner pigs

Treatment	Sex	Length (inches)	Height (inches)	ADG (kg)	FCR (kg)	Weight Gain (kg)	Final Weight (kg)	Dress %	Mortality (%)
<b>Feeding Freq. 1</b>	F	34.98 <sup>a</sup>	20.07 <sup>a</sup>	0.300 <sup>a</sup>	6.52 <sup>a</sup>	29.19 <sup>a</sup>	76.19 <sup>a</sup>	54 <sup>a</sup>	0 <sup>a</sup>
	M	33.96 <sup>a</sup>	19.42 <sup>a</sup>	0.284 <sup>a</sup>	6.47 <sup>a</sup>	28.74 <sup>a</sup>	67.81 <sup>b</sup>	78 <sup>b</sup>	0 <sup>a</sup>
<b>Feeding Freq. 2</b>	F	34.68 <sup>a</sup>	19.79 <sup>a</sup>	0.406 <sup>a</sup>	5.18 <sup>a</sup>	32.07 <sup>a</sup>	78.07 <sup>a</sup>	47 <sup>a</sup>	0 <sup>a</sup>
	M	31.11 <sup>b</sup>	17.8 <sup>b</sup>	0.326 <sup>b</sup>	5.44 <sup>a</sup>	24.96 <sup>b</sup>	65.21 <sup>b</sup>	67 <sup>b</sup>	10 <sup>b</sup>
<b>Feeding Freq. 3</b>	F	35.11 <sup>a</sup>	20.25 <sup>a</sup>	0.275 <sup>a</sup>	6.08 <sup>a</sup>	29.79 <sup>a</sup>	73.04 <sup>a</sup>	70 <sup>a</sup>	0 <sup>a</sup>
	M	32.00 <sup>b</sup>	18.5 <sup>b</sup>	0.276 <sup>a</sup>	6.21 <sup>a</sup>	21.14 <sup>b</sup>	57.14 <sup>b</sup>	70 <sup>a</sup>	0 <sup>a</sup>
<b>SEM</b>		1.56	1.06	0.027	0.324	3.48	4.63	0.00	2.50

<sup>abc</sup>Means in the same column within a parameter with different superscripts differ significantly;  $p < 0.05$ . ADG:

Average daily gain, Freq.: frequency, FCR: Feed conversion ratio, SEM: Standard error of mean

There was no difference ( $p > 0.05$ ) in feed conversion efficiency between males and females across all treatment groups. Weight gain was highest ( $p < 0.05$ ) among females fed twice (32.07 kg) and three times (29.79 kg) daily when compared to males fed twice (24.96 kg) and three times (21.14 kg) daily. Final weights were highest ( $p < 0.05$ ) among females across all treatment groups when compared to males (Table 4). This corroborates the findings of [16] who noted heavier final weights in females when compared to males. In contrast, Dressing percentage was highest ( $p < 0.05$ ) among males fed once (78 %) and twice (67 %) when compared to females fed once (54 %) and twice (47 %) daily. This is supported in the literature where dressing percentage was lower among female pigs [16]. Mortality was higher ( $p < 0.05$ ) in males (16 %) when compared to females (0 %) among pigs fed twice daily.

The interaction between feeding frequency and sex on digestibility and meat characteristics of weaner pigs is presented in Table 5. There was no difference ( $p < 0.05$ ) in dry matter digestibility (DMD) and crude protein digestibility (CPD) between males and females across all feeding frequencies. Ham fat was higher ( $p < 0.05$ ) in males fed once (75.65 g/kg) and twice (319 g/kg) daily when compared to females fed once (49.31 g/kg) and twice (31.56 g/kg) daily. This is not in line with the work of [16] who indicated that fat is higher in the meat of females when compared to male pigs. In contrast, ham fat was lower ( $p < 0.05$ ) in males fed three times daily (42.48 g/kg) when compared to the females in the same group (267 g/kg). This indicates that males fed three times daily spent more time being active and were better able to utilize the energy in the diet in comparison to their female counterparts.

**Table 5:** Treatment and sex interaction on digestibility and meat characteristics of weaner pigs

Treatment	Sex	DMD (%)	CPD (%)	Ham Fat (g/kg)	Ham protein (g/kg)	Ham Ash (g/kg)	Ham Moisture Content (g/kg)	Feed cost/lb gain (TTD)
<b>Feeding Freq. 1</b>	F	63.50 <sup>a</sup>	53.00 <sup>a</sup>	49.31 <sup>a</sup>	78.40 <sup>a</sup>	28.80 <sup>a</sup>	50.50 <sup>a</sup>	4.22 <sup>a</sup>
	M	63.50 <sup>a</sup>	53.00 <sup>a</sup>	75.65 <sup>b</sup>	88.20 <sup>b</sup>	51.10 <sup>b</sup>	53.10 <sup>b</sup>	2.59 <sup>b</sup>
<b>Feeding Freq. 2</b>	F	65.00 <sup>a</sup>	58.00 <sup>a</sup>	31.56 <sup>a</sup>	57.20 <sup>a</sup>	38.70 <sup>a</sup>	68.50 <sup>a</sup>	2.38 <sup>a</sup>
	M	65.00 <sup>a</sup>	58.00 <sup>a</sup>	319 <sup>b</sup>	99.50 <sup>b</sup>	68.90 <sup>b</sup>	76.90 <sup>b</sup>	2.51 <sup>a</sup>
<b>Feeding Freq. 3</b>	F	68.00 <sup>a</sup>	55.00 <sup>a</sup>	267 <sup>a</sup>	110.20 <sup>a</sup>	50.40 <sup>a</sup>	74.80 <sup>a</sup>	2.25 <sup>a</sup>
	M	68.00 <sup>a</sup>	55.00 <sup>a</sup>	42.48 <sup>b</sup>	112.20 <sup>b</sup>	59.41 <sup>b</sup>	73.40 <sup>b</sup>	3.14 <sup>b</sup>
<b>SEM</b>		0.00	0.00	18.27	0.00	0.00	0.00	0.503

<sup>abc</sup>Means in the same column within a parameter with different superscripts differ significantly;  $p < 0.05$ . ADG:

Average daily gain, DMD.: Dry matter digestibility, CPD: Crude protein digestibility, FCR: Feed conversion ratio, SEM: Standard error of mean



Protein in the ham of males was significantly higher when compared to females across all feeding frequencies. Similarly, ash was higher ( $p < 0.05$ ) in the ham of males when compared to ash in the ham of females across all feeding frequencies (Table 5) suggesting that mineralization was better in the muscle of male pigs. Male pigs fed once and twice daily had higher ( $p < 0.05$ ) moisture in the ham meat when compared to females of the same groups. Feed cost per pound of gain was lower for male pigs fed once per day (\$2.59) when compared to females (\$4.22) fed once daily. In contrast, feed cost per pound of gain was higher ( $p < 0.05$ ) in males fed three times daily (\$3.14) when compared to females fed three times daily (\$2.25).

Data in figure 1 reveals that as the fat in the ham muscle increase there is also an increase in ham protein.

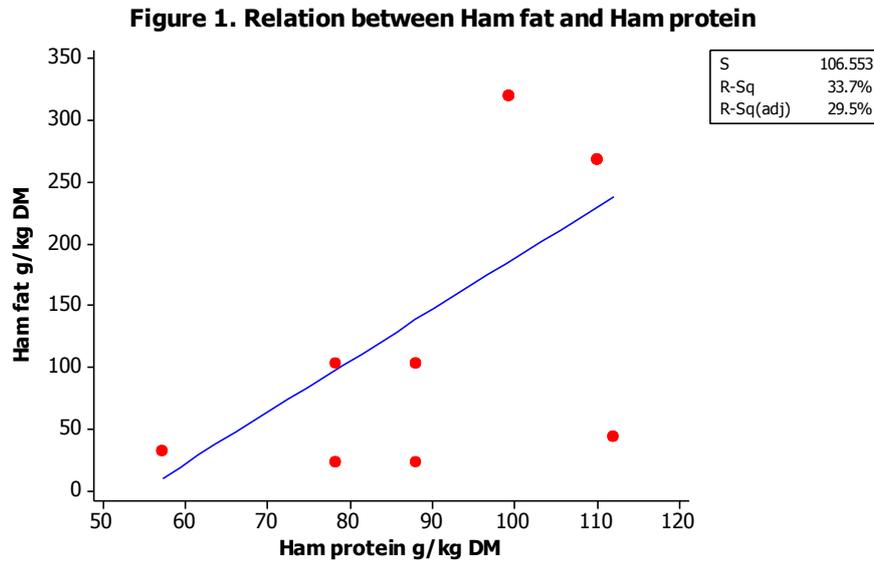


Figure 1: Relation between Ham fat and Ham protein

There was also a significant relationship ( $p < 0.001$ ) between pig length and height as revealed in Figure 2.

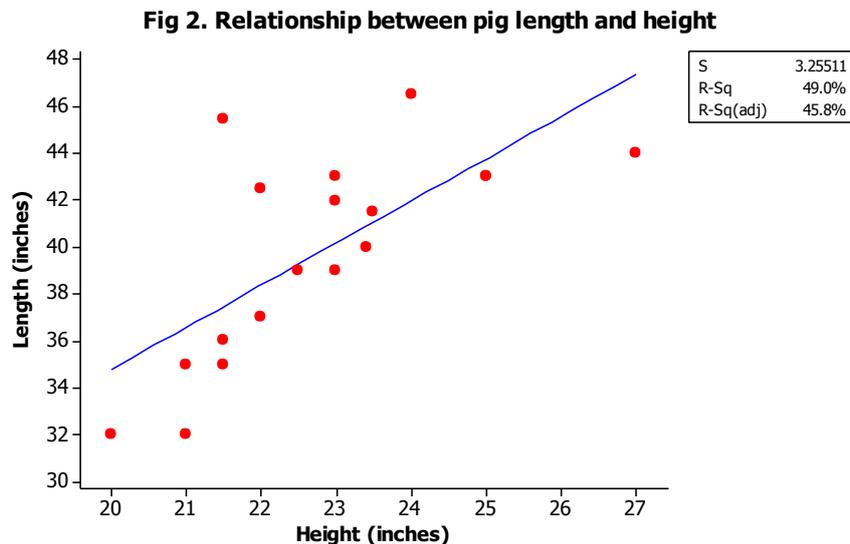


Figure 2: Relation between pig length and height

## Conclusion

Feeding frequency does have an influence on the performance and production cost of growing pigs. The benefits are not numerous with feeding three times per day. Pig farmers in Trinidad should consider feeding twice per day instead of once per day feeding.

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