9. FEEDING MANAGEMENT OF MARKET HOGS

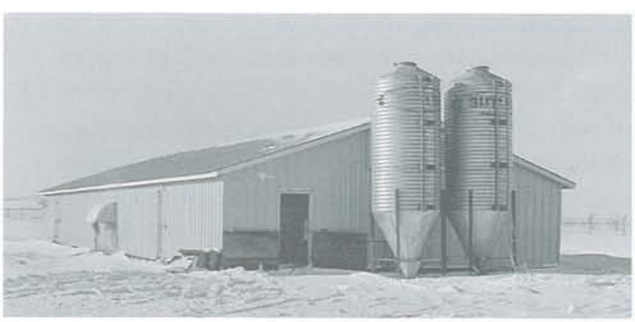
Approximately 60% of the total cost of pork production is associated with growing out the feeder pig. Traditionally, more attention is paid to managing sows and starter pigs than growing-finishing pigs. The breeding and farrowing areas are often considered more challenging and therefore, according to many people, deserve more of management's attention. The indifference shown to the feeder barn probably stems from the presence of apparent problems in the sow-related areas and from a lack of appropriate records in the feeder barn.

Records are very important in identifying both production problems and opportunities to improve performance in the feeder barn. Fortunately, as better record keeping systems and performance monitoring systems become available, and as potential improvements in profitability become more apparent, more attention is paid to the feeder barn. Feed is the largest single expense in any swine operation. Although there must be an absolute minimum, the variation in feed costs among farms is proof that major savings can be achieved in this area. Even on farms with high management standards, differences in feed costs (up to 25% per pig) still exist.

Goals for the Feeder Barn

Establishing production objectives for the feeder barn is important. These objectives will vary from farm to farm depending on a variety of circumstances including pig genotype, health status, environmental control, pig density, and diet composition. The goals defined in Table 9-1 are a reasonable guide for most feeder barns. These goals are identified as good, better, and best to denote the ease with which they can be achieved. The values in the 'good' column are being achieved consistently by many producers. Those in the 'better' column are being met by some producers so are currently possible. The goals in the 'best' column are not all being achieved consistently at the present time, but the potential exists to meet or exceed them under the right combination of management. The tremendous gains made in the recent past provide confidence that the goals in the 'best' column will be met or surpassed in the near future.

Photo 9-1.



Approximately 60% of the total cost of production is associated with the feeder barn. Feed is the major expense.

Table 9-1. Goals for the Feeder Barn.

	Goal Level		
	Good	Better	Best
Age at 105kg	160	150	140
Days in Feeder Barn	110	100	90
Feeder Barn (20 - 105 kg)			
Avg Growth Rate (g)	775	850	950
Feed Conversion	3.20	2.85	2.60
Mortality (%)	2.0	0.5	0.1
Carcass Index	107	110	112

These goals are to be used only as guidelines. The overall objective is to maximize profit. Establishing the proper goals for your operation is just as important, if not more so, than your capital outlay. For example, although superior pig performance is a desirable goal, setting a goal of the highest standard of performance may not be profitable because the extra expense needed to produce the high standard may not be regained from the market. Setting arbitrary goals without records to back them up may also be costly. A strict capital invested to goals accomplished ratio does not exist, either. In some cases, the overall goal of profitability can be attained with a low capital approach that frees the operation from heavy debt and cushions it against depressed prices and high interest rates. Establishing your goals will help you determine the areas important to you, and how much you are willing to spend in each of those areas.

Once production goals have been established, the next step is to develop feeding and management strategies to accomplish these goals. Finally, a record keeping system should be implemented to monitor important production parameters, such as days in the barn, feed usage, carcass lean yield, and mortality.

Lean Tissue Growth in Growing-Finishing Pigs

In feeder pigs, both the growth rate and the composition of growth should be considered. Growth is the increase in body weight with time or age of the pig. A typical growth curve is shown in Figure 9-1. This curve, a sigmoidal growth curve, represents a pig's theoretical growth pattern from fetus to adulthood. It is clear that at an early age, the pig's gain is at an increasingly rapid rate; later, rate of gain is essentially constant and later still, decelerates as the pig approaches full, mature weight. This curve represents a pig's potential but under normal farm conditions less than optimal growth may occur due to limitations in genetics, nutrition, housing, disease, or other management aspects. Furthermore, the curve is influenced by sex — boars and barrows grow faster than gilts. Pigs are generally slaughtered at a weight which is under half their mature body weight and at a time that growth rates are just starting to decline.

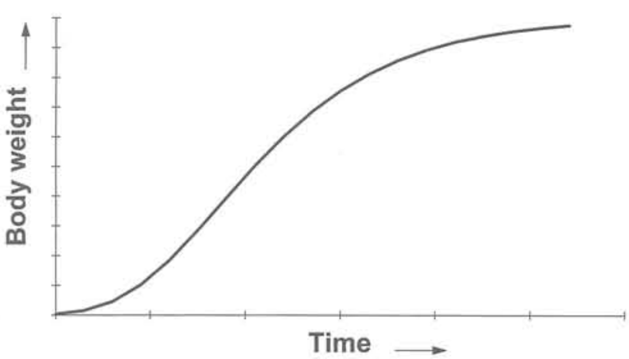


Figure 9-1. Sigmoidal Curve Describing the Theoretical Growth of the Pig from Conception to Adulthood.

In young pigs, growth consists largely of bone and muscle, but as the pig reaches maturity, fat deposition occurs at an increasingly rapid rate. For example, in the new-born pig, muscle and bone represent 29 and 19%, respectively, of total empty body weight while fat represents less than 4% of the total. By 28 weeks of age, muscle and bone represent 32 and 7%, respectively, and fat has risen to 35% of the total (Figure 9-2).

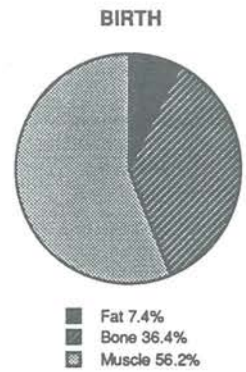


Figure 9-2a.

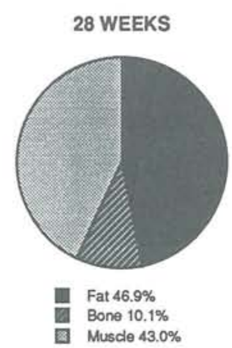


Figure 9-2b.

Figure 9-2. Relative Proportions of Muscle, Bone and Fat in Pigs at Birth and 28 weeks of Age (From McMeakan, 1940).

Since consumers demand high quality lean pork products, it is in the producer's interest to maximize or optimize the accretion (growth) of muscle, or lean body mass and minimize body fat deposition. One important additional advantage is that pigs are much more efficient in producing lean tissue than fat. Pigs require about four times the amount of feed to produce one kg of body fat compared to one kg of body lean. This requirement is due largely to the difference in water content: fat and lean tissue mass contain about 5% and 70% water, respectively. The pork producer can employ a number of strategies to manipulate lean tissue growth in the pig. These strategies include selecting genetically lean animals for breeding, maintaining a high herd health status, carefully formulating market hog diets, and manipulating feed intake.

Fat and lean content of the carcass is measured in many ways around the world. The most common method is to take back fat measurements at specific locations over the last rib and at various distances from the backbone: P1, P2 and P3 (Figure 9-3). Back fat measurements, in turn, can be related to total body fat content. Back fat measurements can be used to estimate body lean content because there is an inverse relationship between body fat and body lean content.

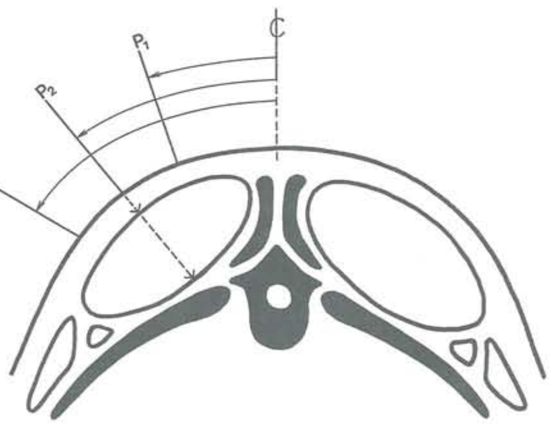


Figure 9-3. Description of P1, P2, and P3 Fat Measurements, Taken over Last Rib and Atop the Loin Eye Muscle.

In the Canadian swine carcass grading system, a special probe is used to determine the measurements, taken 70 mm from the backbone and between the 3rd and 4th last ribs, used to estimate carcass lean content. Since early 1995, the lean yield is expressed as a percentage of the cold carcass sides, rather than of the warm carcass. Depth of back fat and the loin eye muscle is determined at this site. This information is incorporated into an arithmetic formula to estimate carcass lean yield. The estimated lean yield and dressed carcass weight is then used to arrive at an index, which becomes the basis for settlement of value per kg of carcass (Table 9-2). The actual index value that is assigned to each yield class in each carcass weight category may vary between provinces and even between packers within provinces.

Information on carcass lean yield and growth rates can be used to determine lean growth rates in individual groups of feeder pigs. To calculate lean growth rates, assume that the lean content in a 25 kg pig is constant at 35% of live body weight, that carcass dressing percentage is relatively constant at 79% of body weight in market weight pigs, and that the difference in weight between hot carcass weight and cold carcass sides is 8 kg. This 8 kg represents the weight of the head, feet, tail, kidneys and leaf fat, (i.e. the parts that are removed from the carcass before the weight of the cold carcass sides can be determined).

Calculating Lean Growth Rates:

Required information:

- initial weight: 25 kg
- final weight: 105 kg
- average carcass lean yield (from carcass grading slip): 59%
- average days in the growing-finishing barn: 103

Assumptions:

- difference in weight between hot carcass and cold carcass sides: 8 kg
- lean content at initial weight: 35% of body weight
- carcass dressing percentage: 79% of body weight

Calculations:

- lean mass at initial weight:

25 kg x 35%/100 = 8.75 kg

- lean mass at final weight:

(105 kg x 79%/100 - 8kg) x 59%/100 = 44.22 kg

- lean growth rates:

1000 x (44.22 kg - 8.75 kg) / 103 days

= 344 g/d

Alternatively, lean growth rates can be estimated from days in the feeder barn and carcass lean yield as outlined in Table 9-3.

Monitoring lean tissue growth rates in the grower-finisher barn is important for three reasons. First, lean tissue growth, representing the accretion of the valuable parts in the pig's body, is a good indicator of production output. Second, observed lean tissue growth rates allow for an objective comparison of production efficiency between various production units. Lean tissue growth rates are important for determining whether or not pigs are performing at a level close to their performance potential. Third, estimates of lean growth rates and lean growth

Table 9-2. Saskatchewan Carcass Grading Grid (effective March 6, 1995).

Weight Class Kilograms		1 Less 64.99	2 65 - 69.99	3 70 - 74.99	4 75 - 79.99	5 80 - 86.99	6 87 - 89.99	7 90 - 94.99	8 95 - 99.99	9 100 - Plus
Yield Class	% Estimated Lean Yield									
1	>62.8	65	80	102	114	114	114	110	105	97
2	>61.6 - 62.8	65	80	100	113	114	113	109	103	93
3	>60.5 - 61.6	65	80	98	111	113	112	108	100	89
4	>59.5 - 60.5	65	80	97	109	112	110	107	98	87
5	>58.6 - 59.5	65	80	95	107	111	107	105	96	86
6	>57.7 - 58.6	65	80	93	103	103	104	101	94	85
7	>56.9 - 57.7	65	78	92	101	105	102	97	92	83
8	>56.0 - 56.9	65	75	88	99	103	98	94	89	80
9	>55.2 - 56.0	60	73	83	97	101	97	88	84	76
10	<55.19	60	70	80	90	92	90	80	80	70
						Core				

* Please note that for the first time, a minimum fat penalty has been introduced. Any carcasses with less than 8 mm of fat will be discounted by 10 index points.

Table 9-3. Observed Lean Growth Rates in Growing-finishing Pigs (25 to 105 kg body weight) in Relation to Growth Rates and Carcass Lean Yield Content (75-85 kg carcass weight)*.

	Growth rate (g/d)				
Estimated lean yield (%)	>850	800-850	750-800	700-750	<700
> 61	High	High	High	Medium	Medium
59 - 61	High	High	Medium	Medium	Unimpr.
57 - 59	High	Medium	Medium	Unimpr.	Unimpr.
< 57	Medium	Medium	Unimpr.	Unimpr.	Unimpr.

* relates to carcass weights between 75 and 86.99 kg in Saskatchewan; 1995 Canadian carcass grading system;the high, medium, and unimproved lean growth rates correspond to lean growth rates of approximately 380, 340, and 300 g/d.

potential are essential for developing cost-effective feeding strategies in individual production units.

Clearly, the objectives in raising pigs are to optimize lean tissue gain and to minimize the accumulation of body fat. The overall goal is to meet these objectives profitably.

Feed Intake in Feeder Pigs

Feed intake is closely related to growing-finishing pig performance. In addition, estimates of feed intake are required for accurate feed formulation. Unfortunately feed intake appears to vary considerably between different feeder pig units. As it is affected by many factors, it is difficult to accurately predict feed intake as well. These factors are associated with the animal (e.g., body weight, sex, genotype, health status), the feed (e.g., dietary energy density, levels of other nutrients, ingredient composition, freshness, feed processing, bulkiness, water supply) and the environment (e.g., effective environmental temperature, animal density, group size, pen design, feeder design and location).

In 1987, the North American National Research Council (NRC) presented a mathematical equation to predict the voluntary daily energy intake in growing-finishing pigs. When this equation was introduced, digestible energy (DE) content of the diet and the pig's body weight were recognized as two important factors that affect feed intake. More recent estimates of feed intake on commercial Canadian pig farms suggests that pigs under commercial conditions are more likely to consume quantities of feed that are equivalent to 90% of the daily DE intake in growing-finishing pigs as suggested by NRC (1987). Figure 9-4 represents feed intake curves for feeder pigs consuming a diet with a DE content of 3150 or 3400 kcal per kg and at 90% of voluntary feed intake according to NRC (1987). This graph may serve as a benchmark to compare feed intakes on individual pork production units.

Recent work at Purdue University clearly demonstrates that the effect of pig genotype on voluntary feed intake. Their studies demonstrate that in feeder pigs managed under the same conditions and fed similar diets, the difference in feed intake between the various lines of pigs may be as high as 20 - 30%. Pigs that have been selected for (lean) feed efficiency, rather than for lean growth rates, may have lower feed intake capacities as compared to the unselected controls. Another factor associated with the animal is that feed intake is reduced (5% or more) in pigs with (sub-clinical) diseases as compared to pigs managed under minimum disease conditions. For the development of split-sex feeding programs, the difference in feed intake between barrows and gilts should be considered. On average, the difference in feed intake between the two sexes is 10%. However, it tends to increase at increasing body weights and the difference in feed intake between the two sexes will vary with pig genotype and the environment (see split-sex feeding later in this chapter).

One of the main feed factors that determines feed intake is the dietary energy density. Finishing pigs are generally able to compensate for reduction in dietary energy density (with an increase in daily feed intake) in such a manner that the daily energy intake remains constant. Grower (and starter) pigs are generally unable to adjust feed intake with changing energy densities. For these pigs physical feed intake capacity, or "gut fill", determine feed intake, An increase in dietary energy density will result in increases in the daily feed intake. It should be stressed that these principles do not apply to extreme dietary energy densities and will be affected by environmental conditions. The effect of diet energy density on daily energy intake can have important consequences for the optimum energy density in the diet (see "diet formulation" later in the chapter). Other nutrients have limited effects on feed intake when present at levels in the feed which are within practical range. If feed is the suspected problem with intake, then the various aspects of feed formulation and preparation should be quickly evaluated. These include: ingredient composition and quality (inclusion levels of "unpalatable" ingredients, freshness, molds and toxins), feed processing and mixing accuracy (check for the content of the major nutrients: see chapter 10) and the storage and handling of the prepared feed (freshness, contamination of molds after feed preparation).

In terms of the environment, the effective environmental temperature (the actual temperature that the pig "feels"; the net result of air temperature, air movement, humidity, floor type and wetness of skin and floor, etc.), pig density and the design and management of the feeder are important factors that can affect feed intake. For example, for pigs that are under mild heat stress an increase in the effective environmental temperature by 1°C will reduce feed intake by approximately 1% and 2% in grower and finisher pigs, respectively. As far as pig density is concerned, the actual space allowance is more critical than the number of pigs in a group. Feed intake will reduce by about 3% and 2% per 0.1 m^2 reduction in floor space per pig in grower and finisher pigs, respectively.

Feeders should be designed and located in such a way that pigs can assume their normal eating behaviour. The design should discourage feed buildup in the feeder. Feeders should be easily adjusted to maximize feed intake while minimizing feed wastage and not be sensitive to mechanical failure. No sharp objects or protruding objects should be present. If well designed single space feeders are used, one feeder is sufficient for up to 12 pigs. When the water nipple is placed inside the feeder (wet feeders), feed intake is generally higher (1 - 7%) as compared to that of standard dry feeders. Problems with wet pens, water wastage and the developments of molds are more likely to occur when wet feeders are used.

Given the above considerations, it is important to monitor feed intake as well as the main factors that affect feed intake.

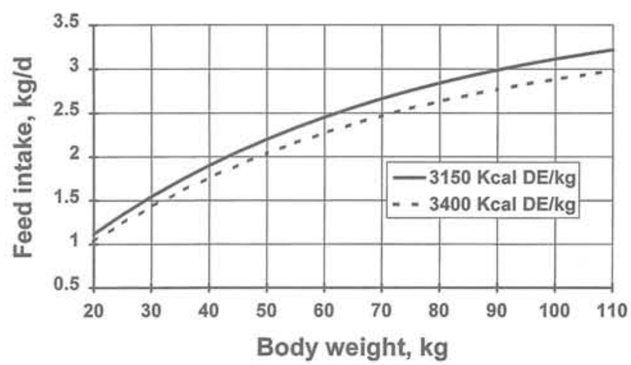


Figure 9-4. Typical Feed Intake Curve for Growing Pigs Consuming a Diet with a DE Content of Either 3150 or 3400 kcal/kg. (Feed intake is equivalent to 90% of voluntary feed intake according to NRC 1987*).

*According to NRC 1987, the voluntary daily DE intake can be predicted from body weight (W, kg). DE intake (Kcal/d) = 13,162 x ($1-e^{-.0176 \times W}$).

Feed Utilization in Feeder Pigs

Pigs use feed for three major purposes: body maintenance functions, lean tissue growth, and body fat deposition (Figure 9 -5). Even if they do not grow, pigs require a certain amount of food to maintain vital body functions such as circulation, respiration, and digestion. Only dietary nutrients that are supplied in excess of maintenance requirements can be used to support growth, either in the form of lean tissue or body fat. Maximizing the utilization of feed for growth means minimizing the amount of feed required for maintenance functions. To maximize growth means that pigs should be maintained in a comfortable environment so they do not expend energy adapting to their environment (e.g., shivering to keep warm). If the environmental temperature is suitable, pigs should not require feed to maintain a constant body temperature, or combat diseases.

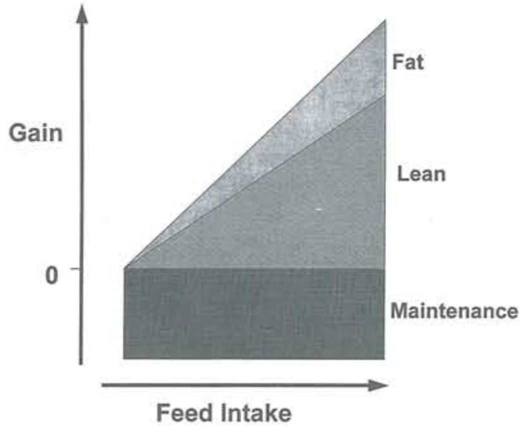


Figure 9-5. Relationship between Feed Intake and Tissue Accretion Rates in Growing Pigs.

When feed intake is increased above that required for maintenance, lean tissue growth in pigs rapidly increases (Figure 9-5). However, even at very low levels of feed intake, growing pigs will deposit some (essential) body fat. It is practically impossible to avoid the deposition of any body fat in growing pigs. In some pigs, and at high levels of feed intake, intake may exceed the amount required for maximum lean tissue growth rates. If so, lean growth is not limited, but large quantities of body fat, which result in reduced carcass lean yield and poor feed efficiency, will also be deposited . This situation generally occurs in finishing pigs (greater than 60 kg body weight) that are fed *ad libitum*, but may occur at lower body weights in pigs with poor lean growth potential. On the other hand, even a high feed intake may be insufficient to maximize lean growth up to body weights greater than 60 kg in boars and other animals with extremely high lean tissue growth potential (Figure 9-6).

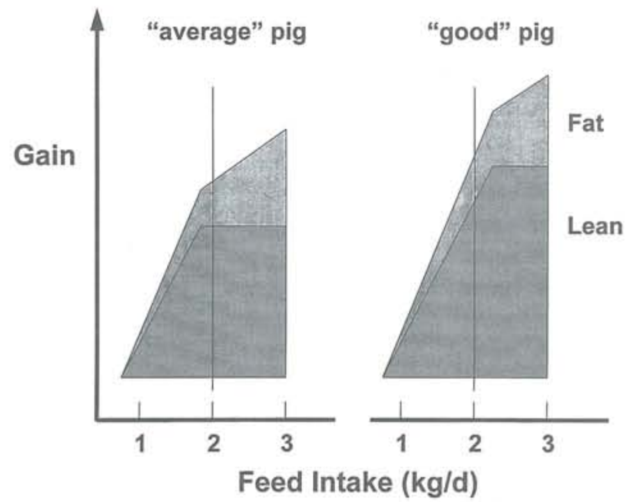


Figure 9-6. The Effect of Feed Intake on Lean Tissue Growth and Body Fat Deposition in Finishing Pigs with Average ("average" pig) and High ("good" pig) Lean Tissue Growth Potential*.

* The maximum lean tissue growth rate is considerably higher in pig type b than in pig type a. To achieve the maximum lean tissue growth rate, the "good" pig requires more feed than the "average" pig. If feed intake in both types of pigs were restricted, e.g., at 2 kg/d, no difference in performance would be observed between the two types of pigs.

The relationships between feed intake, lean tissue growth, and body fat deposition have been explained in Figures 9-5 and 9-6. Figure 9-7 presents the effect of feed intake on growth rate, feed efficiency, and carcass lean content for growing and finishing pigs with average lean growth potential. In

growing pigs, feed intake limits lean growth so should be maximized for optimal growth rate and feed efficiency. In finishing pigs, feed efficiency and carcass value can be improved by moderately restricting feed intake. The optimum level of feed intake in the finishing phase is thus determined by the relative importance of feed efficiency (feed cost), lean yield in the carcass (the carcass grading system), and the value of throughput (the cost of space). In all these relationships it is assumed that performance is determined purely by energy intake and that other nutrients, such as amino acids, vitamins, and minerals, do not limit animal performance.

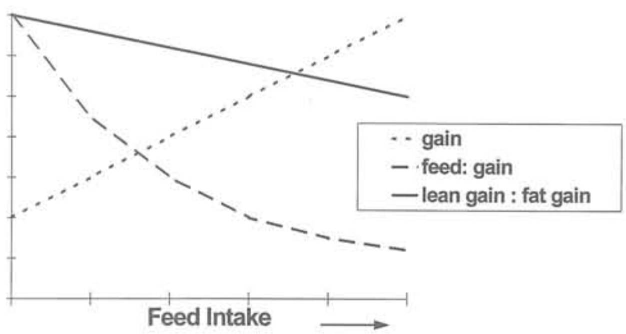


Figure 9-7a.

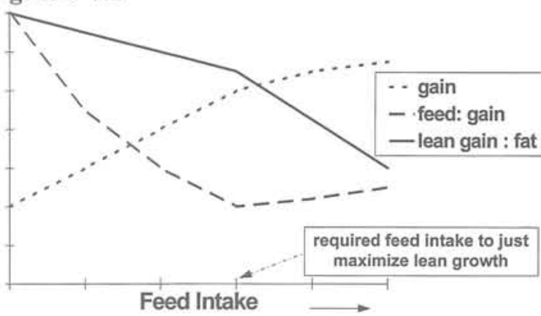


Figure 9-7b.

Figure 9-7. Relationship between Feed Intake and Performance in Growing Pigs where Energy Intake Limits Lean Growth (Figure a), and in Finishing Pigs where Feed Intake does not Limit Lean Growth (Figure b).

Factors Affecting Nutrient Requirements in Growing-Finishing Pigs

Due to differences in animal performance potential, health status, body weight, feed intake, environmental conditions, and other factors, there is a tremendous amount of variation in the optimum nutrient levels in diets for different groups of feeder pigs. Before any attempt is made to formulate diets for feeder pigs, the main factors that determine the optimum nutrient levels in the diet must be considered.

The lean growth rate in the growing-finishing pig is the single most important factor that determines the daily requirements for amino acids and one of the main factors determining requirements for energy. For example, the relationship between dietary lysine levels and lean growth in two types of pigs is demonstrated in Figure 9-8. At low levels of lysine in the diet there is no difference in performance between the two types of pigs. Only when dietary lysine levels are increased can pigs with the higher lean tissue growth potential demonstrate their potential. Pigs with unimproved lean tissue growth potential will not respond to the increase in dietary lysine levels. To avoid over feeding expensive nutrients to an animal that does not require them, and to ensure that an animal with high performance potential receive sufficient quantities, it is important to monitor lean growth rates (see earlier section on lean tissue growth) and to establish the animal's lean growth potential.

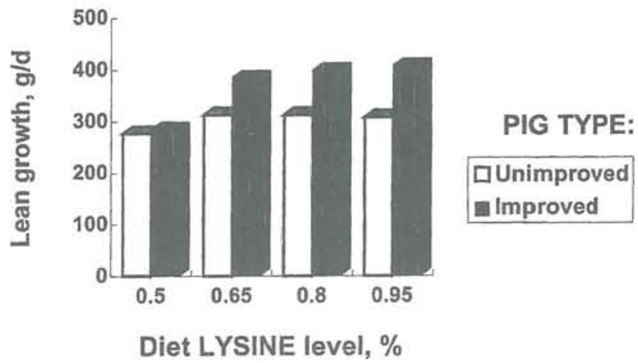


Figure 9-8. Effect of Dietary Lysine Levels and Pig Type on Lean Growth Rates (Stahly 1989, University of Kentucky).

Estimates of lean tissue growth potential in various types of pigs may be provided by the breeding stock supplier. Do not, however, underestimate the effect of the animal's health on lean tissue growth potential. The presence of disease can effectively reduce the animal's lean growth potential (Table 9-4) no matter how high its estimation. Breeding stock is often produced and evaluated in herds with a health status much higher than that in many commercial pork production units. Estimates of lean growth potential that are derived from animals tested in herds with a high health status may not apply to their offspring that are managed on commercial farms.

Table 9-4. The Effect of Health Status on Performance in Growing-Finishing Pigs (Williams 1994, Iowa State University).

Exposure to Disease	Low	High
Feed intake, kg/d	2.47	2.36
Growth rate, kg/d	0.89	0.78
Feed : Gain	2.76	3.04
Muscle in the carcass, %	57.0	52.5

The animal's lean growth potential may be estimated from observed lean growth rates in the feeder barn (see Table 9-3). However, take care in interpreting lean growth rates. Other factors, such as feed intake or unbalanced diets, rather than the animal's potential, may affect observed lean tissue growth rates.

A pig's daily nutrient requirements increase as it grows heavier, but so does its feed intake. In fact, a pig's feed intake increases more rapidly than its increase in daily nutrient requirements. As a result, nutrient levels in the feed can be gradually decreased as the animal grows (Figure 9-9). This concept forms the basis of phase feeding. Phase feeding uses different diet formulations to meet the pig's nutrient requirements at each stage of its production, which reduces over-feeding excessive quantities of expensive nutrients.

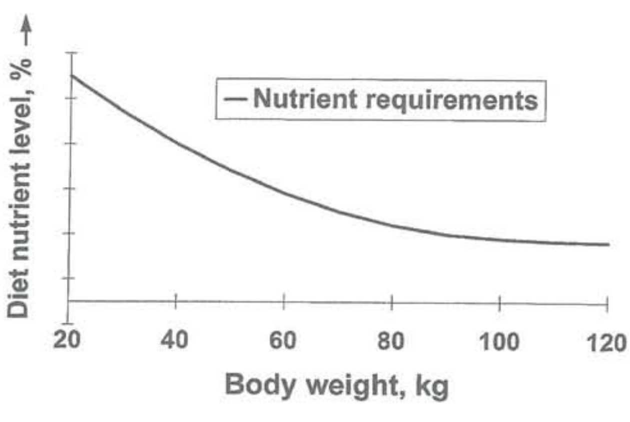


Figure 9-9. Change in Required Dietary Nutrient Levels in Relation to Body Weight.

Because animals require nutrients on a daily basis, estimates of feed intake per day are required to determine the optimum nutrient level in the diet. This estimation is especially important for amino acids in finishing pig diets. For example, based on the animal's lean growth potential, a finishing pig may require 20 g of lysine per day. As there is generally no effect of energy intake on lean growth rates in finishing pigs, daily lysine requirements are not affected by feed intake. If the feed intake in the finishing pigs is 2.50 kg per day then the optimum lysine level in the diet should be 8 g/kg. When feed intake is 3 kg/d, the lysine level should be 6.66 g/kg. This reduction in required dietary lysine level will substantially reduce the cost of the finishing diet.

In growing pigs, up to approximately 60 kg body weight, energy intake generally limits lean growth. A reduction in daily energy (feed) intake will reduce lean tissue growth and the daily requirements for amino acids. If feed intake happens to be reduced in grower pigs, there is no need to increase the dietary amino acid levels in the remaining food intake. For this reason, it is more important to balance the amino acid levels in the grower pig diets based on amino acid to energy ratios than any other ratio, and to formulate finisher pig diets based on daily amino acid intakes.

Question: When should I determine the optimum amino levels in the pig's diet based on daily intakes and when based on amino acid to energy ratios?

Answer: Base finishing pig diets on daily intakes; base grower (and starter) pig diets on amino acid to energy ratios.

Why: In finishing pigs, energy intake does not generally limit lean growth. As a result, there is no relationship between energy (or feed) intake and body protein deposition; daily amino acid requirements are not affected by feed intake. In growing pigs (up to approximately 60 kg body weight), energy intake usually limits lean growth. An increase in feed or energy intake will result in an increase in body protein deposition. As a result, the daily amino acid requirements increase. The optimum amino acid to energy ratio in diets for growing pigs is relatively constant over a range of feed intakes.

The environment also affects a pig's nutrient requirements, especially nutrients needed for body maintenance functions. In modern and well managed, confinement growing-finishing pig facilities, environmental conditions can be optimized and the amount of feed required for maintenance minimized. If the environment is too cold, maintenance energy requirements quickly increase. Under cold stress conditions, growing pigs (25 to 60 kg body weight) require approximately 25 g of extra feed to maintain a constant body temperature per °C drop in environmental temperature. For finishing pigs, this value is approximately 40 g of feed. This demand means that total feed usage would increase by approximately 15% for growing-finishing pigs kept in an environment that is effectively 10 °C too cold for them. This usage is equivalent to a drop in feed conversion ratio from approximately 2.9 to 3.3. The cold environment is one of the major reasons for the poor feed efficiency observed during the winter months in low-cost, outdoor feeder pig housing systems. Remember that the effective environmental temperature to which pigs are exposed is determined not only by the environmental temperature but also by other factors such air speed, air humidity, floor type, dryness of the floor, and the pig's body condition.

In developing feeding programs for feeder pigs it is also important to consider the production objectives and the economic conditions. Different feeding strategies and diet compositions are required when the objective is to maximize income per pig rather than income per pig place per year, or when economic conditions change.

Nutrient Allowances and Diet Formulation

The basic concepts of diet formulation are covered in chapter 5. In that chapter, the importance of formulating diets on the basis of available rather than total nutrients is emphasized, as well as the importance of monitoring feed ingredient quality, feed preparation, and feed handling. As we continue to meet the animal nutrient requirements more closely through phase feeding, split-sex feeding, and feeding for different genetics, these basic concepts of diet formulation and quality control become increasingly important.

Due to the many factors that affect nutrient requirements, there is a wide range in recommended nutrient levels for growing-finishing pigs. For example, recommended lysine levels may range from as high as 1.3% in early grower diets for pigs with extremely high lean growth potential to as low as 0.5% in late finisher diets for pigs with poor lean growth potential that consume large quantities of feed. This variance again stresses the importance of recognizing the main factors that affect nutrient requirements in various groups of pigs for developing unique management and feeding strategies for individual production units. It also supports the need for a factorial, or modelling, approach to estimating nutrient requirements in which the main factors that affect nutrient requirements are considered. However, when such a modelling approach is used, different agencies or researchers will still provide different estimates of nutrient requirements. For example, the estimated lysine requirements for a 50 kg pig with a given rate of lean growth (body protein deposition), estimates may vary by as much as 30% (Table 9-5). Obviously our knowledge of pig nutrition is not yet complete. As we continue to improve our understanding of nutrient utilization in pigs, these discrepancies will disappear.

Table 9-5. Estimated Available (Apparent Ileal Digestible) Lysine Requirements for a Growing Pig at 50 kg Body Weight[1].

Moughan et al., 1987	.54%
Stranks et al., 1988	.59%
Fuller et al., 1989	.43%
TMV[2], 1991	.62%
Moughan, 1992	.65%
Whittemore, 1993	.58%

[1]Average lean tissue growth rate (340 g/d according to the Canadian definition of lean , this is equivalent to130 g/d of body protein deposition). The pig consumes 2.2 kg of a diet with a DE content of 3150 kcal/kg (feed intake is equivalent to 90% of NRC [1987]). Pigs are assumed to be in a thermo-neutral and relatively disease free environment.

[2] Technisch Model Varkensvoeding.

The optimum energy density in feeder pig diets is determined largely by the cost per unit of energy in the available feed ingredients. As mentioned earlier, finishing pigs (over 60 kg body weight), are generally able to adjust feed intake with changes in dietary energy density in such a way that the total daily energy intake remains constant, at least when the diet's DE content ranges between 3000 and 3400 kcal/kg. In other words, if the diet's DE content is reduced by 10% from 3300 to 3000 kcal/kg, the finishing pig will simply consume 10% more feed, growth rate will not be affected, and the feed conversion ratio (feed/gain) will simply increase by 10%. In this case, the optimum energy density in the diets should be based on purely the cost per unit of energy in the diet as outlined in Table 9-6.

Table 9-6. Estimation of the Lowest Cost per Unit of Energy in Growing Pig Diets (varying in energy density)*.

	Diet 1	Diet 2	Diet 3
DE content, kcal/kg	3150	3250	3350
Ingredient comp. (%):			
Barley	59.30	35.29	3.12
Wheat	17.40	42.80	75.51
Soybean meal, 47%	15.10	18.10	18.15
Canola meal	5.20	0.70	0.00
Lysine HCl	-	-	0.03
Premix	3.00	3.11	3.19
Calculated nutrients:**			
DE, kcal/kg	3150	3250	3250
Avail. Lysine, %	0.70	0.72	0.74
Avail. Threonine, %	0.46	0.47	0.48
Prices:			
$/tonne	132.62	138.44	146.11
$/Mcal DE	42.10	42.60	43.61
Estimated Feed usage:			
Kg per pig	160	155	150.5
Feed : Gain	3.55	3.44	3.34
Mcal DE : kg gain	11.18	11.18	11.18

* Prices of ingredients: barley $80/tonne, wheat $95/tonne, soybean meal $265/tonne, canola meal $190/tonne, lysine HCL $3000/tonne, premix $600/tonne.

** Levels of all nutrients are adjusted with diet's energy content to ensure a constant nutrient to energy ratio.

In growing pigs, physical feed intake capacity, or gut fill, generally determines feed intake. An increase in diet DE content will thus result in proportional increase in the daily DE intake. As illustrated by the data in Table 9-7, an increase in energy density in the diet for growing pigs will result in improvements in both feed efficiency and growth rate. For growing pigs, the optimum energy density is not only determined by the cost per unit of energy in the diet, but also by the effect of energy density on growth rate, and thus throughput in the grower barn. As the animal's lean tissue growth potential continue to increase, energy intake will become a limiting factor up to higher live body weights. This situation may also mean that finishing pigs with extremely high lean tissue growth potential may be unable to completely maintain a constant daily energy intake as the energy density in the finishing diet is reduced. Clearly, more information is required on the interactive effects of pig genotype and body weight, as well as thermal environment and animal density, on the optimum energy density in the diet.

In most practical swine diets, lysine is the first limiting amino acid. It is thus appropriate to first define the target (available) lysine level in the diet and to derive the required level of other amino acids from that of lysine based on an optimum amino acid balance (outlined in chapter 3). The suggested allowances of available (apparent ileal digestible) lysine in relation to body weight and lean growth rates are presented in Table 9-8. Allowances are expressed either as lysine to energy ratios or as daily lysine intakes. These suggestions are based on a factorial estimation of lysine requirements to support the indicated lean growth rates. A safety margin of about 5% for the grower phase and 10% in the

Table 9-7. Effect of Dietary Energy Density on the Voluntary Feed Intake and Performance of Entire Male Pigs between 22 and 50 kg Body Weight (Campbell and Taverner, 1986).

DE content, kcal/kg	2820	3035	3250	3466	3600
Voluntary Intake, kg/d	2.19	2.21	2.19	2.17	2.05
Voluntary DE, Mcal/d	6.14	6.62	7.10	7.48	7.39
Growth Rate, g/d	695	776	847	898	913
Feed: Gain	3.16	2.89	2.61	2.39	2.25
Carcass P2	14.40	15.30	15.60	16.00	16.40

finisher diets is already included in these values to allow for inaccuracies in feed preparation and variation in feed intake. In comparison to other factorial estimates of lysine requirements, the suggested allowances can be considered high (Table 9-5). However, the suggested allowances are supported by empirical animal performance studies as well. The actual recommendations that are expressed as a percentage in the diet in Table 9-8 relate to a diet with an energy density of 3150 kcal/kg and for pigs consuming average quantities of feed (90% of NRC 1987; Figure 9-4). If feed intake is different from the indicated values or when the diet DE content is different from 3150 kcal/kg, the available lysine levels in the diet should be adjusted to maintain a constant available lysine to energy ratio in the grower diets, and a constant daily available lysine intake in the finisher diets.

Table 9-8. Recommended Allowances of Available (apparent ileal digestible) Lysine in Relation to Lean Growth Potential and Body Weight in Growing-finishing Pigs.

Body weight (kg)	25–45	45–60	60–70	70–110
High*	2.70 (.86%)	2.35 (.74%)		20.00 (.67%)
Medium*	2.25 (.71%)	17.50 (.61%)		
Unimproved*	1.95 (.61%)	15.50 (.54%)		

* The average lean growth rates are 480, 440, and 400 g/d, for pigs with high, medium, and unimproved lean growth rates, respectively (see Figure 9-6 also).

If only one diet is being used in the feeder barn, do not use a grower type diet because is too expensive to feed all the way to market weight. To optimize profitability, some performance in the early stages of growth should be sacrificed by minimizing overfeeding of expensive nutrients in the finisher phase.

Once the requirements for available lysine are established, the requirements for the other essential amino acids can be determined based on the optimum amino acid balance, i.e., the concept of ideal protein as outlined in chapter 3. It is estimated that per 100 g of available lysine, growing-finishing pigs require 60 to 70 g available threonine, 56 to 64 g of available methionine plus cystine, and 18 to 20 g of available tryptophan. At least 50% of the methionine plus cystine requirements needs to be supplied by methionine. The ratio of these amino acids to lysine increases with increasing body weight or with reductions in lean growth potential.

Question: How do I adjust the suggestions in Figure 9-8 for the diets on my farm? My pigs have an average lean growth potential; I feed a grower and a finisher diet with DE contents of 3300 and 3000 kcal/kg, respectively. I have established feed intake curves on my farm: consumption on my grower and finisher diets are 2.2 and 2.7 kg/d, which is equivalent to 85% of estimated intake according to NRC (1987).

Answer: The available lysine level in the grower diet should be increased to 0.74 %. In the finisher diet it should be 0.65%.

Background: The lean growth potential are average so the recommendation derived for these pigs should be the average lean growth rates — medium — in Figure 9-8. In the grower diet the available lysine to energy ratio should be 2.25. At a DE content of 3300 kcal/kg, the available lysine level should be 7.40 g/kg or 0.74%. In the finishing phase, the daily available lysine requirements are 17.50 g/d. Given the daily feed intake of 2.70 kg, the available lysine level in this finisher diet is 17.50 divided by 2.70, which is 6.50 g/kg or 0.65%.

In Table 9-9, the estimated changes in the balance in which amino acids are required by growing pigs with average lean growth potentials and with increasing body weights are presented. It should be stressed that these values are estimates and that these values may change based on research that is currently in progress.

In Tables 9-10 and 9-11, the suggested additions of vitamins and minerals to practical grower and finisher diets are summerized. These suggested values include a safety margin to account for inaccuracies in feed preparation, variation in requirements for different groups of pigs, loss of potency of vitamins during storage, and the effect of stress on requirements. Given these safety margins and the cost of these nutrients, it is not critical to adjust these suggested levels of fortification for specific groups of pigs. Exceptions may be made for breeding stock, animals with extremely high lean growth potentials (such as entire males) or when diets with extremely high energy densities are fed. In these cases the suggested additions may be increased by up to 20%.

Table 9-9. Estimated Change in the Balance in which Amino Acids are Required by Growing Pigs with Average Lean Growth Potentials and with Increasing Body Weights.

	Body Weight		
	30 kg	60 kg	90 kg
Lysine	100*	100	100
Methionine	28	28	28
TSAA**	58	60	62
Threonine	62	65	67
Tryptophan	18	19	19
Isoleucine	62	62	61

* all values are expressed relative to lysine and as apparent ileal amino acid digestibilities; derived from Fuller, M.F., R. McWilliam, T.C. Wang and L.R. Giles. 1989. Brit. J. Nutr. 63:255-267; and Technisch Model Varkensvoeding (TMV). 1994. Proefstation voor de Varkenshouderij, Postbus 83, 5240 AB, Rosmalen, The Netherlands.

** Total Sulfer Amino Acids - Methionine + Cystine.

Table 9-10. Recommendations for Vitamin Fortification of Grower and Finisher Diets*.

Vitamin	Units/kg	Grower	Finisher
Vitamin A	IU	7000	5500
Vitamin D	IU	700	550
Vitamin E	IU	35[1]	25[1]
Vitamin B_{12}	mcg	20	15
Vitamin C	mg	-[2]	-[2]
Vitamin K	mg	2.5	2
Biotin	mcg	-[3,4]	-[3,4]
Folic Acid	mg	0[4]	0[4]
Niacin	mg	25	20
Pantothenic acid	mg	20	15
Pyrodoxine	mg	0	0
Riboflavin	mg	5	4
Thiamine	mg	0	0
Choline	mg	0	0

*The values in this table are minimum supplemental quantities recommended for practical diets. Due to varying conditions and the influence of the diet type on vitamin requirements, deviations from these numbers may be required in some circumstances. In pigs with extremely high performance levels, when pigs may be used as future breeding stock, or when high nutrient dense diets are fed, these levels may be increased by 10 - 20%.

[1]Higher levels (up to 200 IU/kg) of vitamin E in the finishing diet have been shown to enhance meat quality; higher levels of vitamin E may be required when unsaturated fats are included in the diet (3 IU/kg additional vitamin E per g/kg of additional linoleic acid is recommended).

[2]The pig's requirement for vitamin C remains unclear.

[3]When large quantities of ingredients are used that contain low quantities of available biotin (barley-canola meal based diets) than an inclusion of 50 mcg/kg of biotin is recommended.

[4]Biotin and folic acid should be included in diets for pigs that may be used as future breeding stock (200 mcg/kg of biotin and 1.5 mg/kg of folic acid.

Table 9-11. **Recommendations for Mineral Levels in Grower and Finisher Diets.**

Vitamin	Units	Grower	Finisher
Macrominerals - Total			
Calcium	%	0.70	0.60
Phosphorus	%	0.60	0.50
Available Phosphorus	%	0.25	0.20
Sodium	%	0.15	0.15
Chloride	%	0.18	0.18
Potassium	%	0.35	0.35
Magnesium	%	0.05	0.05
Microminerals - Supplemented			
Iron	mg/kg	70[1]	50[1]
Copper	mg/kg	15[1]	10[1]
Zinc	mg/kg	100[1]	90[1]
Iodine	mg/kg	0.30	0.20
Selenium	mg/kg	0.30	0.30

* The values in this table are minimum levels or supplemented quantities recommended for practical diets. Due to varying conditions and the influence of diet type on mineral requirements, deviations from these numbers may be required in some circumstances. In pigs with extremely high performance levels, when pigs may be used as future breeding stock, or when high nutrient dense diets are fed these levels may be increased by 10 - 20%.

[1] Copper may be used as a growth promotant at 125 mg/kg in the diet. Due to interactions in the utilization of copper, zinc and iron, the levels of iron and zinc should be raised by approximately 60 mg/kg when copper is included at growth promoting levels.

Photo 9-2.

Modern feeder barns provide a climate controlled environment, designed for the confort of pigs as well as farm workers. A proper environment is required if feeder barn goals are to be achieved.

Typical Diets

There are a wide variety of options available to feed growing-finishing pigs. Tables 9-12 and 9-13 present some alternative formulae for the various types of pigs.

Table 9-12 contains diets that might be used in areas where barley and wheat are most available. Table 9-13 offers typical diets for areas where corn is the predominant grain.

Table 9-12. Examples of Growout Diets based on Wheat and Barley.

	1	2	3	4	5	6
Ingredients, %						
Wheat	-	50.00	50.00	60.00	55.35	60.00
Barley	73.23	23.10	21.70	7.50	-	16.72
Peas	-	-	-	-	20.00	-
Soybean meal - 47%	11.70	-	16.90	18.50	10.35	17.60
Soybean meal - 44%	-	11.8	-	-	-	-
Canola meal	10.00	10.00	7.40	9.00	9.30	-
Fat/oil	1.00	1.00	-	1.00	1.00	1.40
Lysine HCl	0.07	0.10	-	-	-	0.18
Threonine	-	-	-	-	-	0.10
Premix	4.00	4.00	4.00	4.00	4.00	4.00
Nutrients, minimum %						
D.E., kcal/kg	3,100	3,100	3,250	3,350	3,350	3,350
Crude protein	17.2	18.3	19.9	21.1	20.6	18.5
Digestible lysine	0.73	0.73	0.78	0.84	0.84	0.84
Digestible methionine	0.20	0.20	0.22	0.23	0.23	0.23
Digestible T.S.A.A.	0.42	0.42	0.47	0.52	0.52	0.52
Digestible threonine	0.45	0.45	0.51	0.56	0.56	0.56
Digestible Tryptophan	0.13	0.13	0.15	0.16	0.16	0.16
Calcium	0.75	0.75	0.75	0.75	0.75	0.75
Phosphorus	0.65	0.65	0.65	0.65	0.65	0.65
Sodium	0.15	0.15	0.15	0.15	0.15	0.15
Chloride	0.15	0.15	0.15	0.15	0.15	0.15

These are **sample** diets only and are for illustrative purposes only. While every attempt has been made to present examples that reflect successful commercial formulations, these examples are not intended for actual use without assistance from a qualified nutritionist.

All amino acid concentrations are expressed as apparent ileal digestible amino acids.

Table 9-13. **Examples of Growout Diets Based on Corn.**

	1	2	3	4	5
Ingredients, %					
Corn	69.25	70.18	64.30	40.70	47.10
Wheat	-	-	-	30.00	-
Peas	-	-	-	-	25.00
Soybean meal - 47%	26.75	-	27.80	23.50	13.85
Soybean meal - 44%	-	24.65	-	-	-
Canola meal	-	-	-	-	7.50
Lysine HCl	-	0.10	-	-	-
Fat/oil	-	1.05	3.90	1.80	2.55
Threonine	-	0.02	-	-	-
Premix	4.0	4.0	4.0	4.0	4.0
Nutrients, minimum %					
D.E., kcal/kg	3,440	3,450	3,650	3,500	3,500
Crude protein	18.60	17.00	18.70	18.67	19.30
Dig. lysine	0.84	0.79	0.86	0.79	0.79
Dig. methionine	0.23	0.22	0.24	0.22	0.22
Dig. T.S.A.A.	0.52	0.46	0.50	0.47	0.47
Dig. threonine	0.56	0.49	0.53	0.51	0.51
Dig. Tryptophan	0.16	0.14	0.15	0.15	0.15
Calcium	0.75	0.75	0.75	0.75	0.75
Phosphorus	0.65	0.65	0.65	0.65	0.65
Sodium	0.15	0.15	0.15	0.15	0.15
Chloride	0.15	0.15	0.15	0.15	0.15

These are sample diets only and are for illustrative purposes only. While every attempt has been made to present examples that reflect successful commercial formulations, these examples are not intended for actual use without assistance from a qualified nutritionist.

All amino acid concentrations are expressed as apparent ileal digestible amino acids.

All diets will support a reasonable level of performance. These formulations are examples only and many other combinations are possible. Due to the many factors that influence pig performance, results with these diets may vary from farm to farm.

These formulations are only samples. Exact rations will depend on the 'actual' composition of the ingredients on hand, which can be determined only by having the feeds tested. Rations used on individual farms may vary from these examples and should be formulated by a qualified nutritionist.

Formulations employing commercial supplements are not included in the tables because their nutrient composition varies among suppliers. Combinations of grains with supplements are possible and interested persons are encouraged to contact their feed supplier for assistance to develop a balanced diet.

No one diet formulation will be the best for all farms under all economic conditions. Flexibility is the key to success in attaining the most value from your feed dollar.

Feed Additives

A whole range of feed additives are available for inclusion in feeder pig diets. They include enzymes, acidifiers, probiotics, feed flavours, medications, toxic binders, etc.. Many of these are discussed in chapters three and eleven. Most of these additives are more effective in diets for weaner and starter pigs and for sows than in diets for feeder pigs. This can be attributed to the relative maturity of the feeder pig's digestive and immune system, and the lack of sudden changes in levels of production and feed intake (such as those around the time of farrowing). The effectiveness of feed additives also differs between individual production units, and in particular with variation in the herd's health status and environmental management. The average effects of the various feed additives that are listed in Table 9 -14 may differ substantially from their effects on individual pig production units. It is thus difficult to make general statements about the cost-benefit relationship of each of these feed additives. Producers that are considering the use of various feed additives are encouraged to demand "proof", or the results of on-farm studies, from the suppliers of these products. It should be noted that the use of many feed additives, and of medications in particular, are under govenment control and subject to the Feeds Act (see also chapter 10).

A situation where feed additives may be particularly effective is when feeder pigs are just moved into the grower-finisher units, especially when pigs are commingled from different sources with varying health status. In these situation, pigs should be fed palatable, highly digestible diets that are hightly fortified with vitamins and minerals and contain appropriate levels of feed medication. The use of feed additives, such as acidifiers, may be considered as well. A practical means to ease the adjustment to the new environment is to feed a good quality pig starter diet for the first week after the pigs have arrived or until feed intake has increased to acceptable levels.

It should be stressed that feed additives should not be used to compensate for poor management and that feed medication, at the allowed levels, will be ineffective in treating clinical levels of disease.

Phase Feeding

Various options are available for feeding growing-finishing pigs. One option is phase feeding, in which more than one diet is fed to pigs between their arrival in the feeder barn and their attainment of market weight. Phase feeding allows producers to meet the pig's nutrient requirements more closely at its various

Table 9-14. Pig Response to Antimicrobials in Feed of Growing-finishing Pigs (16 kg to market weight) (adapted from Zimmerman, 1986).

Antimicrobial	Number Exp	Wt (kg) Initial	Final	Average Daily Gain (g) -	+	% improve	Feed:Gain -	+	% improve
CTC-P-S	7	25	92	738	787	6.6	3.16	3.11	1.8
Bacitracin MD	7	26	98	724	742	1.2	3.01	3.00	0.4
Bacitracin Zn	1	31	100	695	695	0	3.36	3.42	-1.8
Chlortetracycline	17	27	94	694	717	3.3	3.23	3.23	0
CTC:P:ST	2	21	94	790	845	7.0	3.02	2.97	1.8
Copper sulfate	4	21	90	704	724	2.9	3.07	2.96	3.7
Bambermycin	30	37	94	669	687	2.7	3.48	3.36	3.4
Lincomycin	7	38	99	714	750	5.1	3.49	3.43	1.7
Nosiheptide	3	11	92	623	670	7.5	3.35	3.25	3.0
Salinomycin	9	17	94	735	779	6.0	3.05	2.94	3.7
Tiamulin	9	14	72	610	665	8.9	2.97	2.86	3.8
Tylosin	45	30	90	665	689	3.6	3.37	3.26	3.1
Virginiamycin	23	24	93	726	745	2.5	3.13	3.09	1.4

live body weights. For example, a diet with relatively high DE and amino acid levels can be fed to the grower pigs, and energy density and amino acid levels can be reduced in the finishing diet. At the same time, the supply of excessive nutrients can be reduced when phase feeding is applied (see Figure 9-9). It should be noted that a large proportion of feed used in the feeder barn is consumed by the finishing pigs. Based on a typical feed intake and growth curve and a three phase feeding program, feed usage between 25 and 45 kg body weight (grower I), 45 and 70 kg body weight (grower II) and 70 and 105 kg body weight (finisher) would be 18%, 27% and 55% of total feed usage, respectively. This implies that close attention should be paid to the formulation and cost of the finisher diet and that producers can afford to invest in high, nutrient dense grower I diets.

Phase feeding requires the handling of more than one feed in the feeder barn. The feed can be handled in one of two ways: extra feed lines can move the additional feed in bulk, or the pigs can be moved from grower to finisher pens where they are fed different diets. Phase feeding will increase the cost of feed and/or animal handling but these additional costs will be offset by the savings in feed cost. According to the results in Table 9-15, the gross margin per pig and gross margin per pig place per year can be improved substantially when phase feeding is applied. In Table 9-15, gross margins relate to carcass value minus feed cost, feeder pig price, and variable cost per pig.

Table 9-15. Estimated Value of a One versus Two versus Three Phase Feeding Program in Pigs with Average Lean Growth Potential*.

	Phase		
	One	Two	Three
Animal performance			
Growth rate, g/d	0.772	0.784	0.789
Feed : Gain	3.28	3.24	3.22
Carcass index	106.20	106.30	106.30
Financial performance			
Feed cost, $/pig	38.44	37.03	35.89
Gross margin, $/pig	48.85	50.30	51.55
Gross margin, $/pig place/yr	156.23	163.14	168.16

*All diets contained 3150 kcal DE/kg. In the one phase feeding program, one diet (available lysine .65%) was fed from 25 to 105 kg body weight. In the two phase feeding program, Diet I (available lysine .70%) was fed from 25 to 60 kg body weight, and Diet II (available lysine .57%) was fed from 60 kg to market weight. In the three phase feeding program, Diet I (available lysine .75%) was fed from 25 to 45 kg body weight, Diet II (available lysine .60%) was fed from 45 to 75 kg body weight, Diet III (available lysine .52%) was fed from 75 kg to market weight. The levels of other amino acids and calcium and phosphorus were also adjusted in the different diets. 1993 Saskatchewan prices.

Split-sex Feeding

Separate feeding of sexes (barrows, gilts, entire males) is an option that should be considered. Over the last several years, a considerable amount of information on the 'best' feeding regimes for

Table 9-16. Performance of Barrows and Gilts Fed a Similar Diet.

	Sex		
	Barrows	Gilts	Difference
Initial weight, kg	23.9	24.4	
Final weight, kg	105.1	104.1	
Feed intake, kg/d	2.42	2.16	+11%
Gain, kg/d	.84	.78	+8%
Feed: Gain	2.87	2.78	+3%
Dressing percentage, %	80.9	80.3	+.7%
Carcass lean yield, %	48.1	50.5	-5%

*Calculated as performance of barrows - gilts divided by the average performance of the two sexes.

**1993 carcass grading system.

Source: Prairie Swine Centre Inc., 1993

barrows and gilts has been generated. As indicated by the results in Table 9-16, barrows consume more feed, grow faster, have poorer feed efficiency, and lower carcass lean yields than gilts. Generally, the differences in performance between these two sexes increases as pigs grow heavier. Up to approximately 25 kg body weight, identifying any differences in performance between gilts and barrows is difficult, but differences in feed intake and growth rate may be as high as 15% during the finishing phase of production. This is illustrated by the feed intake curves for Prairie Swine Centre barrows and gilts that are presented in Figure 9-10.

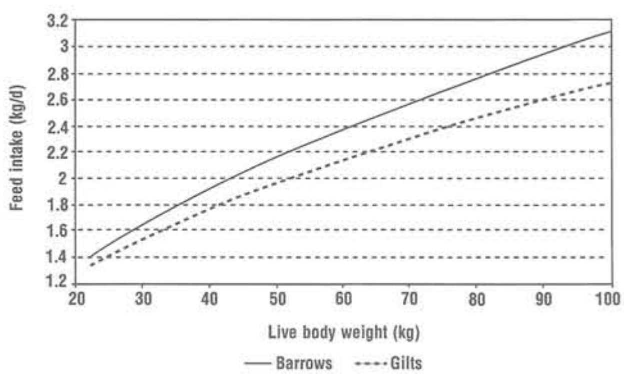


Figure 9-10. Feed Intake Curves of Barrows and Gilts Fed a Similar Diet and Housed in Groups of 12 Pigs per Pen*.

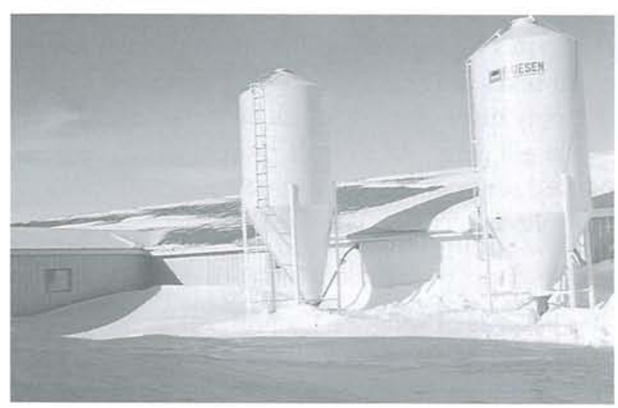
*The DE content of the diet was 3250 kCal/kg; the DE intake (cal/d) as a function of live body weight (W) was best described as 1747 x $W^{0.89}$ for barrows and 1588 x $W^{0.90}$ for barrows and gilts, respectively.

Managing barrows and gilts separately means that the two sexes can be fed different diets. Because of their lower feed intake and higher lean growth rate, gilts require higher levels of amino acids and other nutrients than barrows. Amino acid levels, or amino acid to energy ratios, should be approximately 5% and 15% higher in the gilt's grower and finisher diets, respectively. These numbers are supported by observations from a large scale American study in which the optimum dietary lysine levels were determined for gilts and barrows (Table 9-17). Gilts also respond more favourably to increases in dietary energy density. Producers may consider feeding gilts diets that have higher DE content than those for barrows, and maintaining the higher energy density diets up to higher body weights. On the other hand, the daily feed allowance for barrows may be reduced in the finishing phase during which barrows deposit large quantities of body fat. This reduction will improve feed efficiency and carcass value slightly. If you choose split-sex feeding as a feed option in your operation, keep in mind that difference in performance between the two sexes, and thus the optimum feeding strategy, may vary somewhat with the different pig breeds and genotypes. Monitoring feed intake and performance in the two sexes is important whenever split-sex feeding is applied.

Table 9-17. Effect of Sex and Dietary Lysine Level on Performance in Finishing Pigs (50.7 to 104.6 kg Body Weight; NCR-42 Committee on Swine Nutrition 1993)

	Dietary lysine level (%)			
	.60	.67	.74	.82
Barrows				
Growth Rate, kg/d	.817	.834	.828	.839
Feed Intake, kg/d	2.91	2.99	2.93	2.96
Feed : Gain	3.56	3.54	3.46	3.46
Lean Growth, g/d	306	315	313	320
Gilts				
Growth Rate, kg/d	.738	.781	.777	.779
Feed Intake, kg/d	2.59	2.63	2.59	2.58
Feed : Gain	3.52	3.35	3.32	3.27
Lean Growth, g/d	299	321	322	334

Photo 9-3.



The use of separate diets for Stage I (20 - 60 kg) and II (60 - 105 kg) growers is one way to improve efficiency. Providing diets that are specific for each class of pigs helps to maximize productivity without wasting expensive nutrients.

Feeding Management Options Specifically for Gilts and Castrates

* Feeding higher lysine diets to gilts than to barrows. Gilts are better at converting protein into lean tissue than castrates, therefore the concept of feeding to need will maximize the return per dollar invested in feed.

* Feeding diets with a higher energy density to gilts than to barrows, especially in the finishing phase. In gilts, energy intake will limit lean growth up to higher body weights than in barrows.

* Slaughtering castrates at a lighter weight than gilts. Because gilts are leaner, carcass grades can be maintained at heavier weights. Barrows tend to deposit fat sooner and faster, therefore should be marketed at a lighter weight.

* Feeding a different daily feed allowance to each sex. Barrows' feed intake can be restricted to reduce the deposit of excessive fat in the carcass. Barrows grow faster than gilts but they also lay down fat more quickly.

An additional advantage of managing the two sexes separately is that barn space will be used more efficiently. Because barrows grow faster than gilts, growth rates within pens will be more uniform when the two sexes are kept separately. The barrow pens will empty more quickly so can be turned over faster than the gilt pens. As a result, more pigs can be produced per year using the same amount of space when split-sex feeding is utilized.

The benefits of split-sex feeding will be increased when entire males, rather than barrows, are used in commercial pork production. In North America, entire males cannot (yet) be used for pork production. This situation may change as more information becomes available about the factors that cause the strong, adverse smell (boar taint) in some meat derived from entire male pigs. Lean growth potential are higher in entire males than in gilts. Entire males require more nutrient-dense diets but can utilize these diets more efficiently than gilts.

Photo 9-4.

There is no doubt that in the future barrows and gilts will be fed separatley, some producers are already doing so.

Feeding to Appetite Versus Restricted Feeding

Most pigs in Canada are fed to appetite, which means they are given continuous access to feed. The objective of this feeding method is to maximize feed intake, thus growth rate. There are several benefits to feeding to appetite. Carcass merit will suffer somewhat when pigs are fed to appetite, but the reduced value of a slightly fatter carcass is thought to be more than off-set by a faster growth rate. *Ad libitum* feeding is more easily automated than restricted feeding so that labour costs are lower. Restricted feeding also has benefits, the major one being that feed efficiency and carcass value may improve and growth rates may be reduced when feed intake is reduced (see Figure 9-7).

The results in Table 9-18 indicate that feed intake should be maximized when the production objective is to maximize income per pig place per year. Yet, a 10% reduction in feed intake is expected to increase the income per pig. Efforts to improve carcass quality in Canada have been directed largely at genetic selection and diet formulation. As the lean growth potential of pigs continue to increase due to genetic selection and improvements in health status, the potential benefits of restricted feeding will decline.

Table 9-18. Estimated Effect of Level of Feed Intake on Animal and Financial Performance in Pigs with a Slightly Better than Average Lean Growth Potential*.

Level of feed intake	Average*	Average - 10%
Growth rate, g/d	823.00	729.00
Feed : Gain	2.97	2.88
Carcass dressing %	79.70	79.20
Carcass index	107.80	110.30
Gross margin per pig ($)	30.22	31.42
Gross margin per pig place per year ($)	98.50	92.50

*Upper limit to lean growth is approximately 350 g/d. Average feed intake is considered 90% of voluntary feed intake according to NRC 1987. 1993 Saskatchewan prices.

Limit feeding systems must be carefully managed and controlled to maximize the benefits and minimize the loss in growth rate. A recommended feeding scale for Canada has not been developed. However, if carcass improvement through dietary manipulation is desired, the best approach is to progressively restrict feed intake (as a percentage of *ad libitum*) as the pigs approach market weight. Early restriction (under 60 kg body weight) offers little benefit. Feed intake should not fall below 80% of voluntary feed intake, according to NRC (1987), or growth rate will be seriously impaired. An additional disadvantage of (severe) feed intake restriction is that the variation of feed intake between pigs within pens will increase and, as a result, variation in growth rates may increase. The incidence of pigs doing poorly may increase when feed intake is restricted too severely.

Choice Feeding

Whenever phase feeding or split-sex feeding is applied in the feeder barn, various diets are needed to meet each group of pigs' specific nutrient requirements. One way to reduce the need for different diets and diet changes is to allow the pigs to make their own choice of feed and quantity they want to eat. Various studies have been conducted in which feeder pigs were allowed continuous access to two feeders with different feeds. One diet was formulated to contain high levels of available nutrients to meet the highest possible nutrient requirements of any pig in the pen. The second diet was formulated with low available nutrient levels to meet the requirements of the pig with the lowest possible nutrient requirements. The theory tested was that each pig would adjust its consumption of the two diets to meet its nutrient requirements. Gilts would consume more of the high nutrient diet than barrows, and all the pigs would consume relatively more of the low nutrient diet as they grew heavier and required fewer nutrients per kg of feed. Unfortunately, the observations in many studies were different from the expectations. The pigs tended to over-consume on the more expensive, high nutrient dense diet. Plus, the choice of diets was affected by the presence of small quantities of unpalatable ingredients in both diets. Clearly, more research is needed before choice feeding can be applied to commercial pork production units.

Feeding of Pigs Housed Outdoors

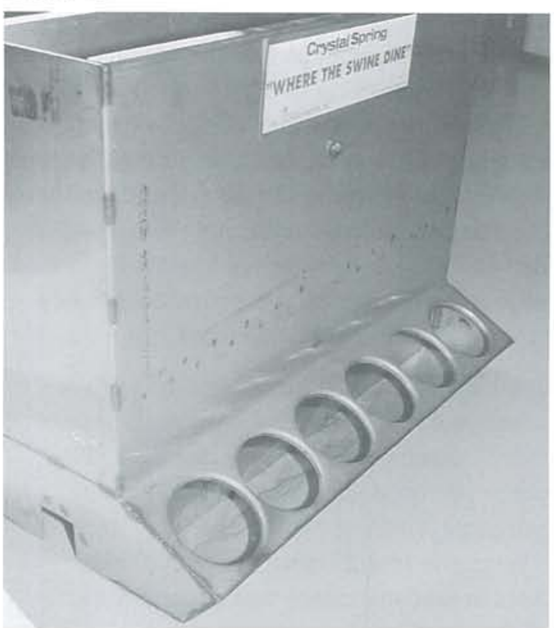
Due to the high cost of constructing new facilities, there has been a renewed interest in low-cost, alternative outdoor housing systems for growing-finishing pigs. Initial experience at the University of Manitoba suggests that during the summer months, pig performance in a low-cost housing system is nearly similar to that of pigs in a conventional feeder barn (Table 9-19). However, in the fall and winter months, feed efficiency is substantially poorer in the pigs housed in the low-cost, outdoor system. The differences in feed efficiency in the fall and winter were 12% and 21%, respectively. Obviously, additional feed cost should be weighed against the reduction in construction and operating costs when these low-cost facilities are considered.

No actual studies have been conducted to determine the nutrient requirements for pigs raised outdoors under Canadian conditions. However, the difference in performance between outdoor and indoor raised pigs during the fall and winter months was due primarily to differences in feed intake. Differences in feed efficiency can be largely attributed to differences in energy required to maintain a constant body temperature. This difference in energy requirement means that the levels of amino acids, vitamins, and minerals can be reduced in the diets that are fed to the outdoor pigs in the fall and winter months because they are consuming more feed. Based on the observations at the University of Manitoba, the dietary levels of amino acids, vitamins and minerals may be reduced by approximately 8 and 15% during the fall and winter months, respectively, as compared with diets for pigs housed in conventional indoor facilities. Despite the reduction in the dietary levels, the daily allowance of these nutrients should still be maintained somewhat higher to account for the larger variation in feed intake and feed wastage in pigs that are housed outside in large groups.

Feed Separation

Feed separation was discussed in detail in chapter 5. Table 9-20 summarizes the results of a Swedish study reported by Dr. Ove Olsson. The study looked at three feed handling systems: 1) mixed feed added directly to 50 kg bags, 2) bulk feed with careful handling, and 3) bulk feed with ordinary handling. Study results show that separation decreased uniform growth and feed efficiency. Separation is a problem that costs money and should receive much more attention than it does.

Photo 9-5.



Since corrosion is a major problem in feeder construction, concrete, plastic, or stainless steel feeders are becoming much more popular in free choice systems.

Table 9-19. Performance Data Comparing Shelter and Conventionally Raised Feeder Pigs During the Summer (May through August, Trial 1), Fall (August through November, Trial 2) and Winter (November through February, Trial 3). (University of Manitoba, Courtesy of Dr. Connor)

	Trial 1 Shelter	Conventional
# of pigs	175	150
Initial weight, kg	23.9	28.20
Final weight, kg	100.80	101.00
Feed intake, kg/d	3.05	2.98
Weight gain, kg/d	0.90	0.92
Feed/gain	3.39	3.24
Carcass index	103.70	103.60
	Trial 2 Shelter	Conventional
# of pigs	177	150
Initial weight, kg	32.50	34.10
Final weight, kg	101.00	100.80
Feed intake, kg/d	3.38	2.92
Weight gain, kg/d	0.92	0.89
Feed/gain	3.67	3.28
Carcass index	103.20	102.80
	Trial 3	
	Shelter	Conventional
# of pigs	178	150
Initial weight, kg	31.7	32.3
Final weight, kg	100.5	101.1
Feed intake, kg/d	3.62	3.19
Weight gain, kg/d	0.90	0.96
Feed/gain	4.02	3.32
Carcass index	103.40	103.0

In the system that was evaluated at the University of Manitoba, approximately 175 pigs were housed in one large group in a quonset-shaped structure, 9.15 x 21.96 m, with the ends opened during most of the year. Pigs were fed from a large 5 tonne feeder and two waterers were present on a cement pad at one end of the shelter. Deep litter straw was present in the remaining area.

Table 9-20. Effect of Feed Handling on Pig Performance.

	Feed Handling System		
	I	II	III
		Careful	Normal
	Bagged	Bulk Handling	Bulk Handling
No. of pigs	24	24	24
Initial weight, kg	20.500	20.500	20.500
Final weight, kg	97.000	96.000	96.300
Average daily gain, kg	0.580	0.560	0.550
Variation in weight gain[1]	0.030	0.038	0.042
Feed efficiency	3.310	3.440	3.550

[1] Standard deviation for growth rate.

Feed Wastage

There is a growing misconception that feed wastage is an over-rated concern. Feed wastage is very difficult to measure but given the design of feeders in use, the frequency (or lack) of adjustments, and the nature of current housing systems, it is apparent that wastage is still a problem to be addressed. Perhaps a more accurate picture of wastage would be painted if feed utilization was referred to as 'feed disappearance' rather than 'feed intake'.

Feed disappearance includes the feed that is wasted as well as the feed that is eaten. The producer pays for the total feed disappearance, not just the feed that is eaten. The difference in terminology is important. Differences in feed conversion of 10% can result solely from controlling feed wastage. According to farm surveys, that 10% can be worth as much as five to six dollars per pig. Controlling excessive wastage is probably the easiest money a farmer will ever make. An important point to consider is proper care and maintenance of the feeders. Buying the right type of feeder will make the job much easier as will care in selecting and positioning feeder adjustments that provide the pigs easy access to feed without wastage.

Feed wastage is particularly high when pigs are floor fed. Results from British studies (Table 9-21) clearly demonstrate that, even when feed intake in floor fed pigs is restricted to reduce feed wastage, performance of floor fed pigs is poorer than those given the same amount of feed through feeders. From these results it can be estimated that feed wastage was approximately 5.5% higher for the floor fed pigs. This increase in feed wastage, in combination with the improvements in performance of pigs that are fed ad libitum through feeders, will quickly pay back for the investment in feeders.

Table 9-21. Effect of Floor Feeding on Growing-finishing Pig Performance (33 to 88 kg body weight).

	Floor	Feeder feeding	
	Feeding	Restricted	Adlib
Feed Disappearance*	2.12	2.11	2.21
Gain (kg/d)	0.74	0.77	0.81
Feed:Gain	2.89	2.74	2.78

*(kg/d) includes feed wastage

Derived from Patterson, D.C. 1989. Anim. Feed Sci. Techn. 26: 251-260.

Feed form and feed processing are also related to feed wastage. As illustrated by the results in Table 9-22, feed efficiency is approximately 8% better in pigs fed pelleted feeds as compared to pigs fed the same diet but in a meal form. As there is little effect of pelleting on the digestibility of nutrients by grower-finisher pigs (as is the case in starter pigs), the difference in performance can largely be attributed to feed wastage. This implies that the effect of feed pelleting on feeder pig performance will depend on feeder design and feeder management; it will be smaller when feeders are well managed and when feed wastage is already minimal. For further discussions on feed processing see chapter 10.

Table 9-22. The Effect of Feed Form on Performance of ad libitum Fed Pigs (35 to 87 kg body weight; combined results of various studies; approximately 1000 pigs per treatment).

	Feed form	
	Pellets	Meal
Feed Disappearance (kg/d)*	2.29	2.17
Gain (kg/d)	0.75	0.78
Feed:Gain	3.06	2.82

*includes feed wastage

Derived from Walker, N. 1990; Pig News and Information Vol. 11 (1) pp. 31-33.

Monitoring Performance

Once the 'correct' feeding regime has been selected, it must be maintained. Performance must be monitored to see if goals are being achieved. If goals are consistently not being achieved, solutions to existing problems must be found. If goals are being met, they should be re-evaluated and new ones set. If the goal is to maximize profit per pig, changes in feed prices relative to the price of pork may require adjustments in the feeding program. If the objective in developing feeding programs is to meet the animals' nutrient requirements as closely as possible, nutrient levels in the feed should be adjusted with changes in observed levels of feed intake.

Monitoring feeder barn productivity is a very worthwhile activity. Full record keeping systems are more complicated than those in the breeding and farrowing areas and may be daunting at first. Some type of monitoring, however, is important — even spot-checking of days-to-market or recording feed conversion on the odd random pen, which requires minimal labour, provides extremely useful information.

The importance of good financial and production records is well established. The computer has helped many of us monitor cash flow, animal flow, and production in a very sophisticated manner. One note of caution: records from a computer are only as correct as the information entered into it and are only as accurate as the program being used. Anyone using a program should learn how the calculations are made so he or she knows how the final numbers are produced. Very often the summaries make important assumptions that can influence how the data is to be interpreted. If unaware of these assumptions, a producer may misunderstand the information and make unsound management decisions. Companies offering record keeping systems are generally more than willing to provide assistance in this regard.

Compare your computer summaries with 'real' data. For example, if the computer says you are weaning 21 pigs per sow per year and you have a herd of 100 sows, are you really weaning 2100 pigs per year? Checks like this one will give you greater confidence in your computer results.

A computer is not necessary to keep records, though. If the number of pigs in a barn is reasonably constant, you can estimate the days to market by measuring the rate of inventory turnover (if the number of pigs in the barn fluctuates too much, the results will be misleading). To measure inventory turnover, you must know the average number of pigs on the farm throughout the year and the number of pigs sold per year, including gilts raised as replacement breeding stock (see Table 9-23). Month-end inventories including nursing pigs, and weanling and market hogs can be used for the calculation. Do not include the breeding herd in your calculation.

Surveys have shown that the average number of 'days to market' is close to 200 days. The experience of some commercial producers, however, indicates that 165 days for pigs to reach 105 kg is a realistic management objective. Better performance (140 - 150 days) is possible with careful management, all-in all-out housing, healthy stock, excellent diets, and maybe just a bit of luck! The data summarized in Table 9-23 demonstrates that the average number of days to market below 150 is possible under commercial conditions.

Table 9-23. Calculation of Days to Market Based on Inventory Turnover.

Item	1	2	3	4	5
From Records					
Avg. Inventory	325	3215	1256	1230	698
# of Pigs Sold/Year	728	5883	2135	3038	1459
Calculated					
Inventory Turnover	2.24	1.83	1.70	2.47	2.09
Avg. Days to Market	163	199	215	148	175

Inventory turnover = number of pigs sold per year - by average inventory.

Average days to market = 365 days in the year - by inventory turnover.

Photo 9-6a.

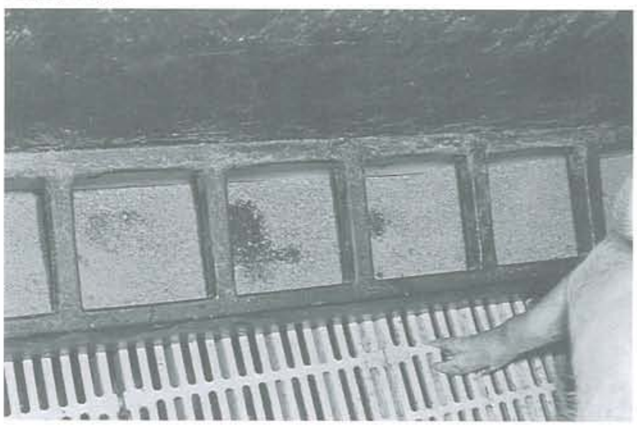
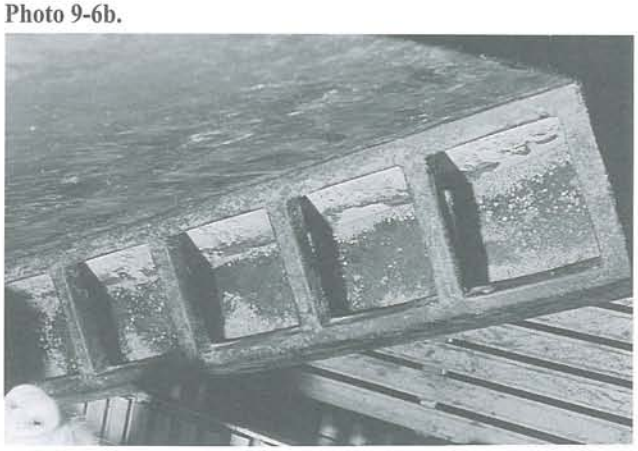


Photo 9-6b.



Feeders need to be adjusted very carefully to avoid wastage due to spill, but also to ensure continuous access to feed. The top (9-6a) feeder is well adjusted, generating little waste. The bottom (9-6b) feeder is acceptable, although some sections may be difficult to eat from.

The feed conversion in a feeder barn can be estimated if you know how much feed entered the barn during the year. This amount is determined by measuring the feed inventory at the beginning of the year; adding all purchases made during the year, then subtracting the year-end inventory. This calculation is much easier if you purchase all your feed but can also be used for the total farm if specific amounts of feed cannot be assigned to individual barns. The following example can be used for a feeder barn only:

Feed disappearance = 545.7 tonnes/year
= 545,700 kg/year

Amount of pork sold = 161,673 kg/year
(from marketing statements)

Live weight sold = 161,673 - 0.79
= 204,650 kg
(79% dressing percent)

Pigs weigh an average of 20 kilograms on entering the feeder barn. Therefore, the total weight gain within the feeder barn will be:

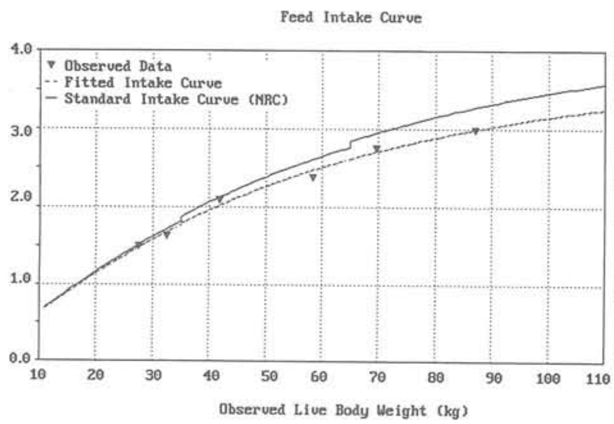
Total weight gain = 204,650 - (2025 weanling x 20 kg/weanling) = 164,150 kg

Feed conversion = 545,700 kg feed/year - 164,150 kg weight gain in the feeder barn = 3.32 kg feed/kg gain

The major disadvantages of inventory-based performance monitoring systemsare that they do not provide information on uniformity of growth and flow of pigs through the barn and on performance at the various stages of growth. Since highly variable growth rates among pigs leads to reduced barn utilization, many producers use individual animal tattoos to monitor average and ranges of days to market. If there is too much variation in starting and ending inventories, estimated feed efficiency can also be badly skewed. Records should be collected over at least a three month period, and more likely over a six month period, before performance can be estimated with reasonable accuracy.

An alternative to these inventory-based record keeping systems is to accurately monitor performance in a limited number of representative pens in the growing-finishing barn. Based on feed usage and body weight gain in the monitor pens, performance in the rest of the barn can be estimated. If feed disappearance and body weight gain is monitored at regular intervals, complete feed intake and growth curves can also be developed.

The feed intake and growth curves, presented in figures 9-11a and 9-11b, are derived from observations on six different pens over a 14 day period. Observations were recorded for feed intake (based on feed disappearance and feed wastage), average body weight, and the number of days the pigs are in the barn. These curves provide information on animal performance at each stage of production. For example, the information on feed intake, growth rate, and feed efficiency summarized in Table 9-24 is derived from the feed intake and growth curves presented in Figure 9-11. The data in Table 9-24 indicate that the overall feed efficiency between 25 and 105 kg body weight is 2.95 in this particular growing-finishing barn. However, the marginal feed efficiency, the amount of feed required to produce the last kg of body weight, is 3.95 between 100 and 105 kg body weight. The overall feed efficiency is required to estimate feed cost per pig. The marginal feed efficiency is required to determine the optimum shipping weight, i.e., the increase in feed cost to raise pigs to heavier weights. For the development of a multi-phase feeding program, the estimated levels of feed intakes can be used to determine the optimum dietary nutrient levels in diets at each individual phase. Prairie Swine Centre Inc. has created a computerized performance monitoring system that allows for the development of a feed intake and growth curve based on a limited number of detailed observations on a selected number of pens. The program can also be used to estimate feed cost and gross margins per pig or per pig place per year.



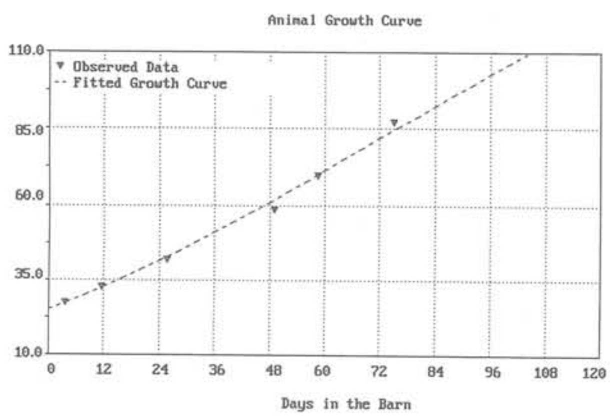


Figure 9-11a and 9-11b. Estimated Feed Intake and Growth Curves Derived from a Limited Number of Detailed Observations on Feed Intake and Body Weights in a Feeder Barn.

Once a reliable system for monitoring herd performance has been established, the success or failure of current management methods can be evaluated. Plus, the benefits of any changes made in management practices can be assessed on the basis of actual measurements taken.

Table 9-24. Estimated Performance of Feeder Pigs Based on Feed Intake and Growth Curves Presented in Figure 9-11.

Wt. Range (kg)	Marg. Days	Cumm. Days	Feed Int. (kg/day)	MargGain (g/day)	Cum. Gain (g/day)	Marg.FCE (g/g)	Cum. FCE (g/g)
25 - 30	8.0	8.0	1.475	628.4	628.4	2.35	2.35
30 - 35	7.3	15.3	1.671	682.4	654.3	2.45	2.40
35 - 40	6.9	22.2	1.868	727.9	677.1	2.57	2.45
40 - 45	6.5	28.7	2.034	766.0	697.3	2.66	2.50
45 - 50	6.3	35.0	2.184	797.5	715.3	2.74	2.55
50 - 55	6.1	41.0	2.322	823.1	731.3	2.82	2.60
55 - 60	5.9	47.0	2.447	843.5	745.4	2.90	2.64
60 - 65	5.8	52.8	2.562	859.0	758.0	2.98	2.68
65 - 70	5.7	58.5	2.666	870.2	769.0	3.06	2.73
70 - 75	5.7	64.2	2.762	877.1	778.6	3.15	2.77
75 - 80	5.7	69.9	2.848	880.3	786.9	3.24	2.81
80 - 85	5.7	75.6	2.927	879.9	793.8	3.33	2.85
85 - 90	5.7	81.3	3.000	876.1	799.6	3.42	2.90
90 - 95	5.8	87.0	3.066	869.2	804.2	3.53	2.94
95 - 100	5.8	92.9	3.126	859.2	807.7	3.64	2.99
100 - 102	2.4	95.2	3.164	850.5	808.7	3.72	3.01

Meat Quality

Meat quality is not valued in the Canadian price settlement system for pig carcasses. The relative carcass value is determined based on dressed carcass weight and the estimated lean yield in the carcass (Table 9-2). Thus, there is no direct benefit for pork producers to produce pig carcasses with superior meat quality. However, the profitability of the meat packer, and indirectly that of the pork producer, will be affected by the quality of the pork products that are sold. Many aspects of meat quality, such as the incidence of pale, soft and exudative (PSE) pork, are affected primarily by pig genotype and the handling of pigs just prior to slaughter. Attempts to reduce the incidence of PSE in pork via manipulation of the composition of the pre-slaughter diet have been largely unsuccessful.

One aspect of meat quality, the quality of intra- and extra-muscular fat, can be manipulated by the diet composition. As more unsaturated fat is included in the finishing pig diet, carcass fat becomes softer and more prone to oxidation or rancidity. This condition can affect shelf-life and consumer acceptance of fresh pork products. If the total fat content of the finishing diet exceeds 4.5%, more saturated fats, such as tallow, should be chosen over vegetable oils, such as soybean or canola oil.

Some other dietary nutrients have been related to various aspects of meat quality, most noticeably vitamin E. Several studies with beef, and a limited number of studies with pigs, have demonstrated that, when up to 200 IU/kg of vitamin E are included in the diet just prior to slaughter, meat colour in fresh meat products can be maintained longer and drip losses can be reduced.

Other Management Considerations

As previously discussed, feed cannot be considered in a vacuum. It must be viewed as part of a total management package.

Floor space per pig is important. It not only influences productivity, but also the pigs' health, behaviour, and well-being. Table 9-25 summarizes floor space guidelines for the feeder barn that were suggested in the *Recommended Code of Practice for the Care and Handling of Farm Animals* recently published by Agriculture Canada. These values are not absolute, but are useful estimates of the space allowances for feeder pigs. There is a very fine line between reducing the space per pig to expand the barn population, and overcrowding causing the barn throughput to suffer. Other factors, such as pen size, the number of pigs per pen, feeder design, and location, will also affect space requirements and performance of growing-finishing pigs. If 15 finishing pigs are grouped in one pen, a pen size of 4.3 m x 2.3 m is suggested. This size is based on the amount of space required according to the Canadian code of practice to accommodate 15 pigs at 95 kg body weight. Given variations in animal performance, the first pig is already shipped from the pen when the average body weight of all pigs in the pen reaches 95 kg.

Controlling the barn temperature is also an important practice. The effective barn temperature, which is the combined effect of many factors, including air temperature, air speed, air humidity, floor type, dryness of floor, and the pig's body condition, all have a direct effect on feed intake and animal performance. If the effective environmental temperature is too cold, extra feed is required to maintain a constant body temperature and feed intake will increase. If, on the other hand, the effective environmental temperature is too hot, feed intake will quickly reduce and growth rates will decline. The optimum temperature range, i.e., the temperature range in which pigs are neither too hot nor too cold, is relatively narrow, and will reduce with increases in live body weight. It is recommended that barn temperatures do not fall below 18 - 20°C for growing pigs. Lower temperatures (12°C) may be acceptable in all-in, all-out barns when the pigs in a given room reach 75 kg of body weight. As pigs approach market weight, a barn temperature of 12°C is quite acceptable if the pigs are dry and free of drafts.

Other housing recommendations include the provision of one waterer for every 15 pigs. The scientific basis for this recommendation is limited, so it should be interpreted as a useful guideline only. Water quality and water flow rates should be monitored regularly. It is recommended that the flow rate for growing-finishing pigs be between 1.0 and 1.5 litres per minute (0.22-0.33 imperial gallon per minute). Consult the manufacturer's recommendations for optimum waterer placement.

Table 9-25. Recommeded Pen Floor Space Allowances for Growing Pigs*

Body weight		Fully slatted		Partial slats	
kg	(lb)	m^2	(sq ft)	m^2	(sq ft)
25	(55)	.30	(3.2)	.33	(3.6)
50	(110)	.48	(5.2)	.53	(5.7)
75	(165)	.62	(6.7)	.70	(7.5)
100	(220)	.76	(8.2)	.85	(9.1)

*Recommended Code of Practice for the Care and Handling of Farm Animals

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