ISSUED: 9-85
REVISED:
Duane E. Reese, Dennis O. Liptrap, Gary R. Parker, Gary L. Cromwell and Tim S. Stahly

Pork production is more likely to be profitable when resources such as labor and feed are used wisely. Since feed costs comprise about 60 to 70 percent of the total costs of production, efforts to reduce feed costs will pay big dividends (table 1). These farm records indicate that the profitability of the swine enterprise is related to feed conversion (pound of feed per pound of gain) and the average cost of the diet. Farms having a high rate of return had a superior feed conversion and lower diet cost than low return farms. The combination of improved feed conversion and reduced diet cost prompted a lower feed cost per 100 pounds of pork produced for the high return farms.

Table 1. - Comparison of high and low income farrow-to-finish swine farms[1,2]

	High Income	Low Income	Difference
No. farms	18	18	
Feed/100 lb of pork produced, lb	385	411	26
Cost of diet/100 lb$	6.25	7.01	.76
Feed cost/100 lb of pork produced,	$25.17	28.19	3.02

[1] *Kentucky Farm Analysis, 1982*

[2] *Income divisions based on net returns/100 lb of pork produced*

The following discussion centers on various factors that affect feed conversion of growing-finishing (40 to 230 pounds) swine. Seventy-five to eighty percent of the feed required to produce a market hog is utilized during the growing-finishing period, so optimum use of feed during this period is an important ingredient in reducing the feed costs of the entire herd. Understanding the factors that affect feed conversion in growing-finishing swine can enable producers to more effectively combine various inputs in order to achieve a low cost of gain. The concepts and research data provided herein should aid producers in making those decisions.

Feedstuff Selection

Pigs tend to consume enough feed to meet their energy requirement; therefore, the quantity of feed they consume varies with the energy level of the diet. Diets composed of low energy feedstuffs are consumed in greater quantities than those containing high energy feedstuffs. Consequently, the amount of feed required per pound of gain is higher for pigs consuming diets formulated with lower energy feedstuffs.

Table 2 shows the relationship between dietary energy concentration and feed intake by comparing the performance of growing-finishing pigs fed corn-soy and barley-soy diets. It is evident that pigs fed barley gained similarly to those fed corn, but they required significantly more feed to produce the same quantity of gain. This is because the metabolizable energy value of corn is greater than that of barley (1,500 vs. 1,320 kcal per pound).

Table 2. Corn vs.. Barley in Grain-Soy Diets for Growing-Finishing Swine[1]

Item	Grain Source	
	Corn	Barley
Daily feed, lb	5.11	5.44
Daily gain, lb	1.66	1.60
Feed/gain	3.08	3.40

[1]3 experiments (Kentucky, Washington State), 216 pigs, 40-224 lb

The environmental temperature in which the animals are housed affects the efficiency of utilization of different feedstuffs. Digestion of alfalfa meal and other fibrous (low energy) feedstuffs produces significant quantities of heat (called heat increment) within the animal which would be useful to pigs housed in a cold environment but a detriment to those in a warm or hot environment. Conversely, fat possesses a low heat increment which makes it more useful for pigs in a hot environment than in a cold environment.

These principles are illustrated in Tables 3 and 4 that show the effect of either alfalfa meal or fat added to a corn-soybean meal diet for growing swine housed at three different temperatures. Maximum use of alfalfa meal was obtained by pigs housed in the cold environment (Table 3) whereas use of fat was maximized in the hot environment (Table 4).

Table 3. - Relative performance of pigs (51 to 121 lb) fed a high fiber vs corn-soybean meal diet in a cold (50°), optimal(72.5°) or hot (95°) environment[1, 2]

Item	Temperature, °˚F		
	50	72.5	95
	% change in performance due to fiber additions		
Avg. daily gain, lb	-1.8	-2.9	-5.4
Feed/gain	-1.5	-8.0	-10.0

[1] Summary of five trials; Stahly and Cromwell, 1981.
[2]Fiber source (dehydrated alfalfa meal) added at the level of 0 or 10% to a corn-soybean meal diet.

Table 4. - Relative performance of pigs (60 to 141 lb) fed a fat supplemented vs corn-soybean meal diet in a cold (50°˚), optimal (72.5°˚) or hot (95°˚) environment[1,2]

Item	Temperature, °˚F		
	50	72.5	95
	% Change in performance due to fat additions		

Avg. daily gain, lb	0	8.8	9.1
Feed/gain	8.0	11.7	14.2

[1]Summary of three experiments; Stahly and Cromwell, 1979
[2]Fat source (tallow) added at the level of 0 or 5% to a corn-soybean meal basal diet.

When formulating swine diets, it is best to select feed ingredients that will result in the least cost of gain and not necessarily maximum feed conversion. Once diets have been formulated, producers should see that conditions are right for maximum utilization of their feed in the swine enterprise.

Size of Grind

Fineness of grind has been shown to affect feed efficiency. In general, the finer a feed is ground, the more efficiently it's utilized. However, under practical conditions, a medium textured feed ground through a 1/4 to 3/8-inch screen is better than one ground very fine. A finely ground feed is more subject to bridging problems in self feeders, creates more dust problems in confinement and may cause an increased incidence of gastric ulcers. Course grinding should be avoided as pigs will tend to sort large particles from smaller ones and cause feed wastage.

Pelleting

The improvement in feed conversion due to pelleting depends on the major ingredients in the diet. Generally, the higher the fiber level, the greater the response from pelleting. In one study, when corn-soy diets were pelleted, feed conversion was improved by an average of 3 percent and daily gain by about 1.2 percent. The improvement in efficiency is probably due to increased energy digestibility and reduced feed wastage. To be economical, the improvement in feed savings should offset the cost of pelleting.

Nutrient Levels in Diets

Diets that are properly formulated and mixed are essential for optimizing feed efficiency. This means avoiding nutrient deficiencies as well as excesses since both are costly. Dietary protein levels have been shown to affect feed efficiency in growing-finishing swine (Table 5). Data compiled from over 20 experiments indicate that gain and feed efficiency are optimized when a '16 percent crude protein corn-soybean meal based diet is provided to growing pigs (40 to 100 pounds) and a 14 percent protein diet is provided to finishing pigs (100 to 230 pounds). Reduced pig performance will occur if other nutrients (salt, phosphorus, etc.) are not adequately supplied in the diets. It is recommended that producers obtain a crude protein, calcium and phosphorus analysis of their feed ingredients and complete diets at least four times per year for quality control purposes.

Table 5. - Average daily gain and feed efficiency as affected by weight of pig and protein level of the diet[1]

Weight range, lb	Protein level, %	Avg. daily gain, lb	Feed/gain
40-100	12	1.27	3.16
	14	1.38	2.58

	16	1.46	2.48
	18	1.51	2.53
100-170	10	1.26	5.08
	12	1.65	3.56
	14	1.70	3.30
	16	1.73	3.39
170-250	10	1.71	4.37
	12	1.80	3.92
	14	1.76	3.80

[1]*Nebraska Swine Report, 1974.*

Antibacterial Agents

The use of antibacterial agents in the diets of growing-finishing swine results in improved feed conversion and gain to various degrees depending on the age of the pig, overall health of the herd and cleanliness of the environment. The average improvement in feed efficiency and gain from the use of antibiotics as feed additives is shown in Table 6. Copper sulfate is not considered an antibiotic but does possess antibacterial properties. High levels of copper (100 to 250 ppm) improves performance of growing-finishing swine similar to antibiotics. Since the majority of the data used to generate these averages were compiled at experiment stations where the environment is generally cleaner than typical farm conditions, the response to antibiotics on the farm is likely to be greater than described.

Table 6. - Response of pigs to various antibiotics during the growing phase (37 to 110 lb) and growing-finishing phase (90 to 189 lb)[1]

Item	**Phase**	
	Growing	**Growing-finishing**
	% improvement	
Avg. daily gain	10.8	4.6
Feed/gain	4.4	2.0

[1]*Data from 599 experiments using 11,449 pigs; Hays, 1977.*

Feed Wastage

Feed wastage from feeders contributes substantially to poor feed conversion in growing-finishing swine. Research at the University of Kentucky indicates that feed wastage from self-feeders reduces efficiency of feed conversion by about 7 percent. Self-feeders should be continually observed and adjusted to minimize wastage while not restricting feed intake. Locating feeders over the solid area of the pen helps producers observe waste in addition to providing pigs an opportunity to consume spilled feed.

Environmental Temperature

Table 7 illustrates the effect of air temperature on the performance of growing pigs. Pigs housed in a cold (50°˚ F) environment utilized feed less efficiently than those housed in a warm (72.5°˚ F) environment because in the cold environment, less feed was utilized for tissue synthesis and more was used for body heat production. The extra body heat generated by pigs housed in the cold environment was needed to compensate for the increased heat loss for the body. Pigs in the hot environment gained considerably less and were slightly less efficient than pigs in the warm environment. Pigs in the hot environment performed more poorly because of reduced feed intake. These data emphasize the importance of maintaining pigs in a nearly optimal temperature to maximize performance. For growing-finishing swine fed ad libitum (full-fed), a temperature of 60 to 70°˚ F is recommended for maximum performance.

Table 7. Effect of environmental temperature on the performance of growing pigs (50-125 pounds)[1]

Item	**Temperature, °˚F**		
	50	**72.5**	**95**
Avg. daily gain, lb	1.70	1.76	1.41
Avg. daily feed, lb	4.86	4.21	3.52
Feed/gain	2.91	2.41	2.52

[1]*Summary of three experiments; Stahly and Cromwell, 1979, 1981.*

The majority of the growing-finishing buildings in Kentucky are not environmentally regulated. As a result, temperature changes outside the building are generally reflected inside, except for the extremes. At times, temperatures inside the building are not desirable for maximum performance. When temperatures are low, consideration should be given to using zone heaters, hovers, or bedding for young pigs. During hot periods, moving large volumes of air in conjunction with sprinkling the hogs periodically with water will help maintain comfort. Insulation under the roof of buildings would aid in making pigs comfortable in both instances.

Composition of Body Weight Gain

In order for pigs to gain weight, they must consume nutrients in excess of their maintenance requirement. The efficiency by which feed is converted to body weight gain above maintenance depends on the composition of the gain. Is fat or muscle the major tissue comprising the body weight gain?

The data in Table 8 illustrates that as body weight of the pig increases, the ratio of fat to muscle in that gain also increases. In other words, as pigs approach market weight, fat comprises an increasing proportion of the weight gain. Because fat requires significantly more feed energy to deposit than muscle, the quantity of feed required per unit of gain increases with body weight.

Table 8. Relationship of pig body weight to composition of gain and feed efficiency[1]

Body weight, lb	Composition of gain (fat/muscle ratio)	Feed efficiency (feed/gain ratio)
50-100	.88	2.9
100-150	.92	3.1
150-200	1.42	3.5
200-250	1.88	4.3

[1]*Adapted from Pond and Manner, 1974 and Kidder et al., 1982.*

By understanding these relationships, producers can improve feed utilization in growing-finishing pigs by two methods: **1)** carefully monitor the weight at which swine are marketed for slaughter, and **2)** select herd replacement animals that are lean. The heritability of backfat thickness in swine is about 50 percent so rapid improvement in carcass leanness is possible through proper selection.

Floor Space and Numbers per Pen
Overcrowding causes animal discomfort and increases disease susceptibility resulting in poor performance. On the other hand, excess space allowances do not facilitate wise use of buildings. Optimum space allowances for swine in confinement and for those in an open-front shed with an outside apron are listed in Table 9. To accommodate the space needs of pigs as they grow, producers generally move them to larger pens at least once during the growing-finishing period. Generally, the number of pigs per pen should be limited to 20 or 30.

Table 9. Space Requirements for Growing-Finishing Swine in Confinement Housing and Shed with Outside Apron[1]

Weight, lb	Confinement housing[2] ft^2/pig	Shed with outside apron	
	inside ft^2/pig	outside ft^2/pig	
30-75	3-4	3-4	6-8
75-150	6	5-6	6-12
150-220	8	5-6	6-12

[1]*Midwest Plan Service Swine Housing and Equipment Handbook, 1983.*
[2]*For slotted, flushed or scraped floor.*

Feeder and Waterer Space
It is generally recommended that producers allow one feeder hole for every four to five pigs. One nipple waterer for every 10 to 15 pigs and one bowl waterer for every 15 to 20 pigs should allow adequate water intake to promote proper feed consumption for maximum growth and efficiency.

Pen Cleanliness
Because most of the growing-finishing buildings in Kentucky are partially slotted, it is important that pigs maintain good dunging patterns to optimize performance. An English study demonstrated that dunging in

the sleeping area caused unsanitary conditions to develop, resulting in a 10 percent reduction in feed efficiency and a 55 percent reduction in gain. The key to maintaining correct dunging patterns in this study was a properly functioning ventilation system which created a cool dunging area. Also wetting the dunging area and feeding on the floor during the first few days upon arrival in the pen tends to help establish good dunging patterns.

Diseases and Parasites

Diseases and parasites can be devastating to feed efficiency. Diseases likely to affect performance of growing-finishing swine include atrophic rhinitis, haemophilus pleuropneumonia, bacterial pneumonia, mycoplasmal pneumonia, dysentery, influenza and erysipelas. European studies have indicated that mycoplasmal pneumonia infection reduces feed efficiency by 6.3 percent and gain by 3.5 percent. Death as a result of disease will have a severe impact on feed efficiency. Parasites likely to affect swine include mange, lice, roundworms, nodular worms, whipworms and lungworms. Studies have shown that parasitism reduces feed efficiency and gain in growing swine by 5 to 10 percent. The effects of parasitism are more severe when pigs are receiving low protein diets.

Slaughtering a representative sample of hogs periodically and inspecting lungs, snouts and livers with a veterinarian provide producers with information concerning the health status of their herds. In addition, good prevention and treatment programs will pay dividends.

Rodents and Birds

Feed consumed by rodents and birds can be substantial depending on the size of the populations. In addition, these pests damage buildings and equipment while exposing swine to a variety of diseases. Screening birds out of buildings, keeping all feed covered and providing fresh bait where needed will reduce feed wastage by pests.

Breeding Herd Performance and Management

Approximately 20 to 25 percent of the feed required to produce a market hog is not consumed directly by that individual, but instead is utilized by the breeding herd. Therefore, breeding herd reproductive efficiency influences the quantity of feed required to produce a market hog. Any practice that increases the number of pigs marketed per female year (female year = average number of females in the herd during each month during the year) results in each market hog being charged with less of the feed consumed by the breeding herd. Factors that have a significant impact on the number of pigs marketed per female year are 1) farrowing rate, 2)litter size, 3)interval from weaning to estrus, and 4) death loss.

Birth weight affects subsequent growth rate and feed utilization by pigs. Data in Table 10 illustrate that pigs weighing less than 1.4 pounds at birth were about 69 pounds lighter at 154 days of age than those weighing 3.8 pounds or more at birth. In such instances, more days are required to reach a given market weight. Thus, more feed goes toward body maintenance, consequently reducing feed efficiency. Properly feeding sows during gestation will help assure that pig birth weights are in an acceptable range to promote optimal performance to market weight.

Table 10. -- Relation of Birth Weight on Subsequent Growth Rate[1]

Weight range, lb	**No. pigs**	**Birth weight, lb**	**56-day weight, lb**	**154-day weight, lb**
Less than 1.4	51	1.17	21.3	127.0

1.4 - 1.99	264	1.72	27.3	158.3
2.0 - 2.59	756	2.29	30.7	173.0
2.6 - 3.19	1418	2.80	34.2	182.0
3.2 - 3.79	831	3.41	36.8	189.2
3.8 and more	361	4.10	38.2	196.0

[1]*Adapted from Noland and Johnson, 1972.*