FATS AND PROTEINS RESEARCH FOUNDATION, INC.

Director's Digest

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A PERSPECTIVE ON USE OF FAT IN GROWING AND FINISHING SWINE DIETS

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INTRODUCTION

"It appears that with fat prices in the neighborhood of 15 cents/lb and corn prices in the $2 to $2.50/bushel range, adding fat at about the 5% level will produce the most economical gain for growing-finishing swine." This was a conclusion by Moser (1977) from work conducted at the University of Nebraska in the mid-1970's using market prices that could well apply to 1992 when fat is added to swine diets as replacement for corn. How well does this conclusion apply to swine production systems of the 1990's and what is the current perspective of using fat for growing swine diets today? During the past decade and a half the feeding of fat has become an acceptable nutritional tool but the strategies for use of this tool have become refined and more complex as the equation is no longer as straightforward. This paper will highlight factors to be considered for a perspective of fat use in swine diets for the 1990's.

I. AN OVERVIEW

A. Biological importance of dietary fat:- Minimum quanitities of essential fatty acids i.e., linolenic, linoleic and arachidonic acids, must be consumed by swine to meet their physiological

needs. These needs will normally be met or exceeded by diets containing corn or oats as the major energy source, although when barley or sorghum grains comprise the major dietary energy sources they may not meet the linoleic requirements of the pig unless a 1-1.5% fat supplement containing high linoleic acid is provided (Stahly, 1984). The primary contributions of feeding fat to swine is the immediate increase in the energy density of the diet. Fat contains 2.25 times the energy concentration provided by dietary carbohydrates. Fat is biochemically utilized more efficiently than carbohydrates for body-fat synthesis which results in less energy loss as heat i.e., lower heat increment (Pettigrew and Moser, 1991). Adding fat to growing swine diets will increase the concentration of fat in the digesta. The effect of high vs lower digesta fat concentrations is to reduce the rate of passage through the gastrointestinal tract which ultimately improves the digestion of carbohydrates and proteins in the small intestine where these nutrients are more efficiently utilized than if digested in the large intestine (Pettigrew and Moser, 1991).

The digestibility of fats by growing pigs can depend on the compositional ratio of unsaturated vs saturated fatty acids (U/S ratio). Fats that contain a U/S ratio of >1.5 will be quite well digested (85-92%), but those that contain a U/S ratio of 1-1.3 will have much lower digestibilities (35-75%; Stahly, 1984). Fat sources that contain high levels of free fatty acids (FFA) are less palatable to pigs. Total fatty acids (comprising both FFA and those combined with glycerol) represent 90% of the composition of the main fat sources with FFA averaging 15% for animal, poultry and blended feed grade animal fats; 30% FFA for blended animal and vegetable fats; 50% FFA for vegetable soapstocks and 5% FFA for vegetable oils (Rouse, 1988).

B. Performance responses to increased dietary energy from supplemental fat: Meade (1977) observed advantages in feed efficiencies and sometimes growth, from inclusion of 5-6% supplemental tallow in growing swine diets, but at higher fat levels, gains decreased. He also observed an increase in carcass backfat thickness in pigs fed added fat, but at that time a small decrease in carcass leanness was not considered to be of practical importance. Moser (1977) concurred that improvement in feed efficiency was the most consistent response from fat feeding, but that higher protein levels must be fed to maintain pig performance when fat replaced corn. Pettigrew and Moser (1991) updated the review of Moser (1977) and analyzed reported responses from adding fat to growing-finishing diets and their conclusions were:- that daily feed intake increased slightly up to 3% fat, then decreased at higher levels (pigs fed ad libitum will adjust intake to meet their energy requirements); that there were overall improvements in daily gains and gain:feed ratios; that adjusting protein:energy ratios did not greatly affect responses to supplemental fat, and that incremental increases in supplemental fat resulted in consistent increases in backfat thickness. Supplemental dietary fat also reduces aerial dust (predominantly feed dust) and settled dust build up in swine houses, which not only improves the environment for both the pigs and swine managers, but also enhances pig performance (Chiba et al., 1985).

C. Other practical considerations: Use of supplemental liquid fat levels > 8% have caused mixing problems and bridging in feeders and storage bins, especially in cold weather. Pre-heating fat to sufficiently high temperatures prior to mixing in all seasons (range 140-200 F) will improve the consistency of the total feed mix. Build-up of fat balls during feed mixing can be reduced by addition of 50% corn after all other ingredients have been added and mixed (Davis, 1985). Dry fat can easily be incorporated into feed mixes but is not as well utilized by finishing pigs as liquid fats (Moser, 1977). Fat incorporated into feed pellets is an alternative method of adding dietary fat, but the pellets have to be durable and not too soft for efficient utilization by the pig. Detailed information on handling, storage and addition of fat sources is available through the Fats and Proteins Research Foundation and the National Renderers' Association publications.

D. Factors to be considered for decisions on fat use:-

a. Importance of reducing feed cost/cwt of pork produced - Top swine producers aim to reduce production costs to $38/cwt or less to maintain their profit potential and a target for feed costs would be 60-65% of total production costs. Differences in feed costs of $4-$5/cwt pork produced have occurred between low and high profit swine operations and therefore improvement in nutritional management practices provides the best opportunity to minimize both feed and total production costs (Shurson, 1992).

b. An appreciation of the general quantitative responses by pigs as affected by:-

1. Ambient temperature; 2. Genotype; 3. Lysine level and, 4. Gender.

Temperature changes can account for much of the variation in feed energy intake by pigs. It has been suggested that for every 2 degrees F drop or rise in temperature below or above the pigs optimal temperature range (60-75 F for 40 to 125 lb pigs; 50-75 F from 125 lb to market), energy intake will increase (cold) or decrease (hot) by 40 kcal/day, which emphasizes the need to consider seasonal modification of diets (Shurson, 1992). Superior genetics can account for an additional $8.60 advantage/ pig vs average genetics in value of growth and carcass traits, but these high-lean-gaining pigs tend to require higher dietary protein (lysine) levels vs those low-lean-gaining genotypes (Stahly, 1989). Kentucky work has shown peak gain (muscle and growth) and feed efficiency occurred at .95% lysine for high lean pigs, .8% lysine for medium lean, and .65% for low lean pigs (Stahly, 1991). This work also indicated that gilts required .05-.08, .14-.17, .17-.20 and .10-.13 greater lysine percentage units for growth than barrows when weighing 65, 130, 175 and 220 lb, respectively. Much of this difference was due to lower feed intakes by the gilts. The quantitative response differences between barrows and gilts indicated above suggest a split-sex feeding system be considered. A potential reduction in production costs of $1/cwt pork produced can result from split-sex feeding but this management change should only be contemplated if existing facilities can be modified at a reasonable cost (Shurson, 1992).

c. Importance of proper feed handling and management:- Economic fat handling systems can be designed to fit each individual's needs. Precise calibration of metering devices when using liquid supplemental fat sources is critical, especially when fat is added at varying temperature ranges. Other management considerations to address include on-farm vs off-farm mixing, type of feeding program (pre-mixes vs base mixes vs concentrates etc.), economies of alternative feed resources, quality control of feed formulations and complete diets, feeder design and management.

II. FACTORS AFFECTING SWINE RESPONSES TO SUPPLEMENTARY FAT -

A. Ambient temperature: Addition of 5% dietary fat (tallow) has stimulated voluntary energy intake by growing pigs in warm (72.5 F) and hot (95 F), but not in hypothermal (50 F) environments (Stahly, 1984). In this example 5% added tallow changed daily gain and feed efficiency in pigs by -1, 0 at 50 F; +9, +6 at 72.5 F; +9, and +8% at 95 F, respectively, compared to those fed 0% added tallow. Supplementary dietary fat increases carcass backfat thickness when pigs are kept in warm environments and fed adequate protein but has only a marginal effect on backfat thickness in cold environments (Stahly, 1984). Added fat may increase the rate of lean growth and fat deposition in heat stressed pigs (Stahly, 1984).

B. Lysine level, gender and genotype: A 5 state study, during which barrows and gilts were fed ad libitum diets from 112 to 230 lb containing .6, .75 or .9% lysine with 0 or 5% fat added to a corn-SBM diet, showed that increasing lysine level linearly improved rate and efficiency of gain and percent muscle in gilts but only improved feed/gain in barrows (Cromwell et al., 1991). In this study added fat improved gain, feed/gain and increased backfat thickness for both sexes. The study showed that gilts require more dietary lysine to maximize lean tissue growth than barrows. There was a trend for better pig performances with added fat at the higher lysine levels. The cost/benefit ratio for fat feeding must be based on the genetic potential of the pig for lean growth.

III. VARYING DIETARY FAT AND LYSINE LEVELS FOR FAST GROWING PIGS - A MINNESOTA STUDY: A recently completed study at the University of Minnesota was conducted with (Landrace X Yorkshire) X Duroc (terminal cross) barrows and gilts from 10 consecutive farrowing groups over a 2-year period. The lean tissue growth rate of a sample of barrows from these pigs averaged .86 lb/day, which indicated that the pigs were quite lean and growing quickly. The study attempted to quantify the performance and carcass quality of growing (8 to 9 wks to 110 lb) and finishing (110-230 lb) pigs fed corn:SBM diets containing varying energy (supplemental animal fat/vegetable soapstock blend) and lysine (adjusting corn:SBM ratio) levels. In year 1 fat levels were 0, 3, 4.5 or 7.5% with .3, .6, .7 or 1% lysine levels. In year 2 fat levels were 0, 2.5, 5 or 7.5% with .4, .567, .734 or .9% lysine levels. Pigs were housed in 15 ft 3 in X 5 ft confinement pens with 10 barrows or gilts/pen. Pigs were allowed ad libitum feed consumption. House temperatures were monitored continuously.

Data from both years were pooled and used to establish predicted performances by barrows and gilts with varying dietary fat and lysine levels. Results are summarized in Table 1. Throughout the study barrows grew an average of 9.2% faster than gilts, which was mainly due to higher feed intakes. There were gain responses to lysine level for both barrows and gilts with performances plateauing at the higher lysine levels. Rate of gain was not effected by fat level. Feed efficiencies (lb gain/lb feed intake, G/F) differentiated by sex and grower vs finishing periods, are depicted in Figures 1-4. In the grower phase G/F tended to improve with fat and lysine level. Responses to fat levels <7.5% were more differentiated for barrows than gilts. In the finshing phase, response to lysine level peaked for barrows and gilts between .7-.8%, at the higher fat levels. There were no overall effects of temperature on pig performance as temperature ranges were not extreme enough when averaged over complete growing or finishing periods to show response differences. The effects of fat and lysine level on carcass lean muscle % are shown in Figures 5 and 6. There were lysine level but not fat level effects on carcass muscle % . There were overall lysine but not fat level effects on carcass backfat thickness, barrows averaging 1.24 and gilts 1.10 inches backfat, respectively. This study indicated that level of supplemental fat should be assessed against economic growth benefits. The study also re-emphasized the importance of adjusting lysine levels, especially if split-sex feeding with fast lean gaining pigs.

IV. SUMMARY AND RECOMMENDATIONS: Fat is an excellent energy source for growing-finishing pigs. Improvement in feed utilization is the most consistent response to fat feeding especially in warm or hot environments. Daily feed intake will vary somewhat with fat level fed, energy requirements of the pigs, and environmental temperature. Nutritional value of fat is influenced by the digestibility of the fat source and the daily level of energy intake from fat. Adequate protein (lysine) intake must be attained to meet the requirements of the genetic growth potential of the pigs in order to elicit positive responses from fat feeding. Gilts will require higher lysine levels for maximizing lean tissue growth than barrows, an especially important consideration for split-sex feeding. Fat feeding will tend to increase backfat thickness but will not effect carcass quality if lysine intake is optimal. Fat levels of 5-7.5% have been shown to provide better opportunities to maintain an efficient gain response with optimum lysine intake than lower levels of added fat. Economics is one of the key factors for use of fat for growing-finishing pigs, but consideration must also be given to efficient feeding management, storage and handling of fat sources.

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TABLE 1. Estimated[a] performance of barrows and gilts[b] from 8 to 9 wk old to 230 lb market weight when fed varying levels of dietary lysine and supplementary fat.

		Supplementary fat level, % as fed							
		0		2.5		5.0		7.5	
Dietary lysine %	Sex	ADG[c]	G/F[d]	ADG[c]	G/F[d]	ADG[c]	G/F[d]	ADG[c]	G/F[d]
		lb							
.3	Barrows	.84	.22	.81	.23	.77	.23	.70	.24
	Gilts	.64	.20	.59	.20	.57	.21	.53	.21
.4	Barrows	1.23	.26	1.23	.27	1.19	.28	1.12	.29
	Gilts	1.06	.26	1.03	.26	1.01	.27	.97	.27
.5	Barrows	1.52	.29	1.54	.30	1.52	.31	1.47	.32
	Gilts	1.39	.30	1.36	.31	1.34	.31	1.32	.32
.6	Barrows	1.74	.32	1.76	.33	1.76	.34	1.74	.35
	Gilts	1.63	.33	1.63	.34	1.61	.35	1.58	.36
.7	Barrows	1.87	.33	1.91	.34	1.91	.36	1.91	.37
	Gilts	1.78	.35	1.78	.36	1.78	.37	1.78	.39
.8	Barrows	1.91	.34	1.96	.35	1.98	.37	1.98	.38
	Gilts	1.85	.36	1.87	.37	1.87	.38	1.87	.40
.9	Barrows	1.87	.34	1.94	.35	1.97	.37	1.92	.38
	Gilts	1.85	.35	1.87	.36	1.87	.38	1.87	.40
1.0	Barrows	1.74	.33	1.80	.34	1.87	.36	1.98	.37
	Gilts	1.74	.33	1.78	.35	1.78	.36	1.78	.38

[a] Data from 1600 pigs from 10 farrowing groups over a 2 year period were used for regression equations to estimate performance trends.
[b] Barrows > daily gains vs gilts regressed across all fat and lysine levels ($P < .05$); lysine effect on daily gains for barrows and gilts regressed across all fat and lysine levels ($P < .05$).
[c] ADG = Av daily gain, lb.
[d] G/F = Av gain, lb/lb feed.

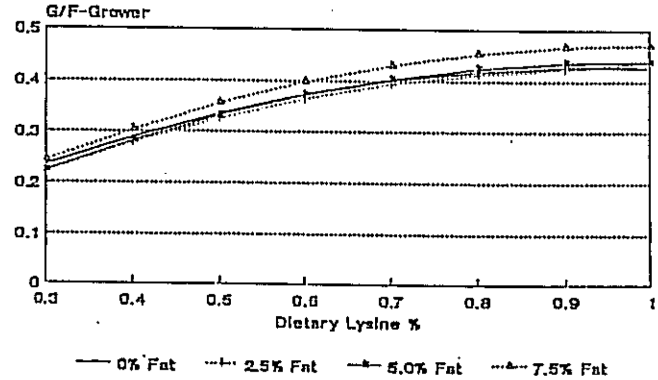

Figure 1. Effect of dietary fat & lysine on feed efficiency by gilts in the grower phase

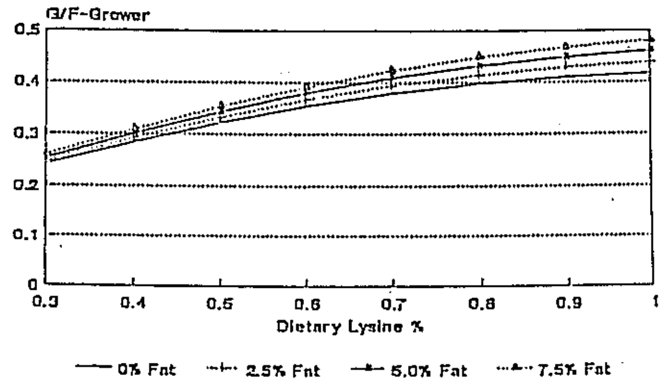

Figure 2. Effect of dietary fat & lysine on feed efficiency by barrows in the grower phase

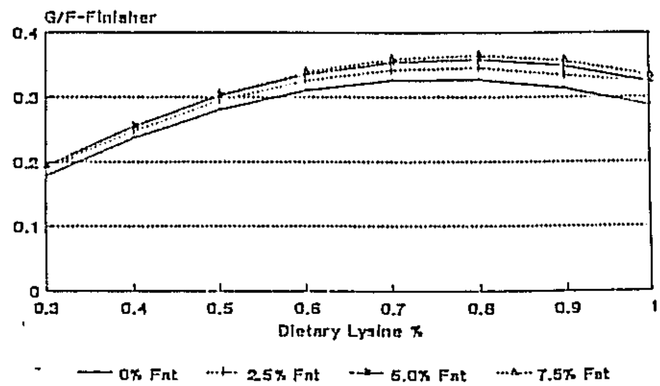

Figure 3. Effect of dietary fat & lysine on feed efficiency by gilts in the finishing phase

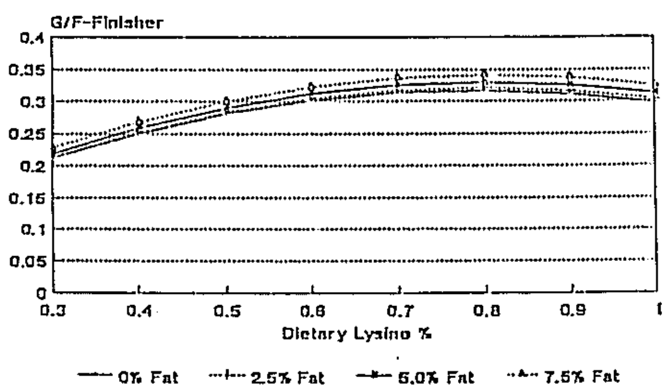

Figure 4. Effect of dietary fat & lysine on feed efficiency by barrows in the finishing phase

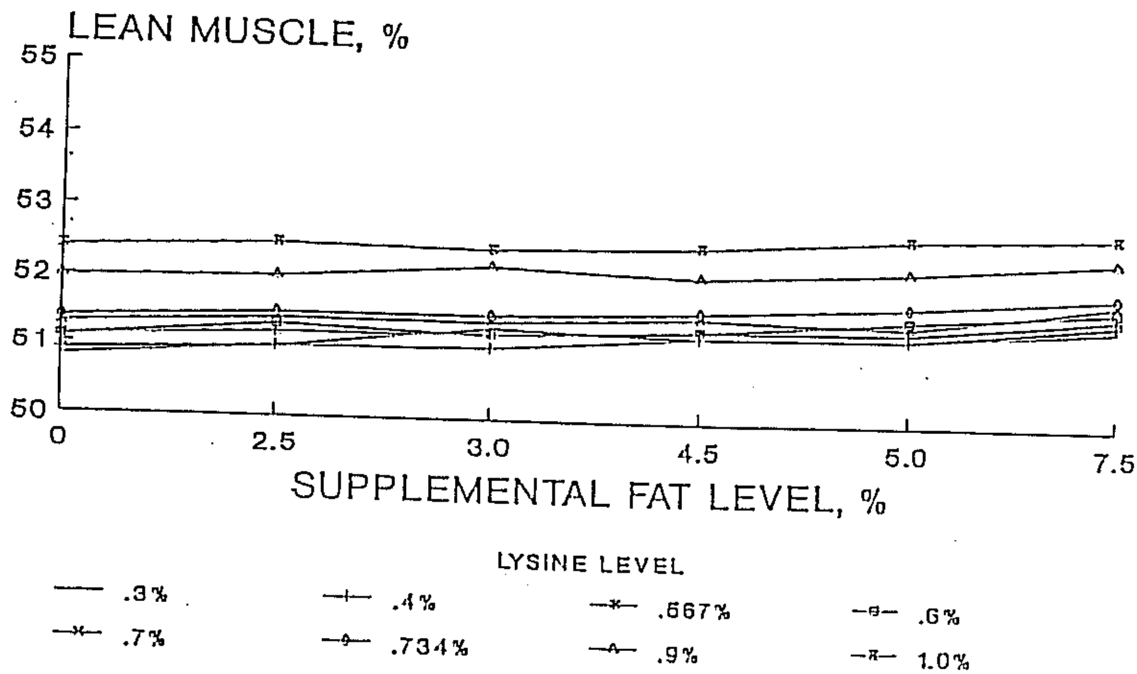

Figure 5. Effect of dietary lysine & fat levels on lean muscle % in market barrows

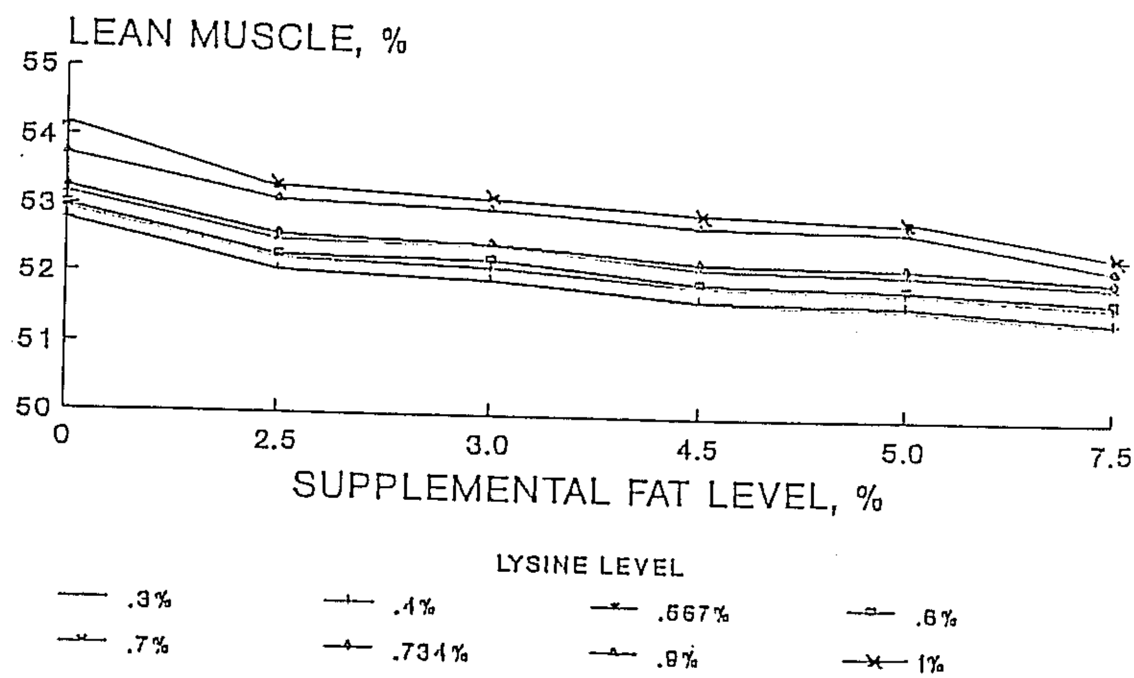

Figure 6. Effect of dietary lysine & fat levels on lean muscle % in market gilts