of the steers were foundered and 3.5% were observed to be somewhat stiff. However, many "stiff" cattle continue to gain, and will grade satisfactorily upon slaughter. Generally, barley-fed cattle have been firm and well covered with outside fat, but with less marbling than desired.

Summary

Increased interest has developed in barley for winter grazing and fattening cattle on the grain. Much of the future for barley depends on the wheat program now under consideration, and barley is less winter hardy than wheat and subject to more freeze out. However, it appears to have promise in many areas where winter pasture can be combined with a feedlot program in the production of finished beef. Yields per acre in terms of weight gain from winter grazing and later fattening program appear to be the neighborhood of 300-400 lb., depending on the growth of winter pasture and yield of barley. Additional items such as labor, supplement, risk and investment should be considered.

The Influence of Slaughter Weight and Limited Feed Intake During Finishing Carcass Merit in Swine

J. C. Hillier, Marvin Heeney and Melvin Bradley

It is well established that carcass traits in swine are high to moderately high in heritability. That economically important carcass traits can be changed significantly through selection, over a period of several years, if modern selection practices are followed and modern aids to selection employed to the fullest. Changes are being made in the direction of both younger and leaner pork and such changes are taking place at an increasing rate, particularly where the producer has the desire to market a superior product. However, a visit to any packer's cooler will reveal that there is a need for a very rapid change in market hogs in the direction of less backfat and increased muscling.

While genetic progress is being made toward a more desirable lean to fat ratio there are forces working against the full expression of this genetic improvement. These forces include more rapid gains as produced by the greater use of rations that are more nearly correct from a nutritional standpoint, less exercise and more nearly ideal temperature conditions as found in modern confinement housing, and the use of feed additives which tend to promote health and thus more

Table 1:—The Influence of Slaughter Weight on Dressing Percentage

Slaughter Weight		150	159	175	180	200	210	215	225	240
Reference No.										
Okla. (1961)	1	70.0		70.6		71.3			70.7	
Okla. (1962)	2					71.2			71.5	
Wallace (1960)	3	70.6			70.8		71.7			72.6
Varney (1962)	4		70.4					71.8		
Cahill	5	75.6					77.6			
Fields (1961)	6		71.4						71.8	
Av.		72.1	70.7	70.6	70.8	71.2	74.6	71.8	71.3	72.6

*Off feed 24 hours before slaughter—no adjustment.

The degree to which hogs tend to become fatter with increased weight is indicated in Table 2. These data indicate that there are distinct fattening patterns associated with breeding groups. This is in agreement with the works of DePope and Whatley (1956) which showed distinct differences among lines in their tendency to fatten, particularly at weights above 170 pounds.

Increases in loin area associated with slaughter weight are shown in Table 3. There is a tendency for the yield of lean cuts, as a percentage of the live weight, to decrease as slaughter weight increases. This is shown in Table 4. No doubt this trend is closely associated with the tendency for the hogs to lay down fat at an increasing rate as they become heavier. The type of hog used will have a good deal to do with the weight at which the highest yield of lean cuts is obtained. The addition of inter and intra muscular fat and the addition of exterior fat to the point of trimming, will increase these lean cut yields, for such fat remains on and within the cut. Up to the point that more fat is being trimmed off than left on cuts increased finish increases lean cut yield.

Table 2:—The Influence of Slaughter Weight on Backfat Thickness

Slaughter Weight		150	159	175	180	200	210	215	225	240
Reference No.										
Okla. (1961)	1	0.99		1.02		1.15			1.24	
Okla. (1962)	2					1.20			1.45	
Wallace (1960)	3	1.13			1.27		1.48			1.52
Varney (1962)	4		1.10					1.50		
Cahill	5	1.40					1.70			
Fields (1961)	6		1.14						1.52	
Av.		1.17	1.12	1.02	1.27	1.17	1.59	1.50	1.40	1.52

Table 3:—The Influence of Slaughter Weights on Loin Area

Slaughter Weight		150	159	175	180	200	210	215	225	240
Reference No.										
Okla. (1961)	1	3.36		3.98		4.41			4.24	
Okla. (1962)	2					4.12			4.33	
Wallace (1960)	3	3.43			3.85		4.07			4.45
Varney (1962)	4		3.66					4.16		
Cahill (1960)	5	---					---			
Fields (1961)	6		3.61						4.39	
Av.		3.39	3.63	3.98	3.85	4.26	4.07	4.16	4.32	4.45

Table 4:—The Influence of Slaughter Weight on Percentage Lean Cuts of Live Weight

Slaughter Weight		150	159	175	180	200	210	215	225	240
Reference No.										
Okla. (1961)	1	39.8		40.6		41.3			40.0	
Okla. (1962)	2					38.8			38.2	
Wallace (1960)	3	38.0			37.8		36.6			35.8
Varney (1962)	4		39.6					38.0		
Cahill (1960)	5	39.3					37.8			
Fields (1960)	6		39.2					38.5		
Av.		39.0	39.4	40.6	37.8	40.0	37.2	38.2	39.1	35.8

The weight of ham associated with live weight is indicated in Table 5. These figures indicate that modern meat type hogs slaughtered at 215 pounds or heavier are producing hams that are heavier than the consumer desired as reported by Fields *et al.* (1961).

Table 5:—The Influence of Slaughter Weight on Weight of Trimmed Ham

Slaughter Weight		150	159	175	180	200	210	215	225	240
Reference No.										
Okla. (1961)	1	11.8		14.1		16.2			17.6	
Okla. (1962)	2					15.3			16.7	
Wallace (1960)	3	10.7			12.9		14.4			16.45
Varny (1962)	4		12.10					15.56		
Cahill (1960)	5	---					---			
Fields (1961)	6		12.15					16.22		
Av.		11.2	12.12	14.1	12.9	15.7	14.4	15.99	17.1	16.45

Restricting Feed Intake

Any scheme for the limiting of feed intake for pigs in an effort to improve leanness should provide adequate nutrients for maximum bone and muscle growth with a small excess of energy to store as fat. High fiber, low energy rations have been tested as a means of improving the carcass qualities of swine.

Crampton, *et al.* (1954) found that restricting the feed to reduce daily gain from 1.7 to 1.3 pounds and extending the feeding period by 17 days reduced the backfat and increased the percentage of grade A carcasses significantly. Hochstetler, *et al.* (1959) studied the effect of varying levels of fiber from different sources upon growth and carcass characteristics of swine. Rations containing from 3 to 8 percent fiber were used. The general response of the pigs was to increase feed consumption as the fiber content of the ration increased, so that daily TDN intakes were not in direct relation to the TDN levels of diets. In general dressing percent was reduced and the yield of lean cuts on the carcass basis increased with the increasing of fiber content.

The effect of limited feeding of corn and pasture was tested by Jordon, *et al.* (1956). The feeding of 50 to 70 percent of a full feed of corn seemed to be the most desirable level for the improvement of leanness in the carcass without seriously reducing rate of gain. Dressing percent reduced markedly with the reduced levels of corn fed. Merkel *et al.* (1958) found that the feed consumption per hundred pounds of gain was increased by restricting the digestible nutrients of the ration. Differences between treatments were not significant when the crude fiber of the ration was less than 10 percent. High fiber levels in the diet tended to reduce dressing percent.

Hillier, *et al.* (1951) found that the dilution of an ordinary swine ration with 20 percent ground prairie hay reduced rate of gain about 30 percent and increased the feed required per unit of by 60 percent. Carcasses from hogs fed the high fiber ration had 0.30 inches less backfat and were calculated to have a value of $0.86 more per hundred than carcass from hogs fed the regular ration. Because of the low dressing percentage of the pigs on the bulky ration the on-foot values of the two groups were the same.

In general the feeding of bulky rations has given the following results as compared to the feeding of rations of normal energy and fiber content; 1. Increased daily feed intake, 2. Reduced feed efficiency, 3. Reduced dressing percentage, 4. Reduced rate of gain, 5. Improvement in the lean to fat ratio, and 6. Greater feed and labor costs. Merkel, *et al.* (1953, 1958). Recently Thrusher, *et al.* (1962) fed rations varying from 62 to 78% TDN. Improvements in carcass values were more than offset in increased feed costs where low energy rations were used.

Because of the generally unsatisfactory results obtained where ordinary rations have been diluted with higher fiber feed, attention has been turned to limiting the daily intake of rations of ordinary TDN value (70-76%).

What is really desired is to feed a level and quality of protein as well as minerals and vitamins necessary for maximum bone and muscle growths but to limit the daily energy intake. Thus protein-energy ratios come into the picture. In work at this station pigs limited to a definite daily intake starting at 175 pounds were slaughtered at 200 and 225 pounds. Feed efficiency was not changed but lean cut yield as a percentage of live weight was increased about one percent.

Becker, *et al.* (1962) limited one group of pigs to 70 percent of a full feed and another to daily intake of five pounds for the period from 114 pounds to slaughter weight. Restriction to 70 percent of a full feed improved feed efficiency by 11 percent, reduced gain 20 percent, (10 days longer to market) and increased the yield of lean cuts by 0.8 percent. Thrasher, *et al.* (1962) limited the intake of a corn-soy ration to 85 and 90 percent of a full fed. Both degrees of limitation reduced the rate of gain and backfat thickness and increased lean cut yield, however, the feed per unit of gain and feed costs was slightly higher in the limited fed groups. Becker, *et al.* (1963) restricted pigs on a corn-soy type ration to 85 and 70 percent of a full feed. On 85 percent of a full feed feed efficiency was maintained while lean cut yield was increased slightly. At 70 percent of a full feed feed efficiency was also improved.

Energy Protein Ratios

Noland and Scott (1960) fed three levels of protein, 12, 16 and 20 percent each at three levels of energy. Carcasses from pigs fed the 1200 calorie ration were fatter than pigs fed the 950 and 1050 calorie ration. Pigs fed the 16 and 20 percent protein rations produced longer and leaner carcasses than those fed the 12 percent protein rations.

Wagoner, *et al.* (1963) fed rations containing from 950 to 1640 calories per pound in combination with protein levels of 13, 19 and 25 percent. Increased protein level resulted in decreased carcass backfat thickness. This may be partially due to decreased feed consumption in the higher energy diets. Increasing energy levels increased the dressing percent. There was no significant inter actions of protein and energy observed in any of the measurements taken. This was interpreted to mean that no serious deficiency of energy or protein existed.

When the protein level is altered in a mixed ration, it is generally done by increasing or decreasing the amount of supplemental protein. Indirectly the amino acids balance is also changed. Kropf, *et al.* (1959) checked the influence of amino acid balance as well as protein level. Providing a poor amino acid balance reduced rate of gain, daily feed intake, and feed efficiency significantly. Carcasses from pigs given the poor amino acid balance tended to be lower in protein and higher in fat than those produced on a better balance of amino acid. Under the conditions of this trial the feeding of a 12 percent protein diet of good amino acid balance did not lower rate of gain or efficiency, cut did tend to produce a fatter carcass than the 16 percent protein ration.

In most studies concerning protein energy ratios protein quality varied as the energy content of the ration changed. Clawson, *et al.* (1962) used rations containing graded levels of from 10 to 18% protein formulated so that a similar ratio of amino acids was maintained in all diets.

Feed efficiency was more closely associated with energy level in the diet than with calorie-protein ratio. As the energy and protein increased in diets of a constant calorie-protein ratio, feed per pound of gain was consistently decreased. The carcass measurements were not significantly influenced by ration treatment, although there was a tendency for both higher energy and lower protein levels to produce fatter carcasses.

Summary

The easiest and most effective means of altering the composition of a pork carcass, from a pig of a given genetic make-up, in the direction of greater leanness, is to slaughter at a lighter weight. A weight of 200 pounds, rather than the present average slaughter weight of about 230 pounds, seems to fit the needs of most interests. These considerations include the lowest feed cost, including breeding herd cost, per pound of hog marketed; maximum conversion of feed to lean pork; optimum size wholesale and retail cuts, and consumer acceptability of the products.

The feeding of low energy rations will produce leaner pork but at the cost of lower dressing percent and increase feed cost as well as increased labor. Limiting the daily intake of a normal energy ration, starting at about 150 pounds and continuing to a slaughter weight, will improve the lean to fat ratio in a carcass and may or may not improve feed efficiency. Lean cut yield as a percentage of live weight may be improved as much as five to eight percent, however such savings are not likely to occur under anything less than ideal environmental conditions.

Even with the most modern equipment it is difficult to limit feed in the amounts and to the individuals desired. In most cases limited feeding will mean increased costs. The financial success of a program of limited feeding will depend on the recognition of increased value at the market.

Literature Cited

Becker, D. E., A. H. Jensen, and B. C. Breidenstein. 1962. *Limited Feeding of Finishing Pigs.* Animal Sci. Dept. University of Ill. Mimeo Rpt. A. S. 571.

Bruner, W. H., Vern Cahill, W. L. Robinson and Richard Wilson. 1958. *Performance of Barrow and Gilt Littermate Pairs at the Ohio Swine Evaluation Station.* J. Animal Sci. 17:875.

Clawson, A. J., T. N. Bloomer, W. W. G. Smart, Jr., and E. R. Barrick. 1962. *Influence of Energy-Protein Ratio on Performance and Carcass Characteristics of Swine.* J. Animal Sci. 21:62

Crampton, E. W., G. C. Ashton and L. E. Loyd. 1954. *The Effect of Restricting Feed Intake of Market Hogs During the Finishing Period on the Quality of the Bacon Carcass.* J. Animal Sci. 13:321.

DePope, J. G. and J. A. Whatley, Jr. 1956. *Live Hog Probes at Various Sites, Weights and Ages as Indicators of Carcass Merit.* J. Animal Sci. 15:1029.

Field, R. A., W. Y. Varney and James D. Kemp. 1961. *Processing Costs, Market Values and Consumer Acceptance of Light and Normal Weight Hogs.* J. Animal Sci. 20:742.

Hillier, J. C., J. A. Whatley, J. V. Whiteman and D. I. Gard. 1951. *The Effect of Energy Content of the Ration and Rate of Gain Certain Characteristics of Pork.* Okla. Agr. Exp. Sta. M. P. 22.

Hochstetler, L. N., J. A. Hoefer, A. M. Pearson and R. W. Luecke. 1959. *Effect of Varying Levels of Fiber of Different Sources Upon Growth and Carcass Characteristics of Swine.* J. Animal Sci. 18:1397.

Jordan, C. E., W. M. Beeson and J. R. Wiley. 1956. *Producing Leaner Market Hogs by Different Feed Combinations and Controlled Corn Intake.* J. Animal Sci. 15:869.

Krapf, D. H., R. W. Bray, P. H. Phillips and R. H. Grummer. 1959. *Effect of Protein Level and Quality in Swine Rations Upon Growth and Carcass Development.* J. Animal Sci. 18:755.

Merkel, R. A., R. W. Bray, R. H. Grummer, P. H. Phillips, and G. Bohstedt. 1953. *The Influence of Limited Feeding by Use of High Fiber Rations Upon Growth, Fattening and Carcass Characteristics of Swine.* J. Animal Sci. 12:903.

Merkel, R. A., R. W. Bray, R. H. Grummer, P. H. Phillips and G. Bohstedt. 1958. *The Influence of Limited Feeding Using Higher Fiber Rations Upon Growth and Carcass Characteristics of Swine.* J. Animal Sci. 17:3.

Noland, P. R. and K. W. Scott. 1960. *Effect of Varying Protein and Energy Intakes on Growth and Carcass Qualities of Swine.* J. Animal Sci. 19:67.

Thrasher, D. M., A. M. Mullins, R. F. Boulware and C. W. Newman. 1962. *Effects of Self-Feeding Rations of Varying Energy Content on Performance and Carcass Characteristics of Pigs.* A. S. Mimeo Cir. 62-9 A. S. Dept. L. S. U.

Wagner, G. R., A. J. Clark, V. W. Hays and V. C. Speer. 1963. *Effect of Protein-Energy Relationships on the Performance and Carcass Quality of Growing Swine.* J. Animal Sci. 22:202.

Wallace, H. D., G. E. McCabe, A. Z. Palmer, J. W. Carpenter, M. Kager and G. E. Combs. 1960. *Feed Lot Performance and Carcass Traits of Growing Finishing Swine as Influenced by Sex and Breed.* Fla. Ag. Expt. Sta. Mimeo. Series. No. 60-13.