iated with improved management will improve performance over time and can not be separated from the genetic differences between pigs of different tests. In addition, differences in performance of pigs of the different breeds do not necessarily reflect breed differences. The relatively small number of animals in some breeds, Polands and Berkshires, for example, leave room for a very large amount of sampling error in these breeds. Also, most pigs that enter the test station are carefully selected and differences in the ability of breeders to select pigs for testing is part of the bias that may exist in breed comparisons of these data. Breeders also learn from past experience and this may be reflected in the average improvement over time for the traits measured.

These data do document the average performance of pigs at the test station and do show a general improvement. Hopefully, most of the improvement is due to improved average genetic merit of the pigs entered into each test. This in turn should result in improved performance of the breeders herd and of herds which purchase breeding stock from breeders who are testing boars. In this way, the Oklahoma Swine Test Station appears to be making an important contribution to improving total efficiency of swine production in Oklahoma.

Performance of Pigs Fed Least Cost Computer Rations

W. G. Luce and C. V. Maxwell

Story in Brief

A trial was conducted to study the performance of pigs fed least cost computer rations as compared to a grain sorghum-soybean meal control ration. Treatments involved were (1) a basal grain sorghum-soybean meal ration (2) a least cost computer ration fed throughout the trial and (3) a least cost computer ration reformulated every 29 days using current prices of the feed ingredients available.

Pigs on treatment 1 (the grain sorghum-soybean meal control ration) tended to have higher daily gains, require less feed per pound of gain, and have a higher average daily feed intake. The generally decreased per-

formance of the pigs on the least cost computer rations (treatments 2 and 3) may have occurred because of ration ingredient combinations being used that was not totally acceptable to the pigs. Furthermore, the results indicate that either the assumed nutritional values of some of the feed ingredients used were overestimated or the requirements of the pigs were underestimated.

Although performance of pigs fed the least cost rations was not as high as expected, the pigs on treatment 3, fed a least cost computer ration reformulated every 29 days had a lower feed ingredient cost per pound of gain than the pigs on the other two treatments.

Introduction

The current high feed costs of livestock producers have resulted in an increased interest in the use of least cost computer rations in an effort to reduce feed costs. This method of ration formulation has gained wide acceptance by industry and university personnel working in the area of swine nutrition. It is often used as a tool to save time in formulating rations and to get ideas on saving costs. When the actual ration is to be used it is often altered by the nutritionist in an effort to make it more acceptable to the pig.

It was deemed feasible to conduct a study measuring performance of pigs fed least cost computer swine rations without making any alterations in the computer output. When alterations are made, the actual ingredient cost of the ration is often increased.

Experimental Procedure

Sixty Hampshire, Yorkshire, and Hampshire X Yorkshire pigs were used in this study conducted in the summer of 1973. The pigs averaging 53.6 pounds were randomly allotted within breed, sex and litter to three experimental treatments with 10 pens (two pigs per pen) in each treatment. All pigs were housed in indoor concrete pens equipped with self feeders and automatic waterers. Pigs completing the experiment were individually removed from test on a weekly basis when they reached 210 pounds.

The treatments were as follows:

Treatment 1. Pigs were fed a grain sorghum-soybean meal basal ration with a crude protein content of 16 percent the first 29 days (period 1) and 14 percent thereafter for the duration of the experiment (period 2 through 4). See Table 1.

Treatment 2. Pigs were fed a 16 percent crude protein least cost ration for 29 days (period 1) and a 14 percent thereafter for the duration

of the experiment (periods 2 through 4). The computer was allowed to use only the ingredients for the 14 percent ration that it had selected for the 16 percent crude protein ration.

Treatment 3. Pigs were fed a least cost computer ration with a crude protein content of 16 percent for the first 29 days. It was the same ration as fed to pigs on treatment 2. Thereafter, a 14 percent crude protein, least cost computer ration was formulated every 29 days (periods 2 through 4) using current prices of feedstuffs. See Table 1.

Nutritional specifications programmed into the computer for ration formulation are shown in Table 2. Vitamin and trace mineral supplementation, digestible energy, calcium, phosphorus, and crude protein content were held constant in all rations. Minimum levels of lysine, threonine, trytophane and methionine were above requirements suggested by the National Research Council, 1968. However, the exact level of these amino acids were not constant in all rations as shown in Table 1. Fiber content although not constant was similar in all rations as shown in Table 1.

Prices used for feedstuffs during all four periods of the experiment are shown in Table 3. The prices used were obtained from a local feed mill in Stillwater, Oklahoma on the day the ration was formulated. The prices were the cost of the ingredient delivered to Stillwater, Oklahoma in railroad car lots. The computer chose during one or more periods all the ingredients prices with the exception of dehydrated alfalfa meal and cane molasses.

The ingredient cost of the rations computed are shown in Table 4. The cost figures given are for ingredients only. No estimated costs were added for grinding, mixing, hauling, storage, etc. The experiment was conducted during a period of rising feed prices which accounts for the gradual increase in prices from periods 1 through 4.

Results and Discussion

Period 1

The results are shown in Table 5. Pigs on treatment 1 had a significantly higher ($P<.01$) average daily gain and significantly higher ($P<.05$) average daily feed intake than pigs on treatments 2 and 3. Little difference was noted among treatments for feed conversion. Feed ingredient cost per pound of gain did not differ greatly among treatments being 15.4, 15.6, and 15.1¢ for treatments 1 through 3 respectively.

It is apparent from the significantly lower feed intake for the pigs on treatments 2 and 3 that the ration fed to those pigs was less palatable than the ration fed to the pigs on treatment 1. However a perusal of the

Table 1. Composition of Experimental Rations

Ingredients	Treatment 1 (Per 1)	Treatment 2 & 3 (Per 1)	Treatment 1 (Per 2,3,4)	Treatment 2 (Per 2,3,4)	Treatment 3 (Per 2)	Treatment 3 (Per 3)	Treatment 3 (Per 4)
Yellow corn		62.97		63.48	65.66		67.81
Grain sorghum	75.80		81.50				
Barley		14.76		20.12			
Wheat						71.45	
Wheat mixed feed					15.97	12.33	17.83
Soybean meal (44%)	20.90	13.19	15.20	7.65			8.41
Peanut meal (50%)		5.81		5.42	3.59	2.01	2.83
Meat and bone scrap (50%)					4.57	3.20	
Dried whey product (17%)					9.08	9.65	
Calcium carbonate	0.80	0.85	0.80	0.83	0.41	0.64	1.10
Dicalcium phosphate	1.50	1.42	1.50	1.50			1.02
Salt	0.50	0.50	0 50	0.50	0.22	0.22	0.50
Vitamin-trace mineral mix[1]	0.50	0.50	1.50	0.50	0.50	0.50	0.50
Total, %	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Content							
Crude Fiber, %	3.51	3.94	3.26	3.91	3.54	3.14	4.09
D E., Mcal, lb.	1.49	1.49	1.49	1.49	1.49	1.49	1.49
Crude protein, %	16.00	16.00	14.00	14.00	14.00	14.00	14.00
Calcium, %	0.70	0.70	0.69	0.70	0.70	0.70	0.70
Phosphorus, %	0.60	0.60	0.59	0.60	0.62	0.60	0.60
Lysine, %	0.83	0.70	0.64	0.55	0.55	0.55	0.55
Threonine, %	0.59	0.62	0.48	0.54	0.55	0.48	0.55
Tryptophane, %	0.20	0.20	0.17	0.17	0.16	0.19	0.17
Methionine, %	0.25	0.25	0.23	0.22	0.26	0.26	0.24
Methionine & Cystine, %	0.53	0.52	0.18	0.46	0.49	0.59	0.46

[1] Supplied 3,000,000 IU vitamin A, 300,000 IU vitamin D, 4 gm riboflavin, 20 gm pantothenic acid, 30 gm niacin, 1,000 gm choline chloride, 15 mg vitamin B_{12}, 6,000 IU vitamin E, 20 gm menadione, 0.2 gm iodine, 90 gm iron, 20 gm manganese, 10 gm copper, 90 gm zinc, and 50 gm chlorotetracycline per ton of feed.

Table 2. Nutritional Specifications used in Least Cost Computer Rations

	16% rations		14% rations	
	minimum	maximum	minimum	maximum
Crude fiber, %	----	5.00	----	6.00
Digestible Energy, Mcal per lb.	1.49	1.49	1.49	1.49
Crude protein, %	16.00	16.00	14.00	14.00
Calcium, %	0.70	0.72	0.70	0.72
Phosphorus, %	0.60	0.62	0.60	0.62
Lysine, %	0.70	----	0.55	----
Threonine, %	0.45	----	0.40	----
Tryptophane, %	0.13	----	0.09	----
Methionine, %	0.25	----	0.20	----
Methionine & Cystine, %	0.50	----	0.40	----
Vitamin-trace mineral mix[1]	0.50	0.50	0.50	0.50

[1] Composition given in footnote[1] of Table 1.

Table 3. Prices of Feedstuffs Used in Computer Rations

Ingredients	Price per Cwt., $ Period 1	Price per Cwt., $ Period 2	Price per Cwt., $ Period 3	Price per Cwt., $ Period 4
Yellow corn	3.45	4.38	4.73	5.35
Grain sorghum	3.15	3.75	3.95	5.50
Barley	3.10	3.10	3.30	5.50
Wheat	4.15	5.00	5.00	8.83
Wheat mixed feed	4.15	3.50	3.85	6.25
Soybean meal (44%)	14.00	14.00	20.00	18.00
Peanut meal (50%)	12.25	20.00	20.00	20.00
Meat and bone scraps (50%)	15.75	20.00	23.00	23.00
Dried whey product (17%)	6.50	6.60	6.60	*[1]
Dehydrated alfalfa meal (17%)	3.50	3.50	3.75	5.00
Cane molasses (wet)	3.43	3.50	3.50	3.75
Calcium carbonate	0.80	0.80	0.80	0.80
Dicalcium phosphate	4.50	4.50	4.50	4.50
Salt	1.25	1.25	1.25	1.25
Vitamin-trace mineral mix	16.00	16.00	16.00	16.00

[1] Dried whey product was not available during Period 4.

Table 4. Ingredient Cost of Experimental Rations

Period	Treatments		
	1	2	3
1	$5.47/cwt.	$5.35/cwt.	$5.35/cwt.
2	6.56	6.33	5.74
3	6.42	6.44	5.90
4	7.38	7.12	6.96

rations would not suggest this. The energy and protein ingredients fed to the pigs on treatments 2 and 3 during Period 1 was yellow corn, barley, soybean meal and peanut meal compared to grain sorghum and soybean meal fed to pigs on treatment 1. See Table 1. One would not normally suspect a large difference in feed intake between the two rations. There was a considerable difference in lysine content of the rations fed to pigs on treatment 1 versus the rations fed to pigs on treatments 2 and 3 (0.83 vs. 0.70 percent). However, the calculated lysine content (0.70 percent) of the rations fed to pigs on treatments 2 and 3 does meet the requirements set forth by the National Research Council, 1968.

Period 2

The results are shown in Table 6. Pigs tended to gain faster on treatment 1 but no significant differences were noted among treatments. No significant differences were likewise noted in feed conversion but the pigs

Table 5. Performance of Pigs on Least Cost Computer Rations — Period 1.

	Treatments		
	1	2	3
Av. initial, wt., lb.	53.2	53.6	54.1
Av. final wt., lb.	92.5	85.8	87.7
No. of days on test	29	29	29
Av. daily gain, l.*	1.36[1]	1.11[2]	1.16[2]
Feed per lb. gain, lb.	2.82	2.92	2.83
Av. daily feed intake, lb.**	3.82[1]	3.22[2]	3.28[2]
Feed ingredient cost per lb. gain, ¢	15.4	15.6	15.1

* Means with different superscripts are significantly different ($P<.01$)
** Means with different superscripts are significantly different ($P<.05$)

Table 6. Performance of Pigs on Least Cost Computer Rations — Period 2.

	Treatments		
	1	2	3
Av. initial wt., lb.	92.5	85.8	87.7
Av. final wt., lb.	133.4	124.2	123.0
No. of days on test	29	29	29
Av. daily gain, lb.	1.41	1.32	1.22
Feed per lb. gain, lb.	3.58	3.50	3.23
Av. daily feed intake, lb.*	4.99[1]	4.53[1,2]	3.93[2]
Feed ingredient cost per lb. gain, ¢	23.5	22.2	18.5

* Means with different superscripts are significantly different ($P<.05$)

on treatment 3 tended to require less feed per pound of gain. The pigs on treatment 1 had the highest average daily feed intake (4.99 pounds) and was significantly higher ($P<.05$) than the 3.93 pounds for the pigs on treatment 3. Feed cost per pound of gain was 23.5, 22.2, and 18.5¢ for the pigs on treatments 1 through 3 respectively.

Although feed ingredients cost per pound of gain was appreciably lower for the least cost rations (treatments 2 and 3), the decreased feed intake of the pigs on these rations still indicate a palatability problem. The combination of yellow corn, wheat mixed feed, peanut meal, meat and bone scraps and dried whey product as shown in Table 1 was apparently not an acceptable diet for the pigs on treatment 3. The complete absence of soybean meal may have been a factor too. Again the lower lysine content of the ration fed to the pigs on treatments 2 and 3 (0.55 percent) as compared to the lysine content of 0.64 percent of the ration fed pigs on treatment 1 may be a factor also.

Period 3

The results are shown in Table 7. Pigs on treatment 1 had a significantly higher ($P<.01$) average daily gain of 1.72 pounds as compared to 1.42 and 1.44 pounds for pigs on treatments 2 and 3 respectively. No significant differences were noted in feed required per pound of gain or average daily feed intake. However, the pigs on treatment 1 tended to require less feed per pound of gain and to have a higher daily feed intake than the pigs on the other two treatments. Feed ingredient cost per pound of gain was 19.1, 20.7, and 18.4¢ for treatments 1 through 3 respectively.

The lowered feed intake of the pigs on treatments 2 and 3 may largely explain the significantly lower daily gains. The grains selected by the computer for the pigs on treatment 3 during period 3 was wheat. However, previous research conducted at this station has not shown the feed-

Table 7. Performance of Pigs on Least Cost Computer Rations — Period 3.

	Treatments		
	1	2	3
Av. initial wt., lb.	133.4	124.2	123.0
Av. final wt., lb.	183.2	165.4	164.8
No. of days on test	29	29	20
Av. daily gain, lb.[1]	1.72[1]	1.42[2]	1.44[2]
Feed per lb., gain, lb.	2.98	3.22	3.12
Av. daily feed intake, lb.	5.20	4.60	4.50
Feed ingredient cost per lb. gain, ¢	19.1	20.7	18.4

[1] Means with different superscripts are significantly different ($P\leq.01$).

ing of wheat to cause a major reduction in feed intake. However, the complete absence of soybean meal from the ration may have been a factor in the reduced feed consumption.

The reason for the decreased feed intake of the pigs on treatment 2 is not as apparent as the grain portion of the ration was 63.48 percent yellow corn and 20.12 percent barley. Likewise, the protein ingredients used was 7.65 percent soybean meal and 5.24 percent peanut meal.

Period 4

The results are shown in Table 8. Pigs were removed individually from test during this period when they reached 210 pounds. Therefore, the average number of days on test is less than the 29 days shown for the other three periods.

No significant differences were noted among treatments for daily gain, feed conversion or daily feed intake. However, the pigs on treatment 1 tended to require less feed per pound of gain. Feed ingredient cost per pound of gain was 24.6, 26.6, and 25.4¢ for treatments 1 through 3 respectively.

Total Period

Performance data as shown in Table 9 was computed for the total feeding period. Average daily gains were 1.58, 1.39, and 1.43 pounds for treatments 1 through 3 respectively. The gains for the pigs on treatment 1 were significantly higher ($P<.05$) than those on treatment 2. No significant differences were noted in feed required per pound of gain or average daily feed intake but the pigs on treatment 1 tended to require less feed per pound of gain and have a higher average daily feed intake.

The lower daily gains of the pigs on treatments 2 and 3 fed the least cost computer rations as compared to those fed on treatment 1 is largely explained by the decreased feed intake. Apparently the combination of

Table 8. Performance of Pigs on Least Cost Computer Rations — Period 4.

	Treatments		
	1	2	3
Av. initial wt., lb.	178.0	162.2	163.6
Av. final wt., lb.	212.2	200.0	209.5
Av. no. of days on test	17.7	20.3	24.2
Av. daily gain, lb.	1.93	1.87	1.94
Feed per lb. gain, lb.	3.34	3.73	3.65
Av. daily feed intake, lb.	6.39	6.96	7.02
Feed ingredient cost per lb. gain, ¢	24.6	26.6	25.4

Table 9. Performance on Pigs of Least Cost Computer Rations — Total Period.

	Treatments		
	1	2	3
Pens per treatment, no.	10	10	10
Pigs per pen, no.	2	2	2
Av. initial wt., lb.	53.2	53.6	54.1
Av. final wt., lb.	213.4	202.0	210.2
Av. no. of days on test	102.8	107.2	109.9
Av. daily gain, lb.	1.58[1]	1.39[2]	1.43[1,2]
Feed per lb. gain, lb.	3.15	3.34	3.20
Av. daily feed intake, lb.	4.95	4.63	4.47
Feed ingredient cost per lb. gain, ¢	20.4	21.5	19.8

[1] Means with different superscripts are significantly different ($P<.01$)

ingredients selected by the computer was not totally acceptable to the pigs. The decreased lysine content of the rations fed the pigs on treatment 2 and 3 may have been a factor also. However, the calculated lysine content of these rations met the requirements set forth by the National Research Council, 1968.

It would appear that by holding digestible energy, calcium, phosphorus, and crude protein constant in all rations and meeting all other known requirements of swine, one should be able to formulate on the basis of least cost using various ingredients. It is obvious from this data that our knowledge of feed ingredients for some feedstuffs available may be limited.

The average feed ingredient cost per pound of gain for the total period was 20.4, 21.5, and 19.8¢ for treatments 1 through 3 respectively. The lower feed cost per pound of gain for the pigs on treatment 3 (least cost rations reformulated every 29 days) would result in a savings of approximately 95¢ per pig as compared to the pigs fed the control ration on treatment 1. However, part of this savings is lost since the pigs gained slower and took approximately seven more days to reach market weight; therefore increasing fixed costs. The higher feed ingredient cost per pound of gain for the pigs on treatment 2 (a least cost ration fed throughout the trial) actually resulted in an increased cost of approximately $1.40 per pig as compared to the pigs fed the control ration on treatment 1. This demonstrates that although the ingredient cost of a ration may be the cheapest, it may yet result in an increase in cost of gains if the ration itself is not acceptable to the pig.