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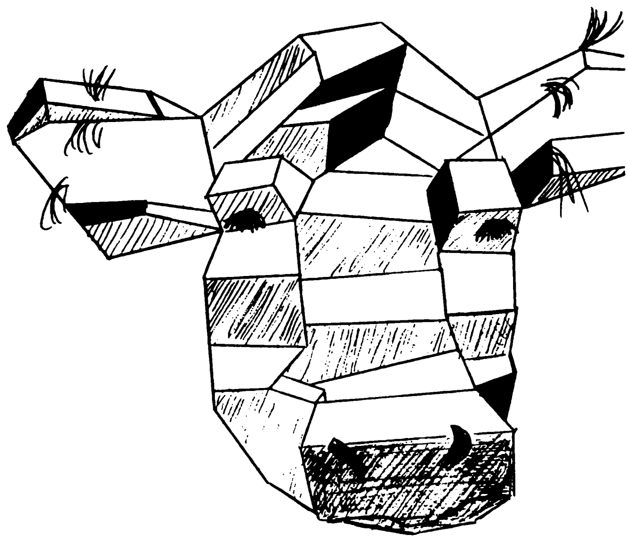

LIVESTOCK RESEARCH REPORT

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LIVESTOCK RESEARCH

REPORT

BY

RESEARCH STAFF

ANIMAL SCIENCE DEPARTMENT

VIRGINIA POLYTECHNIC INSTITUTE

& STATE UNIVERSITY

EDITED BY J. A. GAINES

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MONTHLY WEIGHTS OF BEEF CALVES TO WEANING

K. P. Bovard

What can monthly calf weights tell us about a calf's growth to weaning? Is it strictly linear, or can some curve be used to better describe the process? These are the kinds of questions that prompted this study.

Methods

Data in this report are from calves in the Front Royal breeding experiment. From 1962 through 1967, calves were weighed monthly, usually beginning in May, until weaning. A total of 10,762 weights from 1,646 calves was studied.

Among inbreds average inbreeding of the calves was 24% and of their dams was 12%. In selection calves and their dams, it was 3% and 2%, respectively. Inbreeding levels were higher than this in Shorthorns and Angus, lower in Herefords.

Data were adjusted for differences due to years, age of dam, inbreeding and day of birth. Only linear estimates of average daily gain, ADG, are presented below.

Results and Discussion

In Table 1 are shown the numbers of calves, average birth dates and adjusted 205-day weights for each sex-mating system.

More selection calves, 928, were available for the study than inbreds, 718. Originally, the breeding experiment called for equal numbers in each breeding system: Four inbred lines of 16 females each; and, two selection lines of 32 females, each. Addition of the 32-cow index selection line in Herefords shifted the balance in numbers. Also, small differences in fertility and survival favored selection calves over inbreds.

From average birth dates, Table 1, inbred calves were born 4.5 days later than selection calves. This reflects the inbred cows' later recovery from calving and return to normal cycling.

Bull calves were born 2.7 days later than heifers. This clearly suggests that a longer gestation period is required for bull calves than for heifers.

The adjusted 205-day weights shown bulls 31 lb. heavier than heifers, selection calves 20 lb. heavier than inbreds. Bull and heifer calves in selection lines differed more, 41 lb. than in inbred lines, 19 lb. From a different viewpoint, the difference between the inbred and selection calves was much larger in bulls, 31 lb., than in heifers, 9 lb. Inbreeding is known to depress vigor, vitality and performance, in other species. The physiological stress that inbreeding produces clearly tends to suppress the sex difference in growth rate to weaning.

In Table 2 are presented linear estimates of ADG by sex, line within breed, and mating system. They present in more detail the differences in adjusted 205-day weight described in Table 1. Growth selection calves' gains are clearly better than type calves'; bulls better than heifers'. These results are in good agreement with previous studies of other data at Front Royal and elsewhere.

In this study, the calves' growth was almost entirely linear. A calf's weights taken prior to weaning tend to lie on a straight line.

How was this determined? First, a value called pre-test ADG was calculated as is done for BCIA. It was: (Weaning weight minus birth weight) ÷ days of age. Next, the best-fitting straight line of weight with age was calculated for each calf, using all of its weights through weaning. Last, the best-fitting quadratic curve, one having a single turn, was calculated for each calf, again using all of its weights through weaning.

In Figure 1 are shown the three kinds of curves that resulted. Curve A is a straight line, technically not a curve. Curve B is a decreasing quadratic. With this function, a large linear growth impulse is combined with a very small negative impulse that becomes progressively larger each day. As this second (quadratic) effect becomes larger with age, it causes the straight line to curve downward, as shown in curve B. And, curve C is an increasing quadratic, with a result opposite to that of curve B.

By far, the simplest estimate of a calf's ADG was the pre-test value described first. Its correlation with the best-fitting straight line was 0.988 in a preliminary study of 167 weights from 28 inbred Hereford bulls in 1967. Thus, either calculation--pre-test ADG or the best-fitting straight line--told the same story. But the former was much simpler.

What about curvilinearity? Did quadratic curves describe the growth process better? Here, the answer is both yes and no, depending on what we mean by "better." The quadratic curves did describe the growth processes more completely, and in more detail. They were "better" in the sense that more of the total variation could be explained and removed. But, because the values of the quadratic effects were very small, their description and discussion may cloud the issue more than clarify it.

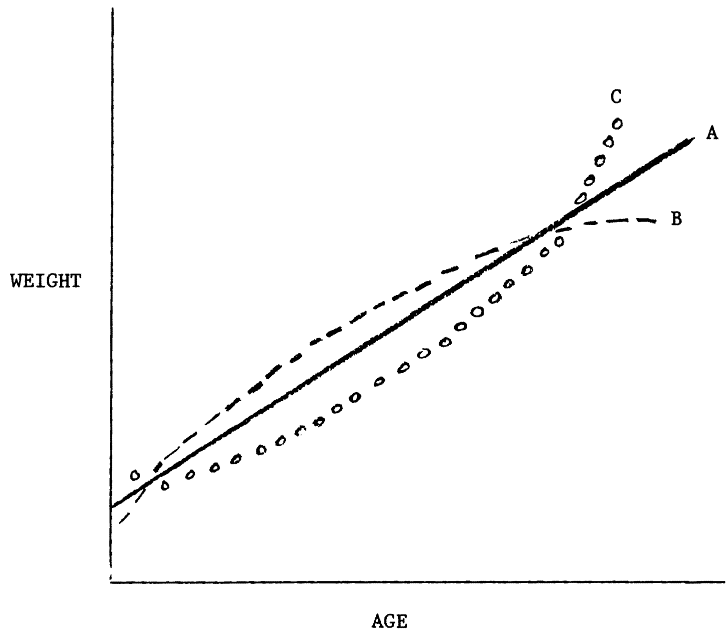

Figure 1. Growth to weaning. Curve A, linear; Curve B, decreasing; and Curve C, increasing.

Detailed analyses, one for each sex-breed-mating system, were made to examine the curvilinearity of growth. In 9 of th 12 analyses, the curvilinear effect was large enough to suggest that it was real, not likely to be an accident of sampling. Among bulls, all results were like curve C, the increasing kind. Among heifers, where the absolute effect was less than half as large as in bulls, two curves were decreasing, like curve B, and four were increasing. But, in all cases with both sexes, the relative importance of the curvilinear growth was indeed small compared to the finding that a calf's growth prior to weaning is a nearly linear process. Weights taken 1-3 months before weaning can be useful in making early selections.

TABLE I. NUMBERS OF CALVES, AVERAGE BIRTH DATES AND ADJUSTED 205-DAY WEIGHTS BY SEX AND MATING SYSTEM FROM MONTHLY WEIGHTS TO WEANING, 1962-67, INCLUSIVE. BEEF CATTLE RESEARCH STATION, FRONT ROYAL, VIRGINIA

Trait	Sex	Mating System: Inbred	Mating System: Selection	Total or Average
No. calves	Female	326	462	788
	Male	392	466	858
	Total	718	928	1646
Birth date[1]	Female	82.0	76.2	79.1
	Male	83.4	80.2	81.8
	Average	82.7	78.2	80.4
205-day wt., lb.	Female	382	391	386
	Male	401	432	417
	Average	392	412	402

[1] Julian date, such that 21 March = day 80; 22 March = day 81; etc.

TABLE 2. ESTIMATES OF LINEAR ADG, LB./DAY, BY SEX, BREED AND LINE WITHIN MATING SYSTEM FROM MONTHLY WEIGHTS PRIOR TO WEANING, 1962-67. BEEF CATTLE RESEARCH STATION, FRONT ROYAL, VIRGINIA.

Mating System	Line[1]	Females			Males		
		A	H	S	A	H	S
Inbred	1	1.72	1.51	1.46	1.63	1.33	1.51
	2	1.56	1.69	1.35	1.64	1.57	1.45
	3	1.73	1.65	1.53	1.70	1.62	1.53
	4	1.62	1.65	1.38	1.55	1.58	1.49
Average		1.66	1.63	1.43	1.63	1.53	1.49
Selection	6-Index	--	1.57	--	--	1.73	--
	7-Type	1.61	1.58	1.55	1.68	1.71	1.62
	8-Growth	1.68	1.76	1.59	1.80	1.82	1.72
Average		1.64	1.63	1.57	1.74	1.75	1.67

[1] Line identification for inbreds:
Angus: Eileenmere, Rock Delus, Blackcap Stamp of Elkton, & Blackwood Bandy, resp.
Hereford: Perfect, Rollo, McHenry, & Silver, resp.
Shorthorn: Statesman, Lord Rothes, Britomac Prince Command, Prince Eric, resp.

POLLUTANT MOVEMENT TO GROUND WATER FROM SWINE WASTE LAGOONS

T. G. Ciravolo[1], D. L. Hallock[2], H. R. Thomas[2], E. R. Collins, Jr.[3], D. C. Martens[1] and E. T. Kornegay

As confinement production increases in Virginia, there is a concurrent concentration of swine with waste disposal becoming an increasingly pressing problem. A relatively inexpensive waste disposal method is to flush the swine waste into an anaerobic lagoon. The lagoon is often constructed by simply excavating soil from the desired location, similar to the construction of farm ponds. Based on the limited experimental data reported in the literature, seepage from waste lagoons might occur. A health hazard could ensue if the seepage was excessive and the ground water was contaminated. Due to a scarcity of experimental data on relationships between ground water contamination and lagoon disposal of swine wastes, this study was initiated to monitor the effect of seepage from anaerobic swine lagoons on ground water quality.

Experimental Procedures

The lagoons under study were located in the Coastal Plain Region of Virginia at the Tidewater Research and Continuing Education Center and at the Virginia Swine Evaluation Station. Both lagoons are located in high water table soils. The wells consisting of 2 in PVC pipe were water jetted to depths of 10, 15, and 20 ft at distances of 10, 50 and 100 ft from the two anaerobic swine lagoons. Pea gravel was placed in each of the wells to reduce the amount of sediment taken up during sampling. Each well was covered with a metal pipe cap having a galvanized slip fit pipe connector bronzed into the center to afford permanent attachment of the water sampling tube which was a 1/2 in PVC pipe cut so as to be about 4 in from the bottom of the well. A two-foot section of 1/2 in PVC pipe was connected to the top of the cap for sampling.

The water sampling devices consisted of five-foot sections of PVC pipe bent to form two loops with a total capacity of 200 ml. A "Sta-rite" self priming shallow well jet pump, 1/3 hp, was used to obtain ground water samples. Wells were purged 24 hours prior to obtaining samples. The samples were collected and frozen in 250 ml plastic bottles that had been previously acid washed.

Recognized ground water pollution indicators are NO_3^-, NH_4^+, soluble phosphates, Cl^- and permanganate number. The latter is similar in principle to the chemical oxygen demand. The U.S. Public Health Department's established limits for Cl^-, NO_3^-, Cu^{++} and Zn^{++} in water for human consumption are (ppm) 250, 45 (10 for N), 1 and 5 respectively. Water quality criteria for other farmstead uses are less

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stringent with the exception of the recommended limit of 20 ppm K and 0.1 ppm Cu for dairy use. In addition to the above, Ca, Mg, Mn and Na were determined in ground water samples.

The frozen samples were allowed to reach ambient temperature and filtered through 0.45 micron filter paper in preparation for chemical determinations. The ground water samples were analyzed for Cl^-, using a Cl titrimeter; NO_3^-, by the phenoldisulfonic acid method; soluble phosphate, according to the Chang and Jackson colorimeteric procedure; chemical oxygen demand, by the EPA low level test; NH_4^+, using an NH_3 electrode and Ca, Mg, K, Na, Cu, Zn and Mn by atomic absorption spectrophotometry. These procedures are outlined in published literature.

Results

Established limits set for Cl^-, NO_3^-, Cu^{++} and Zn^{++} by the United States Public Health Service in drinking water were not exceeded at either site (tables 1 through 4). Ground water samples at the Virginia Swine Evaluation Station at the 10 ft distance and 10 ft depth consistently exceeded the 20 ppm K level set as a water quality criteria for dairy use. Ground water samples from the other wells however did not exceed the 20 ppm K limit. At no sampling date did ground water from the wells at Tidewater Research and Continuing Education Center exceed the recommended limit of 20 ppm K. The 0.1 ppm Cu recommended limit was exceeded at the 20 ft depth that was 50 ft from the lagoon at the Swine Evaluation Station in August and at the 10 ft depth located 50 ft from the lagoon in November. Ground water samples exceeded 0.1 ppm Cu at the Tidewater Research and Continuing Education Center once at the 15 ft depth at a distance of 50 ft from the lagoon in November. Although ground water samples from the various wells did not exceed drinking water standards, contamination was illustrated by the variability in Cl^- concentration, notably in the wells at a distance of 10 ft from the two lagoons. The study is continuing with chemical oxygen demand and fecal foliform bacteria being determined.

Summary

Ground water was monitored at depths of 10, 15 and 20 ft and distances of 10, 50 and 100 ft from two anaerobic swine waste lagoons in the Coastal Plain Region of Virginia. Both lagoons are located in high water table soils. Constituents being determined in ground water samples are coliform bacteria, chemical-oxygen-demand and concentrations of Cl^-, NO_3^-, NH_4^+, soluble phosphate, Mg^{++}, K^+, Na^+, Cu^{++}, Zn^{++} and Mn^{++}. Preliminary summary of the analyses show that U.S. Public Health Department drinking water standards were not exceeded for Cl^-, Cu^{++}, NO_3^- and Zn^{++}. Fluctuations in concentrations of the chemical constituents indicated that ground water contamination occurred only at 10 ft distances.

TABLE 1. CONCENTRATION OF Cl, NO_3-N, K AND Cu AT VARIOUS DEPTHS AND DISTANCES FROM THE SWINE LAGOON LOCATED AT THE SWINE EVALUATION CENTER (HOLLAND, VA.).

Date	Distance from lagoon, ft.	Cl, ppm			NO_3-N, ppm			K, ppm			Cu, ppm		
		Well depth, ft. 10	15	20	10	15	20	10	15	20	10	15	20
Aug 10	10	74.8	12.1	6.2	0.7	0.3	0.2	26.0	--	17.9	0.02	<0.01	<0.01
	50	8.9	5.8	12.2	0.2	0.1	0.4	1.8	2.3	4.4	0.01	0.10	0.13
	100	7.6	8.4	8.3	--*	--	--	--	3.2	3.2	--	0.20	0.04
Nov 17	10	123.4	19.3	9.7	0.2	0.2	0.4	64.5	--	7.1	0.22	--	0.02
	50	13.7	8.5	12.8	0.1	<0.1	0.1	1.4	1.6	5.6	0.01	<0.01	0.02
	100	5.4	10.0	8.4	0.1	0.2	<0.1	1.0	2.5	3.0	0.06	<0.08	0.01
Dec 11	10	20.9	29.5	12.3	2.5	<0.1	<0.1	6.5	5.0	5.0	<0.01	0.01	<0.01
	50	6.5	8.5	6.4	<0.1	<0.1	<0.1	1.2	2.6	1.7	<0.01	0.01	<0.01
	100	5.5	7.5	7.5	<0.1	<0.1	<0.1	1.2	2.0	1.2	0.01	0.01	0.01
Dec 12	10	71.0	27.0	7.5	0.3	<0.1	<0.1	38.4	2.6	1.2	0.01	0.02	0.01
	50	8.0	8.0	7.0	<0.1	<0.1	<0.1	1.0	1.4	1.1	<0.01	0.03	0.01
	100	12.8	7.3	8.0	<0.1	<0.1	<0.1	1.4	1.6	1.4	<0.01	0.03	0.01
Dec 13	10	50.0	26.5	7.8	0.4	<0.1	<0.1	45.4	2.6	1.4	<0.01	0.01	0.01
	50	6.6	8.5	7.3	<0.1	<0.1	<0.1	1.0	1.7	1.1	0.01	0.01	0.01
	100	5.5	7.5	7.5	<0.1	<0.1	<0.1	0.9	1.8	1.0	0.02	0.02	0.02
Dec 14	10	62.0	29.7	4.4	<0.1	<0.1	<0.1	81.9	2.6	1.3	0.07	0.02	<0.01
	50	8.7	7.8	7.5	<0.1	<0.1	<0.1	1.1	1.5	1.1	0.01	<0.01	<0.01
	100	6.0	9.6	14.8	<0.1	<0.1	<0.1	1.2	1.7	--	<0.01	0.02	0.02
Jan 23	10	108.0	27.2	9.2	4.4	2.8	<0.1	32.0	2.2	1.3	<0.01	0.01	0.02
	50	20.5	18.0	17.0	<0.1	<0.1	0.3	1.0	1.7	1.4	0.01	0.01	0.05
	100	13.0	32.0	38.7	<0.1	<0.1	<0.1	1.2	1.8	1.2	0.06	0.03	<0.01
Mr 21	10	86.3	28.8	7.0	0.4	<0.1	<0.1	47.0	1.0	1.4	<0.01	<0.01	<0.01
	50	12.0	10.1	7.5	<0.1	<0.1	<0.1	1.2	1.4	0.9	<0.01	<0.01	<0.01
	100	52.0	12.6	11.2	<0.1	<0.1	<0.1	1.2	1.5	1.1	<0.01	<0.01	<0.01

*Inadequate sample for analysis.

TABLE 2. CONCENTRATION OF Cl, NO_3-N, K AND Cu AT VARIOUS DEPTHS AND DISTANCES FROM THE ANAEROBIC SWINE LAGOON LOCATED AT THE TIDEWATER RESEARCH AND CONTINUING EDUCATION CENTER (HOLLAND, VA.).

Date	Distance from lagoon, ft.	Well depth, ft.											
		10	15	20	10	15	20	10	15	20	10	15	20
		Cl, ppm			NO_3-N, ppm			K, ppm			Cu, ppm		
Aug 10	10	6.6	10.1	7.9	<0.1	0.1	2.6	6.82	4.95	7.81	<0.01	<0.01	0.04
	50	5.4	8.7	--*	4.0	--	0.1	4.51	5.17	4.29	<0.01	<0.01	<0.01
	100	24.7	28.2	9.3	5.5	1.0	6.1	5.17	11.99	4.18	<0.01	<0.01	<0.01
Nov 17	10	8.7	11.4	6.6	1.2	0.2	0.2	5.16	4.72	1.64	<0.01	<0.01	0.02
	50	7.0	7.4	10.3	8.6	0.1	0.4	6.20	2.60	7.40	--	0.28	<0.01
	100	21.2	25.0	6.7	4.4	2.1	0.1	6.24	4.68	1.52	--	0.03	<0.01
Dec 12	10	4.8	8.0	6.3	5.2	0.1	0.7	5.24	1.36	2.32	0.02	0.01	0.02
	50	6.3	7.2	6.0	0.3	0.1	0.1	5.72	1.80	4.36	<0.01	<0.01	0.02
	100	25.5	15.3	5.0	0.2	6.6	0.1	4.88	3.80	1.72	<0.01	<0.01	0.02
Jan 23	10	6.5	130.0	22.8	4.8	0.2	<0.1	5.12	1.87	1.54	0.06	<0.01	<0.01
	50	12.6	106.0	--	4.4	<0.1	--	5.80	1.56	--	0.02	0.04	--
	100	32.4	37.0	12.5	4.4	2.8	<0.1	3.68	2.32	1.60	<0.01	0.03	0.03
Mr 21	10	8.0	15.0	7.4	3.0	<0.1	<0.1	6.40	1.60	1.30	0.02	<0.01	<0.01
	50	8.0	41.8	15.9	4.5	3.8	<0.1	5.10	1.50	1.56	<0.01	<0.01	<0.01
	100	69.0	30.2	11.8	3.0	3.6	<0.1	3.50	3.05	1.44	<0.01	0.02	<0.01

*Inadequate sample for analysis.

TABLE 3. RANGE AND MEAN VALUES FOR THE CONCENTRATIONS OF NO_3-N, NH_4-N, PO_4-P, Ca, Mg, K AND Zn IN GROUND WATER AT VARIOUS DEPTHS AND DISTANCES FROM THE SWINE LAGOON LOCATED AT THE VIRGINIA SWINE EVALUATION STATION (HOLLAND, VA.).

Element	Distance from lagoon, ft	Well depth, ft: 10 Range	10 Mean	15 Range	15 Mean	20 Range	20 Mean
NO_3-N (PPM)	10	<0.01 to 4.40	1.13	<0.10 to 2.80	0.41	<0.10 to 0.40	<0.10
	50	<0.01 to 0.20	<0.10	<0.10 to <0.10	0.10	<0.10 to 0.40	<0.10
	100	<0.01 to 0.10	<0.10	<0.10 to 0.20	0.10	<0.10 to <0.10	<0.10
NH_4-N (PPM)	10	2.50 to 78.00	36.40	0.10 to 2.30	0.50	<0.10 to 1.20	0.50
	50	<0.10 to 0.90	0.20	<0.10 to 1.10	0.20	<0.10 to 0.90	0.30
	100	<0.10 to 0.30	0.20	<0.10 to 0.90	0.30	<0.10 to 0.10	0.30
Cl (PPM)	10	20.90 to 123.40	74.60	12.10 to 29.70	25.00	4.40 to 12.30	8.00
	50	6.40 to 20.50	10.60	5.80 to 18.00	9.40	6.50 to 17.00	9.70
	100	5.40 to 52.00	13.50	7.30 to 3.20	12.50	7.50 to 38.70	13.10
PO_4-P (PPM)	10	<0.06 to 12.50	8.00	<0.06 to 3.60	0.60	<0.06 to 1.20	0.38
	50	<0.06 to 1.00	0.14	<0.06 to 1.00	0.08	<0.06 to 0.20	<0.06
	100	<0.06 to 0.30	0.06	<0.06 to 0.15	<0.06	<0.06 to 2.40	0.35
Ca (PPM)	10	1.30 to 7.90	5.30	1.30 to 2.50	2.12	<0.10 to 2.10	0.73
	50	<0.10 to 0.90	0.37	<0.10 to 0.90	0.49	0.30 to 1.30	1.04
	100	0.20 to 0.90	0.43	0.20 to 1.70	1.08	2.00 to 6.00	2.56
Mg (PPM)	10	4.70 to 11.50	7.90	0.20 to 1.90	1.20	0.10 to 1.10	0.60
	50	0.10 to 0.50	0.20	0.10 to 0.90	0.40	<0.10 to 0.70	0.50
	100	0.20 to 0.50	0.30	<0.10 to 1.50	0.90	0.50 to 2.10	0.40
K (PPM)	10	6.50 to 81.90	42.70	1.90 to 5.00	2.82	1.20 to 17.90	4.58
	50	1.00 to 1.80	1.20	1.40 to 2.60	1.77	0.90 to 5.60	2.15
	100	0.90 to 1.20	1.17	1.50 to 3.19	2.12	1.10 to 3.19	1.72
Zn (PPM)	10	0.04 to 0.71	0.28	0.49 to 1.19	0.66	0.07 to 0.64	0.32
	50	<0.01 to 0.60	0.28	0.15 to 0.72	0.27	0.10 to 0.84	0.48
	100	0.04 to 0.87	0.20	0.04 to >2.80	0.94	0.06 to 0.69	0.39

TABLE 4. RANGE AND MEAN VALUES FOR THE CONCENTRATIONS OF NO_3-N, NH_4-N, PO_4-P, Cu, Mg, K AND Zn IN GROUND WATER AT VARIOUS DEPTHS AND DISTANCES FROM THE SWINE LAGOON LOCATED AT THE TIDEWATER RESEARCH AND CONTINUING CENTER (HOLLAND, VA.).

Element	Distance from lagoon, ft	Well depth, ft: 10 Range	10 Mean	15 Range	15 Mean	20 Range	20 Mean
NO_3-N (PPM)	10	<0.10 to 5.20	2.90	<0.10 to 0.20	0.10	<0.10 to 2.60	0.70
	50	0.30 to 8.60	4.40	<0.10 to 3.80	1.00	<0.10 to 0.40	0.20
	100	0.20 to 5.50	3.50	1.00 to 6.60	3.20	<0.10 to 6.10	1.30
NH_4-N (PPM)	10	<0.10 to 1.20	0.40	<0.10 to 1.40	0.30	<0.10 to 0.50	0.20
	50	<0.10 to 1.80	0.40	<0.10 to 0.40	0.10	<0.10 to 2.40	0.70
	100	<0.10 to 0.90	0.20	<0.10 to 0.20	0.30	<0.10 to 0.60	0.20
Cl (PPM)	10	4.80 to 8.70	6.90	8.00 to 130.00	34.90	6.30 to 22.80	11.80
	50	5.40 to 12.60	7.80	7.20 to 106.00	34.20	6.00 to 15.90	10.80
	100	21.20 to 69.00	34.60	15.30 to 37.00	27.10	5.00 to 12.50	9.10
PO_4-P (PPM)	10	<0.06 to <0.06	<0.06	<0.06 to 0.07	<0.06	<0.06 to 0.08	<0.06
	50	<0.06 to 0.20	<0.06	<0.06 to 0.38	0.08	<0.06 to 0.22	0.07
	100	<0.06 to <0.06	<0.06	<0.06 to 0.30	0.08	<0.06 to 0.10	<0.06
Ca (PPM)	10	0.80 to 5.00	3.43	3.27 to 8.05	5.52	1.70 to 3.80	3.05
	50	1.90 to 3.11	2.50	5.40 to 9.15	7.68	0.04 to 3.89	2.39
	100	6.58 to 16.75	9.73	7.22 to 17.70	11.50	8.70 to 14.50	10.69
Mg (PPM)	10	0.38 to 2.49	1.79	0.82 to 1.65	1.26	0.53 to 1.00	0.71
	50	0.85 to 1.31	1.10	0.61 to 1.24	0.88	0.27 to 1.25	0.83
	100	1.05 to 6.60	3.66	2.16 to 6.60	4.23	0.99 to 1.20	1.07
K (PPM)	10	5.12 to 6.82	5.74	1.36 to 4.95	2.90	1.30 to 7.81	2.92
	50	4.51 to 6.20	5.47	1.50 to 5.17	2.53	1.56 to 7.40	4.40
	100	3.50 to 6.24	4.69	2.32 to 11.99	5.17	1.44 to 4.18	2.09
Zn (PPM)	10	0.10 to 3.88	2.38	0.53 to 1.60	0.90	0.16 to 1.94	0.97
	50	0.37 to 2.11	0.96	<0.10 to 1.35	0.65	0.10 to 1.43	0.49
	100	0.30 to 0.66	0.50	0.20 to 2.00	0.81	0.26 to 0.70	0.52

CORRELATION BETWEEN LIVE AND CARCASS MEASUREMENTS OF FAT THICKNESS IN 4-H CLUB STEERS

Thomas J. Marlowe and Thomas R. Lambuth

The composition of cattle has been of interest to the packing industry, the retailer and the housewife for a long time. More recently scientists and even cattle breeders have become interested in methods of determining the composition, particularly the degree in fatness, of live animals.

A reliable and simple probe method of determining backfat thickness in swine was developed during the fifties. The probe method was tried on cattle but did not prove satisfactory. More recently the knowledge of ultrasonics has been put to use to measure the backfat thickness of live animals. Ultrasonic machines are now being used to determine the backfat thickness of performance tested bulls and made a part of the records available to prospective buyers.

The purpose of this study was to determine the correlation between the backfat measurements of live fat steers by use of an ultrasonic device and the measurement taken on the carcasses of the same steers.

Experimental Procedure

Two trials were conducted using the steers shown in the Bristol 4-H Club shows in 1972 and 1973. There were 129 steers in the 1972 trial and 95 steers in the 1973 trial. The steers ranged in both live slaughter grade and carcass grade from standard plus to prime. They ranged in live weight from 745 to 1325 pounds with an average of 928 pounds in 1972 and 939 pounds in 1973. The percent carcass yield ranged from 54.18 to 63.06% with an average of 58.53% in 1972 and 56.62% in 1973.

All steers were scanned with a Sonoray Model 12 ultrasonic animal tester between the 12th and 13th ribs before slaughter. After the steers had been slaughtered and hung in the cooler for approximately 72 hours the fat thickness was measured at the same location in the carcass by use of a steele rule calibrated in tenths of an inch and converted to centimeters to correspond to the measurements obtained by the Sonoray machine. A correlation coefficient was computed between the two measurements on all steers for each of the two trials.

Results

The means and standard deviations of fat thickness were 0.78 ± 0.04 centimeters for the live animal measurements and 0.80 ± 0.05 centimeters for the carcass measurements in 1972. Similar measurements in 1973 were 0.93 ± 0.03 centimeters for live animal measurements and 1.19 ± 0.05 centimeters for the carcass measurements. The correlation coefficients between the two measurements on each carcass were 0.85 for the 1972 measurements and 0.81 for the 1973 measurements.

THE EFFECT OF GLYCEROL LEVEL, TRIS CONCENTRATION AND THAW TEMPERATURE ON FROZEN RAM SPERMATOZOA

L. Johnson, T. N. Meacham and R. G. Saacke

In spite of many efforts to freeze ram semen, the fertilizing capacity of frozen ram semen has failed to compare to that of other domesticated animals. Numerous researchers have reported conception rates from 0 to 30% with frozen ram semen. Most fertility reports have been below 10%. Yet, the possible impact of artificial insemination in terms of number of ewes bred to large, growthy rams and reduction of reproductive diseases justifies additional research.

The purpose of this study was to determine the best combination of glycerol level, Tris molarity and thaw temperature for minimum spermatozoa injury.

Experimental Procedure

Ten pooled ejaculates of semen were randomly collected from six Finish-Landrace cross rams and one Dorset ram with an artificial vagina. Once collected, the semen was held in a 32 C water bath until diluted. The extenders contained 20% fresh egg yolk by volume and 80% buffer composed of Tris(hydroxymethyl)aminomethane and citric acid monohydrate in distilled water. Antibiotics were added to the diluted semen. The semen was initially diluted in fraction "A", which contained no glycerol. The partially diluted semen was cooled to 6 C in 3.5 hours. Once cooled, the semen was further extended in fraction "B" (glycerol containing fraction) to a final concentration of 25 x 10^6 sperm/ml. Fraction "B" was added at 10, 20, 30 and 40% by volume at 10 to 12 minute intervals to prevent osmotic shock to the sperm. Once glycerolated, the semen was packaged in .5 ml French straws, frozen in N_2 vapor in 8.5 minutes and stored in liquid N_2.

Using a three-dimensional central composite design, 5 levels of glycerol, 5 Tris molarities and 5 thaw temperatures were incorporated in 15 treatments. The glycerol levels studied were 1, 4, 7, 10 and 13% by volume. The Tris molarities were .09, .19, .29, .39 and .49 M. Thaw temperature were achieved by plunging frozen straws into a water bath at 5 C/2 min., 20 C/1 min., 35 C/30 sec., 50 C/15 sec., or 65 C/7.5 sec. The combination of glycerol, Tris and thaw temperature in each treatment is shown in Table 1. Semen was evaluated immediately post-thaw and after 3, 6 and 9 hours of 37 C incubation. Evaluation consisted of direct sperm counts of intact acrosome using differential interference contrast microscopy and estimates of percent sperm motility using phase contrast.

A fertility trial was conducted on 59 ewes using frozen semen. The semen was thawed at 5 C or 50 C and inseminated into estrus ewes. Estrus (heat) was detected with a penialectomized marker ram.

Results

The analysis of variance revealed that ejaculates, hours of incubation and treatments had highly significant effects on percent intact acrosomes and percent motility. The actual response and the response calculated from the multiple regression model for intact acrosome motility are shown in Table 2. Treatments 1-8 as well as 10 and 11 readily show the impact of high glycerol level. In each treatment of higher glycerol, there was a decrease in intact acrosomes and motility. The effects of thaw temperature can be seen in treatments 1-8 as well as 14 and 15. Both intact acrosomes and motility percentages increased with an increase in thaw temperature. Extreme Tris molarities (treatments 12 and 13) were inferior to moderate ones.

There was little interaction between thaw temperature and glycerol or Tris on motility or intact acrosomes. An increase in thaw temperature had relatively little influence on the best Tris molarity or glycerol level. Faster thaws seemed to act only in increasing the acrosome and motility maintenance. No advantage was realized with a thaw temperature higher than 50 C with glycerol level constant at 4% for intact acrosomes or 10% for motility. However, there was a strong interaction ($P<.01$) between glycerol level and Tris molarity on percent intact acrosomes at all incubations. Lower glycerol levels proved superior in maintaining acrosomes at essentially all Tris molarities. There was a progressive decline in intact acrosomes with each glycerol increase. Yet, 4 and 7% glycerol maintained motility better than any glycerol level at all Tris molarity. One percent glycerol produced inferior motility, but 13% was lethal to motility at all Tris levels. Also, extreme Tris molarities were detrimental to motility. Tris levels below .24 M or above .36 M was inferior in motility maintenance.

The optimum combination of glycerol, Tris and thaw temperature was calculated from three equations taken from the multiple regression model and solved simultaneously. The optima for motility and intact acrosomes for the total and each incubation are shown in Table 3. The optimum for the overall mean based on intact acrosomes was 3.1% glycerol, .34 M Tris and 55.8 thaw temperature. The optimum combination changed with hours of incubation, however. At 0 and 3 hours of incubation, maintenance of intact acrosomes was best with moderate glycerol and medium Tris. But as incubation progressed, lower glycerol levels and higher Tris molarities were advantageous. There was little change in thaw temperature due to incubation based on intact acrosomes. The motility was optimal at a combination of 5.7% glycerol, .32 M Tris and 69.5 C thaw temperature. There was essentially no change in the optimum combination for motility at the various incubation periods.

The results from the fertility trial were discouraging, but comparable to that reported by other researchers. Only 6% of the inseminated ewes were pregnant. There were two sets of twins and one single. All the pregnant ewes were inseminated with semen at 50 C rather than 5 C.

TABLE 1. LEVELS OF VARIABLES, CODED VALUES AND TREATMENT COMBINATIONS

Coded Value	-2	-1	0	1	2
Glycerol (% by volume)	1.00	4.00	7.00	10.00	13.00
Tris (molarity)	.09	.19	.29	.39	.49
Thaw (degrees C)	5.00	20.00	35.00	50.00	65.00

Treatment No.	Code	Glycerol	Tris	Thaw
1	-1,-1,-1	4.00	.19	20.00
2	1,-1,-1	10.00	.19	20.00
3	-1, 1,-1	4.00	.39	20.00
4	1, 1,-1	10.00	.39	20.00
5	-1,-1, 1	4.00	.19	50.00
6	1,-1, 1	10.00	.19	50.00
7	-1, 1, 1	4.00	.39	50.00
8	1, 1, 1	10.00	.39	50.00
9	0, 0, 0	7.00	.29	35.00
10	-2, 0, 0	1.00	.29	35.00
11	2, 0, 0	13.00	.29	35.00
12	0,-2, 0	7.00	.09	35.00
13	0, 2, 0	7.00	.49	35.00
14	0, 0,-2	7.00	.29	5.00
15	0, 0, 2	7.00	.29	65.00

TABLE 2. ACTUAL AND CALCULATED MEAN (OF 10 EJACULATES) RESPONSE IN INTACT ACROSOMES AND MOTILITY TO EACH TREATMENT

Treatment No.	Treatment Combination			% Intact Acrosomes Actual response	% Intact Acrosomes Calculated response	% Motility Actual response	% Motility Calculated response
1	4[a]	.19[b]	20[c]	49.1	44.8	15.8	11.9
2	10	.19	20	36.9	31.6	4.5	7.1
3	4	.39	20	50.2	46.7	22.8	15.8
4	10	.39	20	19.0	17.5	5.8	6.5
5	4	.19	50	57.6	54.4	22.5	20.7
6	10	.19	50	47.6	46.5	7.5	13.4
7	4	.39	50	57.9	58.6	32.3	28.6
8	10	.39	50	35.0	34.6	14.0	16.8
9	7	.29	35	46.0	50.9	29.0	30.1
10	1	.29	35	52.2	35.4	3.8	11.3
11	13	.29	35	16.0	-13.7	1.3	-5.3
12	7	.09	35	37.2	41.8	0.3	-1.7
13	7	.49	35	31.7	31.8	2.5	5.5
14	7	.29	5	25.0	29.9	12.8	15.9
15	7	.29	65	57.0	56.7	37.0	34.9

[a]Percent glycerol by volume.
[b]Tris molarity of buffer.
[c]Degrees C of thaw water bath.

TABLE 3. OPTIMUM COMBINATION OF GLYCEROL, TRIS AND THAW TEMPERATURE FOR THE TOTAL AND EACH INCUBATION

	Hours	Glycerol	Tris	Thaw
Intact Acrosomes				
	0	3.8[a]	.30[b]	45.6[c]
	3	4.4	.31	72.7
	6	1.5	.42	51.7
	9	1.0	.49	52.5
	total $\bar{X}$	3.1	.34	55.8
Motility				
	0	6.3	.31	74.6
	3	5.8	.32	65.6
	6	5.5	.33	57.1
	9[d]	---	---	----
	total $\bar{X}$	5.7	.32	69.5

[a]Percent by volume.
[b]Molarity of buffer.
[c]Degrees C of thaw water bath.
[d]Optimum was not calculated since essentially all treatments exhibited 0 motility.

SYSTEMS FOR WINTERING BEEF COWS[1]

W. H. McClure, J. P. Fontenot and T. N. Meacham

One of the most important problems facing Virginia cattlemen with beef cow and calf operations is that of reducing winter feed costs. Labor availability and cost and machinery cost are two major factors. Labor-saving machinery for harvesting and storing forage crops is often economically unfeasible, especially for small operations.

For a number of years some Virginia farmers have been utilizing tall fescue in a winter grazing scheme to reduce the amount of stored feed necessary to maintain a beef cow during the winter season. More recently, there has been a keen interest in utilizing tall forage sorghums as a winter grazing crop for beef cows.

Although tall fescue and the tall forage sorghums have both been rather widely used for wintering beef cows, data on the economics of utilizing these forages, the short and long term effects on the performance of the cows and their calves, or the need for protein supplementation are limited.

A long range experiment designed to study systems of managing beef cows during the winter season was initiated at the Shenandoah Valley Research Station during the winter of 1973-74.

Experimental Procedure

There are 125 cows involved in the trial. Ninety-five of these cows, from the long term crossbreeding study, are Hereford, Angus, Shorthorn or 3-breed crosses between these breeds. All of the cows were diagnosed pregnant in October, 1973 to start calving in late January 1974, and all cows are the same age. These cows were allotted at random into five treatment groups on the basis of type of breeding and weight.

Thirty of the cows used in the test are sired by Charolais or Simmental bulls, and are of various ages and percentage of sire breed. The other breeds represented in these cows are Angus, Hereford, Shorthorn, Brown Swiss and Holstein. These cows were allotted at random, six to each treatment, on the basis of age, type and percentage breeding, and weight. Ten of these cows were open, and were allotted accordingly.

[1]Liquid supplement was supplied by National Molasses Co., Willow Grove, Pa. and the tank by Augusta Cooperative Farm Bureau, Staunton, Va.
Biuret was provided by Dow Chemical Co., Midland, Mich. and mineral supplement by Southern States Cooperative, Richmond, Va.

The British breed cows in the study are all bred by natural mating, and the "exotic" crosses are bred artificially for late winter calving. A Charolais bull was used for natural mating on these cows after several services artificially.

A brief description of the five systems, their development and management follows:

System I. Tall Forage Sorghum (15 acres) and Liquid Supplement. A popular commercial variety of sterile tall forage sorghum was seeded, in late June, in a plowed and prepared seed bed in 18-in. rows at the rate of 14 lb. of seed per acre. Fertilizer was applied at the rate of 140 lb. N., 80 lb. P_2O_5 and 80 lb. K. A herbicide was incorporated with the nitrogen and applied to help provide weed and grass control. During an excellent growing season the sorghum reached heights of 14 to 16 ft. The sorghum was allowed to frost and dry during the early winter, with moderate lodging occurring.

In addition to the 15-acre forage sorghum field, the cows were provided access to a small, partially wooded field with water during the test. Previous close fall grazing had removed most of the forage from this field. A liquid supplement tank was placed in a convenient location in this field and cows were fed liquid supplement free choice during the test.

With the aid of electric fence the cows grazed 1/3 of the field for the first 30 days, 2/3 of the field for the next 30 days and the entire field for the last 30 days. It was estimated that 94% of the forage in the field was consumed by the cows.

The 25 cows were weighed and turned into the sorghum on Jan. 2 and remained until April 1. During this time the cows received no additional feed. The cows were checked twice daily and all calves were identified and weighed at birth.

System II. Forage Sorghum (15 acres) and Biuret Supplement. Forage sorghum for this system was seeded at exactly the same rate and in the same manner as for System I, with the same fertilization and herbicides. Forage yield checks showed the two fields to be quite similar in total forage available.

A small adjacent field with natural shelter and water was also provided for this system. A supplemental feeder box was placed at a convenient location and cows were given access to a dry supplement containing 50% biuret, 48.5% livestock mineral supplement and 1.5% sulphur.

The cows in this system were turned in Jan. 2 and remained until April 1 with no additional feed. Step-grazing was used as with System I.

The only physical difference between System I and System II was the source of nitrogen supplementation.

<u>System III. Tall Fescue (15 acres) and Tall Sorghum (7.5 acres).</u> This system was designed to test the feasibility of using fescue and tall sorghum in combination. One possible theory that may make this system attractive is the possibility that cows could graze on the taller sorghum while snow covers the ground and fescue when the ground is clear.

The sorghum was seeded and managed exactly as in Systems I & II, except that cows were given access to the entire 7.5 acres throughout the test.

Part of the fescue was an old existing sod and part was seeded in the spring of 1973. Tall fescue was seeded at the rate of 15 lb. per acre, with 2 lb. of red clover and 1 lb. of ladino clover per acre. At seeding time, fertilizer was applied at the rate of 40 lb. N., 80 lb. P_2O_5 and 80 lb. K. The old and new fescue was clipped closely about August 1, 1973 and 75 lb. N. per acre was applied. The fescue was allowed to grow or "stockpile" until Jan. 2 without grazing.

The 25 cows in the treatment were turned in on Jan. 2 and handled exactly the same as the cows mentioned in the two previously discussed systems, except that no protein supplement was given. A closely grazed accessory field with natural shelter and water was also provided for the cows in this system. Although the test was concluded on April 1, there was sufficient forage in this system to carry the cows without supplemental feeding until April 22.

<u>System IV. Control - Conventional Winter Management</u>. The 25 cows in this system were allowed to range on a 40-acre field of primarily blue grass and orchardgrass sod with natural shelter and water. Because of an excellent fall growing season and a mild winter, there was considerable aftermath grazing available for the cows in this system. During an average winter at this Station, cows are fed hay until calving and hay plus corn silage or grass silage after calving. Because of the forage available, the cows were fed only 20 pounds of hay per head daily during the 89-day trial. The hay was average quality orchardgrass and red clover. Daily cow management was the same as for the cows in the previously mentioned systems.

<u>System V. Fescue (30 acres)</u>. The 25 cows in this system were grazed during the entire test period on tall fescue with no additional feed being fed. The fescue was partly an old sod, and partly seeded and treated in exactly the same manner as the fescue used in System III. The cows in this system were handled in the same manner as cows in the other systems

and remained on the pasture after the test was concluded until April 22 without additional feed.

The trial was started on Jan. 2, 1974 and concluded on April 1, 1974. All cows were injected with 1,000,000 I.U. of vitamin A and 150,000 I.U. of vitamin D at the beginning of the trial and were sprayed for lice. All lots received a mixture of 1/3 salt, 1/3 steam bonemeal and 1/3 magnesium oxide, fed free choice. Approximately 85% of the cows calved before the test was concluded. Vasectomized bulls were turned in with each group on Mar. 10 and observations were recorded on cows cycling.

Results and Discussion

The chemical composition of the forages is shown in table 1. The protein content of fescue was over 10%,dry basis, compared to 6% for the standing sorghum. Yields of the tall sorghum forage before frost were estimated at 20.4 tons of green weight or 8.56 tons dry matter per acre.

Preliminary results of the trial are shown in tables 2 and 3. The winter of 1974 was milder than normal and cows performed well in every system. There was no indication of hunger or restlessness observed with the cows in any system. The sorghum fields became very muddy on several occasions but no real problems were encountered. The sod fields remained relatively firm. Incidence of calf scours was minimal and not confined to any system, with no death loss or serious illness observed. There was no incidence of fescue foot or grass tetany observed in the cows in any system.

Cows in System II consumed less of the dry supplement than desired. Efforts will be made to correct this deficiency during the 1974-75 test. The occurrence of estrus after calving appeared to be quite uniform among the treatment groups. When calving is completed, a more accurate estimate of the interval from calving to first estrus will be made.

The cows will remain assigned to the same systems and the trial will be repeated for a number of years in an effort to determine the effect of these systems on cow performance over a long period of time.

These results indicate that cows can be wintered under systems other than those conventionally used with less labor, lower feed costs and with no adverse effects on performance.

TABLE 1. CHEMICAL COMPOSITION OF FORAGES

Forage	Dry matter	Composition of dry matter				
		Crude protein	Ether extract	Crude fiber	Ash	NFE
	%					
Fescue, old seeding	48.9	11.27	3.33	29.08	5.62	50.71
Fescue, new seeding	47.7	10.51	2.80	28.12	6.79	51.78
Tall sorghum	67.0	6.02	1.27	36.36	3.02	53.33
Hay	90.7	12.82	2.09	37.43	5.55	42.11

TABLE 2. PERFORMANCE OF COWS ON DIFFERENT WINTERING SYSTEMS

	System I (Sorghum + liquid supplement)	System II (Sorghum + biuret supplement)	System III (Sorghum & fescue)	System IV (Conventional)	System V (Fescue)
No. of cows	25	25	25	25[a]	25
Weight 1-2-74	1004	989	973	973	990
Weight 1-30-74	1000	1012	1052	1057	1059
Gain per cow 1-2 thru 1-30[b]	9	37	92	89	32
Weight 4-1-74	909	879	948	937	995
Total lb. feed per cow	121 (liquid)	18 (biuret-mineral)		1800 (hay)	

[a]One cow died accidentally, 3-20-74.
[b]Includes only cows not calving during this period.

TABLE 3. CALVING PERFORMANCE OF COWS ON DIFFERENT WINTERING SYSTEMS

	System I (Sorghum + liquid supplement)	System II (Sorghum + biuret supplement)	System III (Sorghum & fescue)	System IV (Conventional)	System V (Fescue)
No. cows calving before 4-1-74	21	22	19	16	20
No. calves alive 4-1-74	21	21	19	16	20
Avg. calf age - 4-1-74, days	45	49	43	44	44
Avg. birth weight, lb.	72.5	73.2	75.4	76.4	74.3
Avg. weight, 4-1-74, lb.	137.3	128.3	146.2	133.3	152.0
Calf wt. per day age 4-1-74, lb.	3.05	2.62	3.40	3.03	3.45

SYSTEMS OF FATTENING CATTLE IN SOUTHWEST VIRGINIA[1]

F. S. McClaugherty, J. P. Fontenot, M. B. Wise and R. C. Carter

Much of the land in Southwest Virginia is too steep for practical cultivation. Pastures which consist predominantly of bluegrass and white clover may be quite productive with good management. They are very productive in the spring but forage production declines after about July 1. Thus, with a set stocking rate or with a constant management scheme the pastures would be either understocked in the spring or overstocked in the summer.

In previous research at the Southwest Research Station at Glade Spring, it was shown that heifers could be fattened to desirable finish by July with about one half full feed of grain. It was also shown at that station and at Blacksburg that pastures can be more fully utilized by stocking heavier in the spring and lighter in the summer. Researchers in North Carolina have successfully fattened cattle on pasture with limited grain supplementation. They found that including about 10% animal fat in the ration was a practical method to limit grain consumption of fattening cattle to about 1% of bodyweight.

An experiment was started to test various systems of fattening cattle, using predominantly native bluegrass-clover pastures. The first year's results from this experiment was reported in last year's livestock research report (V.P.I. & S.U. Research Division Report 153). A second trial was conducted during the past year. The results of this trial will be reported in this report.

Experimental Procedure

Thirty-six yearling steers and twelve yearling heifers were used for this experiment. The cattle consisted of Angus, Shorthorn, Hereford and crossbred cattle from different research stations in Virginia. The steers were allotted at random from groups of similar breeding and weight to pasture plots to receive the following treatment:

<u>System 1 - Steers</u>. These were grazed on 0.5 acre per steer with no supplemental grain until July 10. They were then fed in drylot a ration consisting of a full feed of corn silage, limited protein supplement and ground ear corn at 1.2% of bodyweight. Ground shelled corn was substituted for ear corn for the last few days they were on test.

[1]Animal fat was supplied by Valleydale Packers, Bristol, Virginia.

The steers were slaughtered when they reached an estimated slaughter grade of high good to low choice.

System 2 - Steers. They were grazed on 0.5 acre per steer until July 10 and 1.0 acre per steer thereafter, with no supplemental grain. On October 16 the steers were placed in drylot and fed a ration of corn silage, limited protein supplement and corn at approximately 1% of bodyweight. Ear corn was used during the early part of the trial and later they were switched to shelled corn. They were slaughtered when they reached an estimated slaughter grade of high good to low choice.

System 3 - Steers. These steers were grazed on 0.5 acre per head until July 10 and 1.0 acre per head thereafter, and were self-fed a mixture of 90% ground shelled corn and 10% animal fat. They were slaughtered at the end of the pasture season, October 16, 1973.

System 4 - Heifers. The 12 heifers were allotted to two pastures, grazed on 0.5 acre per head and were self-fed a mixture of 90% ground shelled corn 10% animal fat until they were slaughtered on July 10, 1973.

Results

The results of the second year's work are given in Table 1. The heifers were marketed after 70 days. At that time they had gained 2.55 lb. per day and had consumed an average of 9.9 lb. of grain-fat mixture per head per day. The heifers averaged between low and average good in carcass grade.

The best overall performance for the steers was by those that were fed a grain-fat mixture during the entire grazing season. These gained over 3 lb. per head per day for the first 70 days and gained an average of 2.64 lb. per day for the entire grazing season. The carcass grade of these was slightly better than average good. It might be noted that the amount of grain-fat consumed was considerably more than the 1% of bodyweight desired.

Gain until July 10 for the steers fed no supplemental grain was approximately 2.2 lb. per head per day (Systems 1 and 2). Gains were lower after July 10 for the steers which remained on pasture (System 2). The average gain for the entire grazing season for these steers was 1.52 lb., which is certainly respectable for cattle receiving no supplemental grain. Feedlot performance for both groups of steers (Systems 1 and 2) was lower than desired, although gains for both averaged over 2 lb. per head per day. The carcass grade for the steers in Systems 1 and 2 averaged approximately top good. The results indicate that a variety of combinations of management systems can be used for effective utilization for pastures for stocker and fattening cattle.

TABLE 1. MANAGEMENT SYSTEMS FOR FATTENING CATTLE. 1973-74

	Steers			Heifers
	System 1	System 2	System 3	System 4
Initial wt., lb.	598	607	592	528
Wt., July 10, lb.	751	761	810	710
Daily gain, 70 days, lb.	2.18	2.20	3.12	2.55
Wt. Oct. 16, lb.	938	863	1036	
Daily gain, pasture, lb.		1.52	2.64	
Wt. end of feedlot period, lb.	1070	1084		
Daily gain in feedlot, lb.	2.06	2.26		
No. days on test	225	266	168	70
Grain-fat/day, lb.			12.7	9.9
Feedlot ration, lb./day				
Silage	32.8	27.9		
Grain	9.9	9.3		
Soybean meal	2.0	2.0		
Total feed consumption, lb./head				
Grain-fat			2136	694
Corn silage	5088	2733		
Ear corn	1413	472		
Shelled corn	117	526		
Soybean meal	304	192		
Carcass grade[a]	10.8	11.2	10.2	9.5
Dressing %			58.1	54.6
Loin eye muscle area, sq. in.	11.44	12.36	10.13	
Backfat, in.	0.64	0.65	0.62	

[a]Code: 9= low good; 10= average good; 11= high good; etc.

DIFFERENT LEVELS OF FLAVOMYCIN FOR FATTENING CATTLE[1]

J. P. Fontenot, W. H. McClure, F. S. McClaugherty and K. E. Webb, Jr.

Antibiotics are used extensively in feeding beef cattle. There is concern by consumers of transfer to edible tissue of antibiotics fed to farm animals. An antibiotic which would give a response in cattle and not be absorbed into the body would remove these fears from consumers. Flavomycin, a relatively new antibiotic in the U.S., is not absorbed from the digestive tract.

A series of trials were conducted to study the effect of feeding different levels of flavomycin to fattening steer and heifer calves.

Experimental Procedure

A total of 12 lots of group fed fattening beef steer calves and 4 lots of group fed fattening beef heifer calves were used. Four lots of 8 Shorthorn steer calves were used at Blacksburg and eight lots of 6 steer calves were used at the Shenandoah Valley Research Station at Steeles Tavern. The calves at Steeles Tavern consisted of four lots of straight-bred and four lots of crossbred calves. At the Southwest Virginia Research Station at Glade Spring, four lots of seven Shorthorn heifer calves were used. In allotment of the cattle consideration was given to breeding and liveweight. Each group of four lots were randomly allotted to the following levels of flavomycin: 0, 5, 10 and 20 mg. per head daily.

All of the cattle were fed limited levels of protein supplement and grain, and a full feed of corn silage. At Blacksburg the corn silage had been treated with 10 lb. urea per ton at ensiling time. At Blacksburg and Glade Spring, the supplement consisted of soybean meal and at Steeles Tavern the supplement consisted of 50% soybean meal, 42.5% shelled corn and 6.5% feed grade urea. At Glade Spring and Steeles Tavern supplement was fed at the rate of 2 lb. per head daily, whereas at Blacksburg the supplement was fed at the rate of 1 lb. per head per day, since some of the supplemental nitrogen was incorporated in the silage. The flavomycin was mixed with the protein supplement at such levels that the supplement would supply the desired levels of flavomycin. At Blacksburg and Steeles Tavern the grain was fed at approximately 1% of bodyweight and at Glade Spring the grain was fed at a somewhat higher level than 1%.

[1]Supported in part, by a grant-in-aid from Hoechst Pharmaceutical, Inc., Somerville, New Jersey.

The cattle were weighed at the beginning, at intervals during experiment, and at the end. At the end of the experiment the cattle were removed from the flavomycin supplement for a minimum of 7 days prior to slaughter. They were slaughtered by a commercial packer and the following carcass data were obtained: carcass weight, carcass conformation, maturity, marbling, grade, kidney fat, loin eye muscle area and backfat thickness.

Results

The results are summarized in table 1 for the trial in Blacksburg, table 2 for Glade Spring and tables 3 and 4 for replicates 1 and 2 at Steeles Tavern. At the end of 181 days, at which time the antibiotic was removed, there was a trend for a small increase in gain for the trial at Blacksburg from feeding 5 mg. of the antibiotic. There was a 0.09 lb. increase in daily gain when 10 or 20 mg. were fed. There was little difference in intake of corn silage and grain among the lots. There were small differences in feed efficiency, with a trend for an increase in feed efficiency when 10 or 20 mg. were fed. Carcass grades were higher for the antibiotic fed cattle than for the controls. The average grade for the controls was slightly above top good, whereas it averaged slightly better than low choice for the cattle fed 10 mg. flavomycin and between the low and average choice for those fed 20 mg. There were no other consistent differences in carcass characteristics.

In the fattening heifers at Glade Spring, there were no increases in daily gain from feeding 5 or 10 mg. of flavomycin. However, there was approximately 0.13 lb. increase in daily gain for the cattle fed 20 mg. (1.71 vs. 1.84 lb.). The cattle fed 10 mg. flavomycin did not consume as much silage as the other cattle. Less grain was required for the cattle fed 20 mg. flavomycin than for the cattle in any of the other treatments. There were no consistent differences in carcass grade. Dressing percent tended to be higher for the antibiotic fed cattle than for the controls. There were no other consistent differences in carcass characteristics.

Inconsistent results were obtained in the trial at Steeles Tavern. In the crossbred cattle (rep 1, table 3) the control pen performed very well throughout the experiment. Consequently, there were never any improvements in daily gain from feeding of any of the levels of flavomycin. In fact, at the end of the trial the cattle fed 5 mg. of flavomycin had actually gained less than the controls. Likewise, there were no improvements in feed efficiency from feeding the antibiotic. There was a trend for higher carcass grade at high levels of antibiotic.

In the straightbred cattle (rep 2, table 4) at Steeles Tavern, feeding of 5 or 20 mg. of flavomycin resulted in substantial increases in daily gain. There was a trend for an increase when 10 mg. were fed.

There were no large differences in feed consumption and feed efficiency among the different lots. Carcass characteristics were similar for the control cattle and those fed different levels of antibiotic.

No harmful effects of the antibiotics were observed in any of the animals during the experiment.

TABLE 1. EFFECT OF FEEDING DIFFERENT LEVELS OF FLAVOMYCIN TO FATTENING STEERS - BLACKSBURG

	Pen no. and level of flavomycin/day			
	Pen 6, 0 mg.	Pen 4, 5 mg.	Pen 3, 10 mg.	Pen 5, 20 mg.
No. of cattle	8	8	6[e]	8
Initial weight	547	546	580	535
Final wt., lb.	935.6	942.9	985.7	939.4
Gain, 181 days, lb.	388.4	396.9	401.2	404.8
Daily gain, 181 days, lb.	2.15	2.19	2.24	2.24
Daily feed consumed, lb.				
Corn silage	25.15	25.22	24.70	25.08
Grain	7.35	7.31	7.43	7.26
Soybean meal	0.96	0.96	0.94	0.95
Feed/lb. gain, lb.				
Corn silage	11.72	11.50	11.15	11.22
Grain	3.42	3.34	3.35	3.25
Soybean meal	0.45	0.44	0.43	0.42
Carcass information				
Dressing percent[a]	58.22	59.81	59.04	59.25
Conformation[b]	12.4	12.5	15.1	13.1
Maturity[c]	1	1	1	1
Marbling[d]	3.8	4.2	5.0	4.9
Carcass grade[b]	11.3	11.8	12.2	12.6
Kidney fat, %	3.1	3.6	4.0	2.8
Loin eye muscle area, sq. in.	10.27	9.60	10.32	10.14
Backfat thickness, in.	0.80	0.93	0.97	0.90

[a]Based on final weight and warm carcass weight.
[b]Code: 11=high good; 12=low choice; 13=average choice; etc.
[c]Code: 1=young; 2=mature; etc.
[d]Code: 3=slight; 4=small; 5=modest; etc.
[e]All data are for 6 steers. One steer died before trial started and one steer suffered a broken leg on 5/21/73 and was removed from experiment and sacrificed.

TABLE 2. EFFECT OF FEEDING DIFFERENT LEVELS OF FLAVOMYCIN TO FATTENING HEIFERS - GLADE SPRING

	Pen no. and level of flavomycin/day			
	Pen 3, 0 mg.	Pen 2, 5 mg.	Pen 4, 10 mg.	Pen 1, 20 mg.
No. of cattle	7	6	7	7
Initial wt., lb.	503	495	483	470
Final wt., lb.	776.6	764.3	749.4	764.3
Gain, 160 days, lb.	273.7	269.7	266.9	294.0
Daily gain, 160 days, lb.	1.71	1.69	1.67	1.84
Daily feed consumed, lb.				
Corn silage	16.33	15.13	13.86	17.64
Grain	9.67	9.61	9.44	9.52
Soybean meal	2.00	2.00	2.00	2.00
Feed/lb. gain, lb.				
Corn silage	9.55	8.98	8.31	9.60
Grain	5.65	5.70	5.66	5.18
Soybean meal	1.17	1.19	1.20	1.09
Carcass information				
Dressing percent[a]	59.49	60.38	60.28	60.29
Conformation[b]	11.7	11.6	11.8	10.9
Maturity[c]	1	1	1	1
Marbling[d]	4.7	4.3	4.2	4.6
Carcass grade[b]	12.3	11.6	12.0	11.6
Kidney fat, %	3.9	4.4	4.1	4.4
Loin eye muscle area, sq. in.	8.7	8.2	8.4	8.1
Backfat thickness, in.	0.69	0.65	0.68	0.72

[a]Based on final weight and warm carcass weight.
[b]Code: 11=high good; 12=low choice; 13=average choice; etc.
[c]Code: 1=young; 2=mature; etc.
[d]Code: 3=slight; 4=small; 5=modest; etc.

TABLE 3. EFFECT OF FEEDING DIFFERENT LEVELS OF FLAVOMYCIN TO FATTENING STEERS - STEELES TAVERN, REP. 1

	Pen no. and level of flavomycin/day			
	Pen 1, 0 mg.	Pen 3, 5 mg.	Pen 2, 10 mg.	Pen 4, 20 mg.
No. of cattle	6	6	6	6
Initial wt., lb.	449	464	436	445
Final wt., lb.	912.2	889.5	886.5	904.0
Gain, 195 days, lb.	463.3	426.0	450.5	459.0
Daily gain	2.38	2.18	2.31	2.36
Daily feed consumed, lb. (195 days)				
Silage	24.14	21.85	23.73	24.14
Grain	5.22	6.74	6.50	6.59
Supplement	2.00	2.00	2.00	2.00
Feed/lb. gain, lb.				
Silage	10.16	10.00	10.27	10.26
Grain	2.20	3.08	2.81	2.80
Supplement	0.84	0.92	0.81	0.85
Carcass information				
Dressing percent[a]	58.71	57.96	57.36	57.36
Conformation[b]	12.42	12.17	12.17	12.50
Maturity[c]	1	1	1	1
Marbling[d]	3.75	4.0	4.25	4.42
Carcass grade[b]	11.33	11.67	12.00	12.17
Kidney fat, %	3.03	2.90	3.12	2.98
Loin eye muscle area, sq. in.	10.24	10.14	10.06	10.11
Backfat thickness, in.	0.8320	0.8340	0.7401	0.8248

[a]Based on final weight and warm carcass weight.
[b]Code: 11=high good; 12=low choice; 13=average choice; etc.
[c]Code: 1=young; 2=mature; etc.
[d]Code: 3=slight; 4=small; 5=modest; etc.

TABLE 4. EFFECT OF FEEDING DIFFERENT LEVELS OF FLAVOMYCIN TO FATTENING STEERS - STEELES TAVERN, REP. 2

	Pen no. and level of flavomycin/day			
	Pen 5, 0 mg.	Pen 8, 5 mg.	Pen 6, 10 mg.	Pen 7, 20 mg.
No. of cattle	6	6	6	5
Initial wt., lb.	404	401	412	393
Final wt., lb.	826.2	852.3	840.5	860.0
Gain, 195 days, lb.	422.0	451.2	428.3	466.8
Daily gain	2.16	2.32	2.20	2.39
Daily feed consumed				
Silage	20.64	22.79	22.79	22.76
Grain	6.12	6.26	6.31	6.10
Supplement	2.00	2.00	2.00	2.00
Feed/lb. gain, lb.				
Silage	9.54	9.85	10.38	9.51
Grain	2.83	2.70	2.87	2.55
Supplement	0.92	0.86	0.91	0.84
Carcass information				
Dressing percent[a]	57.07	56.96	56.44	56.32
Conformation[b]	11.83	12.25	12.33	12.50
Maturity[c]	1	1	1	1
Marbling[d]	3.92	4.33	3.80	3.50
Carcass grade[b]	11.42	12.08	11.33	11.40
Kidney fat, %	3.12	2.95	3.00	2.46
Loin eye muscle area, sq. in.	9.78	9.83	9.84	9.44
Backfat thickness, in.	0.8471	0.9101	0.7244	0.8331

[a]Based on final weight and warm carcass weight.
[b]Code: 11=high good; 12=low choice; 13=average choice; etc.
[c]Code: 1=young; 2=mature; etc.
[d]Code: 3=slight; 4=small; 5=modest; etc.

WINTERING BEEF CATTLE ON CORN SILAGE SUPPLEMENTED WITH BIURET OR LIQUID SUPPLEMENT[1]

F. S. McClaugherty and J. P. Fontenot

In a trial conducted in 1972-73 there was a trend for steer and heifer calves to gain at a faster rate when they were supplemented with a biuret-mineral mixture than with a liquid supplement. There is considerable interest in these two methods of providing supplemental nitrogen to cattle. Two feeding trials were conducted during this past winter, one with steer calves and the other with heifer calves to study relative value of supplementing corn silage with a biuret-mineral mixture and liquid supplement.

Experimental Procedure

Forty weanling steer calves and 14 weanling heifer calves were used. The steer calves were wintered on small pasture plots with little or no available grazing. The heifer calves were wintered inside the barn. All of the cattle were full fed corn silage, once daily. The steers and heifers were grouped by breeding and weight and allotted at random to the following two treatments: 1) biuret-mineral supplement and 2) liquid supplement. The biuret supplement was composed of 50% biuret, 49.5% commercial mineral mixture and 0.5% supplemental sulfur. The composition of the liquid supplement was similar to that used last year. Urea was used as the main nitrogen supplement and phosphoric acid as the main source of supplemental phosphorus in the liquid supplement. The cattle were weighed initially, at the end and at 14-day intervals during the trial. The trial lasted for 103 days.

Results

The relative effect of feeding the supplements is given in table 1. Performance was almost identical for the steers that were allowed access to the biuret-mineral or liquid supplement. It appeared that the steers fed the liquid supplement compensated for the energy in the supplement by consuming less silage.

In the case of the heifers gains tended to be higher for those fed the liquid supplement. The amount of silage consumed was about the same for both groups of heifers.

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[1]The liquid supplement was supplied by National Malasses Co., Willow Grove, Pa., the commercial mineral mixture by Southern States Cooperative, Richmond, Virginia, and the biuret by Dow Chemical Co., Midland, Michigan.

TABLE 1. EFFECT OF FEEDING BIURET AND LIQUID SUPPLEMENTS

	Steers		Heifers	
	Biuret	Liquid	Biuret	Liquid
No. cattle	20	20	7	7
Initial wt., lb.	458	465	458	471
Final wt., lb.	571	579	553	584
Daily gain, lb.	1.10	1.11	0.93	1.10
Daily feed				
Corn silage, lb.	27.6	22.8	27.4	27.6
Biuret-mineral, oz.	2.8		2.4	
Liquid supplement, lb.		1.9		1.6

PERFORMANCE OF EARLY WEANED LAMBS AT DIFFERENT WEIGHT INCREMENTS

W. H. McClure, R. C. Carter and J. P. Fontenot

Researchers at the Blacksburg, Glade Spring and Steeles Tavern Stations have been involved for a number of years in various projects with a basic common goal of developing "ideal" lamb growing and fattening rations, both from a standpoint of performance and economy. Special emphasis has been placed on developing rations for lambs weaned at an early age and grown in confinement to an optimum market weight.

In view of the recent sharp increases in the costs of all ingredients utilized in rations for early weaned lambs, this system of growing lambs must be re-evaluated from the standpoint of economy and efficiency of gain.

A trial was initiated at the Shenandoah Valley Research Station at Steeles Tavern in 1973 to study the daily gain, feed consumption and efficiency of gain of lambs weaned at different weights and fed in confinement to market weight.

Experimental Procedure

The 180 lambs used in the trial were all weaned on April 24, with the ages ranging from 60 and 112 days and the weights from 30 and 80 lb. The lambs were placed in lots according to the following weight ranges: Lot 1, 30 to 39 lb.; Lot 2, 40 to 49 lb.; Lot 3, 50 to 59 lb.; Lot 4, minimum of 60 lb. No consideration in assignment to lots was given to sex, age, sire or type birth.

At approximately 14 days of age all lambs had been treated for prevention of enterotoxemia, docked, and ram lambs had been castrated. Just prior to the beginning of the trial, the lambs were treated again for prevention of enterotoxemia and injected intramuscularly with a combination of selenium and Vitamin E as a preventive for "stiff lamb" disease and treated for internal parasites.

All lambs were creep fed from 2 weeks of age until weaning. The pelleted ration used during the feeding trial was used as a creep ration for 2 weeks prior to weaning. The ingredient composition of the ration is given in table 1. The calculated crude protein content was 15%. Lambs in each lot were placed on expanded metal floors and self-fed the pellets. Trace mineralized salt was fed free choice.

Feed was weighed into the feeders in each lot daily, and weighed back every 14 days when the lambs were weighed. Lambs from each lot were removed for slaughter at 2-week intervals when they reached a minimum weight of 93 lb.

Results

Table 2 shows the initial weight, average age, weight per day of age, and type of birth and rearing for lambs in the respective lots. There was a 10-day difference in the average age of the lambs between the lightest and heaviest pens. Most of the single birth lambs had grown faster to weaning.

Results of the trial are shown in Table 3. The test was continued until July 17 when the first lambs were sold from Lot 1, and the majority of the lambs in Lots 2, 3 and 4 had been sold. The lambs in Lot 1 showed rather low but consistent gains and excellent feed conversion rates through July 3, at which time gains decreased and feed per pound of gain increased sharply. The lambs in Lot 2 showed slightly better gains than Lot 1, and the feed per pound of gain increased progressively during the test.

The lambs in Lot 3 showed better gains than the lambs in the two lighter lots and excellent feed conversion until after the first lambs were sold from the pen on June 5. The lambs in Lot 4 showed a progressive increase in gain and decrease in feed per pound of gain until the first lambs were sold on June 5.

Results of this trial indicate that the single lambs and the faster growing twins will generally gain well and have satisfactory feed conversion rates until they reach market weight. The lambs with the lower weights per day of age at weaning tended to gain slower and less efficiently throughout the trial.

The trial will be continued in 1974 in an attempt to more accurately determine gain and efficiency trends. There may be a point at which the slower growing and less efficient lambs cannot be fed economically under this system of management during the hot summer months.

TABLE 1. COMPOSITION OF PELLETED RATION[a]

Ingredient	Lb.
Ground ear corn	85.9
Soybean meal (50% protein)	7.0
Fish meal (70% protein)	5.0
Limestone	1.0
Fat	0.5
Salt	0.5
Aureomycin	0.1
Total	100.0

[a]Vitamin additions: 60,000 I.U. Vitamin A, 5,000 I.U. Vitamin E and 6,000 I.U. Vitamin D per 100 lb. ration.

TABLE 2. CHARACTERISTICS OF LAMBS USED ON TEST

	Lot 1	Lot 2	Lot 3	Lot 4
No. of lambs	43	43	48	46
Initial wt., lb.	35.2	45.1	54.8	66.9
Wt. per day age, beginning of test	0.42	0.52	0.60	0.72
Avg. age, days	83.4	86.7	90.9	93.2
Singles, %	21	28	52	96
Twins, %	65	53	36	2
Twins raised as singles, %	14	19	12	2

TABLE 3. FEEDLOT PERFORMANCE[a] OF LAMBS WEANED AT DIFFERENT WEIGHTS

	Lot 1 (43 lambs)			Lot 2 (43 lambs)			Lot 3 (48 lambs)			Lot 4 (46 lambs)		
Date	Wt.	Daily gain	Feed/lb. gain	Wt.	Daily gain	Feed/lb. gain	Wt.	Daily gain	Feed/lb. gain	Wt.	Daily gain	Feed/lb. gain
	-----	-----	-----	-----	-----	-----	lb.	-----	-----	-----	-----	-----
4-24	35			45			55			67		
5-8	42	0.48	2.5	52	0.51	3.0	62	0.52	3.8	74	0.50	4.5
5-22	51	0.67	3.0	61	0.66	3.5	73	0.78	3.2	83	0.62	4.3
6-5	59	0.56	4.0	69	0.61	3.9	83[b]	0.69	3.5	94[d]	0.80	3.7
6-19	66	0.54	4.2	79	0.68	4.2	88[c]	0.53	5.2	91[e]	0.61	6.3
7-3	74	0.51	5.5	89[f]	0.72	5.1						
7-17	79	0.37	7.4	88	0.61	5.4						

[a]Daily gain and feed efficiency for 14-day period preceding given date.
[b]6 lambs sold 6-5.
[c]31 lambs sold 6-19.
[d]33 lambs sold 6-5.
[e]12 lambs sold 6-19.
[f]13 lambs sold 7-3

INFLUENCE OF ZERANOL IMPLANTATION IN GRAZING AND FATTENING HEIFERS[1]

J. P. Fontenot and R. F. Kelly

Dietylstilbestrol (DES) implants have been shown to result in consistent increases in performance of fattening steers. However, in fattening heifers the response from stilbestrol implants has not been as consistent. During a 2-year period it was shown that zeranol implants in grazing steers resulted in a larger increase in gain that DES implants (V.P.I. & S.U. Res. Div. Rep. 145). During a 2-year period an experiment was conducted to study the effect of implanting grazing and fattening heifers with zeranol.

Experimental Procedure

During each of 2 years an experiment was conducted using cattle owned and kept on the Graves Brothers Farm, Syria, Virginia. Each year a minimum of 60 heifers were allotted to the following four treatments according to weight: Lot 1 - no implant; Lot 2 - zeranol implant in the spring; Lot 3 - zeranol implant in the fall; Lot 4 - zeranol implant in the spring and in the fall. The level of implantation was 36 mg. per head. Each year the heifers were started on test in the spring and were grazed on the pastures until November or December. At that time they were placed in a feedlot and fed a fattening ration. Each year the animals were kept as a group on pasture and in the feedlot.

Prior to the beginning of the trial, at the end of the grazing season and at the end of the fattening period the cattle were individually weighed and scored for slaughter grade, mammary development and tailhead elevation. During the first year some of the cattle were slaughtered in March and the remainder in June. In the second year the cattle were slaughtered on April 2, April 23 or April 30. At the beginning and end of the grazing season the cattle were scored for feeder grade. The following data were collected at slaughter: warm carcass weight, loin-eye muscle area, backfat thickness and carcass grade.

Results

The results for trial 1 are given in table 1, and for trial 2, in table 2. Implanting of zeranol in the spring resulted in a consistent

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[1]Appreciation is expressed to Graves Bros. Farm, Syria, Virginia for their cooperation and to Commercial Solvents Corp., Terre Haute, Ind. for supporting, in part, this study with a grant-in-aid.

increase in pasture gain. During the first year the increase in gain was 10.5 lb. per head per day and in the second year, 19.5 lb. Thus, the zeranol implant resulted in an average increase of 15 lb. per head during the grazing season (table 3).

Since a different number of cattle were removed from different lots at different times the feedlot gain is reported only until the first time some of the cattle were marketed (March 26 in 1973 and April 1 in 1974). In trial 1 the use of a 36 mg. zeranol implant resulted in an increase in daily gain of 0.12 lb. per day (lots 1 and 2 vs. 3 and 4. However, in the second year there was only a small increase in gain (0.03 lb./day) between the cattle which received an implant in the fall and those which did not. The average daily gain was 1.42 for those that were not implanted and 1.45 lb. for those that received a 36 mg. zeranol implant. If the results for both years are considered there is, however, a substantial increase in feedlot gain (0.08 lb./day) from use of the zeranol implant.

In both years the use of the implants resulted in marked increases in total gain during both the pasture and feedlot period. The use of an implant at both times resulted in a 51 lb. increase in gain, during the first year, compared to those that received no implant, and an 18 lb. increase the second year (lot 1 vs. lot 4). The average improvement in gain when cattle were implanted in the spring and again in the fall was 34 lb. per head (table 3).

There was no real evidence of tailhead elevation or mammary development attributed to the implants at any time during either trial. Feeder, carcass and slaughter grades were not consistently affected by the implant treatments.

TABLE 1. EFFECT OF IMPLANTING ZERANOL IN GRAZING AND FATTENING HEIFERS - TRIAL 1

Lot no.	1	2	3	4
Implant, spring	None	Zeranol	None	Zeranol
Implant, fall	None	None	Zeranol	Zeranol
No. of cattle	19	18	15	21
Weight data, lb.				
Initial wt., 4/27/72	377	369	375	386
Wt., fall, 11/22/72	556	554	564	588
Pasture gain	179	185	188	203
Daily gain, pasture	0.86	0.89	0.90	0.97
Wt., 3/26/73	683	698	699	743
Feedlot gain	127	143	140	155
Da. gain, feedlot	1.00	1.10	1.09	1.25
Gain, pasture & feedlot	307	321	332	358
Da. gain, pasture & feedlot	0.88	0.99	0.97	1.08
Tailhead elevation[a]				
Initial	0.48	0.38	0.42	0.60
11/22/72	0.42	0.34	0.26	0.33
3/26/73	0.10	0.31	0.25	0.29
Mammary development[b]				
Initial	0	0	0	0
11/22/72	0	0	0	0.02
3/26/73	0.10	0.08	0.08	0.20
Feeder grade[c]				
Initial	11.4	10.7	11.2	11.6
Fall	11.2	9.9	10.7	11.2
Slaughter grade[d]				
Initial	5.4	5.1	5.3	5.4
11/22/72	6.4	5.8	6.5	6.0
3/26/73	11.0	9.8	10.3	10.4
Carcass evaluation[d]				
Carcass grade	11.6	11.1	11.2	11.8
Dressing %	56.8	54.7	55.5	57.1
Loin eye area, sq. in.	10.0	9.8	10.0	9.9
Backfat, in.	0.59	0.53	0.56	0.92

[a]Code: 0-no elevation; 1-elevation; 2-marked elevation.
[b]Code: 0-no development; 1-development; 2-marked development.
[c]Code: 8-high medium; 9-low good; 10-av. good; etc.
[d]Code: 7-av. utility; 8-high utility; 9-low good; etc.

TABLE 2. EFFECT OF IMPLANTING ZERANOL IN GRAZING AND FATTENING HEIFERS - TRIAL 2

Lot no.	1	2	3	4
Implant, spring	None	Zeranol	None	Zeranol
Implant, fall	None	None	Zeranol	Zeranol
No. of cattle	15	13	15	15
Weight data, lb.				
Initial wt., 4/16/73	367	371	361	353
Wt., fall, 12/6/73	568	606	573	570
Pasture gain	201	235	212	217
Daily gain, pasture	0.86	1.01	0.90	0.93
Wt., 4/1/74	736	766	738	740
Feedlot gain	168	160	165	170
Da. gain, feedlot	1.45	1.38	1.42	1.47
Gain, pasture & feedlot	369	396	377	387
Da. gain, pasture & feedlot	1.05	1.13	1.08	1.11
Tailhead elevation[a]				
Initial	0	0.12	0.17	0
12/6/73	0.57	0.46	0.53	0.23
4/1/74	0.37	0.62	0.53	0.37
Mammary development[b]				
Initial	0.17	0.27	0.10	0.03
12/6/73	0.03	0.15	0.03	0.10
4/1/74	0.23	0.54	0.27	0.53
Feeder grade[c]				
Initial	11.0	11.0	10.3	10.8
Fall	11.0	11.6	11.3	11.6
Slaughter grade[d]				
Initial	6.3	6.0	5.8	5.8
12/6/73	7.2	7.9	7.0	7.4
4/1/74	11.0	11.3	11.3	11.3
Carcass evaluation[d]				
Carcass grade	10.9	11.0	10.6	10.9
Dressing %	55.4	55.1	56.1	55.6
Loin eye area, sq. in	9.9	9.4	9.2	9.6
Backfat, in.	0.46	0.58	0.62	0.61

[a]Code: 0-no elevation; 1-elevation; 2-marked elevation.
[b]Code: 0-no development; 1-development; 2-marked development.
[c]Code: 8-high medium; 9-low good; 10-av. good; etc.
[d]Code: 7-av. utility; 8-high utility; 9-low good; etc.

TABLE 3. EFFECT OF IMPLANTING ZERANOL IN GRAZING AND FATTENING HEIFERS - AVERAGE OF TRIALS 1 and 2

Lot no.	1	2	3	4
Implant, spring	None	Zeranol	None	Zeranol
Implant, fall	None	None	Zeranol	Zeranol
No. of cattle	34	31	30	36
Weight data, lb.				
Initial wt., spring	372	370	368	370
Wt., fall	562	580	568	579
Pasture gain	190	210	200	210
Da. gain, pasture	0.86	0.95	0.90	0.95
Wt., spring	710	732	718	742
Feedlot gain	148	152	152	162
Da. gain, feedlot	1.22	1.24	1.26	1.36
Gain, pasture & feedlot	338	358	354	372
Da. gain, pasture & feedlot	0.96	1.06	1.02	1.10
Tailhead elevation[a]				
Initial	0.24	0.25	0.30	0.30
Winter	0.50	0.40	0.40	0.28
Spring	0.24	0.46	0.39	0.33
Mammary development[b]				
Initial	0.08	0.14	0.05	0.02
Winter	0.02	0.08	0.02	0.06
Spring	0.16	0.31	0.18	0.36
Feeder grade[c]				
Initial	11.2	10.8	10.8	11.2
Fall	11.1	10.8	11.0	11.4
Slaughter grade[d]				
Initial	5.8	5.6	5.6	5.6
Winter	6.8	6.8	6.8	6.7
Spring	11.0	10.6	10.8	10.8
Carcass evaluation[d]				
Carcass grade	11.2	11.0	10.9	11.4
Dressing %	56.1	54.9	55.8	56.4
Loin eye area, sq. in.	10.0	9.6	9.6	9.8
Backfat, in.	0.52	0.56	0.59	0.76

[a]Code: 0-no elevation; 1-elevation; 2-marked elevation.
[b]Code: 0-no development; 1-development; 2-marked development.
[c]Code: 8-high medium; 9-low good; 10-av. good; etc.
[d]Code: 7-av. utility; 8-high utility; 9-low good; etc.

A COMPARISON OF RATIONS FOR SUCKLING LAMBS ON HEAVILY STOCKED PERMANENT PASTURE

J. S. Copenhaver, R. C. Carter, F. S. McClaugherty and T. L. Bibb

Previously reported work (Livestock Research Report, 1972-73, page 51) has shown that suckling lambs make very good gains on permanent bluegrass, orchardgrass, fescue and white clover pasture when they are stocked at rates as high as 6-8 ewes and 8-10 lambs per acre. Lambs fed a pelleted creep ration produced satisfactory but costly gains.

in 1973, a test was initiated to compare rations for suckling lambs on pasture to determine which ration would produce the highest gain at the lowest cost. The rations tested were:

1. A pelleted ration (16% protein) consisting of 25% mixed alfalfa hay, 13% soybean oil meal (44%), 5% molasses, 56% corn and 1% vitamins and minerals. This ration was fed in a creep and is the same ration that was used in previous work.
2. A 12% ground corn-soybean oil meal ration fed in a creep and limited fed.
3. A 16% ground corn-soybean oil meal ration fed in a creep and limited fed.

A group of western ewes and their lambs were divided into five groups and randomly assigned to grazing lots at the stocking rate of 6 ewes and 10 lambs per acre. Ewes and lambs were treated for internal parasites, weighed and put in the lots April 12, 1973. Lambs were weighed and drenched at 21-day intervals with alternate treatments of Loxon and Tramisol; ewes were weighed and treated at 42-day intervals. Lambs on limited fed ration received approximately 1 lb. fed/lamb per day in a trough and the creep fed ration was kept before the lambs in a creep feeder.

Lambs were removed from the lots as they reached market weight (95 lb.) and those remaining were removed 8/16/73. The results are shown in Table 1.

TABLE I. COMPARISON OF RATIONS FOR SUCKLING LAMBS ON PASTURE

	12% Corn-soybean meal		16% Corn-soybean meal		16% Pellets
How fed	Limited	Creep	Limited	Creep	Creep
Ewe performance:					
No. ewes/acre	6	6	6	6	6
ADG - lb.	-.071	+.032	+.008	+.008	-.04
Lamb performance:					
No. lambs/acre	10	10	10	10	10
Beginning et. - lb.	33	34	36	32	32
ADG - lb.	.38	.48	.42	.46	.65
Concentrate/day-lb.	.92	1.80	.92	1.81	2.52
Concentrate/lb. gain	2.39	3.73	2.23	4.00	3.99
Concentrate cost/ lb. gain	7.5¢	11.7¢	8.2¢	14.8¢	17.0¢

Cost based on: Corn $1.50/bu., SOM $155/ton, and pellets $85/ton.

There were considerable differences in rate of gain and feed cost per pound of gain. The lambs on pellets made much better gains than those on other rations, but the feed cost per pound of gain was high. The lambs on the 12% limited ration showed the lowest feed cost per pound of gain, but gains were less than satisfactory.

This test is being repeated.

A PERFORMANCE FEEDING TRIAL FOR SIMMENTAL x ANGUS AND LIMOUSIN x ANGUS BULLS AND STEERS

W. H. McClure and R. C. Carter

A test was conducted at the Shenandoah Valley Research Station in the summer and fall of 1973 to determine the performance of Simmental x Angus and Limousin x Angus bulls and steers when uniformly fed on a 140-day performance feeding test.

Experimental Procedure

Pre-test data on the bulls and steers is shown in Table I. All of the calves originated from one farm and had been handled as one herd until the calves were weaned.[1] The calves had been sired artificially by two Simmental or two Limousin bulls, and were out of Angus cows of similar age and quality. Half of the calves by each breed of sire had been castrated at random; the Limousin calves on 12/15/72 and the Simmental calves on 2/28/73. The calves were creep fed to weaning, weaned on May 23 and moved to the research station for the test.

The calves were placed on a coarsely ground ration shown in Table 2 upon arrival at the station, adjusted for one week and started on official test on May 30.

The bulls were fed together in one large pen and the steers together in one large pen. The ration was self-fed and weighed in daily. The bulls and steers were weighed at 14-day intervals during the test and feed in the troughs was weighed back at each weigh day. All cattle in the test were sonorayed at the beginning, middle and end of the test.

The official performance feeding test was concluded on October 17, 1973. Nine of the bulls were selected to be sold at the conclusion of the test and were sold at auction on November 14. The remaining bulls and steers stayed on feed until November 26, at which time they were slaughtered.

Results and Discussion

All of the cattle performed well during the 140-day test. Every Simmental sired bull and two of the three Limousin sired bulls had actual or adjusted 365-day weights of more than 1,000 pounds. One Simmental sired bull had an outstanding actual 365-day weight of 1,300 pounds.

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1 Thanks to Marland Farm, The Plains, Virginia for their cooperation in making the cattle available for this test.

The Simmental sired bulls gained an average of 3.30 during the test as compared to a 3.07 daily gain for the Limousin sired bulls. In comparing gains by the two respective breeds of sires, caution must be taken by the realization that the test included only 3 Limousin sired bulls.

In comparing test results of bulls vs. steers, all bulls in the test gained at the rate of 3.24 pounds per day with a ratio of 7.79 pounds of feed per pound of gain, and all steers gained at the rate of 2.59 pounds per day with a ratio of 8.63 pounds of feed per pound of gain. Performance summary is shown in Table 3.

Periodic backfat thickness measurements indicated that the steers deposited more fat during the test than the bulls. There was no difference in fat deposit patterns between the breeds of sires.

Carcass data is shown for the steers in Table 4. Data on bulls slaughtered is not shown because of the very limited number slaughtered. Although the steers were fed an additional 40 days after the feeding trial was conducted, the steers had probably not yet reached an optimum slaughter period.

TABLE I. PRE-TEST DATA ON BULLS AND STEERS

	Simmental Bulls	Simmental Steers	Limousin Bulls	Limousin Steers
No. head	9	8	3	3
Avg. birth date 1972	Oct. 15	Oct. 15	Oct. 19	Oct. 7
Avg. birth wt.	85.4	84.4	99.3	69.6[a]
Avg. wean. wt.	591.0	543.0	558.0	497.0
Avg. wt./day age at wean.	2.85	2.62	2.75	2.31

[a]Includes one calf born prematurely.

TABLE 2. COMPOSITION OF GROUND RATION (lb/100 lb. RATION)

Ear corn	53.3
Protein supplement[a]	13.8
Mixed hay	25.0
Molasses	7.0
T.M. salt	.5
Limestone	.4

[a]Ingredients per 100 lbs. supplement: 50 lb. soybean meal (50%); 43.5 lb. cottonseed meal (41%); and 6.5 lb. feed grade urea (281%).

TABLE 3. PERFORMANCE AND FEEDING SUMMARY OF BULLS AND STEERS

	Simmental Bulls	Limousin Bulls	Simmental Steers	Limousin Steers
No. head	9	3	8	3
Initial wt.	643	605	588	535
Final wt.	1105	1035	963	867
ADG	3.30	3.07	2.67	2.36
Backfat thickness 5-30	.09	.11	.10	.11
Backfat thickness 8-22	.19	.20	.21	.24
Backfat thickness 10-17	.24	.29	.34	.32
Feed intake, lb./hd/day[a]	25.3	25.3	22.4	22.4
Feed/lb. gain[a]	7.79	7.79	8.63	8.63

[a]Bulls and steers by both breed of sire fed together.

TABLE 4. CARCASS DATA - STEERS

	Simmental Steers	Limousin Steers
No. head	8	3
Sl. wt. (11-26)	1037	921
Dressing % [a]	57.5	57.7
Rib eye area	13.1	11.8
% K H P	2.56	2.67
Fat thickness	.48	.43
Carcass grade[b]	11.0	11.0
% cutability	51.7	51.4
Yield grade	2.3	2.4

[a]Determined by final weight at farm and hot carcass weight.

[b]Code: 10 = avg. good; 11 = high good; 12 = low choice; 13 = avg. choice.

A COMPARISON OF CORN SILAGE AND ALFALFA HAY (MIXED) FOR WINTERING EWES

J. S. Copenhaver, R. C. Carter and W. B. Williams

Two years results of this comparison were reported in the 1972-73 Livestock Research Report. These results indicated that supplemented corn silage is as good as a supplemented hay ration for wintering pregnant ewes but the lambs nursing the silage fed ewes did not gain as fast as those nursing the ewes receiving the hay ration.

The treatments were modified for the 1974 test and are as follows:

Treatment 1 (Control). Prior to lambing, this group of ewes were fed 3 3/4 lb. of second-cutting alfalfa/orchard grass hay and 1 lb. of ground ear corn per head per day. After lambing, they received 4 lb. of hay plus 2 lb. of ground corn daily.

Treatment 2 (Supplemented silage). These ewes were fed 3/4 lb. of ground ear corn, 6 lb. of corn silage (same silage as Treatment 3) and 1/2 lb. of soybean oil meal (44%) per ewe/day prior to lambing and 1 lb. of ground corn, 9 lb. of silage and 1/2 lb. of soybean oil meal (44%) after lambing.

Treatment 3 (Corn silage). These ewes were fed all the corn silage they would eat before and after lambing. This silage was made from 150 bu./acre corn with 20 lb. urea, 10 lb. ground limestone, 4 lb. di-calcium phosphate and 5 lb. of gypsum added per ton as it was ensiled. It tested 39% dry matter when fed. Table I shows rations fed in these treatments.

TABLE I. RATIONS FED--POUNDS/DAY

	Gestation			Lactation		
	Hay(1)	Suppl. Silage(2)	Silage(3)	Hay(1)	Suppl. Silage(2)	Silage(3)
Alfalfa Hay (mixed) lb.	3.75			4.00		
Corn silage lb.		6.00	9.20		9.00	11.90
Ground ear corn lb.	1.00	.75		2.00	1.00	
Soybean Meal (44%) lb.		.50			.50	
Total lb.	4.75	7.25	9.20	6.00	10.50	11.90
Feed Cost/Day	12.0¢	12.1¢	8.7¢	16.1¢	15.8¢	11.2¢

Cost based on: Hay $45/ton; Corn $2.50/bu.; SOM $150/ton; and Silage $18.80/ton.

Sixty western ewes of Suffolk x Rambouillet breeding were assigned to this test. Four weeks prior to expected lambing, (Feb. 15, 1974) the ewes were weighed and divided into three similar groups according to weight and the groups were randomly assigned to treatments.

These ewes were weighed at weekly intervals before lambing and ewes and lambs were weighed weekly after lambing. The test was completed on 4/3/74. The results of this test are found in Table 2.

TABLE 2. COMPARISON OF CORN SILAGE AND HAY FOR WINTERING EWES

	1 Hay (Control)	Suppl. 2 Silage	3 Silage
No. ewes exposed	20	20	20
No. lambing	20	20	20
No. lambs born	42	40	37
No.at end of test	36	33	33
Birth wt., lb.	9.4	9.4	9.7
Singles	8.5	9.2	9.7
Twins	9.9	9.8	9.6
Triplets	7.7	7.3	8.3
Av. age at end of test (days)	40	42	41
ADG (lb.)	.53	.51	.44
Wt./day age	.78	.71	.68
Lamb per ewe (lb.)	55.8	50.3	44.6
Ewe wt. 1/15/74 (lb.)	169	169	168
Ewe gain to lambing (lb.)	28	26	23
Days to lambing	33	30	32
ADG to lambing (lb.)	.85	.87	.72
Wt. before lambing (lb.)	197	195	191
Wt. after lambing (lb.)	161	165	160
Loss from lambing (lb.)	36	30	31
Wt. 4/3/74 (lb.)	157	157	149
Feed cost/pound lamb	18.7¢	20.4¢	16.5¢

Cost based on: Hay $45/ton; Corn $2.50/bu.; SOM $150/ton; Silage $18.80/ton

The lambs in the Control group (1) made slightly better gains than those in the supplemented silage group (2) and considerably better gains (.09 lb./day) than those in the full fed silage group (3). The full fed silage group showed the lowest feed cost/day and per pound of lamb. This work will be repeated next year.

"Litters of Lambs"

PERFORMANCE OF FINN CROSS EWES

R. C. Carter and J. S. Copenhaver

In recent years, sheepmen in Virginia, and the United States, have become much interested in the Finnish Landrace breed of sheep (Finnsheep) because of its high prolificacy. In Finland, the average litter size for mature Finnsheep ewes is 3 lambs per ewe lambing. In the fall of 1970, we obtained 4 Finnsheep ram lambs, 3 from Alberta, Canada, and one from the U.S.D.A. of Beltsville, Maryland. Since then, we have obtained 3 others. Also, some 1/2 Finn-1/2 Rambouillet rams were procured.

These rams were received rather late in the fall of 1970 and only a few ewes were bred to them that fall. From these we raised ten 1/2 Finn ewes in 1971, of which we still have eight. In 1971, a number of Rambouillet and a few Suffolk x Rambouillet ewes were bred to the purebred Finn and 1/2 Finn-1/2 Rambouillet rams. From these matings, we raised thirty 1/2 Finn and Forty-two 1/2 Finn ewes in the spring of 1972.

These 1972 ewes were bred to Suffolk rams in March and April 1973 when they were about 12 months of age. Of the thirty 1/2 Finn ewes, twenty-five lambed in September producing a total of 44 lambs of which 8 were singles and 36 twins. In other words, 2/3 of these yearling ewes had twins in out-of-season breeding. Of the forty-two 1/4 Finn ewes, 30 lambed in September producing 19 single lambs and 12 sets of twins for a total of 43 lambs born.

The ewes bred in March-April 1973, that failed to lamb in September of that year, were bred in September. Those lambing in September had their lambs weaned at about 5 weeks of age and were rebred in November to lamb in April and May 1974. Of twenty-seven 1/2 Finn ewes exposed in November, 22 lambed producing 50 lambs (2 singles, 12 sets of twins and 8 sets of triplets. Of the thirty-seven 1/4 Finn ewes bred in Nobemver, 26 lambed producing 44 lambs (3 singles, 16 sets of twins and 1 set of triplets).

Thus, in a period of 14 months, the thirty 1/2 Finn ewes produced 102 lambs and the forty-two 1/4 Finn ewes produced 96 lambs by the time they were about 26 months of age. The lambs have been vary hardy and death losses have been low. Only 7 of the 102 lambs from 1/2 Finn ewes and 6 of the 96 lambs from the 1/4 Finn's died before weaning. This is substantially less than we normally have from other breeds of ewe.

The lambing results are shown in the table below.

TABLE I. LAMBING PERFORMANCE OF 1/2 AND 1/4 FINN CROSS EWES

Breed cross of ewe	1/2 Finn-1/2 Ramb.			1/4 Finn-3/4 Ramb.		
Lambing season	Fall 1973	Winter 1974	Spring 1974	Fall 1973	Winter 1974	Spring 1974
No. exposed	30	5	27	42	12	37
No. lambing	25	3	22	30	7	26
Lambs born	44	8	50	43	9	44
Lambs raised	41	7	47	39	7	44
Singles	8		2	19	3	9
Twins	36	2	24	24	6	32
Triplets		6	24			3
Deaths to weaning	3	1	3	4	2	0

The results are very encouraging. With the 1/2 Finn crosses, 30 ewes have produced 3.4 lambs per ewe in a 14-month period and within the first two years of their life. The forty-two 1/4 Finn ewes have averaged 2.3 lambs in the same period. Obviously, the 1/2 Finns are more prolific than the 1/4 bloods. Which would be more desirable probably depends on the management system. Under intensive management with early weaning, the greater prolificacy of the half-breds would be more desirable. These young ewes have been able to raise triplets (with creep feed) to weaning time. Under less intensive management, with the ewe nursing her lambs on pasture for 90-100 days, perhaps the 1/4 Finn ewes, with somewhat lower prolificacy, would be more desirable.

The eight 1/2 Finn ewes born in 1971, now 3 years old, have lambed through 4 seasons (2 years). They have 58 lambs born of which 52 were weaned. In this last lambing (spring, 1974) seven had triplets and one twins.

INBREEDING vs. SELECTION FOR IMPROVEMENT OF BEEF CATTLE

R. C. Carter, J. S. Copenhaver and Will T. Butts, Jr.[1]

Research in beef cattle breeding was conducted at the Beef Cattle Research Station, Front Royal, Va. from 1948 to 1973. This research was conducted cooperatively by the Animal Science Department of V.P.I. & S.U. and the U. S. Department of Agriculture. The objective of the research was to compare two major breeding systems for the improvement of growth rate and body conformation of beef cattle. The two systems were: (1) inbreeding with subsequent crossing among inbred lines; and (2) selection for growth rate and conformation.

Four inbred lines were developed in the Angus, Hereford and Shorthorn breeds. In addition, two selection lines, one for growth rate from birth to about a year of age, and one for type or conformation was developed in each of the three breeds. In the selection lines only the single trait, growth rate or conformation, was considered. In the inbred lines selection was based on an index giving equal weight to growth rate and conformation.

Tests to compare the breeding value of the four inbred and two selection lines developed in the Shorthorn breed were started at Blacksburg in 1964. A herd of 120 high grade or purebred Shorthorn cows, unrelated to the Front Royal lines, was assembled. Bulls from each of the inbred and selection lines were mated to approximately equal numbers of cows in the test herd. In the first phase of the test, covering six calf crops, comparisons were made on the progeny of the bulls of the six lines in the first cross. Results from this phase was reported in detail in the 1972-73 Animal Science Department Research report (Research Division Report 173) and will not be repeated here.

The heifer calves sired by bulls of the inbred and selection lines were retained and put back into the herd to replace the original test herd. In Phase II of the test, a second cycle of topcrossing is being carried out. Daughters of bulls of one inbred line are mated to bulls of the other three inbred lines. Daughters of the type and growth selection lines are mated to bulls of the type or growth selection lines but not to the inbred lines. Thus, the comparison in Phase II is between rotational topcrossing of inbred lines with continuous use of bulls from lines selected for growth rate or conformation alone.

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[1] Leader in beef cattle breeding research for Southern Region, Animal Husbandry Research Division, A.R.S., U.S.D.A., Knoxville, Tennessee (Regional Research Project S-10).

In Phase II, both steers and heifers by sires of the inbred and selection lines are placed in the feedlot at weaning and fed out to slaughter weight and condition (750-800 lb for heifers, 900-1000 lb for the steers and high good to low choice grade). Rations for both steers and heifers consist of a full feed of high quality corn silage, protein supplement and 1% of body weight of grain (corn and/or barley) daily. Carcass grades and other carcass data are obtained.

Results and Discussion

Results in terms of adjusted 205-day weaning weight, average daily gain (ADG) in feedlot and carcass grades are shown through the 1972 calf crop in the table below. The values in the table are simple average of steers and heifers.

TABLE 1. TOPCROSS PROGENY MEANS (PHASE II) OF INBRED & SELECTION LINE SIRES (AV. STEERS & HEIFERS)

Line	205-day wt.	ADG	Car. Grade[1]
Inbred 1	461	1.70	12.8
2	453	1.74	11.4
4	450	1.71	12.7
5	436	1.60	11.7
Av. Inbred	448	1.69	12.2
Type	440	1.61	12.2
Growth	471	1.69	11.9

[1]Grade code: 11 = Good Plus; 12 = Low Choice

The results in the table show the progeny of growth selected bulls to be heavier at weaning than those of the inbred bulls. However, this is not true of daily gain in the feedlot nor carcass grade. The average feedlot daily gain for the inbred progenies is equal to that of the growth line offspring. There is little difference in carcass grades with the exception of inbred line 2 which averaged somewhat lower than the other groups. These results suggest that use of bulls of selected inbred lines in rotational topcrossing may compare favorably with those selected for growth rate alone. It is of interest that bulls in the type selection line were near the bottom in respect to growth rate, both 205-day weight and feedlot gain, and were not superior to most of the other lines in carcass grade.

IMPROVING GROWTH RATE IN HAMPSHIRE SHEEP

Harold Hupp, R. C. Carter, J. S. Copenhaver,
W. H. McClure and F. S. McClaugherty

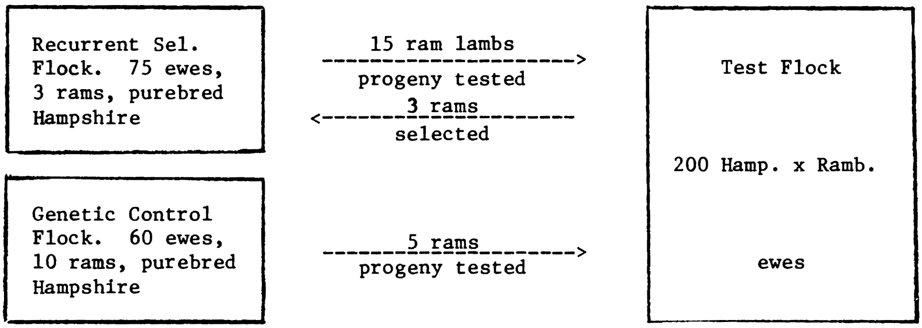
The mutton or Down breeds of sheep, such as the Hampshire or Suffolk, exist primarily to furnish rams to sire market lambs from ewes of a variety of breeds and crosses. Growth rate of the lamb from birth to market or weaning weights is the most important economic characteristic to be selected for in these "ram" breeds. However, heritability of pre-weaning growth rates in these breeds has been found to be quite low, various estimates ranging from near zero to 15-20%. Results from progeny testing of more than 200 Hampshire rams, over a period of nearly two decades, at the Virginia Station, has shown near zero correlation between the pre-weaning growth rate of a ram and the growth of the lambs that he sires.

With such low heritability, or such low predictive value of a ram lamb's own growth rate as an indication of his breeding value, direct selection on individual performance to weaning is not particularly encouraging. Selection on the basis of progeny testing of rams should be more effective, although more expensive and time consuming.

An experiment to test the effectiveness of progeny testing as a basis of selection for the improvement in lamb growth rate was started at the Virginia Station in 1956. Samples of purebred Hampshires, both rams and ewes, were obtained from 14 flocks widely distributed over the United States. Two closed flocks were established from this foundation.

In one flock of 3 rams and about 75 ewes, selection is practiced on the basis of progeny testing of rams and selection of those with the fastest gaining lambs. This procedure is known as recurrent selection and the flock designated as the Recurrent Selection (RS) flock. Another group of 10 rams and 50-60 ewes is maintained without selection as a Genetic Control (GC) flock from which to measure progress made by recurrent selection in the RS flock.

Each year 15 ram lambs from the RS flock are progeny tested by mating each to 10 Hampshire x Rambouillet ewes in a test flock. The 3 rams, of the 15 tested, with the fastest gaining lambs from birth to market weights of 95-110 lb are selected to go back into the RS flock, replacing the 3 used the previous year. At the same time 5 rams from the Genetic Control (GC) flock are also progeny tested by breeding them to 10 of the Hampshire x Rambouillet ewes each. Comparison of the growth rate of lambs sired by the RS and GC rams provides a measure of the progress made by the selection practiced. The progeny testing and mating scheme is shown in the diagram following.



Results and Discussion

Twenty ram lambs were progeny tested in 1972-73 by breeding each to some 12 ewes in the test flock at Steeles Tavern. These consisted of 14 selected at random from the Recurrent Selection (RS) flock, 4 from the Genetic Control (GC) flock and 2 from the outbred flock of the VPI Animal Science Department at Blacksburg. The ewes in the test flock were Suffolk crossbreds and were either 2 or 3 years old. All lambs were weaned at about 60 days of age and finished to market weight of 90 to 110 lb in confinement on slatted floored pens. The lambs were self-fed a complete pelleted ration.

Average daily gains (from birth to market weight) of groups of lambs sired by the 20 rams are shown in Table 1, ranked from high to low. The first 11 progenies were sired by Recurrent Selection rams. The progenies of the 4 Genetic Control lambs ranked 13th, 14th, 16th and 19th, of the 20 tested. The two rams from the outbred flock ranked 12th and 20th.

The results are encouraging. Average rank of the RS rams was higher than had been achieved in any of the earlier years of the test. This suggests that progress has been made in improving the breeding value of the Recurrent Selection flock for transmitting rapid growth to their crossbred progeny.

In Table 2 we show the average of the progeny daily gains for RS and GC lambs for each of the last 6 years. With two exceptions, the RS rams were distinctly superior to the GC rams with respect to progeny growth rates. The same information is shown graphically in the figure following. The upper line shows the difference between the average growth rate of all RS progenies and that of the GC rams. The horizonal base line represents the means of the lambs by the GC rams.

TABLE I. RAM PROGENY AVERAGE DAILY GAINS FROM BIRTH TO MARKET WEIGHT (90-110 lb) - 1972-73

Rank	Ram No.	Progeny ADG	Flock of Origin
1	V-247	.563	RS (Recurrent Selection)
2	V-291	.548	RS
3	V-232	.534	RS
4	V-201	.532	RS
5	V-267	,529	RS
6	V-249	.527	RS
7	V-268	.523	RS
8	V-205	.522	RS
9	V-228	.516	RS
10	V-295	.507	RS
11	V-255	.500	RS
12	V-111	.497	OB (College Outbred)
13	V-616	.492	GC (Genetic Control)
14	V-639	.480	GC
15	V-236	.479	RS
16	V-636	.478	GC
17	V-251	.473	RS
18	V-203	.468	RS
19	V-622	.462	GC
20	V-133	.446	OB

TABLE 2. PROGENY TEST ADG MEANS FOR RECURRENT SELECTION AND GENETIC CONTROL FLOCKS[a]

	Recurrent Selection		Genetic Control
Year	Mean ± S.E.	S.D.[b]	Mean ± S.E.
1968	.620 ± .031	.038	.572 ± .022
1969	.622 ± .038	.042	.613 ± .038
1970	.646 ± .031	.053	.626 ± .013
1971	.610 ± .046	.046	.604 ± .038
1972	.435 ± .060	.015	.391 ± .053
1973	.518 ± .029	.060	.480 ± .013
Mean	.588 ± .040	.042	.561 ± .031

[a] Weight in pounds

[b] S.D. = Selection differential

FIGURE I. ADG DIFFERENCES BETWEEN RECURRENT SELECTION AND GENETIC CONTROL FLOCKS

REPEATABILITY OF LIVE ANIMAL SCORES IN BEEF CATTLE

T. J. Marlowe and L. L. Benyshek

Man has been making visual appraisals of his animals since the formation of the breeds. Livestock shows have been a major part of livestock activities at local, state and national levels for more than a century. Colleges of Agriculture have been training livestock judging teams in competition with other teams almost from the inception of the land grant college system. In 1931 Virginia initiated a livestock grading program for lambs and in 1938 a similar program for cattle. Even though we have a long history of visual evaluation of animals little effort has been made to determine the repeatability of such scores.

The purpose of this study was to determine the repeatability of subjective scoring of animals for such traits as conformation (grade), condition, masculinity or femininity, frame, muscling, soundness and general appearance when scored by both experienced and inexperienced cattle graders.

Experimental Procedure

Three trials were conducted using from 5 to 7 graders in each trial. Graders varied in experience from young graduate students with almost no experience to personnel from the livestock grading section of the Virginia Division of Markets and animal scientists at VPI with more than 20 years of experience. The time lapse between scorings of the same animal varied from 5 days in trial 1 to only a few hours in trials 2 and 3. A simple correlation between the two scores on each animal was obtained for each grader in each of the trials. Also, the average of a committee score of the more experienced graders was used to obtain the correlation for each trait based on committee averages.

Conformation and condition were scored on a scale of 3-17, corresponding to the grading system commonly used in performance testing programs throughout the nation. Masculinity, femininity, frame and muscling were all scored on a scale of 1-5. Soundness and general appearance were scored on both a 1-3 and 1-9 scale in trial 3.

Repeatabilities were obtained separately for bulls, heifers and cows in trial 1. The graders were numbered in alphabetical order from 1-13. Graders 1, 2, 4, 7 and 9 were graduate students. Graders 2, 4 and 9 had little or no previous experience, whereas 1 and 7 had had considerable experience. Graders 3, 5, 6, 10, 12 and 13 were members of the Animal Science Faculty at Virginia Polytechnic Institute and State University. Graders 8 and 11 were employees of the livestock grading section, Virginia Division of Markets. Therefore, the range of experience was from almost no experience to more than 30 years. One grader is nationally recognized as a cattle judge and four others have more than 20 years of experience each.

Trial I. Trial 1 was conducted in February 1971 with graders 1-7 participating, however grader 3 graded only the bulls. In this trial 81 yearling bulls, 81 yearling heifers and 90 mature cows were scored on February 11 and again on February 16 for conformation (grade), condition, masculinity or femininity, frame and muscling. The committee averages were the averages of the individual scores of graders 1, 5, 6 and 7.

Trial II. Trial 2 was conducted on March 21, 1972 with 7 graders scoring 95 yearling bulls on conformation, condition, masculinity, frame and muscle. Bulls were scored independently by each grader before lunch and again after lunch. The 7 graders in this trial included 2 graduate students, 2 graders from the livestock grading section of the Virginia Division of Markets and 3 VPI faculty members, including one nationally known livestock judge. The committee averages in this trial were the averages of the individual scores of all graders except the graduate student with practically no experience (grader no. 9).

Trial III. Trial 3 was conducted on May 11, 1973 by 5 graders consisting of one experienced graduate student, one representative of the livestock grading section of the Virginia Division of Markets and 3 Animal Science faculty members, one of which is a nationally known livestock judge, one in research and the third one is the beef cattle extension specialist with more than 30 years experience. In this trial 70 yearling bulls were scored before lunch and again after lunch on grade, condition, masculinity, frame, muscling, soundness and general appearance. Soundness and general appearance were scored both on a scale of 1-3 and 1-9. The committee average in this trial was the average of all individual scores.

Results and Discussion

The correlation coefficients shown in tables 1-5 show the repeatability of scores by each grader for each trait along with the relationship among the various traits. As was to be expected, the correlation between committee averages were higher than that for individual scores.

Repeatability of Scores. The correlation coefficients between two scorings of each animal represents the repeatability for the trait in question and is shown for yearling bulls in tables 1, 4 and 5. Similar repeatabilities for yearling heifers are shown in table 2 and for Hereford cows in table 3. The repeatability values for yearling heifers and cows should be compared to the repeatability values for yearling bulls only in trial 1 since there was a 5 day lapse in timing between these scorings, whereas in trials 2 and 3 there was only a few hours lapse of time.

Looking first at the repeatability scores for bulls, heifers and cows in trial 1 we see that the repeatability values are quite similar for the yearling bulls and heifers but considerably lower for the cows. Repeatability of scores is considerably lower among the less experienced graders also, particularly graders 2 and 4 who had the least experience of the graders in this trial. The most experienced grader in this trial was grader no. 5 who in general has the highest repeatability scores.

There is also considerable variation in the degree of repeatability among the several traits. For example, in trial 1 the most highly repeatable trait was the condition of the animal, followed closely by an overall conformation score which we have called grade. The least repeatable trait was masculinity or femininity. The highest individual repeatability for this trait was only .55 and the repeatability of committee averages was only .60, .55 and .28 for bulls, heifers and cows, respectively. These low repeatability values do not support the recommendations of livestock judges over the decades that breeders should pay particular attention to masculinity in bulls and femininity in cows when selecting herd replacements.

The amount of time between scorings had a significant influence on the magnitude of the correlation coefficient. Looking in tables 4 and 5 at the repeatability values for trials 2 and 3 on yearling bulls we find that both the individual repeatabilities and the repeatability of committee averages is considerably larger than found in trial 1. Even the relatively inexperienced graders (nos. 4 and 9) in trial 2 have repeatabilities comparable to experienced graders in trial 1. The importance of time becomes even more evident when scores at weaning are correlated with scores as yearlings, with a time difference of approximately 5 months. These correlations for two graduate students and one faculty member were .27, .21 and .40 for grade, and .20, .47 and .48 for condition, respectively. Corresponding repeatabilities of the averages of the three graders were only .28 for grade and .42 for condition.

When animals are scored twice in the same day there is little opportunity for the animal itself to change, therefore, the failure to obtain a perfect correlation between these scores is due largely to the errors of judgment of the grader. Even though repeatabilities of all graders for all traits greatly increased when both scorings were done on the same day there was still considerable variation among traits, with masculinity remaining as the least repeatable of the several traits scored. The repeatability of committee averages was greatly increased with the repeatabilities of grade, frame and muscling being of the order of .90 and condition and masculinity being of the order of .80.

In trial 3 masculinity was dropped and soundness and general appearance added to the list of traits to be scored. Soundness and general appearance were scored both on a scale of 1-3 and a scale of 1-9. The scale used did not appear to be very important except for grader no. 5 who improved his repeatability considerably by using the 1-9 scale. The repeatability of committee averages for these traits were of the order of .8 for general appearance and .7 for soundness.

Relation Among Scores. The correlation coefficients shown in tables 1-5 indicate that most of these traits are positively related. The only exceptions found were the negative correlations between condition and frame score among yearling bulls, between condition and femininity among both heifers and cows and between frame and femininity among cows in trial 1. All of these negative correlations are quite small and non-significant. This generally positive relationship was expected since many of these are part-whole relationships, particularly the correlation of traits with grade since grade is itself an overall conformation score which is influenced by condition, frame and muscling. These correlations were all positive and moderate to high in magnitude. The high correlations between grade and frame and grade and muscling would appear to make the additional scores on frame and muscling of little value. The low correlation between condition and frame indicates that fatter animals appear to be smaller in frame, thus tending to obscure the benefits to be derived from scoring animals on frame; however, both frame and muscling are highly repeatable traits. The high correlations between conformation and general appearance and between frame and general appearance indicate that there is little need for scoring on all three of these traits.

Summary

Three trials were conducted, using a total of 13 graders, to determine the repeatability of subjective scoring of animals for such traits as conformation, condition, masculinity or femininity, frame, muscling, soundness and general appearance. In trial 1, 81 yearling bulls, 81 yearling heifers and 90 cows were scored by 7 graders on 5 days apart. In trials 2 and 3 animals were scored twice on the same day. In trial 2, 95 yearling bulls were scored by 7 graders and in trial 3, 70 yearling bulls were scored by 5 graders. In each trial committee averages were obtained by averaging the individual scores of the most experienced graders and running a correlation between these committee averages. As was expected, the repeatability of committee averages was higher than that for individual scores. In the first trial repeatability values were quite similar for yearling bulls and heifers but considerably lower for cows; also, repeatability was considerably lower for the less experienced graders. There was also a considerable variation in the degree of repeatability among the several traits, with condition and grade being highest and masculinity or femininity lowest in repeatability.

The lapse of time between scorings of individual animals also had a significant influence on the size of the correlation coefficient. In fact, graders with limited experience obtained almost as high repeatability scores on yearling bulls when scored twice on the same day as experienced graders obtained when the grades were taken five days apart.

When animals were scored twice on the same day the repeatability of committee averages was of the order of .90 for grade and frame,

.85 for condition and muscling, .80 for general appearance and masculinity and .70 for soundness. Individual scores, however, were considerably lower. Some individual scores on certain traits were of approximately the same magnitude as the committee averages but no individual score was consistently high on all traits.

Note
The authors express their appreciation to each of the participating graders and to the personnel of Bland Correctional Farm for their assistance and for making the cattle available.

TABLE 1. REPEATABILITY OF AND RELATION AMONG SCORES ON YEARLING BULLS IN TRIAL I.

	Grader							Com
Trait	1	2	3	4	5	6	7	Av.
Grade	.51	.40	.55	.29	.59	.29	.57	.72
Condition	.67	.50	.74	.39	.81	.40	.60	.81
Frame	.43	.38	.43	.49	.57	.36	.45	.71
Masculinity	.16	.39	.55	.47	.55	.45	.27	.60
Muscling	.50	.18	.26	.41	.43	.26	.11	.69
Grd x Con	-.43	.45	.06	.03	.44	.47	.05	.09
Grd x Frm	.67	.53	.27	.54	.63	.66	.31	.71
Grd x Mas	.01	.28	.32	.33	.47	.55	.14	.41
Grd x Mus	.47	.40	.53	.39	.69	.58	.47	.80
Con x Frm	-.48	.16	-.18	-.32	.06	.51	-.26	-.11
Con x Mas	.18	.30	.34	.14	.31	.52	.25	.42
Con x Mus	.06	.44	.20	.41	.24	.59	.04	.32
Frm x Mas	-.09	.33	.10	.15	.26	.53	.02	.18
Frm x Mus	.28	.41	.21	.18	.59	.58	.36	.57
Mas x Mus	.17	.29	.26	.46	.32	.57	.12	.49

TABLE 4. REPEATABILITY OF AND RELATION AMONG SCORES ON YEARLING BULLS IN TRIAL II.

Trait	Grader 4	5	8	9	10	11	12	Com Av.
Grades	.85	.77	.74	.52	.70	.69	.87	.89
Condition	.47	.81	.69	.56	.34	.65	.52	.81
Frame	.80	.74	.77	.51	.87	.58	.90	.91
Masculinity	.47	.69	.42	.53	.21	.57	.52	.78
Muscling	.76	.78	.69	.42	.65	.52	.62	.91
Grd x Con	.10	.48	.78	1.00	.64	.59	.37	.61
Grd x Frm	.92	.58	.55	.60	.81	.37	.93	.81
Grd x Mas	.21	.39	.55	.68	.19	.44	.37	.53
Grd x Mus	.88	.73	.72	.51	.79	.53	.73	.87
Con x Frm	.01	.49	.41	.60	.49	.53	.37	.53
Con x Mas	.27	.58	.56	.68	.25	.51	.43	.73
Con x Mus	.19	.64	.58	.71	.50	.63	.29	.68
Frm x Mas	.12	.43	.35	.60	.30	.70	.41	.48
Frm x Mus	.80	.72	.52	.62	.78	.66	.72	.88
Mas x Mus	.32	.44	.46	.68	.30	.62	.44	.56

TABLE 2. REPEATABILITY OF AND RELATION AMONG SCORES ON YEARLING HEIFERS IN TRIAL I.

Trait	Grader 1	2	4	5	6	7	Com Av.
Grade	.66	.63	.48	.74	.57	.79	.81
Condition	.66	.49	.57	.78	.61	.57	.85
Frame	.41	.55	.57	.72	.64	.32	.72
Femininity	.20	.17	.30	.41	.28	.51	.55
Muscling	.21	.58	.34	.62	.55	.49	.74
Grd x Cond	-.03	.63	.27	.62	.77	.16	.52
Grd x Frm	.74	.67	.65	.55	.73	.39	.77
Grd x Fem	.25	.13	.18	-.22	.50	.09	.15
Grd x Mus	.52	.63	.56	.71	.70	.64	.84
Con x Frm	-.17	.50	.03	.32	.69	-.08	.24
Con x Fem	-.12	.17	-.10	-.36	.37	-.19	-.15
Con x Mus	.28	.61	.38	.48	.75	.33	.67
Frm x Fem	.22	.13	.28	-.10	.49	.06	.16
Frm x Mus	.27	.59	.30	.60	.73	.28	.61
Fem x Mus	.09	.06	-.05	-.10	.35	.04	.03

TABLE 3. REPEATABILITY OF AND RELATION AMONG SCORES ON HEFEFORD COWS IN TRIAL I.

Trait	Grader 1	2	4	5	6	7	Com Av.
Grade	.27	.37	.38	.51	.51	.41	.64
Condition	.35	.33	.36	.42	.57	.09	.60
Frame	.25	.20	.25	.49	.39	.43	.68
Femininity	.34	.23	.27	.34	.33	.18	.28
Muscling	.21	.43	.25	.47	.40	.20	.61
Grd x Con	-.01	.57	.01	.39	.56	-.03	.42
Grd x Frm	.69	.52	.59	.61	.47	.35	.64
Grd x Fem	.13	.15	.06	.00	.33	.00	.00
Grd x Mus	.50	.50	.31	.72	.45	.33	.63
Con x Frm	-.08	.42	-.03	.27	.53	.02	.27
Con x Fem	-.12	.10	.06	-.16	.40	-.15	-.02
Con x Mus	.15	.62	.19	.33	.63	.26	.55
Frm x Fem	.11	.07	.02	.10	.18	-.19	-.08
Frm x Mus	.24	.47	.15	.53	.64	.25	.56
Fem x Mus	.09	.17	-.05	.00	.26	-.02	-.08

TABLE 5. REPEATABILITY OF AND RELATION AMONG SCORES ON YEARLING BULLS IN TRIAL III.

Trait	Graders 1	5	8	10	13	Com Av.
Grade	.78	.80	.84	.58	.80	.91
Condition	.66	.82	.93	.54	.75	.88
Frame	.79	.75	.78	.83	.78	.91
Muscling	.73	.71	.57	.52	.64	.83
Gen Appear 1	.49	.50	.73	.63	.52	.83
Gen Appear 2	.50	.76	.78	.63	.60	.81
Soundness 1	.27	.31	.30	.39	.81	.70
Soundness 2	.29	.61	.43	.39	.71	.66
Grd x Con	.42	.68	.30	.40	.09	.48
Grd x Frm	.73	.70	.81	.57	.76	.83
Grd x Mus	.74	.73	.39	.53	.33	.75
Grd x GA2	.63	.78	.83	.70	.61	.86
Grd x Sd2	.41	.62	.39	.51	.29	.65
Con x Frm	.20	.53	.19	.15	.00	.31
Con x Mus	.44	.62	.44	.31	-.01	.51
Con x GA2	.32	.55	.28	.28	.24	.45
Con x Sd2	.38	.45	.29	.22	.22	.42
Frm x Mus	.58	.61	.27	.59	.42	.61
Frm x GA2	.48	.53	.70	.66	.31	.72
Frm x Sd2	.31	.37	.30	.40	.12	.43
Mus x GA2	.53	.66	.40	.56	.16	.67
Mus x Sd2	.34	.51	.32	.41	.05	.60
GA2 x Sd2	.34	.73	.48	.53	.27	.69

TABLE 6. RANGE OF SCORES BY GRADERS IN TRIAL III.

Trait	Time	Grader 1	5	8	10	13	Com Av.
Grade	AM	8-14	8-14	10-15	9-13	8-15	8.6-13.6
	PM	9-14	7-14	10-15	8-15	9-14	9.4-14.2
Condition	AM	8-12	4-11	4-11	8-11	5-11	4.8-10.6
	PM	8-12	4-12	4-11	8-11	5-11	5.8-11.0
Frame	AM	1-5	1-5	2-5	2-5	2-5	1.8-5.0
	PM	2-5	2-5	2-5	2-5	2-5	2.0-5.0
Masculinity	AM*	1-5	1-4	1-4	1-5	--	1.0-4.6
	PM	2-5	1-5	1-4	1-5	--	1.2-4.6
Muscling	AM	1-5	2-5	2-4	2-5	2-4	1.8-4.6
	PM	2-5	2-5	2-4	2-4	2-4	2.0-4.6
Gen Ap 1	AM	1-3	1-3	2-3	1-3	1-3	1.2-3.0
	PM	1-3	1-3	2-3	1-3	2-3	1.6-3.0
Gen Ap 2	AM	2-8	2-9	4-9	2-8	2-8	2.8-8.2
	PM	2-8	3-9	4-9	2-8	4-8	3.6-8.2
Sound 1	AM	1-3	1-3	2-3	2-3	1-3	1.6-3.0
	PM	1-3	2-3	2-3	1-3	1-3	1.6-3.0
Sound 2	AM	2-8	2-9	4-8	5-8	2-8	3.0-8.0
	PM	2-8	4-9	4-8	2-8	2-8	3.8-8.2

*Range in masculinity was taken from trial II.

HETEROSIS FROM CROSSES AMONG BRITISH BREEDS OF BEEF CATTLE

J. A. Gaines, R. C. Carter and W. H. McClure

The objective of the phase of the experiment to be reported here is to compare straightbred calves with crossbred calves from crossbred dams. This is a continuation of previously reported results from crossing the Angus, Hereford, and Shorthorn breeds, and it is preliminary to results comparing straightbreeding with rotational crossbreeding. In 1960, the cow herd originally consisted of sixty straightbreds (Angus, Hereford, and Shorthorn) and sixty crossbreds (reciprocal two-breed crosses) among the three breeds. It has dwindled to 37 straightbreds and 46 crossbreds. The first five calf crops were used to compare straightbred and crossbred cows, and the results have been reported previously. The sixth through eleventh calf crops are included in this report to compare straightbred calves with three-breed cross calves out of two-breed cross dams. Results are as follows: 278 straightbred matings weaned 233 calves (83.8%); 303 crossbred matings weaned 284 calves (93.7%). There are large differences in birth weight, weaning weight, slaughter weight, and carcass weight, all in favor of the crossbreds. Differences in quality, as measured by feeder grade, slaughter grade, and carcass grade are negligible. The increase in total yield at weaning is of the order of 25%. One more calf crop will be weaned from these cows, after which a full-length publication will be prepared comparing lifetime production of the straightbred versus crossbred cows.

The first calf crop in the rotational crossbreeding phase of the experiment has been slaughtered. There were 137 cows exposed to mating. Weaning weight of 44 straightbred calves was 367 lbs., and of 57 crossbred calves was 414 lbs. Only a portion of the steers was fed out; slaughter weight of 23 straightbred was 850 lbs., and of 24 crossbreds was 893 lbs.

EVALUATING BULL BREEDS FOR BEEF PRODUCTION AT VIRGINIA STATE FARM

T. J. Marlowe[1], E. M. Chenault[2], E. S. Strauderman[2] and R. C. Oliver[3]

This cooperative research was initiated in 1970 as an extension of other cooperative research between the Virginia Division of Correction and the Animal Acience Department of VPI & SU initiated at three other locations in 1968. At the time the project was initiated approximately 350 cows and 90 yearling heifers of Hereford breeding were available for the project.

The objective of the correctional farm is to increase its beef supply for the inmates at State Farm and to be able to supply beef for other institutions. The objectives of the research project are threefold: 1) to evaluate several breeds as possible sire breeds, 2) to evaluate several cow breeds and crosses on reproductive performance, and 3) to determine the best combinations of breeds and mating schemes for maximizing beef production.

The purpose of this article is to present a progress report on phase I (sire breed evaluation) of the project.

Experimental Procedure

Allotment of Bulls and Cows. Prior to the 1971 breeding season cows were allotted at random within age groups to 9 breeding herds of approximately 40 cows each. Two Charolais, 2 Holstein, 1 Hereford and 1 Polled Hereford bull were then allotted at random to 6 of the cow groups. The remaining 3 cow groups were combined for artificial breeding with semen from Simmental bulls. All heifers were bred to either Angus, Hereford or Polled Hereford bulls.

Prior to the 1972 breeding season it was decided that in addition to the sire breeds used in 1971 Brown Swiss and Shorthorn bulls would be added. This addition enlarged the comparisons to 3 British breeds, 2 Continental breeds and 2 American dairy breeds. The main reason for adding the 2 dairy breeds was to provide crossbred females of one-half dairy blood for the phase II comparison on cow productivity.

By adding young cows with their first calves and by bringing additional cows into the herd from Beaumont, 405 cows were available for the 1972 breeding season. Again, cows were allotted at random within age groups into 10 breeding herds of 40 cows each, except that 45 cows went into one herd. Bulls were again allotted at random to the cow herds. This time two bulls of the same breed were turned with each group of cows since the objective was to evaluate sire

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breeds rather than individual sires and since extra bulls were available. Also, three groups of cows were again combined for artificial insemenation with semen from Simmental bulls.

This procedure was followed for the 1973 and 1974 breeding seasons, which will complete phase I of the project. One Polled Hereford and one Simmental bull have been used during all four breeding seasons in order to obtain an estimate of seasonal differences. Otherwise, bulls of all breeds have normally been changed each year in an effort to obtain as wide a sample of bulls of each breed as possible.

The total number of bulls of each breed used in the sire breed evaluation (phase I) are shown in table 1.

TABLE 1. BULLS USED IN PHASE I AT VIRGINIA STATE FARM.

Breeds	1971	1972	1973	1974	Total Diff Bulls
Charolais	MB30	847, 5207	635, 794	24	
	3040	3040	789, MB30	25	9
Brown Swiss		BS1, 39	40, 41	58, 69	6
Hereford	2607				
	6611	6611	6611	7025	3
P. Hereford	229		004, 005	005, 313	
	233	233, 311	034, 233	233	7
Holstein	125, 126	3169, 3170	B2, B3	719, 812	8
Shorthorn		7249, 8226	7249, 7309	0076, 0150	5
Simmental	7053	7052, 7055	7053, 7111	7053, 7116	
	7054	7053, 7056	7056, 7129	7056, 7118	
	7056	7054, 7059	7059	7111, 7129	
				7134	11
Total bull yrs.	11	18	20	19	68/49

The number of bulls used per year ranged from 11 to 20 with an average of 17. Over the 4 year period 9 Charolais, 6 Brown Swiss, 10 Hereford (3 Horned and 7 Polled), 8 Holstein, 5 Shorthorn and 11 Simmental bulls were used for a total of 49 different bulls. Several bulls were used for more than one year. In addition, 6 Angus, 4 Polled Hereford and 2 Horned Hereford bulls were used to breed heifers to calve for the first time.

Identification and Management. All cattle are identified by an ear tattoo and a rubber ear tag (Ritchey). Calves are identified at birth by a metal ear tag and prior to weaning by an ear tattoo. All cows and heifers saved for herd replacements are further identified by a rubber ear tag before going into the breeding herds.

Calves from all breeding groups are treated alike from birth to weaning and from weaning to slaughter, except that samples of each group may be pulled out to make up a new group for special feeding, other special treatment or for slaughter.

Cattle are weighed and scored on conformation and condition at approximately 7, 12 and 18 months of age and at slaughter. Except those animals kept for breeding, all cattle will be slaughtered for use in the penal system. When feasible, carcass data are obtained on the offspring of all experimental animals. These data include live and carcass weights; backfat thickness; loin eye area; kidney, heart and pelvic fat; and a tenderness measurement.

A record is kept on cows requiring assistance when calving, calves lost and why (born dead, died from pulling, injury, scours, drowned, etc.). Cows are pregnancy checked annually and a record kept of all open cows, cows died, or culled for old age, cancer eye, etc. or slaughtered. Cows are weighed and scored on condition annually, normally at time calves are weaned or shortly thereafter.

Measurement Data Recorded. The data recorded for comparison of the several sire breeds include: 1) birth date, weight and sex, 2) calving difficulty, 3) percent of calves born and weaned, 4) weight, grade and condition at approximately 7, 12 and 18 months, 5) slaughter and carcass weights, 6) carcass data such as fat thickness, ribeye area, and tenderness measure and 7) cow weights at 30, 42, 54 and 66 months.

Results to Spring 1974

Data on two calf crops have been recorded at birth, 7 and 12 months and on one calf crop at 18 months. The third calf crop is on the ground and the cows have been rebred for the final calf crop of this phase.

Calves Born and Weaned. The number and percent of calves born and weaned in the first two calf crops are shown in table 2 by breed of sire. In comparing calving percentage it should be remembered that only Simmentals were bred by A.1. All others were by natural service.

TABLE 2. CALVES BORN AND WEANED IN 1972 AND 1973 BY BREED OF SIRE.

Sire Breed	Cows Exposed	Calves Born No.	Calves Born %	Calves Weaned No.	Calves Weaned %	Cows Died
Brown Swiss	45	31	68.9	29	64.4	3
Charolais	159	92	57.9	89	56.0	1
Holstein	124	94	75.8	92	74.2	1
Hereford	80	58	72.5	57	71.2	0
P. Hereford	79	56	70.9	55	69.6	0
Simmental*	161	105	62.2	94	58.4	2
Shorthorn	70	47	67.1	45	64.3	0
Combined	718	483	67.3	461	64.2	7

[a]Based on A.1. only.

Birth Weight. Birth weights by breed of sire are shown in table 3. Simmentals had the heaviest birth weights (78 lb.) followed closely by Charolais (74 lb.) and Holsteins (73 lb.). Brown Swiss and Shorthorn cross calves were slightly heavier (68-69 lb.) than straight Hereford calves (67 lb.). Using unweighted averages, birth weights of the crossbred calves were 9.5% heavier than straightbred calves. Calving difficulty is closely correlated with size of calf at birth. There were no death losses at birth in 1972 and 1973 among the straight Hereford calves. Among the crossbreds death losses at birth ranged from 0.00% for the Herefords to 8.26% for the Simmental crosses. Death loss at birth was 2.7% for all calves and 4.3% at weaning. This is in close agreement with the 1974 US MARC report from Clay Center, Nebraska, where death losses ranged from zero for the Hereford x Angus calves to 11.0% for the Charolais x Hereford calves and an average of 4.6% for all sire breeds. Of 7 cows lost, 2 were bred to Simmentals, 3 to Brown Swiss, 1 to Charolais and 1 to Holstein.

Weaning Weights and Grades. These comparisons for the several sire breeds are also presented in table 3. The order of rank on weaning weights (high to low) for the two calf crops was Simmental, Holstein, Charolais, Shorthorn, Brown Swiss, Polled Hereford and Hereford. Based on unweighted averages the weaning weight of the crossbreds were 68 lb. (21%) heavier than the straightbred calves; 365-day weights were 84 lb. (24.8%) heavier for steers and 81 lb. (24%) heavier for heifers.

These cattle were turned out on poor grass pasture without feed for several weeks after weaning. Later they were fed silage and hay but no concentrate. Consequently, they made almost no gain from weaning to a year of age. Even under these severely adverse conditions all crossbred groups were heavier than the straightbreds at a year of age.

TABLE 3. BIRTH WEIGHT AND WEANING WEIGHT AND GRADES BY BREED OF SIRE.

Sire Breed	No. Head	Birth Weight	Weaning 205-d wt.	Grade
Charolais	89	74	401	11.8
Brown Swiss	29	68	339	9.3
Holstein	92	73	411	10.7
H. Hereford	57	67	315	11.1
P. Hereford	55	67	326	11.0
Simmental	94	78	412	12.0
Shorthorn	45	74	376	11.2

Another way to look at the performance of these cattle is by breed types. They can be divided into British purebreds (Hereford, P. Hereford), British crossbreds (Angus x Hereford, Shorthorn x Hereford), Dairy-Beef crossbreds (B. Swiss x Hereford, Holstein x Hereford) and Continental crossbreds (Charolais x Hereford, Simmental x Hereford). The Angus x Hereford crosses were not a part of the experimental design but several offspring were obtained from cleanup cows and heifers. They have been included for this comparison. These comparisons are shown in table 4. On this basis the order of rank (high to low) on weaning weight at 205 days of age was Continental X's, Dairy X's, British XB and British purebreds. The differences ranged from 18 to 27% in favor of the crossbreds. Similar differences existed at 365 days.

TABLE 4. CALVING % AND BIRTH, WEANING AND YEARLING WEIGHT BY SIRE BREED TYPES.

Breed	% Calf	Birth wt.		205-d wt.		365-day weights Steers		365-day weights Heifer	
Types	Crop Wean	lb	% of PB	lb	% of PB	lb	% of PB	lb	% of PB
British PB	70.4	67	100	320	100	338	100	338	100
British XB	67.1	72	107	377	118	426	126	411	121
Dairy X's	71.6	72	107	394	123	429	127	424	125
Continental X's	56.6	76	113	407	127	410	121	423	125

SUPPLEMENTING PHOSPHORUS TO THOROUGHBRED HORSES IN VIRGINIA[1]

C. J. Carle, J. P. Fontenot and K. E. Webb, Jr.

The horse industry is plagued with problems of keeping the horses sound and functional. Many horses are lost or wasted due to bone problems. Another major problem confronting the horse industry is poor reproductive efficiency. In the initial research we obtained evidence that phosphorus nutrition may have been borderline. Since phosphorus is important for normal reproduction and for proper bone development and maintenance, it was decided to study the effect of phosphorus supplementation.

This research was conducted to study the effect of phosphorus supplementation on blood and hair parameters. Nutritional status of the horses was also observed during the study.

Experimental Procedure

During a 2-year period 117 horses were used, including 2 stallions, 54 mares, 14 yearlings and 47 weanlings. This work was cooperative with four thoroughbred horse farms, two in the Richmond area, Little Hawk Farm, Crozier and the Meadow Stud, Doswell, and two in the Charlottesville area, Keswick Stables, Cobham and Verulam Farm, Charlottesville. Each year, prior to the beginning of the experiment the horses at a given farm were allotted at random on the basis of kind of horse, age, weight, sex of weanlings and yearlings and expected foaling date of the mares to the following two treatments: 1) Control and 2) Phosphorus supplemented.

The experimental period was from November to March. The horses on each farm were fed and managed in the usual manner for that farm. They were fed hay and concentrate in stalls and were turned out for grazing and exercise during the day. The amounts of hay and concentrate fed were recorded daily for each horse.

Defluorinated rock phosphate was the supplemental source of phosphorus for the first year. In the second year dicalcium phosphate was used for the horses on three farms and monosodium phosphate for those

[1] Supported in part by grants-in-aid from Virginia Agricultural Foundation, Keswick Stables, Cobham, Va., Little Hawk Farm, Crozier, Va., Meadow Stud, Inc., Doswell, Va. and Verulam Farm, Charlottesville, Va. The horse farms also made available horses and facilities for the research. Dr. Daniel Flynn, Charlottesville and Dr. Olive Britt, Ashland cooperated and obtained the blood samples.

on the other farm. The amounts of supplemental phosphorus fed, calculated to supply one-half of the National Research Council requirements of the horses, were as follows:

		Grams per head per day		
Year	Supplement	Mares & stallion	Yearlings	Weanlings
1	Defluorinated phosphate	50	50	50
2	Dicalcium phosphate	65	86	86
	Monosodium phosphate	47	62	62

The phosphorus supplements were added to the concentrate part of the ration at each of two feedings per day.

During both years, prior to the beginning of the experimental period and at monthly intervals during the time the horses were on test, blood samples were obtained from each horse and samples of all feeds were taken. During the second year hair samples were taken by clipping a rectangular area on the underside of the horses. The feed samples were analyzed for dry matter, crude protein, crude fiber, ether extract, ash, calcium, phosphorus, magnesium, copper and iron. The blood serum was analyzed for protein, calcium, inorganic phosphorus, magnesium, copper and iron and the blood plasma for carotene and vitamin A. Hair samples were analyzed for calcium, phosphorus, magnesium, copper and iron.

Results

A voluminous amount of data have been collected. Only the pertinent data concerning calcium and phosphorus nutrition will be reported here, since treatment did not appear to affect the other parameters measured. The data in the tables are averages during the time the horses were on test.

During the first year supplementing with phosphorus did not consistently affect serum inorganic phosphorus levels in mares (table 1). During the second year, phosphorus supplementation resulted in average increases in serum inorganic phosphorus in the mares. Although the average response to phosphorus supplementation for all farms was 0.22 mg. per 100 ml., the average response in serum inorganic phosphorus was 0.69 mg. per 100 ml. (2.50 vs. 3.19 mg./100 ml.) in the mares from the farm where the ration was borderline in phosphorus content (Farm no. 1, table 2).

In the case of weanlings, the serum level of inorganic phosphorus was not appreciably altered by phosphorus supplementation (table 3), although the dietary phosphorus levels were usually low or borderline (table 4). Serum inorganic phosphorus was not increased in yearlings by phosphorus supplementation during the first year (table 5). However, the level was increased by over 1 mb. per 100 ml. by supplementation during the second year. Serum inorganic phosphorus levels were lower in mares than for the younger horses.

Phosphorus level in hair of mares was not increased by phosphorus supplementation (table 7). On the other hand, phosphorus supplementation resulted in large increases in hair phosphorus in the younger horses (weanlings and yearlings, table 8). Thus, it appears that blood serum level of phosphorus may be a better indication of phosphorus nutrition in mares, and the hair a better index for younger horses.

The calcium levels in the serum were within the normal range for all horses (tables 9, 10 and 11), and these were not altered by treatment.

Levels of protein, energy, other minerals and vitamin A in the rations appeared to be sufficient. Levels of minerals other than phosphorus in blood serum or hair were not affected by phosphorus supplementation.

TABLE 1. BLOOD SERUM INORGANIC PHOSPHORUS IN CONTROL AND SUPPLEMENTED MARES

Farm no.	Year 1		Year 2	
	Control	Supplemented	Control	Supplemented
	mg/100 ml.			
1	3.06	3.23	2.50	3.19
2	3.04	2.68	3.12	2.91
3	3.58	3.55	2.86	2.95
4	4.16	3.95	2.59	2.91
Avg.	3.46	3.35	2.76	2.98

TABLE 2. CALCIUM AND PHOSPHORUS CONTENT OF RATIONS FOR MARES

		Dry basis			
	Farm	Calcium		Phosphorus	
Year	no.	Control	Supplemented	Control	Supplemented
		%	%	%	%
1	1	0.76	0.87	0.42	0.49
	2	1.06	1.17	0.51	0.58
	3	0.92	1.07	0.27	0.35
	4	0.64	0.85	0.52	0.61
2	1	0.68	0.80	0.24	0.33
	2	0.96	0.95	0.67	0.76
	3	0.57	0.69	0.32	0.51
	4	0.85	1.01	0.39	0.59

TABLE 3. BLOOD PHOSPHORUS SERUM INORGANIC PHOSPHORUS IN CONTROL AND SUPPLEMENTED WEANLINGS

Farm no.	Year 1		Year 2	
	Control	Supplemented	Control	Supplemented
	mg/100 ml.			
1	5.05	5.07	5.50	5.42
2	4.39	4.44	5.28	5.46
3	5.41	5.23	6.10	5.80
Avg.	4.95	4.91	5.60	5.45

TABLE 4. CALCIUM AND PHOSPHORUS CONTENT OF RATIONS FOR WEANLINGS

Year	Farm no.	Calcium		Phosphorus	
		Control	Supplemented	Control	Supplemented
		%	%	%	%
1	1	0.57	0.78	0.40	0.49
	2	0.98	1.22	0.42	0.55
	3	0.72	0.96	0.40	0.54
2	1	0.84	1.04	0.29	0.53
	2	1.02	1.02	0.59	0.79
	3	0.68	0.93	0.39	0.66

TABLE 5. BLOOD SERUM INORGANIC PHOSPHORUS IN CONTROL AND PHOSPHORUS SUPPLEMENTED YEARLINGS

Farm no.	Year 1		Year 2	
	Control	Supplemented	Control	Supplemented
	mg/100 ml.			
2	4.11	3.81	4.42	5.61
4	4.69	4.87		
Avg.	4.40	4.34		

TABLE 6. CALCIUM AND PHOSPHORUS CONTENT OF RATIONS FOR YEARLINGS

Year	Farm no.	Dry basis			
		Calcium		Phosphorus	
		Control	Supplemented	Control	Supplemented
		%	%	%	%
1	2	0.86	1.01	0.44	0.51
	4	0.58	0.81	0.47	0.62
2	2	0.70	0.76	0.46	0.60

TABLE 7. HAIR PHOSPHORUS OF CONTROL AND PHOSPHORUS SUPPLEMENTED MARES

Farm no.	Control	Phosphorus supplemented
	ppm	
1	289	328
2	477	413
3	442	388
4	392	392
Avg.	400	372

TABLE 8. HAIR PHOSPHORUS OF CONTROL AND PHOSPHORUS SUPPLEMENTED WEANLINGS AND YEARLINGS

Kind of horse	Farm no.	Control	Phosphorus supplemented
		ppm	
Weanlings	1	324	376
	2	422	469
	3	402	450
	Avg.	383	432
Yearlings	2	343	486

TABLE 9. BLOOD SERUM CALCIUM IN CONTROL AND PHOSPHORUS SUPPLEMENTED MARES

Farm no.	Year 1		Year 2	
	Control	Supplemented	Control	Supplemented
	mg/100 ml.			
1	12.0	11.9	12.0	11.3
2	12.4	12.1	12.2	11.1
3	12.2	12.4	11.6	11.5
4	11.5	11.9	11.4	11.6
Avg.	12.0	12.1	11.8	11.4

TABLE 10. BLOOD SERUM CALCIUM IN CONTROL AND PHOSPHORUS SUPPLEMENTED YEARLINGS

Farm no.	Year 1		Year 2	
	Control	Supplemented	Control	Supplemented
	mg/100 ml.			
2	12.4	12.1	11.6	11.6

TABLE 11. BLOOD SERUM CALCIUM IN CONTROL AND PHOSPHORUS SUPPLEMENTED WEANLINGS

	Year 1		Year 2	
Farm no.	Control	Supplemented	Control	Supplemented
	mg/100 ml.			
1	11.9	12.0	11.7	11.6
2	12.2	12.2	11.6	11.6
3	12.1	12.4	11.4	11.9
Avg.	12.1	12.2	12.1	11.7

MAGNESIUM SUPPLEMENTATION OF BEEF COWS ON PASTURE[1]

T. M. Frye, J. P. Fontenot and K. E. Webb, Jr.

Supplying of palatable, economical and convenient supplemental magnesium oxide mixtures is important for proper magnesium nutrition for beef cows. Mineral supplementation of cows on pasture is traditionally achieved with ad libitum feeding of palatable mixtures with salt in a loose or block form. This experiment was conducted to evaluate four loose supplemental magnesium oxide mixtures formulated to include trace mineral salt, magnesium oxide and a readily available feedstuff to improve palatability. The ultimate objective is to formulate a mineral mixture that will give optimum magnesium consumption for the control of hypomagnesemic tetany. Evaluation of other supplemental magnesium oxide mixtures was reported in the 1972 and 1973 Livestock Research Reports (VPI & SU Res. Div. Rep. 145 and 153).

Experimental Procedure

Eight Shorthorn beef cows averaging 6 years of age with nursing calves averaging 33 days of age were placed into two outcome groups by age and weight and allotted to two 4 X 4 randomly selected Latin squares. The experiment was conducted for 60 days with four successive 15-day trials. Each trial was divided into a 5-day adjustment and a 10-day measurement period. During each trial, one cow in each Latin square received one of the four test supplemental magnesium mixtures. Each of the eight cows grazed a pasture plot of 0.75 acre. The pasture herbage was predominately orchardgrass, white clover and bluegrass. The test magnesium mixtures were formulated to contain the following ingredients: 1) trace mineralized salt, magnesium oxide and dehydrated alfalfa meal in the ratio of 1:1:1; 2) trace mineralized salt, magnesium oxide and distillers dried grains with solubles, 1:1:1 ratio; 3) trace mineralized salt, magnesium oxide and ground shelled yellow corn, 1:1:1 ratio and 4) trace mineralized salt, magnesium oxide and cottonseed meal, 1:1:1 ratio. Test mixtures were offered to the experimental cows ad libitum in covered mineral boxes constructed to limit mineral feeding to the cows only. Consumption was measured by collecting and weighing the refused amount at the end of each 5 days of the four periods of the experiment. In addition to measuring consumption, an attempt was made to determine the dry matter of each mixture at the end of each 5 days. Also, for the first 10 days of the experiment the mixtures were observed daily to determine if any caking or hardening of the mixtures occurred.

[1]Magnesium oxide was supplied by Getkin Associates, Norristown, Pa.

Results

Mean consumption values for the total mixture, magnesium oxide and magnesium per head per day is shown in table 1. The cows consumed all of the mixtures readily. The amounts of magnesium oxide consumed varied from 1.3 to 1.6 oz. per head per day. There was a trend toward greatest consumption of the mixtures containing corn distillers dried grains and cottonseed meal. However, all mixtures were consumed in sufficient amounts to meet the magnesium requirements of the cows.

Daily observations of the mixtures for the first 10 days of the experiment revealed that no hard lumps or caking formed in any of the mixtures. Generally, the mixtures maintained dry matter levels similar to that of most air dry feeds as shown in table 2. There were no consistent differences in dry matter content among the mixtures. Thus, caking would be no problem if the mixtures are protected from precipitation.

TABLE 1. MEAN CONSUMPTION OF SUPPLEMENTAL MAGNESIUM OXIDE MIXTURES BY BEEF COWS[a]

Item	Mixture designation[b]			
	Dehydrated alfalfa meal	Corn distillers dried grain	Ground shelled corn	Cottonseed meal
	oz/head/day			
Mixture	3.8	4.7	4.2	4.6
Magnesium oxide	1.3	1.6	1.4	1.5
Magnesium[c]	0.68	0.84	0.75	0.83

[a]Mean consumption values are for 4 periods, 10 days each period.

[b]Mixture designations:

Dehydrated alfalfa meal - Trace mineralized salt, magnesium oxide and dehydrated alfalfa meal, 1:1:1 ratio.
Corn distillers dried grain - Trace mineralized salt, magnesium oxide and corn distillers dried grain with solubles, 1:1:1 ratio.
Ground shelled corn - Trace mineralized salt, magnesium oxide and ground shelled yellow corn, 1:1:1 ratio.
Cottonseed meal - Trace mineralized salt, magnesium oxide and cottonseed meal, 1:1:1 ratio.

[c]From feed grade magnesium oxide consumed.

TABLE 2. MEAN DRY MATTER OF MINERAL MIXTURES AFTER 5 DAYS IN MINERAL BOX

Mixture designation[b]	Period[a] 1 May 4-19	2 May 19-June 3	3 June 3-18	4 June 18-July 3
	% dry matter[c]			
Dehydrated alfalfa meal	94.20	83.71	85.00	86.02
Corn distiller's dried grain	95.57	86.57	87.42	90.36
Ground shelled corn	94.76	88.35	94.60	74.13
Cottonseed meal	95.35	83.08	94.97	92.56

[a]Periods covered the time of May 4 to July 3, 1973.
[b]Mixture designations are the same as described in table 1.
[c]Mean dry matter represents dry matter of refusal collected after being in mineral box for five days.

EVALUATION OF DIFFERENT PHOSPHORUS SUPPLEMENTS FOR GROWING-FINISHING BEEF STEERS[1]

K. E. Webb, Jr., J. P. Fontenot and M. B. Wise

The need for phosphorus supplementation in many cattle rations, coupled with the present critical supply of phosphorus supplements emphasize the importance of the evaluation of phosphorus supplements for growing-finishing beef cattle. Several phosphorus supplements have been shown to be well utilized by beef cattle. Among these are bonemeal, Curacao Island phosphate and different sources of dicalcium phosphate and defluorinated phosphate. Two experiments were conducted with growing-finishing cattle to evaluate different phosphorus supplements.

Experimental Procedure

Experiment 1. Thirty Hereford weanling steer calves with an average initial weight of 414 lb. were fed a low phosphorus (0.134%) ration during a 69-day depletion period. The ingredient and chemical composition of this ration is presented in table 1. At the end of the depletion period the cattle were assigned to five blocks of six based on liveweight and serum inorganic phosphorus levels. The cattle within each block were allotted at random to rations containing the following supplemental sources of phosphorus: 1) None; 2) A chemical mixture of mono- and dicalcium phosphate; 3) Defluorinated phosphate; 4) Mexican rock phosphate; 5) Sodium tripoly phosphate; 6) Defluorinated phosphate and sodium tripoly phosphate (1:1 ratio). The animals were fed these experimental rations for 98 days. The ingredient and chemical compositions of the rations are presented in table 1. The control ration contained 0.148% phosphorus, dry basis, and the supplemental sources were added to supply an additional 0.065% phosphorus. An attempt was made to equalize calcium through the addition of ground limestone. The relative percentages of mono- and dicalcium phosphate present in the chemical mixture were calculated to be 87% mono- and 13% dicalcium phosphate.

Feeding and management of the cattle were similar during both depletion and repletion periods. The cattle were fed the rations ad libitum in individual stalls at night inside the barn for approximately 16 hours per day. The remainder of the time the cattle were placed in outside exercise lots where water was available. The cattle were weighed initially and at 2-week intervals. At the time weights were taken, blood samples were obtained and the serum was analyzed for inorganic phosphorus, calcium and magnesium. Ration samples were collected throughout the experiment and were analyzed for the proximate components, calcium, phosphorus and magnesium.

Experiment 2. Forty-eight Hereford weanling steer calves with an average initial weight of 526 lb. were used in this 216-day study. The steers were assigned to eight blocks of six based on weight. Steers within

[1]Supported, in part, by a grant-in-aid from Agricultural Division, Olin, Little Rock Arkansas.

each block were allotted at random to rations containing the following phosphorus supplements: 1) None; 2) A chemical mixture of mono- and di-calcium phosphate; 3) Source A of defluorinated phosphate; 4) Mexican rock phosphate; 5) Monosodium phosphate; 6) Source B of defluorinated phosphate. The source A of defluorinated phosphate was the same source which was used in experiment 1.

The ingredient and chemical compositions of these rations are presented in table 2. The control ration contained 0.116% phosphorus, dry basis, and the supplemental sources were added to supply an additional 0.11% phosphorus. Calcium was equalized in all rations by the use of ground limestone. Washed sand was added to each ration in combination with the ground limestone and supplemental phosphorus source in order to maintain the percentage of other ingredients constant among rations.

Feeding, management and weighing of the cattle, sampling of blood and feeds and analysis of blood and feeds were as described for experiment 1. At the end of the experiment the cattle were slaughtered and carcass data obtained.

Results and Discussion

Experiment 1. Daily gain decreased in the cattle during the depletion period from 1.87 lb. per day at 13 days to 1.32 lb. per day at 69 days. Serum inorganic phosphorus also decreased from an initial level of 4.14 to 2.33 mg per 100 ml at 69 days.

Performance of steers fed the different supplemental phosphorus sources during the repletion phase of this experiment are summarized in table 3. Initial weights were similar. The animals in the control group weighed significantly ($P < .05$) less than the animals in all phosphorus supplemented groups at the end of the trial. This is reflected in significantly ($P < .05$) lower daily gains of the control animals throughout the trial.

For each period, average daily gains among supplemented cattle were highest for the cattle fed the ration supplemented with Mexican rock phosphate. However, differences were usually not significant. At 84 and 98 days rate of gain of the cattle supplemented with defluorinated phosphate was almost as high as for those fed Mexican rock phosphate. There was a strong trend for daily gains to be lowest for the cattle fed the chemical mixture of mono- and dicalcium phosphate, especially during the latter part of the experimental feeding period.

Average daily feed intake was consistently higher for the cattle fed the ration supplemented with Mexican rock phosphate than for the cattle fed the other rations. The differences were usually significant ($P < .05$) during the first 55 days, compared to all other phosphorus supplements and were significant ($P < .05$) at the end of each period, compared to the cattle supplemented with the mixture of mono- and dicalcium phosphate and the 1:1 mixture of defluorinated phosphate and sodium tripoly phosphate. Feed intake of the cattle supplemented with either defluorinated phosphate or sodium tripoly phosphate increased markedly during the last 43 days of the experimental feeding period and by 98 days approached that of the cattle supplemented with Mexican rock phosphate. At 84 and 98 days the intake for these cattle were not significantly different from that of the cattle fed the other supplemental sources.

Feed efficiency was very poor for the cattle fed the low-phosphorus rations. Efficiency was improved somewhat during the latter part of the experiment. This was due to modest gains by these cattle after the first 28 days in spite of a decreased feed intake. The improvement in performance may have resulted from an increase in phosphorus intake by these cattle resulting from consumption of manure from the supplemented cattle. These cattle were frequently observed to be chewing on rocks and consuming manure. At the end of the experimental feeding period feed efficiency was maximum for the cattle supplemented with defluorinated phosphate, Mexican rock phosphate or a 1:1 ratio of defluorinated phosphate and sodium tripoly phosphate. The efficiency was higher for the cattle fed Mexican rock phosphate for the first 55 days than for those fed the other two sources. However, increased efficiency during the last 43 days by the cattle receiving defluorinated phosphate alone or in combination with sodium tripoly phosphate compensated for the lower efficiency during the early stages.

Serum inorganic phosphorus, calcium and magnesium data are presented in table 4. After 28 days of supplementation the control animals showed significantly ($P < .05$) lower serum inorganic phosphorus levels than all supplemented groups with the exception of the animals fed Mexican rock phosphate. At 55 and 69 days the controls were significantly ($P < .05$) lower than the supplemented groups. At 84 and 98 days the values for the controls were still lower, but differences were not significant. Serum inorganic phosphorus increased somewhat during these two periods, which may have been the result of these steers eating manure.

At the end of the experimental feeding period serum inorganic phosphorus was lower for the cattle supplemented with the mixture of mono- and dicalcium phosphate than for the other supplemented cattle. Although differences were not significant, this trend was evident throughout the experiment. At 84 and 98 days the cattle receiving the Mexican rock phosphate showed lower serum inorganic phosphorus than those fed defluorinated phosphate and sodium tripoly phosphate alone or in combination.

Serum calcium levels tended to be highest throughout the experiment in the control animals. At 98 days it was significantly ($P < .05$) higher than in the animals fed sodium tripoly phosphate. Serum magnesium was not affected by treatment.

Experiment 2. Performance data accumulated during this trial are presented in table 5. The initial weights of the cattle on all treatments were similar. At the end of the experiment there were no significant differences in liveweight among the supplemented groups, and they were all significantly ($P < .05$) greater than for the control animals.

Evidence of decreased performance as a result of feeding the low phosphorus ration appeared at 85 days when the daily gain of the control animals was significantly lower ($P < .05$) than that of each supplemented group. Throughout the experiment there were no significant differences among any of the supplemented groups. As in experiment 1 however, the cattle fed the chemical mixture of mono- and dicalcium phosphate showed lower daily gains than the other cattle receiving phosphorus supplements. Daily gains were quite similar throughout the experiment for the cattle receiving the other four supplemental phosphorus sources.

At the end of 57 days a trend appeared for lower feed consumption for the unsupplemented control. This trend continued and from 141 days to the end of the trial the intake was significantly ($P < .05$) lower than for animals supplemented with phosphorus. At the end of the experiment, feed intake for the cattle supplemented with monosodium phosphate and defluorinated phosphate B was significantly ($P < .05$) greater than for the cattle fed the chemical mixture of mono- and dicalcium phosphate. Feed intakes for the cattle receiving defluorinated phosphate A and Mexican rock phosphate were intermediate.

Feed efficiency was not significantly affected by treatment, but as in experiment 1 the unsupplemented animals required the greatest amount of feed per unit of gain. Among the supplemented cattle, there was a trend for higher feed efficiency for those fed defluorinated phosphate A. The values were similar among the other four supplemented groups.

The conformation of the carcasses from all supplemented groups averaged from low to average choice (table 6), significantly ($P < .05$) higher than for the carcasses from the control group. The degree of marbling was greater ($P < .05$) for the animals supplemented with defluorinated phosphate A than for the control animals or those supplemented with the chemical mixture of mono- and dicalcium phosphate. Marbling score in the carcasses from animals fed Mexican rock phosphate, monosodium phosphate and defluorinated phosphate B approached that in the carcasses from steers fed defluorinated phosphate A. Carcass grade, *Longissimus* muscle area, backfat thickness and dressing percent were not significantly affected by treatment. Carcasses of the control animals weighed significantly ($P < .05$) less than those of animals receiving supplemental phosphorus, reflecting the lower performance and final liveweight. Although there were no significant differences in carcass weights among the supplemented cattle, those fed the chemical mixture of mono- and dicalcium phosphate had the lightest carcasses.

At 28 days the animals fed the low phosphorus ration had the lowest serum inorganic phosphorus levels, significantly ($P < .05$) lower than for the cattle fed all supplements, except for animals supplemented with defluorinated phosphate A and monosodium phosphate (table 7). This trend continued and the values for the control cattle were usually significantly ($P<.05$) lower than for the supplemented cattle at each sampling thereafter. By the end of the experiment the serum inorganic phosphorus levels were not significantly different among cattle fed the various supplemental phosphorus sources, but values for all supplemental phosphorus sources were significantly ($P<.05$) higher than for the control ration.

Feeding the low phosphorus control ration resulted in a significant ($P<.05$) elevation in serum calcium from 85 to 197 days. Serum magnesium was significantly ($P<.05$) different at the time of the initial sampling. There is no apparent explanation for this, and it was not significantly different thereafter.

The results from these two experiments indicate that the phosphorus in all of the phosphorus supplements tested is available for growth and finishing in beef cattle. There were generally no significant differences in the supplements tested in the parameters measured; however,there were some trends. Animals supplemented with Mexican rock phosphate had the highest daily gain and feed intake and best feed efficiency in experiment 1. In the same experiment, the animals supplemented with defluorinated phosphate and sodium tripoly phosphate alone or in combination started slower but by the end of the experiment were nearly equal to the animals supplemented with Mexican rock phosphate. This may indicate some adaptation in the ability of the beef animal to utilize these latter two supplements. In both experiments and in most parameters measured, there was a strong trend for the chemical mixture of mono- and dicalcium phosphate to be the least satisfactory phosphorus supplement tested.

TABLE 1. AVERAGE COMPOSITION OF RATIONS FED IN EXPERIMENT 1

Item	Supplemental phosphorus source						
	Depletion	Control	Mono- & di-Ca phosphate	Defl. phosphate	Mexican rock phosphate	Na tripoly phosphate	Defl. phosphate & Na tripoly phosphate
Ingredient composition, %							
Corn cobs, ground	33.7	33.39	33.23	33.33	33.18	33.15	33.245
Dried beet pulp with molasses	28.0	28.0	28.0	28.0	28.0	28.0	28.0
Corn gluten meal	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Grass hay	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Cerelose[a]	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Molasses	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Urea	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Trace mineralized salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Limestone	..	0.31	0.18	0.04	..	0.31	0.17
Mono- & di-Ca phosphate[b]	..	..	0.29	..	..	..	0.165
Defl. phosphate	..	..	..	0.33	..	..	..
Mexican rock phosphate	..	..	..	..	0.52	..	..
Sodium tripoly phosphate	..	..	..	..	..	0.24	0.12
Vitamin A[c]	++	++	++	++	++	++	++
Chemical composition, %							
Dry matter	90.1	90.5	90.7	91.7	91.7	91.7	92.0
Composition of dry matter							
Crude protein	14.65	14.18	14.55	14.29	13.96	14.07	14.24
Crude fiber	18.31	19.89	20.73	21.37	20.28	19.08	19.24
Ether extract	0.89	1.22	1.32	0.87	0.87	0.87	1.09
Ash	4.55	4.97	5.29	4.80	5.02	6.11	6.09
Nitrogen-free extract	61.71	59.74	58.15	58.67	59.87	59.98	59.46
Calcium	0.255	0.442	0.595	0.436	0.393	0.447	0.457
Phosphorus	0.134	0.148	0.216	0.207	0.215	0.219	0.207
Magnesium	0.133	0.138	0.163	0.138	0.130	0.134	0.133

[a]Corn Products Refining Co., New York, N.Y.
[b]A chemical mixture of 87.1% monocalcium and 12.9% dicalcium phosphate.
[c]Vitamin A added to supply 1500 I.U. per lb. ration.

TABLE 2. AVERAGE COMPOSITION OF RATIONS FED IN EXPERIMENT 2

Item	Supplemental phosphorus source					
	Control	Mono- & di-Ca phosphate	Defl. phosphate A	Mexican rock phosphate	Monosodium phosphate	Defl. phosphate B
Ingredient composition, %						
Corn cobs, ground	25.0	25.0	25.0	25.0	25.0	25.0
Dried beet pulp with molasses	10.0	10.0	10.0	10.0	10.0	10.0
Alfalfa meal, dehy.	3.0	3.0	3.0	3.0	3.0	3.0
Urea	0.8	0.8	0.8	0.8	0.8	0.8
Corn gluten meal	6.6	6.6	6.6	6.6	6.6	6.6
Degerminated corn meal	48.2	48.2	48.2	48.2	48.2	48.2
Trace mineralized salt	0.25	0.25	0.25	0.25	0.25	0.25
Molasses	5.0	5.0	5.0	5.0	5.0	5.0
Limestone	0.63	0.41	0.18	..	0.63	0.19
Sand	0.52	0.24	0.41	0.33	0.13	0.41
Mono- & di-Ca phosphate[a]	..	0.50	..	..	..	..
Defl. phosphate A	..	..	0.56	..	..	..
Mexican rock phosphate	..	..	..	0.82	..	..
Monosodium phosphate	..	..	..	..	0.39	..
Defl. phosphate B	..	..	..	..	..	0.55
Vitamin A[b]	++	++	++	++	++	++
Chemical composition, %						
Dry matter	89.72	89.60	89.67	89.43	89.45	89.60
Composition of dry matter						
Crude protein	14.36	14.33	13.92	14.35	14.24	14.03
Crude fiber	14.57	14.34	14.43	13.76	15.94	14.94
Ether extract	0.77	0.86	0.99	0.86	0.92	0.91
Ash	4.04	3.81	3.97	4.07	3.88	4.00
Nitrogen-free extract	66.25	66.66	66.69	66.97	65.02	66.12
Calcium	0.420	0.424	0.416	0.431	0.431	0.430
Phosphorus	0.116	0.229	0.223	0.222	0.220	0.230
Magnesium	0.087	0.087	0.087	0.085	0.085	0.085

[a] A chemical mixture of 87.1% monocalcium and 12.9% dicalcium phosphate.
[b] Vitamin A added to supply 1500 I.U. per lb. of ration.

TABLE 3. EFFECT OF FEEDING STEER CALVES DIFFERENT PHOSPHORUS SUPPLEMENTS ON PERFORMANCE - EXPERIMENT 1

	Supplemental phosphorus source					
Parameter	Control	Mono- & di-Ca phosphate	Defl. phosphate	Mexican rock phosphate	Na tripoly phosphate	Defl. phosphate & Na tripoly phosphate
Initial weight, lb.	499.0	509.1	513.0	511.1	497.0	500.9
Final weight, lb.	526.9[a]	632.1[b]	664.0[b]	675.0[b]	638.0[b]	641.1[b]
Daily gain, lb.						
28 days	0.02[a]	1.30[b,c]	1.32[b,c]	1.56[c]	1.21[b]	1.06[b]
55 days	0.33[a]	1.39[b,c]	1.43[b,c]	1.65[c]	1.34[b,c]	1.19[b]
84 days	0.40[a]	1.28[b]	1.56[b]	1.65[b]	1.54[b]	1.43[b]
98 days	0.29[a]	1.25[b]	1.56[b]	1.67[b]	1.43[b]	1.43[b]
Feed intake per head per day, lb.						
28 days	9.64[a]	11.70[b]	11.92[b]	13.46[c]	12.10[b]	11.22[b]
55 days	9.00[a]	11.75[b]	12.41[b]	13.75[c]	12.54[b,c]	11.75[b]
84 days	8.73[a]	11.73[b]	13.11[b,c]	14.06[c]	13.20[b,c]	12.08[b]
98 days	8.51[a]	11.68[b]	13.29[b,c]	14.15[c]	13.38[b,c]	12.08[b]
Feed per gain, lb.						
28 days	43.38	9.20	9.21	8.75	10.49	10.65
55 days	25.12	8.55	8.82	8.29	9.86	10.04
84 days	16.02	10.05	8.39	8.55	9.00	8.39
98 days	19.59	9.93	8.48	8.48	9.58	8.47

[a,b,c]Means on the same line with different superscripts are significantly different ($P < .05$).

TABLE 4. EFFECT OF FEEDING DIFFERENT PHOSPHORUS SUPPLEMENTS ON BLOOD SERUM COMPOSITION - EXPERIMENT 1

		Supplemental phosphorus source					
Mineral	Days	Control	Mono- & di-Ca phosphate	Defl. phosphate	Mexican rock phosphate	Na tripoly phosphate	Defl. phosphate & Na tripoly phosphate
		mg/100 ml					
Inorganic phosphorus	0	2.28	2.35	2.22	2.31	2.38	2.43
	14	3.65	3.76	4.21	4.20	3.53	3.72
	28	3.32[a]	3.96[b,c]	4.47[c]	3.81[a,b]	4.50[c]	4.16[b,c]
	42	3.09[a]	4.23[b,c,d]	4.68[d]	4.72[c,d]	4.12[b,c]	3.95[b]
	55	3.20[a]	4.97[b]	5.40[b]	4.89[b]	5.59[b]	5.41[b]
	69	2.95[a]	4.00[b]	4.17[b]	4.36[b]	4.60[b]	4.38[b]
	84	3.33	3.91	4.58	4.26	4.99	4.44
	98	3.41	3.80	4.77	4.07	4.97	4.50
Calcium	0	10.86	10.95	10.51	11.18	10.35	10.93
	14	11.50	11.47	10.79	10.51	11.34	11.16
	28	10.57	11.00	10.37	11.34	10.52	10.54
	42	11.52	11.09	10.50	11.10	10.96	10.92
	55	12.15	11.48	11.52	11.66	11.44	11.50
	69	11.65	10.75	10.87	11.21	10.60	11.19
	84	11.31	11.00	10.78	10.66	10.73	10.64
	98	12.24[a]	11.47[a]	11.13[a,b]	11.10[a,b]	10.05[b]	11.27[a]
Magnesium	0	2.02	2.06	1.98	2.10	2.04	2.17
	14	2.11	2.07	2.05	2.04	2.07	2.12
	28	2.00	2.24	2.12	2.13	2.01	2.10
	42	2.13	2.06	2.04	2.05	2.03	2.08
	55	2.27	2.17	2.07	2.23	2.08	2.15
	69	2.26	2.01	2.16	2.23	2.02	2.16
	84	2.12	2.08	2.20	2.15	2.11	2.13
	98	2.33	2.21	2.23	2.19	2.00	2.26

[a,b,c,d]Means on the same line with different superscripts are significantly different ($P < .05$).

TABLE 5. EFFECT OF FEEDING STEER CALVES DIFFERENT PHOSPHORUS SUPPLEMENTS ON PERFORMANCE - EXPERIMENT 2

	Supplemental phosphorus source					
Parameter	Control	Mono- & di-Ca phosphate	Defl. phosphate A	Mexican rock phosphate	Monosodium phosphate	Defl. phosphate B
Initial weight, lb.	533.1	524.0	524.9	521.0	521.0	526.0
Final weight, lb.	810.9[a]	909.9[b]	950.0[b]	938.1[b]	944.0[b]	953.0[b]
Daily gain, lb.						
28 days	2.22	2.07	2.29	2.42	2.11	2.18
57 days	2.11	2.05	2.18	2.35	2.18	2.18
85 days	1.91[a]	2.20[b]	2.27[b]	2.33[b]	2.29[b]	2.29[b]
113 days	1.72[a]	2.07[b]	2.16[b]	2.20[b]	2.27[b]	2.22[b]
141 days	1.67[a]	2.00[b]	2.18[b]	2.20[b]	2.29[b]	2.20[b]
169 days	1.54[a]	2.00[b]	2.13[b]	2.16[b]	2.20[b]	2.16[b]
197 days	1.41[a]	1.85[b]	2.05[b]	1.98[b]	2.00[b]	2.05[b]
216 days	1.32[a]	1.78[b]	1.98[b]	1.94[b]	1.96[b]	1.98[b]
Feed intake per head per day, lb.						
28 days	11.81	11.48	11.62	11.88	11.86	11.88
57 days	13.31	13.44	13.71	14.30	13.93	13.99
85 days	13.73[a]	14.23[a,b]	14.92[b,c]	15.29[c]	15.31[c]	15.33[c]
113 days	13.84[a]	14.85[a,b]	15.73[b,c]	16.19[c]	16.30[c]	16.28[c]
141 days	14.01[a]	15.44[b]	16.41[b,c]	16.83[c]	17.18[c]	16.96[c]
169 days	13.64[a]	15.55[b]	16.79[b,c]	17.01[c]	17.47[c]	17.27[c]
197 days	13.27[a]	15.62[b]	16.85[b,c]	16.98[b,c]	17.51[c]	17.40[c]
216 days	12.85[a]	15.58[b]	16.90[b,c]	16.94[b,c]	17.47[c]	17.40[c]
Feed per gain, lb.						
28 days	5.64	5.84	5.29	5.01	5.48	5.74
57 days	6.50	6.90	6.40	6.11	6.40	6.46
85 days	7.29	6.73	6.58	6.60	6.72	6.82
113 days	8.20	7.53	7.36	7.49	7.26	7.44
141 days	8.58	7.89	7.54	7.70	7.55	7.63
169 days	8.99	8.00	7.87	8.05	7.96	8.13
197 days	9.63	8.65	8.28	8.70	8.74	8.60
216 days	9.99	8.84	8.62	8.84	8.96	8.91

[a,b,c] Means on the same line with different superscripts are significantly different ($P < .05$).

TABLE 6. EFFECT OF FEEDING STEER CALVES DIFFERENT PHOSPHORUS SUPPLEMENTS ON CARCASS CHARACTERISTICS - EXPERIMENT 2

Parameter	Control	Mono- & di-Ca phosphate	Defl. phosphate A	Mexican rock phosphate	Monosodium phosphate	Defl. phosphate B
		Supplemental phosphorus source				
Carcass data						
Conformation[a]	11.8[d]	12.4[e]	12.6[e]	13.0[e]	12.8[e]	12.9[e]
Marbling[b]	2.8[d]	2.8[d]	3.7[e]	3.4[d,e]	3.4[d,e]	3.4[d,e]
Carcass grade[a]	10.0	9.9	11.2	10.8	11.0	10.7
Longissimus muscle area, sq. in.	9.90	10.10	10.42	10.80	10.57	10.81
Backfat thickness, in.	0.78	0.89	0.86	0.85	0.85	0.75
Dressing %[c]	60.34	60.45	61.17	61.46	60.62	61.31
Wt., lb.	489.7[d]	550.0[e]	580.8[e]	576.4[e]	572.0[e]	584.1[e]

[a]Code: 10=avg. good; 11=high good; 12=low choice; etc.
[b]Code: 2=practically devoid; 3=slight; 4=small, etc.
[c]Based on final liveweights and hot carcass weights.
[d,e]Means on the same line with different superscripts are significantly different ($P < .05$).

TABLE 7. EFFECTS OF FEEDING DIFFERENT PHOSPHORUS SUPPLEMENTS ON BLOOD SERUM COMPOSITION - EXPERIMENT 2

		Supplemental phosphorus source					
Mineral	Days	Control	Mono- & di-Ca phosphate	Defl. phosphate A	Mexican rock phosphate	Monosodium phosphate	Defl. phosphate B
		mg/100 ml					
Inorganic Phos.	0	8.39	8.28	8.53	9.06	9.34	8.63
	28	5.19[a]	6.75[b,c]	6.42[a,b,c]	6.54[b,c]	5.76[a,b]	7.18[c]
	57	5.42[a]	6.53[a,b,c]	5.99[a,b]	7.20[b,c]	7.06[b,c]	7.53[c]
	85	3.87[a]	6.43[b]	6.46[b]	8.15[c]	6.94[b,c]	6.74[b]
	113	3.98[a]	7.42[b]	6.43[b]	7.66[b]	7.06[b]	8.06[b]
	141	3.44[a]	6.40[b]	6.94[b]	7.64[b]	6.73[b]	7.08[b]
	169	3.72[a]	6.58[b]	7.19[b]	7.77[b]	6.98[b]	6.67[b]
	197	5.05[a]	7.63[b,c]	6.78[b,c]	7.97[c]	6.59[b]	8.00[c]
	211	4.38[a]	7.06[b]	6.48[b]	6.72[b]	6.70[b]	7.20[b]
Calcium	0	9.06	9.68	9.29	9.43	9.41	9.11
	28	9.60	9.36	9.22	9.42	9.31	9.43
	57	10.70	10.07	10.09	10.05	9.99	10.14
	85	11.01[a]	10.29[b]	10.19[b]	10.02[b]	10.00[b]	10.14[b]
	113	12.58[a]	11.41[b]	11.26[b]	11.38[b]	11.05[b]	11.54[b]
	141	12.66[a]	11.16[b]	11.14[b]	11.33[b]	10.29[b]	10.99[b]
	169	12.18[a]	10.82[b]	11.13[b]	10.81[b]	10.47[b]	10.64[b]
	197	10.24[a]	9.36[b]	9.25[b]	9.04[b]	9.13[b]	9.11[b]
	211	11.08	10.96	10.69	10.08	10.16	10.86
Magnesium	0	2.04[a]	2.12[a]	2.14[a]	1.98[a,b]	2.12[a]	1.80[b]
	28	2.20	2.20	2.27	2.16	2.22	2.18
	57	2.16	2.25	2.14	2.16	2.09	2.11
	85	2.10	2.16	2.18	2.12	2.21	2.16
	113	2.12	2.14	2.14	2.14	2.20	2.19
	141	2.28	2.14	2.19	2.23	2.04	2.11
	169	2.17	2.26	2.18	2.20	2.27	2.22
	197	2.14	2.16	2.08	2.11	2.10	2.08
	211	2.00	2.00	2.07	1.94	2.01	2.02

[a,b,c]Means on the same line with different superscripts are significantly different ($P < .05$).

FERMENTATION OF ENSILED BROILER LITTER[1]

L. F. Caswell, J. P. Fontenot and K. E. Webb, Jr.

Two problems confronting the approval of broiler litter for use as a livestock feed are medicinal drugs and pathogenic organisms that may be present in the litter. Research at this station over the past several years has shown that litter can be rendered free of pathogens by a number of processing methods. The effect of processing method on medicinal drug residues in litter is not well documented. Certain processing methods may increase dustiness and undesirable odor in litter while others may have beneficial effects. Some processing methods add expense, in terms of labor, material, and energy requirement. Also, a decrease in nutritive value of litter accompanies processing methods which employ dry heat.

If litter is ensiled with another material such as a forage, it then acquires a degree of seasonality. Ensiling of litter as it comes from the broiler house or following the addition of water may make it a more desirable product in that: 1) drugs and pathogens may be reduced or eliminated; 2) nutritive value may be improved or at least maintained; 3) palatability may be enhanced; 4) the product may be less obnoxious to handle after ensiling; 5) silage feeding equipment may be advantageously used; and 6) seasonality aspects may be eliminated.

The study reported herein was conducted to determine the level of moisture necessary for optimum fermentation of ensiled broiler litter and to evaluate the effect of ensiling on bacterial content. The overall purpose of this experiment was to ascertain the feasibility of ensiling broiler litter alone in an attempt to obtain guidelines for similar ensiling studies on a larger scale.

Experimental Procedure

Wood shaving based broiler litter was obtained from one commercial broiler house. One group of broilers had been reared on the litter. The litter was screened through 1 in. hardware cloth to remove compacted material. Upon arrival at Blacksburg the litter was mixed in a horizontal mixer and rebagged until ensiling the following day.

Samples of the litter were dried overnight (about 20 hr.) and the moisture content thus determined was used to calculate the amount of water needed to prepare materials containing the desired moisture levels. Distilled water was added at appropriate levels so the resultant mixture contained 15.6% (no water added), 20%, 30%, 40% and 50% moisture. Forty-four pounds

[1]Litter was obtained from Rocco Feeds, Inc., Harrisonburg, Va.

of each material was prepared either by mixing in a Hobart mixer for 10 min. (two batches of 22 pounds each for both the 15.6 and 20% moisture levels) or by turning the litter on the floor with shovels while the water was slowly added (44 pounds per batch for the 30, 40 and 50% moisture levels). The sticky consistency of the materials mixed with shovels prevented the use of the Hobart mixer for preparation of those mixtures.

The 44 pounds of each mixture were used to prepare two initial mixture samples (frozen for subsequent analyses) and eight silos, each containing 4.4 pounds of mixed material. The material was firmly packed into double-thickness one gallon polyethylene bags supported by one gallon cardboard food containers. Two of the eight silos were equipped with thermistor probes inserted into the center of the packed material with both polyethylene bags tightly twisted and individually sealed around the thermistor lead. Similarly, both bags were individually sealed for the remaining six silos, being careful to expel the air above the packed material before sealing. Initial temperature and initial silo weight measurements were made. All silos were stored in the laboratory for daily silo and ambient temperature measurements.

Samples of the initial mixtures were analyzed for proximate components and fermentation characteristics, and total bacteria and coliform counts were performed. In addition, qualitative tests for Salmonella, Shigella and Proteus were conducted. After an average fermentation of 47 days each silo (except those subjected to temperature measurement) was weighed and opened,and samples were aseptically removed for microbial tests. Also, additional samples were removed and analyzed for total nitrogen (crude protein), ammonia nitrogen, dry matter, crude fiber, ether extract, ash and NFE. Water extracts of the fermented materials were subjected to pH measurement and analyzed for water soluble carbohydrates, lactic acid and volatile fatty acids.

Results

The chemical composition of the litter used is presented in table 1. All proximate components were within normal ranges for litter. Temperatures of the silages generally reflected ambient temperature.

Table 2 shows the composition of the initial mixtures and silages. The dry matter of the materials was, in all cases, slightly lower than desired. Apparently, drying of the samples before ensiling the litter was incomplete, causing an error in calculation of the amount of distilled water to be added to the litter. For the initial mixtures, the actual moisture level was 1.62 to 2.82 percentage units higher than expected. Dry matter content of both the initial mixtures and the silages was, of course, significantly ($P < .01$) affected by treatment. Ash was significantly

($P < .01$) higher for silages containing 40 and 50% moisture than it was for the 15.6, 20 and 30% moisture treatments. In the initial mixtures, ash was lower ($P < .01$) for the 20% than for the 40% moisture level. Other proximate components were not significantly affected by treatment. The significant ($P < .01$) decrease in water soluble carbohydrates for the 30, 40 and 50% moisture treatments is indicative of fermentation of sugars in these silages.

Further evidence of fermentation is presented in table 3. It will be noted that pH values for the initial mixtures were not significantly different, whereas pH of the silages was significantly ($P < .01$) lowered with each added increment of water up to the 40% moisture level. Values for pH for the silages containing 15.6 or 20% moisture are quite similar to those for the corresponding initial mixtures, indicating limited fermentation with low moisture levels. The initial mixtures were devoid of lactic acid. Lactic acid level in the silages was significantly ($P < .01$) increased with increasing moisture level. Acetic acid was the only volatile fatty acid found in measurable quantities in the initial mixtures and silages. In the initial mixtures acetic exhibited a trend, though not significant, toward elevation with the increasing addition of water to litter. For the silages, acetic acid was significantly ($P < .01$) elevated by each additional increment of moisture beginning at the 20% moisture level.

Using the water soluble carbohydrate values for silages and initial and final silo weights permitted presentation of the data in table 4. Carbohydrate fermented in terms of grams per 100 g of dry matter was significantly ($P < .01$) higher for the 30, 40 and 50% than for the 15.6 and 20% moisture levels. As percent of initial, carbohydrate fermentation followed the same pattern. For the 30, 40 and 50% moisture levels, values ranged from 30.61 to 34.49%. Dry matter loss was significantly ($P < .01$) greater for the 40 and 50% moisture treatments, but values for 30, 40 and 50% moisture levels were approximately what would be expected under conventional ensiling of a larger mass. Thus, it appeared that a minimum of 30% moisture was essential for good fermentation.

Table 5 shows the total and ammonia nitrogen levels of the initial mixtures and silages. Total nitrogen was not significantly affected by treatment. Ammonia nitrogen was significantly ($P < .01$) higher for the 50% initial mixture than it was for the other four treatments and was significantly ($P < .01$) higher for the 30 and 40% treatments than for the 15.6 and 20% moisture levels. For the silages, ammonia nitrogen was similarly increased by the addition of water to litter, but the increased levels of ammonia nitrogen in silages were generally lower than in the initial mixtures. This response indicates that nitrogen redistribution is an event that occurs soon after addition of water, but as fermentation takes place, the ammonia may be incorporated into other nitrogenous compounds.

Further fractionation of total nitrogen into uric acid nitrogen and protein and nonprotein nitrogen is needed to elucidate the route of nitrogen redistribution during the fermentation process.

Bacterial data for the initial mixtures and silages is presented in table 6. Ensiling of all materials resulted in marked reductions in total bacteria. The counts at the 30 to 50% moisture levels were only 3 to 14% of the counts for the litter ensiled with no additional moisture. Coliforms were completely eliminated by ensiling the material containing 20% or more moisture. Proteus, found in the initial mixtures, was destroyed by ensiling. This finding is of particular importance since Proteus bacteria can cause gastrointestinal and/or urogenital tract infections in animals and man.

Data collected in this study indicate that broiler litter will sustain fermentation when ensiled if water is added. Evaluation of fermentation characteristics indicate that the moisture level of litter must be increased to at least 30% to initiate active fermentation. Ensiling was found to have no detrimental effect on the nutrient content of litter. Although total bacteria counts of fermented litter may not be as low as desired, enteric bacteria are destroyed through ensiling thus rendering the material free of pathogens capable of inducing intestinal or urogenital tract disorders.

TABLE 1. CHEMICAL COMPOSITION OF INITIAL BROILER LITTER[a]

Item	
Dry matter, %	81.38
Composition of dry matter, %	
Crude protein	31.45
Ether extract	3.54
Crude fiber	19.50
NFE	26.06
Ash	19.44
Water-soluble carbohydrates	2.63
Total nitrogen	5.03
Ammonia nitrogen, % of total nitrogen	12.92

[a]Values represent an average of six samples of litter.

TABLE 2. COMPOSITION OF INITIAL MIXTURES AND SILAGES

Treatment	Dry matter	Composition of dry matter: Crude protein	Ether extract	Crude fiber	NFE	Ash	Soluble carbohydrate
	%	%	%	%	%	%	%
Initial mixtures							
15.6% moisture	81.58[a]	31.19	3.50	18.50	27.39	19.42[a,b]	2.65
20% moisture	77.45[b]	31.48	3.67	18.85	26.88	19.13[a]	2.67
30% moisture	67.80[c]	32.59	3.10	19.49	25.22	19.60[a,b]	2.70
40% moisture	57.88[d]	31.87	3.45	20.59	24.35	19.75[b]	2.62
50% moisture	48.38[e]	30.43	3.66	19.93	26.41	19.58[a,b]	2.60
Silages							
15.6% moisture	81.03[f]	31.77	3.68	18.36	26.90	19.29[f]	2.61[f]
20% moisture	77.21[g]	31.32	3.62	19.08	26.56	19.43[f]	2.66[f]
30% moisture	67.78[h]	30.33	3.27	18.92	27.91	19.57[f]	1.89[g]
40% moisture	57.25[i]	30.88	3.57	18.16	27.45	19.94[g]	1.75[g]
50% moisture	47.55[j]	32.32	3.50	19.34	24.71	20.13[g]	1.73[g]

[a,b,c,d,e] Means for initial mixtures in the same column having different superscripts are significantly different ($P < .01$).

[f,g,h,i,j] Means for silages in the same column having different superscripts are significantly different ($P < .01$).

TABLE 3. FERMENTATION CHARACTERISTICS OF INITIAL MIXTURES AND SILAGES

Treatment	pH	Lactic acid, % of DM	Acetic acid, % of DM
Initial mixtures			
15.6% moisture	7.78	0.00	0.83
20% moisture	7.74	0.00	0.91
30% moisture	7.77	0.00	1.01
40% moisture	7.72	0.00	1.20
50% moisture	7.68	0.00	1.28
Silages			
15.6% moisture	7.81[a]	0.00[a]	0.99[a]
20% moisture	7.63[b]	0.24[b]	1.15[a]
30% moisture	6.12[c]	2.21[c]	2.33[b]
40% moisture	5.39[d]	4.58[d]	3.14[c]
50% moisture	5.43[d]	5.14[e]	4.17[d]

[a,b,c,d,e] Means for silages in the same column having different superscripts are significantly different ($P < .01$).

TABLE 4. EXTENT OF WATER-SOLUBLE CARBOHYDRATE FERMENTATION AND DRY MATTER LOSS OF SILAGES

Treatment	Carbohydrate fermented g/100 g DM	Carbohydrate fermented % of initial	Dry matter loss, %
15.6% moisture	0.07[a]	2.37[a]	1.06[a]
20% moisture	0.02[a]	0.63[a]	0.76[a]
30% moisture	0.82[b]	30.61[b]	0.83[a]
40% moisture	0.89[b]	33.93[b]	2.18[b]
50% moisture	0.90[b]	34.49[b]	2.93[b]

[a,b]Means in the same column having different superscripts are significantly different ($P < .01$).

TABLE 5. TOTAL AND AMMONIA NITROGEN OF INITIAL MIXTURES AND SILAGES

Treatment	Total nitrogen, % of DM	Ammonia nitrogen, % of total nitrogen
Initial mixtures		
15.6% moisture	4.99	12.43[a]
20% moisture	5.04	14.39[a]
30% moisture	5.22	20.27[b]
40% moisture	5.10	25.43[b]
50% moisture	4.87	34.27[c]
Silages		
15.6% moisture	5.08	14.59[d]
20% moisture	5.01	15.92[d,e]
30% moisture	4.85	14.24[d]
40% moisture	4.94	17.20[e]
50% moisture	5.17	21.06[f]

[a,b,c]Means for initial mixtures in the same column having different superscripts are significantly different ($P < .01$).

[d,e,f]Means for silages in the same column having different superscripts are significantly different ($P < .01$).

TABLE 6. BACTERIAL CONTENT OF INITIAL MIXTURES AND SILAGES

Treatment	Total bacteria X10^9 per gram	Coliforms per gram	Salmonella	Shigella	Proteus
Initial mixtures					
15.6% moisture	1.748	123,500[a]	-	-	+
20% moisture	2.235	97,250[b]	-	-	+
30% moisture	1.998	92,000[b,c]	-	-	+
40% moisture	2.525	84,250[b,c]	-	-	+
50% moisture	2.325	69,500[c]	-	-	+
Silages					
15.6% moisture	0.209[d]	10[d]	-	-	-
20% moisture	0.187[d]	0[e]	-	-	-
30% moisture	0.024[e]	0[e]	-	-	-
40% moisture	0.007[e]	0[e]	-	-	-
50% moisture	0.024[e]	0[e]	-	-	-

[a,b,c]Means for initial mixtures in the same column having different superscripts are significantly different ($P < .01$).

[d,e]Means for silages in the same column having different superscripts are significantly different ($P < .01$).

COMPOSITION AND DIGESTIBILITY OF CATTLE FECAL WASTE

D. M. Lucas, J. P. Fontenot and K. E. Webb, Jr.

Large quantities of cattle fecal wastes are produced each year in the United States. At one time this material was considered a valuable agricultural asset as a source of plant nutrients. However, the present trend toward more concentrated livestock production is a deterrant to this method of disposal.

Recently, refeeding of cattle manure to ruminants has been investigated. This would provide a means of alleviating the animal waste problem, as well as a method of recovering some of the potentially valuable nutrients contained in these materials.

An experiment was conducted to evaluate the composition and digestibility of cattle feces produced by steers fed a ration containing approximately 50% roughage.

Experimental Procedure

Six yearling Angus steers averaging 540 lb. initially were used in a series of three total collection metabolism trials. In all trials, steers were fed 5.5 lb. of their respective ration twice daily at 7:00 a.m. and 5:00 p.m. Steers had access to water at all times, except during the feeding periods, which lasted approximately 45 minutes. All rations were ground through a 1/2 inch screen and mixed in a vertical mixer.

In trial 1 all steers received a basal ration composed of ear corn, grass hay, soybean meal, molasses and trace mineralized salt (table 1). The ration was supplemented with vitamin A. Trial 1 consisted of an 8-day preliminary period and a 20-day collection period. The purpose of this trial was to determine the composition of feces produced when a 50% roughage ration was fed to steers, and to allow collection and drying of steer feces to be used in subsequent trials.

In trials 2 and 3 the effect of adding 20% dried cattle feces to the basal ration was studied. A switch-back design was used for these trials. For trial 2 steers were paired by weight and steers within each pair were randomly allotted to one of two rations: 1) basal ration or 2) experimental ration. The basal ration was essentially the same as that fed in trial 1. However, the ingredient composition of the basal ration differed slightly from that fed in trial 1 due to a higher crude protein content of the grass hay. The experimental ration was composed of 80% basal ration and 20% dried feces. The amount of each ingredient is shown in table 2. The chemical composition of the feces containing ration was quite similar to that of the basal ration, although substitution of 20% feces did result in a slight lowering of crude protein and a small increase in crude fiber content, as compared to the basal ration (table 2).

Grab samples of rations were taken at each feeding. Feces and urine were collected and sampled daily. After sampling, the remainder of the feces was spread in screen wire drying trays at a depth of approximately 1 inch and dried for 24 hr. in a forced draft oven at 120° C. (248° F). At the end of each trial, rumen contents were sampled with a stomach tube 2 hr. after feeding and jugular blood samples were taken 6 hr. after feeding.

Results

All rations were consumed readily and there were no feed refusals during any of the trials.

The chemical composition of dried steer feces collected in trial 1 is presented in table 3. The dried steer feces contained 13.18% crude protein, 38.79% NFE, 70.94% cell walls and 5.38% ash. Generally, the composition of the dried steer feces was similar to that of a grass-legume roughage.

Values for apparent digestibility, and TDN and metabolizable energy content of the basal and experimental rations are presented in table 4. Substitution of dried steer feces for 20% of the basal ration resulted in a highly significant ($P < .01$) decrease in apparent digestibility of all components listed.

Apparent digestibility and TDN and metabolizable energy content of dried steer feces fed in trials 2 and 3, calculated by difference, were low (table 5). Apparent digestibility of dry matter was quite low, 16.55%, as was apparent digestibility of crude protein and crude fiber, 26.06 and 17.32%, respectively. TDN content of the dried feces was 13.53%, on a dry basis, and metabolizable energy content was only 714 kcal per kilogram of fecal dry matter, compared to 58.33% and 2766 kcal per kilogram of basal ration dry matter, respectively.

Data concerning the utilization of nitrogen in the basal and experimental rations are presented in table 6. Nitrogen intake was similar between rations, with a slightly higher nitrogen intake from the basal ration. Fecal excretion of nitrogen was somewhat higher for steers receiving the feces containing ration, although their nitrogen intake was slightly lower than that for steers receiving the basal ration. Again this shows the poor digestibility of nitrogen contained in the feces portion of the ration. Slightly greater urinary excretion of nitrogen was observed for steers receiving the basal ration, but this may be a result of higher nitrogen absorption. Nitrogen retention expressed as grams per day, percent of nitrogen intake, or percent of absorbed nitrogen was significantly decreased by substitution of 20% feces in the ration.

There were no significant differences in ruminal fluid pH and volatile fatty acid concentrations due to addition of feces to the ration. Ruminal fluid ammonia-nitrogen was lower in steers receiving the feces containing ration as compared to steers receiving the basal ration; however, this difference was not reflected in blood urea levels.

Summary

Six yearling steers were used in a series of three metabolism trials to determine the composition of feces voided by steers fed a ration containing approximately 50% roughage, and to determine the apparent digestibility of these feces when fed back to steers. The dried steer feces fed contained approximately 13.2% crude protein, 38.8% NFE and 71% cell walls, dry basis. Apparent digestibilities for components of dried steer feces were quite low, 16.6% for dry matter, 26% for crude protein and 16% for energy. It appears that dried feces from steers fed a 50% roughage ration has limited value for refeeding to steers.

TABLE 1. COMPOSITION OF RATION - TRIAL 1

Item	Basal ration
Ingredient composition, %	
Ground ear corn	34.50
Ground hay	43.00
Soybean meal	17.00
Molasses	5.00
Trace mineralized salt	0.50
Vitamin A[a]	+
Chemical composition	
Dry matter, %	88.52
Composition of dry matter, %	
Crude protein	14.26
Ether extract	2.34
Crude fiber	22.77
Ash	5.00
NFE	44.15
Cell solubles	49.72
Cell walls	50.28
Acid-detergent fiber	29.20
Lignin	7.28
Cellulose	20.50
Insoluble ash	1.41
Hemicellulose	21.08

[a]Supplied 4000 I.U. per kilogram of ration.

TABLE 2. COMPOSITION OF RATIONS - TRIALS 2 and 3

Item	Ration: Basal	Ration: Experimental (20% feces)
Ingredient composition, %		
Ground ear corn	37.00	29.60
Ground hay	43.00	34.40
Soybean meal	14.50	11.60
Dried steer feces	--	20.00
Molasses	5.00	4.00
Trace mineralized salt	0.50	0.40
Vitamin A[a]	+	+
Chemical composition		
Dry matter, %	88.22	88.41
Composition of dry matter, %		
Crude protein	15.78	14.67
Ether extract	2.16	2.18
Crude fiber	21.81	24.08
Ash	5.28	5.30
NFE	44.14	44.44
Cell solubles	48.50	43.82
Cell walls	51.50	56.18
Acid-detergent fiber	28.04	31.31
Lignin	6.82	7.47
Cellulose	20.49	22.48
Insoluble ash	0.59	1.03
Hemicellulose	23.46	24.88
Gross energy, kcal/kg dry matter	4563	4606

[a]Supplied 4000 I.U. per kilogram of ration.

TABLE 3. CHEMICAL COMPOSITION OF DRIED STEER FECES

Item	Dried steer feces
Chemical composition	
Dry matter, %	91.55
Composition of dry matter, %	
Crude protein	13.18
Ether extract	2.81
Crude fiber	31.39
Ash	5.38
NFE	38.79
Cell solubles	29.06
Cell walls	70.94
Acid-detergent fiber	44.82
Lignin	9.41
Cellulose	30.30
Insoluble ash	5.09
Hemicellulose	26.12
Gross energy, kcal/kg dry matter	4866

TABLE 4. APPARENT DIGESTIBILITY AND TDN AND METABOLIZABLE ENERGY CONTENT OF BASAL AND FECES CONTAINING RATIONS

Item	Ration	
	Basal	Experimental (20% feces)
No. of animals	6	6
Apparent digestibility, %		
Dry matter	68.19	57.43**
Organic matter	67.43	56.04**
Crude protein	69.39	61.26**
Ether extract	62.64	53.43**
Crude fiber	60.14	48.75**
NFE	70.70	58.66**
Cell solubles	76.61	69.10**
Cell walls	60.25	48.33**
Acid-detergent fiber	51.24	38.14**
Cellulose	58.35	45.36**
Hemicellulose	71.03	61.18**
Energy	66.52	55.73**
TDN, %	58.33	49.42**
Metabolizable energy kcal/kg dry matter	2766	2325

** Significantly ($P < .01$) different from basal ration.

TABLE 5. APPARENT DIGESTIBILITY AND TDN AND METABOLIZABLE ENERGY CONTENT OF DRIED STEER FECES

Item	Dried steer feces
Apparent digestibility,[a] %	
Dry matter	16.55
Organic matter	14.36
Crude protein	26.06
Ether extract	26.86
Crude fiber	17.32
NFE	7.61
Cell solubles	21.48
Cell walls	15.43
Acid-detergent fiber	5.21
Cellulose	12.16
Hemicellulose	27.55
Energy	16.13
TDN,[b] %	13.53
Metabolizable energy[a] kcal/kg dry matter	741

[a]Calculated by difference by method of Crampton and Harris (1969).
[b]Calculated using digestion coefficients calculated by difference by method of Crampton and Harris (1969).

TABLE 6. UTILIZATION OF NITROGEN IN BASAL AND DRIED STEER FECES CONTAINING RATIONS[a]

	Ration	
	Basal	Experimental (20% feces)
Nitrogen intake, g/day	109.60	102.28
Nitrogen excretion, g/day		
Fecal	34.00	39.65
Urinary	62.06	58.79
Total	96.06	98.44
Nitrogen retention		
Grams per day	13.54[b]	3.84[c]
Percent of nitrogen intake	12.35[b]	3.75[c]
Percent of absorbed nitrogen	17.91[b]	6.13[c]

[a]Each value represents the mean for 6 steers.
[b,c]Means in same row having different superscripts are significantly different ($P < .05$).

AMINO ACID ABSORPTION BY THE SMALL INTESTINE OF SHEEP IN VITRO

W. A. Phillips, K. E. Webb, Jr. and J. P. Fontenot

Amino acids are the basic components of protein. Muscles, organs and enzymes are composed largely of protein and without these life would not be possible. Amino acid or protein nutrition of an animal is therefore extremely important. Amino acid nutrition of many monogastric species has been studied extensively. Until recently, however, little attention has been given to the amino acid nutrition of the ruminant. Ruminants are unique in their digestive characteristics, differing distinctively from the monogastric. The knowledge that the microbial population of the rumen could synthesize all amino acids needed by the animal delayed the development of interest in amino acid nutrition of ruminants. It is now realized that in order to increase growth, efficiency and production as these relate to protein needs, more basic information must be obtained about amino acid nutrition of ruminants. This study was undertaken to develop an in vitro procedure to study amino acid absorption characteristics of ruminant small intestine. The amino acids valine, threonine and methionine were selected for study.

Experimental Procedure

Sections from the small intestine of sheep were obtained to study the in vitro absorption of threonine, valine and methionine. Young lambs averaging 57 lb. bodyweight were used as donors of intestinal tissue. These lambs were housed in an open shed on wire mesh flooring and fed once daily. The ingredient and chemical composition of the ration fed is presented in Table 1. The lambs were group fed and feed was adjusted at two-week intervals to maintain a growth rate of 0.25 lb. per head per day. One lamb was used for each incubation. An incubation consisted of studying the absorption of a single amino acid by the duodenum, jejunum and ileum. Five lambs were used for valine incubations and three each for the threonine and methionine incubations.

The lamb designated as a donor for a given incubation was fasted 24 to 36 hours before the incubation, but was allowed free access to water. Sections of the duodenum, jejunum and ileum were located and removed. Intestinal sections were then everted and cleaned with buffered media to remove any remaining feed particles. Following this, they were cut into 8 cm lengths. These segments were formed into sacs filled with either buffered media or buffered amino acid solution. Following this the sacs were incubated using conventional procedures. During the incubation a mixture of O_2 - CO_2 was continuously bubbled through the flasks and they were maintained at 39° C.

Results

Amino acid uptake from the mucosal fluid is expressed as μmoles of the amino acid per gram of dry tissue per 45 minutes. These values are presented in table 2. In general, the absorption of all three amino acids increased as the distance from the pylorus increased. The exception to this was in the jejunum where threonine absorption was least and where methionine absorption was greatest.

Accumulation of amino acids in the serosal fluid is possibly the best indicator of overall absorption of amino acids (table 3). The amino acids that appear in the serosal fluid are those that can be utilized by the animal. The jejunum always released the least amount of each amino acid into the serosal fluid. The site of greatest accumulation of all three amino acids in the serosal fluid was the ileum. In all cases, the accumulation of amino acids in the serosal fluid by the ileum was significantly ($P < .01$) greater than the other two sections.

The jejunum accumulated the least amount of all three amino acids in the tissue (table 4). Tissue accumulation of the amino acids was similar between the duodenum and the ileum except for threonine where the ileum accumulated significantly ($P < .05$) more.

The effect of intestinal site on absorption of amino acids was evaluated by combining all incubations without regard to amino acid (table 5). The absorption of amino acids from the mucosal fluid increased as the distance from the pylorus increased. The jejunal section removed twice the amount of amino acids as the duodenum but this difference was not significant. Both the duodenal and jejunal sections were significantly ($P < .01$) lower than the ileum. Appearance of amino acids in the serosal fluid followed the same order as absorption from the mucosal fluid. Both the duodenum and the jejunum transported significantly ($P < .01$) less amino acids into the serosal fluid than the ileal section. The duodenum actually absorbed amino acids from the serosal fluid as indicated by the negative value. The jejunum released a very small amount of amino acids into the serosal fluid in relation to the amount absorbed from the mucosal fluid. The ileum and the duodenum accumulated significantly ($P < .05$) more amino acids in the tissue than did the jejunum. The amount of retention by the jejunum was about one-half that of the duodenum and ileum.

The difference between removal of amino acids from the mucosal fluid and the accumulation of amino acids in the serosal fluid might be expected to indicate the tissue accumulation of amino acids. In all cases, the expected tissue accumulation of amino acids is low. This may indicate that the structures of the amino acids are being changed or that they are being used as an energy source by the tissue.

The duodenum is capable of absorbing amino acids from the mucosal fluid and accumulating these amino acids in the tissue. The release of amino acids into the serosal fluid by the duodenum is small if any. This section appears to be of little importance as a site of amino acid absorption. The jejunum absorbed valine and methionine readily, but absorbed only a small amount of threonine. The amino acids it did absorb from the mucosal fluid were neither found in the serosal fluid nor accumulated in the tissue. This may indicate that the jejunum used these amino acids for energy or the structure of the amino acids was altered by transamination. The ileum maximized movement of all three amino acids. It consistently absorbed the greatest amount from the mucosal fluid and released the greatest amounts into the serosal fluid. The ileal tissue also accumulated as much amino acid as the duodenum, but this was a much smaller portion of the amount transported through the tissue than the duodenum. The ileum appears to be the most active and efficient site of valine, threonine and methionine absorption in the sheep.

TABLE 1. COMPOSITION OF RATION FED TO GROWING WETHERS

Item	Ration
Ingredient composition, %	
Ground grass hay	55.40
Ground ear corn	25.10
Soybean meal	18.50
Iodize salt	0.90
Limestone	0.10
Vitamin A[a]	+
Vitamin D[b]	+
Chemical composition	
Dry matter, %	91.19
Composition of dry matter, %	
Crude protein	15.08
Ether extract	1.56
Crude fiber	26.54
Ash	5.67
NFE	51.15

[a]Supplied 1300 I.U. per kilogram of ration.
[b]Supplied 220 I.U. per kilogram of ration.

TABLE 2. ABSORPTION OF AMINO ACIDS FROM THE MUCOSAL FLUID BY INTESTINAL SECTIONS

Site	Amino acid[a]		
	Valine	Threonine	Methionine
Duodenum	83.60[b]	13.05[d]	26.24[d]
Jejunum	126.53[b]	1.17[d]	177.10[e]
Ileum	206.72[c]	140.75[e]	168.76[e]

[a]Expressed as μmoles per gram of dry tissue per 45 minutes.
[b,c]Means in the same column with different superscripts are significantly different ($P < .01$).
[d,e]Means in the same column with different superscripts are significantly different ($P < .05$).

TABLE 3. ACCUMULATION OF AMINO ACIDS IN THE SEROSAL FLUID BY INTESTINAL SECTIONS

Site	Amino acid[a]		
	Valine	Threonine	Methionine
Duodenum	16.65[b]	10.03[b]	5.51[b]
Jejunum	4.21[b]	5.47[b]	4.35[b]
Ileum	82.50[c]	85.93[c]	38.74[c]

[a]Expressed as μmoles per gram of dry tissue per 45 minutes.
[b,c]Means in the same column with different superscripts are significantly different ($P < .01$).

TABLE 4. ACCUMULATION OF AMINO ACIDS BY INTESTINAL TISSUE DURING THE INCUBATION PERIOD

Site	Amino acid[a]		
	Valine	Threonine	Methionine
Duodenum	51.84[b]	25.41[d]	18.80
Jejunum	21.90[c]	19.95[d]	15.15
Ileum	58.23[b]	44.45[e]	16.15

[a]Expressed as μmoles per gram of dry tissue per 45 minutes.
[b,c]Means in the same column with different superscripts are significantly different ($P < .01$).
[d,e]Means in the same column with different superscripts are significantly different ($P < .05$).

TABLE 5. AMINO ACID TRANSPORT BY DIFFERENT INTESTINAL SECTIONS

Item	Amino acid change by site[a]		
	Duodenum	Jejunum	Ileum
Mucosal fluid	-53.67[b]	-101.55[b]	-178.63[c]
Serosal fluid	-3.99[b]	0.37[b]	71.89[c]
Tissue	36.34[d]	19.45[e]	43.51[d]

[a]Expressed as μmoles per gram of dry tissue per 45 minutes.
[b,c]Means in the same row with different superscripts are significantly different ($P < .01$).
[d,e]Means in the same row with different superscripts are significantly different ($P < .05$).

BROILER LITTER AS A WINTERING FEED FOR BEEF COWS AND HEIFERS [1]

K. E. Webb, Jr., J. P. Fontenot and W. H. McClure

Broiler litter, a solid waste from the poultry industry, has been used primarily as fertilizer. Economic studies indicate that the plant nutrient value of animal wastes is not sufficient to justify the hauling of these. Broiler litter has been shown to have substantial nutrient value for ruminants and has been fed experimentally to beef cattle and sheep in practical rations. Generally, performance of the animals has been satisfactory and no problems with animal health have been encountered. The Food and Drug Administration does not sanction the feeding of broiler litter because of potential drug residues and disease organisms.

Two experiments have been conducted with ewes to determine the effect of feeding broiler litter on performance. In both experiments, there were no differences in performance of ewes fed 0, 25 or 50% broiler litter, but copper toxicity was encountered in the litter-fed animals. The litter contained high levels of copper as a result of feeding copper sulfate to the chicks.

Sheep are more sensitive to high levels of copper in the ration than cattle. One experiment has been completed and another started at the Shenandoah Valley Research Station to study the long term effect of feeding high levels of litter containing high levels of copper to cows and heifers during the winter.

Experimental Procedure

Experiment 1. Thirty-three aged beef cows were allotted at random by weight and breeding to three lots. The wintering rations for the three lots were as follows: 1) Hay, 2) 80% broiler litter, 20% ground shelled corn and 3) 80% broiler litter, 20% ground shelled corn and 160 ppm copper. The hay was mostly clover and of good quality. The ration for lot 3 had copper sulfate added to provide the equivalent of an additional 200 ppm copper in the litter or 160 ppm in the ration. The litter used was removed from broiler houses bedded with wood shavings and was stacked in an open shed to go through a "heat" prior to feeding. The rations were fed in such amounts as to supply the TDN requirements for pregnant cows. The cows in lot 1 were fed 18 lb. of hay per head per day and the cows in lots 2 and 3 were fed 16.5 lb. of the litter-corn mixture per head per day.

The cows were kept in small lots to minimize grazing. The cattle were weighed at 14-day intervals and rotated among the lots at each weigh day to minimize differences among the lots. This experiment was conducted

[1]Broiler litter was supplied by Rocco Feeds, Inc., Harrisonburg, Va.

during two winters. Liver samples were obtained by biopsy each fall and spring.

Experiment 2. Forty-two weanling heifers were allotted at random by weight and breeding to three lots. The first winter the animals in lot 1 were fed 8.5 lb. mixed hay, 3.0 lb. ear corn and 1.0 lb. of a complex urea supplement per head per day. The animals in lots 2 and 3 were self-fed a mixture of 50% litter and 50% ear corn. Copper was added to the ration in lot 3 to supply an additional 100 ppm copper. During the second winter, the heifers were fed the following rations: 1) Hay, 2) 75% broiler litter, 25% ground ear corn and 3) 75% broiler litter, 25% ground ear corn and 160 ppm copper. Weighing and management of the heifers was as described for the cows in experiment 1. The plan is to breed the heifers in the spring of 1974 and to continue the animals on experiment for 5 to 7 years to measure the long term effect of feeding high levels of litter and copper. The animals will be grazed as a group during the summer on native pasture. Liver samples were obtained by biopsy before the experiment started in December 1972. Additional samples will be obtained each spring and fall during the entire experiment.

Results

During the two winters of experiment 1, there was no effect of feeding broiler litter or the high copper ration on cow performance. The average weight gain for the cows before calving was -20, 8 and 18.5 lb. for the cows in lots 1, 2 and 3, respectively. The average calving percentage was 63.6, 58.5 and 69.7 and birth weight of the calves was 72, 76 and 74 lb. for lots 1, 2 and 3, respectively.

Liver copper levels were elevated by feeding the litter-corn rations as indicated by the higher liver copper levels detected from samples obtained each spring (table 1). The first winter the addition of copper to the litter-corn ration resulted in higher liver copper levels than the litter-corn ration but this was reversed the second winter. Copper was removed from the liver during the summer grazing period as indicated by the values for the fall samples. These levels decreased to approximately the same point at the end of each summer. Although these were higher than for the hay-fed cattle, they were certainly not high enough to suspect copper toxicity.

In experiment 2, the daily gain of the heifers was 0.50, 0.86 and 0.83 lb. per head per day for the first winter and 0.54, 1.07 and 1.10 lb. per head per day for the second winter for lots 1, 2 and 3, respectively. There appeared to be a trend for the heifers fed the litter rations to gain more than those fed the control rations. There was no effect of adding additional copper to the ration.

As in experiment 1, feeding broiler litter did increase liver copper levels (table 2). Samples obtained on May 4, 1973 indicate that liver copper levels were 115.59, 300.20 and 773.00 ppm for lots 1, 2 and 3, respectively. At the end of the second winter (April 4, 1974) the corresponding levels were 72.99, 197.27 and 729.46 ppm. Feeding the added copper increased liver copper above that of the animals fed the plain litter-corn ration. There was a decline in liver copper during the summer grazing period as indicated by the samples taken on December 2, 1973. This experiment is still in progress and will continue for another 5 to 7 years.

TABLE 1. EFFECT OF FEEDING BROILER LITTER TO COWS ON LIVER COPPER LEVELS - EXPERIMENT 1

	Wintering ration		
Sampling date	Hay	Litter + corn	Litter + corn + copper
	ppm		
12-8-70	53.58	71.03	80.58
4-23-71	33.52	449.27	536.84
12-7-71	42.86	179.01	162.07
4-19-72	59.69	485.59	402.70
11-21-72	48.47	176.66	152.70

TABLE 2. EFFECT OF FEEDING BROILER LITTER TO HEIFERS ON LIVER COPPER LEVELS - EXPERIMENT 2

	Wintering ration		
Sampling date	Hay	Litter + corn	Litter + corn + copper
	ppm		
12-12-72	40.33	31.90	27.59
5-4-73	115.59	300.20	773.00
12-2-73	74.06	106.65	157.95
4-17-74	72.99	197.27	729.46

EFFECT ON SOIL AND PLANT MINERAL LEVELS FOLLOWING APPLICATION OF MANURE FROM SWINE FED HIGH DIETARY COPPER.

E. T. Kornegay [1], J. D. Hedges[1], D. C. Martens[2] and C. Y. Kramer[3]

In last year's Livestock Research Report, it was shown that when manure from pigs fed high dietary levels of copper was incorporated into a silty loam soil, the copper remained in the surface 4 in. of the soil. As expected the copper level of the soil was increased (9.7 vs. 24.7 ppm), but there was only a trend toward increased copper in the corn ear leaf (7.2 vs. 8.3 ppm). Phosphorus, magnesium and calcium levels of the soil were increased with no change in the plant level of magnesium and calcium when control and high copper manure were applied. The study was continued for the second year to determine the effect of repeated application of manure containing a relatively high level of copper on growth and nutrient composition of corn (*Zea mays L.*) and on ion movement in soil.

Procedure

Manure collected from finishing pigs fed diets with and without a growth stimulating level of added copper (250 ppm in 1972 and 370 ppm in 1973) was incorporated into a Groseclose silt loam at the rate of 32.0 and 26.2 (6.9 and 5.7 on dry matter basis) ton per acre, respectively, for 1972 and 1973. The wet manure was applied between rows when corn was about 4 in. tall and worked into the surface 4 in. of the soil with a rotary tiller. The following treatments were randomly assigned to plots within each block: 1) no manure applied; 2) control manure applied from pigs fed ration without added copper 3) high copper manure applied from pigs fed rations containing growth stimulating levels of copper. Treatments were the same for each plot both years. The average composition of the manure for both years on a dry basis was 3.66% nitrogen, 3.13% calcium, 0.94% magnesium, 2.53% phosphorus, 1.31% potassium, 763 ppm zinc, 2135 ppm iron (table 1). The copper content was 80 ppm for control manure and 1914 ppm for high copper manure. Wet manure each year contained about 22% dry matter.

Results

The copper content in the upper 4 in. of the soil was significantly increased both years when high copper manure was applied with values of 14 vs. 47 ppm for the second year (table 2). There was a small increase in the copper content of the corn ear leaf (average of both years - 7.2 vs. 8.9 ppm) when manure from pigs fed diets containing high copper was applied (table 4). The copper content of grain from soil receiving high copper manure was not different from that of grain from soil receiving no manure (table 5). Copper in

[1]Department of Animal Science.
[2]Department of Agronomy.
[3]Department of Statistics.

the washed roots of the mature corn plants was doubled (5.6 vs. 11.2 ppm) when the high copper manure was added.

During one growing season, copper did not appear to move down, however, plowing after the first year increased the copper level in the 4 to 8 in. depth with a small increase in the 8 to 12 in. depth (table 2).

Potassium, zinc, phosphorus, calcium and magnesium levels of the soil were increased when manure was applied (table 3). Zinc, calcium, magnesium and potassium like copper appeared to remain in the surface 4 in. of the soil until after plowing when the contents of these elements were increased in the 4 to 8 in. depth and to some extent the 8 to 12 in. depth. Phosphorus unlike the other minerals moved down although the surface 4 in. contained the highest level.

The soil iron level was not affected by the application of manure (table 2). This is not unexpected as the amount of iron added is small in comparison to the amount present in the soil (13.5 ppm added vs. about 23,000 ppm present).

The zinc, potassium and phosphorus contents of the corn ear leaf were increased a small amount when both control and high copper manure were applied with the effect of potassium and phosphorus carrying over to the grain. The iron and calcium contents of the ear leaf were not affected by application of manure, but there was a decrease in calcium content of the grain from the application of control and high copper manure. Corn yields were increased ($P < .05$) on plots which had control and high copper manure applied as compared to the plots which had no manure applied (134.7 and 134.4 vs. 113.4 bu/acre).

TABLE 1. DRY MATTER, NITROGEN AND MINERAL COMPOSITION OF MANURE FROM MARKET HOG[a].

	Type of Manure by Years			
	Control diet[b]		High Cu diet[c]	
	1st Year	2nd Year	1st Year	2nd Year
Dry matter, %	21.4	22.0	21.8	22.0
Nitrogen, %	3.87	3.66	3.71	3.58
Iron, ppm	2071	2279	1819	2370
Copper, ppm	88	72	1460	2367
Zinc, ppm	864	596	929	621
Calcium, %	3.37	2.60	3.57	2.96
Phosphorus, %	2.78	2.13	2.96	2.26
Magnesium, %	0.94	0.88	0.97	0.93
Potassium, %	1.21	1.22	1.27	1.52

[a]Nitrogen and minerals are expressed on a dry matter basis.
[b]Contained 7-10 ppm copper in both years.
[c]Contained 250 and 370 ppm Cu, respectively, for the first and second years.

TABLE 2. THE EFFECT OF MANURE APPLICATION ON THE SOIL COPPER, ZINC AND IRON LEVELS.

Soil depth, in	Copper, ppm			Zinc, ppm			Iron, %		
	No manure	Control manure	High Cu manure	No manure	Control manure	High Cu manure	No manure	Control manure	High Cu manure
				June - 1st year[a]					
0-4	8.9	8.0	8.3	30.3	33.8	28.5	2.0	2.1	1.9
4-8	8.7	8.3	8.1	31.4	31.4	32.3	2.2	2.0	2.0
8-12	9.9	8.6	8.2	28.1	27.1	27.1	2.3	2.2	2.5
				September - 1st year[b]					
0-4	10.2	9.4	24.7[c]	40.3	46.0	45.1	2.2	2.0	2.1
4-8	10.0	9.7	9.9	43.7	37.5	35.1	2.3	2.1	2.2
8-12	9.6	10.5	10.5	32.7	45.3	39.7	2.5	2.9	2.6
				September - 2nd year[d,e]					
0-4	14.0	15.3	47.0[f]	31.0[g]	42.1	43.6	2.7	2.6	2.9
4-8	13.5	12.8	22.3	27.6[g]	39.0	36.8	3.0	3.0	2.8
8-12	13.5	13.3	15.0	28.5	29.0	30.1	3.7	3.3	2.9

[a] Initial sampling
[b] Depth effect significant (P <.05) for iron.
[c] Significantly (P <.05) larger than other means at this depth.
[d] Treatment effect significant (P <.01), depth effect significant (P <.01) and depth times treatment interaction significant (P <.01) for copper.
[e] Treatment and depth effects significant (P <.01) for zinc.
[f] Significantly(P<.01) larger than other means at this depth.
[g] Significantly (P <.05) lower than other means at this depth.

TABLE 3. THE EFFECT OF MANURE APPLICATION ON THE SOIL PHOSPHORUS, CALCIUM, MAGNESIUM AND POTASSIUM LEVELS (Dilute HCl-H_2SO_4 Extractable).

Soil depth, in	No Manure	Control Manure	High Cu Manure	No Manure	Control Manure	High Cu Manure
	PHOSPHORUS, ppm			MAGNESIUM, ppm		
	June - 1st year[a,b]					
0-4	54	55	44	59	55	56
4-8	39	47	32	60	50	58
8-12	21	26	17	66	59	61
	September - 1st year[b,c,d]					
0-4	50	60	60	66	119	119
4-8	44	56	56	77	95	81
8-12	22	31	32	91	90	90
	September - 2nd year[b,d,f]					
0-4	44[e]	60	59	45[e]	117	97
4-8	49[e]	60	60	49[e]	76	73
8-12	36	43	45	59	74	69
	CALCIUM, ppm			POTASSIUM, ppm		
	June - 1st year[a]					
0-4	612	599	602	156	152	150
4-8	576	517	498	154	149	136
8-12	550	583	508	149	153	123
	September - 1st Year[b,c,g]					
0-4	557	960	898	154	156	156
4-8	602	632	566	156	156	156
8-12	583	531	534	149	152	149
	September - 2nd year[c,d,h]					
0-4	355	771	586	91[i]	137	123
4-8	377[e]	462	462	102	116	108
8-12	410	346	443	103	120	100

[a]Initial sampling.
[b]Depth effect significant ($P < .01$) for phosphorus and calcium.
[c]Treatment effect significant ($P < .05$) for phosphorus, calcium and potassium.
[d]Depth times treatment interaction significant ($P < .05$) for magnesium and potassium.
[e]Significantly ($P < .05$) lower than other means at this depth.
[f]Treatment effect significant ($P < .05$) for magnesium.
[g]Depth times treatment interaction significant ($P < .01$) for calcium & potassium.
[h]Treatment effect approached significance ($P < .10$) for calcium.
[i]Significantly ($P < .01$) lower than other means at this depth.

TABLE 4. THE EFFECT OF MANURE APPLICATION ON EAR LEAF, COPPER, IRON, ZINC, CALCIUM, MAGNESIUM, PHOSPHORUS AND POTASSIUM LEVELS.

	Treatments		
Mineral	No feces	Control manure	High Cu manure
Copper, ppm			
1st year	7.2	7.1	8.3
2nd year	7.1	7.3	9.5[a]
Average	7.2	7.2	8.9[b]
Iron, ppm			
1st year	89.7	107.2	88.7
2nd year	79.9	87.1	85.9
Average	84.8	97.2	87.3
Zinc, ppm			
1st year	25.5	25.5	26.0
2nd year	27.6	39.3	39.1
Average	26.5[c]	32.4	32.6
Calcium, %			
1st year	0.35	0.38	0.36
2nd year	0.29	0.31	0.31
Average	0.32	0.35	0.34
Magnesium			
1st year	0.14	0.15	0.14
2nd year	0.13	0.14[a]	0.13
Average	0.13	0.15	0.13
Phosphorus, %			
1st year	0.26	0.42[a]	0.29
2nd year	0.22	0.37[d]	0.31
Average[e]	0.24	0.39	0.30
Potassium, %			
1st year	1.79	1.85	1.91
2nd year	1.89	2.12	2.02
Average	1.84[c]	1.98	1.97

[a]Significantly (P <.05) higher than other two means.
[b]Significantly (P <.01) higher than other two means.
[c]Significantly (P <.05) lower than other two means.
[d]Significantly (P <.05) different only from no manure treatment.
[e]Each mean is significantly (P <.01) different.

TABLE 5. THE EFFECT OF MANURE APPLICATION ON COPPER, IRON, ZINC, CALCIUM, MAGNESIUM, PHOSPHORUS AND POTASSIUM LEVELS OF GRAIN AND ROOTS (PPM), SECOND YEAR.

	Treatments		
Minerals	No manure	Control manure	High Cu manure
		Grain	
Copper	1.43	1.19[a]	1.60
Iron	26.2	27.4	25.6
Zinc	21.1	22.3	21.0
Calcium	46.6[b]	36.4	36.3
Magnesium	1048	1085	1114
Phosphorus	2335[c]	2650	2583
Potassium	2901[c]	3099	3077
		Roots	
Copper	6.2	5.0	11.2[b]
Iron	573	811	778
Zinc	49.5	38.3	46.1
Calcium	1998	1928	1852
Magnesium	361	469	378
Phosphorus	694	760	602
Potassium	90	110	89

[a]Significantly (P <.05) lower than high Cu manure.
[b]Significantly (P <.05) higher than other means.
[c]Significantly (P <.01) lower than other means.

Conclusions

It appears that when pig manure is spread and incorporated into the surface of the soil, the copper, zinc, potassium, calcium and magnesium contained in manure does not move downward during one growing season. On the other hand, phosphorus moved downward, although the surface 4 in. contained the highest level. The soil copper levels (8 to 10 ppm) in this study were on the lower side of a range (8 to 57 ppm) of soil copper reported for a variety of soils throughout the United States. The copper content of the ear leaf was increased for corn grown on the plots receiving high copper manure as compared to no manure or control manure plots; however, levels are well within a suggested sufficient range. In this study little increase in copper concentration occurred in corn grain from 47.4 lb of copper per acre in two annual applications of hog manure to a silt loam soil having a pH of 5.5. The concentrations in the grain were in the range of that which is normally fed to farm animals.

COMMERCIALLY GROWN HIGH LYSINE CORNS FOR SWINE.

E. T. Kornegay, J. D. Hedges, K. E. Webb, Jr. and H. R. Thomas[a]

Over the past few years several universities have shown that the protein levels of swine rations can be lowered when high lysine corn (opaque - 2) containing a high level of lysine is fed in combination with a protein supplement. During 1973 due to the tremendously high price of soybean meal, a considerable acreage of high lysine corn was grown commercially in Virginia by swine producers. The purpose of this study was: 1) to determine the amino acid and protein levels of several samples of commercially grown high lysine corns and 2) to evaluate the use of commercially grown high lysine corns in swine growing rations.

Experimental Procedures

Thirty samples of high lysine corn (HLC) and ten samples of normal corn (NC) obtained from several locations throughout Virginia were analyzed for protein and amino acids. High lysine corns varying in lysine content were compared to normal corn in three feeding trials with growing pigs. Corn-soybean meal rations fortified with minerals, vitamins and antibiotics were fed in all trials. All pigs were self-fed and had water available at all times.

In trial 1 conducted on a swine producer's farm[b], 110 crossbred pigs (4 pens of 14 pigs each per treatment) averaging 15.4 lb were paired according to weight and randomly assigned to one of the following dietary treatments: 1) normal corn - 18% protein level, 2) high lysine corn - 16% protein level. The protein level of both rations was lowered two percentage units after five weeks and the test was continued for an additional five weeks. During the first 5-weeks the pigs were housed in pens with aluminum slotted floors in an enclosed building with controlled temperature. During the second 5-weeks the pigs were housed on wood slats in a building with side curtains.

In trial 2, conducted at Blacksburg, 88 pigs (2 pens of 7 pigs and one pen of 8 pigs each per treatment) averaging 21.8 lb were randomly assigned to dietary treatment from outcome groups based on weight and sex. Normal and high lysine corns were fed in rations containing 18 and 16% protein initially. At about 30 lb the protein

[a]Appreciation is expressed to C. F. Jordan, John Blaha and Charlie Babb for their help in conducting the feeding trials; to C. R. Cooper, J. H. Carter, L. B. Allen and Swanson Jennings for collecting samples; and to C. Y. Kramer for statistical analysis of data; to Mr. John Buschmann, New Canton, Va. for donating the high lysine corn used in two of the feeding trials; to Carol Shipp and M. R. Holland for calculating amino acids.

[b]Jordan Brothers, Sulfolk, Va.

levels of all rations were reduced two percentage units and the pigs were continued to about 75 pounds. Pigs were housed in pens with totally slotted floors in an enclosed building with controlled temperature.

In trial 3, conducted at Holland, 90 crossbred pigs (3 pens of 6 pigs each per treatment) averaging 32.6 lb were randomly assigned from outcome groups based on weight and sex to the following dietary treatments: 1) 16% protein NC ration, 2) 14% protein NC ration, 3) source 1 HLC ration, 4) source 2 HLC ration, 5) source 3 HLC ration. Rations 1, 3, 4 and 5 were formulated to have an equal total lysine level (0.78%) with ration 2 having a lower lysine level (0.64%). The test was continued for 45 days at which time the pigs weighed 105 pounds. Pigs were housed in pens with partially slotted floors in an enclosed building with controlled temperature.

Results

Protein levels in the HLC samples ranged from 7.1 to 9.4% with an average of 8.2% and lysine levels ranged from 0.29 to 0.49% with an average of 0.35% (table 1). In the NC samples, protein levels ranged from 7.3 to 9.5% with an average of 8.5% and lysine levels ranged from 0.20 to 0.25% with an average of 0.23%. All analyses were expressed on an 88% dry matter basis. These data show a positive, although not high, relationship between protein and lysine levels in HLC, but no relationship in NC (figure 1). The prediction equation was $Y = -0.048 + 0.049X$; $r^2 = 0.34$ ($P < .01$) for HLC with Y = % lysine and X = % protein.

In trial 1, feedlot performance was not different between pigs fed the NC ration and the HLC corn ration at a two percentage units lower protein level (table 2). The amount of soybean meal is reduced about 5% when protein is reduced two percentage units.

In trial 2, feedlot performance was related to the lysine level irrespective of the type of corn (table 3). Pigs fed the HLC 18-16 protein sequence had the best feedlot performance followed by pigs fed the NC 18-16 and HLC 16-14 protein sequences. Poorest performance was obtained from pigs fed the NC 16-14 protein sequence.

In trial 3, feedlot performance was similar for all diets containing the same level of lysine (diets 1, 3, 4 and 5) and was greater than that of pigs fed diet 2 containing a lower level of lysine (table 4).

Conclusions

High lysine corns obtained from several locations were variable in protein and lysine levels. The lysine in high lysine corn appeared to be as available to the growing pig as the lysine in normal corn. However until corn breeders reduce the wide variation in the lysine level of high lysine corn, ration formulations should be based on actual lysine analysis of the corn to be used, if optimum performance of the pigs is to be maintained and if maximum value of the high lysine corn is to be obtained.

TABLE 1. CRUDE PROTEIN AND LYSINE LEVELS OF SOME VIRGINIA GROWN CORNS IN 1973 (88% DRY MATTER BASIS)

Corns	No. of samples	Protein	Lysine
		%	%
High Lysine			
Mean	30	8.22	0.354[a]
Range		7.12-9.36	0.285-0.486
Normal			
Mean	10	8.51	0.229
Range		7.36-9.49	0.202-0.249

[a]Five samples had values higher than 0.40%, nine samples had values between 0.35 and 0.40%, fourteen samples had values between 0.30 and 0.35% and two samples had values below 0.30 percent.

TABLE 2. FEEDLOT PERFORMANCE OF PIGS FED STARTER RATIONS WITH NORMAL AND HIGH LYSINE CORNS. TRIAL 1.

	Treatments					
	Phase 1[a]		Phase 2[b]		Overall	
Protein level, calc., %	18	16	16	14	18-16	16-14
Corn type	NC	HLC	NC	HLC	NC	HLC
No. of pigs[c]	54	56	54	56	54	56
Avg initial wt., lb	15.6	15.4	39.5	37.4	15.6	15.4
Avg final wt., lb	39.5	37.4	87.6	82.4	87.6	82.4
Avg daily gain, lb[c]	0.68	0.63	1.37	1.28	1.03	0.96
Avg daily feed intake, lb[d]	1.48	1.39	3.67	3.41	2.58	2.40
Feed/gain[d]	2.18	2.21	2.67	2.64	2.50	2.50

[a]Zero to five weeks.
[b]Five to ten weeks.
[c]Each mean represents 4 pens of pigs.
[d]Each mean represents two double pens of pigs.

TABLE 3. FEEDLOT PERFORMANCE OF PIGS FED RATIONS CONSISTING OF NORMAL AND HIGH LYSINE CORNS. TRIAL 2.

	Ration			
	1	2	3	4
	Normal Corn		High Lysine Corn[a]	
Lysine level, calc., %[b]	.95-.80	.80-.65	1.04-0.90	.89-.75
Protein level, calc., %[c]	18-16	16-14	18-16	16-14
No. of pigs	22[d]	22	22	22
Avg initial wt, lb.	21.9	21.7	21.9	21.7
Avg final wt, lb.	74.4	69.3	76.0	74.0
Avg daily gain, lb.	1.16	1.01	1.25	1.11
Avg daily feed intake, lb.	2.63	2.50	2.63	2.64
Feed/gain	2.27	2.48	2.10	2.38

[a]High lysine corn was donated by Mr. John Buschmann, New Canton, Va.
[b]Used a normal corn lysine value of 0.22% and a high lysine corn lysine value of 0.35%.
[c]The protein level of each ration was lowered when the pen of pigs averaged about 30 pounds.
[d]Consisted of two pens of 7 pigs each and one pen of 8 pigs.

TABLE 4. FEEDLOT PERFORMANCE OF PIGS FED RATIONS CONTAINING HIGH LYSINE CORNS WHICH VARIED IN LYSINE CONTENT. TRIAL 3.

	Ration				
	1	2	3	4	5
	Normal Corns		High Lysine Corns		
Lysine level, calc., %	0.78	0.64	0.78[a]	0.78[b]	0.78[c]
Protein level, calc., %[d]	16.0	14.0	14.7	14.5	13.3
No. of pigs[e]	18[f]	18	18	18	18
Avg initial wt, lb.	34.8	34.9	34.8	34.7	34.5
Avg final wt, lb.	105.6	99.4[g]	108.9	107.2	106.7
Avg daily gain, lb.	1.60	1.45[g]	1.65	1.61	1.60
Avg daily feed intake, lb.	4.28	4.03	4.37	4.26	4.17
Feed/gain	2.63	2.78[h]	2.64	2.63	2.60

[a]Source 1 analyzed 0.297% lysine and 8.0% protein (Cutchins).
[b]Source 2 analyzed 0.349% lysine and 8.4% protein (Buschmann).
[c]Source 3 analyzed 0.484% lysine and 9.0% protein (Eller).
[d]Analyzed 16.1, 14.3, 14.5, 14.5 and 14.7.
[e]Length of test was 45 days.
[f]Three pens of 6 pigs each.
[g]Significantly (P <.05) lower than other means.
[h]Significantly (P <.05) higher than other means.

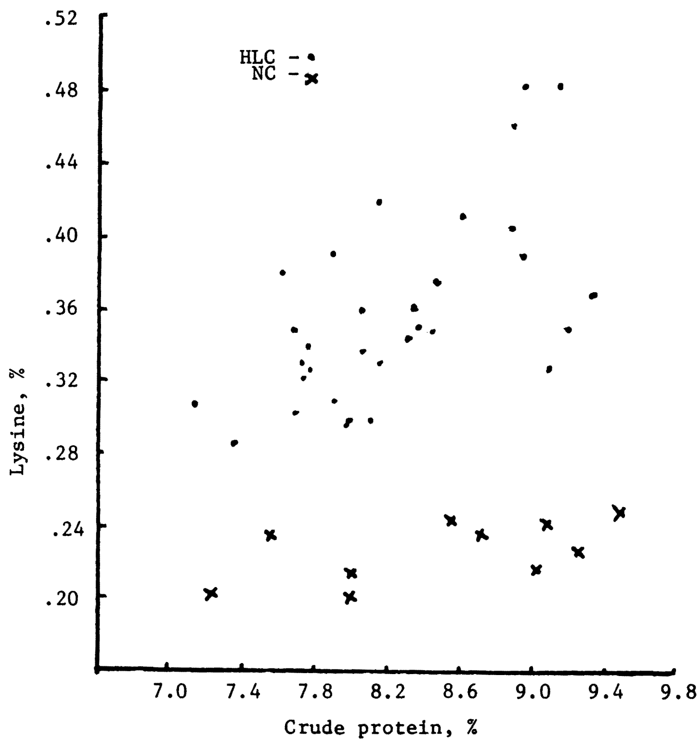

FIGURE 1. RELATIONSHIP OF CRUDE PROTEIN AND LYSINE LEVELS OF NORMAL AND HIGH LYSINE CORNS (88% DRY MATTER BASIS)

COMPARISON OF SIMPLE VERSUS COMPLEX STARTER DIETS

E. T. Kornegay[1]

Previous studies at this university showed that the addition of dried whey to starter diets which were pelleted and in which lysine levels were equalized did not consistently improve feedlot performance. These trials were conducted to compare a simple corn soybean meal starter diet with and without dried whey and a complex commercial starter diet.

Experimental Procedure

In trial 1, 117 pigs (three pens of 13 pigs each per pen per treatment) averaging 15.0 lb and in trial 2, 75 pigs (two pens of 8 pigs and one pen of 7 pigs per pen per treatment) averaging 12.8 lb were fed the following diets: 1) 18% corn soybean meal, 2) 18% corn-soybean meal with 17.5% dried whey, 3) a commercial starter[2] for 14 days and then diet 2 in trial 1. In trial 2, the commercial starter was fed for only 7 days and then diet 3 shown in table 1. Trial 1 was terminated when the pigs averaged about 38 pounds; however, in trial 2 all pigs were changed to a 16% protein diet (table 1) when they averaged about 40 pounds and were continued until they averaged about 65 pounds. Pigs in both trials were housed in an enclosed temperature controlled nursery with totally slotted floors. All pigs had access to a pelleted commercial creep diet at about 2 weeks of age. Each pen was equipped with a self-feeder and automatic waterer.

Results

Trial one. Over the entire test period of 35 days, pigs fed the commercial starter for 14 days and then diet 2 were more efficient ($P < .05$) than pigs fed the corn-soybean diets without and with dried whey (diets 1 and 2) continuously. Most of the differences occurred during the final three weeks of the trial. There was an improvement initially in daily gain ($P < .01$), feed efficiency ($P < .05$) and feed intake ($P < .01$) for pigs fed the commercial starter. Feed intake of pigs fed the corn-soybean meal diet with whey was also improved initially.

Trial two. As in trial one, pigs fed the commercial starter initially (7 days) and then a corn-soybean meal diet containing

[1]Appreciation is expressed to John Blaha and Fred Barlow for their help in conducting the experiment and to Dr. C. Y. Kramer for statistical analysis, and to Triple "F" Feeds, Des Moines, Iowa for supplying materials.

[2]Toasty soats, No 2470 supplied by Triple "F" Feeds, Des Moines, Iowa 50322.

Golden Soats[2], Trizyme[2] and dried whey until pigs reached about 40 lb gained faster and were more efficient than pigs fed the corn-soybean meal diet without whey. Contrary to results in trial 2, pigs fed the corn-soybean diet with 17.5% whey gained as fast and were as efficient as pigs fed the commercial diet.

In both trials, there appeared to be some compensation during the later periods by pigs doing poorer during the earlier period.

Conclusion

Average daily gain appeared to be greater for pigs fed the more complex diets with improvements in feed intake in some cases, and improvement in feed efficiency in some cases. In general the pigs fed the more complex diet grew a little faster and were more efficient. Whether it is more economic to feed the simple or the complex diets will depend on the relative prices of the starter diets and ingredients and the importance of time.

TABLE 1. COMPOSITION OF DIETS

	Diets			
	1[a] w/o whey	2[a] with whey	3[a] with GS[b]	4 16% protein
	%	%	%	%
Corn (8.7%)	68.64	53.74	46.48	76.05
Soybean meal (44%)	27.51	25.86	19.52	21.32
Golden soats[c] (20.6)	--	--	20.00	--
Dried whey (12%)	--	17.50	10.00	--
Limestone	0.45	0.45	0.55	0.63
Defluorinated phosphate	1.80	1.35	1.50	1.00
Vitamin premix[d]	0.70	0.70	0.70	0.25
Plain salt	0.50	--	0.22	--
T.M. premix[e]	0.15	0.15	0.15	--
Antibiotic[f]	0.25	0.25	0.25	0.25
Trizyme[c]	--	--	1.00	--
Swine trace mineral salt	--	--	--	0.50

[a]Calculated to contain: 18.1% crude protein, 0.87% Ca and 0.68% P.
[b]To be fed after feeding Toasty Soats Pre Creep #2470 for 7 to 10 days.
[c]Supplied by Triple "F" Feeds, Des Moines, Iowa.
[d]Supplied (per lb of premix): 0.6 g riboflavin, 3.1 g pantothenic acid, 3.1 g niacin, 4.8 mg vitamin B_{12}, 100 g choline chloride, 600,000 I.U. vitamin A, 110,000 I.U. vitamin D, 1,000 I.U vitamin E and 150 mg MPB.
[e]Contained (%): 12.23 $ZnSO_4$, 5.3 $FeSO_4$, 12.13 $MnSO_4$ H_2O, 0.20 $CoCl_2 \cdot 6H_2O$, 0.10 KI and 70.01 limestone.
[f]Contained 20 g of chortetracyline, 10 g of penicillin and 20 g sulfathiazole per lb of premix.

TABLE 2. FEEDLOT PERFORMANCE OF WEANLING PIGS FED DIFFERENT STARTER DIETS.

	Diets		
Criteria	1 w/o whey	2 with whey	3 commercial
	Trial 1		
No. of pigs	39	37(2)[a]	39
Avg initial wt, lb	14.9	14.7	14.9
Avg final wt, lb	36.6	37.6	37.4
Avg daily gain, lb	0.58	0.61	0.65
Avg daily feed intake, lb	1.19	1.26	1.21
Feed/gain	2.05	2.08	1.88[b]
	Trial 2 (Initial to 40 lb)		
No. of pigs	24(1)[c]	24(1)[c]	25
Avg initial wt, lb	12.8	12.6	12.8
Avg daily gain, lb	0.69[d]	0.83	0.88
Avg daily feed intake, lb	1.47	1.49	1.58
Feed/gain	2.12[e]	1.80	1.81
	(40 lb to 63 lb)		
Avg daily gain, lb[f]	1.12	1.07	0.99
Avg daily feed intake, lb	2.81	2.65	2.45
Feed/gain	2.51	2.47	2.48
	(Initial to 63 lb)		
Avg final wt, lb	58.9	64.5	64.7
Avg daily gain, lb	0.82[g]	0.92	0.93
Avg daily feed intake, lb	1.86	1.96	1.94
Feed/gain	2.28	2.12	2.10

[a]Two pigs died during the early part of the trial--data was not included.
[b]Significantly (P <.05) lower than the other means.
[c]One pig each on diets 1 and 2 died after two weeks on test.
[d]Significantly (P <.01) lower than the other means.
[e]Significantly (P <.01) higher than the other means.
[f]Significant (P <.05) treatment effect (1 > 3).
[g]Significantly (P <.05) lower than the other means.

EVALUATION OF PHOSPHORUS LEVELS FOR GESTATING-LACTATING GILTS AND SOWS.

B. W. Kite, Jr. and E. T. Kornegay

Calcium and phosphorus are the two essential minerals needed in the largest amounts by domesticated animals. Although many studies have been conducted with growing-finishing swine examining calcium and phosphorus levels, ratios and availability from a variety of sources, few studies have been conducted with gravid swine. In a previous study, a greater number of sows completed five parities when fed a higher level of calcium and phosphorus. Improved mating, conception and farrowing rates were found for sows fed the higher level of calcium and phosphorus. The main objectives of this study were: 1) to compare the reproductive performance of confinement housed sows fed either 10 or 15 g daily of phosphorus with a constant intake of 15 g of calcium and continued for three parities and 2) to measure calcium, phosphorus and nitrogen absorption and retention during the last third of gestation.

Experimental Procedure

Thirty-six crossbred, 20 Hampshire and 10 Yorkshire gilts which had been raised in total confinement on concrete were paired at breeding and randomly assigned to either a high phosphorus ration (15 g P daily) or a low phosphorus ration (10 g P daily). The calcium intake was 15 g daily for both phosphorus levels. A 15% protein corn-soybean meal ration fortified with appropriate minerals and vitamins was fed at a level of 4 lb during breeding for about 11 weeks, afterwards 5.0 lb per head/day until farrowing. After breeding, gilts remained on a partially slotted concrete floor until 5 weeks before farrowing. A balance trial was then conducted to measure calcium, phosphorus and nitrogen absorption and retention.

Results

Daily ration intake, feces and urine output and composition of rations, feces and urine values by ration across lactations are shown in table 1. Farrowing performance was not significantly different between sows fed the high or low level of phosphorus (table 2). Average litter weights did increase from lactation 1 to lactation 3. No significant difference in calcium or nitrogen absorption or retention was noted between rations across lactations (table 3). Sows fed the high phosphorus ration had significantly ($P < .001$) higher daily fecal and urine excretion and absorption of phosphorus. The high P fed sows retained ($P < .05$) a larger amount of phosphorus in grams per day, although, they were less efficient when retained phosphorus was expressed as a percentage of the absorbed. Hair calcium content was higher ($P < .01$) across lactations for high P fed sows than for low P fed sows; whereas, no significant difference was noted across lactation or rations for hair phosphorus content (table 4). Serum calcium levels were not different between rations. Serum phosphorus levels were higher ($P < .001$) for high P fed sows as compared to the low P fed sows, but were not different between lactations.

Conclusions

From the data presented for three parities, it appears that the lower dietary level of phosphorus (10 g daily) is adequate as measured by farrowing performance. Although more grams of phosphorus were absorbed and retained by sows fed the high P ration, the sows fed the low P ration were more efficient in the utilization of phosphorus. This study is continuing for five parities, but after three parities it appears that there is no need to increase the phosphorus level above the current NRC recommendations for gestating gilts and sows. This preliminary report should be interpreted with caution as breeding data has not been analyzed yet and certain trends are evident which might become significant after five parities.

TABLE 1. DAILY RATION INTAKE, FECES AND URINE OUTPUT AND COMPOSITION OF RATION, FECES AND URINE BY RATION.

	Ration	
	Low P	High P
Intake, g.	2163.85	2165.24
Calcium,%	0.69	0.68
Phosphorus, %	0.47	0.65
Nitrogen, %	2.49	2.45
Fecal output, g.	201.24	208.47
Calcium, %	4.50	4.22
Phosphorus, %	2.87	3.50
Nitrogen, %	3.14	3.11
Urine output, ℓ	4.60	4.15
Calcium, g/ℓ	0.07	0.06
Phosphorus, g/ℓ	0.19	0.68
Nitrogen, g/ℓ	6.06	6.14

TABLE 2. FARROWING PERFORMANCE FOR SOWS FED HIGH AND LOW LEVELS OF PHOSPHORUS.

Item	Ration	
	Low P	High P
No. of sows	72	72
Avg live pigs/litter, no.	8.6	8.8
Avg dead pigs/litter, no.	0.6	0.4
Avg mummies/litter, no.	0.1	0.1
Total pigs/litter, no.	9.3	9.3
Avg birth, kg.	1.2	1.2
Avg litter wt., kg	10.35	11.2

TABLE 3. DAILY ABSORBED AND RETAINED CALCIUM, PHOSPHORUS, AND NITROGEN FOR SOWS FED HIGH AND LOW LEVELS OF PHOSPHORUS.[a]

	Calcium		Phosphorus		Nitrogen	
	Low P	High P	Low P	High P	Low P	High P
No. of sows	55	59	55	59	49	53
Intake, g.	14.76	14.58	10.07	13.96***	55.05	56.14
Fecal, g.	9.00	8.73	5.76	7.27***	6.39	6.46
Urine, g.	0.30	0.23	0.70	2.37***	21.71	21.49
Absorbed, g.	5.76	5.85	4.31	6.69***	47.06	46.27
Absorbed, % of I	38.67	40.44	42.52	48.00***	87.89	87.75
Retained, g.	5.46	5.62	3.55	4.33*	25.35	24.77
Retained, % of I	36.60	38.67	34.79	31.22	46.93	46.52
Retained, % of A	94.01	95.48	78.91	62.11***	53.24	52.98

[a]Least squares means.

***(P <.001) *(P <.05)

TABLE 4. CALCIUM AND PHOSPHORUS CONTENT OF SERUM AND HAIR FOR SOWS FED HIGH AND LOW LEVELS OF PHOSPHORUS.

Item[b]	Ration[a]	
	Low P	High P
No. of sows	42	35
Serum		
Ca, Mg/100 ml.	11.33	11.28
P, mg/100 ml.	6.31	6.89**
Hair		
Calcium, %	0.093	0.135**
Phosphorus, %	0.016	0.013

[a]Ten and 15 g respectively.
[b]Least square means.
**(P <.01)

EVALUATION OF A ZINC-METHIONINE COMPLEX AS A GROWTH STIMULANT FOR SWINE

H. R. Thomas and E. T. Kornegay[a]

Claims of fantastic improvements, 30% for growth rate and 20% for feed efficiency, have been reported for a zinc-methionine complex (ZMC), yet there are no reports in the scientific literature about this proposed non-antibiotic growth stimulant. These trials were conducted to evaluate this compound for growing and finishing swine.

Experimental Procedures

One hundred-fifty crossbred pigs (trial 1 - 3 pens of 6 pigs each per treatment, trial 2 - 2 pens of 6 pigs each per treatment) averaging 40 lb were fed the following dietary treatments: 1) low zinc (30 ppm Zn), 2) diet 1 plus 0.1% ZMC[b] (120 ppm Zn), 3) normal zinc (80 ppm Zn), 4) diet 3 plus 0.1% ZMC (170 ppm Zn), 5) high zinc (170 ppm Zn). Fortified corn-soybean meal-peanut meal-fish flour diets were self-fed in trial 1 with peanut meal omitted in trial 2. Calculated 16% protein diets (770 ppm choline and 44 ppm tylosin added) were fed to 100 lb, then calculated 14% protein diets (550 ppm choline and 22 ppm tylosin added) were fed to market weight of about 210 pounds. Protein levels analyzed 16.1 and 15.6%, respectively for the calculated 16 and 14% in trial 1. In trial 2, the analyzed protein levels were 15.6 and 13.6%, respectively for the calculated 16 and 14% levels. Analyzed Zn levels across trials were 31,109, 83,169 and 163 respectively for diets 1 through 5. Pigs were randomly allotted from outcome groups based on weight and sex to treatment and were housed in pens with partially slotted floors in an enclosed building with temperature controlled by fans.

Results

In trial 1, there were no changes in daily gain, feed intake or feed/gain ratios when either zinc or ZMC was added to the low zinc or normal zinc diets (table 1). Similar results were also found in trial 2; however, there was a trend ($P < .10$) for feed/gain ratios to be improved when ZMC was added. An analysis of the combined data for both trials revealed no significant differences in feedlot performance due to added zinc or ZMC. No problems were experienced with parakeratosis on the low zinc diets (30 ppm Zn) although this level of zinc is considered deficient. Slightly higher levels of calcium could have caused problems. All diets were calculated to contain 0.6 and 0.5% calcium and 0.5 and 0.4% phosphorus respectively for the 16 and 14% protein levels.

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[a]Appreciation is expressed to Dr. C. Y. Kramer for statistical analysis, Jim Hedges for mineral and protein analysis and Charlie Babb and Carl Eure for caring for animals.

[b]ZinPro 40 supplied by Norwich Agricultural Products, Norwich, N.Y. 13815.

A response would not have been expected from the methionine in the ZMC as the diets did have adequate choline and research at other universities has been unable to show a response to synthetic methionine in similar diets.

Conclusion

Results from two trials using 150 crossbred pigs from 40 lb to 210 lb failed to show any response in gain or feed efficiency due to either zinc or ZMC under the conditions of this study. A trend toward improved feed/gain ratios in one trial when ZMC was added suggest that additional research is needed to firmly establish whether or not ZMC is beneficially as a growth stimulant.

TABLE 1. FEEDLOT PERFORMANCE OF PIGS FED RATIONS WITHOUT AND WITH ADDED ZINC AND ZINC-METHIONINE COMPLEX. TRIALS 1 AND 2.

	Diets[a,b]				
	1	2	3	4	5
	Low Zinc		Normal Zinc		
Criteria	w/o ZMC	with ZMC	w/o ZMC	with ZMC	with Zinc
Avg daily gain, lb[c,d]					
Trial 1	1.55	1.52	1.49	1.56	1.55
2	1.66	1.80	1.80	1.70	1.75
Wtd. avg	1.60	1.63	1.61	1.65	1.63
Avg daily feed intake, lb					
Trial 1	5.01	4.76	4.63	4.69	4.69
2	5.45	5.64	5.90	5.65	5.72
Wtd. avg	5.19	5.11	5.14	5.08	5.10
Feed/Gain					
Trial 1	3.13	3.13	3.11	3.01	3.04
2[e]	3.28	3.14	3.28	3.16	3.27
Wtd. avg	3.19	3.13	3.18	3.07	3.13

[a]A calculated 16% protein diet was fed to 100 lb and then a 14% protein diet was fed to market.
[b]Calculated (and analyzed) zinc levels were 30 (31), 120 (109), 80 (83), 170 (169) and 170 (163) respectively for rations 1 through 5.
[c]There were 18 pigs per mean (3 pens of 6 pigs each) averaging 39.5 lb initially in trial 1 and 12 pigs per mean (2 pens of 6 pigs each) averaging 40.1 lb initially in trial.
[d]Average final wt (lb) was 207.4, 210.6, 209.2, 209.4 and 209.4, respectively for diets 1 through 5.
[e]Trend (P <.10) for ZMC diets (2 and 4) to be lower than diets without ZMC (1 and 3).

EFFECT ON SUBSEQUENT FEEDLOT PERFORMANCE OF WITHDRAWING DIETARY ANTIBIOTICS WHEN SWINE WEIGH 75 AND 150 POUNDS.

E. T. Kornegay, H. R. Thomas[1] and C. Y. Kramer[2]

The use of antibiotics as a feed additive to improve feedlot performance of swine is widely recognized. It is equally well known that the greatest response occurs with the young growing pig. Some reports suggest that it is beneficial to continue antibiotic supplementation in swine rations throughout the finishing phase to maintain the advantage derived from the fortification of the ration of young pigs. The objective of this study was to determine the effect on subsequent feedlot performance of withdrawing antibiotics from rations when pigs weighted 75 and 150 pounds.

Experimental Procedure

In trial 1, phase one, 128 pigs (2 pens of 16 pigs each per treatment) averaging 17.9 lb were randomly assigned from outcome groups based on weight and sex to dietary treatment shown in table 1. In trial 2, phase one, 112 pigs (2 pens of 14 pigs each per treatment) averaging 23.4 lb were randomly assigned from outcome groups based on weight and sex to the same dietary treatment as in trial 1 (table 1). In both trials, when the pigs averaged about 75 lb they were paired by weight and sex within each pen and randomly assigned to treatments shown in table 1 for phase 2. This assignment of pigs was continued until market weight with antibiotics withdrawn from pigs receiving treatment 3 when they average 150 pounds. In trial 3, 90 pigs (3 pens of 5 pigs each per treatment) averaging about 75 lb which previously were fed on an 18% protein ration containing the antibiotic combination used in phase 1 of trials 1 and 2 were randomly assigned to treatments 2, 3 and 4 shown in table 1.

Pigs in all trials were housed in pens with partially slotted floors in an enclosed building with temperature controlled. Feed and water were available at all times. Data was statistically analyzed using the analysis of variance.

Results

Average daily gains and feed intakes were increased (11% for both) and feed/gains were decreased (3%) during phase 1 when pigs were fed rations containing the combination of antibiotics (table 2).

In phases 2 and 3 (75 lb to market weight) of trial 1, there appeared to be some compensation by pigs fed rations 1 and 2 as compared to pigs fed rations 3 and 4. Average daily gains and feed intakes were increased for pigs fed ration 1 as compared to rations 2,

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[1] Tidewater Research and Continuing Education Center.
[2] Department of Statistics.

3 and 4 and for rations 1 and 2 as compared to rations 3 and 4. However, feed/gains were not significant differences between treatments in trial 1. Feedlot performance was not different between treatments in trial 2 and for the combination of data for trials 1 and 2.

When summarized from weaning to market, there were no differences between treatments for average daily gains and feed intakes in trial 1. In trial 2, and for the combination of data for trials 1 and 2, average daily gains and feed intakes were less for pigs fed ration 1 as compared to pigs fed rations 2, 3 and 4 and for pigs fed rations 1 and 2 as compared to pigs fed rations 3 and 4. Feed/gain was not different between treatments for either trials 1 or 2 and the combination of the two trials.

In trial 3, effects of treatments were not significantly different, although there may have been a trend for feed/gain to be lower for pigs fed rations containing antibiotics to market weight.

Summary and Conclusions

In three trials feedlot performance was determined for pigs in which antibiotics were withdrawn from their ration at 75 and 150 pounds. Feedlot performance was improved (11% for gain and feed intake and 3% for feed/gain) during the earlier part of the trials (20 to 75 lb) when an antibiotic combination was included in the ration. However, there appeared to be compensation during the latter part of the trials, because there were no differences between treatments for feed/gain when the data was summarized from weaning to market. Also daily gains and feed intakes for the entire test from weaning to market were improved in only one of the three trials.

Under conditions in which these trials were conducted, the addition of antibiotics for the entire growing-finishing period would be a questionable practice as there were no differences in mortality, feed/gain and only slight improvement in daily gain. If the disease level had been higher than that of the two university herds involved in these trials, a greater response might have been obtained. These results suggest that under similar management conditions and with a similar disease level to that of the herds in which these tests were conducted, the response to antibiotics during the finishing phase may be negligible.

Table 1

EXPERIMENTAL DESIGN.

	Treatments[a]							
	1		2		3		4	
	a	b	a	b	a	b	a	b
Phase 1 (Weaning to 75 lb)	NA[b]		CSP[c]		CSP[c]		CSP[c]	
Phase 2 (75 to 150 lb)	NA	NA	NA	NA	T[d]	PS[e]	T[d]	PS[e]
Phase 3 (150 lb to Mkt)	NA	NA	NA	NA	NA	NA	T[f]	PS[g]

[a]Crude protein levels of corn-soybean meal rations were 18, 16 and 14%, respectively, for phase 1, 2 and 3.
[b]No antibiotic added.
[c]CSP 250, 5 lb/ton. Contained 20 g chlortelracyline, 10 g penicillin and 20 g sulfathiozole per lb of premix.
[d]Tylosin, 4 lb/ton. Contained 10 g tylosin per lb of premix.
[e]Pro-Strep, 0.67 lb/ton. Contained 60 g of penicillin and 60 g of streptomycin per lb of premix.
[f]Tylosin, 2 lb/ton.
[g]Pro-Strep, 0.34 lb/ton.

Table 2

FEEDLOT PERFORMANCE OF PIGS FED RATIONS CONTAINING ANTIBIOTICS WHICH WERE WITHDRAWN AT VARIOUS STAGES. Trials 1 and 2.

	Treatments							
	1a	1b	2a	2b	3a	3b	4a	4b
	NA	NA	CSP	CSP	CSP	CSP	CSP	CSP
	NA	NA	NA	NA	T	PS	T	PS
	NA	NA	NA	NA	NA	NA	T	PS
	Weaning to 75 lb[a]							
Avg daily gain, lb								
Trial 1	0.78		0.86		0.94		0.91	
2[b]	1.10		1.27		1.28		1.23	
Avg[c]	0.95		1.07		1.11		1.07	
Avg daily feed intake, lb								
Trial 1	1.84		1.94		2.11		2.02	
2	2.57		2.94		3.02		2.76	
Avg[b]	2.21		2.44		2.56		2.39	
Feed/Gain								
Trial 1	2.35		2.27		2.25		2.22	
2	2.32		2.31		2.36		2.24	
Avg[d]	2.34		2.29		2.31		2.23	
	75 lb to market[e]							
Avg daily gain, lb								
Trial 1[f,g]	1.49	1.47	1.37	1.41	1.37	1.39	1.37	1.38
2	1.41	1.26	1.36	1.35	1.43	1.41	1.44	1.37
Avg	1.45	1.36	1.36	1.38	1.40	1.40	1.41	1.37
Avg daily/feed intake, lb								
Trial 1[f,g]	4.89	5.03	4.74	4.62	4.67	4.50	4.62	4.65
2	4.87	4.35	4.73	4.79	4.94	4.83	5.00	4.76
Avg	4.88	4.67	4.74	4.71	4.81	4.67	4.81	4.70
Feed/Gain								
Trial 1	3.30	3.43	3.47	3.27	3.41	3.24	3.38	3.39
2	3.45	3.45	3.49	3.54	3.46	3.43	3.48	3.47
Avg	3.37	3.44	3.48	3.41	3.44	3.34	3.43	3.43
	Weaning to Market							
Avg daily gain, lb								
Trial 1	1.26	1.23	1.20	1.27	1.26	1.26	1.21	1.25
2[b,h]	1.32	1.22	1.32	1.31	1.38	1.35	1.37	1.33
Avg[b,h]	1.28	1.22	1.26	1.29	1.32	1.31	1.29	1.29
Avg daily feed intake, lb								
Trial 1	3.80	3.81	3.73	3.80	3.84	3.74	3.63	3.79
2[b,h]	4.04	3.74	4.09	4.10	4.25	4.18	4.23	4.09
Avg	3.92	3.77	3.91	3.95	4.04	3.95	3.93	3.94
Feed/Gain								
Trial 1	3.03	3.11	3.12	3.00	3.05	2.96	3.01	3.03
2	3.00	3.07	3.10	3.15	3.09	3.09	3.08	3.07
Avg	3.06	3.08	3.11	3.07	3.06	3.02	3.05	3.05

[a]Thirty-two pigs (16/pen) averaging 17.9 lb per mean in trial 1 and 28 pigs (14/pen) averaging 23.4 lb in trial 2.
[b]Significant (P < .05) treatment effect (1< 2, 3 and 4).
[c]Significant (P < .01) treatment effect (1< 2, 3 and 4).
[d]Significant (P < .05) treatment effect (1>2, 3 and 4).
[e]Twelve pigs (6/pen) per mean in trials 1 and 2. Average final weight was 216.3 and 197.2 lb, respectively for trials 1 and 2.
[f]Significant (P < .05) treatment effect (1 and 2> 3 and 4).
[g]Significant (P < .01) treatment effect (1> 2, 3 and 4).
[h]Significant (P< .05) treatment effect (1 and 2< 3 and 4).

Table 3

FEEDLOT PERFORMANCE OF PIGS FED RATIONS CONTAINING ANTIBIOTICS WITHDRAWN AT VARIOUS STAGES. Trial 3.

	Treatments				
	2a	3a	3b	4a	4b
	NA	T	PS	T	PS
	NA	NA	NA	T	PS
	75 lb to market[a,b]				
Avg daily gain, lb	1.59	1.60	1.42	1.57	1.66
Avg daily feed intake, lb	5.36	5.43	4.88	5.29	5.37
Feed/Gain	3.43	3.40	3.45	3.37	3.25

[a]Fifteen pigs (5/pen) averaging 73.6 lb initially. Average final wt was 208 pounds.

[b]All pigs had been fed a 16% protein ration containing CSP 250 prior to the study. See table 1, footnote c.

BOAR MANAGEMENT: EFFECT OF REARING SYSTEMS ON SEXUAL MATURITY AND SEX HORMONE LEVELS

H. R. Thomas, T. N. Meacham and E. T. Kornegay[1]

An increasing number of reports from producers indicate that poor reproductive performance by boars obtained for herd sires is a major problem in the swine industry. This problem has been complicated and intensified where large numbers of animals are confined in small areas on concrete floors. Multiple farrowing increases the demands on herd sires. A lack of libido and lameness seem to be the two major problems.

These experiments were designed to study the effects of physical and social environment upon age at puberty, libido and sex hormone levels in the blood and tissues.

Experimental Procedure

Purebred and crossbred boars were used in these trials. They were housed in concrete floored pens, partially slotted concrete pens or in dirt lots. All boars were fed ad libidum until they weighed approximately 200 lbs and were hand-fed 5 lbs daily thereafter.

In trial 1, 20 purebred and 20 crossbred boars, approximately 12 weeks old, were randomly assigned to the following treatments: 1) dirt lots - invididual, 2) dirt lots - group, 3) partially slotted concrete pens - individual and 4) partially slotted concrete pens - group.

In trial 2, 20 crossbred boars were randomly assigned to 4 concrete floored pens. Two groups of boars (5 per pen) were housed with 5 females to the pen. Two groups of boars were similarly housed without females. A vacant pen separated the groups of boars.

Boars were exposed to the females in estrus at weekly intervals to determine age at puberty. All boars were scored as follows: 1) no interest, 2) interest, 3) mounting without penetration, 4) mounting with penetration and 5) mating.

At approximately 10 months of age blood samples were taken for testosterone and androstenedione assays. Boars were then slaughtered with testes and seminal vesicles removed for hormonal assay and histological evaluation.

Results

Results of age at puberty and testosterone levels are summarized in table 1. Preliminary conclusions are as follows.

[1]Appreciation is expressed to Dr. W. D. Oxender, Dept. of Dairy Science, Michigan State University, East Lansing, for hormone assay of blood and testes.

1) Purebred and crossbred boars appeared to reach sexual maturity at about the same age (190 vs. 199 days).

2) Boars reared in dirt lots were more active reproductively than boars reared in partially slotted concrete. They reached puberty 19 days earlier.

3) Group rearing appears to encourage sexual activity. Age at puberty was 23 days earlier with group reared boars when compared with individually reared boars.

4) Only slight differences were observed in age at puberty of boars reared with or without females.

5) Thirteen percent of the sixty boars used in these two trials were not satisfactory for herd sires as based on weekly exposure to estrual females.

6) There appeared to be no correlation between testosterone level and age at puberty.

TABLE 1. AGE AT PUBERTY AND TESTOSTERONE LEVELS OF TESTES AND BLOOD.

Comparisons	Age at Puberty	Testosterone Levels	
		Testicular	Blood Serum
	days	ng/mg	ng/ml
Trial 1			
Purebreds	190*	0.386	5.848
Crossbreds	199*	0.434	7.129
Dirt Lots	185	0.411	7.455
Concrete	204	0.408	5.522
Individually Reared	206	0.406	7.401
Group Reared	183	0.413	5.576
Trial 2			
Reared with Females	187	0.370	4.080
Reared without Females	196	0.395	3.520

*1 Purebred and 1 crossbred boar did not reach sexual maturity at 8 months of age.

ZINC REQUIREMENT FOR GESTATING-LACTATING SOWS

H. R. Thomas[1], S. J. Lahoda[2], J. D. Hedges and E. T. Kornegay[3]

The importance of zinc in animal nutrition was markedly increased when it was discovered in 1955 that parakeratosis in swine was caused by a zinc deficiency. The role of zinc in promoting and controlling metabolic events in the animal is becoming increasingly evident. Although the exact biochemical function is not known, zinc is involved in wound healing, proper bone formation, protein and carbohydrate metabolism, normal reproduction in the male and female and in normal growth of hair and skin. The requirement of the growing and finishing pig for zinc has been extensively studied, however, the requirement of the sows for zinc has been studied only when a higher than normally fed level (1.4 to 1.6%) of calcium was fed for one or two lactations.

The objective of this study was to evaluate the dietary zinc requirement of sows fed a corn-soybean meal ration containing recommended levels of calcium, housed in total confinement on concrete and kept in the herd for five parities.

Experimental Procedures

Eighty mature crossbred gilts (three approximately equal replications) were randomly assigned from outcome groups based on breeding date to treatments in a 2 x 2 factorial experiment with the following treatments: no added zinc (34 ppm) vs. 50 ppm added zinc (84 ppm), and total vs. partially slotted floors during breeding and gestation.

A 15% crude protein corn-soybean meal ration fortified with minerals and vitamins and containing either 34 or 84 ppm zinc was fed at a daily level of 4 lb per sow prior to breeding and through the 104th day of gestation. The daily feed intake was increased to 7 lb on the 105th day of gestation and remained at this level until parturition. During lactation, the daily feed intake was increased gradually so that on the seventh day following farrowing sows would obtain their maximum daily feed intake. The individual sow's daily feed intake during lactation was based on 1 lb of ration for each suckling pig with a minimum daily allowance of 6 lb daily per sow. All sows irrespective of treatment were farrowed in the same farrowing house. A 3 sow-group multiple farrowing schedule was following with each sow group cycling about every 150 days.

Sampling and recording criteria used were: mating, conception and farrowing rate, number of pigs farrowed and weaned; weight of pigs at birth and at weaning; sow blood serum zinc, sow hair zinc, pig testes zinc, pig coccygeal (tail bone) zinc. Sow blood samples were taken from the anterior vena cava and hair samples taken from the back prior to weaning.

[1]Tidewater Research and Continuing Education Center.
[2]Department of Statistics.
[3]Appreciation is expressed to Charlie Babb for feeding and caring for the sows.

Results

After four parities, there were no differences in the farrowing or weaning performance of sows fed either a low or high dietary level of zinc, and of sows housed on either total or partial slotted floors during gestation (table 1). As expected there was a linear increase from the first to fourth parity in the number of live and total pigs farrowed per sow.

Sow serum zinc levels were increased about 20% and sow hair zinc levels were increased about 10% when sows were fed the higher dietary zinc level as compared to the lower dietary zinc level. Dietary zinc levels appeared to have no effect on the zinc contents of the baby pigs testes or coccygeal (tail bone). For an unexplained reason, zinc content of the testes was lower for pigs from sows that had farrowed 3 or 4 times.

This study is being continued for an additional parity (total of five). The final report will also include breeding and conception data.

Summary

After four parities, there appeared to be no major differences between a low (34 ppm) and a high (84 ppm) dietary level of zinc as measured by farrowing and weaning performance. Sow serum and hair zinc levels were increased when sows were fed the higher dietary level of zinc. Also type of floor (partial or totally slotted) had no major influence on the various criteria. A preliminary conclusion would be that supplemental zinc is not necessary for a corn-soybean meal ration if recommended calcium levels are used.

TABLE 1. FARROWING AND WEANING PERFORMANCE, SOW SERUM AND HAIR ZINC CONTENT AND BABY PIG TESTES AND COCCYGEAL ZINC CONTENT OF SOWS FED TWO DIETARY ZINC LEVELS. SUMMARY OF FOUR PARITIES.

Criteria[a,b]	Treatments							
	Lactation				Zinc Level		Type Floor	
	1	2	3	4	Low	High	Total	Partial
Farrowing data								
Avg no of sows	74	67	57	21	103	114	109	107
Live pigs, no	8.5	8.9	10.1	11.2[c]	9.8	9.6	9.5	9.9
Stillborn, no	0.2	0.5	0.6	0.5	0.5	0.4	0.4	0.5
Mummies, no	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2
Total pigs, no	8.8	9.6	10.8	11.7[c]	10.3	10.1	9.9	10.5
Avg birth wt, lb	3.2	3.2	3.4	3.4	3.2	3.3	3.4	3.2
Weaning data								
Weaned, no	7.7	7.6	8.5	7.9	8.0	7.8	8.0	7.9
Avg weaned wt, lb	15.2	15.0	16.4	14.8[d,e]	15.1	15.6	15.6	15.2
Total weaned wt, lb	116.2	111.1	133.0	117.1[c]	117.4	121.2	121.4	117.2
Sow serum zinc, μ/100 ml	102.1	104.4	120.4	113.8	100.7	119.6[f]	113.4	106.9
Sow hair zinc, ppm	205.9	209.8	201.1	209.2	197.2	215.8[g]	208.7	204.2
Pig testes zinc, ppm[h]	86.8	93.7	79.1	73.2[c]	81.6	84.8	83.3	83.1
Pig coccygeal zinc, ppm[h]	79.5	78.4	72.3	65.3	73.2	74.6	73.2	74.6

[a] Least square means.
[b] Trial to be continued through 5 parities.
[c] Lactation effect significant (P <.001).
[d] Lactation x zinc effect significant (P <.001).
[e] Lactation effect significant (P <.05).
[f] Zinc effect significant (P <.01).
[g] Zinc effect significant (P <.05).
[h] Freeze dried.