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PUREBRED VERSUS CROSSBRED COWS OF THREE BEEF BREEDS

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

The objective of this experiment is to compare the productivity of purebred and crossbred cows in terms of percentage calf crop born and weaned, birth and weaning weights of the calves, as well as their post-weaning performance. The cow herd consisting of sixty purebreds (Angus, Hereford, and Shorthorn), and sixty crossbreds (reciprocal two-breed crosses) among these three breeds, was purchased as calves in 1960. Contracts were made with six breeders to mate a random one-half of each herd to a bull of a different breed and half to a bull of the same breed. Thus both purebred and crossbred heifers came from each of six herds.

The heifers were bred first, as two-year-olds, in 1962. Six bulls were used the first year; twelve bulls were used each succeeding year. Bulls used each year (except the first) were two purebreds of each of the Angus, Hereford, and Shorthorn breeds, and two crossbreds of each of the crosses Angus x Hereford, Angus x Shorthorn, and Hereford x Shorthorn (or the reciprocals). The crossbred bulls were bred to the purebred cows and the purebred bulls to the crossbred cows. Thus all calves were either three-breed or backcrosses. All bull calves were castrated soon after birth.

This report is based on pre-weaning and weaning results from five calf crops and post-weaning results from four calf crops. The total number of matings involved is 587. The average birth date of 273 calves from purebred dams was 18 Feb.; it was 15 Feb. for 279 calves from crossbred dams (table 1). Bull calves from purebred dams weighed 72 lbs. at birth; those from crossbred dams weighed 75 lbs. Heifer calves from purebred dams weighed 69 lbs. at birth; those from crossbred dams weighed 71 lbs. From 294 matings of purebred cows 92.9% calved and 88.4% weaned calves; from 292 matings of crossbred cows 95.5% calved and 89.0% weaned calves (tables 2 and 3).

Steers (142 in no.) from purebred dams weighed 447 lbs. at weaning; 137 steers from crossbred dams weighed 460 lbs.; 121 heifers from purebred dams weighed 426 lbs. at weaning; 125 from crossbred dams weighed 449 lbs. (table 4). Feeder grade at weaning was choice minus for all groups (table 5).

With respect to post-weaning performance, 102 steers from purebred dams gained 2.15 lbs./day on full feed, graded choice minus alive before slaughter, and graded choice in the carcass. The slaughter weight of these steers was 908 lbs., the carcass weight was 541 lbs., and the dressing percent was 59.9. The 98 steers from crossbred dams gained 2.21 lbs./day on feed and graded choice minus before slaughter and in the carcass; their slaughter weight was 945 lbs., carcass weight was 562 lbs., and dressing percent was 59.6 (tables 6 and 8).

Ninety-three heifers from purebred dams gained 1.90 lbs./day on feed and graded choice minus before slaughter and in the carcass; their slaughter weight was 752 lbs., carcass weight was 443 lbs., and dressing percent was

58.7. Ninety heifers from crossbred dams gained 1.92 lbs./day on feed and graded choice minus before slaughter and in the carcass; their slaughter weight was 772 lbs., carcass weight was 456 lbs., and dressing percent was 59.0 (tables 7 and 9).

Tentative conclusions at this time are: (1) no difference between purebred and crossbred cows in percent calves weaned (when the calves are crossbred), (2) weaning weights of steer calves were 13 lbs. and those of heifer calves were 23 lbs. in favor of crossbred dams, (3) steer calves from crossbred dams weighed 37 lbs. more at time of slaughter and had heavier carcasses by 21 lbs., compared to steers from purebred dams, (4) heifer calves from crossbred dams weighed 20 lbs. more at slaughter and had heavier carcasses by 13 lbs., compared to heifer calves from purebred dams.

TABLE 1. BIRTH DATES AND WEIGHTS

Breeding of Dams	No. of Calves	Av. Birth Date	Av. Birth Weight	
			Males	Females
Purebred	273	18 Feb.	72 lbs.	69 lbs.
Crossbred	279	15 Feb.	75 lbs.	71 lbs.

TABLE 2. MATINGS, CALVES BORN AND CALVES ALIVE AT 36 HOURS

Breeding of Dams	Matings	Calves Born		Alive at 36 Hours
		No.	%	
Purebred	294	273	92.9	271
Crossbred	292	279	95.5	274
Difference		6	2.6	3

TABLE 3. CALVES WEANED OF COWS MATED

Breeding of Dams	Matings	Calves Weaned	Calves Weaned of Cows Mated, %
Purebred	293	259	88.4
Crossbred	291	259	89.0

TABLE 4. AGES AND WEANING WEIGHTS

Breeding of Dams	Av. Age at Weaning	Weaning Weight	
		Steers	Heifers
Purebred	232 days	447 lbs.	426 lbs.
Crossbred	234 days	460 lbs.	449 lbs.

TABLE 5. FEEDER GRADE AT WEANING

Breeding of Dams	Feeder Grade	
	Steers	Heifers
Purebred	11.7	12.0
Crossbred	12.0	12.0

Grade Code: Choice Minus, 12; Good Plus, 11.

TABLE 6. POST-WEANING DATA ON STEERS

Breeding of Dams	No. Fed	Daily Gain, lb.	Slau. Grade	Carcass Grade
Purebred	102	2.15	12.1	12.7
Crossbred	98	2.21	12.2	11.9

Grade Code: Choice, 13; Choice Minus, 12.

TABLE 7. POST-WEANING DATA ON HEIFERS

Breeding of Dams	No. Fed	Daily Gain, lb.	Slau. Grade	Carcass Grade
Purebred	93	1.90	11.9	11.7
Crossbred	90	1.92	12.1	11.7

Grade Code: Choice Minus, 12; Good Plus, 11.

TABLE 8. POST-WEANING DATA ON STEERS

Breeding of Dams	No. Fed	Slaughter Weight, lbs.	Carcass Weight, lbs.	Dressing %
Purebred	102	908	541	59.9
Crossbred	98	945	562	59.6

TABLE 9. POST-WEANING DATA ON HEIFERS

Breeding of Dams	No. Fed	Slaughter Weight, lbs.	Carcass Weight, lbs.	Dressing %
Purebred	93	752	443	58.7
Crossbred	90	772	456	59.0

ENVIRONMENTAL INFLUENCES ON GROWTH RATE AND GRADE OF YEARLING BEEF CATTLE[1/]

Gary A. Waugh and Thomas J. Marlowe

Progress through selection for economic traits in beef cattle can be accelerated by recognition of the major environmental factors which obscure genetic differences among animals. Since genetic improvement of any trait depends in part on the heritability of that trait and since heritability is increased by reducing the environmental variation, adjusting for known environmental effects should make selection more effective.

The objective of this study was to estimate the magnitude of as many as possible of these non-genetic or environmental influences on average daily gain (ADG) and grade of yearling cattle of the Angus and Hereford breeds and to obtain appropriate correction factors for these effects.

Materials and Methods

The data used in this study came from several sources. They included 635 records on yearling bulls that went through a 140-day performance test at Culpeper, sponsored by the Virginia BCIA; 307 bulls that went through a similar 168-day performance test at the Beef Cattle Research Station, Front Royal; and 1,749 bulls performance tested in 38 private herds in Virginia. The heifers included 440 head raised in the Bland Correctional Farm herd, 631 head raised in the research herds at Front Royal, 160 head raised in the research herd at Middleburg and the remainder raised in 56 private herds throughout the state. There were 1,498 Angus bulls, 2,217 Angus heifers, 1,289 Hereford bulls and 1,402 Hereford heifers in the complete study.

All records were coded according to herd, year, age of dam, age of animal, month of birth and pre- and postweaning management practice. Each breed-sex group was treated separately in the statistical analyses. The effects of herd, year, age of dam, month of birth, age of animal and pre- and postweaning management practice were treated as independent variables, whereas ADG and grade were the dependent variables. The data were analyzed by least squares procedures.

Prior to the statistical analyses, the unadjusted means and standard deviations were obtained for each herd, year, age of dam (years), month of birth, age of animal (months) and pre- and postweaning management practice subclass. Furthermore, preliminary least squares analyses were run to estimate the effect of each division of each independent variable on the two dependent variables. Those independent variables having no significant influence on the dependent variable in question were not included in later analyses. A t-test was performed to determine which of the partial regression coefficients within each submatrix were significantly different from the other partial regression coefficients. Those not differing significantly from one another were grouped together in later analyses.

[1/]The authors gratefully acknowledge the data supplied by the Beef Cattle Research Station, Front Royal; Va. Forage Research Station, Middleburg; Bland Correctional Farm; and the Virginia BCIA.

Results and Discussion

The number of observations, unadjusted means and partial regression coefficients for each breed-sex group are shown in tables 1 and 2. Table 3 shows the simple phenotypic relationships between pairs of the several independent variables and between each of the independent variables and the two dependent variables within each breed-sex group. Since most of these relationships are quite low and none greater than 0.5, they could all be included together in the least squares models to obtain their individual and combined effects on the dependent variables.

The effect of each independent variable on the two dependent variables of each breed-sex group are discussed separately.

Herds and Years. Both herd and year effects on ADG and grade were highly significant. The coefficients for these effects are not given in the tables, however, because it is not recommended that adjustment be made for these effects. Rather, it is recommended that comparisons and selections be made within herds and years.

Age of Dam. Age of dam was a significant source of variation on ADG in all groups. Yearling cattle out of two- and three-year-old dams had the slowest overall growth rate, whereas those out of mature dams (6-11 year-olds) had the fastest growth rate. This effect was slightly different for bulls and heifers, however. The growth rate of yearling heifers out of 12-15 year-old dams was significantly lower than those out of 6-11 year-old dams. This was not true for the bulls. This would indicate that the older cows producing calves that were kept as bulls were a more highly select group. Since there was no significant difference between the growth rates of the bulls from 6-11 and 12-14 year-old dams, they were grouped together in the final analyses.

The age of the cow had little influence on the grade of yearling cattle and was significant only among the Angus heifers. The range in average grades among the age-of-dam groups was less than 0.2 of a grade point among the bulls and approximately 0.5 of a grade point among the heifers. These values are too small to justify correction factors for age-of-dam effect.

Age of Animal. ADG was significantly influenced by the age of the animals in all groups. Short yearlings (10-13 months of age) had the highest ADG with ADG decreasing in each successive age group. Preliminary analyses indicated certain logical groupings for each breed-sex group. These groupings were slightly different for the four breed-sex groups (as shown in tables 1 & 2) and are based on t-tests of the partial regression coefficients when an estimate was obtained for each month-of-age group separately. Estimates for months not differing significantly were grouped together for the final analyses.

The age of the animal when graded was not an important source of variation in grades. The range of grade differences among the various age groups was only 0.19, 0.29. 0.10 and 0.11 among the Angus bulls, Angus heifers, Hereford bulls and Hereford heifers respectively. These differences were significant only for the Hereford bulls and even then it was too small to be of any practical importance.

Month of Birth. In contrast to its effect on ADG of weanling calves, month of birth appeared to have no significant influence on the ADG of yearling cattle. Therefore, this factor was not included in tables 1 and 2. On the other hand, it significantly influenced the grade in all breed-sex groups. The general trend was for animals born during February through July to grade lower than those born during August through January. This might be a result of more creep feeding in the latter group as indicated by the positive correlation coefficients between month of birth and preweaning management practice.

Preweaning Management. All animals were grouped into three categories as: (1) no creep, (2) creep fed and (3) on nurse cow. The third group was eliminated in the analyses. Creep feeding as calves significantly increased the lifetime ADG of yearling Hereford cattle. On the other hand, it had no significant effect on the yearling Angus cattle included in this study. This difference probably came about from the greater milk supply provided by the Angus cows. Hereford yearlings that were creep fed as calves had a 0.12 lb. advantage in lifetime ADG among the bulls and a 0.06 lb. advantage among the heifers over the non-creep fed cattle.

Creep feeding had no significant influence on yearling grades of any of the breed-sex groups, although there was a positive correlation of .2 to .3 between preweaning management practice and yearling grade in all groups. The least squares analyses also indicated a 0.2 to 0.3 grade point advantage for the creep fed cattle.

Postweaning Management. All animals were grouped according to postweaning management into three groups: (1) those receiving no grain supplement, (2) those receiving limited grain and (3) those receiving full feed during the latter growth period. Because of the small number of bulls falling into the first category, they were not included in the analyses.

The kind of postweaning treatment used had a significant effect on ADG of all groups, with growth rate being higher for the better fed animals. This difference amounted to 0.04 lb. for Angus bulls and 0.12 lb. for Hereford bulls in lifetime ADG between limited-fed and full-fed animals. This difference was considerably larger when full feeding started at the earlier ages and lasted for longer periods. Differences in heifers amounted to 0.15 lb. for the Angus and 0.24 lb. for the Hereford between the full-fed and no-grain groups.

The kind of postweaning treatment received had a significant effect on yearling grade of the Angus heifers and Hereford bulls only, but the trend was the same for the other groups.

Summary

The objective of this study was to estimate the magnitude of the major environmental factors that affect growth rate and grade of yearling beef cattle and to obtain correction factors for their effects. Four breed-sex groups consisting of 1,498 Angus bulls, 2,217 Angus heifers, 1,289 Hereford bulls and 1,402 Hereford heifers were analyzed separately by least squares methods. The environmental factors of herd, year, age of dam, month of birth, age of animal, pre- and postweaning management practice, and selected interactions were treated as independent variables, whereas ADG and grade were the dependent variables. All of the independent variables except month of birth and preweaning management practice significantly affected the growth rate of Angus cattle and all except month of birth significantly affected the growth rate of Hereford cattle. Growth rate increased with age of dam and level of nutrition and decreased with age of animals on test. Creep feeding as calves significantly affected the lifetime gains of yearling Hereford cattle but not of Angus cattle nor the yearling grades in any of the breed-sex groups. In general, the environmental factors studied had a much smaller effect on grade than on growth of yearling cattle. One exception was the significant effect of month of birth on yearling grade. Only the effect of management was of practical importance on grade.

TABLE 1. EFFECTS OF AGE OF DAM, AGE OF ANIMAL, AND POSTWEANING MANAGEMENT PRACTICE ON ADG AND GRADE OF ANGUS BULLS AND HEIFERS

Effect	Number of Observations	Unadjusted Means		Part. Reg. Coefficients[3]	
		ADG	Grade[2]	ADG	Grade
Bulls					
Age of Dam in years					
2	153	1.92	12.8	-.11[a]	-.03[a]
3-5	612	2.02	12.9	-.04[b]	0.11[a]
6-14[1]	733	2.06	12.8	0.00[c]	0.00[a]
Age of Animal in months					
10-13[1]	1045	2.06	12.8	0.00[a]	0.00[a]
14	200	2.02	13.0	-.05[b]	0.05[a]
15	115	2.00	13.0	-.11[c]	-.02[a]
16	68	1.92	13.1	-.14[c,d]	0.07[a]
17-19	70	1.78	13.0	-.19[d]	0.17[a]
Postweaning Management Practice					
Full Fed[1]	1164	2.07	12.8	0.00[a]	0.00[a]
Limited-Fed	334	1.91	12.9	-.04[b]	-.18[a]
Heifers					
Age of Dam in years					
2,3	654	1.30	12.0	-.06[a]	-.12[a]
4,5	579	1.33	12.1	-.01[b]	0.06[b]
6-11[1]	876	1.35	12.2	0.00[b]	0.00[b,c]
12-15	108	1.29	11.9	-.05[c]	-.42[c]
Age of Animal in months					
10-13[1]	1271	1.42	12.1	0.00[a]	0.00[a]
14	251	1.29	11.8	-.06[b]	-.14[a]
15,16	281	1.22	12.2	-.16[c]	0.15[a]
17-19	414	1.14	12.3	-.26[d]	0.11[a]
Postweaning Management Practice					
Full Fed[1]	140	1.54	13.3	0.00[a]	0.00[a]
Limited-Fed	966	1.41	12.0	-.12[b]	-.63[b]
No Grain	1111	1.23	12.1	-.15[c]	-.63[b]

[1]Selected base
[2]Fancy = 15 to 17, Choice = 12 to 14, Good = 9 to 11, etc.
[3]Values with different superscripts are significantly different (P<.05).

TABLE 2. EFFECTS OF AGE OF DAM, AGE OF ANIMAL, AND PRE- AND POSTWEANING MANAGEMENT PRACTICES ON ADG AND GRADE OF HEREFORD BULLS AND HEIFERS

Effect	Number of Observations	Unadjusted Means ADG	Unadjusted Means Grade[2]	Part. Reg. Coefficients[3] ADG	Part. Reg. Coefficients[3] Grade
Bulls					
Age of Dam in years					
2,3	328	2.00	12.8	-.10[a]	-.03[a]
4,5	387	2.10	12.9	-.02[b]	0.12[a]
6-14[1]	574	2.13	12.9	0.00[b]	0.00[a]
Age of Calf in months					
10-12[1]	660	2.12	12.8	0.00[a]	0.00[a]
13,14	421	2.09	12.9	-.04[b]	0.04[a,b]
15-19	208	1.98	13.0	-.14[c]	0.10[b]
Preweaning Management					
Creep Fed	793	2.12	13.1	0.12[a]	0.16[a]
Non Creep Fed[1]	496	2.03	12.6	0.00[b]	0.00[a]
Postweaning Management					
Full Fed[1]	1041	2.12	12.9	0.00[a]	0.00[a]
Limited Fed	248	1.96	12.8	-.12[b]	-.26[a]
Heifers					
Age of Dam in years					
2,3	334	1.30	11.7	-.05[a]	-.08[a]
4-6	587	1.31	11.6	-.03[a]	-.07[a]
7-10[1]	383	1.31	11.6	0.00[b]	0.00[a]
11-14	98	1.30	11.3	-.04[a]	-.40[a]
Age of Animal in months					
10[1]	254	1.42	12.0	0.00[a]	0.00[a]
11-15	657	1.37	11.6	-.02[a]	0.00[a]
16-18	293	1.17	11.3	-.08[b]	-.09[a]
19	198	1.14	11.3	-.10[b]	-.11[a]
Preweaning Management					
Creep Fed	168	1.55	13.0	0.06[a]	0.26[a]
Non Creep Fed[1]	1234	1.27	11.4	0.00[b]	0.00[a]
Postweaning Management					
Full Fed[1]	59	1.65	12.5	0.00[a]	0.00[a]
Limited Fed	559	1.41	11.7	-.09[b]	-.22[a]
No Grain	784	1.21	11.5	-.24[c]	-.28[a]

[1]Selected base

[2]Fancy = 15 to 17, Choice = 12 to 14, Good = 9 to 11, etc.

[3]Values with different superscripts are significantly different ($P<.05$)

TABLE 3. SIMPLE PHENOTYPIC CORRELATION COEFFICIENTS AMONG TRAITS

Variables	Breed-Sex Group[1]	Age of Dam	Month of Birth	Years	Age of Animal	Preweaning Management	ADG	Grade
Postweaning Management	AB	.03	-.21	.21	.10	-.19	.27	-.02
	AH	.01	-.22	.04	-.32	.13	.42	.11
	HB	.05	-.23	.10	.09	.01	.22	.05
	HH	-.04	-.19	-.24	-.41	.17	.48	.12
Age of Dam	AB		.00	-.03	-.08	-.04	.16	-.01
	AH		.00	.07	.01	.05	.07	.02
	HB		.03	.05	-.03	-.03	.18	.02
	HH		-.05	.06	.13	-.03	.01	-.04
Month of Birth	AB			-.01	.28	.10	-.11	.10
	AH			-.08	-.17	.20	-.08	.02
	HB			.00	.01	.11	.04	.13
	HH			.01	-.30	.26	.11	.20
Years	AB				.09	-.01	.16	.23
	AH				.05	-.02	.01	.16
	HB				-.03	-.02	.08	.27
	HH				.24	-.07	-.21	.05
Age of Animal	AB					.02	-.25	.07
	AH					-.03	-.45	.05
	HB					.12	-.16	.04
	HH					-.08	-.41	-.15
Preweaning Management	AB						.08	.17
	AH						.21	.24
	HB						.15	.20
	HH						.35	.32

[1] AB = Angus bulls, AH = Angus heifers, HB = Hereford bulls, HH = Hereford heifers.

CULPEPER ROP TESTED BULLS COMPARED TO OTHER BULLS IN BCIA HERDS

T. J. Marlowe and A. L. Eller, Jr.

Sometime ago the directors of the Virginia Beef Cattle Improvement Association (BCIA) asked the writers to take a look at how the bulls performance tested and sold at Culpeper are performing for their new owners. This was a difficult chore since those bulls went into 20 states and most of those remaining in Virginia went into herds which are not in our state performance testing program. Therefore, this study was based on the responses obtained from a mail survey and from personal contacts, along with a comparison of the performance of the progeny of the Culpeper tested bulls with the performance of progeny of other bulls used in BCIA herds in Virginia.

Materials and Methods

A survey letter was sent out in 1965 to all purchasers of Culpeper ROP tested bulls asking for the following information:

1. Have the bulls you bought been active, sound breeders?
2. What breeding problems have you had? Comments:
3. If you have had calves by the bulls, how have the calves suited you and how have they performed?
4. Have the bulls you bought grown out and gotton big enough?

In addition to the survey, personal contacts were made during the period of 1965 to 1967 on approximately 85 farms. During these farm visits, bulls were observed as to condition, size and conformation. Approximately half of the bulls were actually weighed and graded during the visit. The owner was questioned concerning how the bull had been handled; any fertility problems; and the number, quality and performance of his calves. His reactions were recorded.

The third and soundest approach was to compare the performance of calves sired by Culpeper tested bulls with calves sired by other bulls in the same herd and year. Of the 97 bulls purchased by Virginia BCIA members only 33 had produced progeny in herds in which other bulls had sired progeny in the same years so that comparisons could be made. There are 25 other Culpeper bulls in BCIA herds that were purchased during 1965-67 which had no progeny tested to date. Many of the others were used as the only bull so that no comparisons could be made.

The performance of 1311 progeny of 33 Culpeper tested bulls was compared to the performance of 2362 progeny of 79 other bulls in 26 BCIA herds. All comparisons were within year and herd.

Results and Discussion

The responses obtained from the survey and farm visits indicate that the Culpeper tested bulls have been very well received and performed well in most cases. A tabulation of the responses over the years 1959 through 1963 showed ratios of favorable to unfavorable ranging from 3:1 to 5:1 with an average of 4:1 based on 128 responses from buyers of Angus bulls. Comparable figures on buyers of Hereford bulls ranged from 3:1 to 13:1 with an average of 6:1 based on 60 responses. Non-commital responses were not included.

In the comparisons of progeny performance of Culpeper vs other bulls in BCIA herds, there were 54 comparisons among the Angus. These comparisons were between 723 offspring of 15 Culpeper tested bulls and 1487 offspring of 54 other bulls used in 15 herds over a 1 to 5 year period. Comparisons were made for adjusted ADG, 205-day weight, weaning grade and index value. The percentage of comparisons favoring the Culpeper tested bulls was 68.5% for ADG, 68.5% for 205-day weight, 51.8% for grade and 63.0% for index. The average number of offspring per bull was 48.2 for the Culpeper bulls and 27.5 for the other bulls. The average differences (Culpeper-other) were 0.047 lb. in ADG, 9.4 lb. in 205-day weight, 0.0 grade and 2.3 index points.

There were 25 comparisons among the Herefords. These comparisons were between 588 offspring of 18 Culpeper bulls and 875 offspring of 25 other bulls in 11 herds over a 1 to 5 year period. The percentage of comparisons favoring the Culpeper bulls was 64.7% for adjusted ADG, 67.6% for 205-day weight, 58.8% for weaning grade and 67.6% for index. The average number of offspring per bull was 32.7 for the Culpeper bulls and 35.0 for the other bulls. The average differences (Culpeper-other) were 0.06 lb. in ADG, 15.1 lb. in 205-day weight, 0.14 grade point and 3.3 index points.

Summary

In an attempt to find out how the bulls that were performance tested and sold at Culpeper by the Virginia BCIA have performed for their new owners, three approaches were taken: (1) a survey letter was sent in 1965 to all previous buyers of Culpeper bulls, (2) personal contacts were made with the owner or manager on 85 farms, and (3) the performance of 1311 progeny of 33 Culpeper tested bulls was compared with the performance of 2362 progeny of 79 other bulls in 26 BCIA herds over a 1 to 5 year period. All comparisons were within the same herd and year.

The responses obtained from the survey and farm visits indicate that the Culpeper bulls have been well received and performed well in most cases. The comparison of progeny performance showed that the Culpeper bulls were favored in about 68% of the comparisons when growth was compared and 52 to 59% when grade was compared. The average difference in 205-day weight was 9 to 15 pounds but there was essentially no difference in weaning grade.

THE EFFECT OF INBREEDING ON REPRODUCTION IN BEEF CATTLE[1]

E. V. Krehbiel and R. C. Carter[3]

It has long been believed that inbreeding of animals sharply reduces their reproductive performance. In beef cattle there is rather little critical information available as to just how much reduction to expect in calving rates or calf survival from a given level of inbreeding. A study was made to estimate the effect of inbreeding on reproductive efficiency using records from the Aberdeen-Angus and beef Shorthorn herds at the Beef Cattle Research Station at Front Royal.[2]

The data included breeding, calving and weaning records on 13 calf crops produced from 1950 through 1962. There were 1489 matings among 48 bulls and 422 cows in the Angus herd, and 1584 matings among 50 bulls and 446 cows in Shorthorns. Ages ranged from yearlings to 11 years for bulls and 2 to 12 years for the cows. The measures of reproduction studied were: (1) fertility of the mating, i.e. whether a calf was born from a mating including stillborn; (2) viability or survival of the calf to weaning.

The beef cattle breeding project at Front Royal has as its principal objective the comparison of two major breeding systems: (1) inbreeding (with subsequent crossing), and (2) single trait mass selection. In both breeds, Angus and Shorthorn, four inbred and two selection lines were established. Selection in one line of each breed was based on growth rate from birth to about 12 months of age; in the other line type or conformation at the same age was the basis of selection. Both the inbred and selection lines were derived on the same foundation stock.

Inbred lines were designated as lines 1, 2, 3, 4 or 5; type selection as line 7, and growth selection as line 8. Line 9 designates outbred animals including foundation herds, cows in test herds used for progeny testing of potential foundation sires, and miscellaneous animals not in inbred or selection lines.

Average Inbreeding:

The number of matings and average inbreeding per mating for each of the Shorthorn and Angus lines are shown in table 1 and graphically in figures 1 and 2. Maximum inbreeding of a mating was 40% in Angus and 50% in Shorthorns.

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[1]Based on paper given by the authors at the 59th annual meeting of the American Society of Animal Science, Reno, Nevada, 31 July, 1967.

[2]Research conducted in cooperation between the Animal Science Department, V.P.I. Research Division, and the Animal Husbandry Research Division, ARS, U.S. Dept. of Agriculture.

[3]Joint credit is due B. M. Priode and K. P. Bovard, Beef Cattle Research Station, Front Royal, and J. A. Gaines, V.P.I. Animal Science Department, Blacksburg.

TABLE 1. NO. MATINGS AND AVERAGE INBREEDING OF MATING FOR ANGUS AND SHORTHORN LINES

Line		No. Matings	Av. Inbred
		ANGUS	
Inbred	1	250	14.0%
	2	150	20.0
	3	182	8.5
	4	149	12.4
Type Sel.	7	206	2.6
Growth Sel.	8	253	2.5
Outbred	9	299	0.8
		SHORTHORN	
Inbred	1	183	30.0%
	2	188	25.6
	4	133	9.9
	5	155	10.0
Type Sel.	7	284	3.0
Growth Sel.	8	322	5.0
Outbred	9	319	5.7

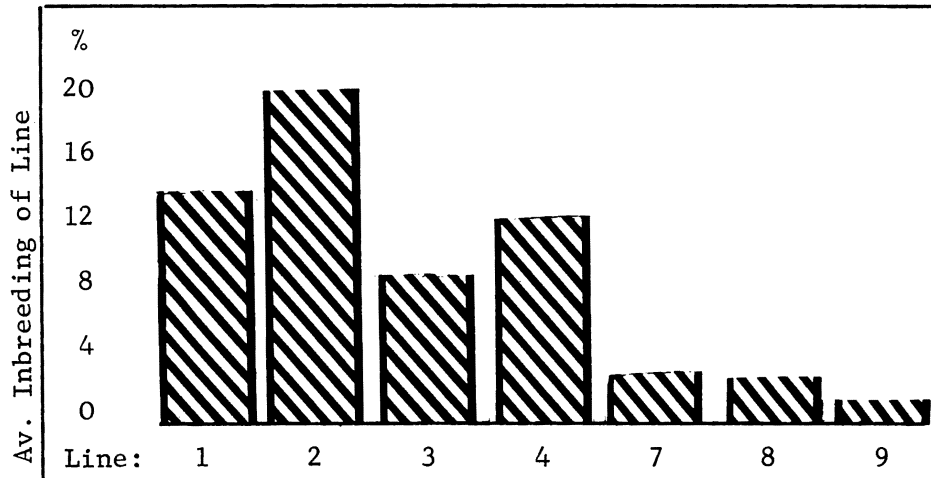

Fig. 1. Average inbreeding of matings in Angus lines

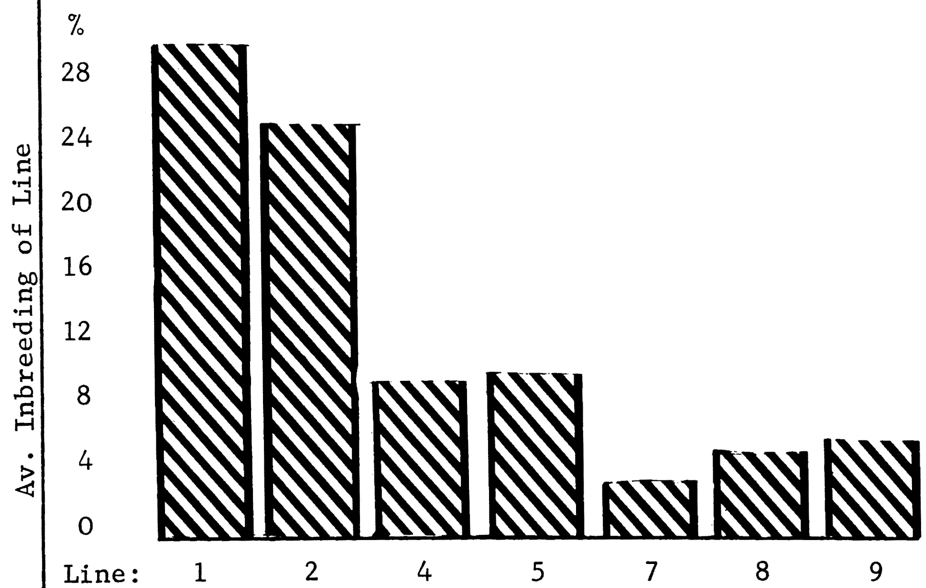

Fig. 2. Average inbreeding of matings in Shorthorn lines

Effects of Inbreeding on Fertility and Calf Survival:

One way to get an idea of the average effect of inbreeding is simply to look at the unadjusted averages, classified according to degrees of inbreeding. This is done in table 2, which shows the average fertility and calf survival for the Angus and Shorthorn herds by each 10% increase in inbreeding. This table suggests only a little decrease in fertility up to 10% inbreeding, but moderate to large decrease at levels approaching 20% or higher. This is further brought out by comparison of the fertile and infertile matings. In Angus the average inbreeding of all matings was 7.6%. The average inbreeding of all fertile matings was 6.3% but 10.8% for the infertile matings. In Shorthorns the comparable values were 11.1% inbreeding for all matings, 10.4% for the fertile and 12.6% for infertile matings.

Some caution should be used in interpreting these unadjusted averages however. No adjustments were made for the varying effects of years and ages of cows and bulls. Since there were unequal numbers in the various year-age groups, the averages may be less precise than would be desirable. Nonetheless, the results do suggest some decline in reproduction with increasing levels of inbreeding.

Calf survival to weaning also showed some decline with inbreeding, though not so much as fertility.

TABLE 2. AVERAGE FERTILITY AND CALF SURVIVAL (UNADJUSTED) BY PERCENTAGE INBREEDING IN ANGUS AND SHORTHORN HERDS

Inbreeding of Mating	Angus			Shorthorn		
	% of all Matings	Fert. %	% Calf Survival	% of all Matings	Fert. %	% Calf Survival
0	53.5	77	85	40.5	72	83
1-9	18.4	76	83	19.2	68	81
10-19	6.9	53	77	16.6	63	84
20-29	17.0	62	78	13.3	59	76
30+	4.2	58	84	10.4	60	72
Av.		72	83		67	81

Comparison of Lines:

When one compares the various lines, however, the picture is not so clear. Tables 3 and 4 show the average fertility for the seven Angus and Shorthorn lines. These are adjusted averages (least squares means) with differences due to average effects of years and ages removed.

In Angus the highest average fertility level was 89%, in the outbred line 9. However inbred line 2, with the highest average inbreeding, 20%, was second among the 7 Angus lines and slightly higher, though not significantly so, than the two selection lines, which averaged only 2 1/2%

inbreeding. In Shorthorns, inbred line 5 with 10% inbreeding was highest in fertility, but inbred line 4, with essentially the same level of inbreeding, 9.9%, was lowest in fertility. Shorthorn inbred line 1, with highest inbreeding of any line in either breed, 30%, ranked second among the Shorthorns.

TABLE 3. FERTILITY OF ANGUS LINES

Line	No.	Av. Inbreed	Fert. %*
9 Outbred	299	0.8%	89
2 Inbred	150	20.0	79
7 Type Sel.	206	2.6	78
8 Growth Sel.	253	2.5	72
1 Inbred	250	14.0	70
4 Inbred	149	12.4	64
3 Inbred	182	8.5	50
Total or Av.	1489	7.6	72

*Means connected by a solid vertical line not significantly different ($P \geq .05$).

TABLE 4. FERTILITY OF SHORTHORN LINES

Line	No.	Av. Inbreed	Fert. %*
5 Inbred	155	10.0%	70
1 Inbred	183	30.0	64
8 Growth Sel.	322	5.0	63
9 Outbred	319	5.7	59
7 Type Sel.	284	3.0	59
2 Inbred	188	25.6	54
4 Inbred	133	9.9	46
Total or Av.	1584	11.1	59

*Means connected by a solid vertical line not significantly different ($P \geq .05$).

A similar pattern is seen with respect to calf survival to weaning. When lines are compared, there is a lack of relationship between inbreeding of the line and percentage calves weaned of calves born. Line averages (least squares means) for the Angus lines are shown in table 5. Angus inbred line 2, with the highest average inbreeding, 17.7%, had the highest average calf survival of all Angus lines. Inbred line 3, with the lowest inbreeding of the four Angus inbred lines, was lowest in calf survival. Remember that line 2 also had the highest fertility among the Angus inbred lines and line 3 the lowest fertility of any of the seven Angus lines, a point of possible significance.

Differences in calf survival among the Shorthorn lines were small and non-significant, and are not shown.

TABLE 5. SURVIVAL OF CALVES, ANGUS LINES

Line	No.	Av. Inbreed. of Calf	Surv. %*
2 Inbred	111	17.7%	97
8 Growth Sel.	168	2.0	93
7 Type Sel.	151	2.3	90
1 Inbred	167	12.7	87
4 Inbred	101	10.3	83
9 Outbred	269	0.8	83
3 Inbred	96	7.2	77
Total or Av.	1063	6.3	87

*Means connected by a solid vertical line not significantly different ($P \geq .05$).

Discussion and Conclusions

It seems difficult to draw general conclusions as to how much reduction in fertility and other measures of reproductive performance can be expected from a given amount of inbreeding. Certainly some reduction can be expected in certain breeding lines. Generally the poorest reproductive performance among the Front Royal lines occurred in one of the inbred lines. On the other hand, some of the most highly inbred lines were equal or superior to the outbreds in fertility and calf survival. This is in accord with the long-held belief among cattlemen that some families can "take" inbreeding better than others.

Perhaps we are wrong to attempt to express the "average" effects of inbreeding on reproductive efficiency in terms of an average reduction of a certain percentage in calf crop for each 5 or 10% increase in inbreeding. Our experience at Front Royal suggests that the response to inbreeding is uniquely the property of a particular line or family, and that measures of "average" response are largely meaningless when used for prediction of response in an individual line or family. Also the effect of a given increment of inbreeding, say 5 or 10%, may vary according to the amount of inbreeding already present. There is fairly good evidence that inbreeding levels up to 10 or 12%, about the level resulting from a half brother - sister mating, does not cause very much reduction in fertility. The critical level seems to be around 20% inbreeding.

There is a relationship between the level of fertility in a line and the interval between generations--and hence the rate at which it is possible to increase the level of inbreeding. Lines of low fertility cannot be inbred as rapidly, in terms of years, as those of higher fertility, a point not generally understood. The question then becomes, which is cause and which effect?

Most of the Front Royal inbred lines have been in reproductive trouble at one time or another. So far we have been fortunate to have all of them "work out of it" so to speak. It seems that if an inbred line can survive such a reproductive "time of trouble", and slough off enough deleterious genes, possibly through natural selection, it can go on with reasonable reproductive performance. Charley Kincaid's (the late Dr. Charles M. Kincaid) expression for this process was that the inbred line "squeezed through a knothole". Once a line makes it successfully through the reproductive knothole it usually survives with reasonable fertility.

In conclusion it may be said that the effects of inbreeding on reproduction in beef cattle will vary from severe to negligible, depending on the genetic makeup of the foundation stock. Inbreeding can be a powerful tool to uncover and purge a population of a lot of "genetic trash". It is probably too risky for an individual small breeder to undertake, except cautiously. However alternate cycles of inbreeding and crossing of selected partially inbred lines should be an effective method of producing "elite" stocks. It might be profitably undertaken by large breeding establishments, particularly if the use of artificial insemination becomes extensive in beef cattle.

FEED CONSUMPTION, FEED EFFICIENCY AND CERTAIN CARCASS TRAITS IN SELECTED LINES OF CATTLE

G. G. Green and C. J. D. McVeigh, Jr.

An experiment was initiated to determine if differences in growth rate, feed consumption and certain carcass traits could be demonstrated among inbred lines of cattle and two other lines; one in which type and another in which rate of growth was the principal criterion for selection.

Experimental Procedure

Sixteen weanling Shorthorn steers were full-fed individually a coarsely ground ration of 62% shelled corn, 28% mixed hay, 9% cottonseed meal, 0.5% trace mineralized salt, and 0.5% ground limestone. In addition, each steer was fed 20,000 IU of Vitamin A per day. Records were kept of the feed consumed daily by each steer. Upon termination of the experiment (175 days), live slaughter and carcass grades were determined. Ribeye area and fat thickness over the ribeye were obtained from the chilled carcasses.

Results and Discussion

The data are summarized in table 1. Average daily gain was lowest (2.58 lbs./day) in the inbred line, highest (2.89 lbs./day) in the growth line, and intermediate (2.74 lbs./day) in the type line. Total feed consumption followed the same general pattern. The type line required the most feed per pound of gain (8.05 lbs.) with the inbred line being the most efficient and the growth line intermediate. These data indicate that steers which gain the fastest may not necessarily be the most efficient. They eat more. The type line graded higher, had the largest ribeye and greatest fat thickness. The grade differential (slaughter grade minus initial grade) is considerably smaller in the growth line than in either of the other two lines.

TABLE 1. GROWTH, FEED CONSUMPTION AND CERTAIN CARCASS TRAITS OF THREE LINE STEERS FULL-FED 175 DAYS

Criterion for Selection	Inbred	Type	Growth
Number of steers per line	*5	3	7
Coefficient of inbreeding	0.38	0.12	0.07
**Initial grade	10.3	12.8	13.0
Initial weight (lbs.)	394	488	487
Average daily gain (lbs.)	2.58	2.74	2.89
Feed consumed/day (lbs.)	20.01	22.19	22.77
Feed required/lb. of gain (lbs.)	7.75	8.09	7.89
**Live slaughter grade	12.48	15.26	13.67
**Carcass grade	13.00	13.66	13.28
Area of ribeye (sq. in. per cwt. of carcass)	1.74	1.78	1.63
Fat thickness over ribeye (in.)	.62	.78	.66

*Data from one steer omitted as a result of carcass inspection.
**10=Good, 11=High Good, 12=Low Choice, 13=Choice, etc.

DIFFERENT LEVELS OF SUPPLEMENTAL GRAIN FOR FATTENING WEANLING STEER CALVES FED HIGH CORN SILAGE RATIONS

J. P. Fontenot, J. S. Copenhaver and R. C. Carter

Trials were conducted in 1965-66 and 1966-67 to study the effect of feeding different levels of grain to weanling steer calves fattened on high corn silage rations. The results of these trials were summarized in the 1965-66 and 1966-67 Progress Reports. A third trial is in progress and a summary of the results up to April 4 will be given in this report.

Experimental Procedure

Thirty-four weanling Shorthorn steer calves were allotted to five lots according to breeding. The steers in all lots were full fed corn silage and fed 2.5 lb. cottonseed meal per head daily. In addition, they were fed the following levels of grain:

Lots 1 and 2 - None
Lots 3 and 4 - One-half of full feed
Lot 5 - Full feed

The steers were fed twice daily. The corn silage contained 31.8% dry matter, 2.96% crude protein, 7.19% crude fiber, 0.98% ether extract, 1.30% ash and 19.40% NFE. Based on the chemical composition the calculated TDN content of the silage was 21.6%. The grain consisted of a 1:1 mixture of ground ear corn and ground barley. Trace mineralized salt and a mixture of one part trace mineralized salt and three parts ground limestone were provided free choice.

Results

The trial is still in progress. Performance data up to April 4, 1968 are given in table 1. Daily gains were very good for all lots. At the end of 126 days daily gains were similar for the steers fed corn silage and protein supplement as for steers fed one-half full feed of grain, in addition. Daily gains were considerably higher for the steers full-fed grain. In the previous two trials gains were similar for the cattle fed one-half full feed and a full feed of grain.

Silage intake decreased as grain intake increased.

TABLE 1. EFFECT OF FEEDING DIFFERENT LEVELS OF GRAIN TO FATTENING WEANLING STEER CALVES FED HIGH CORN SILAGE RATIONS (PRELIMINARY RESULTS)

Lots	1 and 2	3 and 4	5
Level of grain	None	1/2 Full feed	Full feed
No. of steers	13[a]	13	7
Av. weight data, lb.			
Initial wt.	473	473	483
Wt., 4/4	722	722	796
Gain	249	250	312
Daily gain	2.00	1.98	2.48
Av. daily feed, lb.			
Corn silage	38.6	24.3	18.2
Cottonseed meal	2.43	2.35	2.38
Grain		5.87	11.72
Lb. feed/lb. gain			
Corn silage	19.5	12.3	7.4
Cottonseed meal	1.2	1.2	1.0
Grain		3.0	4.8

[a]One steer died after the start of the trial.

VALUE OF HIGH UREA SUPPLEMENTS IN BEEF CATTLE FATTENING RATIONS[1]

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

Fattening trials were conducted at the Shenandoah Valley Station, Steeles Tavern with weanling beef steer calves in 1965-66 and 1966-67 to study the value of different high urea supplements and the results were reported in the 1965-66 and 1966-67 Progress Reports. A third trial is in progress and a summary of the results up to April 4, 1968 will be given in this report.

Experimental Procedure

Twenty-one crossbred weanling steer calves from crossbred cows were allotted to lots 1-4 and 24 crossbred weanling steer calves, from straightbred cows, were allotted to lots 5-8. Allotment was made according to breeding of the steers. The steers were fed a limited amount of high quality corn silage, a full feed of grain and two lb. per head daily of supplement. The cattle were fed twice daily. The supplements contained approximately 41% calculated crude protein. The composition of the supplements is given in table 1. Briefly, the composition was as follows:

Lots 1 and 5 - Cottonseed meal
Lots 2 and 6 - Urea and ground shelled corn
Lots 3 and 7 - Urea, ground shelled corn and cottonseed meal. The urea level was 50% of that in the supplement for lots 2 and 6.
Lots 4 and 8 - Urea, ground shelled corn, dehydrated alfalfa meal, dry molasses and defluorinated phosphate. This was designated as complex urea supplement.

Vitamin A was included in all supplements at a level of 1,000,000 I.U. per 100 pounds. The grain consisted of a 2:1:1 mixture of ear corn, barley and wheat. The cattle in all lots had access to a mineral mixture of one part salt and one part defluorinated phosphate.

The corn silage contained 39.5% dry matter. The calculated TDN content of the silage was 28.2%.

Results

The trial is still in progress. The results for the two lots fed the same supplement were averaged and the average values at the end of 127 days on trial are shown in table 2. Feed intake figures were equal for the cattle fed the various supplements. At the end of 127 days there were no marked differences in rate of gain among the cattle fed the various supplements. Feed efficiency values were not substantially different among the cattle fed the different supplements.

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[1]Appreciation is expressed to E. I. Dupont de Nemours & Co., Inc., Wilmington, Delaware for supplying the feed grade urea.

TABLE 1. COMPOSITION OF PROTEIN SUPPLEMENTS USED IN FATTENING TRIAL

Ingredient	Composition (%) of supplements by lot[a] Lots 1 & 5	Lots 2 & 6	Lots 3 & 7	Lots 4 & 8
Cottonseed meal	100.0		50.4	
Shelled corn		88.0	43.6	63.2
Urea, feed grade[b]		12.0	6.0	11.8
Dry molasses				5.0
Dehydrated alfalfa meal				15.0
Defluorinated phosphate				5.0

[a]Vitamin A was added to all supplements at the level of 1,000,000 I.U. per 100 lb. supplement.
[b]Contained 281% protein equivalent.

TABLE 2. PERFORMANCE OF FATTENING STEERS FED DIFFERENT PROTEIN SUPPLEMENTS

Protein supplement	Cottonseed meal	Corn-urea	Corn-urea-CSM	Complex urea
Lots	1 & 5	2 & 6	3 & 7	4 & 8
No. of steers	11	11	12	12
Av. weight data, lb.				
Initial wt.	560	541	568	564
Wt., 4/4/68	868	842	874	858
Gain	308	300	306	294
Daily gain	2.42	2.36	2.41	2.32
Av. daily ration, lb.				
Corn silage	17.6	17.6	17.6	17.6
Supplement	2.0	2.0	2.0	2.0
Grain	7.9	7.9	7.9	7.9
Lb. feed/lb. gain				
Corn silage	7.3	7.4	7.3	7.6
Supplement	0.8	0.8	0.8	0.8
Grain	3.2	3.4	3.3	3.4

THE VALUE OF A HIGH UREA SUPPLEMENT AND DIFFERENT LEVELS OF SUPPLEMENTAL GRAIN FOR FATTENING WEANLING BEEF CALVES ON HIGH CORN SILAGE RATIONS[1]

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

In 1965-66 and 1966-67 trials were conducted at the Southwest Station, Glade Spring to study the value of a high urea supplement and the relative value of two levels of grain supplementation for fattening weanling heifer calves on high corn silage rations. The results of these trials were reported in 1965-66 and 1966-67 Progress Reports. A third trial was conducted in 1967-68 and the results of that trial will be given here.

Experimental Procedure

Forty-seven crossbred heifers, 22 from straightbred dams and 25 from crossbred dams were used. The 22 heifers from straightbred cows were allotted to lots 1-4 and the 25 from crossbred cows were allotted to lots 5-8. The cattle received the following concentrates:

Lots 1 and 5 - Urea supplement and a limited level of ear corn
Lots 2 and 6 - Cottonseed meal and a limited level of ear corn
Lots 3 and 7 - Urea supplement and a high level of ear corn
Lots 4 and 8 - Cottonseed meal and a high level of ear corn

The grain level fed lots 1, 2, 5 and 6 was adjusted periodically to 1% of bodyweight and that for lots 3, 4, 7 and 8 was adjusted to 2% of bodyweight. The urea supplement contained 63.2% ground shelled corn, 11.8% feed grade urea (281% protein equivalent), 5.0% dry molasses, 15.0% dehydrated alfalfa meal and 5.0% defluorinated phosphate. The calculated crude protein content of the supplement was 41%, similar to the crude protein content in cottonseed meal. Stabilized vitamin A was incorporated into the cottonseed meal and the urea supplement at the rate of 1,000,000 I.U. per 100 lb. supplement. The supplements were fed at the rate of two lb. per head per day. In addition to the grain and protein supplement the heifers were full fed high quality corn silage. The cattle were fed twice daily. Based on average chemical composition the calculated TDN content of the corn silage was 21.3%. The heifers had access to a 1:1 mixture of salt and ground limestone.

Results

The trial is still in progress. Performance data up to April 9 are shown in table 1. At the end of 138 days level of grain feeding did not substantially alter rate of gain. There were no large differences in daily gain between the cattle fed the two supplements. However, gains were

[1]Appreciation is expressed to E. I. Dupont de Nemours & Co., Inc., Wilmington, Delaware for supplying the feed grade urea and to Chas. Pfizer and Co., Inc., New York, N. Y. for supplying the vitamin A.

slightly in favor of the cattle fed the high urea supplement. The cattle full-fed grain required more grain and less silage per pound of gain than those fed one-half of a full feed of grain. Feed efficiency was similar for the cattle fed cottonseed meal and the urea supplement.

TABLE 1. THE VALUE OF A UREA SUPPLEMENT AND RELATIVE VALUE OF DIFFERENT LEVELS OF GRAIN FOR FATTENING WEANLING HEIFER CALVES ON A HIGH CORN SILAGE RATION. 138 DAYS

Lots	1 & 5	2 & 6	3 & 7	4 & 8
Supplement	Urea	Cottonseed meal	Urea	Cottonseed meal
Level of grain	1/2 Full feed	1/2 Full feed	Full feed	Full feed
No. of cattle	12	11	12	12
Av. wt. data, lb.				
Initial wt.	510	537	515	521
Wt., 4/9/68	773	815	784	778
Gain	264	260	278	257
Daily gain	1.90	1.87	2.00	1.85
Av. daily feed, lb.				
Corn silage	25.8	27.5	17.1	15.0
Supplement	2.0	2.0	2.0	2.0
Ear corn	6.1	6.1	11.8	11.9
Lb. feed/lb. gain				
Corn silage	13.5	14.2	8.6	8.0
Supplement	1.0	1.0	1.0	1.1
Ear corn	3.2	3.2	6.0	6.3

VALUE OF A HIGH UREA SUPPLEMENT FOR WINTERING WEANLING HEIFER CALVES FED A HIGH CORN SILAGE RATION[1]

J. P. Fontenot and F. S. McClaugherty

During 1966-67 a trial was conducted to compare the relative value of a high urea supplement and cottonseed meal for wintering weanling heifer calves fed a high corn silage ration. The results of that trial were summarized in V.P.I. Res. Div. Res. Rpt. 122, p. 71. Another trial was conducted and the results will be given in this report.

Experimental Procedure

Thirty weanling Shorthorn heifer calves were assigned to three groups (replicates) based on weight. The heifers within each of the three replicates were paired according to breeding and weight, and the heifers within each pair were allotted at random to two lots. For one of the two lots the supplement consisted of cottonseed meal and for the other lot it consisted of a high urea supplement. All lots were full fed corn silage and were fed one lb. protein supplement and a limited level of mixed hay per head per day. Thus, three lots (lots 1, 3 and 5) were fed cottonseed meal and three (lots 2, 4 and 6) were fed the high urea supplement. The composition of the high urea supplement was 63.2% ground shelled yellow corn, 5.0% dry molasses, 11.8% feed grade urea, 15.0% alfalfa meal and 5% defluorinated phosphate. The urea supplement was calculated to contain approximately the same crude protein as cottonseed meal. Vitamin A was added to both supplements at the level of 1,000,000 I.U. per 100 lb. supplement. The hay contained 15.7% crude protein. Based on the chemical composition of the corn silage the calculated TDN content of the silage was 21.3%.

The heifers fed the urea supplement were gradually adjusted to the urea supplement. Water and a 1:1 mixture of salt and limestone were available at all times. The heifers were weighed at 14-day intervals.

Results

Rate of gain and feed intake data are given in table 1. Although there were no consistent differences between lots within replicates there was a tendency for lower daily gain for the urea-fed cattle. When the figures for each supplement were averaged, the daily gain was 1.23 lb. for the heifers fed cottonseed meal and 1.20 lb. for those fed the urea supplement. Feed intake was equal for all lots.

[1]Appreciation is expressed to E. I. Dupont de Nemours & Co., Inc., Wilmington, Delaware for supplying the feed grade urea and to Chas. Pfizer and Co., Inc., New York, N. Y. for supplying the vitamin A.

TABLE 1. VALUE OF A HIGH UREA SUPPLEMENT FOR WINTERING WEANLING HEIFER CALVES FED A HIGH CORN SILAGE RATION

	Replicate 1		Replicate 2		Replicate 3		Average	
	Lot 1 CSM	Lot 2 Urea	Lot 3 CSM	Lot 4 Urea	Lot 5 CSM	Lot 6 Urea	Lots 1,3,5 CSM	Lots 2,4,6 Urea
No. of heifers	5	5	5	5	5	5	15	15
Av. wt. data, lb.								
Initial wt., 11/21	507	497	424	435	367	394	433	442
Final wt., 4/9	659	654	590	575	561	556	603	595
Gain	152	158	166	170	194	172	171	167
Daily gain	1.09	1.14	1.19	1.22	1.40	1.24	1.23	1.20
Av. daily feed								
Corn silage	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2
Cottonseed meal	1.0		1.0		1.0		1.0	
High urea supplement		1.0		1.0		1.0		1.0
Mixed hay	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

EFFECT OF FEEDING DIFFERENT LEVELS OF NITRATE ON VITAMIN A METABOLISM OF FATTENING BEEF CATTLE[1]

J. P. Fontenot and R. E. Lichtenwalner

In trials conducted at V.P.I. in 1965-66 and 1966-67 it was found that feeding 1% potassium nitrate did not alter rate of liver vitamin A depletion in fattening weanling steer calves. There was rapid depletion in all cattle. A trial was started in 1967 to study the effect of feeding 1 and 2% potassium nitrate on vitamin A metabolism of fattening weanling calves.

Experimental Procedure

Twelve weanling steer calves were allotted to three rations based on breeding and weight. The composition of the three fattening rations is shown in table 1. The rations for lots 1, 2 and 3 contained 0, 1 and 2% potassium nitrate, respectively. All rations contained approximately 67% calculated TDN and 12.5% calculated crude protein. The actual crude protein contents, determined by analysis, were 13.3, 13.4 and 14.0% for lots 1, 2 and 3, respectively. Dehydrated alfalfa meal was used as the supplemental carotene source. The carotene contents, determined by analysis, were 3.3, 2.7 and 3.0 mg./lb. for lots 1, 2 and 3, respectively. Initially, barley was not included in the rations. Due to abnormally high moisture content of the ear corn used later in the trial, 15% barley was included in the ration and the hay content was increased from 20 to 25%.

The steers were kept in individual stalls, inside the barn, at night for about 16 hours daily, where they were individually fed. When not in the barn the steers were in large exercise lots with access to water. An attempt was made to feed the steers within each outcome group of three equal amounts of feed. The level was determined by the steer within each outcome group consuming the least amount.

The cattle were weighed at the beginning of the trial and at approximately 14-day intervals. Liver samples were obtained by biopsy prior to the start of the trial in December and again in January and February. Blood samples were taken at the same time. Additional samples will be obtained in April and June.

Results

Performance data up to April 5, 1968, liver vitamin A and blood methemoglobin values are given in table 2. Feeding 1 or 2% potassium nitrate did not adversely affect performance. In fact, there was a trend for higher daily gain for the cattle fed 2% potassium nitrate. Liver vitamin A depletion was rapid for all rations. At the February biopsy there had been greater depletion in the nitrate fed cattle. Methemoglobin values were low for all cattle.

[1]Appreciation is expressed to Nitrogen Division, Allied Chemical Corporation, Hopewell, Va. for supplying the potassium nitrate.

TABLE 1. COMPOSITION OF RATIONS

Added nitrate (KNO_3)	None	1%	2%
Lot no.	1	2	3
Ration composition, %			
Grass hay	21.2	21.2	22.0
Ear corn	65.0	43.8	27.8
Shelled corn	4.2	14.2	26.2
Alfalfa meal	1.9	1.9	1.9
Barley	3.8	3.8	6.0
Limestone	0.7	0.7	0.7
Trace mineralized salt	0.5	0.5	0.5
Soybean meal	12.7	13.0	12.9
Potassium nitrate	0.0	1.0	2.0

TABLE 2. EFFECT OF FEEDING DIFFERENT LEVELS OF NITRATE TO FATTENING CATTLE

Added nitrate (KNO_3)	None	1%	2%
Lot no.	1	2	3
No. of cattle	4	4	3[a]
Av. weight data, lb.			
Initial wt.	471	444	561
Wt., 4/5/68	697	676	751
Gain	226	232	251
Daily gain, lb.	2.10	2.15	2.33
Av. daily feed, lb.	16.0	14.4	16.0
Lb. feed/lb. gain	7.63	6.70	6.90
Liver vitamin A, mcg./gm.			
December, 1967	48.0	59.9	91.5
January, 1968	14.7	13.7	27.4
February, 1968	14.8	8.0	13.6
Liver vitamin A depletion, %			
January, 1968	69.4	77.1	70.1
February, 1968	69.2	86.6	85.1
Blood methemoglobin, % of total hemoglobin			
December, 1967	0.16	0.27	0.44
January, 1968	0.03	0.01	0.00
February, 1968	0.04	0.07	0.08

[a]One steer died during the trial. Cause of death was not related to the ration fed.

EFFECT OF ADDED NITRATE AND DIFFERENT PROTEIN SUPPLEMENTS ON VITAMIN A METABOLISM OF FATTENING BEEF CATTLE[1]

R. E. Lichtenwalner and J. P. Fontenot

Numerous feedlot experiments have shown that liver vitamin A values decrease through the fattening period, although the carotene content of the fattening rations is adequate. It has been suggested that high nitrate levels of certain feeds may interfere with carotene utilization. In previous research at V.P.I. feeding 1% potassium nitrate did not alter rate of liver vitamin A depletion in fattening steers in which there was a rapid rate of depletion. It has been shown that increased ammonia levels in non-ruminants increased rate of vitamin A depletion. Rate of ammonia production in the rumen is affected by the source of nitrogen. When comparing urea, soybean meal and corn gluten meal, the highest rate of ammonia production is expected when urea is fed and the lowest rate when corn gluten meal is used. Research was initiated to study the effect of feeding these different nitrogen (crude protein) supplements, with and without added nitrate on vitamin A metabolism of beef steers fed fattening rations containing adequate carotene.

Experimental Procedure

Thirty weanling calves (24 steers and 6 heifers) were divided into five groups based on origin, breeding, initial weight and sex. The cattle within each group were allotted to six rations. Three sources of nitrogen with and without nitrate were used. Specifically, the design of the experiment is as follows:

Ration	Nitrogen source	Added nitrate
1	Urea	none
2	Urea	1%
3	Corn gluten meal	none
4	Corn gluten meal	1%
5	Soybean meal	none
6	Soybean meal	1%

The composition of the rations is given in table 1. Initially, barley was not included in the rations but due to abnormally high moisture content of the ear corn used later in the trial 15% barley was substituted into the rations and the grass hay composition increased from 20 to 25%. The rations contained approximately 67% calculated TDN and 12.5% calculated crude protein. As shown in table 1, the actual crude protein levels varied between 13.1 and 14.1%. An attempt was made to equalize the carotene levels of the rations at 3 mg. per lb. by using dehydrated alfalfa meal as a carotene supplement. The actual values ranged from 1.9 to 3.0 mg./lb. among rations.

[1]Appreciation is expressed to W. R. Grace and Co., Research Division, Clarksville, Md. for supplying the urea and to Nitrogen Division, Allied Chemical Corporation, Hopewell, Va. for supplying the potassium nitrate.

TABLE 1. COMPOSITION OF RATIONS USED

Nitrogen source	Urea		Corn gluten meal		Soybean meal	
Added nitrate (KNO_3)	None	1%	None	1%	None	1%
Lot no.	1	2	3	4	5	6
Ingredient composition, %						
Grass hay	21.0	22.0	21.0	20.0	20.0	21.0
Ear corn	38.6	22.6	60.5	54.2	63.1	45.2
Shelled corn	32.7	43.7	4.0	12.6	0.0	13.5
Alfalfa meal	1.8	1.8	1.0	1.0	1.9	1.9
Barley	3.0	6.0	3.0	0.0	0.0	3.0
Urea	1.6	1.6	0.0	0.0	0.0	0.0
Corn gluten meal	0.0	0.0	9.2	9.8	0.0	0.0
Soybean meal	0.0	0.0	0.0	0.0	13.8	13.2
Limestone	0.6	0.6	0.6	0.6	0.7	0.7
Trace mineralized salt	0.5	0.5	0.5	0.5	0.5	0.5
Defluorinated phosphate	0.2	0.2	0.2	0.2	0.0	0.0
Potassium nitrate	0.0	1.0	0.0	1.0	0.0	1.0
Chemical composition						
Crude protein, %	13.1	13.5	13.1	14.1	12.8	13.7
Carotene, mg./lb.	1.9	1.9	2.4	2.3	2.2	3.0

The cattle were individually fed twice daily the respective rations in a coarsely ground form. The cattle were kept in the individual stalls inside the barn at night for about 16 hours. When not in the barn, the steers were placed in large exercise pens with access to water. An attempt was made to feed all cattle within each outcome group equal amounts of feed. The level was determined by the amount eaten by the animal within a given outcome group consuming the least amount.

The cattle were weighed at the beginning of the trial and at approximately 14-day intervals. Liver samples were obtained by biopsy prior to the start of the trial in December, and again in January and February. Blood samples were also taken at the same time. Rumen fluid samples were obtained in January and February. Additional samples of liver, blood and rumen fluid will be taken in April and June.

Results

Performance data up to April 5 and data for liver vitamin A and carotene values, blood methemoglobin and rumen ammonia are shown in table 2.

At the end of 108 days rate of gain was less for the urea-fed steers than for those fed corn gluten meal and soybean meal. Lower gains for the urea-fed steers may be due to the length of the adjustment period. All steers were allowed only seven days for gradual adaptation to the respective rations. Rate of liver vitamin A depletion was very rapid for cattle fed all rations. At 72 days (February) there was a trend toward more rapid depletion in the nitrate-fed steers. Depletion was most rapid with the least available source of nitrogen (corn gluten meal).

Rumen fluid ammonia levels reflect the availability of the nitrogen from the three protein sources and were highest in the urea rations, lowest in the corn gluten meal ration and intermediate in the soybean meal rations. Added nitrate did not markedly alter the rumen ammonia levels.

TABLE 2. EFFECT OF FEEDING DIFFERENT CRUDE PROTEIN SUPPLEMENTS AND ADDED NITRATE (PRELIMINARY RESULTS)

Nitrogen source	Urea		Corn gluten meal		Soybean meal	
Added nitrate (KNO_3)	None	1%	None	1%	None	1%
Lot no.	1	2	3	4	5	6
No. of cattle	5	4	5	5	5	5
Av. weight data, lb.						
Initial wt.	523	526	506	510	514	506
Wt., 4/5/68	741	719	739	756	746	760
Daily gain	2.02	1.78	2.17	2.28	2.15	2.35
Av. daily feed, lb.	15.6	14.3	15.6	15.5	15.9	15.9
Lb. feed/lb. gain	7.74	8.03	7.23	6.83	7.41	6.75
Liver vitamin A, mcg./gm.						
December, 1967	74.9	74.9	68.4	55.9	73.8	90.4
January, 1968	27.7	32.1	25.6	17.3	31.2	40.3
February, 1968	24.3	20.5	15.6	11.0	25.9	25.7
Depletion, Dec. to Feb., %	67.6	72.6	77.2	80.3	64.9	71.6
Liver carotene, mcg./gm.						
December, 1967	22.8	28.4	25.8	25.3	33.3	30.2
January, 1968	24.8	26.0	20.4	31.9	24.0	28.4
February, 1968	25.3	15.4	31.5	27.0	20.8	22.2
Rumen fluid ammonia nitrogen, mg./100 ml.						
January, 1968	36.4	27.9	7.6	13.7	17.7	17.5
February, 1968	25.9	24.6	8.3	10.6	16.1	17.8
Blood methemoglobin, % of total hemoglobin						
December, 1967	0.03	0.05	0.05	0.05	0.06	0.06
January, 1968	0.07	0.13	0.02	0.16	0.10	0.14
February, 1968	0.08	0.11	0.05	0.11	0.04	0.07

EFFECTS OF FEEDING DIFFERENT MAGNESIUM LEVELS TO BEEF COWS AT DIFFERENT STAGES OF LACTATION

R. E. O'Kelley and J. P. Fontenot

Grass tetany is one of the major nutritional diseases of ruminants. It is also referred to as hypomagnesemia, grass staggers, winter tetany and wheat pasture poisoning. If diagnosed early, the disturbance can usually be treated effectively. However, the onset and development of the disease are relatively rapid, and death often occurs before the affected animals are discovered. Due to a high mortality rate, stockmen often encounter heavy financial losses.

In general, the occurrence of hypomagnesemic tetany is most prevalent in older cows during the early stages of lactation, but may also occur during late pregnancy. A deficiency of magnesium in the ration and disturbances in magnesium metabolism have been suggested as factors involved in the development of tetany. Information concerning the magnesium requirement of beef cows is essentially nonexistent. The objectives of these experiments were to study the effects of feeding different levels of magnesium to beef cows during the different stages of lactation and to establish the magnesium requirement for such cows.

Experimental Procedure

Three experiments were conducted with eight aged lactating Angus cows at 1, 3 and 5 months after calving, representing early, mid- and late lactation, respectively. Prior to the beginning of the first experiment the cows were assigned to two groups of four according to date of calving, and remained within these respective groups for the three experiments. Each experiment was composed of two trials. For the first trial of each experiment the cows within each group were randomly allotted to four rations containing different levels of magnesium. For the second trial, the cows within each group were reallotted to the four rations by incomplete randomization, the restriction being that no cow would receive the same ration for the two consecutive trials within an experiment.

The basal ration (Ration 1, table 1) consisted of natural ingredients and was calculated to be low in magnesium, but to meet the other nutrient requirements of lactating beef cows. The average magnesium content of the basal ration for the three experiments was 0.09%. Rations 2, 3 and 4 consisted of the basal ration plus sufficient magnesium oxide to supply 0.10%, 0.20% and 0.30% magnesium, in addition to the amount in the basal ration. The levels of supplemental magnesium were 0, 10.9, 21.8 and 32.7 gm. per day, respectively, for the four rations.

The cows were placed in individual stalls twice daily (8:00 a.m. and 3:00 p.m.) for two hr. and fed one-half the daily ration at each feeding. The remainder of the time the cows were maintained with their calves in drylot with access to water.

TABLE 1. COMPOSITION OF BASAL RATION

Ingredient	Lb./day
Corn cobs	16.00
Ground yellow shelled corn	5.10
Corn gluten meal, 41% crude protein	2.65
Defluorinated phosphate	0.13
Trace mineralized salt	0.12

Stabilized vitamin A was added at the rate of 24,000 I.U. per day.

Each of the two trials within each experiment consisted of a 5-day adjustment period and a 10-day experimental period. During the adjustment period the cows received the basal ration plus 25.5 gm. of supplemental magnesium per day. The four rations supplying the different magnesium levels were fed during the 10-day experimental period. For each trial blood and urine samples were taken at the end of the 5-day adjustment period and on alternate days during the 10-day experimental period. The cows were weighed at the beginning of each adjustment period and at the end of each experimental period. Between trials the cows were maintained on a conventional hay-grain ration calculated to meet the nutritional requirements.

Feed, blood serum and urine samples were analyzed for magnesium and calcium. Blood serum inorganic phosphorus was determined and urine was analyzed for creatinine. Urinary calcium and magnesium values were expressed per unit of creatinine, since the proportion of creatinine to other substances such as magnesium and calcium in the urine is fairly constant during the day for a given animal.

Results

Experiment 1, Early Lactation

The effect of magnesium level in the ration on blood serum magnesium during early lactation is shown in table 2. Increasing the level of magnesium intake increased serum magnesium values. Average blood serum magnesium values for the five sampling days for both trials were 1.72, 2.03, 2.22 and 2.48 mg. per 100 ml. for Rations 1, 2, 3 and 4, respectively (table 2). The linear regression equation, using the serum values for the five sampling days in each trial, for the effect of dietary magnesium (X) on blood serum magnesium (Y) was $Y = 1.53231 + 2.44701X$ ($P<.01$). Therefore, each 0.1% increase in the magnesium level of the ration would increase the blood serum magnesium 0.245 mg. per 100 ml.

Data for the effect of magnesium level of the ration on blood serum calcium and inorganic phosphorus and on urinary magnesium and calcium per unit of creatinine are given in table 2. Blood serum inorganic phosphorus tended to be lower at the higher magnesium levels. Urinary magnesium increased linearly ($P<.01$) and urinary calcium decreased linearly ($P<.01$) with each increase in ration magnesium.

TABLE 2. EFFECT OF RATION MAGNESIUM LEVEL ON AVERAGE BLOOD SERUM MAGNESIUM, CALCIUM AND INORGANIC PHOSPHORUS, AND AVERAGE URINARY MAGNESIUM AND CALCIUM DURING EARLY LACTATION[a]

Level of magnesium, %	0.09	0.19	0.29	0.39
Ration no.	1	2	3	4
Blood serum composition, mg./100 ml.				
Magnesium	1.72	2.03	2.22	2.48
Calcium	8.36	8.60	8.70	8.66
Inorganic phosphorus	7.08	7.02	6.37	6.50
Urinary concentration, mg./100 mg. creatinine				
Magnesium	20.24	30.97	39.44	44.11
Calcium	41.97	35.72	18.62	11.68

[a]Average of samples taken on days 2, 4, 6, 8 and 10 for the two trials within each experiment.

Experiment 2, Mid-Lactation

Relative blood serum magnesium values for the four levels of magnesium during mid-lactation are shown in table 3. Differences in serum magnesium values among the cattle fed the different magnesium levels were established after two days on the experimental rations and persisted throughout the experimental period. At mid-lactation blood serum magnesium increased with the level of ration magnesium up to the 0.29% level, then decreased. The average values for the five sampling days within the two trials were 1.90, 1.99, 2.43 and 2.27 mg. per 100 ml. for the rations containing 0.09, 0.19, 0.29 and 0.39% magnesium, respectively (table 3). The data were represented best by the cubic regression model, $Y = 2.89849 - 19.02878X + 103.24408X^2 - 149.89484X^3$ ($P<.01$) where Y refers to the serum magnesium level and X refers to the percent dietary magnesium. Serum calcium and inorganic phosphorus values were not significantly affected by the level of ration magnesium.

Average values for urinary magnesium and calcium excretion per unit of creatinine at the four levels of dietary magnesium are shown in table 3. Urinary magnesium increased with ration magnesium up to, but not beyond, the 0.29% level. When the level of magnesium in the ration was increased from 0.29 to 0.39%, urinary magnesium decreased. Thus, the urinary magnesium data followed a cubic regression pattern ($P<.01$). Calcium excretion tended to decrease as the level of ration magnesium increased, but differences were not significant.

Experiment 3, Late Lactation

The effect of ration magnesium level on blood serum magnesium is shown in table 4. The average values for serum magnesium for the five sampling days within the experimental periods during late lactation were 1.89, 2.00, 2.17 and 2.35 mg. per 100 ml., respectively, for Rations 1, 2, 3 and 4. The effect of ration magnesium on blood serum magnesium was represented by the linear equation, $Y = 1.73755 + 1.63901X$ ($P<.01$) with Y referring to serum magnesium and X referring to percent magnesium of the ration. Level of magnesium in the ration did not significantly influence the blood serum calcium or inorganic phosphorus level. All values were within the normal range.

TABLE 3. EFFECT OF RATION MAGNESIUM LEVEL ON AVERAGE BLOOD SERUM MAGNESIUM, CALCIUM AND INORGANIC PHOSPHORUS, AND AVERAGE URINARY MAGNESIUM AND CALCIUM DURING MID-LACTATION[a]

Level of magnesium, %	0.09	0.19	0.29	0.39
Ration no.	1	2	3	4
Blood serum composition, mg./100 ml.				
Magnesium	1.90	1.99	2.43	2.27
Calcium	9.62	9.43	9.04	9.38
Inorganic phosphorus	6.99	6.74	6.58	6.72
Urinary concentration, mg./100 mg. creatinine				
Magnesium	19.80	23.26	36.65	30.10
Calcium	26.18	24.75	18.46	19.40

[a]Average of samples taken on days 2, 4, 6, 8 and 10 for the two trials within each experiment.

A linear increase ($P<.01$) in urinary magnesium excretion per unit of creatinine was observed with increases in magnesium intake. Urinary calcium per unit of creatinine decreased with increases in ration magnesium up to the 0.29% level.

TABLE 4. EFFECT OF RATION MAGNESIUM LEVEL ON AVERAGE BLOOD SERUM MAGNESIUM, CALCIUM AND INORGANIC PHOSPHORUS, AND AVERAGE URINARY MAGNESIUM AND CALCIUM DURING LATE LACTATION[a]

Level of magnesium, %	0.09	0.19	0.29	0.39
Ration no.	1	2	3	4
Blood serum composition, mg./100 ml.				
Magnesium	1.89	2.00	2.17	2.35
Calcium	9.30	9.29	9.31	9.38
Inorganic phosphorus	6.52	6.57	6.42	6.35
Urinary concentration, mg./100 mg. creatinine				
Magnesium	17.40	24.88	34.38	45.98
Calcium	41.22	24.83	20.38	20.67

[a]Average of samples taken on days 2, 4, 6, 8 and 10 for the two trials within each experiment.

Summary

Three experiments were conducted with eight aged lactating Angus cows to study the effects of ration magnesium levels at early, mid- and late lactation. The individual experiments consisted of two consecutive 15-day trials. Each trial consisted of a 5-day adjustment period and a 10-day experimental period. During the adjustment period the cows were fed a ration containing 0.31% magnesium. During the experimental period four rations containing 0.09%, 0.19%, 0.29% and 0.39% magnesium were fed. Generally, increasing the level of ration magnesium significantly increased blood serum magnesium during the three stages of lactation but did not influence serum calcium or inorganic phosphorus. In general, urinary magnesium per unit of creatinine was significantly increased with each increase in ration magnesium at the three stages of lactation. Urinary calcium per unit of creatinine was significantly decreased with increasing magnesium intake during early and late lactation and tended to decrease during mid-lactation but was not significant. As calculated from the regression equations obtained at each stage of lactation for the effect of ration magnesium on serum magnesium, rations would need to contain 0.20, 0.19 and 0.16% magnesium to maintain blood serum magnesium levels of 2.0 mg./100 ml. during early, mid- and late lactation, respectively. Based on a daily feed intake of 24 lb. per day, the magnesium requirement would be 22.1, 21.1 and 17.4 gm. per day for the three stages of lactation, respectively.

THE EFFECT OF PREPUBERTAL PLANE OF NUTRITION ON SUBSEQUENT LACTATION IN BEEF COWS

S. F. McClure III and T. N. Meacham

In the spring of 1967, a study was undertaken to determine the effect of nutrition from six months of age until puberty on the milk production and composition in seven sets of twin beef heifers. One heifer from each set was essentially full-fed a hay and grain ration while her sister was limited fed to gain between 0.75 and 1.0 lb. daily to puberty.

The heifers calved during a period extending from 1 May to 13 July. The milk production estimates were made using the calf nursing method and the estimates were begun when the calves were approximately one month of age. Milk production estimates were made three times monthly through the sixth month of lactation. Milk samples for protein and butterfat determination were obtained by milking out a quarter by hand once a month.

At the beginning of the experiment, there were six sets of twins and their calves. Due to a stillbirth and early post-partum death losses, the three complete sets of twins and their calves are included in this report throughout lactation. A fourth set is used in the birth weight comparisons.

The results of the study are shown in tables 1 and 2. Table 1 illustrates the performance of the calves. Average birth weights of the calves from the low plane cows were considerably heavier than those of their twin sisters. It would appear that the level of nutrition had a greater influence than did heredity since there were wide differences between the calves from each pair of dams. Calf weights at 90 days tended to favor the calves on the high plane cows; however, calf weights at 180 days are approximately the same for both the high and low plane groups. The average daily gains to 180 days are quite close, the high plane calves gaining only 1.82 and the low plane calves 1.84 lbs./day.

In table 2, analysis of the milk from the high and low plane cows showed that the milk from the low plane cows maintained a higher percent protein during the second through fourth month of lactation. However, the daily milk production was higher for the high plane cows throughout the six months of lactation with the differences between the two groups becoming increasingly smaller toward the end of the lactation period. The level of milk production in low plane cows was more persistent throughout the lactation period whereas the milk production in the high plane groups showed a more marked decrease toward the end of the lactation period.

TABLE 1. CALF PERFORMANCE TO 180 DAYS

		Pair values[a] and treat. means	
		High Plane	Low Plane
Birth wt. of calves, lbs.		72.0	82.0
		57.0	70.0
		81.0	83.0
		63.0	81.0
	Ave.	68.3	79.0
Calf wts. @ 90 days, lbs.		306	254
		174	178
		209	216
	Ave.	230	216
Calf wts., @ 180 days, lbs.		391	389
		273	283
		321	323
	Ave.	328	332
Ave. daily gain to 180 da., lbs.		2.17	2.16
		1.52	1.57
		1.78	1.79
	Ave.	1.82	1.84

a/Figures on the same line represent the values for the heifers from each set, one high plane, one low plane.

TABLE 2. MILK PRODUCTION AND COMPOSITION

		Pair values[a] and treat. means	
		High Plane	Low Plane
Milk production 2 to 6 mo. lbs./day		14.50	14.35
		8.04	9.94
		13.44	10.14
	Ave.	11.9	11.5
Milk protein, %		3.56	3.20
		3.49	3.70
		3.28	3.80
	Ave.	3.44	3.57
Milk fat, %		3.26	2.60
		2.07	2.08
		4.05	3.12
	Ave.	3.13	2.60

a/Figures on the same line represent the values for the heifers from each set, one high plane, one low plane.

WINTERING BEEF COWS ON APPLE POMACE SILAGE

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Apple pomace can provide most or all of the roughage needed for wintering pregnant and lactating beef cows. However, DDT, and more recently Kelthane and Tetradifon (tedion), have been used by apple producers in their insect control programs. These insecticides have been measured in apple pomace and their residues can accumulate in animal tissues above legal tolerance levels. Thus, apple pomace is not an acceptable cattle feed at the present time until the pesticide residue problems are solved.

DDT spray residues in apple pomace were 7-15 ppm (parts per million) through the late 1950's. This was high enough to cause deposits of 7 ppm, the legal tolerance, in cattle fed pomace for more than a few weeks. The present experiment was started in cooperation with USDA scientists at Beltsville, Maryland and Front Royal, Virginia to see if current DDT levels in apple pomace from the Winchester, Virginia area are safe for beef cows. Currently, the DDT residues in this pomace have been generally less than 5 ppm.

During the winter of 1965-66, three groups of five pregnant cows each, received either apple pomace silage, grass silage, or corn silage. Silages were fed *ad lib*. and supplemented to equalize protein and energy intake of the three groups. Perianal fat samples (from the rump area) were taken from the cows prior to feeding, and at 16, 24, and 40 weeks after the test began. Samples at 24 weeks represented the average calving time of all cows.

During the winter of 1966-67 a similar study was made. Three groups of six pregnant cows each received either apple pomace silage, corn silage, or equal parts of the two silages. Further, half the cows in the second year's test had been in the previous year's test sample. Thus, it was possible to check the DDT carry-over.

The apple pomace in the 1965-66 period contained 1.19 ppm DDT on an as fed basis. Cows on this treatment received 19 lbs. per day for 109 days, until early March when the supply was exhausted. They received grass silage for the remaining 27 days of the winter feeding period. Cows on the other two treatments received 20 and 14 lbs. per day of grass silage and corn silage, respectively.

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In 1966-67, the apple pomace contained 0.64 ± 0.30 ppm DDT, much less than the previous year. Average daily consumption of silages in the three groups was: pomace, 19 lbs.; corn silage, 22 lbs.; and pomace plus corn, 10 and 11 lbs., respectively. Results presented in table 1 show that pre-feeding levels of DDT were unusually high (9.2 ppm) for the cows receiving grass silage. We have no explanation for this. As feeding continued, DDT levels rose rapidly in the pomace-fed cows, reaching 11.4 at 16 weeks, when the pomace supply was exhausted. Despite this, levels rose to 13.7 at 24 weeks. Probably, this was largely a function of fat cover, since most cows had calved shortly before this, were milking heavily, and were relatively thin at that time. In this work, and in studies of heptachlor residues at the Front Royal Station this pattern has been seen: the thinner cattle generally have higher residue levels than those with more fat cover, other things equal. DDT levels of the cows on the grass and corn silage treatments dropped to less than 3 ppm and remained at these low levels. Residues in calves at 16 weeks were related to their dams'. DDT level in calves from pomace-fed cows was 7.2 ppm, slightly in excess of legal tolerance. The two calves with highest levels in this group were sampled again at 26 and 38 weeks of age, with residues of 2.8 and 1.4 ppm, respectively.

Data from the second year's work (1966-67) in table 1 show clearly that the average levels in the cows were much lower, in no case even half the legal tolerance. Cows in the intermediate treatment, half pomace and half corn silage, generally showed intermediate levels of DDT.

Carry-over effects from the previous year, shown in table 2, were small.

Results indicated that the accumulation of DDT residue in pomace-fed cows and their calves should not pose a problem in beef cow herds, except during the feeding period and no more than about 16 weeks after calving. Available samples at the end of pomace feeding during experiment II indicated that on a whole tissue basis perianal fat contained 0.58 and 0.16 ppm kelthane when animals were fed pomace and pomace plus corn, respectively. The same samples contained 0.45 and 0.20 ppm tetradifon. The pomace, during this experiment, contained from 0.01 to 0.45 ppm kelthane and 0.16 to 0.65 ppm tetradifon. A study is currently underway to investigate the residue patterns of kelthane and tetradifon when fed as contaminants in apple pomace.

TABLE 1. TOTAL DDT CONTENT (ppm) OF FAT SAMPLES, WHOLE TISSUE BASIS, FROM COWS AND CALVES, BEEF CATTLE RESEARCH STATION, FRONT ROYAL, VIRGINIA

Winter of	Silage fed	N[a]	DDT in cows (weeks after feeding began) 0	7	16[c]	24[c]	40[c]	DDT in Calves[b]
1965-66	Pomace	5	4.9		11.4	13.7	4.2	7.2
	Grass	5	9.2			2.7	2.8	4.1
	Corn	5	5.8			2.0	2.0[d]	2.5[d]
1966-67	Pomace	6	1.0	2.1	1.1	2.2	0.9	2.0
	P + C	6	1.3	1.1	0.7	1.9	1.2	1.5
	Corn	6	1.4	0.9	0.8	1.3	1.2	1.9

[a]Number of animals per treatment.

[b]Calves were 16 weeks of age.

[c]In 1966-67, weeks after beginning are 14, 20, and 36, respectively.

[d]Average of 4, not 5, observations.

TABLE 2. SECOND YEAR CARRY-OVER EFFECT ON DDT LEVEL IN FAT OF COWS RECEIVING POMACE VS. CORN OR GRASS SILAGE IN 1965-66, BEEF CATTLE RESEARCH STATION, FRONT ROYAL, VA.

1965-66 Treatment	N	1966-67 values, weeks after start 0	7	14	20	36
Pomace	6	1.7	1.8	1.7	2.2	1.1
Grass or corn	12	1.0	1.2	0.9	1.6	1.1

HEPTACHLOR RESIDUES IN BEEF COWS AND CALVES KEPT IN CONFINEMENT

K. P. Bovard,[1] J. P. Fontenot[1] and B. M. Priode[2]
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Given a set of pregnant beef cows in the fall, what kind of residue problems and levels would be encountered if they received a conventional, but heptachlor-contaminated, ration during gestation, during lactation, or both? Answers to these questions were sought from a one-year study, cooperative with the USDA, and conducted at the Beef Cattle Research Station, Front Royal, Virginia. The work was begun in November 1966.

During the last four months of pregnancy 20 cows were placed in confinement. Ten received a conventional wintering ration containing alfalfa hay moderately to highly contaminated with heptachlor residues (heptachlor plus heptachlor epoxide). The remaining ten received the same ration, but free of residues. At calving time, half the cows on each treatment were transferred to rations of the opposite kind, i.e., either contaminated or residue-free ("clean"). Perianal fat biopsies were obtained prior to the beginning of the experiment and periodically during its progress. Fat biopsies were also obtained from the calves at five and at six months of age. All samples were analyzed for heptachlor and its epoxide and the total of these compounds are reported.

The residue pattern presented in table 1 is simple, striking and clear. Cows receiving residue-free rations during the entire study (lot 5) remained free of residues, and their calves did too. (The values of 0.01 ppm in lot 5 in January, and 0.02 in lot 6 in November reflect unimportant background concentrations). Cows receiving a contaminated ration during gestation, and then shifted to a residue-free ("clean") ration after calving (lot 6), were already moderately contaminated (0.43 ppm) in January and slightly more so by April (0.69 ppm). Most cows in this lot had calved and were receiving the "clean" ration for several days prior to the April biopsy. Despite this, average residues increased to 0.69 ppm at that time, with almost no change during the following four months. Their calves were moderately contaminated in August, slightly less so in September, 0.56 and 0.45 ppm, respectively. From the experimental plan, it can be seen that the calves' contamination resulted from residues the cows accumulated prior to calving. Most of this residue transfer was probably via the milk since cows receiving heptachlor contaminated feeds produce contaminated milk. Cows receiving a clean ration during gestation, but switched to a contaminated ration after calving (lot 7), were already slightly contaminated (0.20 ppm) in April, much more so in June and August, 0.76 and 1.53 ppm, respectively. Their calves' levels were much higher in August and September than those from lot 6. For cows receiving the contaminated ration throughout (lot 8), residue levels, initially negligible, rose rapidly throughout the feeding study. Calves were also the most highly contaminated at both sampling times, 1.21 and 0.80 ppm, respectively.

[1]VPI, Dept. of Animal Science, Front Royal and Blacksburg, Va., respectively.
[2]ARS, Animal Husbandry Research Division, Front Royal, Va.

This experiment clearly shows the nature and extent of the heptachlor residue problem. Cows that received contaminated feed rapidly absorb the residues. Even after five months of residue-free rations, internal residues which accumulated during the last four months' gestation persisted and were dissipated very slowly over the period studied. No symptoms of poisoning were seen in any of the cows or calves on the test. So long as the zero tolerance regulation remains in effect, feeding pregnant and lactating beef cows a ration known to contain heptachlor would indeed be unwise.

TABLE 1. HEPTACHLOR RESIDUES (PARTS PER MILLION) IN FAT SAMPLES OF COWS AND THEIR CALVES, 1966-67. BEEF CATTLE RESEARCH STATION, FRONT ROYAL, VIRGINIA

			Cows					Calves	
Lot	Gest'n.[a]	Lact'n.[b]	2 Nov.	26 Jan.	12 Apr.	15 June	23 Aug.	23 Aug.	26 Sept.
5	Clean	Clean	tr.[c]	0.01	tr.	tr.	tr.	tr.	tr.
6	Cont.[d]	Clean	0.02	0.43	0.69	0.68	0.67	0.56	0.45
7	Clean	Cont.	tr.	0.01	0.20	0.76	1.53	1.10	0.65
8	Cont.	Cont.	tr.	0.48	0.92	1.05	1.53	1.21	0.80

[a]Gestation
[b]Lactation
[c]Trace
[d]Contaminated

HEPTACHLOR RESIDUES IN FATTENING STEERS FED CONTAMINATED ALFALFA

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Heptachlor is an insecticide which was widely used to control alfalfa weevil in the East until 1964. Presently, it is not registered because its residues were found in milk and were very persistent in animal fat tissues. In 1965 a study with the USDA was begun to examine some of the problems in feeding heptachlor-contaminated alfalfa at the Beef Cattle Research Station, Front Royal, Virginia. All samples were analyzed for heptachlor and its epoxide and the total of these compounds are reported.

A two-stage study with 20 yearling steers was begun in June 1965. The fattening ration contained 52% locally grown alfalfa, or its equivalent, moderately to highly contaminated with heptachlor residues. For the first 189 days, phase 1, all steers received the contaminated ration. During the succeeding 18 months, the steers were divided in four lots. One pen of five (lot 1) served as a positive control and continued to receive the same contaminated ration. The remaining steers received residue-free feed. Five (lot 2) received a fattening ration *ad lib*. Five (lot 3) received the same ration *ad lib*., with protamone added. Protamone is a synthetic growth hormone that was added to see if its action would hasten the residue dissipation. And five steers (lot 4) received the same ration as lot 2, but limited in amounts calculated to maintain body weight, *i.e.*, no gain.

Results in table 1 show that the experimental animals were already mildly contaminated with residues of 0.19 to 0.29 ppm (parts per million) when the study began in June 1965. Residues rose rapidly to 0.60 to 0.75 ppm during the first five months in phase 1, the "load" phase of the study. During the second (dissipation) phase, residues of the positive control (lot 1) steers rose slightly, then leveled off while weights continued to increase.

In lots 2, 3 and 4 heptachlor residue levels first rose, then fell slowly, but did not closely approach the legal tolerance of zero. Three treatments were compared for their effects on the rate of decreasing accumulated residues. None was effective in the sense of bringing the cattle close to the zero tolerance required. There was a trend suggesting that residues were lower among fatter animals, and vice versa. This means that, other things equal, fatter cattle showed less relative contamination. Since heptachlor residues, like DDT, are deposited more in fat than in lean tissue, a kind of "dilution" effect seemed to be operating. Results in table 1 show this.

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[1]VPI, Dept. of Animal Science, Front Royal and Blacksburg, Va., respectively.
[2]ARS, Animal Husbandry Research Division, Front Royal, Va.

The study shows clearly that feeding rations that have moderately contaminated alfalfa will cause a rapid increase in heptachlor residues. With continued feeding of the contaminated ration, residues stabilized around 1.00 ppm with no substantial increase thereafter. Among steers receiving residue-free rations in the second phase, deposits of heptachlor and its epoxide in the fat first rose then slowly diminished. Even after 18 months on a residue-free regime, the contamination was well above the required zero tolerance. No symptoms of poisoning were seen among the cattle tested.

In summary, feeds containing heptachlor residues must not be fed to animals being fattened for slaughter. Almost certainly, carcasses of cattle receiving heptachlor-contaminated feed for more than a few weeks would contain some residue. As such, they would be in violation of existing regulations and subject to condemnation.

TABLE 1. BEGINNING, INTERMEDIATE AND FINAL WEIGHTS AND HEPTACHLOR RESIDUE LEVELS OF FATTENING STEERS. BEEF CATTLE RESEARCH STATION, FRONT ROYAL, VIRGINIA

	Phase 1				Phase 2			
	4 June 1965		9 Nov. 1965		1 July 1966		17 May 1967	
Lot	Wt.,lbs.	H+HE[a],ppm	Wt.,lbs.	H+HE[a],ppm	Wt.,lbs.	H+HE[a],ppm	Wt.,lbs.	H+HE[a],ppm
1	609	0.19	942	0.60	1291	1.01	1549	0.94
2	620	0.29	1000	0.69	1320	0.56	1722	0.19
3	650	0.21	1002	0.74	1180	0.69	1483	0.24
4	653	0.19	1008	0.70	977	1.24	1046	0.52

[a]Heptachlor and heptachlor epoxide, parts per million.

HIGH SILAGE RATIONS FOR FATTENING WESTERN LAMBS

W. H. McClure and J. P. Fontenot

The practice of feeding low-grade native feeder lambs has become increasingly popular in Virginia in recent years. The increased popularity of this enterprise, together with a shorter supply of available native lambs for feeding, has resulted in a higher cost for feeder lambs and a lower margin of profit.

Because of Virginia's proximity to the strong Eastern lamb market, the limited supply of native feeder lambs and the increasing popularity of lamb feeding as a source of supplemental income for many farmers, the possibility of feeding western feeder lambs must be studied.

Results of an experiment conducted at the Shenandoah Valley Research Station in 1965-66 indicated that low-grade native feeder lambs could be economically and satisfactorily fattened to a desirable slaughter weight and grade on a ration of corn silage and protein supplement alone or supplemented with two levels of corn.

An experiment was conducted at the Shenandoah Valley Research Station in 1967-68 to study the value of corn silage and the relative value of two levels of grain supplementation for fattening western feeder lambs.

Experimental Procedure

Eighty feeder lambs of Montana origin were secured in late November for the trial. The lambs were Hampshire x Rambouillet (blackface) and Columbia x Rambouillet (whiteface) breeding. The lambs weighed approximately 60 lb. upon arrival at the station. Prior to the start of the trial the lambs were vaccinated against enterotoxemia and treated for internal parasites. The lambs were allotted into eight lots of ten lambs each, according to breed, sex and weight and were fed the following rations:

Lots 1 and 5 - Corn silage, full fed and 0.25 lb. soybean meal daily.
Lots 2 and 6 - Corn silage, full fed, 0.25 lb. soybean meal daily, plus limited shelled corn.
Lots 3 and 7 - Corn silage, full fed, 0.25 lb. soybean meal daily, plus a high level of shelled corn.
Lots 4 and 8 - Self-fed a 40:60 ground hay and concentrate ration.

The ground hay and concentrate ration fed to lots 4 and 8 served as a control ration, and may be termed a typical ration for fattening lambs. The corn silage used in the test was finely chopped, of excellent quality and tested 39.5% dry matter. Limited ground shelled corn was fed to lots 2 and 6 at a level of approximately 0.75% of bodyweight daily. Ground shelled corn was fed to lots 3 and 7 at the rate of approximately 1.5% of bodyweight per day. The hay and concentrate ration fed to lots 4 and 8 contained 40% ground alfalfa hay, 55% ground shelled corn and 5% molasses.

Vitamins A and D were added to the soybean meal for lots 1, 5, 2, 6, 3 and 7 at a level of 2,500 I.U. of vitamin A and 625 I.U. of vitamin D per pound. The hay and grain ration contained 250 I.U. vitamin A and 65 I.U. vitamin D per pound of complete ration. A mineral supplement containing two parts trace mineral salt, one part defluorinated phosphate and one part ground limestone was fed free choice. Additional ground limestone at the rate of 0.5 lb. per pen per day was fed to the lambs on the silage rations.

The lambs receiving silage were full-fed once daily. Soybean meal and corn were fed on top of the silage. The troughs were cleaned out each morning before feeding. The consumption figures in table 1 reflect the total amount of silage given to the lambs, with no allowance being made for silage wasted or refused. There was actually very little wastage or refusal, primarily because of the fine chop on the silage. The lambs receiving the hay and grain ration were self-fed.

The lambs received two treatments for internal parasites. Slaughter grades were taken 14 days before the completion of the trial. They were slaughtered in March 1968 after a 96-day feeding test.

Results

The results are given in table 1. Silage consumption decreased as the level of corn fed increased. Lambs fed only corn silage and soybean meal gained 0.37 lb. per day. There was no difference in the daily gain of the lambs on the two different levels of corn supplementation, 0.43 lb. per day for each group. These gains were similar to those for the lambs fed the hay and grain ration (0.44 lb.). Feed efficiencies were excellent for all lambs, and much better for the lambs fed silage in this test than in the preceding one.

Slaughter grades ranged from low to average choice for the lambs fed no grain in addition to corn silage and protein supplement to top choice-low prime for the lambs fed the high corn level in addition to corn silage and protein supplement (lots 3 and 7), and those fed the hay-grain ration (lots 4 and 8). Carcass grades showed a similar trend as slaughter grades. Dressing percentages were rather low for all lambs, ranging from 44.4% for lots 1 and 5 to 48.5% for lots 4 and 8. The low grades and dressing percentages for the lambs in lots 1 and 5 may be at least partly attributed to the fact that all lambs were slaughtered at the same time. Because of the lower gains in these lots, many lambs went to slaughter weighing less than 90 lb.

Although feed cost per pound of gain figures may be considered relative, they are included for this test (table 1). These figures show that the cost per pound of gain was quite low for all lambs fed silage, ranging from 11.1 cents per pound of gain for the lambs fed corn silage and protein supplement and no grain to 13.6 cents per pound of gain for the lambs fed the high grain level in addition to silage and protein supplement. These figures are much lower than the 21.9 cents per pound of gain for the lambs fed the conventional hay and grain ration.

TABLE 1. HIGH SILAGE RATIONS FOR FATTENING WESTERN LAMBS

	Corn silage			Hay-grain
Grain level	None	Low	High	
Lots	1 & 5	2 & 6	3 & 7	4 & 8
Initial wt., lb.	58.8	59.3	60.8	63.4
Final wt., lb.	94.1	100.6	102.4	105.2
Daily gain, lb.	0.37	0.43	0.43	0.44
Daily ration, lb.				
Corn silage	5.49	4.49	3.45	
Soybean meal[a]	0.25	0.25	0.25	
Corn		0.56	1.12	
Mixed ration				3.47
Feed per lb. gain, lb.				
Corn silage	15.0	10.4	8.0	
Corn		1.3	2.6	
Soybean meal[a]	0.68	0.58	0.58	
Mixed ration				7.96
Feed cost per lb. gain[b] cents	11.1	11.5	13.5	21.9
Slaughter grade[c]	12.6	13.4	14.7	14.6
Carcass grade[c]	12.3	12.7	13.6	14.0
Dressing %	44.4	45.1	46.6	48.5

[a]50% crude protein guarantee.
[b]Based on following prices per ton: Corn silage, $10; shelled corn, $50; 50% soybean meal, $105; alfalfa hay, $40. Ground hay and grain ration includes grinding and mixing cost with mobile mill.
[c]Code: 12 = low choice; 13 = av. choice; etc.

DIFFERENT PROTEIN LEVELS FOR FATTENING EARLY WEANED LAMBS

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

Feeding standards normally list the protein requirements of fattening feeder lambs. The experiments on which these are based were conducted with lambs weaned at a heavier weight and older than lambs which are weaned early under intensified lamb production programs. Only limited research has been conducted concerning the protein requirement of early weaned lambs. An experiment was conducted to study the effects of two protein levels for early weaned fattening lambs.

Experimental Procedure

A trial was conducted at the Shenandoah Valley Research Station, Steeles Tavern during each of two years, 1966 and 1967, with early weaned lambs. The lambs were weaned at a minimum of 60 days of age and of 30 lb. in weight. Each year the lambs were allotted into four lots and placed on expanded metal floors for the trial. Two of the lots were self-fed a pelleted ration containing approximately 15% crude protein and two were self-fed a pelleted ration containing approximately 18% crude protein. The composition of the pellets is shown in table 1.

TABLE 1. COMPOSITION OF PELLETED RATION FED

Feeds	Lb. feed/100 lb. ration 15% protein	 18% protein
Alfalfa meal, 15% protein, sun cured	35.00	35.00
Shelled corn	49.15	41.85
Soybean meal, 50% protein	10.60	17.90
Molasses	5.00	5.00
Vitamin premix[a]	0.25	0.25

[a]Vitamin premix supplied 60,000 I.U. vitamin A, 1,500 I.U. vitamin D and 5,000 I.U. vitamin E per 100 lb. final feed.

Results

There were several cases of "stiff lamb" disease in the lambs fed both rations. These usually responded to intramuscular injections of a combination of vitamin E and selenium. However, performance of the lambs was excellent for both years.

The results for the lambs in the two lots receiving the same ration were averaged each year. Also the two years' results were averaged for each protein level. The average data are given in table 2. Daily gains were very good and not substantially different between protein levels. The average values for both trials were 0.66 and 0.68 lb. for the lambs fed the 15 and 18% protein pellets, respectively. Daily feed intake and feed efficiency were similar for the two protein levels. Average slaughter grade was low to average prime for the lambs fed both rations.

TABLE 2. AVERAGE PERFORMANCE OF EARLY WEANED LAMBS FED DIFFERENT PROTEIN LEVELS

	1966		1967		Av., 1966 and 1967	
Protein content of pellets, %	15	18	15	18	15	18
No. of lambs	73	77	96	99	169[a]	176[a]
No. of days on test	73.3	72.4	70.0	67.1	71.4	69.4
Initial wt., lb.	48.7	46.9	54.1	53.8	51.8	50.8
Final wt., lb.	99.0	97.2	99.2	98.6	99.1	98.0
Daily gain	0.69	0.70	0.64	0.67	0.66	0.68
Daily feed, lb.	3.13	3.14	3.01	3.11	3.06	3.12
Lb. feed/lb. gain	4.56	4.52	4.67	4.66	4.62	4.60
Slaughter grade[b]	15.6	15.4	15.6	15.6	15.6	15.5

[a]Total no. of lambs.
[b]Code: 15 = low prime; 16 = av. prime; etc.

Acknowledgement: Appreciation is expressed to Agricultural Processing Corp., Salem, Va. for supplying the vitamin premixes.

INTENSIVE LAMB PRODUCTION FROM PASTURE[1]

R. C. Carter, J. S. Copenhaver and F. S. McClaugherty

For the past 10 years a considerable proportion of our research effort at V.P.I. has been directed toward development of practical management systems that would permit severalfold increases in the number of sheep that can be profitably carried on the average farm. We feel that larger flocks or production units, large enough to provide a major portion of the income from a farm, are imperative if the sheep industry is to survive and prosper in our area. Small flocks, although highly profitable in terms of return per unit of input, do not provide a significant volume of income, are usually neglected, and too often liquidated.

The principal hazard to concentration of sheep numbers on a restricted acreage is the increased level of disease and parasite infection that usually occurs. Mature sheep develop resistance or tolerance to most internal parasites and can be concentrated fairly heavily on pastures. In fact there is good evidence that the worm burden is lower when pastures are grazed heavily than when grazed at more moderate levels. Lambs, however, are very susceptible, and become severely infected with worms during late spring and early summer, when grazed with their mothers at moderate to heavy stocking rates, particularly during wet seasons.

If intensive sheep production is to be successful in the temperate humid regions of the United States, some method must be found to avoid infection of lambs by internal parasites. This really means breaking the chain of infection from the ewe to the lamb. Several management systems to accomplish this have been tried by the research team at V.P.I., for the past several years. The more successful of these, that we are now recommending to be put in practice, are reviewed below.

Rotational Grazing vs. Set Stocking

We have not found rotational grazing, either of permanent bluegrass pastures or seeded grass and clover mixtures, to be superior to set stocking. Higher carrying capacity per acre was attained but lamb growth rates and market grades were lower than under continuous grazing, too low in fact to be acceptable. Nor were we able to demonstrate any improvement in parasite control from rotational grazing, contrary to common belief and recommendation.

Orchard grass-ladino clover pastures were not particularly satisfactory for ewes and lambs. The clover was eaten into the ground with great relish to the neglect of the orchard grass, which quickly headed and became unpalatable. The orchard grass ladino pasture did carry greater numbers but again lamb gains and market grades were much lower than those on permanent bluegrass-white clover sods.

Pure stands of ladino clover were found to be excellent for lamb grazing, superior to permanent bluegrass-white clover pastures. But it was very difficult to maintain stands more than one or two years. We believe that a limited acreage of pure stands of ladino clover, perhaps on low ground or under irrigation, would be desirable for growing out early weaned lambs.

[1] Based on talk given by R. C. Carter at Univ. of Kentucky Annual Sheep Short Course, 16 February, 1968.

Intensive Pasture Systems

A number of intensive management systems that we have found successful, and which we are recommending to our producers, are shown in outline form below: the figures for expected lamb performance, in terms of lamb growth rates and grades, and the feed consumption figures, are based on experimental results at V.P.I. over several years.

System I. Heavy Set Stocking - Creep Feed Lambs

1. Turn ewes and lambs on pasture at rate of 3 to 5 ewes and their lambs per acre; creep feed lambs pelleted ration no. 3

2. Expected Lamb Performance (based on V.P.I. data)

Dry years:	.6 lb. daily gain	Grade low Prime
Wet years:	.4 lb. daily gain	av. Choice

3. Creep Feed Consumed (Av. for 4 years' tests)

Dry years:	1.4 lb. per day	85 lb. per lamb	$3.15
Wet years:	.8 lb. per day	80 lb. per lamb	$3.00

4. Be prepared to wean lambs in wet years by June 1 or earlier if worm burden builds up. Sell heavy lambs, finish lighter ones in dry lot.

5. Graze ewes 6-10 per acre pasture after lambs are weaned until two weeks before breeding. Then flush by giving them run of available pasture or meadow aftermath.

This system permits large increases in sheep carried with least change from conventional management. It works particularly well in dry seasons. In wet seasons worms will become a problem. Then it is absolutely necessary to wean the lambs before the worm burden becomes too high, not later than June 1 at Blacksburg, earlier at lower elevations. Sell the heavier lambs and finish the lighter ones in barn or dry lot. The amount of creep feed consumed by the lambs is about equal in either wet or dry seasons. In dry periods the lambs eat more per day, but gain faster and get to market weight quicker, on about the same amount of creep feed. Heavy stocking is better than more moderate rates. Worm infection is lower on short pastures.

Early Weaning Systems

The following two systems are based on our observation that January-February born lambs carry only a moderate to light worm burden by the beginning of the pasture season, about mid-April in our part of Virginia. By weaning the lambs then and finishing them to market weight away from adult sheep, the chain of infection from ewe to lamb is effectively broken, and rather heavy stocking rates may be achieved.

System II. Early Weaning - Finish Lambs in Dry Lot

1. Lamb in normal season - January-March 15.

2. Wean lambs at beginning of pasture season, about April 20 at Blacksburg, (60-75 days of age; 40-65 lbs.).

3. Finish lambs in dry lot, full feed pelleted ration no. 3 plus a little hay. Slotted floors, concrete or dirt floors, satisfactory.

4. Expected Lamb Performance:
   Gain .6 lb./day — Choice + to Prime grade

5. Feed Cost:
   175 lbs. pellets, 45 lbs. hay, $7.50 per head

6. Graze 6-10 ewes/acre until 2 weeks before breeding. Then flush by giving them run of all pastures or meadows.

System III. Early Weaning - Finish Lambs on Pasture

1. Same as System II above, except that lambs are finished on clean, high quality pasture after weaning. Give access to pelleted ration no. 3 in self feeder.

2. Expected Lamb Performance:
   Gain .55 lb./day — Choice + grade

3. Feed Cost:
   125 lbs. pellets, $4.75 per lamb, plus pasture

Finishing early weaned lambs on pasture involves less cash outlay for purchased feed than dry lot feeding, and replaces hay with pasture. Lamb gains are satisfactory although a little less than for lambs in dry lot. However we lost one or two lambs out of 20 or 25 of the early weaned-pasture group each year, for no apparent reason. If a small acreage of pure ladino clover pasture were available it would be excellent for this system.

System IV. Late Weaning - Finish Lambs in Dry Lot

1. Lamb January-March 15.

2. Turn ewes and lambs to pasture April 15-20 at rate of 2 ewes and their lambs per acre, with 1 cattle to 2 1/2-3 acres.

3. Wean lambs under 75 lbs. late May or early June. Sell heavy lambs; finish others, in dry lot, on full feed pelleted ration (no. 3) plus a little hay.

4. Graze ewes 6-10/acre until 2 weeks before breeding.

5. Expected lamb performance (late weaned) ADG .51 lbs./day, Choice + grade.

6. Feed cost, 100 lb. pellets, 15 lbs. hay, $3.85/head.

This system involves least outlay for purchased feed, yet permits large increases in sheep numbers on the average farm. In combination with cattle grazing, it effectively utilizes the spring pasture surplus and permits lightening the grazing load when pastures are less productive in midsummer. It seems highly practical and we are recommending it to our sheep producers.

System V. Grazing Ewes and Lambs (Not Weaned) on Separate Pastures

1. Lamb January-March 15.

2. At beginning of pasture season, graze ewes and lambs on separate pastures from 5:00 PM to 7:00 AM. Stocking rates, 6 ewes per acre, 12-16 lambs per acre.

3. Put ewes and lambs together during day (7:00 AM to 5:00 PM) in barns or dry lot (Burley tobacco barns are excellent).

4. Provide pelleted ration (no. 3) in creep for lambs while in barn, <u>but not while on pasture</u>.

5. Expected lamb performance - ADG 0.6 lb./day, top Choice to low Prime grade

6. Feed cost, 1.95 lbs. pellets/day; 115 lbs./lamb; $4.30

7. Little labor is required after about a week in separation of ewes from lambs. Cut them through a chute or through a gate. Man and a boy, or man and a dog, are sufficient.

System V. is not original with us. It was modified from a similar system in use at the Dixon Spring, Illinois, Station. They housed their lambs and ewes together at night. However most of the grazing by sheep in the summer is done between sundown and dark in the evening, and between daylight and 7-8:00 AM in the morning, so housing in the daytime seems more logical and fits better with normal working hours. A few acres of pure ladino clover for the lambs to graze would be ideal. This is an effective system and would permit large increases in sheep numbers on the average farm with only a little increase in labor and a modest feed cost per lamb. The principal barrier seems to be a psychological one, the largely imaginary concept of difficulty in the daily separation of lambs from ewes.

Lamb Pelleted Ration No. 3

Ground alfalfa or alfalfa-orchard grass hay, field cured	25.0%
Ground shelled yellow corn	55.1
Soybean oil meal 44%	13.0
Molasses	5.0
Ground limestone	1.0
Vitamin A-D-E Premix	0.9
	100.0

(2,000,000 I.U. Vit. A; 500,000 I.U. Vit. D;
35,000 I.U. Vit. E per ton feed)

This ration has developed over several years of experience with early weaning and confinement rearing. We now use it for all of our lambs, in creep feeding before weaning, for early weaned lambs reared in confinement, and for creep fed or early weaned lambs on pasture.

Economics of Intensive Lamb Production Systems

In any discussion of new production-management systems the question always arises "Will it pay?" While we do not have complete costings on these systems we can at least make some rough and ready "horseback" calculations that can be used for comparisons among the various systems.

Assumptions:

It is necessary to assume some values, costs and expected returns in order to compare the different systems. Feed requirements are based on experimental data over 6 to 10 years. The value of $16.00 for annual ewe cost, including replacement, was arrived at by G. A. Allen, Extension Sheep Specialist, and members of the Agricultural Economics Department. We are assuming a yearling beef steer will gain 275 lbs. during the summer grazing season and that the "put on" is worth $16.00 per cwt. or $44.00 return for the season. Ewes are to average 1 1/3 lambs; lambs to sell at an average weight of 95 lbs. at $25.00 cwt.; seven lbs. wool per ewe at 60 cents per lb., amounting to a gross return per ewe of $35.95. The pelleted lamb ration is valued at $75.00 per ton and alfalfa hay at $40.00.

I. CONVENTIONAL MANAGEMENT

1 Yearling Steer; 1 Ewe, 1 1/3 Lambs; 2 1/2 Acres Pasture

Returns:	
Steer, 275 lbs. put on, at $16.00	$44.00
1 1/3 Lambs at $23.75 per head	31.75
7 lb. wool at 60 cents	4.20
	79.95
Costs:	
Ewe cost	16.00
	63.95
Net Return per Acre Pasture:	$25.58

This is a very typical pattern of pasture stocking and management in the bluegrass areas of Virginia. It is based on the old rule of "one ewe - one cattle".

II. LATE WEANING-SELL HEAVY LAMBS JUNE 1
FINISH LIGHT LAMBS IN DRY LOT

1 Yearling Steer; 8 Ewes, 11 Lambs; 3 1/2 Acres Pasture

Returns:		
Steer, 275 lbs. put on, at $16.00		$44.00
11 lambs, 95 lbs. at $25.00		261.25
56 lbs. wool at 60 cents		33.60
		338.85
Costs:		
8 ewes at $16.00	$128.00	
Feed for 6 lambs at $3.85	23.10	
		151.10
Net Returns:		187.75
Return per Acre Pasture:		$53.64

This is a system we favor very much. It permits a fourfold increase in ewe numbers over the conventional system shown above, without much reduction in cattle numbers. It is well designed to utilize the early spring surplus of grazing, and to lighten the grazing load later in the season. It should more than double the return per acre of pasture.

III. EARLY WEANING LAMBS (APRIL 20)
FINISH LAMBS IN DRY LOT

1 Yearling Steer; 12 Ewes, 16 Lambs; 4 Acres Pasture

Returns:		
Steer, 275 lbs. put on, at $16.00		$44.00
16 lambs, 95 lbs. at $25.00		380.00
84 lbs. wool at 60 cents		50.40
		474.40
Costs:		
12 ewes at $16.00	$192.00	
Lamb feed 16 at $7.50	120.00	
		312.00
Net Returns:		162.40
Return per Acre Pasture:		$40.60

This system permits carrying 3 ewes per acre of pasture without much reduction in cattle numbers. It shows less return per acre of pasture than II above (late weaning). Faster gaining lambs, with consequent reduction in feed costs, would result in greater returns.

VERY EARLY WEANING (CONFINEMENT REARING OF LAMBS) REBREEDING EWES FOR MULTIPLE LAMBING

J. S. Copenhaver and R. C. Carter

The most intensive lamb production system studied over the past several years involves weaning the lambs at 30 to 40 days of age, rearing them to market weight on slotted floored pens, and rebreeding the ewes following weaning to raise an average of more than one lamb crop in a year's time.

Pilot Study

A pilot study of this system was carried out at Blacksburg, from 1962 through 1964, with a small group of four-year-old Western blackface crossbred ewes. These ewes raised five lamb crops during the trial. This test was considered very successful. The ewes averaged 2.8 lambs born and 2.5 lambs marketed per ewe year. The lambs were weaned at an average age of 37 days and an average weight of 35 lbs. Average daily gains of the lambs was 0.6 lb. per day from birth to an average market weight of 100 lbs., with an average market age of 152 days. Practically all the lambs graded Prime. The lambs were fed a complete pelleted ration containing 35% dehydrated alfalfa and 65% concentrates, with an average protein content of about 15%. Feed consumption averaged 3.3 lbs. per pound of gain and a total of 303 lbs. per lamb. Most of the ewes were rebred fairly soon after weaning with the exception of one year when the breeding season fell in April and May. Average interval between lambings was 220 days or a little over seven months.

Production Study

The success of the 1962-64 production study encouraged us to expand the project on a larger scale approaching a fair sized farm unit. This trial began in the fall of 1964 with 230 yearling ewes. Several problems were studied in this trial: (1) comparison of production and costs between the early weaning-multiple lambing system, and conventional management with ewes lambing once per year and nursing their lambs on pasture to market weight; (2) comparison of ewes of different breeds and breed crosses; (3) problems involved in keeping ewes in continuous confinement on dry feed; and (4) comparison of different seasons of breeding and lambing.

Results of the first three years, comparing early weaning-multiple lambing with conventional once-a-year lambing, are shown in table 1. These results are not nearly as favorable as those attained in the earlier study (1962-64). A number of problems arose that had not been experienced in the earlier pilot study, and some mistakes were made. These have now been corrected and the difficulties largely overcome. We feel that we now know most of the critical problems likely to be encountered in the early weaning system and that they can be, and in fact have been, solved. Results for the past two lamb crops, which are not included in table 1, are highly satisfactory, in fact the best by a substantial margin that we have had to date including the 1962-64 pilot study.

TABLE 1. PRODUCTION STUDY 1965-67
COMPARISON OF MANAGEMENT SYSTEMS

	Early Weaning Mult. Lambing	Conventional Control
Ewe Production:		
No. ewe years	321	74
Lambs born	525	108
Lambs marketed	434	93
Lambs born/ewe year	1.64	1.46
Lambs mktd./ewe year	1.35	1.26
Average Lamb Performance:		
Birth weight, lbs.	10.5	9.8
ADG birth-market	.53 lbs./day	.63
Av. Market age	163	139
Market weight, lbs.	93.0 lbs.	94.7
Market grade	14.3 (C+)	14.2(C+)

Part of the difficulty resulted from trying to force the ewes into two lambing seasons, six months apart. Initially half the ewes were bred for January and July lambing, and half to lamb in April and October. We have found that six months is just too short an interval between lambings. Not enough of the spring lambing ewes became rebred. We now feel that the practical objective is three lamb crops in two years, and that this can be achieved. The ewes bred to lamb in April and October did somewhat better than those in January and July. However the two groups have tended to move together in their lambing pattern and are now handled as one flock.

A partial explanation of the poorer lamb performance may be the fact that the test was started with all yearling ewes. These young ewes did not get their lambs off to a fast start before weaning as did the older ewes in the earlier test. Our experience has shown that it is quite important to have the lambs gaining rapidly before weaning at 30-40 days. It is important to get the lambs onto a highly palatable creep feed as early as possible.

Coccidiosis infection resulting in bloody scours, unthrifty lambs and some death losses, occurred in some of the early weaned lambs. It was brought under control by use of sulfaquinoxoline in the drinking water. Coccidia can always be found in lamb feces, the only interval parasite of any significance under the slotted floor system, but acute infection seems to occur only when the lambs are otherwise unthrifty. Perhaps we will have to follow the poultryman's practice of keeping medication in the drinking water.

Lamb Rations:

But the principal mistake we made was no doubt in changing the lamb ration. During the first part of this trial a mixed ground hay-grain ration (not pelleted), produced in our own mill, was used in an attempt to reduce cost. This ground ration was not as palatable as the pelleted ration previously used and daily consumption was lower, resulting in lower gains.

Some trouble was also experienced from mineral deficiency or unbalance. In the earlier pilot study defluorinated phosphate was added to the ration to provide a presumed proper calcium: phosphorous balance. Several wether lambs in this trial had urinary calculi (kidney stones). Mineral supplementation was left out of the ground hay-grain ration in hope of avoiding the urinary calculi problem. There was no occurrence of urinary calculi on this ration but several lambs showed severe calcium deficiency. This was no doubt part of the reason for the fairly unsatisfactory growth rate of lambs on this ration.

The ration we are now using, V.P.I. Lamb Ration No. 3, is shown below. It is pelleted which seems to be rather important. The use of home grown alfalfa-orchard grass hay, instead of the rather expensive dehydrated alfalfa meal, substantially reduces the cost. The addition of 1% ground limestone seems to have solved the calcium problem, and there has been no occurrence of kidney stones so far. The ration is very palatable and growth rate has been the highest we have had with early weaned lambs. We are using it both as a creep ration and as the sole ration following weaning. Protein content is 14-15%, depending on different batches of hay. A protein level of about 15% seems adequate for early weaned lambs based on other experiments at the Shenandoah Valley Station.

LAMB RATION NO. 3 (PELLETED)

Ground Alfalfa-Orchard Grass Hay	25.0%
Ground Yellow Corn	55.1
Soybean Oil Meal (44%)	13.0
Molasses	5.0
Ground Limestone	1.0
Vitamin A-D-E Premix	0.9
	100.0

(2,000,000 I.U. Vit. A; 500,000 I.U. Vit. D;
35,000 I.U. Vit. E, Ton Feed)

Very palatable, high consumption and rapid lamb gains. No urinary calculi, no calcium deficiency, no stiff lamb disease, so far.

Comparison of Ewes:

Table 2 shows the average performance of the four kinds of ewes used in the Production Study. The Suffolk x Rambouillet crossbred ewes have been the best producers, averaging about 0.2 lamb more marketed per year than either Dorset or Dorset x Rambouillet crosses. The Rambouillets have done poorest so far averaging about 2/3 of a lamb less than the Suffolk x Rambouillet crossbreds. There has been no large difference in growth rate of lambs from any of the ewe groups. Lambs from the Dorset ewes graded highest at market weight and those from Rambouillets lowest, the difference being about 1/3 of a grade.

There has been some trouble from mastitis and spoiled udders among the ewes weaned at 30-40 days. It has been worst in the Rambouillets and least in the Suffolk x Rambouillet crosses. This is a problem still to be solved under the early weaning system. Our present practice is to reduce feed to the ewes several days before weaning. This is apparently effective in reducing the milk flow, as indicated by increased consumption of creep feed by the lambs, but has not completely solved the udder trouble.

TABLE 2. PRODUCTION STUDY 1965-67
COMPARISON BREEDS-BREED CROSSES
EARLY WEANING - MULTIPLE LAMBING SYSTEM

	Dorset	Dor. x Ramb.	Ramb.	Suf. x Ramb.
No. ewe years	94	106	107	106
Lambs born) Per ewe	1.90	1.86	1.28	1.98
Lambs mktd.) yr.	1.55	1.58	1.11	1.75
Av. birth wt.	10.5	9.4	10.2	10.5
ADG, birth-mkt.	.48	.50	.51	.52
Av. Sl. Gr.	15.3 (P-)	14.7 (P-)	13.9 (C+)	14.4 (C+)

14 = Choice plus; 15 = Prime minus

Ewes in Confinement:

A group of 25 Suffolk x Rambouillet ewes are kept in confinement in a barn continuously and bred for January and July lambing with lambs weaned early. These are compared in table 3 with ewes of the same breeding and lambing at the same season, but which were run on pasture after their lambs were weaned. Ewes in confinement did better in terms of lambs born and lambs weaned at the January lambings than those on pasture, but much poorer at the July lambings. Not nearly as many became rebred following weaning of their spring lambs. It is evident that we still have much to learn about ewe nutrition and management under confinement.

TABLE 3. PRODUCTION STUDY 1965-67
EWES IN CONFINEMENT VS. EWES ON PASTURE (SUFF. x RAMB. ONLY)
EARLY WEANING - MULTIPLE LAMBING

	Jan. Lambing		July Lambing	
	Conf.	Past.	Conf.	Past.
Lambs born) Per ewe	1.40	1.31	.38	.72
Lambs raised) mated	1.34	1.09	.24	.66
Av. birth wt.	9.6	10.4	12.8	11.2
ADG, birth-wean.	.55	.56	.68	.62

Fall Lamb Crop of 1967:

After all the difficulties and disappointments experienced in the earlier years of the Production Study it is gratifying to be able to report that most of the problems seem to have been overcome, at least so far as lamb performance is concerned. This is shown by the results from the fall 1967 lamb crop, our best results to date. This group of lambs averaged 0.8 lb. gain from birth to weaning and .74 lb. from birth to marketing. Several lambs gained 1.0 lb. per day for their lifetime. These lambs averaged 97 lbs. market weight at an average age of 115 days and Prime in market grade. This was accomplished with an average feed consumption (including creep feed) of 243 lbs. pelleted Ration No. 3 per lamb, or 2.89 lbs. feed per pound of gain, our best feed conversion to date. Table 4 shows the average performance of these lambs in comparison with that of the lambs in the earlier pilot study of 1962-64, our best previous results.

TABLE 4. SUMMARY OF BEST RESULTS
EARLY WEANING - REARING ON SLOTTED FLOORS

	Fall Lamb Crop, '67	Pilot Test 1962-64
Birth weight	11.3	11.4 lbs.
Weaning weight	40.2	34.7 lbs.
Weaning age	38	37.2 days
ADG Birth-wean.	.80	.62 lbs./day
Wean.-market	.70	.59 "
Birth-market	.74	.60 "
Market weight	96.8	99.9 lbs.
Market age	115	152 days
Market grade	Prime	Prime -
Feed per lb. gain	2.89	3.38 lbs.
Feed per lamb	243	303 lbs.
Feed cost cwt. gain	$9.95	$12.68
Feed cost per lamb	$8.36	$11.36

Economic Considerations of Multiple Lambing Systems

In any discussion of Early Weaning - Multiple Lambing - Confinement Rearing systems, the question always arises "Can it be made to pay?" We have tried some rough "horseback" economic calculations to at least set some limits of costs and returns necessary for profitable operation.

Assumptions:

The figure of $16.00 for annual ewe cost was arrived at by George Allen, our Extension Sheep Specialist at V.P.I., working with some of our Agricultural Economics staff. It seems to be a reasonable value and is one we have used extensively. We are assuming an annual lamb production of 2.5 lambs per ewe year; a feed conversion of 3.25 lbs. feed per pound of gain, the feed to cost $75.00 per ton, or $10.31 per lamb; lambs to weigh 95 lbs. at marketing, and to sell at $25.00 per cwt.; 7 lbs. wool per ewe valued at 60 cents per pound.

(1) Using these values we arrive at the following:

Gross Return/Ewe Year		
2 1/2 lambs, 95 lbs. at $25.00/cwt., $23.75/lamb		$59.39
7 lbs. wool at 60 cents		4.20
		63.59
Costs		
Ewe Cost per Year	$16.00	
Lamb Feed	25.78	
		41.78
Return per Ewe Year		21.80

(2)	If we assume a lower feed conversion of 3.0 lbs., feed per pound of gain, feed cost per lamb is reduced to $9.56 and returns per ewe year is	23.68
(3)	If we average only 2 lambs per ewe year with other values the same as (1) above. Return per ewe year is	15.08
(4)	With 2 lambs per ewe year and cost per ewe $20.00 per year, other values the same as (1), return per ewe year reduced to	7.28

Conclusions:

Thus it would appear that for the system to be profitable, we must average more than 2 lambs per ewe year, and that ewe costs must be held to $16.00 per year or less. Feed conversion is of course important but 3 to 3 1/2 lbs. feed per pound of lamb gain seems reasonable and attainable. Each reduction of 1/4 lb. feed required per pound of gain would lower feed cost per lamb by about 75 cents and increase return per ewe by $1.50 to $2.25 depending on number of lambs she produces per year.

Problems and Recommendations
Early Weaning - Multiple Lambing Systems

The principal problems likely to be encountered in early weaning - confinement rearing and multiple lambing, based on our several years of experience, are listed below. Several of these problems need additional research to obtain the best solution, but we feel that enough is known now so that a workable management system can be put together that will permit successful and profitable operation of the program on commercial farms. Our present recommendations are shown in outline form below.

Principal Problems:

1. Young ewes may not provide their lambs with an adequate "head start" for early weaning.
2. Mineral content of lamb ration: to avoid urinary calculi - yet provide adequate mineral nutrition; Ca/P balance; Selenium content related to "stiff lamb disease".
3. Vitamin Requirements: Vitamin A - Vitamin D, Vitamin E related to "stiff lamb disease".
4. Mastitis and udder injury in ewes under early weaning.
5. Coccidiosis: always present, infection may become acute under stress.
6. Temperature and ventilation.
7. Feed requirements of ewes in confinement, quantitative and qualitative.
8. Sterile rams for off season breeding; use more than one per flock.

Recommendations:

I. Breed for 3 lamb crops in 2 years

	Breed	Lamb
1st Cycle	Aug.-Sept.	Jan.-Feb.
	Mar.-April	Aug.-Sept.
	Oct.-Nov.	Mar.-April
2nd Cycle	Aug.-Sept.	

....and repeat

II. Breeds of Ewes and Rams -

Ewes: Western Blackface (prefer Southwest)
Suffolk x Ramb. or Hamp. x Ramb.

Rams: 1st choice, Suffolk - lambs hearty at birth, fast growing, adequate fat cover at 95-100 lbs. under confinement rearing to grade Prime. Short fleece an advantage in hot weather.

2nd - Large, growthy Hampshire.
Hampshire sired lambs weighing 95 lbs. or above get too fat under confinement rearing on high energy rations.

III.
1. Lamb in lambing barn for convenience.
2. Transfer ewes and lambs to slotted floored pens at about 3 days, 12 sq. ft. per ewe and lamb.
3. Creep feed lambs pelleted ration (No. 3). Use heat lamp in creep in cold weather, plain bulb in warm weather.
4. Vaccinate lambs for "overeating disease" before weaning, and for sore mouth if it is a problem.

IV.
1. Wean at 4-6 weeks of age, 30 lbs. or heavier (weight probably more important than age).
2. Provide 6-8 sq. ft. floor space for weaned lambs.
3. Full feed pelleted ration No. 3 to lambs (silage OK in season).
4. Market at 95-100 lbs.

V. Ewe Feeding:

A. Winter Lambing Ewes -

1. Pasture alone as long as adequate.
2. After pasture season, 6 lbs. corn silage plus 1/4 lb. protein supplement or 3 lbs. mixed or legume hay.
3. Beginning one month before lambing add additional 1/2 lb. grain.
4. After lambing, full feed silage or hay (say, 6 lbs. silage or 3 lbs. hay), plus 1 1/2 lbs. grain, with sufficient protein. (We prefer to feed some hay, about 1 lb. per day, along with silage).

B. Summer or Fall Lambing Ewes -

1. Beginning one month before lambing, house ewes in barn during day and feed 1/2 - 3/4 lb. grain, no hay; turn back to pasture at night.
2. After lambing, same as above.

VI. Temperature and Ventilation:

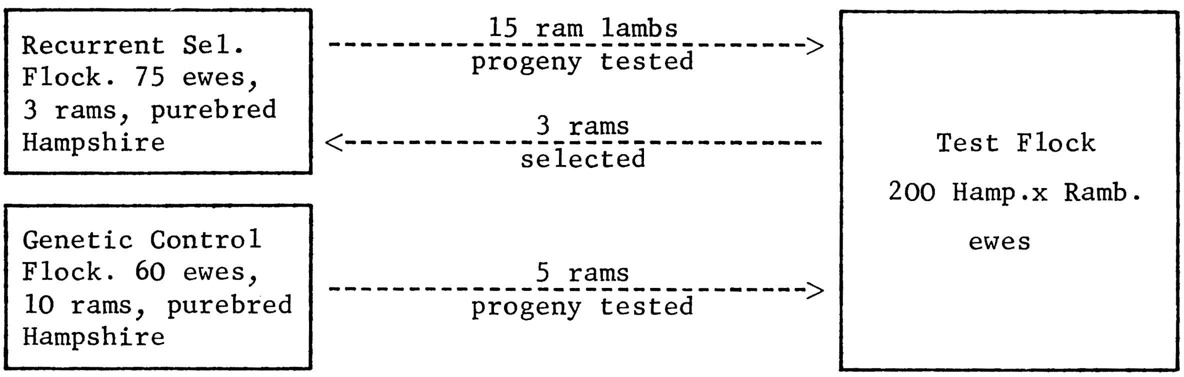
1. Tightly enclose space under slotted floors in winter. Lambs can stand quite low temperatures in open sheds if there is no under-floor draft.
2. Provide adequate ventilation in winter to control moisture and ammonia, but avoid direct drafts.
3. In summer maximum ventilation is necessary. Reflective roofs and high ceilings help control temperatures and provide ventilation.

RECURRENT SELECTION AS A BREEDING METHOD FOR IMPROVING GROWTH RATE IN SHEEP

R. C. Carter, W. H. McClure, J. S. Copenhaver and F. S. McClaugherty
(Contributing to Southern Regional Project S-29)

An experiment to evaluate the effectiveness of Recurrent Selection as a method for improvement of the breeding value for growth rate in Hampshire rams, has been underway since 1956. A flock of purebred Hampshires was assembled that year by purchases from a number of breeders, with as wide a range of geographic diversity as possible. Ewes and rams were obtained from flocks in California, Oregon, as well as from the Eastern United States, including a flock established on recent imports from England, and from already established flocks of the V.P.I. Animal Science Department. This flock, known as the recurrent selection flock, consists of 60 to 75 ewes and three rams.

Each year 15 ram lambs from the recurrent selection flock are progeny tested by breeding each to 10 ewes in a test flock of 200 Hampshire x Rambouillet crossbred ewes. These 15 rams are evaluated according to the average growth rate of their lambs from birth to market or weaning weight. The three rams whose progeny have the highest average growth rate are selected to go into the recurrent selection flock each year, replacing the three rams used the previous year. The diagram below shows the breeding scheme.



A genetic control flock, based on the same foundation stock as the recurrent selection flock is maintained without selection, as a base from which to measure progress made by recurrent selection. Each year five rams, produced in the genetic control flock, are also progeny tested along with the 15 recurrent selection rams. Comparison of the average growth rate of the lambs sired by the two groups of rams provides a measure of genetic improvement made in the selection flock.

Results

Progeny test comparisons were made between rams from the recurrent selection and genetic control flocks in 1963, 1965, 1966 and 1967. (No progeny test was carried out in 1964 owing to the replacement of the test flock with a group of young ewes from the same source as the original test flock). Average daily gains of the lambs, from birth to slaughter or to June 13, sired by each ram, and the ranks of the individual rams, are shown on the table on the opposite page.

In 1963 two genetic control rams, progeny tested with 12 rams from the recurrent selection flock, ranked 6th and 13th among the 14 rams tested. In 1965 the five genetic control rams ranked 5th, 9th, 17th, 19th and 20th. The genetic control rams in 1966 ranked 10th, 15th, 16th, 18th and 19th, among the 20 rams tested. In 1967 the two top genetic control rams ranked 5th and 6th, the others 11th, 18th and 20th.

These results are encouraging and indicate that real genetic progress is being made in improving the breeding value of the recurrent selection rams in transmitting rapid growth to their lambs.

AVERAGE DAILY GAINS[1] AND RANK OF PROGENIES RECURRENT SELECTION AND GENETIC CONTROL RAMS[2]

Rec. Sel. Rank	Rec. Sel. Prog. ADG	Gen. Cont. Rank	Gen. Cont. Prog. ADG	Rec. Sel. Rank	Rec. Sel. Prog. ADG	Gen. Cont. Rank	Gen. Cont. Prog. ADG
	1963				1965		
1st	.665			1st	.562		
2	.643			2	.556		
3	.632			3	.550		
4	.625			4	.546		
5	.622					5th	.538
		6th	.619	6	.533		
7	.616			7	.518		
8	.604			8	.515		
9	.600					9th	.515
10	.595			10	.511		
11	.592			11	.510		
12	.590			12	.509		
		13th	.562	13	.507		
14th	.556			14	.506		
				15	.492		
				16	.470		
						17th	.463
				18th	.462		
						19th	.456
						20th	.425
Av.	.62		.59		.52		.48
	1966				1967		
1st	.709			1st	.634		
2	.704			2	.624		
3	.669			3	.623		
4	.667			4	.620		
5	.666					5th	.619
6	.663					6th	.608
7	.654			7	.596		
8	.643			8	.593		
9	.642			9	.586		
		10th	.626	10	.583		
11	.625					11th	.580
12	.621			12	.578		
13	.617			13	.574		
14th	.611			14	.573		
		15th	.603	15	.571		
		16th	.598	16	.570		
17th	.596			17	.567		
		18th	.592			18th	.560
		19th	.549	19th	.559		
20th	.534					20th	.550
Av.	.64		.59		.59		.58

[1] 1963 and 1966, 1967 adjusted to single wether lamb; 1965 adjusted to twin ewe lamb.

[2] No progeny test in 1964

PERFORMANCE TESTING RAMS

W. H. McClure, G. A. Allen and U. E. Pfleiderer

The V.P.I. Agricultural Experiment Station and Extension Division, in cooperation with the Virginia Purebred Sheep Breeders Association, has completed a six-year period of ram performance feeding tests. These trials, conducted annually during the years 1962 through 1967, were designed in such a manner that certain selected yearling rams were subjected to a feeding test where management, feed and environment would be uniform. Since 1965 the feeding tests have been conducted by the Virginia Purebred Sheep Breeders Association.

In 1961 the purebred association requested the help of the Virginia Agricultural Experiment Station in setting up and carrying out a ram performance test. The Experiment Station felt that valuable research information could be gained from such a project, so it agreed to conduct the test on an actual cost basis. The test was initiated in 1962 at the Shenandoah Valley Research Station, Steeles Tavern.

Rams for the 1963, 1964, 1965, 1966 and 1967 tests were selected from flocks participating in a farm production testing program. To be eligible for nomination to the feeding tests, the lamb index of the ram was required to be in the top 50% of his flock. The rams were inspected for desirable type qualities and soundness by a committee of breeders and thoroughly checked by a veterinarian before admittance to the feed test.

In February of each year, rams approved for the feeding test were delivered to the test station. An adjustment period of two weeks was used during which time the rams were sheared, vaccinated and treated for internal parasites. In late February the official 84-day feeding test was started. The rams were penned according to weight and breed and self fed a ground ration of 50% ear corn, 20% peanut hulls, 25% legume-grass hay, 5% soybean oil meal, plus Vitamins A and D. The rams were weighed at two-week intervals during the test. The feeding test ended in late May, at which time the rams were sheared again and the ration reduced. Worm treatments were given at certain intervals as the need was indicated by fecal tests. Just prior to the sale, the rams were examined again by a veterinarian and fertility checked. The day before the sale they were given another inspection and graded by a committee from the Virginia Dept. of Agriculture on the basis of Fancy AA, Choice A, and Good G.

The feeding trial has provided information regarding practical procedures for testing young rams. The practice of selling unfitted, closely shorn rams that have been graded rather than evaluated in the show ring may become a popular and sound management procedure. The rams sold have been popular with the buyers, and information to date indicates that the performance of these rams has been quite satisfactory. The economic evaluation placed by the buyers on these rams in the last six years can be derived from the prices shown in table 1.

TABLE 1. NUMBERS OF RAMS SOLD AND AVERAGE ANNUAL PRICES

Year	No. of Rams	Price	Chev.	Dor.	Hamp.	South.	Suff.
1962	51	85.78		5	34	8	4
1963	64	89.73	4	5	35	11	9
1964	71	94.44		7	43	12	9
1965	63	102.62		5	34	10	14
1966	84	112.20		11	44	4	25
1967	104	120.00		22	55	2	25

TABLE 2. AVERAGE DAILY GAIN (POUNDS)

Breed	1962	1963	1964	1965	1966	1967	Av.
Cheviot		.52					.52
Dorset	.53	.52	.60	.57	.60	.44	.52
Hampshire	.60	.60	.68	.72	.71	.61	.65
Southdown	.48	.47	.44	.52	.53	.65	.49
Suffolk	.74	.75	.88	.87	.77	.81	.81

The average daily gain for each breed for the six-year period is shown in table 2 above. As expected, average daily gain ranked the same as breed size.

Table 3 contains beginning and ending weights, and in some cases, 16-months weight. Beginning weights of the Dorset, Hampshire and Suffolk rams were lighter the first two years than they were the last four.

TABLE 3. RAM WEIGHTS, BEGINNING AND END OF TEST AND 16 MONTH WEIGHT (POUNDS)

Year:	1962	1963	1964	1965	1966	1967	Ave.
	Ram Weights						
DORSET:							
Beginning	136	127	147	150	140	149	142
End	181	174	191	202	191	185	187
16 Month Wt.		157			181	171	170
HAMPSHIRE:							
Beginning	148	148	171	161	160	161	158
End	199	202	221	227	219	212	213
16 Month Wt.	181	191	216	220	212	206	204
SOUTHDOWN:							
Beginning	112	108	123	111	113	106	112
End	153	150	157	158	157	160	156
SUFFOLK:							
Beginning	137	130	160	171	176	164	156
End	201	198	225	250	242	233	225
16 Month Wt.		204		252	247	235	234

TABLE 4. CHANGE IN PRICE PER UNIT (1/3 GRADE) INCREASE IN GRADE, 1967

Breed	Change of Grade (1/3 Grade)	Change in Price 1967 $	Change in Price 1962-67 $
Dorset	1	34.06	27.36
Hampshire	1	24.80	21.42
Suffolk	1	56.41	41.02
Southdown	1		9.17

TABLE 5. CHANGE IN PRICE PER TEN POUND UNIT INCREASE IN 16 MONTH WEIGHT

Breed	Change in Price 1967 $	Change in Price 1962-67 $
Dorset	13.27	10.16
Hampshire	8.94	7.21
Suffolk	23.40	13.33
Southdown		8.18

Tables 4 and 5 reflect the fact that the buyers gave rather strong emphasis to the type scores of the rams. They paid about as much for 1/3 grade increase in type score as they did for 30 pounds increase in 16-months weight.

EVALUATION OF RAM PERFORMANCE TESTING THROUGH PROGENY TESTING

U. E. Pfleiderer, R. C. Carter and W. H. McClure

Some measure of value of yearling performance testing of rams, discussed in the preceding article (pages 73 - 75), may be had by comparing the growth rates of lambs sired by rams that had gone through the performance test. Each year from 12 to 20 Hampshire ram lambs, produced in the Recurrent Selection project (see page 70), were progeny tested by breeding them to 10 ewes each in a test flock at the Steeles Tavern Station. Since 1962 most of these rams were also entered in the Virginia Purebred Sheep Breeders Assn. Performance Test.

The lambs sired by these rams were all raised at the Steeles Tavern Station under uniform conditions. In the three earlier years, 1962-64, the lambs nursed their mothers on permanent bluegrass white clover pastures, without creep feed, until marketed at weights of 90-100 lbs. Since 1965 (through 1967) the lambs were weaned at about 60 days of age weighing around 45 to 60 lbs. and finished to market weight in confinement on slotted floored pens with a full feed of a pelleted complete ration. This early weaning and feeding in confinement of the lambs was designed to reduce the variability in lamb growth rate, due to ewe difference and to competition between twins, and thus permit a more accurate evaluation of the rams' breeding value for transmitted growth rate. Because of this difference in feeding and management the ram performance - progeny comparisons are shown separately for each of the three year periods.

Results

Table 1 shows the 120-day weights, average daily gain on yearling test and 16 month weights of the rams, and the average daily gain of the lambs sired by them in the progeny test.

TABLE 1. MEANS AND VARIANCES OF 120-DAY WEIGHT, ADG ON YEARLING TEST AND 16 MONTHS WEIGHT OF THE RAMS AND THE ADG OF THEIR OFFSPRING IN THE TEST FLOCK[1]

Years	No. of Rams	120-Day Wt. lbs.		ADG on Yr. Test lbs.		16 Mo. Wt. lbs.		ADG of Offspr. lbs.	
		$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
1962-64	26	95.2	14.8	.661	.097	200.6	16.6	.583	.032
1965-67	34	109.6	13.4	.671	.138	208.8	17.6	.575	.031
1962-67	60	102.8	14.1	.666	.120	205.0	17.1	.578	.032

[1] 120-day wt. of the rams and ADG of the offspring are adjusted for differences in sex and type of birth.

The genetic correlations between the performance of the rams on yearling feeding test, and the daily gains of their offspring from birth to market weight of 90-100 lbs., are shown in table 2. For the years 1962-64, when the lambs were not weaned, the correlation between the lambs' growth rate and their sire's performance test record was essentially zero. In the three later years however, when the lambs were early weaned, the correlations were positive, .09 between lambs' growth rate and sires' ADG on test, and .29 with the sires' 16 month weight.

TABLE 2. CORRELATION (GENETIC) BETWEEN THE DAILY GAIN ON TEST AND 16 MONTHS WEIGHT OF THE RAMS AND AVERAGE DAILY GAIN FROM BIRTH TO MARKET WEIGHT OF THEIR LAMBS

1962-64:	
Lambs Daily Gain with Sires ADG on Test:	-.00
Lambs Daily Gain with Sires 16 Month Wt.:	-.03
1965-67:	
Lambs Daily Gain with Sires ADG on Test:	.09
Lambs Daily Gain with Sires 16 Month Wt.:	.29

From these results it is concluded that the 16 months weight of a ram has a moderate selective value in predicting the growth rate of his offspring. Daily gain of the rams on an 84-day yearling performance test is probably of less value than 16 months weight.

The higher correlation between the rams' test performance and their progeny's growth rate, during 1965-67, when the lambs were early weaned, shows clearly that most of the variation in preweaning growth rates of lambs is due to variation in the ewes' milking ability, and to competition between twins. Earlier work at V.P.I. has shown little relationship between the preweaning growth rate of a ram and that of his progeny. Some postweaning performance testing of the ram seems necessary to evaluate his breeding value to transmit rapid growth to his offspring.

Heritability of Yearling Growth Rate and 16 Months Weight:

To further evaluate the relative importance of daily gain on yearling test and 16 months weight of rams, estimates of heritability were made of these two traits. Only records on Hampshire rams were used. Useful records were available on 158 Hampshire rams in 46 sire progenies, consigned to the performance test by private breeders, and from 62 rams by 17 sires entered in the test by the Experiment Station. These estimates are shown in table 3.

TABLE 3. HERITABILITY ESTIMATES

	Breeder's Rams	Station Rams
ADG - Yearling Test	.25	.13
16-Months Weight	.65	.48

This again suggests that the 16-months weight is perhaps a better measure of a ram's genetic potential for growth than daily gain on an 84-day yearling performance test.

THE REPLACEMENT VALUE OF PEANUT MEAL IN CORN-SOYBEAN MEAL RATIONS FOR GROWING PIGS

E. T. Kornegay, T. N. Meacham and H. R. Thomas

Peanut meal is known to be deficient in lysine when used as the only protein supplement in formulating swine rations. Previous work has shown that lysine supplementation (0.3 to 0.6%) of corn-peanut meal rations improved gain to almost that obtained with corn-soybean rations.

It has also been reported that approximately 50% of the soybean meal could be replaced by peanut meal in rations for growing pigs and that 75 to 100% of the soybean meal could be replaced by peanut meal in rations for finishing pigs.

Although it appears clear that lysine improves the gain of pigs fed corn-peanut meal ration and that finishing pigs perform better than growing pigs on rations containing a high portion of the protein supplement as peanut meal, the amount of peanut meal that can be used in grower and finisher rations has not been precisely determined. The objective of this trial was to determine the proportion of peanut and soybean meals that can be recommended for swine grower rations.

Experimental Procedure

One hundred and eight crossbred growing pigs were allotted to three weight classes (55, 66 and 74 lb.). Within each weight class the pigs were randomly assigned to six groups. Six treatments, zero, 15, 30, 45, 60 and 100% of crude protein from soybean meal replaced by peanut meal, were randomly assigned to groups in each weight class. Composition of rations is given in table 1. Rations containing 16% crude protein were fed until the pigs weighed 100 pounds, then the crude protein was reduced to 13% for the remainder of the trial. Pigs were housed in concrete floored pens in an enclosed feeding barn equipped with automatic waterers and self-feeders. Feed consumption and body weight was taken either weekly or every two weeks. The length of the trial was six weeks.

Results

Average daily gain, feed intake and feed efficiency were unchanged when 15 and 30% of the soybean meal protein was replaced by peanut meal protein (table 2). The substitution of 45, 60 and 100% of the soybean meal with peanut meal resulted in a depression of average gain, feed intake and feed efficiency with the greatest effect when 100% of the soybean meal was replaced. With all criteria, the differences were significant ($P<0.01$) when 100% of the soybean meal was replaced with peanut meal. Further, average daily gains were significantly different ($P<0.01$) at 45 and 60% replacement of soybean meal with peanut meal.

TABLE 1. COMPOSITION OF DIETS FOR PEANUT MEAL STUDY USING 45% PEANUT MEAL

Ingredients	Diets					
	1	2	3	4	5	6
SBM[1],%	100	85	70	55	40	0
PNM[1],%	0	15	30	45	60	100
Phase 1 (16% crude protein)						
Gr. yellow corn (8.9%)	79.4	79.0	78.7	78.3	77.7	76.7
Soybean meal (50%)	17.8	15.2	12.4	9.8	7.2	----
Peanut meal (44%)	----	3.0	6.1	9.1	12.3	20.5
Defluor. phosphate	1.5	1.5	1.5	1.5	1.5	1.5
Limestone	0.4	0.4	0.4	0.4	0.4	0.4
Salt[2]	0.5	0.5	0.5	0.5	0.5	0.5
Vit. premix[3]	0.4	0.4	0.4	0.4	0.4	0.4
$ZnSo_4$, gm.	(10)	(10)	(10)	(10)	(10)	(10)
$CuSo_4$, gm.	(0.6)	(0.6)	(0.6)	(0.6)	(0.6)	(0.6)
Antibiotic						
Calculated Lysine %	0.74	0.71	0.66	0.61	0.57	0.47
Phase 2 (13% crude protein)						
Gr. yellow corn (8.9%)	86.6	86.4	86.2	86.0	85.8	85.1
Soybean meal (50%)	10.6	9.0	7.4	5.8	4.3	----
Peanut meal (44%)	----	1.8	3.6	5.4	7.1	12.1
Defluor. phosphate	1.7	1.7	1.7	1.7	1.7	1.7
Salt[2]	0.5	0.5	0.5	0.5	0.5	0.5
Vit. premix[3]	0.4	0.4	0.4	0.4	0.4	0.4
$ZnSo_4$, gm.	(10)	(10)	(10)	(10)	(10)	(10)
$CuSo_4$, gm.	(0.6)	(0.6)	(0.6)	(0.6)	(0.6)	(0.6)
Antibiotic						
Calculated Lysine %	0.52	0.50	0.47	0.45	0.43	0.36

[1]Percent crude protein from the respective supplement.

[2]Contained (%): 0.2 Mn, 0.16 Fe, 0.033 Cu, 0.01 Co, 0.007 I, 0.005 Zn, 99.5 NaCl.

[3]Contained: 0.4 gm. riboflavin, 1.0 gm. pantothenic acid, 20.0 gm. choline chloride, 4.0 gm. niacin, 3.2 mg. vitamin B_{12}, 6,000,000 I.U. Vitamin A, and 200,000 I.C. Vitamin D per pound of premix.

[4]As needed - replace corn.

The calculated level of lysine for diet 3 (30% peanut meal) was 0.66 and 0.47 respectively for the 16% and 13% crude protein diets which is comparable to the requirement as suggested by Becker and co-workers at the University of Illinois.

Summary

As much as 30% of the soybean meal protein in corn-soybean meal rations may be replaced with peanut meal protein without reducing feed intake, rate and efficiency of gain of growing pigs.

TABLE 2. FEED INTAKE, RATE AND EFFICIENCY OF GAIN OF GROWING PIGS FED VARYING AMOUNTS OF PEANUT MEAL SUBSTITUTED FOR SOYBEAN MEAL

	Diets[a]					
	1	2	3	4	5	6
Soybean meal, %	100	85	70	55	40	0
Peanut meal, %	0	15	30	45	60	100
Av. daily gain, lb.	1.50[b]	1.51[b]	1.52[b]	1.30[c]	1.23[c]	.86[d]
Av. daily feed intake, lb.	4.56[b]	4.42[b]	4.68[b]	4.25[b]	4.25[b]	3.39[c]
Feed per lb. of gain, lb.	3.04[b]	3.07[b]	3.08[b]	3.25[b]	3.52[b]	4.15[c]

[a]Eighteen pigs initially per treatment. Three replicates of 6 pigs each averaging 55, 66 and 74 lb. Seven pigs were removed during the experiment due to unrelated causes: Diet 2, 1 pig; diet 3, 1 pig; diet 5, 2 pigs and diet 6, 3 pigs.

[bcd]Values on the same line with different superscripts differ significantly ($P<0.01$).

UTILIZATION OF UREA BY THE GROWING-FINISHING HOG

T. N. Meacham, H. R. Thomas and W. E. Horsley, Jr.

Feed represents approximately 80% of the cost in producing a market hog. One of the principal cost ingredients in the ration is the protein supplement. Significant savings could be made in feed costs if a cheaper source of protein could be devised. Urea and other non-protein nitrogen sources have been used extensively in ruminant feeding. The limited information available on the use of urea by swine is conflicting. This study was conducted to investigate the use of urea as a substitute for part of the ration protein for growing-finishing swine. The differential use of urea by pigs early in the feeding period as compared to the final phases was also evaluated.

Procedure

Trial I:

Fifty-six crossbred feeder pigs averaging approximately 60 lbs. were allotted by weight to eight groups of five pigs each. Two groups were assigned to each of the four experimental rations at random. Ration 1 was composed of a standard corn-soybean meal growing ration, containing 15% protein and served as the basal. Ration 2 was the negative control and contained 10% less total protein than the basal. Ration 3 was the same as ration 2 with urea added to produce a 15% total protein ration. Ration 4 was identical to ration 1 initially. When the pigs receiving ration 4 reached 125 lbs. live weight, ration 4 was replaced with ration 3. This was done to evaluate urea utilization during the last phase of the finishing period.

All rations were adjusted to a 13% protein basis when the pigs reached 125 lbs. Ration 2 contained 11.7% total protein during this phase.

The pigs were self-fed the rations on concrete in an enclosed building. Live weights were taken at two-week intervals and the hogs were marketed when their respective pens averaged approximately 200 lbs.

Trial II:

Sixty crossbred feeder pigs averaging 49 lbs. were allotted by weight into three outcome groups averaging 39, 48 and 60 lbs., respectively. The pigs in each outcome group were assigned at random to the four experimental rations. This provided a pen of five pigs from each weight group on each of the four rations. The experimental rations were similar to those used in trial I. The total protein level in the basal was 16% initially and then reduced to 14% at 75 lbs. and to 12% at 125 lbs. live weight.

Weighing and feeding procedures were the same as in trial I.

Trial III:

Forty crossbred feeder pigs averaging 48 lbs. were allotted by weight to eight lots of five pigs each. Two lots were randomly assigned to four experimental rations. The experimental rations and protein levels used were similar to those fed in trial II. Management procedures were the same as in the previous trials.

Trial IV:

In trial IV, the experimental approach was changed and four iso-nitrogenous rations containing 0, 10, 20 and 30% of the ration protein as urea were fed. Two groups of six pigs each received each ration. One group averaging 64 lbs. (heavy) and the other 48 lbs. (light) were assigned at random to the four rations. A 16% crude protein ration was fed to 75 lbs. live weight, 14% ration to 125 lbs. and a 12% crude protein ration to the end of the feeding period. The hogs were removed as they passed 180 lbs. live weight. Body weight gains and feed efficiency were determined weekly. The rations were self-fed from metal feeders.

At the end of the feeding period a portion of the hogs from each ration group were slaughtered. Carcass length, backfat thickness, loin-eye area, percent ham and loin and percent yield values were determined. From rations 1, 2, 3 and 4, carcass data were obtained from seven, four, six and one animal, respectively.

Results

Trial I:

The average daily gain (ADG) and feed per pound of gain data are shown in table 1. Up to 125 lbs. live weight there was a slight advantage in ADG for the basal groups as compared to the urea fed group which in turn gained somewhat faster than the negative control. This tended to indicate that some urea was being utilized. The ADG after 125 lbs., however, was definitely in favor of the basal group, 1.53 lbs., compared to around 1.39 for the other three groups. When the gains are examined over the entire trial, there appears to be little difference among those pigs receiving the negative control ration, urea throughout or urea after 125 lbs. There was, however, considerable variation between the two replications within a ration group which tended to mask a definite trend or pattern.

Up to 125 lbs. live weight, the feed required per pound of gain was lower for the basal groups, followed by the urea fed groups and was highest for the negative controls. After 125 lbs., the pattern changed somewhat with the ration 1 groups the lowest, followed by rations 2 and 4. Ration 3 groups required the greatest amount of feed. Overall averages for the entire trial were not too different. Ration 1 continued to have the lowest requirement with little differences among the other three ration groups.

TABLE 1. AVERAGE DAILY GAIN AND FEED EFFICIENCY - TRIAL I (POUNDS)

	Rations			
	1 Basal	2 Negative control	3 Urea	4 Basal/[a] urea
No. of pigs per ration[b]	10	10	10	10
Av. daily gain to 125 lbs.				
Repl. 1	1.35	1.14	1.14	1.18
2	1.29	1.13	1.25	1.32
Av.	1.32	1.14	1.20	1.25
Av. daily gain after 125 lbs.				
Repl. 1	1.37	1.39	1.20	1.29
2	1.70	1.38	1.60	1.48
Av.	1.53	1.39	1.40	1.38
Overall mean	1.42	1.27	1.30	1.31
Feed efficiency (feed/lb. of gain) to 125 lbs.				
Repl. 1	3.37	3.94	3.64	3.46
2	3.28	3.44	3.35	3.17
Av.	3.32	3.69	3.50	3.32
Feed efficiency (feed/lb. of gain) after 125 lbs.				
Repl. 1	4.28	4.46	4.35	4.54
2	3.92	4.20	4.55	4.09
Av.	4.10	4.33	4.45	4.32
Overall mean	3.71	4.01	3.97	3.82

[a]Ration 4 is the basal up to 125 lbs. live weight. After pigs average 125 lbs., the urea ration (ration 3) is fed to 200 lbs.
[b]There were two replicates of five pigs each on each ration.

Trial II:

The performance data for trial II are shown in table 2. The basal group had the highest ADG to 125 lbs. The urea ration (ration 3) and the ration 4 (basal) groups were similar, but below the ration 1 group. The negative control group had the lowest gains to this point. At the end of the trial, the basal and the urea ration had the fastest overall gain, 1.65 lbs./day. The negative control group was considerably below with an ADG figure of 1.46 lbs. The rapid gains of the replicates on ration 3 during the final period brought the gains for this ration up equal to the basal (ration 1). Ration 4 pigs were intermediate in gains. The basal groups were consistently more efficient throughout the trial; however, there was not a great deal of difference among the four ration groups, particularly rations 2, 3 and 4.

The results of trial II indicate that the pigs were utilizing urea, but not too efficiently. Comparing ration groups 2 and 3 points out the use made of the added nitrogen from urea. These findings are in general agreement with trial I. The overall performance in trial II was better, but the pattern among the ration groups was similar.

TABLE 2. AVERAGE DAILY GAIN AND FEED EFFICIENCY - TRIAL II (POUNDS)

	Rations			
	1 Basal	2 Negative control	3 Urea	4 Basal/[a] urea
No. of pigs per ration[b]	18	18	18	18
Av. daily gain to 125 lbs.				
Repl. 1 (39)[c]	1.61	1.41	1.49	1.48
2 (48)	1.41	1.32	1.29	1.36
3 (60)	1.47	1.20	1.37	1.30
Av.	1.50	1.31	1.38	1.38
Av. daily gain after 125 lbs.				
Repl. 1	1.82	1.65	1.78	1.86
2	1.66	1.70	1.99	1.70
3	1.89	1.48	1.99	1.60
Av.	1.79	1.61	1.92	1.72
Overall mean	1.65	1.46	1.65	1.55
Feed efficiency (feed/lb. of gain) to 125 lbs.				
Repl. 1	3.42	3.99	3.46	4.10
2	2.91	3.33	4.05	3.09
3	2.87	3.14	3.07	3.09
Av.	3.07	3.49	3.53	3.43
Feed efficiency (feed/lb. of gain) after 125 lbs.				
Repl. 1	4.03	4.03	3.87	3.87
2	4.00	3.90	3.71	3.95
3	3.95	3.94	4.19	4.09
Av.	3.99	3.96	3.93	3.95
Overall mean	3.53	3.72	3.73	3.69

[a]Ration 4 is the basal to 125 lbs. live weight. After pigs average 125 lbs., the urea ration (ration 3) is fed to 200 lbs.
[b]There were three replicates of six pigs each on each ration.
[c]No. in parenthesis is the initial weight of the replicate groups.

Trial III:

The results in trial III (table 3) were quite disappointing. In this trial, urea was definitely not being utilized and actually may have been depressing the performance of the pigs. Up to 125 lbs. the basal groups (rations 1 and 4) made excellent gains and were quite efficient. The urea group (ration 3) gained considerably slower and took an additional pound of feed per pound of gain. The negative control group was also below the basals, but had a higher ADG and lower feed per pound of gain figure than the urea (ration 3) group. Again comparing rations 2 and 3, it appears that urea was depressing gains whereas in trials I and II, the opposite seems to be the case.

TABLE 3. AVERAGE DAILY GAIN AND FEED EFFICIENCY - TRIAL III (POUNDS)

	Rations			
	1 Basal	2 Negative control	3 Urea	4 Basal/urea[a]
No. of pigs per ration[b]	10	10	10	10
Av. daily gain to 125 lbs.				
Repl. 1 (47)[c]	1.72	1.35	1.43	1.53
2 (48)	1.68	1.48	1.22	1.80
Av.	1.70	1.41	1.32	1.66
Av. daily gain after 125 lbs.				
Repl. 1	1.51	1.57	1.26	1.42
2	1.51	1.50	1.28	1.49
Av.	1.51	1.53	1.27	1.45
Overall mean	1.61	1.47	1.30	1.55
Feed efficiency (feed/lb. of gain) to 125 lbs.				
Repl. 1	2.66	3.12	3.99	2.86
2	2.80	3.13	3.65	2.76
Av.	2.73	3.12	3.82	2.81
Feed efficiency (feed/lb. of gain) after 125 lbs.				
Repl. 1	3.86	4.46	6.08	4.54
2	4.12	4.49	4.91	4.39
Av.	3.99	4.47	5.45	4.47
Overall mean	3.36	3.80	4.63	3.64

[a]Ration 4 is the basal ration to 125 lbs. live weight. After pigs average 125 lbs., the urea ration (ration 3) is fed to 200 lbs.
[b]There were two replicates of five pigs each on each ration.
[c]Average weight in pounds of each replicate initially.

After 125 lbs. the performance in all four ration groups is reduced. This was due in part to a mild pneumonia outbreak in all the pens. The basal groups and ration 4 groups were affected more noticeably. Nevertheless, the pattern remained the same with the ration 3 pigs having the poorest performance and the basal groups the best performance. The negative control (ration 2) and the ration 4 pigs were somewhat similar during the 125 to 200 lb. period.

Trial IV:

The results of trial IV (table 4) indicate a linear and negative response in ADG to increasing levels of urea in the ration. The control group (ration 1) had the highest ADG and the 30% urea protein (ration 4) the lowest. The light weight lot on ration 3, however, gained at about the same rate as the light weight lot on ration 2. The heavy lots on these rations however followed the overall linear pattern. The feed required per pound of gain followed the same general trend. As the percentage of the ration protein from urea increased, the feed per pound of gain increased. Again, the light weight lots on rations 2 and 3 reversed this pattern as they did with the ADG values. The feed intake of the group 2 (10% urea nitrogen) pigs was somewhat greater which increased the feed per pound of gain figures for this group.

The carcass data indicate the same overall pattern as the performance data. The 30% urea nitrogen group is represented by only one animal which makes any comparison questionable as far as this group is concerned. Only one animal that could be slaughtered in this group reached slaughter weight when the trial was terminated. Ration groups 2 and 3, however, can be compared with the control group. Backfat thickness increased as the percentage of urea in the ration increased. Loin eye area decreased as the urea level increased. There was a similar drop in ham and loin percentage also. There was no apparent effect on percent yield or carcass length due to the level of urea in the ration.

Conclusions

In trials I and II, it appeared that urea was being utilized to a limited extent by the growing-finishing pig. In trials III and IV this did not seem to be the case; in fact, urea appeared to have a depressing effect on ADG and feed efficiency in trial III.

In trial IV, a linear and negative response in ADG and feed efficiency was obtained as the level of urea in the ration was increased. When 10 and 20 percent of the ration protein is supplied as urea, there is a moderate depression in performance, but there is a marked effect when 30% of the protein is from urea. The performance on 10 and 20% urea protein is fairly similar.

Backfat thickness, loin eye area and percent ham and loin on the carcass values are adversely affected by the addition of urea. Carcass length and percent yield are not affected.

TABLE 4. AVERAGE DAILY GAIN, FEED EFFICIENCY AND CARCASS DATA OF HOGS FED VARYING LEVELS OF UREA - TRIAL IV (POUNDS)

	Rations			
	1	2	3	4
% protein from urea	0	10	20	30
No. of pigs per ration[a]	12	12	12	12
Av. daily gain				
Heavy (64)[b]	1.36	1.49	1.23	0.90
Light (48)	1.44	1.23	1.26	0.60
Av.	1.40	1.36	1.24	0.75
Feed efficiency				
Heavy	3.44	3.62	3.93	4.72
Light	3.10	3.99	3.75	4.93
Av.	3.27	3.81	3.84	4.82
Carcass Data				
No. of hogs measured	7	4	6	1
Backfat thickness, inches	1.17	1.3	1.3	1.4
Loin eye area, sq. in.	4.98	4.39	4.05	2.94
% ham and loin	38.77	36.15	36.18	34.99
% yield	75.7	76.5	75.8	75.0
Carcass length	28.8	28.4	28.8	28.8
Slaughter weight	184	181	186	184

[a]Number of pigs indicated represents six in the light and six in the heavy group for each ration.
[b]Initial weights for each group.

CONFINEMENT VS. OPEN LOT ENVIRONMENTS ON REPRODUCTIVE PERFORMANCE AND BLOOD COMPONENTS OF SOWS

F. B. Masincupp and T. N. Meacham

As the economic pressure of high labor costs and the need for greater efficiency forces the swine producer toward complete confinement of his breeding animals, knowledge of the influence of this environment on reproduction becomes critical. Confinement may demand drastic changes in brood sow management. This study was initiated in the summer of 1966 to determine if females reared and maintained in complete confinement on concrete had a reproductive efficiency similar to those managed conventionally in open lots.

Procedures

Groups I-O and I-C:

Twelve crossbred Yorkshire x Hampshire gilts were allotted at 56 days of age to two treatment groups according to litters in August of 1966. One group was placed in a large open lot (group I-O) and the other confined on a concrete floor or concrete slats (group I-C). Both groups were self-fed until they weighed 150 lbs. and limited fed thereafter to control growth. Feed intake was regulated so that the gilts in each group grew at approximately the same rate.

The gilts were checked daily for estrus to evaluate the effect of rearing environment on puberty and also to determine if the environment influenced the physical condition and health of the gilts.

All gilts were hand mated at the second and third estrus after puberty. Farrowing data were collected on each litter and summarized by groups and treatments.

The gilts in each treatment group were bled periodically during their first gestation and lactation cycle. Blood samples were taken at the following times during the cycle: (1) estrus, (2) 30th day of gestation, (3) 60th day of gestation, (4) 90th day of gestation, (5) after 48 hours of confinement in farrowing crate, (6) 14th day of lactation, (7) 21st day of lactation, and (8) 2 days after litter was weaned. Estimations of blood glucose, sedimentation rate, hematocrit and adrenal corticosterone levels were to be made on each sample.

All litters were weaned at 28 days of age and weaning weights were obtained for each litter and the percentage of pigs farrowed that were weaned calculated for each treatment group.

After weaning, the sows were returned to their respective environments and rebred at the first estrus post weaning. The interval from weaning to estrus was determined in each case. The sows will continue under this program for four reproductive cycles.

Groups II-O and II-C:

Fourteen Yorkshire x Hampshire gilts farrowed in August and September, 1966, were allotted to the same two environmental treatments. The same experimental procedures used for groups I-O and I-C were employed for groups II-O and II-C.

Results

The effect of rearing environment on age at puberty and on farrowing and litter performance is shown in table 1. The average age at first estrus of the I-O and II-O (open lot) and the I-C and II-C (confinement) gilts showed that the I-O gilts reached puberty about 16 days earlier than the I-C gilts. This difference was consistent for both groups I and II.

Only five of the six gilts in the I-C group farrowed as one gilt failed to settle. She was due to farrow on July 4, 1967, but was found to be in heat that day. She had shown no signs of estrus from breeding until her expected farrowing date. Three of the gilts in group II-C did not farrow. Upon autopsy it was found that one had cystic ovaries, another had a congenital defect of the reproductive tract, and the third failed to settle for unknown reasons. All of the gilts in the I-O and II-O groups were bred and all farrowed.

In the first farrowing performance of the sows, the most appreciable differences were in number of pigs farrowed per litter; 8.9 vs. 10.0; average weaning weight, 15.0 vs. 16.2; and percent weaned, 76.5 vs. 66.0 for confinement and open lot groups, respectively. Two litters of 6 and 10 pigs were lost at birth in group I-O which accounted for the large difference in weaning percent.

After farrowing, another sow in group I-C was lost due to a broken leg and still another has not returned to estrus since farrowing. One sow in group II-C has returned to estrus but has failed to settle. Three sows in group I-O have been lost since farrowing their first litters, two due to broken legs and one due to septacemea. One sow in group II-O has failed to settle. It was observed that this sow became extremely wild right after farrowing.

The interval from weaning to estrus clearly showed that the open lot reared gilts (I-O and II-O) returned to estrus quicker and more uniformly than did the confinement gilts. However, the extremely long interval for the I-C group can be attributed to two gilts in the group which took 174 and 141 days, respectively, to return to heat after weaning their first litters. The interval for group II-C was still more than twice that of II-O.

TABLE 1. EFFECT OF TWO ENVIRONMENTS ON REPRODUCTIVE PERFORMANCE OF SOWS

	Confinement			Open Lot		
Groups	I-C	II-C	Ave.	I-O	II-O	Ave.
No. gilts initially	6	7	13	6	7	13
Age at first heat, days	236	232	234	223	214	218
First litter performance-No. sows	5	4	9	6	7	13
No. pigs farrowed/litter	10.6	7.2	8.9	9.2	10.7	10.0
Av. birth wt., lbs.	2.6	3.0	2.8	2.7	2.8	2.75
No. weaned/litter	8.6	5.2	6.9	5.2	8.1	6.8
Av. weaning wt., lbs. (28 days)	13.8	16.9	15.0	16.3	16.2	16.2
Percent weaned, %	81	72	76.5	56	76	66
Interval, weaning to estrus						
No. sows	3	4	8	3	7	10
Days	107	12.2	60	5	5.3	5.2
Second litter performance-No. sows	4[a]	3	7	3	6	9
No. pigs farrowed/litter	9.5	8.3	9.0	10.7	7.8	8.8
Av. birth wt., lbs.	2.8	3.2	3.0	3.1	3.2	3.2
No. weaned/litter	5 (3)[b]	6.7	6.0	7.3	5.8	6.3
Av. weaning wt., lbs. (28 days)	17.4 (3)	13.9	15.4	18.5	17.9	18.1
Percent weaned, %	60 (3)	80	71	69	74	72

[a]One sow did not farrow first time; rebred to farrow 12/22/67.
[b]Values are for three sows in group I-C. The litter on the fourth sow has not been weaned.

The second farrowing and litter performance data indicate that the environmental effects were reduced. The performance of the "confinement" and "open lot" sows was similar. The major difference observed was a 2.7 lb. advantage in average weaning weights for the I-O and II-O sows. One litter in group I-C has not been weaned at this time.

The blood analyses are not complete, but most of the blood glucose, hematocrit and sedimentation rates have been determined and are shown in table 2. Only a few adrenal corticosterone levels have been measured and these data will be reported at a later date. The blood glucose levels obtained for the two groups, I and II-C and I and II-O, are slightly lower than the normal blood sugar values, but are within the reported normal range. The I and II-O sows generally had higher glucose levels at the eight sampling times than the I and II-C sows. The overall averages were: 39.8 mg.% and 43.3 mg.%. Hematocrit values, on the other hand, were slightly above the normal range of 38-42. The mean levels for the "C" and "O" sows were: 46.4 and 43.3%, respectively. The greatest treatment effect was seen in sedimentation rates. The "O" sows averaged over the eight periods 25.9 and the "C" sows 12.9 mm/hour. The normal range is 0-14 mm/hour. The highest value for both groups was observed at 2 days post weaning. If elevated blood sugar levels and higher sedimentation rates are indicative of a stress condition, it would appear that the I, II-O sows were stressed to a greater degree than I, II-C sows.

TABLE 2. INFLUENCE OF CONFINEMENT AND OPEN LOTS ON BLOOD GLUCOSE HEMATOCRIT AND SEDIMENTATION RATE IN SOWS

Reproductive Period	Blood Glucose Mg. %		Hematocrit		Sedimentation mm/hr.	
Groups[a]	C	O	C	O	C	O
Estrus	39.5	47.1	45.4	42.6	14.4	26.6
30 days gestation	36.9	37.6	49.5	44.6	7.8	19.7
60 days gestation	35	38.8	46.9	44.3	14.4	23.8
90 days gestation	39.5	37.3	46.8	44.1	14	29.6
48 hours confinement[b]	42.8	52.1	43.5	40.3	16.8	21.4
14 days lactation	44.3	49.7	44.8	42.8	6.1	27.1
21 days lactation	39	43.7	45.1	43.7	10.3	19.5
2 days post weaning	41.4	41.4	49.6	44.1	19.4	39.2
Ave.	39.8	43.4	46.4	43.3	12.9	25.9
Normal Range	40-240		38-42		1-14	

[a]The two treatment groups are confined, (C), and open lots, (O). Sub groups I, II-C and I, II-O are combined.

[b]Blood samples taken 48 hours after being placed in farrowing crate.

SWINE FEEDING METHODS - WEANING TO MARKET

H. R. Thomas

Rapid economical gains are essential if swine producers are to receive a fair profit from their labor and investment. Equipment for the grinding, mixing and handling of feed has been developed and its use can result in the minimization of labor. Floor-feeding, which has been recently developed, provides predetermined amounts of feed at scheduled intervals throughout the day. The feed is dumped on the floor eliminating the necessity for self-feeders in the pen.

It was found in a previous experiment at the Tidewater Research Station that pigs fed by the floor-feeding system did not perform as well as those on the self-feeding system. In this study, it was not possible to feed the pigs on the floor-feeding system at the same daily feed intake level as the self-fed pigs. A problem of underfeeding and overfeeding developed resulting in failure to keep pigs at the optimum feed intake level, which is essential for maximum efficient growth. These findings are contrary to other published reports. The objective of this experiment was to compare several feeding methods and to observe their effect on the rate of gain and feed efficiency of growing and finishing swine.

Experimental Procedure

Eighty crossbred pigs were randomly assigned to two replicates, each replicate contained four treatments. The treatments were:

S.F. - Self-fed, a complete mixed ration
F.C. - Free-choice, a shelled corn and supplement
F.F. - Floor-fed, a complete mixed ration
H.F. - Self-fed, shelled corn - hand-fed supplement

Each group of pigs was housed in a 5 x 15 ft. pen which was within a completely enclosed and ventilated building. Four of the pens had 8 ft. slats and four had 4 ft. slats. Slats were 3 inches wide and made of reinforced concrete.

The completely mixed ration used for self-feeding and for floor-feeding was prepared by an automatic grinding and mixing electric mill. The same protein supplement was used as a feed ingredient for all treatments. Pigs on the floor-feeding system were fed five times per day during the initial phase of the test and during the latter phase were given an additional feeding at midnight. An attempt was made to provide floor-fed pigs with as much feed as they would consume, thereby approximating self-feeding. Water was available at all times.

Pigs on the hand-fed supplement (H.F. treatment) were fed 1/2 lb. per head daily up to an average weight of 90 lbs., 3/4 lb. from 90 to 135 lb., and 1.0 lb. from 135 to 200 lb. All pigs were weighed at two-week intervals and feed consumption was computed at the end of each weigh period.

Results

The results of this experiment are summarized in table 1. These data have not been analyzed statistically, but there are indications of differences between treatments. Since replicate differences are small with the exception of the floor-fed groups, the two replicates will be discussed together. The average daily gain was highest for pigs self-fed (S.F.) the complete ration, followed by pigs self-fed corn and supplement (F.C.) separately and pigs self-fed corn and hand-fed the supplement (H.F.). In replicate I, gain of pigs floor-fed the complete ration (F.F.) was the same as groups F.C. and H.F., however, in replicate II, the gain of this group was much lower than all the other groups.

Average daily feed intake was greatest in the self-fed and floor-fed treatments (5.86 and 5.68 lb. respectively) and lowest in the free-choice and corn hand-fed supplement group (5.17 and 4.94 lb. respectively). Pigs on the floor-fed treatment were the least efficient, followed closely by the self-fed group. They required 4.29 and 3.75 lb. of feed per lb. of gain. Both the free-choice fed and the self-fed corn, hand-fed supplement groups required 3.52 lb. of feed per lb. of gain. Pigs on the self-fed and the free-choice fed treatments required 83 days to reach 200 lb. in weight. The other treatments required 90 days to reach 200 lb. with the exception of the floor-fed group in replicate II. This treatment required 97 days to reach 198 lb. It should be noted that the pigs floor-fed in replicate II performed rather poorly throughout the entire study and one pig died midway through the test. The poor performance of the pigs on shelled corn at the beginning of the trial would tend to indicate the corn was extremely hard or flinty and daily feed intake was low during this growth period. (Corn dried to less than 12% moisture for storage).

Summary

In this test, it is doubtful if the slight differences between self-feeding and free-choice feeding would offset the cost of grinding and mixing. Since floor-feeding resulted in poorer performance both from the standpoint of rate and efficiency of gain than self-feeding and required an average of 10 days longer to reach 200 lb. in weight, it would appear that the floor-feeding could best be used as a system for feeding breeding stock instead of finishing hogs. Hand-feeding supplement in combination with shelled corn fed ad libitum is a fairly simple way of finishing hogs, but is rather unpopular with the producers, mainly because of the labor required for daily feeding.

TABLE 1. AVERAGE DAILY GAIN, FEED INTAKE AND FEED EFFICIENCY OF GROWING-FINISHING PIGS FED BY DIFFERENT METHODS

	Feeding Method*			
Criteria	S.F.	F.C.	F.F.	H.F.
Replicate I (8' slats)				
No. of pigs	10	10	10	10
Initial wt., lb.	76	77	76	76
Final wt., lb.	208	200	204	202
Length on test (days)	83	83	90	90
Av. daily gain, lb.	1.60	1.47	1.43	1.40
Av. feed intake, lb.	6.10	5.14	6.17	4.85
Feed/lb. gain, lb.	3.82	3.49	4.32	3.46
Replicate II (4' slat)				
No. of pigs	10	10	10	10
Initial wt., lb.	76	77	76	76
Final wt., lb.	203	198	198	203
Length on test (days)	83	83	97	90
Av. daily gain, lb.	1.53	1.46	1.22	1.40
Av. feed intake, lb.	5.63	5.20	5.20	5.04
Feed/lb. gain, lb.	3.68	3.56	4.26	3.59
Total Trial				
No. of pigs	20	20	20	20
Initial wt., lb.	76	77	76	76
Final wt., lb.	205	199	201	202
Length on test (days)	83	83	93	90
Av. daily gain, lb.	1.56	1.46	1.32	1.40
Av. feed intake, lb.	5.86	5.17	5.68	4.94
Feed/lb. gain, lb.	3.75	3.52	4.29	3.52

*S.F. denotes Self-feeding - complete ration
F.C. denotes Free-choice feeding (shelled corn and supplement)
F.F. denotes Floor-feeding - complete ration
H.F. denotes Self-fed corn, Hand-fed supplement

INFLUENCE OF WEANING AGE ON GROWTH AND DEVELOPMENT OF THE BABY PIG

H. R. Thomas, T. N. Meacham and E. T. Kornegay

Although considerable experimentation has been undertaken in recent years to establish an optimum time for weaning the baby pig, the practicability of early weaning has not been determined. Research conducted at the V.P.I. Swine Research Centers at Blacksburg and Holland during the summer of 1966 revealed that pigs weaned at 1 day of age were not physiologically ready for weaning. If weaned at this age, about 60% of the pigs died within a few days. When compared with pigs weaned at 7, 14, 21 and 35 days of age, pigs weaned at 1 day of age had the lowest rate of gain and were significantly less efficient than pigs weaned at 7, 14 and 21 days. Mortality rate during the post-weaning period was the same in all weaning groups except those weaned at 1 day of age.

Experimental Procedure

Fifteen litters, involving 141 crossbred pigs, were used in this experiment. Five litters were weaned at each of the following times, 7, 21 and 35 days. The pigs had access to a commercially prepared creep ration from birth to 56 days of age. The 7-day weaned group was fed a commercial calf milk replacer from 7 to 14 days of age. Each litter was confined in a separate pen allowing feed consumption and pig weights to be recorded by litter. All pigs were weighed at weekly intervals from weaning to 56 days of age. Rate and efficiency of gain were computed from birth to weaning and from weaning to 56 days of age.

Data on the reproductive performance of the sows after weaning are presented in another report.

Results

Performance data of the baby pig are shown in table 1. During the nursing period, the percentage of deaths increased as the length of the nursing period was increased. The percentage of post-weaning losses decreased as suckling period was increased. These data substantiate findings of the earlier work in which it was evident that mortality rates were extremely high when pigs were weaned at ages of 1 day to 7 days. Although these data have not been subjected to a statistical analysis, it appears that pigs weaned at 7 days of age gained less than those weaned at 21 and 35 days with pigs weaned at 21 days having the greatest gain. It appears that the earlier weaned pigs were more efficient.

Summary

The mortality rate was higher in pigs weaned at 7 days as compared to those weaned at 21 and 35 days. Also gain from birth to 56 days and from weaning to 56 days was less in pigs weaned at 7 days as compared to those weaned at 21 and 35 days; however, feed efficiency was in favor of the earlier weaned pigs.

TABLE 1. EFFECT OF WEANING AGE ON BABY PIG PERFORMANCE

Criteria	Weaning Age (Days)		
	7	21	35
No. litters	5	5	5
Ave. no. pigs farrowed alive	8.8	9.4	10.0
Ave. no. pigs weaned	7.4	7.8	7.6
Ave. no. pigs at 56 days	6.0	7.2	7.6
Pigs died while nursing (%)	15.9	17.0	24.0
Pigs died post-weaning (%)	18.9	7.7	0
Pigs alive at 56 days (%)	68.2	76.6	76.0
ADG, birth to 56 days, lbs.	.39	.58	.52
ADG, weaning to 56 days, lbs.	.40	.64	.59
Ave. wt., 56-day, lbs.	24.60	35.20	31.6
Feed/lb. gain, birth to 56 days, lbs.[1]	1.69	1.83	2.12
Feed/lb. gain, weaning to 56 days, lbs.	1.68	1.78	1.89

[1]Sow feed included.

INFLUENCE OF LACTATION INTERVAL ON SUBSEQUENT REPRODUCTION IN THE SOW

T. N. Meacham, C. J. D. McVeigh, and H. R. Thomas

Previous work at this station (1967 Progress Report) has indicated that length of lactation may have an influence on the reproductive performance of the sow. The work reported previously was confounded by what appeared to be an acute temperature stress during the post-weaning breeding season. To study this problem further, two groups of sows were bred and sacrificed in the fall and winter. The first group was bred during late October and early November, a period of generally cool weather. A second group was bred during late December and January and early February, the cold season.

Procedures

The original work involved 39 litters of pigs farrowed in the spring and summer weaned at 1, 7, 14, 21, 28, and 35 days of age. One group of nine litters were farrowed at the Blacksburg station (trial 1) and the remaining 30 farrowed at the Tidewater station in Holland, Va., (trial 2). The sows at each location were checked for estrus after their litters were weaned and bred at the first heat. The interval from weaning to estrus, weaning to conception interval, conception rate and subsequent litter size at birth or slaughter was determined.

The current work involved a group of 19 sows whose litters were all weaned at 28 days and the sows rebred, (trial 3). The sows were slaughtered at an average of 44 days of gestation and litter size determined. A second group of 19 sows (trial 4) had their pigs weaned at 1, 7, 21, or 35 days of age. The sows were similarly checked for heat and bred and the same observations as outlined above were made. These sows were slaughtered and litter size determined.

Results

The reproductive performance of the sows in the various weaning-age groups from the four trials is shown in table 1.

Trial 1

The nine sows in trial 1 had fairly uniform response across all weaning ages with the exception of the one-day weaning group. The two sows in this group failed to settle on the first service after weaning. One sow had a post partum heat. Both settled on the second service. Estrus and conception was from 4-6 days post weaning. Litter size, however, was definitely greater when the lactation period was from 21 to 35 days as compared to 1, 7, or 14 days.

Trial 2

In trial 2, the temperature stress was apparent in that the interval from weaning to estrus ranged from 14 to 60 days. Conception rates were also reduced, ranging from zero for the one-day-group to 60 for the 35-day-group. Litter size in the sows that did settle was low, ranging from 4.0 to 11.0 embryo per litter at slaughter. The anestrous periods experienced by the sows seemed to be correlated with periods of high ambient temperature.

Trial 3

The 19 sows in trial 3 displayed a much more normal reproductive behavior. The interval from weaning at 28 days to estrus averaged 8.5 days. Three of the sows had intervals of 20, 27, and 28 days, which increased the average interval. Excluding these three long intervals, the average interval would be 5.4 days. One of the 19 sows returned in heat after the first service, but settled on the second service. The conception rate on one service was 84% for the group. Two sows exhibited cystic follicles at slaughter, but had not returned to estrus. Litter size averaged 12.9 feti at 44 days of gestation.

Trial 4

In trial 4, the overall performance was quite good. Of the 19 sows involved, 18 were detected in heat. The two sows in the one-day weaning group failed to settle and were rebred. The mean interval for the seven-day weaning group was 11.8 days. Two of the 6 sows had intervals of 21 and 25 days, which extended the mean interval from weaning to estrus. At the 21-day weaning, the interval was 4.7 and in the 35-day-group, the interval was 7.0 days. One sow in the 35-day-group failed to exhibit estrus after weaning. Only one service was required for all groups except the one-day weaning group where both sows returned. These were apparently postpartum heats which normally are not fertile. Conception rates and litter size data were determined at slaughter at an average of 55 days post breeding.

Conclusions

Conception rates, as determined at slaughter, were 100% of all groups. Litter size was also similar among the four groups in trial 4, with the exception of the 21-day weaning group. This group had an average fetal count of 7.2. This figure included two litters of only 2 feti. Excluding these two litters would increase the average to approximately 10 feti/litter, which is quite close to the other three groups.

The rather uniform litter size in trial 4 did not substantiate the indication from trial 2 that litter size was increased as the lactation period increased.

The extremely poor reproductive performance in trial 2 appears to be due in large part to the temperature stress experienced during this trial. Subsequent trials at that location (trials 3 and 4) with similar sows and

TABLE 1. EFFECT OF LITTER AGE AT WEANING ON SUBSEQUENT REPRODUCTIVE PERFORMANCE OF THE SOW

Weaning age, days	Trial	No. Sows	No. sows in heat post-weaning	Wean.-estrus interval days	No. serv. per sow	Conception rate, first service %	No. sows bred or farrowing	Litter size at slau.
1	1	2	2	6.5	2	0	2	7.0
	2	5	2	20.0	---[c]	0	0	0
	4[a]	2	2	5.0	2	0	2	10.0
7	1	2	2	4.0	1	100	2	6.5
	2	5	5	19.8	---	20	1	11.0
	4	6	6	11.5[b]	1	100	6	11.5
14	1	2	2	6.0	1	100	2	7.0
	2	5	4	14.0	---	20	1	4.0
21	1	1	1	5.0	1	100	1	12.0
	2	5	5	60.2	---	40	2	8.5
	4	6	6	4.8	1	100	6	7.2
28	1	1	1	5.0	1	100	1	11.0
	2	5	4	61.3	---	20	1	9.0
	3	19	19	8.5	1.1	84.2	17	12.9
35	1	1	1	4.0	1	100	1	11.0
	2	5	5	23.6	---	60	3	7.3
	4	5	4	7.0	1	100	4	10.0

[a]In trial 4, one sow lost her pigs at birth and one at one day.
[b]Two of the six sows had intervals of 25 and 21 days in 1.
[c]No. of services data are not available for trial 2.

management had fairly normal reproductive performance. The post-weaning interval to first estrus appears to average from five to nine days for sows weaned from 1 to 35 days under these conditions. No definite relationship appeared between length of lactation and the length of the interval from weaning to estrus.

There does not appear to be a relationship between length of lactation beyond one day and subsequent reproduction under the conditions of the trials in this study. Conception rate on first service of sows in the one-day-weaning groups was zero in three trials. Weaning at 7, 14, 21, or 35 days did not influence the interval to first estrus, conception rates, or litter size.

PACKAGING MEAT PRODUCTS TO REDUCE OR PREVENT PEST DAMAGE WITHOUT THE USE OF PESTICIDES

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The production of country hams depends upon an aging period of from four to nine months at ambient temperatures and humidity. During this period the hams are subjected to infection by many types of insects. The control of insects in country hams during the aging period is difficult. Insect control can be achieved by low temperatures which are expensive by insecticides which may leave residues or by the use of packaging materials which will prevent the invasion of insects. With the recent emphasis on pesticide residues in foods it has become necessary to attempt control of insects without the use of pesticides.

The objectives of this experiment were to investigate the usefulness of wrapping materials in the prevention of insect infection throughout the aging period and to study the effects of using wrapping materials on the quality of the aged hams.

Experimental Procedure

Trial I

One hundred sixty (160) hams were allotted to treatments as shown in table 1. The hams were given a standard dry salt cure for two days/lb. and then allowed an additional salt equalization period equal in length to the curing period. After salt equalization one-half the hams in each lot were smoked at 90° F for four days. The hams were then placed in aging chambers when the treatment period began. Each aging chamber (one for each treatment) was inoculated with approximately 10,000 ham skipper pupae (*Piophila casei* L.) every two weeks. The skippers were controlled by a MeBr fumigation in the control lot every 21 days. At the end of the aging period, the hams were baked at 350° F to an internal temperature of 170° F and evaluated by a trained taste panel.

TABLE 1. DESIGN OF EXPERIMENT. NUMBER OF HAMS PER TREATMENT

Treatment							
Control		Kraft paper		Cellulose acetate		Cryovac	
Smoked	Unsmoked	Smoked	Unsmoked	Smoked	Unsmoked	Smoked	Unsmoked
20	20	20	20	20	20	20	20

Trial II

Trial II was a repeat of trial I with the following modifications: Lot 3 was changed from a cellulose acetate film to polycarbonate, lot 4 was fumigated every 42 days with MeBr instead of using the cryovac film. Also, samples of the lean and fat from the hams were analyzed for bromine residues.

Results and Discussion

In trial I, Kraft paper bags and cryovac film were the most effective packaging materials in prevention of insect (skipper) invasion. Fumigation with methyl bromide on a 21-day schedule was only slightly successful in prevention of damage from skippers. The cellulose acetate packaged hams were severely infested with skippers to the degree that they were inedible and had to be discarded without securing taste panel data. The hams packaged in cryovac had significantly lower losses during aging and lower percent total loss. Also, these hams (cryovac) were completely protected from skippers.

The hams from trial I were cooked and evaluated by a trained taste panel. The cooking losses for the hams are shown in table 2. The hams from lot 4 had highly significantly greater total evaporation loss, total drip loss and total cooking loss than the hams from lots 1 or 2. In all treatments the smoked hams had lower cooking losses though these differences were not significant and probably reflect the fact that smoking is a drying process.

TABLE 2. COOKING LOSSES OF HAMS IN TRIAL I

Lot		Total evaporation loss	Total drip loss	Total cooking loss
		%	%	%
1	U	5.77	8.03	13.93
	S	4.12	6.94	11.06
2	U	5.27	7.24	12.51
	S	4.06	6.49	10.55
3	U			
	S			
4	U	10.44[a]	12.02[a]	22.79[a]
	S	7.25[a]	10.20[a]	17.45[a]

[a]Significant at 1%.

The taste panel scores are shown in table 3. None of factors (flavor, odor, tenderness, juiciness or overall acceptability) were significantly different due to the type of packaging material used. There was a trend for the hams packed in cryovac (lot 4) to have lower scores, especially in the unsmoked cell. These hams (lot 4 unsmoked) also had the lowest, most undesirable odor scores. The cooked odor of the lot 4 unsmoked hams was typical of fermented hams. Because of this undesirable flavor and odor the lot 4 (cryovac) treatment was judged to be unacceptable and was not used in trial II. The Kraft paper bag appeared to be superior to MeBr fumigation, cellulose acetate or cryovac both from the standpoint of prevention of insect damage and taste panel acceptability.

TABLE 3. TASTE PANEL SCORES FOR HAMS OF TRIAL I

Lot		Flavor	Odor	Tenderness	Juiciness	Overall acceptability
1	U	3.93[a]	4.52[a]	5.43[a]	5.22[a]	4.78[a]
	S	4.86	5.45	4.64	4.71	4.92
2	U	5.08	5.80	5.16	5.00	5.26
	S	5.36	6.25	4.84	4.98	5.36
3	U					
	S					
4	U	3.72	3.83	5.87	5.03	4.61
	S	5.57	5.86	5.76	5.64	5.71

[a]1 = dislike; 9 = like extremely.

In trial II fumigation with MeBr every 21 days (lot 1) was successful in preventing insect invasion. Lot 2 (Kraft paper bags) was successful in preventing invasion of the skipper but did allow mites to affect the hams. The damage to the hams from the mites was not severe enough to render them unfit for consumption but does serve to emphasize the problem of insect control in long aging periods without temperature or humidity controls. The polycarbonate film (lot 3) failed to protect hams from skipper invasion. This film has ideal "breathing" qualities but is very brittle and hard to use as a wrapping material. The skipper gained access to the hams from minute cracks in the film which were formed when the hams were packaged. The skipper infection was so severe that the hams were judged inedible.

Summary

As a result of two trials using various wrapping materials to control the skipper (*Piophila casei* L.) in hams during the aging period it appears that neither the fumigation with MeBr or wrapping with Kraft paper bags, cryovac or a polycarbonate film will be effective when high populations of the insect are present. Under the conditions of these two trials only the use of MeBr as a fumigant appears to show promise.