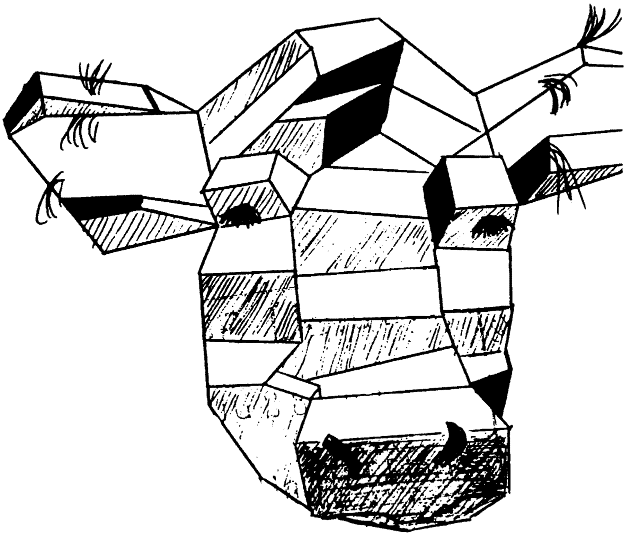
1977-78



LIVESTOCK RESEARCH REPORT

Research Division Report 174

Virginia Polytechnic Institute
and State University
Blacksburg, Virginia 24061
July 1978

1977-1978
LIVESTOCK RESEARCH
REPORT

BY
RESEARCH STAFF
ANIMAL SCIENCE DEPARTMENT
VIRGINIA POLYTECHNIC INSTITUTE
& STATE UNIVERSITY

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COLLEGE OF AGRICULTURE

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DEPARTMENT OF ANIMAL SCIENCE (703) 951-6311

June 1, 1978

TO: Livestock Producers
Research Personnel
Consumers of Livestock Products
Other Interested Readers

The faculty and graduate students of the Animal Science Department are pleased to offer the following reports based on research conducted during the past year. We feel that these reports will convey information which will be useful to the livestock industry of Virginia.

Research information in this booklet includes nutrition, physiology, genetics and management studies conducted with beef cattle, swine, sheep and horses. It is our hope that the information contained herein will contribute to the production of livestock and livestock products in a more efficient and economical manner.

If additional information is desired by the reader on subjects presented in this booklet, this information may be obtained by contacting the authors at the Animal Science Department, V.P.I. & S.U., Blacksburg, Virginia 24061. We would be pleased to hear from you.

Sincerely yours,

Milton B. Wise

Milton B. Wise, Head
Animal Science

MBW:jw

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RUMINANT NUTRITION

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ENERGY CONSERVATION AND UTILIZATION OF ENERGY ALTERNATIVES FOR ENVIRONMENTAL CONTROL OF SWINE SHELTERS[1]

D. H. Vaughan, B. J. Holmes, E. S. Bell,
E. T. Kornegay and E. R. Collins

Annually, hog production in the U.S. uses over 50 million gallons of LP gas, 2 billion kilowatt-hours of electricity, 115 million gallons of gasoline, and 80 million gallons of diesel fuel. Annual energy usage for heating environmentally controlled swine shelters is estimated to be on the order of 2-4 x 10^{12} BTU. The decreasing availability of fossil fuels, as well as rising costs, is already being felt by the agricultural industry. The fuel oil shortage of 1973-74 and the natural gas shortage of the severe winter of 76-77 highlighted the fossil fuel crisis for the American people. Although the main cuase for these energy crises has probably been due to fuel distribution problems, they serve as examples of what can be expected in the future. Energy conservation measures must be practiced and alternate sources of energy must be developed so that the reliance of food production on fossil fuels is reduced.

Most of the heat energy used in hog production is required for the farrowing and brooding phases of production. Electricity and LP gas are commonly used in heating farrowing and nursery housing. Poor environmental conditions seriously increase death losses of baby pigs. From birth to weaning, creep areas must be maintained at about 85°F with a house ambient temperature of about 65°F. These temperatures can be reduced as the pigs become older. For pigs between 8-14 weeks of age (over 40 pounds in weight), room temperature should be kept between 65-75°F, depending on age. Some of the heat required to maintain temperatures in the creep areas comes from the metabolic heat given off by the pigs, but it is seldom economical to replace energy for heating with energy from additional food for the pig. In fact, from an economic standpoint, energy costs for swine production are small compared to feed, labor, and investment costs. Increasing fuel costs and diminishing fuel supplies, however, can change this picture.

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[1]This research is funded by the U.S. Department of Agriculture with pass-through funds from the U.S. Department of Energy.

Much of the energy for heating swine buildings is used to maintain temperatures that can be achieved with solar energy systems. In this report, the operation and performance of a solar assisted heat pump system for heating a pig nursery building is discussed. Energy conservation practices used in the study include high density housing of pigs using triple decking of cages. This installation is located at the Swine Research Center at VPI & SU.

Solar Heated Swine Nursery

A solar assisted water-to-air heat pump using an inexpensive "farmer-built", insulated water pond for thermal storage is being used to heat a pig nursery building. A schematic flow diagram of the system is shown in Figure 1. Flat plate water-cooled solar collectors are being used to collect the sun's heat to improve the heat pump performance by increasing the temperature of the water source to the heat pump. When the heat pump is off, the solar heat is stored in a heat storage pond. At night and during cloudy periods when solar energy is not available, heated water from the heat storage pond is used as the water source to the heat pump. By manual control, the waste lagoon can also be used to supply heat. A 50 gallon tank, located at the outlet from the heat pump, is used as a reservoir for the liquid (water and antifreeze). Bypasses are provided to shunt the flow around system components. Flowmeters are used for monitoring the flow rates through the collector panels and the heat pump. The heating system is controlled automatically using solenoid valves, a Rho Sigma differential thermostat, thermostats, and appropriate control circuitry.

The portable baby pig nursery is 8 ft. wide by 16 ft. long with an 8 foot ceiling. Plywood construction (1/4 inch interior and 1/2 inch exterior) was used with 3-1/2 inches of fiberglas insulation in the walls, floor and ceiling. The building has an aluminum roof and is mounted on 4 x 6 pressure-treated skids. A thermostatically operated ventilating fan is mounted in the wall. The nursery is equipped with flat deck cages (2 wide and 3 high with 6 pigs per cage) and waste disposal through a floor drain.

The heat pump is installed near the ceiling with the air inlet directed to pull air from near the floor. Heating, or cooling, is accomplished by presetting the heat pump thermostat to the desired building temperature. If the water source temperature is inadequate (less than 35°F exit temperature), the heat pump (low pressure switch) is factory preset to shut off. When this condition occurs, the heat pump is reset automatically after a preset time (1 hour). Electric resistance heaters automatically take over supply of the building heat when the heat pump is off.

Seven solar collectors totaling 170 square feet are mounted at an angle of 52 degrees from the horizontal (for winter conditions) and oriented due south. The angle of tilt can be varied. Flowmeters control the flow (0.5-1.0 gpm) through each collector. An Eppley pyranometer for measuring solar radiation is mounted in the same plane with the collectors.

The heat storage pond (5 feet square on the surface and 5 feet deep with a 1 foot square bottom) is insulated on the sides, bottom, and top with styrofoam insulation (R-21). A coiled plastic pipe heat exchanger (1/2 inch diameter and 500 feet long) is installed in the pond. Solar-heated water is directed into the exchanger at the bottom of the pond.

An anaerobic waste treatment lagoon, located adjacent to the swine facilities, is available for backup heat supply at times when solar energy is not available. Dimensions of the lagoon are 100 ft. by 100 ft. with a depth of 3-5 feet. Two heat exchangers presently located in the lagoon each consists of 300 feet of black plastic pipe with 0.5 inch nominal diameter and about 1/16 inch wall thickness. These heat exchangers were selected and designed to be inexpensive, corrosion resistant, easy to construct and repair, and readily acceptable to the swine producer.

System Performance

Three groups of 36 pigs each were raised in the solar heated facility during the winter of 1977-78. The winter weather (below freezing much of the time with cloudy periods and about 30-40 inches of snow) provided stress conditions for the heating system. Pig health and growth were good throughout each of the test periods.

To monitor the performance of the solar heating system, data acquisitions equipment was used to record system temperatures, available solar radiation, weather data, electric power consumption, and pig environmental conditions. Temperature and solar radiation data were logged onto a programmable data system and a tape recorder data terminal. Data was then transferred to the VPI & SU computer center at specified times via an acoustic coupler telephone modem.

A computer program was developed to analyze and plot characteristic system temperatures to better describe system operation. As examples, Figures 2 and 3 show system water and air temperatures, respectively, for January 21 and 22, 1978. As seen from the solar flux data in Figure 2, January 21 was a clear, sunny day whereas January 22 was cloudy. Ambient temperature ranged between zero to minus 10°C (14-32°F) while the building temperature was maintained around 24°C (75°F). To reduce the number of points on each graph and to make the graphs easier to read, the plotting routine allowed points to be printed only when the data was meaningful. For example, inlet and outlet collector temperatures are not printed for night conditions since the collectors are not operational after sunset.

The bounded curves in Figure 3 include all temperature readings inside the cages and nursery building. Thermocouples were evenly distributed throughout each tier of cages. Peaks on these bounded curves are due to the pigs sucking on the thermocouples. In Figure 3, air temperatures for the inlet and outlet of the heat pump were plotted only for periods when the heat pump was operating. This procedure was also followed for the inlet and outlet water source temperatures in Figure 2.

The water temperature in the heat storage pond increased during the afternoon of January 21 when excess solar heat was being stored in the pond.

Economic Feasibility

Although the system discussed here requires electrical energy to operate the heat pump, a coefficient of performance of 2.5 provides a savings in electricity of more than 60%, and elimination of direct-fired fossil fuel heaters. An economic analysis of a typical 20-crate farrowing house and nursery equipped with this type of system and located in Blacksburg, Virginia, indicates that significant fossil fuel savings are possible (Table 1). Fuel costs, based on present rates, can also be reduced appreciably. The initial cost of system components for the heat pump system will be higher and, thus, must be amortized over a longer period. Maintaining a higher inlet water temperature will increase the system COP and reduce operating cost. Also, with a higher COP, it may be possible to select a smaller heat pump which would reduce capital requirements. Complete analyses of the economic and performance data from the past winter heating tests should help determine the feasibility of this type of solar heating system for Virginia swine producers.

TABLE 1. COSTS ANALYSIS FOR A SOLAR ASSISTED HEAT PUMP SYSTEM

	LP Gas	Fuel Oil	Electricity (Heat Pump)
Quantity/year	1,475 gal.	970 gal.	11,930 KW-HR
Cost/year*	$700	$485	$358
$Electricity/$Fuel	.51	.74	--

*Based on $0.475/gal. LP gas, $0.50/gal. fuel oil, and $0.03/KW-HR electricity.

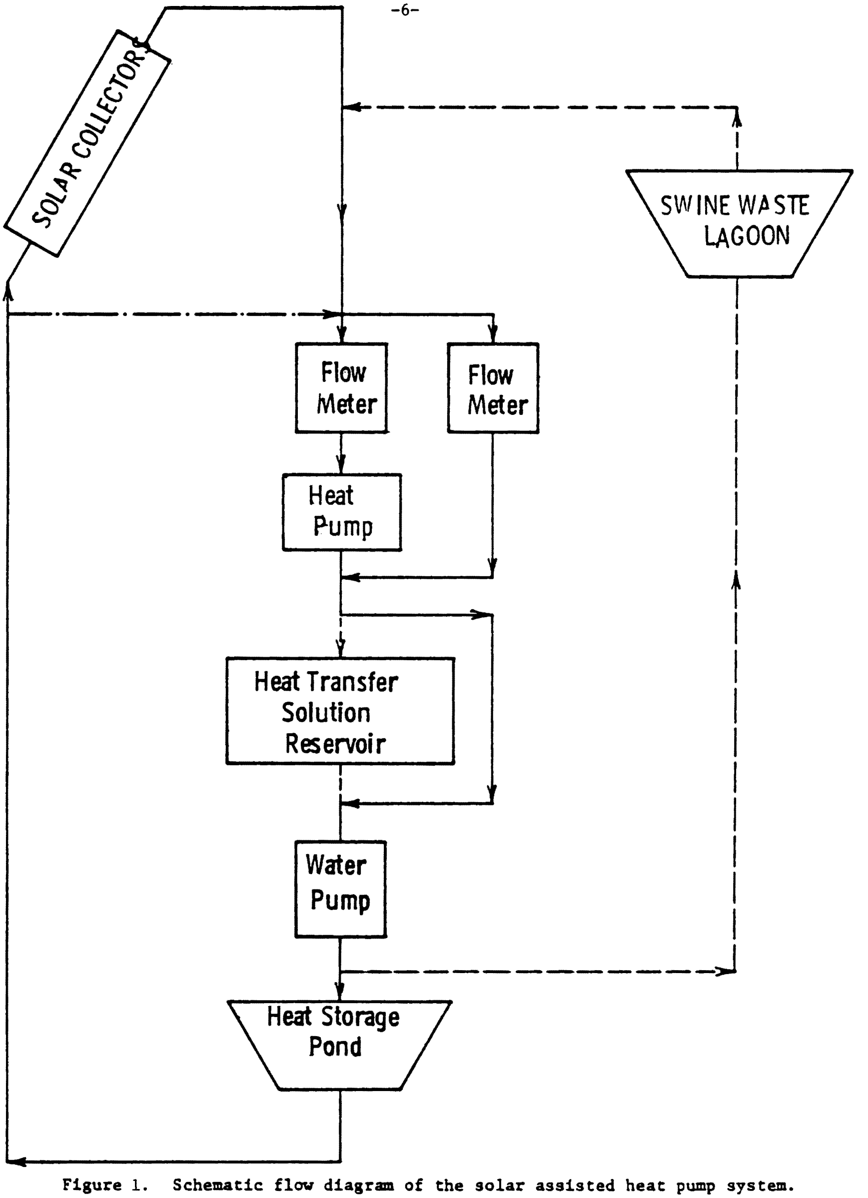

Figure 1. Schematic flow diagram of the solar assisted heat pump system.

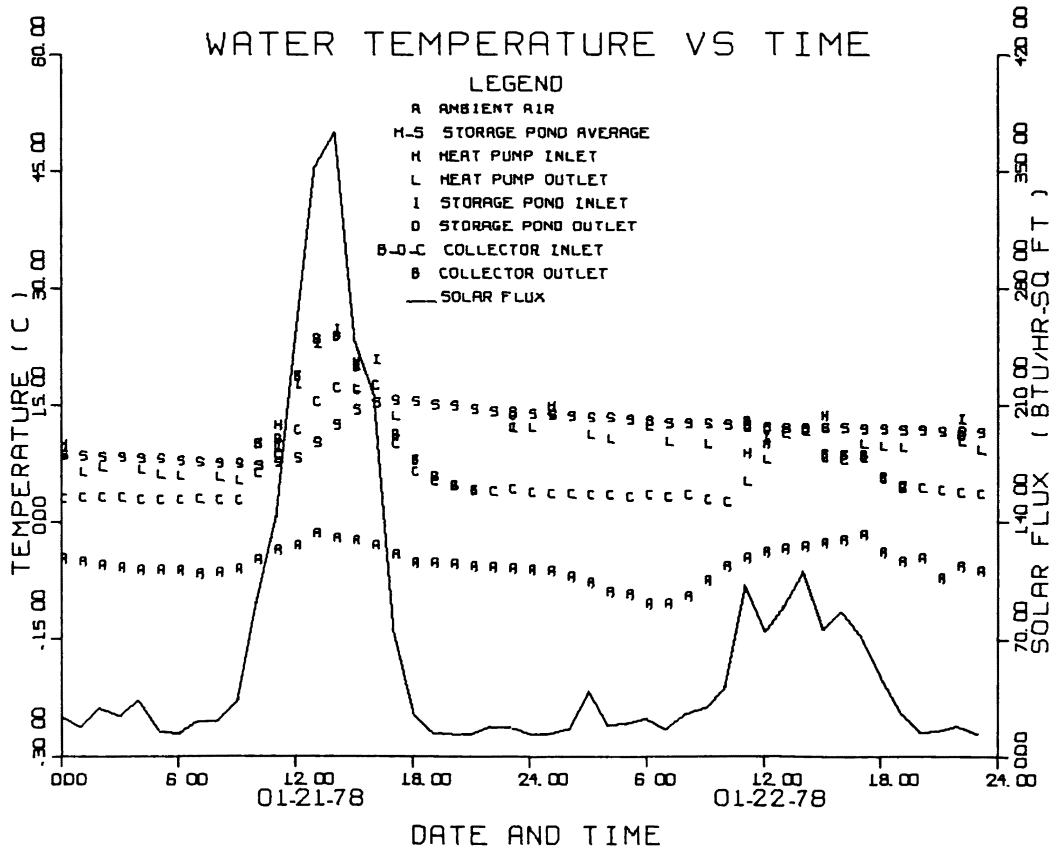

Figure 2. System water temperatures and solar flux for January 21-22, 1978.

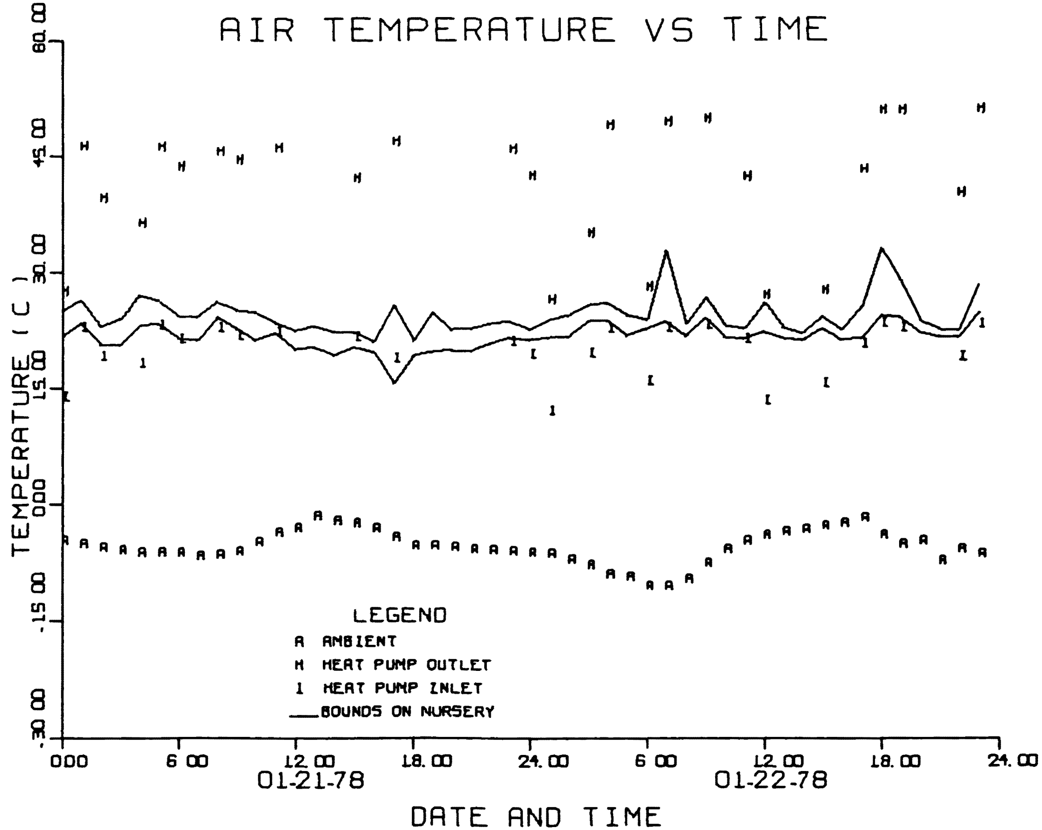

Figure 3. System air temperatures for January 21-22, 1978.

EFFECT OF IMPLANTING ZERANOL IN BULLS AND HEIFERS[1]

W. D. Lamm and C. R. Underwood

A considerable amount of data has been accumulated showing increased rate of gain by implanting zeranol in steers and heifers during the suckling and growing-finishing stages. A paucity of data exists, however, concerning: 1) the effect of age at first implant, and 2) the effect of implanting bulls. This study was designed to answer these questions.

Experimental Procedure

This study was conducted at the Catawba Research Station, Catawba, Virginia, beginning January 15, 1977. As calves were born, every fifth calf, regardless of sex, was kept as an unimplanted control. Every first and third calves born were implanted with 36 mg zeranol at birth and every 100 days thereafter. The second and fourth calves born were implanted with 36 mg zeranol at 100 days of age and every 100 days thereafter. Essentially, 1/5 of the calves were controls, 2/5 were implanted at birth and 2/5 were implanted for the first time at 100 days of age. The treatments were assigned without regard for sex of the calf.

The implant dates were birth, June 3, September 7 and December 21 for the appropriate treatments. The calves nursed their dams on pasture until weaned.

After the calves were weaned October 18, 1977, they were allotted within sex and implant treatment to one of the three following growing-finishing rations: 1) full feed of corn silage 2) 1% body weight cracked corn + full feed of corn silage, or 3) full feed of corn grain + 10 lb. corn silage. Each calf also was fed two lb. soybean meal and 1.5 oz. of a commercially available vitamin-mineral mixture daily. Salt and water were available _ad libitum_.

Scrotal circumference measurements of the bull testicles were obtained October 21, 1977 and May 5, 1978. Histopathological sections of testicular and seminal vesicle tissues have been obtained and will be reported in a future report. Also, carcass data will be available at that time.

Results

The results obtained to date are shown in table 1. Implanting heifer calves at birth produced 47 lb. more live weight per calf at weaning than unimplanted heifer calves. Implanting heifer calves at 100 days of age for the first time resulted in a 27 lb. advantage over controls. The effect of implanting bulls either at birth or 100 days of age resulted in slower rates of gain compared to control bull calves. The limited number of control bull calves should be noted.

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[1]Appreciation is expressed to Henry Dickerson, Dave Gibson and Alan Lee for care of the experimental animals.

After 141 days on feed, the control bulls gained faster than the implanted bulls (3.26 vs 3.06 lb. per day). As observed during the suckling phase, bull calves receiving one less implant (100 day treatment) gained .1 lb. per day faster than bulls implanted at birth. Little difference was observed between the two implanted heifer groups, but they gained .14 lb. per day faster than the control heifers. Feed efficiency was not monitored.

When the suckling and growing-finishing phases are combined, bulls implanted at birth gained slower than bulls implanted at 100 days or unimplanted bulls. Heifers implanted at birth, however, weighed 43.7 lb. more than unimplanted heifers and 22.8 lb. more than heifers implanted for the first time at 100 days of age.

Scrotal circumference measurements revealed the unimplanted bulls had more testicular development than implanted bulls at weaning (table 2). Bulls receiving four implants (birth + every 100 days) had less development than bulls implanted at 100 days of age (3 implants).

After 196 days (May 5, 1978), similar relationships existed between the zeranol implant treatments as observed at weaning. Little sexual activity or aggressiveness was observed in any of the bulls although they were fed adjacent to pens of growing-finishing heifers.

TABLE 1. EFFECT OF IMPLANTING ZERANOL IN BULLS AND HEIFERS

	Treatments					
	Control[a]		Birth[b] + 100 days		100 days[c] + 100 days	
	B	H	B	H	B	H
No. of calves	4	12	16	6	12	13
Suckling Phase						
Avg. birth weight, lbs.	80	68	73	71	72	68
Weaning weight, lbs. (10/18/77)	576	459	544	506	567	486
Gain over controls	-	-	-32	47	-9	27
Finishing Phase						
Weight, 11/22/77, lbs.	560.0	488.2	544.4	513.3	556.7	491.2
Weight, 4/12/78, lbs. (141 days on feed)	1020.0	824.1	969.7	870.8	994.6	845.0
Gain, lbs. 11/22/77 to 4/12/78	460.0	335.9	425.3	357.5	437.9	353.8
Daily gain, 141 days, lbs.	3.26	2.38	3.02	2.54	3.10	2.51
Gain over controls 11/22/77 to 4/12/78 (141 days on feed)	-	-	-34.7	21.6	-22.1	17.9
Combined						
Gain (birth to 4/12/78)	940.0	756.1	896.7	799.8	922.6	777.0
Gain over controls	-	-	-43.3	43.7	-17.4	20.9

[a]Unimplanted.

[b]Implanted at birth and subsequently every 100 days with 36 mg zeranol (total of 4 implants).

[c]Implanted at 100 days of age and subsequently every 100 days with 36 mg zeranol (total of 3 implants).

TABLE 2. TESTICULAR MEASUREMENTS OF BULLS IMPLANTED WITH ZERANOL

	Treatments		
	Control[a]	Birth[b] + 100 days	100 days[c] + 100 days
No. of bulls	4	16	12
Scrotal circumference, cm			
Initial (10/21/77)	27.25	21.38	25.30
Final (5/5/78)	36.75	31.47	34.00
Differences (196 days)	9.50	10.09	8.70
Age of bulls (days)			
Initial (10/21/77)	258	252	246
Final (5/5/78)	454	448	442

[a]Unimplanted.

[b]Implanted at birth and subsequently every 100 days with 36 mg zeranol (total of 4 implants).

[c]Implanted at 100 days of age and subsequently every 100 days with 36 mg zeranol (total of 3 implants).

PRECONDITIONING OF BEEF CALVES PRIOR TO WEANING

W. D. Lamm

It has been recognized in the beef cattle industry that weaning of the suckling calf represents perhaps the most stressful time period in a beef animal's life. Teaching the calf to eat a dry ration and drink water out of something other than a stream can be a traumatic experience.

With this background, a study was initiated to determine if calves could be taught to eat a dry ration the month prior to weaning, or if weaning calves a month early and feeding them in a drylot would promote faster gains. The study utilized calves born from January 15 to May 1, 1977.

Experimental Procedure

In the fall of 1977 a preconditioning study was conducted at three Virginia Tech farms. The treatments at each location differ slightly, so will be discussed independently of each other.

Glade Spring Farm

This study involved 52 steer and heifer calves of mixed breeding. On September 21, 1977, the bull calves were castrated and all calves were vaccinated with Electroid-7, IBR-PI_3 (intranasally) and pasteurella, and wormed. On September 27 the calves were weighed and allotted by sex, breed and weight to one of three treatments. The treatments were: 1) controls, grazing pasture with their dams 2) grazing pasture with their dams plus access to a creep ration 3) grazing pasture with their dams plus access to a creep ration with their dams for two days. Perhaps the dams would teach the calves to eat the creep ration. The composition of the creep rations is presented in table 1.

On October 5 the calves received a second pasteurella shot and a pour-on grubicide was applied.

In an effort to eliminate differences which may exist in location of the creep feeders, the two creep-fed lots of cows and calves were exchanged on October 14.

Observations such as time required to locate the creep feeder, feed consumption and efficiency, and calf weight change were obtained. The trial was concluded October 24, 1977.

Hoge Farm

Forty (40) steer and heifer calves of mixed breeding were randomly allotted by sex, weight and breed to two treatments. The treatments consisted of: 1) controls, grazing pasture with their dams 2) grazing pasture with their dams plus access to a creep ration. The creep ration fed is shown in table 1. The trial was begun October 3 and concluded October 28, 1977.

Beef Teaching Herd

This procedure involved 58 bull, steer and heifer calves of mixed breeding. On October 4 they were allotted by sex, weight and breed to two treatments. The treatments were: 1) controls, grazing pasture with their dams 2) weaned and placed in a drylot on a growing ration. Water and a commercially available mineral mixture were available ad libitum.

Results

Glade Spring Farm

The results of this study are presented in table 2. Calves creep fed gained similarly for the 27 day test period to calves not creep fed. Their efficiency of utilization of the feed, however, was very desirable. The third treatment indicated that during the 27 day period, there was no advantage to allowing the cows to eat creep feed the first two days of the creep feeding trial. It should be noted, however, that the two lots of creep-fed calves and their dams were exchanged after 17 days on test. The data up to that point indicate these calves were gaining rapidly (2.29 lb. per day). Exchanging the lots appeared to depress their performance and enhanced the performance of the calves creep fed alone throughout the test period. Location of the creep feeders in relation to normal cattle traffic patterns may have influenced the performance of both lots of calves.

Allowing cows to eat creep feed the first two days of the test period encouraged earlier consumption of the creep feed by their calves. However, this may not justify the added feed required for the cows to train the calves to eat.

Hoge Farm

The results of this study are presented in table 3. The creep-fed calves did not gain as fast as calves not creep fed. The efficiency with which they converted feed to live weight was similar, however, to that observed in creep-fed calves at the Glade Spring Farm (1.73 vs 1.62). It appears that creep feeding just prior to weaning will not produce heavier calves at weaning.

Beef Teaching Herd

The results of this trial are presented in table 4. Calves weaned and fed a 60% roughage ration gained .4 lb. per day slower than calves nursing their dams for 28 days. Therefore, if a producer was only interested in selling pounds of calf at weaning, it appears it would be more advantageous to sell the calf directly off the cow. If he wanted to carry the calf through the winter, however, it might prove financially advisable to wean the calf a month earlier than normal and begin feeding it a dry ration, since milk production will be minimal by that stage of lactation.

Summary

The data indicated that increased calf weight at weaning could not be achieved by creep feeding the calves the last month prior to weaning.

However, these calves were familiar with eating a dry ration by weaning time.

Weaning calves early and feeding them a roughage ration in drylot did not produce weight gains similar to calves remaining with their dams on pasture. Perhaps a higher concentrate level in the ration would have supported more weight gain.

Further studies will be conducted to determine the optimum creep ration and pre-weaning treatments necessary to reduce weaning stress and increase calf weight.

TABLE 1. RATIONS FED TO CALVES INVOLVED IN PRECONDITIONING STUDY

Ingredient	% Composition, as fed	
	Creep rations[a]	Drylot ration[b]
Cracked corn	75	25
Ground grass-legume hay	15	60
Soybean meal	5	10
Molasses	5	5

[a]Used at Glade Spring and the Hoge Farm.

[b]Used in the Beef Teaching Herd.

TABLE 2. PERFORMANCE OF CALVES AT THE GLADE SPRING FARM

Item	Treatments		
	Control	Creep (calves only)	Creep (cows + calves)
No. of calves	18	17	16
Initial weight, lb. (9/27/77)	422	421	426
Final weight, lb. (10/24/77)	467	466	455
Daily gain (27 days)	1.67	1.67	1.07
Total feed, lbs.	-	1244	2682
Feed/animal, total	-	73.2	167.6
Feed/animal/day	-	2.71	6.21
Feed/gain	-	1.62	5.80
Mid weight (10/14/77)[a]	-	447	465
Daily gain (17 days)	-	1.53	2.29
Final weight (10/24/77)	467	466	455
Daily gain (10 days)	-	1.90	-1.0
Daily gain (27 days)	1.67	1.67	1.07

[a]Both lots receiving creep feed were exchanged.

TABLE 3. PERFORMANCE OF CALVES AT THE HOGE FARM

Item	Treatments	
	Control	Creep
No. of calves	20	20
Initial weight, lb. (10/3/77)	469	478
Final weight, lb. (10/28/77)	517	523
Daily gain (26 days)	1.85	1.73
Total feed, lbs.	-	1556
Feed/animal, total	-	77.8
Feed/animal/day	-	2.99
Feed/gain	-	1.73

TABLE 4. PERFORMANCE OF CALVES IN THE BEEF TEACHING HERD

Item	Treatments	
	Control	Drylot
No. of calves	29	29
Initial weight, lb. (10/4/77)	416	415
Final weight, lb. (10/31/77)	461	449
Daily gain (28 days)	1.61	1.21
Total feed, lbs.	-	7188
Feed/animal, total	-	247.8
Feed/animal/day	-	8.85
Feed/gain	-	7.31

SYNCHRONIZATION OF ESTRUS WITH $PGF_{2\alpha}$. ANGUS VS ANGUS X HOLSTEIN ON TWO WINTER FEEDING LEVELS[1]

T. N. Meacham and W. D. Lamm

Procedures

All cattle (98) received an initial injection (IM) of 25 mg $PGF_{2\alpha}$ on May 23, 1977. Eleven days later on June 3, a second 25 mg injection of $PGF_{2\alpha}$ was given, and K-Mar heat detection pads were glued to the backs of cows. Yellow livestock marking crayon was also applied on the rump at the time the heat detection pads were attached. The smearing or rubbing off of the yellow marks were taken as supplemental indications of estrous activity. The cattle were artifically inseminated approximately 80 hours later on June 6. Those females with activated tags were inseminated with a mixed dose containing equal numbers of sperm cells from two bulls. Those females without activated tags or other indication of heat were inseminated with Polled Hereford semen. The cows were palpated for pregnancy 52 days later on July 28.

On June 23, three Polled Hereford cleanup bulls were turned with the cows. The cow herd was pregnancy tested again on November 30, 1977.

Results

The response to the estrous synchronization treatment is summarized in table 1 by breed group and feeding level. The Angus cows on both energy levels showed a greater incidence of estrus following synchronization, 79 and 83%, compared to the crossbreds, 61 and 68%.

The percentage of cows calving to the synchronized estrus insemination favored the Angus cows slightly, 57% vs 54%. Cows of both breeds on the 80% energy feeding level had higher calving rates to the synchronized estrus, 60.5 vs 51.0%. This same trend was evident in the total percent calving to AI plus cleanup bulls, 93 vs 82%. The Angus X Holstein cows had a higher final calving percentage, 90 vs 85%.

The overall performance indicated that 55.8% of the synchronized cows calved to the insemination made during the synchronized estrus.

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[1] Appreciation is expressed to Henry Dickerson, Dave Gibson and Alan Lee for care of the experimental animals.

TABLE 1. PERFORMANCE OF ANGUS AND ANGUS X HOLSTEIN COWS AND THEIR CALVES ON TWO WINTER FEEDING LEVELS (1976-77)

	100% N.R.C.		80% N.R.C.	
	Angus	Angus x Holstein	Angus	Angus x Holstein
No. of cows	24	26	23	25
Initial weight (11/30/76)	1006.2	1108.3	1009.1	1107.8
Average calving date (1977)	February 7	February 6	February 11	February 9
Weight change from 12/1/76 to immediately post-partum, lbs.	43.4	29.1	38.1	14.8
Average calf birth weight, lbs.	65.9	70.5	67.4	73.7
% calves born alive	57.0	84.6	72.7	75.0
% calves alive 4/21/77[a]	52.4	84.6	68.2	70.8
Calf weaning weight 10/18/77				
No. of calves	11	22	15	16
Avg. weight (all calves)	447.3	563.4	467.3	556.2

[a]Cows and calves returned to pasture.

SYNCHRONIZATION OF ESTRUS WITH PROSTAGLANDIN[1]

T. N. Meacham and W. D. Lamm

Introduction

Controlled breeding through the use of estrous synchronization promises to be a valuable management tool to the beef producer. If the occurrance of estrus can be regulated, artificial insemination of beef cattle will have wide application and breeding and calving seasons consolidated. This study was conducted to evaluate estrous synchronization under field conditions.

Procedure

Ninety-eight Angus and Angus x Holstein cows received an initial injection (IM) of 25 mg prostaglandin ($PGF_2\alpha$) on May 23, 1977. Eleven days later on June 3, a second 25 mg injection of $PGF_2\alpha$ was given, and K-Mar heat detection pads were glued to the backs of cows. Yellow livestock marking crayon was also applied on the rump at the time the heat detection pads were attached. The smearing or rubbing off of the yellow marks were taken as supplemental indications of estrous activity. The cattle were artificially inseminated approximately 80 hours later on June 6. Those females with activated tags were inseminated with a mixed dose containing equal numbers of sperm cells from two bulls. Those females without activated tags or other indication of heat were inseminated with Polled Hereford semen. The cows were palpated for pregnancy 52 days later on July 28.

On June 23, three Polled Hereford cleanup bulls were turned with the cows. The cow herd was pregnancy tested again on November 30, 1977.

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The response to the estrous synchronization treatment is summarized in table 1 by breed group and feeding level. The Angus cows on both energy levels showed a greater incidence of estrus following synchronization, 79 and 83%, compared to the crossbreds, 61 and 68%.

The percentage of cows calving to the synchronized estrus insemination favored the Angus cows slightly, 57% _vs_ 54%. Cows of both breeds on the 80% energy feeding level had higher calving rates to the synchronized estrus, 60.5 _vs_ 51.0%. This same trend was evident in the total percent calving to AI plus cleanup bulls, 93 _vs_ 82%. The Angus x Holstein cows had a higher final calving percentage, 90 _vs_ 85%.

The overall performance indicated that 55.8% of the synchronized cows calved to the insemination made during the synchronized estrus.

[1]Appreciation is expressed to Henry Dickerson, Dave Gibson and Alan Lee for care of the experimental animals.

TABLE 1. SYNCHRONIZATION OF ESTRUS WITH $PFG_{2\alpha}$ BY BREED AND ENERGY LEVEL

	100%		80%	
	Angus	Angus x Holstein	Angus	Angus x Holstein
No. cows treated	24	26	23	25
Cows in Estrus	19	16	19	17
%	79	61	83	68
Cows calving, AI	10	11	13	14
%	50	52	65	56
Treatment Av. %	51		60.5	
Cows Calving AI + bulls	20	21	20	25
%	83	80.7	87.0	100
Treatment Av. %	82		93.2	

PERFORMANCE OF ANGUS AND ANGUS X HOLSTEIN COWS AND THEIR CALVES ON TWO WINTER FEEDING LEVELS[1]

W. D. Lamm and T. N. Meacham

With increased emphasis on larger, growthier calves, the use of beef-dairy cross females as brood cows appears promising. This type of female produces more milk and has been shown to wean heavier calves than conventional beef cows. The physiological stress of the increased milk production of these dairy-cross cows may cause a delay in the return to estrus after calving. The influence of greater body size of the crossbred cow on the nutrient requirements for production may also be involved when feed supplies are relatively limited.

Experimental Procedure

As reported in last year's report (Research Division Report 172), 47 Angus (A) and 51 Angus x Holstein (AH) 2-year-old heifers were initially pasture bred by registered Angus bulls from April 12 to June 25, 1976. After a summer grazing period, they were confined to drylots where they were wintered on corn silage and soybean meal at either 80 or 100% of N.R.C. energy (TDN) requirements from December 1, 1976, to April 21, 1977. At this time the cows and their calves were returned to pasture.

Cow Wintering Study

On November 30, 1977, the cows which had received either the 80 or 100% energy levels during the 1976-77 wintering period were assigned to the same ration treatment. Both breed groups within each energy level were confined separately and fed once per day. Angus and AH cows receiving the 80% energy level were fed 20.8 and 21.3 lb. of corn silage and .09 and .18 lb. of urea daily, respectively. Angus and AH cows receiving the 100% energy level were fed 26.0 and 26.6 lb. of corn silage and .02 and .10 lb. of urea daily, respectively. The cows began calving March 13, 1978 and finished May 9, 1978. On March 9, the two groups of cows fed each energy level were comingled such that immediately after parturition cows were fed lactation rations. The lactation rations were 24.8 and 31.9 lb. corn silage, and .33 and .54 lb. urea for the 80% A and AH cows, respectively. The 100% A and AH cows received 31.0 and 39.9 lb. corn silage, and .24 and .42 lb. urea, respectively. The gestation and lactation rations were formulated according to N.R.C. requirements for beef cows weighing 1045 lb. The rations for the AH cows were an average of the N.R.C. requirements for beef and dairy cows weighing 1045 lb. Urea was used as the nitrogen supplement since it would not supply energy to the ration.

The majority of the cows and calves were placed onto spring pasture May 3, 1978. Later calving cows and their calves were turned onto pasture May 12, 1978.

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[1]Appreciation is expressed to Henry Dickerson, Dave Gibson and Alan Lee for care of the experimental animals.

When the cows entered the wintering period they were scored by three qualified graders for condition, frame and muscle. Hip and wither heighth measurements were obtained. The cows were weighed at 28-day intervals until February 22, 1978, and were next weighed immediately postpartum. At parturition, birth weights were obtained and the calves were injected with 2cc vitamin A and D, 5cc blackleg and 4cc selenium (a selenium deficiency was diagnosed in two autopsied calves). Days to first estrus and rebreeding performance will be monitored in the cows postpartum.

1977 Calf Crop

On August 22, the bull and heifer calves from the 1977 calf crop were injected with pasteurella and electroid-7; were treated with IBR and PI_3 intranasally, wormed with boluses and treated with a pour-on grubicide. They remained on pasture with their dams until October 18, 1977.

From weaning until November 22 the calves were gradually adapted to growing-finishing rations. The calves were fed in confinement, within sex, one of the following rations: 1) full feed of corn silage 2) 1% bodyweight cracked corn + full feed corn silage 3) full feed of cracked corn + 10 lb. corn silage (as fed). In addition, all calves were fed two lb. soybean meal and 1.5 oz. of a commercially-prepared vitamin-mineral mixture daily. Salt and water were available *ad libitum*.

Results

The data reported herein will include performance of the 1977-78 cow wintering period and the suckling phase of the 1977 calf crop.

The Angus x Holstein cows fed 80 or 100% energy levels during the 1976-77 wintering period began the 1977-78 wintering period weighing 64.8 and 170.1 lb. less than they did December 1, 1976, respectively (table 1). The Angus cows experienced little weight change between the start of the first winter and the start of the second winter.

Cow evaluation parameters (table 1) indicated Angus were fatter and more thickly muscled, whereas the crossbred cows were larger framed at the beginning of the second winter. The 80% AH cows had higher condition scores than the 100% AH cows. The explanation for this is unclear.

By February 22, 1978 (84 days), all cows had gained weight compared to their starting weights. The 100% cows had gained an average of 1.49 lb. per day while the 80% cows gained .79 lb. per day. The 100% AH cows gained most rapidly (1.68 lb. per day). Perhaps this was compensatory gain since they began the trial at the lightest average weight.

Postpartum weights indicated a net gain of cow weight of 34.5 and 41.3 lb. for A and AH cows, respectively, compared to their starting weights. The 80% energy level A and AH cows, however, lost 41.6 and 63.2 lb. body weight, respectively, during the gestation period (November 30 to parturition).

Calving performance reflected the fact that 89.1% of the 100% energy level cows calved while 93.8% of the 80% energy level cows calved. Calf birth weights were approximately four lb. heavier for the 80% energy level cows. Each 80% level breed group lost two calves at birth while each breed group receiving the 100% level lost one calf.

Feed consumption data for the cows are presented in table 2. After 84 days, the 80% energy level cows had consumed approximately 440 lb. less corn silage than those cows fed the 100% energy level. However, the 80% level cows ate approximately seven lb. more urea. No ill effect of the urea supplementation was observed.

It appeared that cows fed either energy level were not fed to maximum intake and in fact, they chewed the bark off trees located in their drylots.

Performance of the 1977 calf crop during the suckling phase is presented in table 3. All male calves remained intact. Bull calves from Angus dams wintered at the 100% energy level weighed more at weaning than those from dams fed the 80% energy level (503.8 vs 479.3 lb.). The reverse effect was observed, however, in the heifer calves (415.0 vs 456.9 lb.). The trend in the calves from the crossbred cows was for calves from the 100% energy level cows to be slightly heavier at weaning compared to calves from the 80% energy level cows.

Within energy levels, the bull and heifer calves from AH dams were heavier compared to bull and heifer calves from A dams.

Data from the growing-finishing phase of this study is not summarized at the present time. It will be presented in a future report.

TABLE 1. PERFORMANCE OF ANGUS AND ANGUS X HOLSTEIN COWS AND THEIR CALVES ON TWO WINTER FEEDING LEVELS (1977-78)

	100% N.R.C.		80% N.R.C.	
	Angus	Angus x Holstein	Angus	Angus x Holstein
No. of cows (total)	24	22	23	25
No. of cows (calving)	20	21	20	25
Cow initial wt. (12/1/76)	1006.2	1108.3	1009.1	1107.8
Cow initial wt. (11/30/77)	1031.5	938.2	1011.6	1043.0
Cow evaluation parameters (11/30/77)				
Condition score[a]	13.0	8.9	12.2	10.2
Frame score[b]	3.0	3.5	3.1	3.7
Muscle score[c]	3.2	2.7	3.0	2.9
Hip heighth, in.	47.4	50.2	47.5	50.3
Wither heighth, in.	47.5	50.1	47.9	50.2
Cow weight, 2/22/78, 84 days	1141.0	1079.5	1084.6	1102.8
Daily gain, 84 days	1.30	1.68	.87	.71
Cow weight immediately postpartum	1066.0	979.5	970.0	979.8
Weight change (11/30/77 to postpartum)	+34.5	+41.3	-41.6	-63.2
Calf birth weight, lb.	85.0	89.0	90.0	93.3
Calves born alive, %	95.0	95.4	90.0	92.0

[a]17 = extremely fat, 16 = moderately fat, etc.

[b]5 = very large for breed, 4 = above average for breed, etc.

[c]5 = extremely thick for breed, 4 = above average for breed, etc.

TABLE 2. CONSUMPTION OF COWS WINTERED AT 80 AND 100% OF N.R.C. REQUIREMENTS FOR ENERGY (1977-78)

	100% N.R.C.		80% N.R.C.	
	Angus	Angus x Holstein	Angus	Angus x Holstein
No. of cows	24	22	23	25
Lbs. feed consumed per cow, as fed[a] (11/30/77 to 2/22/78), 84 days				
Corn silage	2184.0	2234.4	1747.2	1789.2
Urea	1.5	8.4	7.3	15.1
Lbs. feed consumed per cow per day, as fed (11/30/77 to 2/22/78)				
Corn silage[b]	26.0	26.6	20.8	21.3
Urea[b]	.02	.10	.09	.18
Lactation rations per cow, as fed[c]				
Corn silage	31.0	39.9	24.8	31.9
Urea	.24	.42	.33	.54

[a]A mineral mixture of magnesium oxide, defluorinated phosphate and trace mineralized salt in a 1:1:1 ratio is supplied year round *ad libitum*.

[b]All rations increased by 10%, as fed, on 2/13/78.

[c]Fed from parturition until pasture season (May 3 or 12, 1978).

TABLE 3. PERFORMANCE OF SUCKLING BULL AND HEIFER CALVES (1977 CALF CROP)

	Cow Wintering Treatments							
	100% N.R.C.				80% N.R.C.			
	Angus		Angus x Holstein		Angus		Angus x Holstein	
	B[a]	H[b]	B	H	B	H	B	H
No. of calves	4	7	13	9	7	8	9	8
Average birth date	February 7		February 6		February 11		February 9	
Birth weight, lb.	63.0	69.5	71.8	67.1	78.0	68.7	77.1	69.6
Weaning weight, (10/18/77), lb.	503.8	415.0	590.4	524.4	479.3	456.9	590.6	512.1
Gain, birth to weaning, lb.	440.8	345.5	518.6	457.3	401.3	388.2	513.5	442.5

[a]Bull calves.

[b]Heifer calves.

EFFECTS OF AIR CONDITIONED HOUSING ON THE REPRODUCTIVE PERFORMANCE OF GESTATING SWINE

H. R. Thomas, E. T. Kornegay and J. W. Knight

A major problem in the swine industry is decreased reproductive performance associated with breeding during the extremely hot summer and early fall months (July, August and September). This problem is a multi-faceted one which may result from the adverse effects of high ambient temperatures on the reproductive performance of either the boar or the sow or both, and which is greatly influenced by the quality of management.

It is well established that exposure of boars to elevated ambient temperature causes a reduction in semen quality and decreased conception rates and litter sizes (Thibault _et al_., 1966; Mazzarri _et al_, 1968: McNitt and First, 1970; Christenson _et al_., 1972; and Wettemann _et al_., 1976). It is equally well established that exposure of gestating sows or gilts to high environmental temperatures during the first few weeks post-breeding adversely affects embryonic survival (Heitman _et al_., 1951; Tompkins _et al_., 1967; Edwards _et al_., 1968; and Omtvedt _et al_., 1971).

This study was conducted to evaluate the efficacy of housing bred sows and gilts in an air conditioned building for the first 30 days of gestation as a means of reducing the deleterious effects of summer heat on reproductive performance.

Experimental Procedures

This study was initiated in the summer of 1975 and continued during the summers of 1976 and 1977. The number of females used in this study is shown in table 1. During each trial, one-half of the sows or gilts bred was housed in an air conditioned building (AC) and the other half in an open-sided building (OS). In both the 1975 and 1977 studies, gilts were put in either the AC or OS breeding building just prior to breeding and were kept there for 30 days post-breeding. In the 1976 study, sows were weaned and put in either the AC or OS breeding building and kept there for 30 days post-breeding.

The studies were conducted in a sow confinement building 24 ft wide and 90 ft long. One-half of the building was of solid block construction, completely enclosed, insulated and cooled by three air conditioner units with a total cooling capacity of approximately 10 tons. The other half of the building was of block construction on the ends with blocks rising to a height of five feet on the north and south sides. A three foot wide plastic curtain, which could be manually raised or lowered, covered the remainder of the north and south sides of the building. Table 2 summarizes the ambient temperatures during the duration of these studies. The temperature to which the females housed in the OS building were exposed varied with the outside weather condition. The temperature in the air conditioned section was kept at 70 $\pm$ 2.0° F throughout the study.

In order to eliminate the effects of heat stress on the libido, semen quality and sperm viability of the boar and thus complicating our interpretation of the effects on the female, all boars in all trials were housed in the air conditioned building. Females were checked for estrus daily and mated following the onset of estrus. All animals were fed five pounds per head per day of a 15% crude protein corn-soybean meal gestation diet fortified with vitamins and minerals and meeting all NRC recommendations. All females were moved to a common gestation building following the initial 30 days of gestation.

Results and Discussion

Table 1 summarizes the reproductive performance of the sows and gilts used in this study. There was no significant treatment effect on conception rate seen in any of the three years individually or for the three years combined. In all three years those females housed in the AC building tended to have a slightly larger litter size, both in terms of total pigs born and number of pigs born alive. This difference was not significant ($P \geq .10$) in any individual year, due to limited numbers, but the difference was significant ($P < .05$) when the three years were combined. Overall, there were 1.2 more total pigs and 1.0 more live pigs per litter for the AC *vs.* the OS building housed females. These data suggest that housing gilts and sows in an AC building during the first 30 days of gestation may result in decreased embryonic death loss and thus a larger litter size at farrowing. It is well established that the greatest amount of embryonic death loss occurs during the first 30 days of gestation (Knight *et al.*, 1977).

There was also a significantly ($P < .01$) larger average litter birth weight for the AC housed females when the data for the three years was combined. This appeared to be due primarily to the large and significant ($P < .01$) advantage enjoyed by the AC housed sows over the OS housed sows in 1976. The average birth weight per pig was not significantly different ($P > .10$) in any year or combined, indicating that the difference in litter birth weight was primarily a reflection of the increased litter size in the AC housed females.

In 1976, there was a significantly ($P < .01$) larger number of pigs alive at 7, 14, 21 and 28 days post-farrowing in the AC housed sows. The data for 1976 caused these parameters to also be significant ($P < .05$) when all years were combined. The reason for the decreased survival of the pigs from the OS housed sows in 1976 is not known. It should be pointed out, however, that this difference was not seen in 1975 or 1977.

Additional trials will be conducted during the summer of 1978 and succeeding years in order to accumulate sufficient numbers to facilitate more valid comparisons and more definitive conclusions.

Summary

There was no significant ($P > .10$) difference in conception rate between gilts and sows housed in air conditioned or in open-sided buildings during the first 30 days of gestation. However, those females housed in an air conditioned

building did have a larger litter size ($P < .05$). This suggests that housing gilts and sows in an air conditioned building may reduce the embryonic death loss which occurs during the first 30 days of gestation. Additional trials are being conducted in this area.

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TABLE 1. A THREE-YEAR SUMMARY OF REPRODUCTIVE PERFORMANCE DATA FOR SOWS AND GILTS HOUSED IN AN AIR CONDITIONED VS. OPEN-SIDED BREEDING BUILDING FOR 30 DAYS POST-BREEDING DURING THE SUMMER

	Years and treatment							
	1975		1976		1977		Combined	
	AC	OS	AC	OS	AC	OS	AC	OS
No. bred	27	26	24	25	31	35	82	86
No. farrowed	23	22	22	22	25	30	70	74
No. aborted	0	0	0	0	1	1	1	1
Conception rate, %	85.2	84.6	91.7	88.0	83.9	88.6	86.6	87.2
Avg. total pigs/litter	11.9±2.8[a]	10.9±2.4	12.7±2.3	11.3±2.6	9.6±2.2	8.7±2.5	11.3±2.4*	10.1±2.5
Avg. live pigs/litter	11.4±2.8	10.6±2.4	11.8±1.8	10.5±3.0	9.2±2.2	8.3±2.2	10.7±2.3*	9.7±2.5
Avg. stillbirths/litter	.5	.3	.9	.8	.5	.3	.6	.5
Avg. litter wt., lb.	35.4±7.5	32.1±8.2	35.9±6.8**[b]	29.4±7.4	26.6±6.5	23.8±6.6	32.1±7.0**	26.2±7.2
Avg. pig birth wt., lb.	3.04±.54	2.95±.43	2.86±.50	2.66±.50	2.75±.38	2.87±.50	2.99±.45	2.72±.48
Avg. no. alive								
7 days	9.5±2.0	9.3±2.4	10.0±1.9**	7.7±2.8	8.1±2.2	7.6±2.2	9.1±2.1*	8.2±2.5
14 days	9.2±1.8	8.7±2.6	9.6±1.8**	7.2±2.6	7.8±2.4	7.4±2.3	8.8±2.0*	7.7±2.5
21 days	8.9±1.9	8.5±2.7	9.3±1.5**	6.8±2.6	7.5±2.3	7.3±2.4	8.5±1.9*	7.5±2.5
28 days	8.8±2.1	8.4±2.8	9.0±1.5**	6.5±2.5	7.4±2.5	7.2±2.3	8.4±2.0*	7.3±2.5
Percent alive								
7 days	83.3	87.7	84.7 **	73.3	88.2	91.2	85.3	84.5
14 days	80.7	82.1	81.3 **	68.6	85.2	88.8	82.4	80.0
21 days	78.1	80.2	78.8 **	64.8	82.1	87.6	79.7	77.9
28 days	77.2	79.2	76.3 **	61.9	80.8	86.0	78.0	76.1
Total mortality to 28 days (inc. stillbirths), %	26.0	23.4	29.3 **	41.9	23.2	17.9	26.3	27.6

[a]$\bar{X}$ ± S.D.
[b]Statistical comparisons made only between treatments, within years.
*(P < .05) **(P < .01).

TABLE 2. A SUMMARY OF AMBIENT TEMPERATURES DURING THE 30-DAY POST-BREEDING PERIOD[ab]

	Year		
	1975	1976	1977
Dates of breeding period	8/11-9/5	7/23-8/17	7/1-7/23
Avg. monthly temp., °F			
July	-	76.4	79.3
August	78.8	74.9	79.1
September	71.3	69.1	-
Temp. range, °F			
July	-	58-95	51-98
August	57-97	47-93	54-99
September	48-92	47-92	-
Avg. maximum temp., °F			
July	-	90	91
August	90	86	90
September	81	82	-
Avg. minimum temp., °F			
July	-	68	68
August	67	64	68
September	62	57	-

[a]These values represent the temperatures to which the females in the open-sided building were exposed during the first 30 days of gestation.

[b]The temperature in the air conditioned building during these same periods was 70 $\pm$ 2.0 °F.

A COMPARISON OF BULL AND STEER CARCASS CHARACTERISTICS

T. J. Marlowe and W. E. Wyatt

In the past there has been a consumer prejudice against bull beef. This has led to a reduced market value for bulls as compared to steers. During recent years, there has been a trend away from fat carcass beef with a preference toward the leaner cuts. Since it is well known that bull beef carries less fat and a higher percentage of lean, a new interest has developed in bull beef because of its more economical production. It is well known that bulls grow faster than steers. Recent work at Nebraska, Wyoming, Oklahoma and other places has shown that bulls yield from 2.6 to 4.8% more lean cuts than do steers and were superior in growth at all ages from birth to slaughter.

In 1968 a cooperative cattle breeding research project was initiated by the senior author with the Bland Correctional Center at Bland, Virginia. As a byproduct of that research, carcass data were collected on 220 bulls and 301 steers slaughtered at the Center's slaughter plant during the years 1971-1977. The purpose of this study was to compare bull and steer carcasses for several important traits.

Materials and Methods

All male calves were left intact until slaughtered from the first two calf crops. A random half of the male calves from each breed group were left intact until slaughter from the third and fourth calf crops and all calves thereafter were castrated at birth or prior to weaning. All cattle were slaughtered at the Center averaging about 19 months of age. Carcass data collected included carcass weight, ribeye area in square inches, kidney knob weight, backfat thickness and a marbling and tenderness score. The tenderness score was obtained by the use of the Armour Tenderometer on the chilled carcass. Using these data and the BIF Guidelines, values were calculated for carcass weight per day of age, ribeye area and kidney knob weight per hundred pounds of carcass weight, yield and quality grades and percentage of lean cuts.

The statistical procedure used to estimate the least squares means was Harvey's Least Squares Program with access through SAS 1976. Since both bulls and steers were not available in all years and since heifers were slaughtered in all years, the heifer data were analyzed to obtain year adjustment factors to be applied to the bull and steer data. After adjusting for year effects, variables included in the model were breed of sire, breed of dam, sex, the interaction terms for breed of sire x breed of dam, breed of sire x sex, and breed of dam x sex, along with age at slaughter as a regression.

The authors express their appreciation to Mr. Wilson and Mr. Saunders at Bland Correctional Center for collecting the carcass information; to Dr. R. F. Kelly, Food Science Department, for calculating the yield and quality grades and yield of lean cuts; and to Dr. Klaus Hinkelmann and Sharon Meyers, Statistics Department, for assisting with the statistical analysis.

TABLE 1. COMPARISON OF CARCASS TRAITS OF BULLS AND STEERS

	Number observations	Slaughter weight (lbs)	Carcass weight (lbs)	Carcass weight per day of age (lbs)	Number observations	Tenderness	Number observations	Quality grade
Bulls:	220	1127**	614**	1.01**	180	17.4*	201	8.8
Steers:	301	1008	532	0.86	209	16.2	299	8.8
Difference:		119	82	0.15		1.2		0.0

	Number observations	Ribeye area (in^2)	Ribeye area per 100# carcass wt. (in^2)	Kidney weight (lbs)	Kidney weight per 100# carcass wt. (lbs)	Backfat (in)	Marbling	Yield grade	Yield of lean cuts (%)
Bulls:	201	13.66**	2.24	9.7**	1.6**	0.12**	2.96	1.14**	54.22**
Steers:	301	12.04	2.27	13.1	2.5	0.18	3.25	1.65	53.11
Difference:		1.62	-0.03	- 3.4	-0.9	-0.06	-0.29	-0.51	1.11

**P < .01

Results and Discussion

A comparison of the adjusted bull and steer measurements for each of the traits is shown in table 1. The difference in least squares means in live weight at approximately 19 months of age was a highly significant 118.6 pounds advantage for the bulls. This is in general agreement with Arthaud et al. (1977) and Jacobs et al. (1977), although the magnitude of the differences is somewhat less. The advantage in carcass weight was 18.3 pounds and 0.15 pounds in carcass weight per day of age. The ribeye area of bulls was 1.62 square inches larger than steers. However, when converted to ribeye area per 100 pounds of carcass weight there was no significant difference between bulls and steers. This finding is contrary to that reported by Tanner et al. (1970) in which they found a significant advantage of 0.2 square inches per 100 pounds of carcass weight for bulls over steers. Steers had significantly heavier kidney weights, both on an actual and per hundred pound of carcass weight basis. These differences amounted to 3.4 and 0.9 pounds, respectively. Bulls had significantly less backfat than steers, but the differences in marbling scores were nonsignificant. Tenderness measures taken by use of the Armour Tenderometer showed bulls to be significantly less tender than steers, however, both groups were sufficiently tender to meet the criteria for choice grade beef. Bulls had more favorable yield grades (1.14) than did steers (1.65). Carcass quality grades were in the low good range for both groups. Bulls yielded 2.1% more lean cuts than did steers. This difference was highly significant.

When one considers that bulls produce 82 additional pounds of leaner carcass beef with 3.4 pounds less kidney knob, 1.62 square inches more ribeye, more desirable yield grade and 2.1% more total lean cuts with no appreciable loss in tenderness, marbling or quality grade, the advantages of producing bull beef become obvious. Relating the weight advantage above to a 100-cow herd producing an 85% calf crop with 50% of the calves being males, the expected increased pounds of carcass beef annually would be 3485 pounds. However, for this advantage to be realized in monitary returns the consuming public must be re-educated.

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MANAGEMENT SYSTEMS FOR EWES AND LAMBS

W. H. McClure, G. A. Allen, Jr., R. E. Blaser, J. P. Fontenot and J. M. Moore

For a number of years sheep research and on-farm production in Virginia has tended to become more intensified. Such practices as early weaning and multiple lambing have been common. Because of rising feed costs and greater labor requirements, there may be justification for considering the use of extensive production systems requiring less feed and labor and making more use of available winter forages.

A long-term ewe and lamb management systems experiment was initiated at the Shenandoah Valley Research Station in the spring of 1974 to study the comparative merits of fall, winter and spring lambing and various management practices for ewes and lambs as related to these lambing dates. The 220 ewes used in the project were all sired by Suffolk rams and basically out of black-face type western ewes.

Experimental Procedure

The following is a basic outline for the test:

TREATMENT 1-A -- 150 Ewes

Pre-Breeding:	Vasectomized rams turned in May 1 to May 20.
Breeding Dates:	May 20 to June 25. Four Suffolk and 2 Dorset rams were used.
Pre-Lambing Management:	Ewes on good summer and fall pasture, plus 1/2 lb. grain per head daily, 2 weeks before lambing. Ewes diagnosed carrying twins were fed .75 lb grain per day.
Lambing dates:	October 15 - November 20 - Ewes were lambed on pasture.
Post-Lambing Management:	All ewes were put on permanent or native pasture until Nov. 1. After November 1: 1. Ewes were grazed on stockpiled and fed fescue, 1 lb. grain per ewe daily and lambs creep fed. 2. Ewes grazed fescue and lambs creep fed. (Ewes were supplemented with good quality hay when snow covered ground.)

3. Conventional Management:
   Good quality hay, plus 1 lb grain per ewe daily and creep for lambs.

Weaning Age: 90 days.

Post-Weaning Management:
1. Top quality corn silage + corn at level of 2% body weight + supplement.
2. Standard, 25% hay and 75% concentrate ground ration, self fed.

TREATMENT 1-B

All ewes were pregnancy checked just prior to Sept. 1.
Ewes not bred were re-exposed to rams.

Pre-Breeding: Vasectomized rams were used Aug. 1 - Sept. 1.

Breeding Dates: Sept. 1 - Oct. 25. Suffolk and Dorset rams were used.

Pre-Lambing Management:
1. Grazed on fescue pasture.
2. Native pasture plus hay were supplemented with 1/2 lb. grain for all ewes 30 days before lambing and 1 lb. grain 15 days before lambing.

Lambing Dates: Jan. 25 - Mar. 1

Post-Lambing Management:
1. Fescue grazing plus 1 lb. grain per ewe daily and creep for lambs.
2. Small grain pasture and creep for lambs. (Ewes were supplemented with good quality hay when snow covered ground.)
3. Conventional Management:
   Good quality hay plus 1 lb. grain per ewe daily and creep for lambs.

   All ewes were grazed on spring pasture between Apr. 20 and May 1.

Weaning Date: June 15.

Post Weaning Management:
1. Grain on grass
2. Pasture
3. Dry lot

TREATMENT 2 - 75 Ewes

Pre-Breeding: Vasectomized rams were used, October 10 - November 1.

Breeding Dates: Nov. 1 - Dec. 5 - Suffolk and Dorset rams were used.

Pre-lambing Management:	1. Fescue pasture 2. Native pasture and good second cutting hay 3. Small grain pasture and average quality hay	)	All treatments received hay when snow covered pasture.

All ewes received 1/2lb. grain 30 days before lambing and 1 lb. grain 15 days before lambing.

Lambing Dates: Mar. 25 - May 1. Lambing on pasture.

Post-Lambing Management:

1. Fescue grazing until Apr. 20 and creep for lambs.
2. Conventional Management: Good quality hay plus 1 lb. grain per ewe daily and creep for lambs.

   After Apr. 20, all ewes and lambs were grazed on spring pasture.

Weaning Age: 120 days

Post Weaning Management:

1. Dry lot
2. Grain on grass
3. Grass

Results and Discussion

The test was completed in the fall of 1977. Because of seasonal weather differences it was not possible to follow through completely with each management system each year.

The percent lamb crop born and weaned from the fall lambing ewes was consistently lower, although the lambs performed well and commanded high prices on the strong spring markets. The number of ewes settling for fall lambing varied from year to year, probably due to weather conditions at breeding time. It should be pointed out again that the ewes used in this test were predominantly 3/4 black face (Hampshire or Suffolk) and probably do not possess the genetic ability to breed as consistently for fall lambing as do some of the white faced breeds.

All of the fall born lambs received a creep ration until they were weaned at 90 days of age, and management of the ewes had very little effect on the performance of the lambs to weaning. On the basis of these results it may not be profitable to feed grain to ewes beyond two weeks after lambing if they are grazing high quality stockpiled fescue. It must be noted that there was very little snow cover during the winters that this test was conducted and results would probably be different if there had been considerable snow cover. There was very little difference in the post-weaning performance of these lambs on the silage-grain or ground hay and grain ration.

Lambing percentages for the winter lambing ewes were consistently higher than for the fall lambing ewes, although the severe cold in 1977 is reflected in the percent lamb crop weaned. The effect of the different pre-weaning treatments of the ewes and lambs on weaning or 90-day lamb weights was minimal, although the actual cost of raising the lambs to this weight may be quite different. All the lambs received a creep ration until they were weaned. Lambs finished in the dry lot or fed grain on pasture performed better than lambs grown out on pasture alone after weaning. Again, post-weaning cost of finishing these lambs to market weight could be quite different.

The spring lambing ewes weaned lamb crops similar to the winter lambing ewes. An advantage for spring lambing compared to winter lambing is reflected during the 1977 season when the severe cold weather at lambing time resulted in fewer lambs weaned. The effect of pre-lambing treatment on post-weaning performance has been similar for the three different treatment groups, although the lambs whose dams grazed small grain pastures prior to lambing made exceptionally good pre-weaning gains. Post-weaning gains for the spring lambs were quite similar to the post-weaning performance for the winter lambs.

The results of this test indicate that fall, winter and spring lambing systems each have advantages and disadvantages and indicate that a variety of systems may be used, depending upon availability of labor, housing, forages and feed concentrates. It should be pointed out that this test was conducted in the Shenandoah Valley, west of the Blue Ridge mountains and that the performance of spring born lambs would certainly not be as good in areas east or south of the Blue Ridge mountains. Small grain pastures, especially rye, and high quality stockpiled fescue pastures can be used to a distinct economical advantage for ewes both before and after lambing.

TABLE 1 -- Summary of Results

1. Fall Lambing (October 15-Nov. 20) - Treatment 1-A

	74-75	75-76	76-77
No. Ewes Lambing	30	77	57
Percent Lamb Crop Weaned	90%	101%	111%

Weaning Wt. of Lambs 90 days of age

	Fescue	Fescue + Grain	Control - (Hay-grain-pasture)
1975	50 lbs.	56 lbs.	57 lbs.
1976	47 lbs.	50 lbs.	56 lbs.
1977	49 lbs.	48 lbs.	47 lbs.

Postweaning Performance (Average Daily Gain)

	Ground Hay-Grain	Silage-Grain
1975	.63 lbs.	.56 lbs.
1976	.54 lbs.	.52 lbs.
1977	.58 lbs.	.54 lbs.

2. Winter Lambing (January 25 to March 1) - Treatment 1-B

	1975	1976	1977
Number Ewes Lambing	91	59	48
Percent Lamb Crop Weaned	160%	154%	122%

Average Daily Gain of Lambs to Weaning (90 days of age)

	Fescue + Grain	Sm. Grain + Grain	Hay + Grain
1975	.53 lbs.	.61 lbs.	.54 lbs.
1976	.66 lbs.	.70 lbs.	.68 lbs.
1977	.69 lbs.	.73 lbs.	.66 lbs.

Postweaning Performance (Average Daily Gain)

	Dry Lot	Pasture + Grain	Pasture
1975	.50 lbs.	.52 lbs.	.28 lbs.
1976	All lambs finished in dry lot.		
1977	.62 lbs.	.53 lbs.	.41 lbs.

3. Spring Lambing (March 25 to May 1) - Treatment 2

	1975	1976	1977
Number Ewes Lambing	79	61	47
Percent Lamb Crop Weaned	140%	161%	158%

Average Weaning Weight

Prelambing Treatment	Fescue + Grain	Sm. Grain + Grain	Hay + Grain
1975	61.8 lbs.	69.3 lbs.	54.2 lbs.
1976	73.1 lbs.	80.1 lbs.	76.2 lbs.
1977	71.6 lbs.	77.3 lbs.	74. 1 lbs.

Postweaning Performance (Average Daily Gain)

	Dry Lot	Pasture + Grain	Pasture
1975	.48 lbs.	.46 lbs.	.31 lbs.
1976	All Grazed		
1977	.59 lbs.	.51 lbs.	.33 lbs.

DOUBLE AND TRIPLE DECKING IN THE NURSERY TO INCREASE CARRYING CAPACITY

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Swine producers continue to intensify their operations to increase over-all productivity and thus reduce unit costs. The swine industry is becoming increasingly aware of the need to increase the density of old and new nurseries in order to reduce building and operating costs per pig. Equally important is the need for equipment and facilities that will be more conducive to meeting environmental needs of weaned pigs. Decking, double and triple, offers producers the potential of increasing the density of new and old nurseries, and if properly designed, decking can provide a means of improving management during the critical postweaning period.

The objective of this research was to compare the performance and behavior of three-to four-week weaned pigs when housed in single, double and triple deck cages or pens for five weeks after weaning.

Experimental Procedures

Two series of trials were conducted. In the first series three similar trials were conducted to compare the performance and behavior of pigs housed in a single deck nursery, typifying a conventional nursery, and a double deck nursery with the bottom deck being the same as in the single deck nursery. In the second series, three similar trials were conducted to compare the performance, behavior and general health of pigs housed on the various decks of a triple deck nursery.

Single and double deck nurseries. Two equally sized environmentally controlled nursery rooms, 7.5 x 12 x 15 ft were constructed to minimize effects from non-uniformity of temperature and ventilation. The single deck nursery (SDN) was divided into four 3 x 12 ft pens with a 3 ft alley. The double deck nursery (DDN) was similarly divided into four 3 x 12 ft pens on the bottom deck and had four 3 x 8 ft pens on the top deck. The top deck pens were built directly above the bottom deck pens and were centered in such a way that they were not directly above the bottom deck feeder and waterer. The plan and profile views of the double deck are shown in figure 1. The floors in each nursery were totally slotted using flat expanded metal, 9 gauge, 0.75 x 1.5 inches, thus urine and feces could fall through to the pit.

Each nursery was equipped with a 15,000 BTU electric heater and a 14 in variable speed exhaust fan. Two vertically suspended sections of duct pipe (6 ft), each containing a 65 CFM blower fan, were placed at 6 ft intervals along the alley in the DDN to maintain equal temperature and air movement among the top and bottom decks. Thermometers were placed on the pen-partition at pig height (protected) and readings were made each morning and afternoon. Temperature during the test period was decreased from 80 F in the first week to about 74 F in the last week. The relative humidity in the SDN and DDN ranged between 51 and 71 percent. These trials were conducted in the colder months of the year (January thru April), thus a minimum ventilation rate was maintained in both nurseries (5 to 9 CFM per pig from first to fifth week).

Two small plastic feeders (10 lb capacity each) were used initially in the SDN and DDN pens. When the average weight of pigs in a pen was 25 lb the two small feeders in each pen were replaced with one large feeder (100 lb capacity). Nipple waterers were installed at the opposite end of the pen from the feeders. A 3 x 3 ft rubber mat was placed on the floor at the feeder end of pen to monitor feed wastage, to provide a solid surface for the pigs to lay on and a solid surface to spread a little feed initially which encouraged pigs to eat, and promoted a good dunging pattern. A continuous dim light (25 watt bulbs), was provided in each nursery room to minimize vices characteristic of early weaned pigs, such as tail and ear biting and underline suckling of pen-mates, and to reduce excitability.

In trials 1 and 2, 128 crossbred pigs (12 pigs per pen in single and bottom decks and 8 pigs per pen in top deck) were used. All pigs had 3 sq ft of floor area. In trial 3, 104 pigs (10 pigs per pen in single and bottom decks and 6 pigs per pen in top deck) were used, thus each pig had an average of 3.6 sq ft on the single and bottom decks and 4 sq ft in the top deck. The average initial weight (lb) and age (days) was 15.0 and 25.7; 14.7 and 26.9; 13.6 and 24.5, respectively, for trials 1, 2 and 3.

Triple deck nursery. Galvanized wire cages, stacked in three decks, were located in an environmentally controlled solar heated 6.8 x 7.5 x 15.4 ft nursery. Each cage, 24 x 46 x 47 in was partitioned into two equal parts so that there were a total of 12 cages (4 cages per deck). The plan and profile views are shown in figure 2. The building was well-insulated and ventilation was similar to that in the DDN. A vertically suspended section (6 ft) of duct pipe containing a 65 CFM blower fan placed on each side of the room to help maintain a relatively equal temperature was among the three decks. Six thermometers were evenly spaced, three each at the top and bottom. Temperatures were recorded twice daily (morning and afternoon). Initially the temperature was maintained at about 80 F but was reduced after the first week at the rate of about 1 F per week with minimum of about 74 F during the last week. There were, however, small daily variations, and the top deck was generally 3 to 5 F warmer than the bottom deck.

A plastic feed trough was attached outside the front of each cage and a water nipple was located on the rear panel. A 0.5 x 18 x 21 in plywood sheet serving the same purpose as the rubber mat in the SDN and DDN, was placed on the floor of each pen adjacent to the feeder. Urine and feces fell trough the cages to the floor, which was washed daily.

In trials 4 and 5, there were 36 pigs in each trial with 3 pigs per cage (2.7 sq ft/pig), while in trial 6, 24 pigs were used, 2 pigs per cage (4 sq ft/pig). The average initial weight (lb) and age (days) was 10.7 and 19.0; 11.4 and 24.2; 11.5 and 22.8, respectively, for trials 4, 5 and 6.

General. At birth, pigs were weighed, navel cords dipped in iodine, needle teeth clipped, tails docked, ears notched for identification. All males were castrated at approximately one week of age. The pigs were vaccinated against atrophic rhinitis and given an iron injection. From two weeks of age until weaning, the pigs were given access to a 22% creep diet containing 10% dried whole whey.

Pigs were randomly assigned to treatments from outcome groups based on sex, weight and litter. A 22% crude protein corn-soybean meal diet containing 10% dried whole whey was fed until the average weight of pigs in a cage was 15 lb. The diet was then changed to a 20% corn-soybean meal diet containing 10% dried whey. At 25 lb, the diet was changed to an 18% corn-soybean meal diet without whey. The 22% starter diet was reground with a portable hammer mill with a .065 in screen to prevent sifting which is characteristic of young pigs (i.e., selective eating of the coarse corn at the expense of other equally vital feed ingredients). About .25 lb of feed was spread on the rubber mat or plywood for the first 3 days to encourage early consumption of feed. A small quantity of feed was placed in the feed trough or feeders daily during the first week to ensure fresh diet. During subsequent weeks, the diet was supplied in greater quantities to ensure that pigs had diet available at all times.

Pigs were weighed weekly and total feed consumption recorded. Feed per gain was calculated. The general appearance and behavior of pigs were observed and recorded twice daily. Each trial lasted for 5 weeks. As much as humanly possible, the pigs in all trials were given identical management throughout the study.

Results and Discussion

Single and double deck nursery. There was no over-all difference in average daily gain, feed intake and feed per gain between pigs housed in the single and double deck nurseries (table 1). Pigs housed in the top deck of the double deck nursery appeared to consume a little more feed during the first week, thus gaining a little faster; however, this trend was not observed throughout the trials and there was no over-all difference in performance between the pigs housed on the bottom and top decks.

Triple deck nursery. Average daily gain, feed intake and feed per gain were not different ($P>.10$) for pigs housed on the top, middle and bottom decks (table 1). Average daily gain was very similar between pigs reared in the triple deck (.71 lb), double deck (.73 lb) and single deck (.73 lb) nurseries. Pigs reared in the triple deck nursery consumed less feed per day (1.08 lb) than pigs housed in the double (1.30 lb) and single (1.33 lb) deck nurseries, thus pigs reared in the triple deck nursery required less feed per gain (1.52) than pigs reared in the double (1.79) and single (1.83) deck nurseries.

Subjective observations of pig behavior. There was no detectable behavioral difference between the pigs in the three types of nurseries and on the various decks. The dunging pattern was similar during the entire test period with the feces being dropped toward the rear of the pen. Both feces and urine passed easily through the expanded metal floor, although there was some accumulation at the corners of the pens. The feces was soft during the first week, but appeared to have a normal consistency thereafter. Pigs appeared clean on all decks. There was no incidence of feces or urine from the top deck dropping on the pigs below except when pigs were being handled and moved during weighing.

More grunting was noted in the younger pigs and more fighting among the bigger pigs during the first few days postweaning. Very few cases of underline suckling and mounting of pen mates were observed. During the first week a few pigs were observed to chew and spit out some diet. It was observed that the pigs slept on the rubber or plywood mats during the first week, but were spread out thereafter.

Mortality. Two pigs died in trial one, one each from the single and bottom decks. One pig was also removed from the bottom deck during the third week in trial one due to a serious ear infection. There were no death losses nor health problems observed in any of the other trials in either the double or the triple deck nursery.

These data indicate that decking in the nursery is an effective means by which a producer may increase nursery density and thus reduce building and operating costs per pig without adversely affecting pig performance. Double and triple decking in an already existing nursery appears to offer a means by which a swine producer could expand his operational capabilities with considerably less cost than would be involved in constructing a conventional single deck nursery system. In this age of escalating costs of construction and building materials, decking also offers a means by which a new producer entering swine production may minimize construction costs and capital outlay for facilities without sacrificing animal performance.

Summary

Two series of three trials each were conducted for five weeks to compare the performance and general health of three to four week weaned pigs when housed in a single and a double deck nursery and in a triple deck nursery. Pigs in all nurseries and on all decks performed well with no apparent ill effects on health, appearance and behavior.

TABLE 1. AVERAGE DAILY GAIN, FEED INTAKE AND FEED EFFICIENCY OF PIGS HOUSED IN SINGLE, DOUBLE AND TRIPLE DECK NURSERIES.

Postweaning	Single	Double deck		Triple deck		
period, days	deck	Bottom	Top	Bottom	Middle	Top
Avg init wt, lb	14.4[a]	14.4[a]	14.4[b]	11.2[c]	10.4[c]	12.0[c]
Avg final wt, lb	40.2	39.5	40.7	37.9	34.0	36.9
Avg init age, days	25.6	25.8	25.6	23.1	21.6	21.3
Avg Daily Gain, lb.[d]						
0-7	.21	.20	.24	.20	.17	.18
8-14	.65	.61	.68	.61	.56	.62
15-21	.76	.74	.78	.82	.75	.81
22-28	.92	.91	.92	1.02	.95	1.05
29-35	1.13	1.11	1.11	1.01	.94	1.04
0-14	.43	.40	.46	.40	.36	.40
0-21	.54	.52	.57	.54	.49	.54
0-28	.64	.62	.66	.66	.61	.66
0-35	.73	.71	.75	.73	.67	.74
Avg Daily Feed Intake, lb.[d]						
0-7	.39	.35	.43	.25	.22	.26
8-14	.92	.88	.84	.77	.65	.72
15-21	1.40	1.29	1.39	1.12	1.05	1.15
22-28	1.79	1.70	1.68	1.68	1.57	1.66
29-35	2.11	2.12	2.19	1.71	1.64	1.73
0-14	.65	.61	.64	.51	.44	.49
0-21	.87	.84	.89	.72	.64	.71
0-28	1.13	1.07	1.09	.96	.87	.96
0-35	1.33	1.28	1.31	1.11	1.03	1.11
Feed per Gain[d]						
0-7	1.86	1.75	1.79	1.25	1.29	1.44
8-14	1.44	1.44	1.25	1.34	1.21	1.27
15-21	1.86	1.76	1.88	1.37	1.41	1.45
22-28	1.99	1.94	1.91	1.67	1.67	1.59
29-35	1.89	1.94	2.02	1.74	1.82	1.71
0-14	1.58	1.56	1.40	1.42	1.38	1.27
0-21	1.71	1.66	1.63	1.32	1.34	1.34
0-28	1.81	1.76	1.74	1.45	1.46	1.44
0-35	1.83	1.80	1.78	1.52	1.54	1.51

[a] There were 8 pens of 12 pigs per pen and 4 pens of 10 pigs per pen (trials 1 thru 3) per mean.

[b] There were 8 pens of 8 pigs per pen and 4 pens of 6 pigs per pen (trials 1 thru 3) per mean.

[c] There were 8 cages of 3 pigs per cage and 4 cages of 2 pigs per cage (trials 4 thru 6) per mean.

[d] Mean values for all parameters measured were not significantly different ($P < .10$).

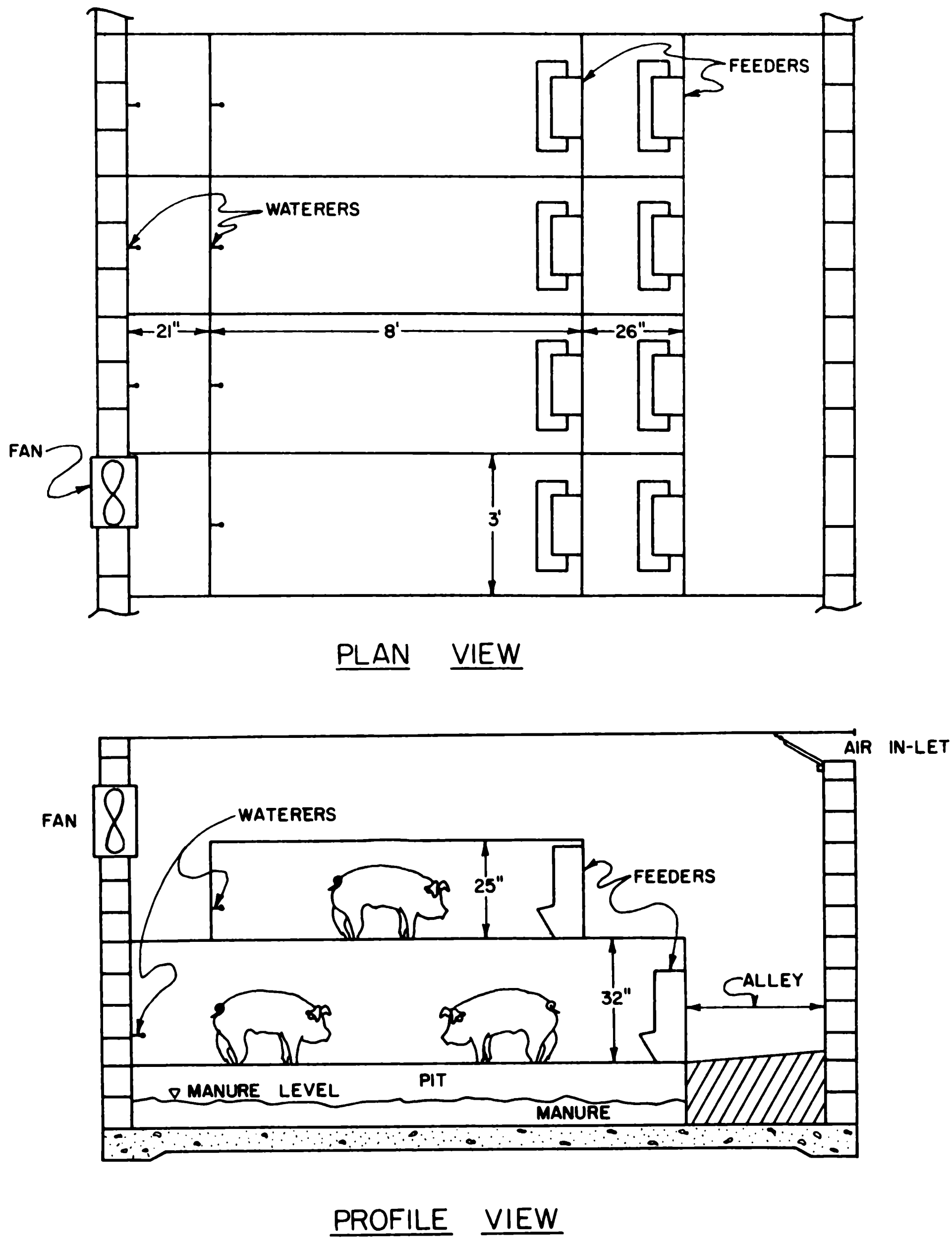
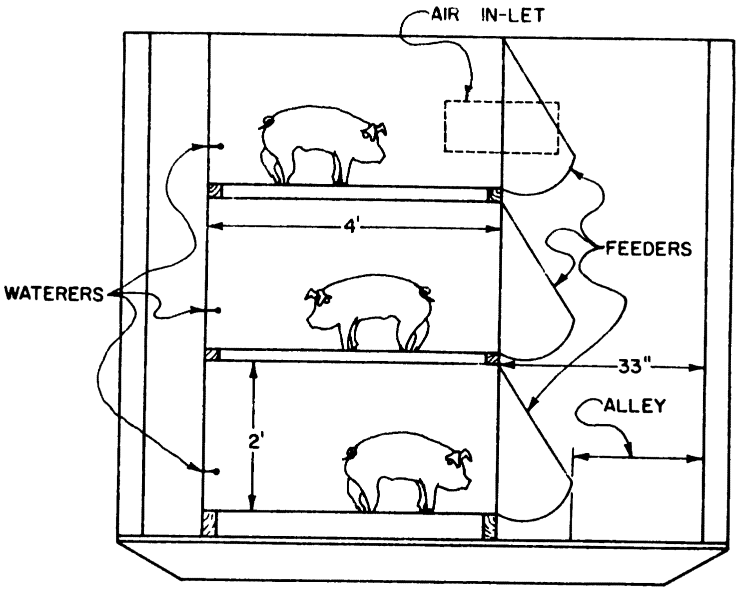
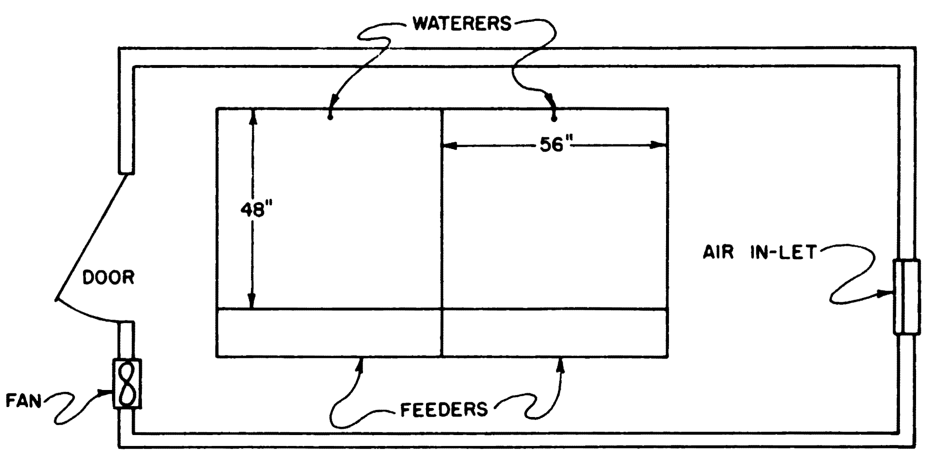


Figure 1. Plan and profile view of double deck nursery.



PROFILE VIEW



PLAN VIEW

Figure 2. Plan and profile view of triple deck nursery.

A CHARACTERIZATION OF INTERSEXUALITY IN SWINE

J. W. Knight, H. G. Kattesh and J. S. Clauss

Although the intersex condition affects only 0.2% of the overall swine population in the United States, in certain herds some degree of intersexuality may be observed in up to 10% of the animals farrowed. The type and extent of abnormality exhibited is quite variable, making detailed scientific study of such anomalies difficult. Intersexes can, however, be divided into two major classifications - true hermaphrodites, which contain both testicular and ovarian tissues, and pseudohermaphrodites, which contain only testes or only ovaries with portions of both male and female reproductive tracts. There is considerable evidence that the expression of intersexuality is controlled by genetic factors, the condition being more prevalent in purebred than in crossbred swine. The present study was conducted to characterize an intersex swine with respect to selected phenotypic, morphological and endocrine parameters.

Experimental Procedure

A purebred Yorkshire intersex swine was farrowed at the VPI&SU Swine Center in Blacksburg and reared to the age of ten months under standard management conditions. At this time the animal was examined to characterize the type and extent of the abnormality. The external genitalia and physical characteristics of the animal were assessed and the behavioral characteristics were noted. An indwelling catheter was placed in the anterior vena cava of the animal via the jugular vein and exteriorized to facilitate frequent sampling of blood and minimize the stress associated with each sample collection. Blood samples were collected every 30 minutes over a continuous 24-hour period as well as for 6 hours following exogenous challenges of either human chorionic gonadotropin (HCG) or testosterone. These samples were analyzed by radioimmunoassay for plasma testosterone to determine the endocrine capabilities of the animal. The animal was then sacrificed and the reproductive tract removed for examination.

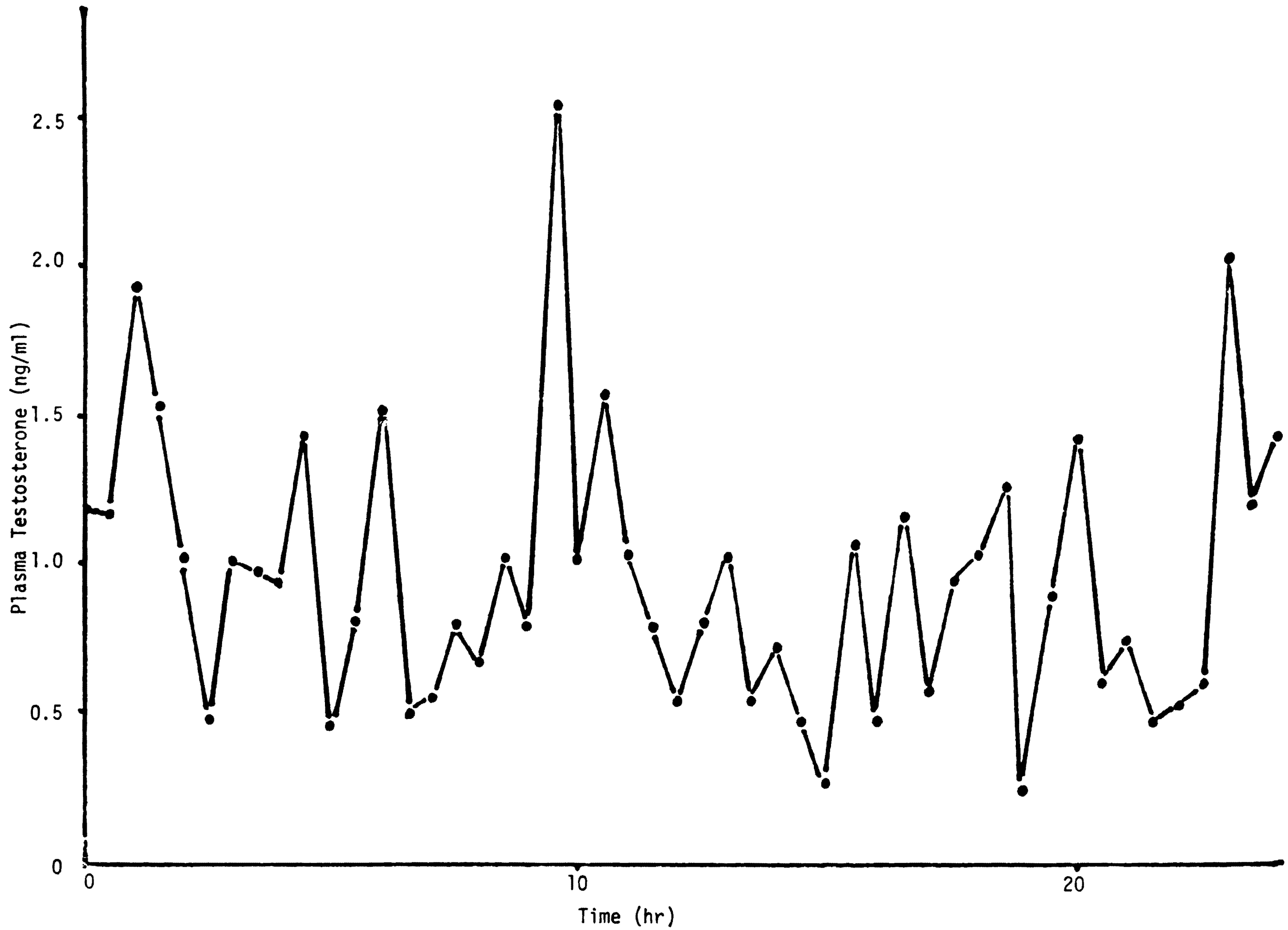
Results and Discussion

The external genitalia of the animal was predominately female. The vulva was upturned and elongated, with an enlarged protruding clitoris. The animal urinated through an orifice resembling that of a normal gilt although urination occurred in spurts, which is typical for a boar. A well-developed scrotum contained one testis, the left, with the right testis being abdominal. On the belly of the animal was a rudimentary sheath which contained no penis. By ten months of age the animal had developed the secondary sex characteristics of a boar; e.g., prominant and heavy muscling over the neck, thickened skin and tusk growth. The behavior of the animal resembled that of a boar. It salivated, mounted, achieved an erection of the elongated clitoris and demonstrated typical male copulatory behavior including a thrusting of the pelvis.

Removal of the reproductive tract following euthanasia enabled a detailed examination of the reproductive tract. The tract contained only testes, classifying the animal as a male pseudohermaphrodite. The testes were small, with the scrotal testis much smaller than the abdominal testis. Associated with each testis was a well developed epididymis which led to a structure resembling an oviduct, uterine horns and body, cervix, and vagina. The reproductive tract was supported by a well developed, normal appearing broad ligament. Lying along the cervix was a pair of well-developed seminal vesicles and lying along the vagina was a similarly well-developed pair of bulbo-urethral glands and a prostate gland. Within the vagina was a highly coiled internal penis which continued externally as the enlarged clitoris. The internal penis was associated with well-developed retractor penis muscles. Cross-sectional analysis of the uterine horns revealed a poorly developed uterine endometrium.

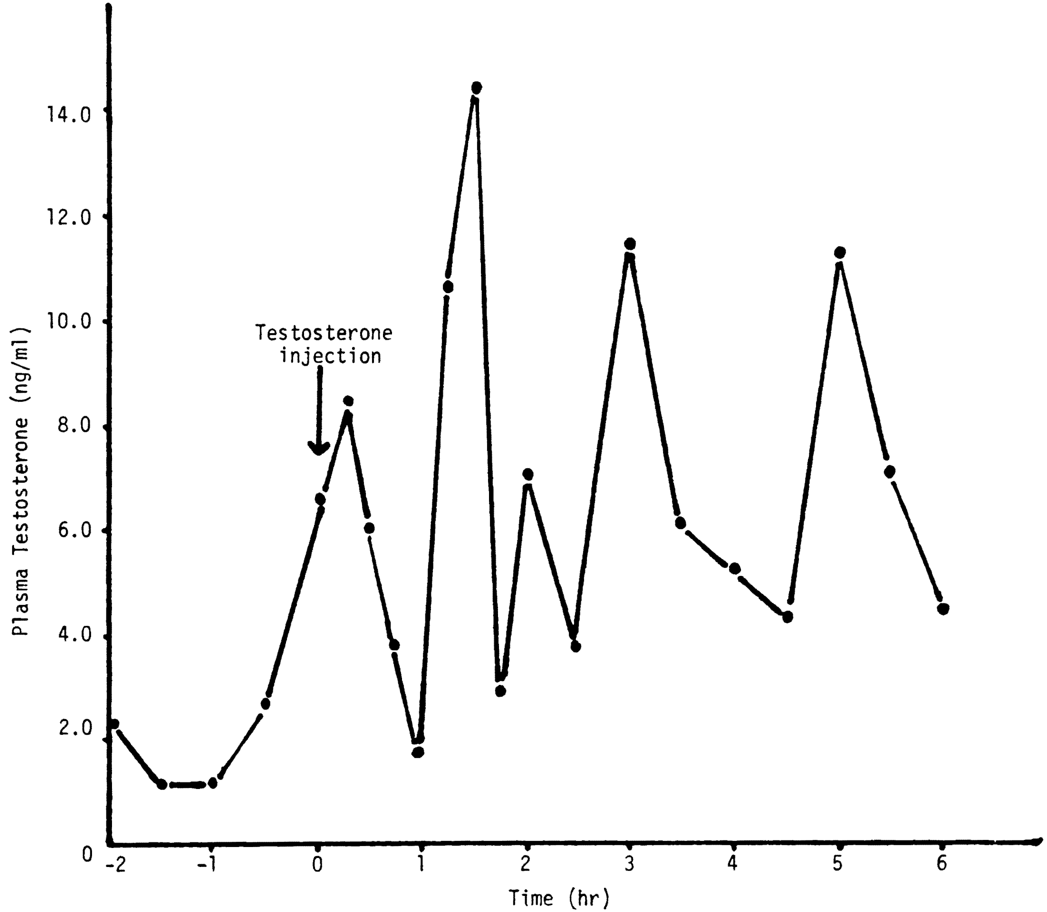
A plot of the 24-hour variation in plasma testosterone is shown in figure 1. Values range between 0.5 and 2.5 ng/ml with major peaks occurring at approximately 10-hour intervals. This diurnal variation in plasma testosterone shows a pattern similar to that of a normal boar. The response to an exogenous testosterone challenge is shown in figure 2. Testosterone injection resulted in a marked increase in plasma testosterone levels over the baseline values. The sharp drop in plasma testosterone immediately following injection may be due to a shutdown of endogenous testosterone production following the initial surge of injected hormone. Figure 3 contains a plot of the response of plasma testosterone to HCG challenge. Plasma testosterone level showed a marked increase one hour following injection of HCG. The response of the testes to exogenous hormonal challenge is similar to that reported by other workers and similar to preliminary results in our lab using normal boars. These data indicate that the testicular tissue of the animal was capable of a normal response to pituitary gonadotropins and that the normal positive and negative feedback relationships of a boar were operational. Plasma samples will subsequently be assayed for androstenedione and luteinizing hormone concentrations.

In summary, this intersex swine contained, with the exception of ovaries, all components of both male and female reproductive tracts. External genitalia was female but secondary sex characteristics were male. Behavioral traits and endocrine profile resembled those of a normal boar.



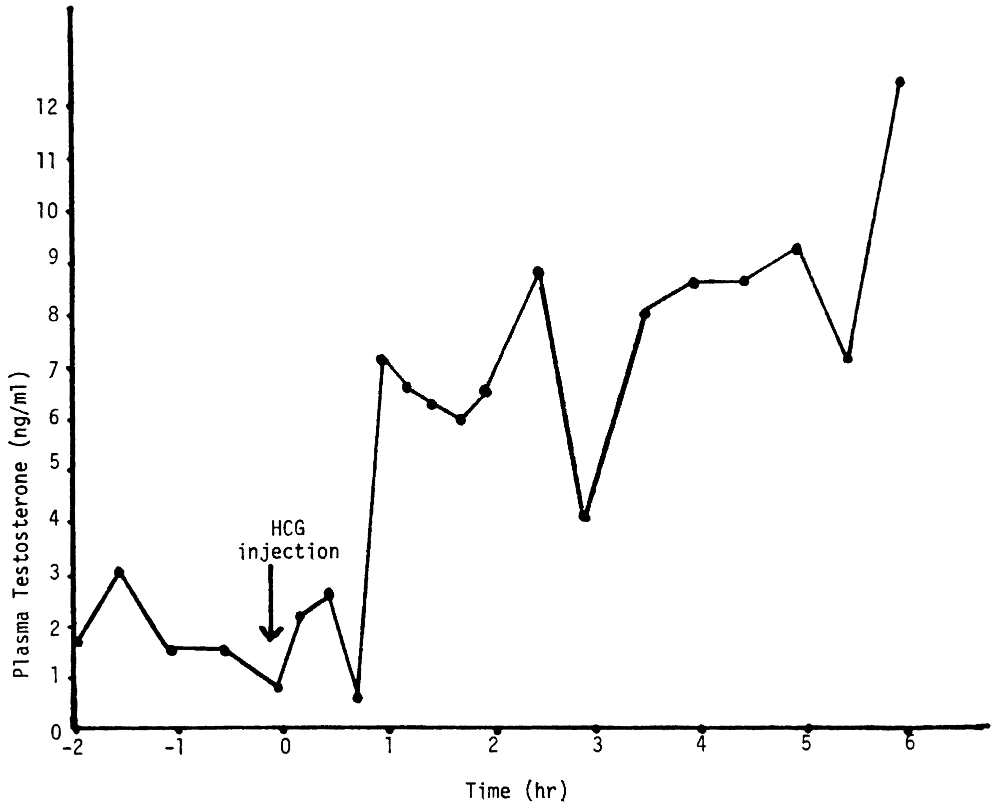
24 Hour Variation in Plasma Testosterone

Figure 1.



Response of Plasma Testosterone to Testosterone Challenge

Figure 2.



Response of Plasma Testosterone to HCG Challenge
Figure 3.

EFFECTS OF APPLIED STRESS DURING MIDGESTATION ON SELECTED ENDOCRINOLOGICAL, PHYSIOLOGICAL AND REPRODUCTIVE PERFORMANCE PARAMETERS OF GILTS

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The mechanism(s) by which stress affects reproduction is not well understood. Marple et al. (1972) found that a high temperature, low humidity environment decreased plasma corticosteroid concentrations and increased plasma adrenocorticotrophic hormone (ACTH) in non-pregnant crossbred gilts when compared to controls. It was suggested that the temperature-humidity stress induced a change in turnover time and increased the release rate of corticosteroid. Further studies by Marple and Cassens (1973) and Marple et al. (1974) on a swine herd bred to be stress susceptible, established that the metabolic clearance and turnover rates of cortisol were elevated in stress susceptible swine. Their data also incicated that stress susceptible swine had significantly higher ($P < .01$) mean plasma cortisol and corticosteroid binding globulin (CBG) concentrations and a significantly lower ($P < .01$) mean cortisol-CBG affinity than non-stress susceptible swine.

Likewise, Kattesh et al. (1976), in an initial investigation similar to the present one, demonstrated a depression in glucocorticoid concentrations concomitant with exposure to applied heating and crowding stress. They also reported a positive ($P < .01$) correlation between glucocorticoid concentration and CBG binding capacity ($r = .63$) and found no changes in the affinity of cortisol to bind CBG over the period of stress treatment.

The objective of this investigation was to examine the effects of combined heat and crowding stress on gilts during mid-pregnancy. Parameters examined included corticosteroid concentrations, cortisol binding capacity to corticosteroid binding globulin (CBG) and affinity of cortisol to bind to CBG prior to and during applied stress, and the subsequent reproductive performance of the gilts.

Experimental Procedures

A total of 26 mature, nulliparous gilts consisting of 21 purebred Yorkshires and 5 crossbreds (Hampshire X Yorkshire X Duroc) were checked for estrus once daily and bred following initial estrus detection and again within 12 hours of the first breeding to one of five Yorkshire boars and randomly assigned in equal numbers to either a stressed or control group. One gilt in each treatment group returned to estrus shortly after the initiation of treatment and one gilt in the control group aborted at 97 days of gestation. Thus, the data which will be reported is based upon

[1]Appreciation is expressed to the Virginia Pork Industry Commission for financial support.

12 stressed and 11 control gilts.

Gilts assigned to the stressed group were assumed pregnant based upon non-return to estrus by 21 days post-breeding and were moved to the stress chamber where they remained for the next 50 days of gestation (i.e., in the heat chamber from day 21 to day 71 of pregnancy). The 12 stressed gilts were housed in two wooden slotted floored pens (6 gilts/pen). The space per gilt in the stressed group was .9 m^2. The average daily temperature within the stress chamber during the 50 days of treatment was 34.0 ± .2 C (range = 28-38 C). The average percent relative humidity in the chamber over this same period of time was 49.6 ± 1.7 (range = 40-64). Control gilts were maintained in an outside dirt lot and subjected to normal ambient temperatures over the same days of gestation. The average daily temperature, percent and relative humidity during this period was 4.5 ± 0.6 C (range = -8 to 22 C) and 70.4 ± 1.8 (range = 43 to 100), respectively. Rectal temperature was monitored in all gilts throughout gestation.

All gilts in both treatment groups were bled via vena cava puncture day -1 and 0 prior to treatment initiation and at 1, 5, 9 ± 1, 29 ± 1 and 50 (end of treatment) days afterwards. Additional samples were taken 15 ± 3 and 40 ± 1 days after treatment ended to determine possible carry-over effects of the stress treatment. These nine sampling periods corresponded to days 20, 21, 22, 26, 30±1, 50±1, 71, 86±3 and 111±1 of gestation, respectively. Plasma glucocorticoid concentrations were measured on each sample using a competitive protein binding assay (Murphy, 1967), as modified by Gwazdauskas et al. (1973). Cortisol binding capacity to CBG and the affinity of cortisol to bind CBG were also measured according to the techniques of Pegg and Keane (1969) and Marple et al. (1974) as modified by our lab.

All animals were hand fed a 16% crude protein corn-soybean meal diet at a rate of 2.3 kg per head per day throughout gestation. At the time of feeding, animals in the stress chamber were moved to an adequately spaced, solid floored room kept at normal ambient temperatures and permitted 30 min to consume the ration. Average daily feed consumption was measured during the treatment period to assess possible effects of the stress treatment on appetite. Feed consumption was also measured for the control animals which were fed on a concrete slab within the dirt lots. Water was provided ad libitum to both groups.

All data were statistically analyzed by simple linear regression (Snedecor and Cochran, 1967) to evaluate the effects of treatment, time and their interactions on glucocorticoid concentration, cortisol binding characteristics and gestation length, total number of pigs born, number born alive, number stillborn, survival rate at 3, 7 and 14 days and total and mean birth weights. Significant differences among means were determined using the method of Duncan (1955).

Results

The mean glucocorticoid concentrations for the stressed and control gilts as measured at the nine sampling periods are shown in table 1. An analysis of the mean corticoid changes by time indicated an initial

TABLE 1. GLUCOCORTICOID CONCENTRATIONS (ng/ml) CORTICOSTEROID BINDING GLOBULIN (CBG) BINDING CAPACITIES (μg/100 ml) AND ASSOCIATION CONSTANTS (K_a x $10^8 M^{-1}$) FOR STRESSED AND CONTROL GILTS[†] PRIOR TO AND FOLLOWING INITIATION OF APPLIED STRESS

Day of treatment[1]	Stressed (N = 12)			Control (N = 11)		
	Glucocorticoid	CBG	K_a	Glucocorticoid	CBG	K_a
-1	39.2 ± 3.7^{abc}	---	---	47.6 ± 7.9	---	---
0	36.2 ± 4.5^{abc}	$8.7 \pm .3^{a}$	$4.0 \pm .7^{a}$	45.5 ± 8.1	$8.5 \pm .4$	$5.1 \pm .7^{ab}$
1	36.4 ± 4.4^{abc}	$8.1 \pm .2^{a}$	$2.4 \pm .3^{b}$	47.6 ± 6.9	$8.5 \pm .4$	$5.9 \pm 1.0^{ab}_{f}$
5	29.8 ± 2.6^{bc}	---	---	42.4 ± 7.2	---	---
9 ± 1	$34.2 \pm 4.7^{bc}_{e}$	$6.5 \pm .3^{b}_{e}$	$2.5 \pm .3^{b}_{e}$	$54.8 \pm 5.1_{f}$	$9.1 \pm .4_{f}$	$5.8 \pm 1.0^{ab}_{f}$
29 ± 1	34.7 ± 6.7^{bc}	$6.9 \pm .3^{b}_{e}$	$3.2 \pm .3^{ab}$	45.5 ± 6.9	$9.2 \pm .5_{f}$	6.6 ± 1.3^{a}
50	51.5 ± 6.6^{a}	$6.7 \pm .3^{b}_{e}$	$3.0 \pm .4^{ab}$	53.7 ± 8.7	$8.6 \pm .6_{f}$	$3.3 \pm .5^{b}$
65 ± 3	39.1 ± 5.3^{abc}	---	---	56.4 ± 6.7	---	---
90 ± 1	47.3 ± 5.3^{ab}	---	---	60.8 ± 5.3	---	---

[†] $\bar{X} \pm$ S.E.M. of combined purebred and crossbred values.
[1] Day -1 of treatment corresponds to day 20 of gestation etc.
[abc] Means with different superscripts in the same column are significantly different (P< .05 or greater).
[ef] Means with different superscripts in the same row pertaining to the same parameter are significantly different (P< .05 or greater).

TABLE 2. COMPARISON OF REPRODUCTIVE PERFORMANCE OF STRESSED AND CONTROL GILTS†

Parameter	Stressed	Control
Gestation length, days	114.1 $\pm$ 0.4	114.8 $\pm$ 0.6
To. pigs born, No.	10.0 $\pm$ 0.6	11.2 $\pm$ 0.7
To. pigs born alive, No.	8.7 $\pm$ 0.7	9.7 $\pm$ 0.5
To. stillborn, No.	1.3 $\pm$ 0.5	1.5 $\pm$ 0.5
To. mummified fetuses, No.	0.4 $\pm$ 0.3	0
To. pigs alive, 3 days, No.	7.7 $\pm$ 0.6	8.8 $\pm$ 0.6
To. pigs alive, 7 days, No.	7.2 $\pm$ 0.6	8.5 $\pm$ 0.6
To. pigs alive, 14 days, No.	7.1 $\pm$ 0.7	8.1 $\pm$ 0.8
To. birth wt., kg.	10.3 $\pm$ 1.0	12.2 $\pm$ 1.0
Mean birth wt., kg.	1.18 $\pm$ 0.05	1.25 $\pm$ 0.05

† $\bar{X} \pm$ S.E.M.

depression in corticoid levels in the stressed gilts during the first 5 days of treatment. The glucocorticoid concentration at day 5 of treatment (day 26 of gestation) represented a significant ($P < .01$) nadir. From day 5 to day 29 of treatment, glucocorticoid concentrations remained significantly lower ($P < .05$) than pre-treatment values. However, the concentrations increased from day 29 of treatment (day 50 of gestation) until the termination of applied stress at day 71 of gestation. The glucocorticoid levels at this point were significantly ($P < .01$) greater than pre-treatment basal levels. Following this apex coincident with the termination of treatment, there was a precipitous decline followed by a significant increase ($P < .05$) in glucocorticoid concentration for the stressed gilts over the last two sampling periods. No significant ($P > .10$) changes were found among mean glucocorticoid concentrations for each sampling period in the control gilts when similarly analyzed. There was a significant ($P < .05$) curvilinear relationship ($r^2 = .25$) between glucocorticoid concentration and time for the stressed animals when samples taken prior to and during treatment were analyzed. The coefficient of variation for glucocorticoid concentration was similar for both the stressed and control gilts (CV = 44.9 and 46.5%, respectively).

The CBG binding capacities and association constants for control and stressed gilts during the treatment period are shown in table 1. The CBG binding capacities for both groups of gilts were similar during days 0 and 1 of the treatment period. However, from day 9 until the end of the treatment, the stressed gilts exhibited significantly ($P < .01$) lower CBG binding capacities compared to either initial basal levels or to the values for control gilts at the respective sampling periods. Stressed gilts had significantly lower ($P < .05$) mean association constants at the first and ninth days of treatment as compared to the mean K_a values measured for the control gilts. Within treatment, mean K_a values from day 1 to day 50 in the stressed gilts were significantly ($P < .05$) lower than the day 0 value.

Parameters measured pertaining to the overall reproduction performance of the two treatment groups of gilts are shown in table 2. There was no difference between stress treated (114.1 ± 0.4 days) and the control (114.8 ± 0.6 days) gilts in regards to gestation length. Control gilts farrowed an average of 1.2 more total pigs and 1.0 more live pigs compared to the stressed gilts, but these differences were not statistically significant ($P > .10$). Likewise, there were no significant ($P > .10$) treatment differences in regard to number of stillborn pigs or mummified fetuses.

Survival rates of pigs at 3, 7 and 14 days of age were similar for both groups of gilts. The total birth weights and mean birth weights of the pigs from the control gilts tended to be slightly higher than the values for the stressed gilts. However, based upon the number of pigs involved, these differences were not statistically significant ($P > .10$) treatment effects on the sex ratio at any of the observation periods.

The average daily rectal temperature, as measured throughout the treatment period, was not significantly ($P > .10$) different between stress ($38.8 \pm .04$ C) and control ($38.7 \pm .04$ C) gilts, suggesting that the stress was not severe enough to result in an elevation of internal body temperature. A more rapid respiratory rate was observed in the stressed gilts, but unfortunately, this difference was not quantified.

Feed consumption for the stressed gilts measured during the treatment period averaged 58% of that consumed for the control gilts during the same period of time. Although a depression in appetite was apparent for the stressed gilts, overall mean differences in body weights between the two treatment groups were not significant (P >.10).

Summary

The effects of applied heat and crowding stress during midgestation on glucocorticoid concentrations, corticosteroid binding globulin (CBG) characteristics and reproductive performance parameters of 23 gilts were evaluated. Plasma glucocorticoid concentrations were significantly reduced by day 5 post-stress initiation. A return to pre-treatment glucocorticoid concentrations by the end of the stress treatment was observed. The CBG binding capacities similarly declined in stressed gilts. The affinity (K_a) of cortisol to bind to the CBG molecule was significantly (P< .05) lowered in the stressed gilts by day 1 of stress. Reproductive performance was not measurably affected by stress.

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SCROTAL CIRCUMFERENCE AND TESTICULAR CONSISTENCY OF YEARLING BEEF BULLS

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The need has arisen for a method of predicting potential fertility in beef bulls at the earliest possible age. If the potentially subfertile bull can be identified and eliminated, the breeder could then greatly improve the efficiency of his breeding program.

Measurements of scrotal circumference (SC) and testicular consistency (TC) and their relationship with fertility have been studied in dairy bulls. It appears that there is a positive relationship, particularly with SC. However, little research has been conducted to determine if these relationships hold true for beef bulls. This study was conducted to: a) determine the SC and TC of performance tested, yearling beef bulls of various breeds; b) correlate these values with performance data; c) study the relationship between several semen characteristics and SC and TC measurements of yearling beef bulls; and d) attempt, by means of a buyer survey, to evaluate the overall desirability of the beef bulls sold through two Virginia B.C.I.A. Bull Test Stations.

Experimental Procedure

Nine hundred fifteen beef bulls ranging in age from 270 to 528 days were measured at three locations in Virginia over a two-year period from January, 1976 to April, 1977. There were 515 Angus, 19 Hereford, 6 Santa Gertrudis, 14 Red Angus, 120 Simmental, 2 Devon, 20 Charolais, 3 Brangus and 216 Polled Hereford (Table 1). All bulls were classified by breeds and 30-day age groups within breeds. Bulls 330 days of age or less were designated as Age Group 1. Age Group 8 included all bulls 511 days of age or older. Average daily gain and final weight values were based on the 140-day performance test.

Initial testicular measurements were made before the bulls were placed on 140-day performance test. Final testicular measurements were made after the bulls had completed the performance test.

Initial scrotal circumference and final scrotal circumference measurements were taken with the testes fully descended into the scrotum. These measurements were made at the largest diameter of the scrotum using a flexible circular metal tape. The metal tape was calibrated in centimeters with values recorded to the nearest .5 cm.

Testicular consistency measurements were taken at the same location on the scrotum using a two spring tonometer consisting of a weak and a strong spring. The weak and strong spring tonometer values reported were an average of two weak and two strong spring values per bull. TC values were measured on a .1 cm scale.

Seven bulls of the Angus and Polled Hereford breeds were each collected for two weeks. Each ejaculate was evaluated for volume, concentration, and percentage of cells showing progressive forward motility. First ejaculates were also evaluated for the percentage of intact acrosomes. SC and TC measurements were taken and correlated with the semen characteristics to relate these measurements to sperm quantity and quality, respectively.

Two buyers' surveys were sent to the person or organization which purchased the bulls sold through the two Virginia B.C.I.A. Bull Test Stations, Culpeper and Red House. The first survey asked the buyer to evaluate the bull's development, fertility, and soundness. The second survey asked the buyer to evaluate the bull's calves and the bull's fertility after a breeding season.

Statistical analyses were conducted to compare initial and final values of SC and TC with the performance parameters and to relate SC and TC values with sperm quantity and quality.

Results

The means and standard deviations for initial and final SC were derived for animals by breed and by age groups within breeds. These values are shown in Table 2 for the Angus, Simmental and Polled Hereford breeds. Means and standard deviations for the Hereford, Santa Gertrudis, Red Angus, Devon, Charolais, and Brangus breeds were calculated, but are not shown due to the small number in these breeds.

Final weak-spring TC values were correlated .87 ($P<.01$) with final strong-spring TC values for all breeds. Therefore, the values in Table 3, for TC, are final weak-spring readings only. Initial weak and strong-spring TC values were taken, but due to the small numbers are not shown.

Both initial and final SC values increased as age increased for the breeds shown in Table 2. TC decreased as age increased (Table 3).

Correlation coefficients between final SC and final weak-spring TC with performance traits for all breeds are shown in Table 4. Highest correlations were found between final SC and final weight .54 and age .43 (both $P<.01$). Initial SC measurements were correlated .60 ($P<.01$) with final SC values. Final SC was negatively correlated with final weak-spring TC, -.31 ($P<.01$). Final weak-spring TC was correlated -.25 with final weight and -.38 with age (both $P<.01$).

Least-squares means for final SC for the Angus breed were greater than the means for Simmental and Polled Hereford ($P<.01$).

The correlations between SC and first and second ejaculate semen traits are shown in Table 5. SC was positively correlated with ejaculate volume, .53 ($P<.01$) for first ejaculate, .57 ($P<.05$) for second ejaculate; and with sperm output, .55 for first ejaculate and .71 for second ejaculate ($P<.01$). No significant correlations were found between TC and the semen traits.

There was no significant correlation found between the percentage calf crop, determined from the buyer surveys, and the sire's final SC value.

Table 6 presents the recommended minimum final SC values for the Angus, Simmental and Polled Hereford breeds. These values were calculated from the recommendation that any bull whose final SC is two standard deviations or more below the mean for its breed and age should be considered subfertile.

Summary

Nine hundred fifteen yearling beef bulls were measured to determine SC and TC values. The bulls were assigned to 30-day age groups within breeds. SC is an easily measured trait and highly correlated with age, final weight, ejaculate volume and sperm output. There is a significant difference in final SC means between breeds.

Testicular consistency, as determined in this study, does not appear to be of value in predicting semen quality.

TABLE 1

NUMBER AND DISTRIBUTION OF BULLS BY BREED AND LOCATION

Breed	Culpeper[a]	Red House[a]	Marland Farms[b]	Total
Angus	202	312	1	515
Hereford	13	6	-	19
Santa Gertrudis	3	3	-	6
Red Angus	4	10	-	14
Simmental	7	18	95	120
Devon	2	-	-	2
Charolais	3	17	-	20
Brangus	2	1	-	3
Polled Hereford	83	133	-	216
			Total	915

[a]Virginia BCIA Bull Test Stations.

[b]Private bull test station.

TABLE 2

INITIAL[a] AND FINAL[b] SCROTAL CIRCUMFERENCE BY BREED AND AGE GROUP (1976-1977)

Age Range	Angus		Simmental		Polled Hereford	
(Days)	ISC[c]	FSC[d]	ISC	FSC	ISC	FSC
≤ 330	-	32.8 ± 2.8 (4)	-	32.3 ± 2.0 (7)	-	-
331-360	25.6 ± 2.5[e](12)[f]	33.0 ± 3.1 (71)	22.5 ± 2.4 (11)	33.6 ± 2.2 (22)	24.4 ± 4.3 (8)	32.3 ± 2.9 (21)
361-390	26.4 ± 2.7 (33)	34.4 ± 2.7 (133)	24.8 ± 2.3 (29)	34.5 ± 2.8 (43)	27.4 ± 2.8 (25)	33.8 ± 2.7 (50)
391-420	29.6 ± 2.7 (55)	36.1 ± 3.4 (137)	27.5 ± 2.1 (21)	35.8 ± 2.3 (34)	29.9 ± 3.1 (19)	34.2 ± 2.8 (41)
421-450	32.4 ± 2.7 (35)	37.0 ± 3.3 (106)	33.4 ± 2.3 (5)	40.0 ± 1.2 (5)	30.6 ± 2.5 (30)	35.5 ± 2.4 (60)
451-480	33.4 ± 2.8 (23)	37.9 ± 2.8 (47)	-	38.5 ± 2.9 (7)	31.0 ± 3.5 (18)	35.9 ± 2.7 (33)
481-510	35.0 ± .0 (1)	39.2 ± 2.3 (15)	-	44.5 ± .0 (1)	30.6 ± 2.1 (5)	35.4 ± 2.1 (11)
≥ 511	-	38.4 ± 1.4 (2)	-	34.3 ± .0 (1)	-	-

[a]Measurements taken at the beginning of 140-day performance test.

[b]Measurements taken at the end of 140-day performance test.

[c]Initial Scrotal Circumference in centimeters.

[d]Final Scrotal Circumference in centimeters.

[e]Mean ± standard deviation.

[f]( ) Number of observations.

TABLE 3

FINAL[a] WEAK SPRING TESTICULAR CONSISTENCY BY BREED AND AGE GROUP[b] (1976)

Age Range (Days)	Angus	Simmental	Polled Hereford
$\leq$ 330	1.85 $\pm$ .10[c] (3)[d]	1.85 $\pm$ .09 (7)	-
331-360	1.77 $\pm$ .16 (48)	1.85 $\pm$ .10 (21)	1.65 $\pm$ .25 (6)
361-390	1.79 $\pm$ .14 (78)	1.84 $\pm$ .11 (42)	1.75 $\pm$ .19 (12)
391-420	1.71 $\pm$ .18 (64)	1.81 $\pm$ .08 (34)	1.74 $\pm$ .12 (20)
421-450	1.70 $\pm$ .15 (63)	-	1.61 $\pm$ .18 (30)
451-480	1.58 $\pm$ .25 (23)	1.69 $\pm$ .22 (17)	1.57 $\pm$ .24 (15)
481-510	1.59 $\pm$ .16 (14)	1.45 $\pm$ .00 (1)	1.60 $\pm$ .15 (6)
$\geq$ 511	1.55 $\pm$ .21 (2)	1.70 $\pm$ .00 (1)	-

[a]Measurements taken at the end of 140-day performance test in centimeters.

[b]All values reported in centimeters.

[c]Means $\pm$ standard deviation.

[d]( ) Number of observations.

TABLE 4

CORRELATION COEFFICIENTS OF FINAL[a] SCROTAL CIRCUMFERENCE AND FINAL[a] WEAK SPRING TESTICULAR CONSISTENCY WITH PERFORMANCE TRAITS (1976-1977)

Trait	Final Scrotal Circumference	Final Weak-Spring Testicular Consistency
Adj. 205-day wt.	.27** (858)[d]	.01 (466)
Final wt.[b]	.54** (915)	-.25** (522)
A.D.G.[c]	.11** (915)	.12** (522)
Adj. 365-day wt.	.28** (858)	.03 (466)
Wt./Da. Age	.26** (915)	.06 (522)
Age	.43** (915)	-.38** (522)

[a]Measurements taken at the end of 140-day performance test.

[b]Weight taken at the end of 140-day performance test.

[c]Average daily gain on 140-day performance test.

[d]( ) Number of observations.

**P<.01.

TABLE 5

CORRELATION COEFFICIENTS OF SCROTAL CIRCUMFERENCE WITH SEMEN TRAITS OF THE FIRST AND SECOND EJACULATE

Trait	Scrotal Circumference	
	First Ejaculate	Second Ejaculate
Volume	.53**(23)[a]	.57* (19)
Concentration	.01 (22)	.30 (19)
Motility[b]	.27 (23)	.17 (19)
Intact acrosome[c]	-.16 (22)	-
Total sperm output	.55**(22)	.71**(19)

[a]( ) Number of observations.

[b]Percentage of sperm showing progressive forward motility.

[c]Percentage of intact normal acrosomes.

*P<.05.

**P<.01.

TABLE 6

RECOMMENDATIONS FOR MINIMUM FINAL SCROTAL CIRCUMFERENCE BY BREED AND AGE (1976 & 1977)[a]

Age		Breeds		
Group	Range (Days)	Angus	Simmental	Polled Hereford
1	≤ 330	27.2[b] (4)[c]	28.3 (7)	-
2	331-360	26.8 (71)	29.2 (22)	26.5 (21)
3	361-390	29.0 (133)	28.9 (43)	28.4 (50)
4	391-420	29.3 (137)	31.2 (34)	28.6 (41)
5	421-450	30.4 (106)	37.6 (5)	30.7 (60)
6	451-480	32.3 (47)	32.7 (7)	30.5 (33)
7	481-510	34.6 (15)	44.5 (1)	31.2 (11)
8	≥ 551	35.6 (2)	34.3 (1)	-

[a]Values shown are 2 s.d. below observed breed average for data in this study.

[b]All values reported in centimeters.

[c]() Number of observations on which recommendation is based.

ADJUSTMENT FACTOR COMPARISONS FOR CROSSBRED AND STRAIGHTBRED COWS

T. J. Marlowe and W. H. Whittle, Jr.

Because of the rapid growth of crossbred cows in commercial cow-calf operations, and also because of the use of crossbred cows in estimating the breeding value of herd sires, there is a need to know if the adjustment factors presently in use for straightbred cows and calves are also applicable to straightbred cows producing crossbred calves and/or to crossbred cows producing crossbred calves.

Materials and Methods

Data from five research herds and four herds in the Virginia Beef Cattle Improvement Program (BCIA) were used in this study. Certain limitations were placed on the data used, however, to include: 1) all herds must have been producing straightbred (SB) calves, crossbred (XB) calves out of straightbred cows and crossbred calves out of crossbred cows; 2) records must have been made during a five-year period, 1972-1976; 3) calves must have been weighed within the age range of 120-299 days; 4) cows were divided into age groups at calving of 18-25, 26-35, 36-45, 46-55 or 56-116 months, and coded as 2, 3, 4, 5 and 6-10 year olds; 5) calves were classified as straightbred calves (group 1), crossbred calves out of straightbred cows (group 2), and crossbred calves out of crossbred cows (group 3) and all bull calf records were eliminated.

Straightbred cows included Angus, Charolais, Hereford and Polled Hereford. Crossbred cows included Angus x Hereford, Brown Swiss x Hereford, Charolais x Hereford, Holstein x Hereford, Red Polled x Hereford, Shorthorn x Hereford, Simmental x Hereford, Charolais x Angus, Holstein x Angus, Charolais x Holstein, and Angus x Shorthorn.

Records were available on 5031 straightbred calves, 6718 crossbred calves out of straightbred cows and 3154 crossbred calves out of crossbred cows for a grand total of 14,903 records. Of these, 3590 records were from the five research herds and 11,313 from the four BCIA herds. A further breakdown showed 1046 and 2108 in group 1; 1679 and 5037 in group 2; and 865 and 4166 in group 3 for the research and BCIA herds, respectively.

The statistical model used to estimate the least squares means and constants was Harvey's Least Squares and Maximum Likelihood General Program for Fixed Models, revised January 1977. Included in the model for each of the breeding groups analyzed separately were the independent variables of herd, year, age of dam, sex of calf, season of birth, age of calf, and age of dam x sex of calf interaction. When all breeding groups were included in a single analysis, the model was enlarged to include breeding groups and breeding group x sex and breeding group x age of dam interactions.

The age of dam and month of birth groupings were based on the study by Marlowe, Mast and Schalles (1965). Months of birth were grouped and coded as season of birth as follows: 1 = January and June, 2 = February and May; 3 = March and April, 4 = July and September, 5 = August and October, and 6 = November and December.

The number of observations within each breeding group is shown in table 1 by herd, year, age of cow, season of birth and sex of calf subgrouping.

Results and Discussion

In the combined analysis (table 3) all independent variables included in the model (herd; year; age of dam; sex, season of birth and age of calf; breeding group; and the three interaction terms) had a significant effect ($P < .01$) on each of the dependent variable (birth weight, preweaning ADG and weaning weight) with the exception of sex x breeding group interaction which was significant at the .04 level. In the individual breeding group analyses, all independent variables had a significant effect on weaning weight except for the age of dam x sex interaction in breeding groups I and II.

These analyses indicate that the major non-genetic influences for which adjustments would be beneficial to the breeder when comparing animal performance under similar management conditions and within the same year in his own herd are age of cow, sex of calf and age of calf at weaning, especially if calves are weighed outside of the BIF recommended age range of 160 to 250 days. In these analyses, the effect of age when weights were taken accounted for a large fraction of the total sums of squares.

Age of Dam. Calf birth weights, preweaning ADG and weaning weights all increased as age of dam increased from two years to maturity (6-10 years), with the largest differences occurring between the two- and three-year-old cows and the differences diminishing as the cows got older. The age of dam effect on weaning weight was similar within the three breeding groups. For example, the differences in calf weaning weights between two-and three-year-old dams were 49, 51 and 56 pounds for straightbred calves, crossbred calves out of straightbred cows and crossbred calves out of crossbred cows, respectively. Differences among the three breeding groups were small for the other age of cows groups also, except for the differences between the three- and four-year-old cows. In this case, the difference for the straightbred cows producing crossbred calves was almost double that of the other two groups (22, 38, 21 pounds).

Sex of Calf. Steer calves were heavier at birth, grew faster to weaning and weaned heavier than heifer calves by about 18 pounds. This difference was greatest between the straightbred calves.

Breeding Group. Kind of cows and mating system (straight-or crossbreeding) has a highly significant effect on birth weight, preweaning ADG and weaning weight. Crossbred calves were heavier at birth, gained faster from birth to weaning and weaned heavier than straightbred calves. Crossbred cows produced calves that were heavier at birth, grew faster and weaned heavier than straightbred calves or crossbred calves out of straightbred cows. However, these analyses indicate that age of dam effect was similar in each breeding group except for the much larger difference between three-and four-year-old straightbred cows producing crossbred calves. Sex differences were smaller when the calves were crossbred regardless of whether they were out of straightbred or crossbred cows (20 vs 12 or 10).

TABLE 1. NUMBER OF OBSERVATIONS BY GROUPS WITHIN HERDS, YEARS, AGE OF DAM, SEASON OF BIRTH AND SEX OF CALF CLASSIFICATION

Classification		Group 1	Group 2	Group 3	Combined
Herd	1400	142	230	180	552
	2057	125	145	303	573
	2401	269	280	362	911
	2402	64	180	181	425
	2403	102	194	135	431
	2404	288	795	189	1272
	4017	1804	2174	827	4809
	5000	2037	2504	704	5245
	7027	200	212	273	685
Year	1972	1450	1042	184	2676
	1973	1411	1197	457	3065
	1974	1160	1835	661	3656
	1975	500	1538	698	2736
	1976	510	1106	1154	2770
Age of cow	2	1029	1139	977	3145
	3	1029	1235	938	3202
	4	659	1257	518	2434
	5	537	873	341	1751
	6	1777	2214	380	4371
Season	1	216	458	182	856
	2	804	896	574	2274
	3	3185	3671	1497	8353
	4	58	90	77	225
	5	159	317	213	689
	6	609	1286	611	2506
Sex	heifer	2634	3799	1775	8208
	steer	2397	2919	1379	6695
Total observations		5031	6718	3154	14,903

TABLE 2. LEAST SQUARES MEANS FOR WEANING WEIGHT BY AGE OF DAM, SEX OF CALF, SEASON OF BIRTH AND BREEDING GROUP

Variable	Breeding groups		
	I	II	III
Age of cow			
2	301	314	362
3	350	365	418
4	372	403	439
5	378	411	442
6-10	389	423	449
Sex of calf			
H	348	377	412
S	368	389	432
Season of birth			
Jan, Jun	361	370	428
Feb, May	357	374	420
Mar, Apr	362	382	414
Jul, Sept	358	396	433
Aug, Oct	361	401	414
Nov, Dec	349	375	422
Overall mean	358	378	408

Group I = straightbreds; II = crossbred calves out of straightbred cows; III = crossbred calves out of crossbred cows.

TABLE 3. LEAST SQUARES MEANS FOR BIRTH WEIGHT, PREWEANING AVERAGE DAILY GAIN AND WEANING WEIGHT BY BREEDING GROUP, AGE OF DAM, SEX OF CALF AND SEASON OF BIRTH WHEN ALL BREEDING GROUPS WERE INCLUDED IN THE SAME ANALYSIS

Variable	Birth weight	Prewean ADG	Wean weight
Breeding group			
I	67.4	1.41	362
II	72.4	1.51	390
III	73.5	1.66	419
Age of dam			
2	65.7	1.25	326
3	70.8	1.47	379
4	72.8	1.60	409
5	73.1	1.63	414
6-10	73.1	1.68	424
Sex of calf			
H	68.8	1.49	381
S	73.3	1.56	399
Season of birth			
Jan, Jun	72.4	1.50	384
Feb, May	71.2	1.51	385
Mar, Apr	70.8	1.53	390
Jul, Sept	68.9	1.55	401
Aug, Oct	71.6	1.55	397
Nov, Dec	71.6	1.50	384
Overall mean	71.1	1.53	390

Group I = straightbreds; II = crossbred calves out of straightbred cows; III = crossbred calves out of crossbred cows.

Season of Birth. The effect of season of birth was small (but significant) on birth weight, preweaning gains and weaning weight. The biggest surprise was to learn that calves born during the summer months weaned at about the same weight as calves born during other seasons. This is contrary to what was found by Marlowe, Mast and Schalles (1965) and others.

Age at Weighing. This variable was highly significant in all analyses and accounted for a large percentage of the total variation. This finding indicates that calves should be weighed as close to the same age as is practical.

It appears that the same age of dam adjustment will apply equally well to straightbred and crossbred cows except perhaps when straightbred cows are producing crossbred calves, in which case some additional adjustment may be needed for the three-year-old cows. There also appears to be a difference in adjustments needed for sex difference between straightbred and crossbred calves.

PERFORMANCE OF FINN CROSS EWES

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

Preliminary results of this test were reported in the 1973-74, 1974-75, 1975-76, 1976-77 Livestock Research Reports.

Three groups of ewes (located at Blacksburg) are involved. They are 1/2 and 1/4 Finn blood, the other 1/2 or 3/4 being Rambouillet, plus a small control group of Suffolk x Rambouillet ewes. These ewes are under an intensive management system with the lambs weaned at about five weeks of age and the ewe rebred in an attempt to raise three lamb crops in two years.

Seventy 1/2 Finn, ninety 1/4 Finn and nineteen Suffolk x Rambouillet ewes are being compared in this test. Eight of the 1/2 Finn ewes were born in 1971, thirty in 1972 and thirty-two in 1973. Forty-two 1/4 Finns were born in 1972 and forty-eight in 1973.

These ewes are handled as two flocks and are bred to lamb in September, April and January. Those that don't settle for September lambing are put with rams so that they can lamb in January. If they don't lamb in January they will have an opportunity to lamb in April. The cumulative production of these ewes is shown in table one below. The striking feature of this table is the high level of prolificacy of the 1/2 Finn ewes. The average number of lambs weaned (5-6 weeks) per ewe year is 2.75 for the 1/2 Finns, 2.18 for the 1/4 Finns and 1.7 for the Suffolk x Rambouillet.

TABLE 1. CUMULATIVE EWE PERFORMANCE 1972-1978

Kind of Ewe	No.	Age	Lambs born/ewe	Lambs weaned/ewe	Lambs born/ ewe year	Lambs weaned/ ewe year
1/2 Finn	8	7(6)	20.0	19.1	3.3	3.2
	30	6(5)	16.0	14.6	3.2	2.9
	32	5(4)	10.2	9.8	2.6	2.5
					(a)2.93	(a)2.75
1/4	42	6(5)	12.8	11.9	2.6	2.4
	48	5(4)	8.8	8.1	2.9	2.0
					(a)2.31	(a)2.18
Suffolk x Rambouillet	19	5(4)	7.7	6.9	1.9	1.7

() Productive years
a Average

The number of lambs born per ewe by season is shown in table two below. The performance of all ewes has improved with age. There is an indication of a seasonal difference in lambing performance. There were fewer lambs born in September (with a smaller percent of ewes lambing) and more in April than January.

TABLE 2. NUMBER OF LAMBS BORN PER EWE PER SEASON

Kind of Ewe	JANUARY	APRIL	SEPTEMBER	AVERAGE
1/2 Finn	2.29	2.61	1.87	2.28
1/4 Finn	1.88	2.04	1.53	1.82
Suffolk x Rambouillet	1.85	1.86	1.81	1.84

The conception rates of the ewes are shown in table three. The 1/2 Finn ewes are more consistent in lambing performance than either of the other kinds of ewe. They did much better than others when lambing in the fall season.

TABLE 3. CONCEPTION RATES (PERCENT EWES EXPOSED THAT LAMBED)

Kind of Ewe	Winter Lambs	Spring Lambs	Fall Lambs	Average
	%	%	%	%
1/2 Finn	79	78	62	73
1/4 Finn	79	79	47	65
Suffolk x Rambouillet	75	58	25	51

The 1/2 Finn ewes are lasting longer than the 1/4 Finn and the Suffolk x Rambouillet. Survival rates are: 1/2 Finn 73%, 1/4 Finn 66% and Suffolk x Rambouillet 62%.

All lambs were sired by Suffolk rams. Litters were reduced to two lambs per ewe shortly after birth and ewe was credited with weaning these extra lambs. Ewes and lambs were housed on slotted floor pens, lambs were weaned at 5-6 weeks of age and grown to market weight in these pens. They were fed a 16% concentrate ration from birth to market.

Lambs out of the Suffolk x Rambouillet ewes (control) were heaviest at birth and made the most rapid gain while those out of the 1/2 Finn ewes were lightest at birth and gained slowest. The performance of the lambs is shown in table four.

TABLE 4. PERFORMANCE OF LAMBS

Kind of Ewe	Average Birth wt.		Average Daily Gain Birth - Weaning		Average Daily Gain Birth - Market	
	lbs.	kgm.	lbs.	gms.	lbs.	gms.
1/2 Finn	8.61	3.91	.606	274.9	.531	240.9
1/4 Finn	9.44	4.28	.649	294.4	.572	259.5
Suffolk x Rambouillet	10.36	4.70	.703	318.9	.628	284.9

GLADE SPRING PROJECT

Three sets of ewes are being compared at Glade Spring. 1/2 Finn x 1/2 Dorset, 1/4 Finn x 3/4 Dorset and purebred Dorsets. All ewes are managed conventionally, lambing once each year. Suffolk rams are turned to the ewes October 1 and removed November 15 of each year. Ewes lamb from February 20 through March 25. Lambs remain with the ewes until they reach market weight except occasionally lambs from multiple births (3 or 4) will be transferred to ewes with only one or no lambs.

TABLE 1. CUMULATIVE EWE PERFORMANCE 1973-1978

Kind of Ewe	Lambs born/ ewe year	Lambs raised/ ewe year
1/2 Finn	1.95	1.65
1/4 Finn	1.49	1.29
Dorset	1.03	.84

The lambing performance of all ewes has improved with age. The 1/2 Finn ewes raised more lambs than the 1/4 Finn and the Dorset. The performance of the Dorset ewes has been very poor.

The lambs out of the Dorset ewes gained more rapidly than those out of the other kinds of ewe. The average daily gains were: Dorset .55 lbs. (250 gms.), 1/4 Finn .52 lbs. (236 gms.), and 1/2 Finn .50 lbs. (227 gms.)

HETEROSIS FROM CROSSES AMONG BRITISH BREEDS OF BEEF CATTLE

J. A. Gaines, C. Hill, J. M. Hagerbaumer and W. H. McClure

This report covers the productive lifetime of a herd of beef cows that originally consisted of sixty straightbreds and sixty F_1 crossbreds. The objective of the first five calf crops was to compare straightbred and crossbred cows when all the calves were crossbreds (either three-breed crosses or backcrosses). The objective of the next seven calf crops (sixth through twelfth, inclusive) was to compare straightbreeding with rotational crossbreeding, so the straightbred cows were bred to produce straightbred calves, and the crossbred cows were bred to produce three-breed cross calves.

With respect to birth and weaning data on the calves of the first five calf crops, records on 604 matings and 567 births were used. Crossbred cows were 31.9 kg heavier than straightbred cows (year means ranged from 26.8 to 40.7), and the difference was rather consistent through all five calf crops. Calves from crossbred cows performed significantly better than those from straightbred cows for weaning weight (8.4 kg in the heifers and 6.0 kg in the steers). Weaning weight differences were reduced 20% when cow weight effects were taken into account in the analysis. There were 2.1% more calves born, but .7% fewer calves weaned from the crossbred cows than from the straightbred cows. Calves from Angus cows performed better than calves from Hereford or Shorthorn cows. When differences in calf performance, cow reproductive performance and cow size were all combined (kg of calf/100 kg cow/cow year), the Angus cow ranked first among all breeds and crosses. Significant differences were found between the kinds of crossbred cows for weaning weight of calf. Comparisons of reciprocal crosses showed cows resulting from matings involving Hereford dams excelled the reciprocals.

With respect to post-weaning information on the calves of the first five calf crops, records on 214 heifers and 234 steers were used. The data showed few differences that were biologically significant. Practically speaking, most of the differences between crossbred cow types and straight breed means were small, indicating a definite decline in the influence of cow size and breeding after the calves were weaned. Some of the differences between backcross and three-breed cross calves (those for growth traits) were significant in favor of the three-breed crosses.

When straightbreeding was compared with rotational crossbreeding in the sixth through twelfth calf crops, crossbred calves were superior to straightbred calves for weaning weight (22.3 kg) and weaning grade (.5 grade point, which equals 1/6 of a U.S. grade). Differences in calves from reciprocal cross dams indicated strong maternal effects for weanling performance.

Cow efficiency was measured as the ratio of each calf's weaning weight to its dam's average mature weight. Across all cow groups, no consistent trend existed for efficiency of production as related to cow size. However, as a whole, crossbred cows were more efficient in producing weanlings, even though they averaged 31.9 kg heavier at maturity.

Cow fertility and longevity were studied using percent live births, percent calves weaned and efficiency per cow year. Crossbred cows showed a 4.0% advantage for live births and a 9.4% advantage for calves weaned. Crossbred calves averaged nine days older than straightbreds at weaning. There were 41 more kilograms of calf weaned per cow year from crossbred dams; the crossbred dams were also 2% more efficient in producing their calves. Longevity was greater in the crossbred cows than in the straightbred cows.

This summary is based on articles which are forthcoming in the Journal of Animal Science.

PERFORMANCE AND LIVER COPPER LEVELS OF BEEF COWS FED BROILER LITTER[1]

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

Broiler litter, a solid waste from the poultry industry, has been shown to have substantial nutritive value. To date, however, the Food and Drug Administration does not sanction the use of broiler litter or any other animal waste as a feed ingredient. Some of their primary concerns are related to drug residues and heavy metal residues. In the 1974 Livestock Research Report (V.P.I. & S.U. Res. Div. Rep. 158) the results of an experiment of feeding broiler litter to cows was discussed. In that report it was indicated that feeding as high as 80% broiler litter as a wintering ration had no detrimental effects on the performance of cows. The present study was initiated at the Shenandoah Valley Research Station in December of 1972 and will continue for several years to evaluate the effect of long-term feeding of broiler litter on the performance of cows and upon the accumulation of copper in the liver of cows. Preliminary results of this experiment were presented in the 1974, 1975, 1976 and 1977 Reports.

Experimental Procedure

Forty-two weanling heifers were allotted at random by weight and breeding to three lots. The first winter (1972-73) the animals in lot 1 were fed 8.5 lb of mixed hay, 3 lb ear corn and 1 lb of a complex urea supplement per head per day. The animals in lots 2 and 3 were self-fed a mixture of 50% broiler litter and 50% ear corn. Copper was added to the ration in lot 3 to supply an additional 100 ppm copper. During the second and third winters the heifers were fed the following rations: lot 1 - Hay; lot 2 - 75% broiler litter, 25% ground ear corn; and lot 3 - 75% broiler litter, 25% ground ear corn and 160 ppm supplemental copper. During subsequent winters the cows were fed the following rations: lot 1 - hay; lot 2 - 80% broiler litter, 20% ground shelled corn; lot 3 - 80% broiler litter, 20% ground shelled corn and 160 ppm supplemental copper. The litter used was removed from broiler houses bedded with wood shavings and was stacked in an open shed to go through a heat prior to feeding. The rations were fed in such amounts as to supply the TDN requirements. The 1976 and 1977 grazing seasons were poor and the cows entered the winter in a thin condition. Therefore, the amounts of each ration fed were increased. In addition, the cattle on both litter rations received 2 lb and 3 lb/head/day of long hay during 1976 and 1977, respectively.

The cattle were kept in small lots to minimize grazing. The cattle were weighed at 28-day intervals and feed consumption was recorded. Liver samples were obtained by biopsy each fall before the cattle were put on the wintering feed and each spring before they were turned to pasture. The cattle grazed as a group during the summer on native pastures. The cattle were bred for the first time in the summer of 1974 and calved in the late winter and early spring of 1975. These calves

[1]The broiler litter was supplied by Rocco, Harrisonburg, Virginia.

were weaned November 25, 1975. At the time of this report, the cattle have the fourth calf crop on the ground. Liver samples are obtained in the fall and in the spring of each year.

Results

Data on ration consumption, average daily gain and calving performance are presented in table 1. As can be seen from the data in the table, ration consumption by the cattle is quite good and there are no particular trends for any of the rations. Average daily gains tend to indicate that the cattle fed litter rations gained slightly better during the first two wintering periods. However, the control cattle compensated for their slower winter gains during the summer grazing periods. The average daily gains listed for the period December 5, 1974 to April 24, 1975 show a loss in weight which reflects the loss from calving of the heifers. During the fourth wintering period the cows fed the litter ration supplemented with copper gained slightly while the other two groups lost weight. During the fifth wintering period all groups lost small amounts of weight. During the 1977-78 winter, cows fed hay gained somewhat more than those fed it er. The negative gain in the litter plus corn plus copper treatment includes the weights of two cows that calved prior to April 4, 1978.

Calving performance for the first three calf crops was quite good. The numbers of calves born show no detrimental effect of feeding broiler litter or broiler litter plus additional copper. Likewise, birth weights and weaning weights of the calves do not indicate any detrimental effect of feeding broiler litter.

The effect of feeding broiler litter on liver copper livels is presented in table 2. As can be seen from the data in this table, liver copper levels are highest in the spring following the feeding of broiler litter during the winter period. The levels of liver copper were lowest in the animals fed the conventional hay ration and highest for those animals fed the litter plus corn plus copper ration with the values for the litter plus corn ration being intermediate. It will be noted that at the end of the winter feeding periods copper is elevated in the liver of animals fed litter, especially those fed additional copper. However, these levels are not high enough to suspect a toxicity problem. By the end of the summer grazing period, the liver copper levels decline markedly. This experiment is still in progress and to date no detrimental effects of feeding broiler litter as wintering feed have been observed in these animals. This study will continue for several more years.

TABLE 1. EFFECT OF FEEDING BROILER LITTER TO HEIFERS ON RATION CONSUMPTION, AVERAGE DAILY GAIN AND CALVING PERFORMANCE

	Wintering ration		
Parameter	Hay	Litter + corn	Litter + corn + copper
No. of cows[a]	14(12)	14(12)	14(12)
Ration consumption, lb/head/day			
12-31-72 to 5-10-73	12.3	11.4	13.4
1-7-74 to 4-15-74	16.5	16.1	17.2
12-5-74 to 4-24-75	14.5	13.0	12.8
12-18-75 to 4-16-76	17.2	13.8	15.6
12-28-76 to 4-18-77[b]	21.7	18.9	20.0
12-8-77 to 4-4-78[c]	20.1	17.6	18.4
Average daily gain, lb.			
12-13-72 to 5-10-73	.58	.84	.90
1-7-74 to 4-15-74	.53	1.06	1.09
12-5-74 to 4-24-75[d]	-1.24	-1.36	-1.12
12-18-75 to 4-16-76	-.08	-.11	.25
12-28-76 to 4-19-77[e]	-.18	-.12	-.11
12-8-77 to 4-6-78[f]	.61	.28	-.09
Calving performances[g]			
No. calves born	33	33	33
Birth wt. of calves, lb	70	70	71
Weaning wt. of calves, lb.	324	316	341

[a]Numbers in parentheses indicate number of cows remaining on experiment as of 4-6-78.
[b]Includes 2 lb of hay per head per day from 1-25-77 to 4-18-77 for the litter + corn and litter + corn + copper treatments.
[c]Includes 3 lb of hay per head per day from 1-9-78 to 4-4-78 for the litter + corn and litter + corn + copper treatments.
[d]Includes loss of weight due to calving.
[e]Three cows in the group fed hay and two cows in each of the other two groups had calved prior to 4-19-77.
[f]Two cows in the litter + corn + copper group calved prior to 4-6-78.
[g]Data from 1975, 1976 and 1977 calf crops.

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

Sampling date	Wintering ration: Hay	Litter + corn	Litter + corn + copper
	ppm[a]		
12-12-72	44.8	31.9	27.6
5-4-73	109.8	300.2	773.0
12-2-73	68.6	106.7	158.0
4-17-74	73.0	197.3	729.5
12-4-74	136.1	178.5	239.3
4-29-75	51.1	251.1	669.8
12-11-75	56.1	83.6	189.8
4-16-76	37.6	706.0	1134.5
12-14-76	27.0	187.8	219.0
4-26-77	34.5	757.3	964.4
12-7-77	19.8	154.3	186.3
4-6-78	53.6	1263.9	1726.7

[a]Dry basis.

CONCENTRATE LEVEL AND SODIUM BICARBONATE, THEIR RELATIONSHIP TO PERFORMANCE TESTING BULLS

G. L. Minish, K. E. Webb, Jr., and D. A. Danilson

Introduction

Previous work conducted at Virginia Tech and other research stations throughout the midwest have compared levels of concentrate (0, .5, 1.0 and 1.5% of the body weight) added to a full feed of corn silage for fattening steers. The 1.0% level consistently was the optimum from the standpoint of daily gains and carcass desirability. Sodium bicarbonate, a rumen buffer, has also been compared on various levels of energy for finishing feedlot steers and has shown in several instances significant improvement in feed efficiency and gains, especially on higher energy diets.

Against this background, it appeared logical to evaluate the energy level and the effect of sodium bicarbonate (a buffer) on the total performance of bulls on feed test. Bulls tend to gain faster, more efficiently, produce carcasses of higher cutability and grade slightly lower at the same weight and frame pattern than steers. Bulls, thus, appear to have a later maturity pattern which could dictate a different feeding regime. A study was conducted to evaluate energy level on a full feed of corn silage and the use of sodium bicarbonate with bulls on performance test.

Procedures

Research was conducted on bulls from the VPI&SU teaching and research herds. Twenty-four bull calves ranging in age from 200 to 240 days were weaned and allotted as evenly as possible for weight and breed. The cattle officially started on the 140-day feed test November 21, 1977. Individual two-day weights were taken at the start and end of the experiment. A 2 x 2 factorial arrangement was used to compare energy level and sodium bicarbonate with bulls on performance test. Design of the energy treatments was as follows: Treatment I consisted of a full-feed of corn silage, 1.0 lb of shelled corn per 100 lbs of body weight and 2.0 lbs of supplement (44% soybean meal) per head daily; Treatment II received a full feed of corn silage, 1.5 lbs of shelled corn per 100 lbs of body weight and 2.0 lbs of supplement per head daily. One half of the bulls within each respective energy treatment received .25 oz of sodium bicarbonate per 100 pounds of body weight and the remaining one half received no sodium bicarbonate. All lots were provided a free choice salt mineral mix of one part trace mineralized salt, one part ground limestone and one part defluorinated rock phosphate. Weights were taken at 28-day intervals to monitor performance and were used to adjust shelled corn and sodium bicarbonate intakes.

Results

When two concentrate levels were fed, 1.0 versus 1.5 pounds of corn added daily per 100 pounds of body weight to a full feed of corn silage, daily gains and feed conversion slightly favored the 1.0% level. This was not statistically significant ($P > .05$). Little difference existed in dry matter consumption between energy treatments. From this study, it appears that a ration composed of a full feed of corn silage and 2 lb soybean meal and supplemented with 1% body weight as corn grain will produce optimum performance in bulls. This agrees with earlier work conducted with feedlot steers.

Sodium bicarbonate produced no significant effect on the total performance of bulls on test with no apparent interaction with energy levels tested.

TABLE 1. PERFORMANCE OF BULLS ON TWO CONCENTRATE LEVELS WITH AND WITHOUT SODIUM BICARBONATE

Item	(1% added concentrate)		Treatment II (1.5% added concentrate)	
	Sodium bicarbonate	Control	Sodium bicarbonate	Control
No. head	6	6	6	6
Avg. dry matter consumption, lb/head/day	19.7	19.6	19.7	20.8
Group feed conversion, lb/lb	6.46	5.99	6.72	6.86
140 day gain, lb/day	3.05	3.29	2.93	3.03

TABLE 2. PERFORMANCE OF BULLS ON TWO ENERGY LEVELS

Item	Treatment I (1% added concentrate)	Treatment II (1.5% added concentrate)
No. head	12	12
Avg. dry matter consumption, lb/head/day	19.65	20.3
Group feed conversion, lb/lb	6.23[a]	6.79[a]
140 day gain, lb/day	3.17[a]	2.98[a]

[a]Means on the same line having the same superscript letters do not differ (P >.05).

TABLE 3. PERFORMANCE OF BULLS SUPPLEMENTED WITH SODIUM BICARBONATE

Item	Sodium bicarbonate	Control
No. head	12	12
Avg. dry matter consumption lb/head/day	19.7	20.2
Group feed conversion, lb/lb	6.59[a]	6.43[a]
140 day gain, lb/day	2.99[a]	3.16[a]

[a]Means on the same line having the same superscript letters do not differ (P >.05).

SYSTEMS FOR WINTERING BEEF COWS[1]

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

One of the most important problems facing Virginia cattlemen with beef cow and calf operations is that of reducing winter feed costs. Labor availability and cost and machinery cost are major factors. Labor-saving practices for utilizing forages for wintering cows such as allowing the cows to graze the crop, are attractive, especially for small operations.

Some Virginia farmers have been utilizing tall fescue in a winter grazing scheme to reduce the amount of stored feed necessary to maintain a beef cow during the winter season. More recently, there has been a keen interest in utilizing tall forage sorghum as a winter grazing crop for beef cows. Although tall fescue and the tall forage sorghums have both been rather widely used for wintering beef cows, data on the economics of utilizing these forages, the short and long-term effects on the performance of the cows and their calves, or the need for protein supplementation are limited.

A long range experiment designed to study systems of managing beef cows during the winter season was initiated at the Shenandoah Valley Research Station during the winter of 1973-74 and continued annually through the winter of 1976-77.

Experimental Procedure

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

Thirty of the cows used in the test were sired by Charolais or Simmental bulls, and were of various ages and percentages of sire breed. The other breeds represented in these cows were Angus, Hereford, Shorthorn, Brown Swiss and Holstein. These cows were allotted at random, six to each treatment, on the basis of age, breeding, and weight. Because of the poor breeding performance of some of these cows, some were culled after the 1973-74 trial and all were re-randomized to different treatment systems beginning with the 1974-75 season.

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

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

A brief description of the five systems, with 25 cows in each system follows:

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

In addition to the 15-acre forage sorghum field, the cows had access to a small, partially wooded field with water during the test. Previous close fall grazing had removed most of the forage from this field each year. A liquid supplement dispenser equipped with lick wheels was placed in a convenient location in this field. The supplement contained about 32% crude protein. With the aid of an electric fence the sorghum field was divided into three parts and cows were forced to close graze each section before being turned into a new section. Cows were checked twice daily and all calves were identified and weighed at birth.

System II. Forage Sorghum (15 acres) and Biuret Supplement. Forage sorghum for this system was seeded at the same rate and in the same manner as for system I, with the same fertilization and herbicides. Forage yield checks showed the two fields to be quite similar in total forage available. Two fields used for forage sorghum during the trial, and System I & II were rotated between these two fields annually.

A small adjacent field with natural shelter and water was also provided for this systen. A supplemental feeder box was placed at a convenient location and cows were given access to a dry supplement containing 50% biuret, 48.5% livestock mineral supplement and 1.5% sulphur, during the 1973-74 test. A mixture containing magnesium oxide was also fed to the cows free choice. After the first year this supplement was changed to contain 43.5% biuret, 20% magnesium oxide, 20% livestock mineral supplement, 15% dry molasses and 1½% sulphur. Consumption per cow for subsequent tests was slightly better.

System III. Tall Fescue (15 acres) and Tall Sorghum (7.5 acres). This system was designed to test the feasibility of using fescue and tall sorghum in combination. One theory that makes this system attractive is the possibility that cows would graze on the taller sorghum while snow covers the ground and fescue when the ground is clear. Also, the higher protein in fescue would supplement the protein deficient sorghum forage.

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

Part of the fescue was an old existing sod and part was seeded in the spring of 1973 at the rate of 15 lb fescue, 2 lb red clover and 1 lb of ladino clover per acre. At seeding time, fertilizer was applied at the rate of 40 lb N, 80 lb P_2O_5 and 80 lb K per acre. The fescue was clipped closely about August 1 each year and "stockpiled" until the test was started about December 15. Nitrogen was applied at the rate of 40 lb per acre on fescue containing a good stand of clover and 100 lb per acre where there was no clover.

The cows were handled exactly the same as the cows mentioned in the two previously discussed systems, except that no protein supplement was offered. The cows remained in the treatment until early April each year. A closely grazed accessory field with natural shelter and water was also provided for the cows in this system.

System IV. Control - Conventional Winter Management. The cows in this system were allowed to range on a 40-acre field of primarily bluegrass and orchardgrass sod with natural shelter and water. Because of excellent fall growing seasons and relatively mild winters, there was considerable aftermath grazing available for the cows in this system each year except 1976-77. The cows were fed average quality grass and legume hay each year as needed. Daily cow management was the same as for cows in the previously mentioned systems.

System V. Fescue (30 acres). The 25 cows in this system were grazed during the entire test period on tall fescue with no additional feed being fed except when there was considerable snow cover on the ground. The fescue was partly an old sod and partly newly seeded in 1973. Fertilization and management were exactly the same as for the fescue used in System III. The cows in this system were handled in the same manner as cows in the other systems and remained on the pasture after the test was concluded each year without additional feed.

All cows were injected with 1,000,000 I.U. of vitamin A and 150,000 I.U. of vitamin D at the beginning of the trial and were sprayed for lice. All cows except those in Lot 2 received a mixture of 1/3 salt, 1/3 steam bone meal and 1/3 magnesium oxide, free choice.

Results and Discussion

Crude protein analyses of the fescue used in this test has ranged from 10.8% to 12.0%, and clearly defines that cows grazing stockpiled fescue do not need additional protein supplementation. The crude protein analyses of the stockpiled tall sorghum have constantly shown a value of slightly more than 6%, and the need for additional protein supplementation has been definitely established. Results over the four-year period indicate that there is very little difference between the liquid supplement and the dry biuret supplement, although the cows receiving the liquid supplement have experienced less weight loss.

Results of the four years of the test are shown in Table 1. Cows grazing fescue alone have consistently shown a lower weight loss than cows in the other treatments. There has been very little difference in calf birth weights or calf weight/day of age to weaning.

The tall forage sorghum has varied considerably from season to season as far as tons of dry matter/acre and cow grazing days per acre are concerned. This difference is directly related to rainfall during the growing season. The tall forage sorghum system offers the advantage, during a good growing season, of providing a large quantity of forage for winter grazing on a small acreage. During the best season the tall forage sorghum provided adequate grazing for 140 cow days per acre. The stockpiled fescue has been much more predictable as far as available forage is concerned, and stocking rates could have been increased each year.

The winter of 1976-77 was much more severe than previous winters. Weight loss per cow was much greater for the cows grazing forage sorghum than in previous years, and the weight loss for the cows in the fescue-sorghum treatment group was lower than in previous years. In spite of the severe winter, the cows grazing fescue accepted and consumed less than 100 lbs. of hay each. Because of the dry summer and fall, the stockpiled fescue did not accumulate as much dry matter as in previous years, but there was still adequate forage available. When compared to the cows on conventional treatment, there is strong evidence that stockpiled fescue is exceptionally valuable when there is a combination of a dry summer and a severe winter.

The system combining tall forage sorghum and fescue has proved to be very adequate and could possibly be adapted for use on many farms. This system does offer the distinct advantage of providing grazing with the forage sorghum while there is snow cover on the fescue. There seems to be no need for additional protein in this system.

On the basis of data to date, all "stockpiling" systems compare favorably with the conventional system of wintering cows. Calves in all treatments have performed well to weaning. No severe problems have occured with calving on pasture during the winter months. Labor requirements for cows on the sorghum and fescue treatments have been much less than for cows wintered on the conventional management system. The trial was terminated in the fall of 1977.

Data from this test should be useful in providing guidelines for various systems for managing beef cows during the winter. A new trial will be started in the fall of 1978 to incorporate useful data from this test and to continue efforts to develop various systems for successfully grazing cows and ewes on various stockpiled forages.

TABLE 1 - PERFORMANCE OF COWS ON DIFFERENT WINTERING SYSTEMS - 4 YEARS

	System I (Sorghum + liquid supplement)	System II (Sorghum + biuret supplement)	System III (Sorghum & fescue)	System IV (Conventional)	System V (Fescue)
No. of cows (Total)	96	94	96	96	90
Weight, Beginning Dec. (Avg.)	1056	1071	1063	1071	1097
Weight, Final, Apr. (Avg.)	917	878	996	937	1066
Weight Loss per cow (Entire winter Period) (Avg.)	-127.75	-169.50	-32	-108	-27
Total feed per cow, lb. (Avg.)	182 (liquid)	21 (biuret mineral)	69	2626 (hay)	92 (hay)
Cow grazing days per acre (Avg.)	113	113	119	-	94
No. calves weaned (Total)	79	81	83	82	76
Birth weight, lb. (Avg.)	76.0	76.8	78.8	79.1	78.1
Calf wt. per day of age, to weaning, lb. October (Avg.)	1.93	1.90	1.96	1.90	1.96

CHANGES IN CHEMICAL COMPOSITION OF STOCKPILED TALL FESCUE-RED CLOVER GRAZED BY GROWING-FINISHING STEERS

C. P. Bagley, J. P. Fontenot, F. S. McClaugherty, R. E. Blaser and K. E. Webb, Jr.

Stockpiling Kentucky 31 tall fescue-red clover is a new and innovative system of wintering beef animals to decrease hay feeding. Virginia Tech researchers reported in 1963 that tall fescue accumulates high levels of total nonstructural carbohydrates (soluble sugars) during the fall. This increase in soluble sugars increases the nutritive value of the forage and possibly increases palatability of fescue. The combination of increased nutrient content and the high dry matter yields of tall fescue afforded by stockpiling may be sufficient to support growing-finishing beef steers. A comparison of top grazing and whole plant grazing of the forage was also included in this study. The concept of top grazing is to allow more selective grazing by the cattle. Pregnant beef cows which have a relatively low nutrient requirement could graze behind the top grazers to fully utilize the forage.

The overall objective of the study was to produce fat beef steers at four times during the year rather than only once. The performance during the year is summarized in another report in this publication. The specific objective of the research reported in this report was to study the changes in composition of the stockpiled fescue-red clover during the winter grazing period.

Experimental Procedure

Ky 31 tall fescue-red clover pastures were fertilized with 112 kg of nitrogen per hectare in mid-August and allowed to accumulate for winter grazing by growing and finishing steers. The seven treatments (six steers per treatment) included four groups of weanling steer calves and three of yearling steers. Each system contained three fescue plots.

All pastures were also sampled prior to and after steers grazed the plots. Samples were used to determine total dry matter yield and nutrient composition in the pastures. Pasture samples were harvested using 10 cm wide electric hand clippers at randomly chosen areas in the pastures. The clippers had a block underneath so that samples would not be taken below a height of 3 cm. The third fescue-red clover pasture to be grazed within each system was sampled when the animals were initially allowed access to the other pastures on November 18 (day 0) and at 25, 99, 125, and 140 days after the initial sample. Samples were dried in a forced air oven at 53^{o}C and later assayed for *in vitro* dry matter disappearance, total nonstructural carbohydrates, crude protein and the Van Soest forage analysis for fiberous components.

Results and Discussion

The average daily gains for the 140-day winter grazing period are given in table 1 for the various systems. Performance for the remainder of the year and carcass characteristics are given in another report (pp. to). Rate of gain for the first 70 days of the wintering trial were higher with increasing levels of grain, while top grazing had no beneficial effects. During the first 70 days of this trial, hay was fed for almost 50 days because of the snow and ice accumulation which made grazing of the pastures impossible. No differences due to grazing pressure in the pastures would be expected in this case because all animals received similar quantities of hay. During the second 70 days significant differences in daily gain of calves were observed between top and whole plant grazing. Yearling weight gains were closely related to level of grain supplementation.

Dry matter yields and digestibilities of the fescue-red clover are given in table 2. *In vitro* digestibility was highest in November, decreased slightly in December and was greatly reduced in February. The digestibility remained low in March, then increased sharply in April. Dry matter yields increased slightly from November to December, indicating some growth of the plant was occurring. Yields decreased 20% from December to February, due to a higher rate of leaf death. Digestible dry matter available was much lower in February due to a combination of lowered yields and lower quality forage as evidenced by *in vitro* dry matter digestibility.

Crude protein, total nonstructural carbohydrates, cell walls, acid detergent fiber and hemicellulose levels are presented in table 3. Crude protein content remained high during the entire wintering phase. The abrupt increase in crude protein during April was due to the regrowth of fescue and red clover. Nonstructural carbohydrate levels were highest in November, decreased slightly in December and declined abruptly in February. The total nonstructural carbohydrates represent nutrients that are almost 100% digestible. These components are lost very easily due to leaching caused by adverse weather conditions. The freezing and thawing accompanied by snow and ice resulted in what is commonly called "winter burn". This is most evident in the grass changing from green to brown during the winter. The loss of nutrients, of which the first to be lost are the most soluble, is reflected in a decreased *in vitro* digestibility. Losses in cell solubles resulted in increases in the fibrous components which are less digestible. Analysis for cell walls separates the nutrients of the plant into two broad categories, cell soluble fraction which is almost 100% digestible, and cell wall fraction which is poorly digested. Percent cell walls and acid detergent fiber both increased during the winter and began to decrease with plant regrowth in early spring. Several researchers have shown that high hemicellulose contents in the plant reduce palatability. Hemicellulose levels increased with time in the fescue-red clover mixtures until regrowth began in April. This indicates that the plant was not only lower in nutrient content, but also was less palatable.

Comparisons of top and whole plant grazing with reference to percent cell walls and nonstructural carbohydrates are found in table 4. The lower values listed in the "difference" rows for top grazing, as compared to whole plant grazing shows that the grazing pressure was lower, allowing more selective grazing and a higher quality grazing by the top grazing. This would explain the faster weight gains in cattle allowed to top graze as compared to those which were on the whole grazing systems. The forage consumed would be higher in cell solubles and lower in fiber levels which increased performance.

TABLE 1. DAILY GAINS OF FORAGE FINISHING STEERS ON STOCKPILED FESCUE - RED CLOVER

Kind of steers	Weanling calves				Yearlings		
Type of grazing	Top		Whole		Top	Whole	
Grain level, % of bodywt.	0	.5	0	.5	0	.5	1.0
Acre per group	7[a]	5	5	3.5[b]	7[a]	3.5[b]	4
	kg	kg	kg	kg	kg	kg	kg
Initial weight	234	235	234	239	329	330	326
Final weight	277	305	269	292	364	386	417
Daily gain							
0 - 70 days	.24[c]	.47[d]	.25[c]	.47[d]	.26[c]	.38[d]	.63[e]
71 - 140 days	.39[c]	.52[c]	.25[d]	.29[d]	.25[d]	.43[c]	.68[e]
0 - 140 days	.31[c,d]	.50[e]	.25[c]	.38[d]	.25[c]	.40[d]	.65[f]

[a] Yearling and weanlings were grazed together due to similarities in the systems.

[b] Yearlings and weanlings were grazed together due to similarities in the systems.

[c,d,e,f] Means in the same row with different superscript letters are different ($P<.05$).

TABLE 2. DRY MATTER DIGESTIBILITY AND YIELD OF STOCKPILED FESCUE - RED CLOVER.

		Yield per hectare	
Sampling date	*In vitro* digestibility	Dry matter	Digestible dry matter
	%	kg	kg
11-18-76	69.5[a]	3893[a]	2705[a]
12-13-76	65.5[b]	3987[a]	2609[a]
2-25-77	48.7[c]	3328[b]	1622[b]
3-23-77	50.2[c]		
4-6-77	59.7[d]		

[a,b,c,d]Means in the same column with different superscript letters are different ($P<.05$).

TABLE 3. CRUDE PROTEIN, TOTAL NONSTRUCTURAL CARBOHYDRATES, CELL WALLS, ACID DETERGENT FIBER AND HEMICELLULOSE LEVELS IN FESCUE-RED CLOVER

	Sampling date				
Item	11-18-76	12-13-76	2-25-77	3-23-77	4-6-77
	%	%	%	%	%
Crude protein	15.7^{b}	16.8^{b}	15.8^{b}	15.3^{b}	21.0^{c}
T.N.C.[a]	13.6^{b}	10.4^{b}	3.7^{c}	3.2^{c}	4.0^{c}
Cell walls	48.8^{b}	55.4^{c}	67.1^{d}	69.4^{d}	58.4^{c}
Acid detrg. fiber	28.4^{b}	33.1^{c}	41.9^{d}	40.6^{d}	34.0^{c}
Hemicellulose	20.3^{b}	$22.2^{b,c}$	$24.3^{c,d}$	28.8^{d}	23.1^{c}

[a]Total nonstructural carbohydrates.

[b,c,d,e]Means in the same row with different superscripts are different ($P<.05$).

TABLE 4. CELL WALLS AND TOTAL NONSTRUCTURAL CARBOHYDRATES COMPOSITION OF INITIAL AND RESIDUAL FORAGES.

	Pasture grazing dates					
	11/18-12/13/76		12/13/76-2/25/77		2/25-4/6/77	
Item	Cell walls	TNC[a]	Cell walls	TNC[a]	Cell walls	TNC[a]
Whole grazing						
Initial	49.8	10.7	62.3	6.9	65.7	3.9
Residual	68.7	4.3	78.5	1.5	62.3	2.9
Difference	18.9	- 6.4	16.2	-5.4	- 3.4	-1.0
Top grazing						
Initial	51.8	11.5	61.1	7.7	69.2	3.5
Residual	67.2	4.4	73.0	1.8	63.4	2.8
Difference	15.4	- 7.1	11.9	-5.9	- 5.8	- .8

[a]Total nonstructural carbohydrates.

PALATABILITY OF TALL FESCUE AT DIFFERENT SEASONS

C. P. Bagley, J. P. Fontenot, R. E. Blaser and K. E. Webb, Jr.

Tall fescue is generally characterized as a forage that produces high dry matter yields, grows earlier in the spring and later in the fall, and is more resistant to drought and excessive moisture than many of the other cool season forages. However, cattle gains on fescue forages are typically lower than on bluegrass or orchardgrass, presumably due to decreased dry matter intakes of cattle on fescue. An innovative method of managing fescue is fall accumulation (stockpiling) of the forage for winter grazing to replace hay as a feedstuff. The method of stockpiling tall fescue consists of fertilizing a closely grazed fescue plot with 60 to 90 lb of nitrogen per acre around August 10, allowing the forage to accumulate until November for winter grazing by cattle. Tall fescue managed in this manner produces a high yielding forage that retains more nutrients due to its winter hardiness than other forages.

Four palatability trials were conducted to determine the palatability or acceptability of Kentucky 31 tall fescue in May, July, November and February.

Experimental Procedure

Four palatability trials were conducted with crossbred wethers beginning on May 7, July 21, November 3 and February 12. The animals were fed at 12 hr intervals at 5 to 10% above ad libitum intakes, with refusals collected daily. Water and salt were available at all times. Animals were housed in individual stalls in an enclosed barn. The trial consisted of a 5-day transition, a 5-day preliminary and a 10-day collection periods.

During each trial 6 sheep were fed the freshly cut fescue forage and 6 were fed coarsely ground alfalfa hay. The alfalfa was used as a standard forage to compare fresh fescue intakes at different seasons. The alfalfa hay was from a common source and bales were randomly allotted to trials. Prior to each trial, the alfalfa hay was mixed and ground in a hammermill through a 2.5 cm screen. The tall fescue was harvested daily from a .5 hectare plot from specific areas in the plot which were randomly determined. The fescue was chopped through a forage chopper after harvesting.

Initially, the fescue plot was mowed and the dead leaf material was removed. Nitrogen, phosphorus and potassium were applied on April 13 at a rate of 56 kg per hectare, according to soil test results. The plot was again mowed and raked at the conclusion of the May and July trials to allow uniform regrowth of fescue. Fall accumulation of fescue was begun on August 11 after application of 101 kg of nitrogen per hectare. Half the plot was used for the November trial with the other half being used in the February palatability trial.

Results

The high quality alfalfa hay used in the four palatability trials as a reference hay contained 17.4% crude protein, 54.6% neutral detergent fiber and had an *in vitro* dry matter digestibility of 62.7%. The quality of the alfalfa remained high and did not deteriorate. Plant heights and various chemical components of fescue are shown in tables 1 and 2. Fescue was in the late boot stage during the May palatability trial and the vegetative stage in the July, November and February trials. *In vitro* digestibility and total nonstructural carbohydrates were highest in November and lowest in February. Crude protein content did not vary greatly (9.7 to 10.6%), but was slightly lower in February. Levels of hemicellulose were highest in February and May and similar in November and July.

Dry matter intakes for fescue and alfalfa expressed as $g/kg^{.75}$ and relative fescue intake, compared to alfalfa are presented in table 3. Feeding alfalfa hay as a reference forage was conducted so that the variation due to climatic factors and differences in sheep could be removed. Intakes of alfalfa hay in February and especially in November were lower than in the May and July trials. The sheep used in these first two trials were older, heavier wethers of slightly different breeding than those used in the latter trials. Relative intakes were highest in November, slightly higher for July as compared to May, and lowest in February.

Relative dry matter intakes tended to closely and negatively follow hemicellulose levels in the plants. Several researchers have reported high hemicellulose levels to be a major factor in decreasing palatability of feedstuffs. Hemicellulose levels were not different between July and November. However, the level of soluble sugars (T.N.C.) was higher in November which could account for the increased palatability at that time.

These results indicate that managing tall fescue by fall accumulation maximizes nutrient quality and palatability, which also produces high dry matter yields. The quality and palatability of this forage certainly declines during the wintering period. However, in mid-February, after several months of extremely cold weather and large snow accumulations, a forage with over 9% crude protein still remains. Fescue tends to be more resistant to "winter burn" than most forages, with some green plant leaves still being present in late winter. A large drop in the soluble sugar content occurred, along with decreasing palatability in February. The forage at this point still appears suitable for beef animals which are not at a high level of production, and is probably higher in quality than some hays. Certainly, when maximizing production of beef animals, it would be a good management practice to graze the fescue heavier during the early season (November) and possibly use some alternate sources of energy later in the winter, if needed.

TABLE 1. AVERAGE PLANT HEIGHTS, STAGE OF GROWTH, TOTAL NONSTRUCTURAL CARBOHYDRATES AND CRUDE PROTEIN CONTENT OF FESCUE FORAGE

Item	Trial date: May	July	November	February
Plant height, cm.	.57	19	48	42
Stage of growth	Late boot	Vegetative	Vegetative	Vegetative
T.N.C.[a,b] %	13.9	9.9	15.9	5.5
Crude protein[b] %	10.4	10.3	10.6	9.7

[a] Total nonstructural carbohydrates.
[b] Dry basis.

TABLE 2. *IN VITRO* DIGESTIBILITY, CELL WALLS, ACID DETERGENT FIBER AND HEMICELLULOSE LEVELS OF FESCUE FORAGE

Item	Trial date: May	July	November	February
	%	%	%	%
In vitro digestibility	67.2	62.8	68.5	43.0
Cell walls	65.6	63.3	59.8	72.6
Acid detergent fiber	36.0	38.3	35.0	39.9
Hemicellulose	29.5	27.7	27.5	32.8

TABLE 3. DRY MATTER INTAKES AND RELATIVE INTAKES OF FESCUE FORAGE AND ALFALFA HAY

Trial date	Dry matter intake, $g/kg^{.75}$		
	Fescue	Alfalfa	Relative intake[a]
May	76.6	121.3	63.3[b,c]
July	82.2	113.5	72.1[b]
November	57.9	68.4	87.7[d]
February	50.2	94.1	53.9[c]

[a] Expressed as a percent of alfalfa hay intake.

[b,c,d] Means in the same column with different superscript letters are different ($P<.05$).

CHANGES IN CHARACTERISTICS OF DEEP STACKED BROILER LITTER WITH TIME

G. R. Dana, J. P. Fontenot, J. A. Duque, W. Sheehan and K. E. Webb, Jr.

The utilization of broiler litter as a feedstuff for ruminants has been well documented by numerous investigators. Broiler litter is an especially good source of protein and certain minerals for ruminants. Various processing methods including heat and chemical treatment, and ensiling litter alone or with other feedstuffs have been used. The majority of research, however, has involved processing of freshly collected broiler litter. Although this is an excellent means of utilizing broiler litter, it may not always be feasible on a practical basis. A more common practice would be for a producer to accumulate the litter and store it protected from adverse weather until ready to incorporate it in some feeding regime or process it. With this in mind, the objective of this study was to determine changes in deep stacked broiler litter with time.

Experimental Procedure

Approximately 22 tons of wood shaving litter were collected from a broiler house shortly after removal of the birds. The material was transported from the broiler house and stacked at a depth of about 5 ft in a covered building open on all sides. Six thermistor probes were placed at alternate depths 18 and 32 in from the surface of the stack. The temperatures at these sites were then monitored daily. Initial samples were taken throughout the house and weekly samples were taken thereafter for a period of 6 wk. Stack samples were taken at a depth of 12 to 36 in from the surface. Sampling sites were chosen and marked to give a uniform sample each week. The sites were then randomly allotted to one of the 6 weeks with a total of four sites sampled per week. Water extract was made from the sample for microbiological assay and pH. The remainder of the sample was processed and frozen for later analysis.

Results

Temperature changes within the stack are given in table 1. Temperatures at the depth of 18 in were consistently higher than those at 32 in. A maximum temperature of 54.0^{o}C was recorded after one week at 18 in. At the depth of 32 in, 3 wk were required to attain a maximum temperature of 45.8^{o}C. In both cases, temperatures declined after the maximum was reached. However, the decline was greater at the 18 in depth. Dry matter dropped significantly after one week as is shown in table 1. Dry matters were then found to rise and stabilize at around 66%. Although the decrease after 1 week was probably due to sampling error, there was a significant difference between the initial samples at week 0 and all other weeks. The lowest pH value (7.38) was found to occur initially. The highest value was found after 2 wk, 8.13, after which pH stabilized at around 8.0 except for a noticeable drop to 7.70

at the fifth week. In general, lactic acid levels were low throughout the study (table 1). The highest value of 0.27% of the dry matter was found initially. Low lactic acid production indicates a minimal amount of anaerobic fermentation occurred within the stack.

Microbiological assays were performed initially and throughout the 6 week experiment (table 2). Salmonella and Shigella were not present at any time. Proteus growth was observed initially and at weeks 2 and 4. Total coliform assay revealed 1 colony at the dilution of 1:100 (4 wk). No growth was observed at higher dilutions. Fecal coliforms were not observed at any time during the course of the study.

Summary

Stack temperatures were found to be greater at 18 in than 32 in. Maximum temperature was attained after 1 wk at 18 in and after 3 wk at 32 in. Litter pH was lowest initially and highest at 2 wk, after which it stabilized. Lactic acid was 0.27% of the dry matter initially,after which values tended to decline. Based on pH and lactic acid production, minimal fermentation occurred within the stack. Fecal coliforms, Salmonella and Shigella were not present at any time during the 6 wk study. Total coliforms were detected once and Proteus growth appeared intermittently throughout the experiment.

TABLE 1. TEMPERATURE, DRY MATTER, pH AND LACTIC ACID CHANGES IN DEEP STACKED BROILER LITTER WITH TIME

Week	Temperature (°C) 18 in	32 in	Dry matter, %	pH	Lactic acid,[a] %
0	39.2[b]	31.1[b]	72.0[b]	7.38[b]	0.27[b]
1	54.0[c]	42.5[c]	63.0[c]	8.04[c,d]	0.22[b,c]
2	52.5[c]	45.7[c]	66.3[d]	8.13[d]	0.18[b,c]
3	48.6[c,d]	45.8[c]	65.9[d]	7.89[c]	0.04[b,c]
4	46.7[b,c,d]	43.7[c]	65.4[d]	7.91[c]	0.0[c]
5	44.9[b,c,d]	41.6[c]	65.6[d]	7.70[d]	0.0[c]
6	43.0[b,d]	40.2[c]	66.8[c,d]	7.92[c]	0.24[b,c]

[a] Dry basis.

[b,c,d] Means within the same column with different superscripts are different (P<.01).

TABLE 2. MICROBIOLOGICAL ASSAYS OF DEEP STACKED BROILER LITTER

Week	Salmonella	Shigella	Proteus	Coliform colonies	
				Total	Fecal
				10^2	10^2
0	-	-	+	0	0
1	-	-	-	0	0
2	-	-	+	0	0
3	-	-	-	0	0
4	-	-	+	1	0
5	-	-	-	0	0
6	-	-	-	0	0

FERMENTATION AND DIGESTIBILITY OF BROILER LITTER ENSILED AT DIFFERENT MOISTURE LEVELS BY ADDITION OF WHEY OR WATER[1]

J. A. Duque, J. P. Fontenot, K. E. Webb, Jr. and J. C. A. Berger

The disposal of animal wastes presents a major pollution problem. However, waste products contain nutrients which may be utilized by animals. Approximately 11 million tons of whey, a byproduct of cheese manufacturing and 48 million tons of poultry waste are produced in the United States annually.

Studies conducted with broiler litter have shown that the optimum moisture level for ensiling of broiler litter is 40%. Liquid whey has been found to be an excellent source of carbohydrate and an effective hay crop silage additive by decreasing pH and increasing lactic acid of alfalfa hay silage.

Experiments were conducted to study further the effect of moisture level on ensiling of broiler litter, by addition of whey or water.

Experimental Procedure

A preliminary study was conducted with small laboratory silos. The wood shaving based broiler litter used in this preliminary study had been stacked for a period of 3 to 4 wk.

Fresh liquid whey was obtained from a cheese manufacturer and kept under refrigeration until it was used. Twenty kilogram mixtures were prepared to obtain moisture levels of 22 (no whey or water added), 30, 40, 50, 60 and 70% by addition of whey or water. The mixtures were prepared by mixing on the floor with shovels. The whey or water was added to the mixtures (30, 40, 50, 60 and 70% moisture levels) slowly while mixing the litter. Initial mixture samples were taken prior to ensiling. Cardboard food containers were used to support two 1 gal. polyethylene bags which contained the well packed material. Each polyethylene bag was individually sealed and an attempt was made to expel the air above the packed material before sealing. Each treatment was composed of six laboratory silos, and these were allowed to ensile for a minimum of 45 days. Each silo was weighed before it was opened. Initial and ensiled samples were assayed for microbial count, proximate components, pH, lactic acid, water soluble carbohydrates and volatile fatty acids.

[1]Appreciation is expressed to Rocco, Inc. for supplying the broiler litter and Beatrice Food Company, Radford, Va. for supplying liquid whey.

A second small silo study was conducted, using the same procedures as described above, except the litter was obtained from a broiler house immediately after the birds were marketed. A study was also conducted with large silos to evaluate the nitrogen utilization and digestibility of rations containing ensiled broiler litter.

Wood shaving based broiler litter was obtained from a commercial broiler house. One group of broilers had been reared on the litter for 11 weeks. Representative samples were taken along the house and piled in one place.

Fresh liquid whey was obtained from a cheese manufacturer. For the large silos, liquid whey or water was added to obtain mixtures containing 13% (no whey or water added), 30%, 40%, and 50% moisture. Each treatment was prepared to contain 200 kg of material on dry basis. Prior to ensiling, the broiler litter was ground in a hammer mill through a 0.6 cm. mesh screen. A weighed amount of litter, containing 13.1% moisture (no whey or water added), was thoroughly mixed in a horizontal mixer and augered into two silos. Each silo consisted of a 190 l. metal drum lined with double thickness plastic bags. An attempt was made to expel as much air above the ensiled material as possible prior to sealing the bags. Silos were allowed to ensile for a minimum of 45 days.

Two metabolism trials were conducted with 27 crossbred wethers allotted at random in each trial. The composition of the experimental rations used in the trials is shown in table 1. Nine different rations were fed in both trials consisting of: 1) low protein basal alone or supplemented with: 2) 13% moisture litter silage; 3) and 4) 30% moisture litter silage with water or whey added; 5) and 6) 40% moisture litter silage with water or whey added; 7) and 8) 50% moisture litter silage with water or whey added; 9) soybean meal. The supplemental material provided 50% of the dietary nitrogen for the eight respective rations. All rations were equalized in available energy. Vitamins A and D were supplemented in the rations at levels to supply 770 IU and 200 IU per animal per day, respectively. Sheep were fed 700 g on dry matter basis of the respective rations plus 10 g of trace mineralized salt per day.

Each trial consisted of 5-day transition, 10-day preliminary and 10-day collection period. Animals were fed twice daily at 12 hr intervals and water provided _ad libitum_ except during the two 2 hr feeding periods. Ruminal fluid and blood samples were taken at the end of the collection period of each trial.

Results and Discussion

Fermentation parameters of initial mixtures and silage materials from small silo study I are presented in table 2. The pH of the initial mixtures was not significantly different among moisture levels. Values for pH for silages containing the addition of whey or water generally decreased with each increment of moisture. However, pH levels for the silage material containing 30% moisture by addition of whey or water, and 60% and 70% moisture by addition of water were slightly lower than those for the corresponding initial mixtures, indicating limited fermentation. Level of lactic acid for silages increased with each increment of moisture by addition of whey. However, lactic acid level for silages containing the addition of water showed slight increase.

Table 3 shows the fermentation characteristics of initial mixtures and silages from small silo study II. There was no significant difference among pH levels of initial mixtures. Silages showed a decrease in pH value with each increment of moisture by addition of whey or water, with the exception of the 60% and 70% moisture levels by addition of water. There was no significant difference among pH values of 40% and 50% moisture levels by addition of whey or water. In fact, levels for the 40% moisture were the same for the silages containing whey or water added. Silage material containing 60% and 70% moisture by addition of whey or water showed putrefaction and a very unpleasant odor.

Lactic acid levels for the silages showed an increase with each increment of moisture by addition of whey. However, levels of lactic acid were observed to increase with each increment of moisture by addition of water only up to 50%. There was no significant difference among levels of lactic acid for 40% and 50% moistures.

Soluble carbohydrate levels were higher for the initial material containing whey than for the initial material containing water. Levels of carbohydrate in the ensiled material generally decreased with each increment of moisture by addition of whey or water.

Table 4 shows the total coliform counts for initial and silage mixtures of the second small silo study. Initial mixtures containing the addition of water showed a higher coliform count than the initial mixtures containing the addition of whey. A positive test was observed for proteus organisms. Fecal coliforms, salmonella and shigella organisms were not present in the initial mixtures. Ensiling at all moisture levels resulted in the complete elimination of coliforms and proteus organisms.

Nitrogen utilization data are presented in table 5. Fecal nitrogen was not significantly affected by treatment. Urinary nitrogen was not different among nitrogen supplemented rations, but it was lower for the sheep fed the control ration. Nitrogen retention, expressed as grams per day or percent of intake, was not significantly different, regardless of nitrogen source, but it was lower for the lambs fed the negative control rations.

Table 7 shows the apparent digestibility data of dry matter and crude protein. Dry matter digestibility of the negative control ration was 53.8%, whereas for the nitrogen supplemented rations the values ranged from 65.2 to 67.5%. Apparent digestibility of crude protein was 37.3% for the negative control ration and ranged from 60.9 to 65.0% for the nitrogen supplemented rations.

TABLE 1. COMPOSITION OF EXPERIMENTAL RATIONS FED IN METABOLISM TRIALS (%)

Ingredient	Corn	Nitrogen supplements: Broiler litter silage by moisture level & addition: 13% moisture	30% moisture: Whey	30% moisture: Water	40% moisture: Whey	40% moisture: Water	50% moisture: Whey	50% moisture: Water	Soybean meal
Corn cob fraction	53.88	37.17	40.48	41.36	41.48	41.72	40.91	42.76	51.54
Corn, grain, grnd.	45.22	43.06	41.18	41.12	40.67	40.88	41.26	39.86	35.60
Litter silage, 13% moisture		19.76							
Litter silage, 30% moisture			18.36	17.53					
Litter silage, 40% moisture					17.71	17.41			
Litter silage, 50% moisture							17.88	17.42	
Soybean meal									12.16
Limestone, grnd, mn 33% calcium	0.1								
Defluorinated phosphate	0.8								0.6
Vitamin A palmitate[a]	+	+	+	+	+	+	+	+	+
Vitamin D supplement[b]	+	+	+	+	+	+	+	+	+

[a] 770 IU per animal daily.
[b] 200 IU per animal daily.

TABLE 2. FERMENTATION CHARACTERISTICS OF INITIAL MIXTURES AND SILAGES FROM SMALL SILO STUDY I

Type of material	Estimated moisture (%)	pH (%)		% of Dry matter			
				Lactic acid		Acetic acid	
		Whey	Water	Whey	Water	Whey	Water
Initial mixture	22		7.85		0.05		0.19
	30	7.78	7.85	0.13	0.20	0.18	0.15
	40	7.74	7.86	0.50	0.16	0.21	0.21
	50	7.67	7.89	0.88	0.17	0.24	0.15
	60	7.56	7.92	1.34	0.06	0.19	0.19
	70	7.42	7.97	2.29	0.08	0.19	0.21
Silages	22		8.38[e]		0.12[a]		0.04
	30	7.15[b,c,d]	7.30[c,d]	0.53[a]	0.61[a]	0.94	0.72
	40	6.74[b]	6.85[b,c]	0.69[a]	0.61[a]	1.16	0.86
	50	5.77[a]	6.81[b,c]	3.08[b]	0.15[a]	1.52	2.13
	60	5.88[a]	7.50[d]	3.74[b]	0.12[a]	1.49	6.19
	70	5.71[a]	7.20[b,c,d]	7.24[c]	0.20[a]	2.37	8.46

[a,b,c,d,e] Means on the same parameter for silages having different superscripts are significantly ($P<.05$) different.

TABLE 3. FERMENTATION CHARACTERISTICS OF INITIAL MIXTURES AND SILAGES FROM SMALL SILO STUDY II

Type of material	Estimated moisture (%)	pH (%)		% of Dry matter: Lactic acid		Acetic acid		Soluble carbohydrates	
		Whey	Water	Whey	Water	Whey	Water	Whey	Water
Initial mixture	13		7.81		0.27		0.25		2.41
	30	7.74	7.93	0.53	0.16	0.21	0.29	4.43	2.48
	40	7.77	7.96	1.64	0.31	0.28	1.25	5.04	3.08
	50	7.69	7.94	2.76	1.78	0.55	0.50	0.65	3.05
	60	7.68	7.98	3.39	2.23	0.26	0.43	8.99	3.27
	70	7.38	8.07	5.15	3.33	0.28	0.56	12.23	3.81
Silages	13		$7.88^{c,d}$		0.18^{a}		0.05^{a}		2.28
	30	6.67^{b}	6.77^{b}	$1.50^{a,b}$	$1.42^{a,b}$	$1.53^{a,b}$	$1.66^{a,b}$	3.82	2.84
	40	5.57^{a}	5.57^{a}	$5.23^{c,d}$	4.85^{c}	$1.85^{a,b}$	$1.72^{a,b}$	4.13	3.35
	50	5.24^{a}	5.55^{a}	$1.27^{c,d}$	$6.10^{c,d}$	$3.23^{b,c}$	$1.82^{a,b}$	3.16	2.86
	60	5.16^{a}	7.39^{c}	6.65^{d}	1.95^{b}	4.00^{c}	$3.15^{b,c}$	2.00	2.42
	70	5.11^{a}	7.94^{d}	9.11	$0.36^{a,b}$	4.34^{c}	10.07	2.49	2.32

^{a,b,c,d}Means on the same parameter for silages having different superscripts are significantly (P<.01) different.

TABLE 4
COLIFORMS IN INITIAL AND SILAGE MIXTURES[a,b]

Estimated moisture	Total, initial		Total, silages	
	Whey	Water	Whey	Water
%	X 10^3 per gram		X 10^3 per gram	
13		264.3		0
30	16.5	22.8	0	0
40	1.3	120	0	0
50	4.6	14.3	0	0
60	1.2	99.5	0	0
70	2.7	1075	0	0

[a]Fecal coliforms, Salmonella and Shigella were not present in the initial mixtures.

[b]Proteus was found in initial mixtures but eliminated during the ensiling process.

TABLE 5

NITROGEN UTILIZATION BY SHEEP FED ENSILED BROILER LITTER

Item	Corn[a]	Nitrogen supplements				
		Broiler litter silage				Soybean meal[a]
		13% moisture	30% moisture	40% moisture	50% moisture	
Nitrogen intake - water, g/day	7.53	12.69	12.39	12.38	12.61	13.20
" " - whey, g/day			12.67	12.57	12.57	
Fecal N - water, g/day	4.72	4.96	4.72	4.88	5.07	4.63
" " - whey, g/day			4.91	4.61	4.89	
Urinary N - water, g/day	2.37[c]	5.84[b]	6.15[b]	6.06[b]	5.61[b]	6.49[b]
" " - whey, g/day			6.15[b]	6.04[b]	6.06[b]	
N-retention - water, g/day	0.43[c]	1.88[b]	1.52[b]	1.45[b]	1.94[b]	2.08[b]
" " - whey, g/day			1.62[b]	1.92[b]	1.62[b]	
N-retention - water, % of intake	5.74[b]	14.82[c]	12.26[bc]	11.66[bc]	15.40[c]	15.73[c]
" " - whey, % of intake			12.73[bc]	15.29[c]	12.93[bc]	

[a]No water or whey added.

[b,c]Means on the same parameter having different superscripts are significantly (P<.05) different.

TABLE 6
APPARENT DIGESTIBILITY BY SHEEP FED ENSILED BROILER LITTER

		Nitrogen supplements				
		Broiler litter silage				
	Corn[a]	13% moisture[a]	30% moisture	40% moisture	50% moisture	Soybean[a] meal
	%	%	%	%	%	%
Dry matter						
Water	53.8[c]	67.3[b]	67.5[b]	66.6[b]	65.2[b]	66.3[b]
Whey			67.1[b]	67.2[b]	67.0[b]	
Crude protein						
Water	37.3[c]	60.9[b]	62.8[b]	60.6[b]	59.8[b]	65.0[b]
Whey			61.3[b]	63.3[b]	61.0[b]	

[a]No water or whey was added.

[b,c]Means on the same parameter having different superscripts are significantly (P<.05) different.

EFFECT OF IMPLANTING ZERANOL IN SUCKLING CALVES AND AT PERIODICAL INTERVALS UNTIL FATTENED IN THE FEEDLOT[1]

J. P. Fontenot, R. F. Kelly and W. D. Lamm

It has been shown that implanting zeranol increases gain in growing and finishing steers and heifers, and in suckling calves. In previous research it was found that implanting steers at the beginning of the pasture season improved gain during the grazing season and did not affect the response to implanting at the beginning of the subsequent fattening phase. The recommendation is to implant calves at periodic intervals from the suckling stage until slaughter.

The purpose of the experiment reported here was to study the effect of implanting zeranol in suckling calves and at periodic intervals until finished in the feedlot.

Experimental Procedure

One hundred and forty four suckling steer and heifer calves owned by and kept on Graves Bros. Farm, Syria, Va. were started on experiment July 1, 1976. At that time the calves were paired on the basis of sex, breeding (straight-bred or crossbred), and weighed. One of the calves in each pair was allotted at random to be implanted with 36 mg of zeranol (trade name: Ralgro) on that day, and the other calf was not implanted. The calves were grazed until fall. They were grazed at different locations but the control and implanted calves within a pair were grazed at the same location.

On October 25, 1976 the calves were removed from pasture and put into drylot. At that time one-half of the calves which had and one-half of those which had not been implanted in the summer were implanted with 36 mg zeranol. Likewise, in the spring of 1977 and the fall of 1977 half of the calves within each sub-group were implanted with 36 mg of zeranol. The treatments the animals received from the time they were started until the last period prior to slaughter are shown below.

[1]Appreciation is expressed to Graves Bros. Farm, Syria, Va. for their cooperation and IMC, Chemical Group, Terre Haute, Indiana for supporting in part this study with a grant-in-aid.

Treatment no.	Treatment Summer, 1976	Fall, 1976	Spring, 1977	Fall, 1977
1	None	None	None	None
2	None	None	None	Zeranol
3	None	None	Zeranol	None
4	None	None	Zeranol	Zeranol
5	None	Zeranol	None	None
6	None	Zeranol	None	Zeranol
7	None	Zeranol	Zeranol	None
8	None	Zeranol	Zeranol	Zeranol
9	Zeranol	None	None	None
10	Zeranol	None	None	Zeranol
11	Zeranol	None	Zeranol	None
12	Zeranol	None	Zeranol	Zeranol
13	Zeranol	Zeranol	None	None
14	Zeranol	Zeranol	None	Zeranol
15	Zeranol	Zeranol	Zeranol	None
16	Zeranol	Zeranol	Zeranol	Zeranol

After weaning the cattle were kept as one group through the subsequent winter and grazing periods. The calves which are estimated to be in choice condition were slaughtered in March, 1978 and the remainder were slaughtered in May. At the beginning of the trial and at the end of each phase, the cattle were individually scored for grade, mammary development and tailhead elevation.

Results

The results of the calves up to weaning were presented in last year's Research Report (V.P.I. & S.U. Res. Div. Rep. 172, p. 46).

The detailed data are given in table 1 for the cattle on the 16 treatments. The summary of the response and gain per head and daily gain for the different periods is given in table 2. As shown in the table, there was a substantial response in daily gain during each of the periods. The response ranged from about 5 to 19%. The variation, and the fact that some of the cattle were not kept on the experiment for the duration of the experiment for reasons not related to the treatments, does not allow the establishment of a direct relationship between number of implants and treatment. However, it is possible to calculate the response of cattle to zeranol implants which had and had not received an implant during the previous period. When these are summarized, the average difference in response between the animals that had, and had not received an implant during the previous period is only 1 lb per head during the entire period, which indicates that cattle continued to respond to the zeranol implant even if they were implanted in the previous period.

It is obvious from the limited data that substantial responses were obtained from implanting with zeranol. With higher rates of performance larger improvements would probably have been obtained. However, even with the moderate rates of performance, if the cattle getting no implant (lot no. 1) are compared with those receiving four implants (lot no. 4), the difference was 56 lb in total gain or an increase of over 9% from implanting the zeranol.

The implants did not have any effect on tailhead elevation, mammary development, feeder or slaughter grade or carcass characteristics.

Table 1. Effect of Implanting Zeranol at Periodic Intervals.

Treatment no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Implant[a], summer, 1976	None								Zeranol							
Implant[a], Fall, 1976	None				Zeranol				None				Zeranol			
Implant[a], spring, 1977	None		Zeranol		None		Zeranol		None		Zeranol		None		Zeranol	
Implant[a], fall, 1977	None	Zeranol	None	Zeranol	None	Zeranol	None	Zeranol	None	Zeranol	None	Zeranol	None	Zeranol	None	Zeranol
Weight and gain data, lb.																
Initial wt., July 1, 1976	260	257	268	270	294	264	299	218	263	239	235	277	253	267	294	259
Wt., Oct. 25, 1976	398	415	396	389	391	399	411	391	403	356	388	397	406	401	436	400
Gain/head, summer	134	119	128	119	92	135	111	159	141	130	153	120	147	141	142	141
Daily gain, summer	1.15	1.02	1.10	1.03	.79	1.17	.96	1.36	1.21	1.12	1.32	1.03	1.27	1.21	1.23	1.22
Wt., Apr. 22, 1977	502	493	466	479	500	533	508	442	497	480	454	473	505	476	511	490
Gain/head, winter	90	84	70	82	80	117	105	84	80	93	60	84	105	89	83	92
Daily gain, winter	.50	.47	.40	.46	.45	.65	.58	.47	.45	.52	.33	.52	.59	.50	.47	.52
Cumulative gain/head	231	195	198	218	182	255	214	224	227	192	218	211	247	212	228	241
Cumulative daily gain	.78	.66	.67	.74	.62	.87	.72	.76	.77	.77	.74	.71	.84	.72	.77	.82
Wt., Nov. 7, 1977	547	537	634	622	654	654	717	606	676	617	582	614	629	640	611	629
Gain/head, summer	132	102	189	156	154	174	190	159	164	166	142	141	110	136	92	139
Daily gain, summer	.66	.51	.95	.78	.77	.87	.95	.80	.82	.87	.71	.71	.55	.68	.46	.69
Cumulative gain /head	354	287	393	353	336	399	406	338	390	396	364	352	354	355	346	380
Cumulative daily gain	.72	.58	.80	.72	.68	.81	.82	.79	.79	.90	.74	.83	.72	.72	.70	.77
Wt., Mar. 20, 1978	819	825	885	941	917	937	1055	885	915	932	917	881	910	866	874	909
Gain/head, winter	230	267	251	317	263	283	302	279	240	290	265	258	281	226	262	280
Daily gain, winter	1.73	2.01	1.89	2.38	1.98	2.13	2.27	2.09	1.80	2.18	1.99	1.94	2.11	1.70	1.97	2.10
Cumulative gain/head	606	569	644	658	599	682	690	666	630	687	649	611	635	581	609	660
Cumulative daily gain	.97	.90	1.03	1.05	.96	1.09	1.10	1.06	1.00	1.10	1.04	.98	1.01	.93	.97	1.05
Feeder grade[b]																
Initial, July 1, 1976	12.5	12.6	12.4	11.8	12.1	13.2	11.7	12.2	12.4	11.6	11.0	13.0	13.6	11.6	13.4	12.0
Oct. 25, 1976	11.6	11.3	11.0	9.9	10.9	12.5	11.4	11.8	11.4	9.6	10.9	11.6	12.0	12.5	12.9	12.1
Apr. 22, 1977	10.5	11.0	10.3	10.3	11.4	10.6	10.2	7.2	11.5	10.7	10.6	10.6	9.9	9.7	10.3	9.8
Nov. 7, 1977	9.7	9.4	9.6	10.3	9.4	11.0	10.0	9.0	10.8	10.7	8.4	10.1	9.0	10.7	10.2	9.5

Table 1. Effect of Implanting Zeranol at Periodic Intervals. (cont)

Treatment no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Implant[a], summer, 1976	None								Zeranol							
Implant[a], fall, 1976	None				Zeranol				None				Zeranol			
Implant[a], spring, 1977	None		Zeranol		None		Zeranol		None		Zeranol		None		Zeranol	
Implant[a], fall, 1977	None	Zeranol	None	Zeranol	None	Zeranol	None	Zeranol	None	Zeranol	None	Zeranol	None	Zeranol	None	Zeranol
Mammary development[c]																
Initial, July 1, 1976	0	.06	.07	0	0	0	0	.05	.05	0	0	0	0	0	0	0
Oct. 25, 1976	.06	0	0	0	0	0	0	0	.11	0	0	0	0	0	.19	0
Apr. 22, 1977	.33	0	.28	.07	.33	.17	.25	.21	.12	.07	.28	.25	0	.33	.17	.30
Nov. 7, 1977	0	0	0	0	.17	0	1	.4	.33	0	0	.25	0	0	0	0
Mar. 20, 1978	0	.50	.42	.20	.50	0	0	.62	.33	.12	.40	.36	0	.67	.12	.50
Tailhead elevation[d]																
Initial, July 1, 1976	.28	.06	.14	.39	.44	.06	.07	0	.17	.12	.15	.17	0	.19	.25	.14
Oct. 25, 1976	.19	.25	.64	.55	.37	.33	.19	.39	.55	.43	1	.69	.79	.44	.50	.86
Apr. 22, 1977	.25	.08	.36	.50	.17	.30	.50	.07	.37	.21	.44	.44	.29	.83	.67	.50
Nov. 7, 1977	0	.20	.25	.30	.17	.20	0	0	.17	0	0	.62	0	.50	0	.75
Mar. 20, 1978	0	.50	.25	.21	.17	.10	.25	.25	.30	.37	.20	.50	.50	.67	.25	.67
Slaughter grade[b]																
Nov. 7, 1977	5.3	4.4	5.4	5.7	5.6	5.7	5.5	4.5	6.0	5.5	4.6	5.4	4.8	6.0	5.5	5.2
Mar. 20, 1978	11.2	9.7	10.3	10.1	11.5	10.6	11.6	10.7	11.2	11.7	9.8	11.1	11.9	11.2	11.6	11.6
Carcass data																
Dressing %	61	62	60	60	61	62	60	59	60	60	61	62	58	46	61	61
Maturity	1.3	1	1.1	1.2	1	1	1	1	1	1	1	1.3	1.2	1.8	1	2
Marbling	4	4	4.7	4.6	4.1	5	3.7	4.9	3.9	4.5	4.7	4.2	4.5	4.4	3.5	4.6
Kidney fat, %	2.5	2.2	2.2	2.5	2.8	2.2	1.7	2.6	2.3	2.1	2.7	2.7	2.3	2.6	2.1	2.3
Loineye muscle area, sq in.	10.8	11.2	8.6	10.8	11.6	11.6	13.3	10.6	11.4	11.6	11.6	11.5	10.2	10.3	13.0	11.4
Backfat thickness, in.	.35	.42	.50	.37	.51	.42	.35	.50	.39	.29	.42	.41	.45	.38	.30	.32
Quality grade[b]	11.8	12.0	12.7	12.2	12.1	13.0	10.7	12.7	11.5	12.5	12.7	10.9	12.2	9.4	11.5	8.5
Yield grade	2.2	2.8	2.8	2.7	3.0	2.6	1.9	3.0	2.4	2.1	2.6	2.5	2.8	2.9	1.7	2.2

[a]36 mg Zeranol.

[b]Code: 11=high good; 12=low choice; etc.

[c]Code: 0=no development; 1=development; 2=marked development.

[d]Code: 0=no elevation; 1=elevation; 2=marked elevation.

TABLE 2. RESPONSE OF CATTLE TO ZERANOL IMPLANTS DURING DIFFERENT PERIODS

Period	Gain during period			
	Gain per head		Daily gain	
	Control	Zeranol	Control	Zeranol
Summer 1[a]	125	139	1.07	1.20
Winter 1[b]	80	95	.46	.53
Summer 3[c]	142	151	.72	.76
Summer 4[d]	262	275	1.97	2.07

[a]Treatment no. 1-8 *vs*. 9-16.

[b]Treatment no. 1-4 and 9-12 *vs*. 5-8 and 13-16.

[c]Treatment no. 1,2,5,6,9,10,13,14 *vs*. 3,4,7,8,11,12,15,16.

[d]Treatment no. 1,3,5,7,9,11,13,15 *vs*. 2,4,6,8,10,12,14,16.

EFFECT OF IMPLANTING ZERANOL IN SUCKLING CALVES[1]

J. P. Fontenot, R. F. Kelly and W. D. Lamm

This is part of an experiment to study the effect of implanting zeranol in suckling calves and at intervals until fattened. The first group of calves were started on test in 1976 and the results were reported in the 1977 Research Report. This report concerns the second group of calves which were started in 1977.

Experimental Procedure

One hundred sixty-two suckling steer and heifer calves owned by and kept on Graves Bros. Farm, Syria, Virginia were started on test June 27, 1977 and were weaned on November 7, 1977. On June 27, the cattle were paired on the basis of sex, breeding and weight and one of the calves in each pair was selected at random to be implanted with 36 mg zeranol (trade name: Ralgro) on that day, and the other calf was not implanted. The calves were grazed until fall at four different locations, but the control and implanted calves within a pair were grazed at the same location.

At weaning they were removed from pasture and placed in dry lot. At that time, one-half of the calves which had and one-half of the calves which had not been implanted in the summer were implanted with 36 mg zeranol.

At the beginning of the trial and at the end of the grazing season the calves were individually scored for feeder grade, mammary development and tailhead elevation.

Results

The effect of implanting zeranol in suckling calves during the 1977 season is shown in table 1. Rate of gain for all calves was quite good, considering the time of the year the calves were started. The implanted calves gained 15 lb more than the controls, for an average increase of 8%. This is essentially the type of response that we have obtained previously.

Implanting calves did not have any effect on feeder grade, mammary development or tailhead elevation. It should be pointed out that the implants should not be used on heifers to be kept as replacements or for bulls to be used for breeding until the effect of the implants on these animals is more clearly understood.

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[1]Appreciation is expressed to Graves Bros. Farm, Syria, Virginia, for supplying the cattle and facilities and to IMC Chemical Group, Terre Haute, Indiana for supplying the implants and for supporting this work in part by a grant-in-aid.

TABLE 1. EFFECT OF ZERANOL IMPLANTS IN SUCKLING CALVES

	Implant	
Item	None	Zeranol
Initial wt., lb.	212	218
Wt., weaning, lb.	383	413
Summer gain/head, lb.	180	195
Daily gain, lb.	1.35	1.46
Feeder grade[a]		
Initial	11.4	11.4
Weaning	11.3	11.6
Mammary development[b]		
Initial	.08	.08
Weaning	.02	.08
Tailhead elevation[c]		
Initial	.25	.19
Weaning	.15	.15

[a]Code: 11=high good; 12=low choice; 13=average choice, etc.
[b]Code: 0=no development; 1=development; 2=marked development.
[c]Code: 0=no elevation; 1=elevation; 2=marked elevation.

ECONOMIC POTENTIALS FROM PERENNIAL FORAGE-CATTLE FINISHING SYSTEMS[1]

J. P. Fontenot, F. S. McClaugherty, J. L. Hale, C. P. Bagley and R. E. Blaser

Many of the conventional systems for fattening cattle require large amounts of grain feeding. As the demand on protein and cereal grains for direct human consumption continues to increase, so will the cost for fattening cattle with these conventional systems. Forage-animal systems of management for growing and fattening cattle on land not suitable for grain and legume cereals, without protein supplementation, and with little or no grain feeding, has strong potentials for reducing the costs of fattening cattle. With the vast land areas in the United States not suitable for tilled crops, the development of such systems shows even more potential, especially in Virginia.

Cattle can be fattened to good to good to choice grade by feeding grain on summer pasture at 1% of bodyweight. Conventional forage systems are generally limited by seasonal growth, producing fat cattle for market at only one or two times during the year. Forage systems are needed which produce fat cattle for marketing at different times of the year.

Fescue accumulated from early August after nitrogen fertilization has been found to be high in nitrogen and water soluble carbohydrates during the late fall and winter. This stockpiled fescue has been used successfully for wintering brood beef cows and stocker cattle. Perhaps, this forage could be used with minimum grain supplementation for fattening cattle during the winter. During the summer it could be grazed, along with other forages such as bluegrass-white clover and alfalfa-orchardgrass.

Experimental Procedure

The main objective of the research was to develop perennial forage-cattle management systems that provide forages of adequate nutritional value for economical liveweight gains for growing and fattening cattle without protein supplements and little or no grain feeding for finishing cattle at different times of the year. Both fall and spring calves have been incorporated in an effort to produce fat cattle at four times throughout the year: April, July, October and January. A description and summary of the seven systems being studied in this experiment are outlined in figure 1. A total of 24 weanling steer calves and 18 yearling steers were used in the test at the Southwest Virginia Research Station. The cattle which were not slaughtered in October were fed corn silage plus protein supplement in the feedlot. All cattle are implanted with Ralgro (36 mg) each spring and fall, following appropriate withdrawal times before slaughter. These same systems with the same number of cattle are being tested at Middleburg also.

[1]Experiment conducted at Southwest Virginia Research Station, Glade Spring.

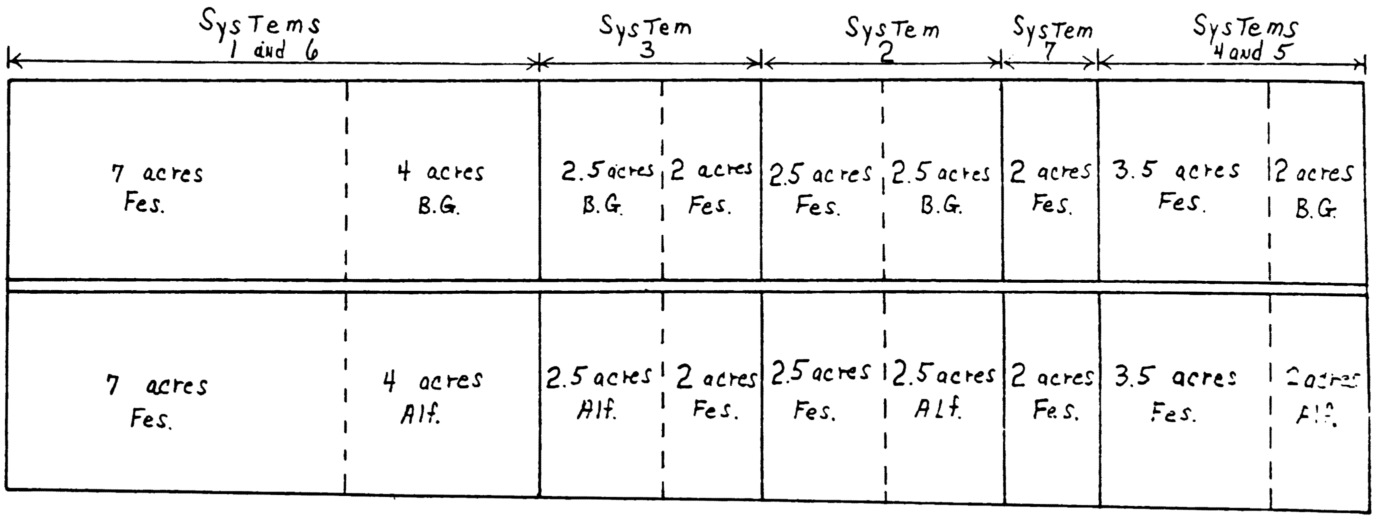
Results

Preliminary results for the first year are given in tables 1 and 2. The gains of the cattle were not very good during the winter of 1976-77, especially those not fed supplemental grain. This was due mainly to accumulation of snow on the pastures for about 50 days during the winter. Gains from April to July were very good and were not increased by grain feeding.

Gains from July to October were not as high as during the spring, and were not consitently increased by grain feeding. Daily gains in the feedlot were suboptimal. Perhaps, some grain should be fed.

Carcass grades averaged good or higher at each time of slaughter. The highest grades were at the end of the feedlot phase.

Figure 1. Description of Systems for Forage Finishing of Cattle



Description of Systems:

System no.	Kind of steers, fall, 1976	Type of grazing	Grain level, % of bodywt.	Time of slaughter
1	Weanling calves	Top	0	½ Oct.-½ Jan.
2	Weanling calves	Top	.5	½ Oct.-½ Jan.
3	Weanling calves	Whole	0	½ Oct.-½ Jan.
4	Weanling calves	Whole	.5[a]	½ Oct.-½ Jan.
5	Yearlings	Whole	.5[a]	July
6	Yearlings	Top	0	July
7	Yearlings	Whole	1.0	April

[a]Increased to 1.0% of bodyweight in April

Table 1. Forage Finishing of Steers in Southwest Virginia (November to July)

System	1	2	3	4	5	6	7
Kind of steers, initial	Weanling calves				Yearlings		
Type of grazing	Top		Whole		Whole	Top	Whole
Grain level, % of bodywt.	0	0.5	0	0.5[a]	.5[a]	0	1.0
Number of steers	6	6	6	6	6	6	6
Beginning wt., 11-18-76, lb.	515	516	515	525	725	724	718
Spring wt., 4-21-77, lb.	651	727	651	704	917	860	978
Gain per head, winter, lb.	136	211	136	179	192	136	260
Daily gain, winter, lb.	.88	1.37	.88	1.16	1.25	.88	1.69
Weight July 19, 1977, lb.	870	938	865	902	1,150	1,087	1,051[b]
Gain per head, spring, lb.	219	211	214	198	233	227	73[b]
Daily gain, spring, lb.	2.46	2.37	2.40	2.22	2.62	2.55	2.28[b]
Gain per head, winter + spring, lb.	355	422	350	377	425	363	333[b]
Daily gain, winter + spring, lb.	1.46	1.73	1.44	1.55	1.75	1.49	1.79[b]
Slaughter grade[c]	8.0	9.3	8.7	9.2	10.8	10.0	11.0[b]
Carcass grade[c]	---	---	---	---	10.0	9.8	11.7[b]
Feed consumed, lb./head (11/18/76-7/19/77)							
Ground shelled corn	---	957	---	1,177	1,511	---	1,703[b]
Salt	---	145	---	164	208	---	181[b]
Alfalfa hay	767	918	942	780	1,034	1,059	980[b]

[a] Increased to 1.0% of bodyweight in April.
[b] Final weight was May 23, 1977.
[c] Code: 8.0 = top standard; 9.0 = low good; 10.0 = avg. good; etc.

Table 2. Forage Finishing of Steers in Southwest Virginia (July-January), Weanling Calves

System	1	2	3	4
Type of grazing	Top		Whole	
Grain level, % of bodywt.	0	1.0	0	1.0
Weight Oct. 18, 1977, lb.	997 (990)[b]	101.4 (1012)[b]	948 (960)[b]	1042 (1038)[b]
Gain per head, July - Oct., lb.	153	103	136	142
Daily gain, lb.	1.68	1.13	1.49	1.56
Gain per head, Apr. - Oct., lb.	346	287	297	338
Daily gain, lb.	1.92	1.60	1.65	1.88
Total feed consumed, lb/head (11/18/76-10/18/77)				
Ground shelled corn	---	1,407	---	2,062
Salt	---	205	---	271
Alfalfa hay	767	918	942	780
Slaughter grade[a]	10.3	11.0	9.3	10.0
Carcass grade[a]	10.7[b]	11.7[b]	10.7[b]	10.0[b]
Weight, Jan. 9, 1978, lb.	1,082	1,114	1,069	1,097
Gain in feedlot, lb.	92	102	109	59
Daily gain, lb.	1.10	1.21	1.30	.7
Feed per head (feedlot)				
Corn silage, lb.	3,294	3,620	3,550	3,380
Soybean meal	162	162	162	162
Slaughter grade[a]	11.8	12.0	11.8	12.3
Carcass grade[a]	12.0	11.3	12.0	12.3
Dressing %	57.7	59.6	57.6	59.6

[a] Code: 9 = low good; 10 = avg. good; 11 = high good; etc.
[b] Cattle slaughtered in October (3/system).

ENSILED CORN FORAGE AND BROILER LITTER FOR FINISHING HEIFERS[1]

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

It has been shown that weanling calves can be finished on a ration of high quality corn silage, limited grain and protein supplement. Broiler litter has been shown to contain about 30% crude protein, dry basis, and the nitrogen is efficiently utilized by ruminants.

One promising method of using broiler litter is to ensile it with corn forage. We found that good ensiling occurred when 30% broiler litter, dry basis, was mixed with corn forage at ensiling time. In a previous trial, performance of fattening heifers fed silage and 1% bodyweight of concentrates was similar when fed an ensiled mixture of 70% corn forage and 30% broiler litter, dry basis, with no protein supplement, as those fed regular corn silage supplemented with soybean meal. An additional study was conducted in 1976-1977 to study the value of broiler litter ensiled with corn forage for finishing heifers.

Experimental Procedure

Forty-eight straight bred and crossbred weanling heifer calves were grouped according to breeding and weight and allotted to two replications of four pens of 6 head each. Four pens were fed regular corn silage and four were fed silage containing 70% corn forage and 30% broiler litter, dry basis. Within each kind of silage two pens were not fed supplemental protein and two were fed 2 lb soybean meal per head per day. Sufficient grain was fed to provide a total concentrate (grain plus protein supplement) level of about 1% for bodyweight. The silages were full-fed.

The broiler litter contained 76% dry matter and the corn forage combined with it contained 42% dry matter. The proportions used to give a level of 30% litter, dry basis, in the silage were 81% corn forage and 19% broiler litter. The litter was placed on top of each wagon load of corn forage with a front-end loader. The capacity of the front-end loader had been calibrated by weighing a number of scoops. Likewise, a number of wagon loads of corn forage had been weighed.

The heifers were weighed initially at monthly intervals and at the end of the trial. At the end of the trial the cattle were slaughtered and carcass data were obtained.

[1] Appreciation expressed to Rocco, Harrisonburg, Va. for supplying the broiler litter.

Results

The corn forage-litter mixture ensiled very well. Mixing of the corn forage and litter occurred as the forage wagon was emptied into the blower, and during blowing of the mixture into the silo. The chemical composition of the feeds is given in table 1. The protein content of the regular corn silage was 8.0%, dry basis. Substituting broiler litter with 30% of the dry matter of the corn forage increased the level of protein to 15.7%, dry basis.

Performance data are given in table 2. Rate of gain was lowest for the cattle fed no protein supplement (1.78 lb per day), but was much higher than during the previous year when no protein supplement was fed. Supplementing this with soybean meal increased the daily gain to 2.07 lb. The rate of gain for the heifers fed the ensiled corn silage-litter was higher than for the regular corn silage fed animals. In fact, the daily gain when no protein supplement was fed (2.23 lb) was similar as when protein supplement was fed (2.27 lb), in addition to the corn-litter silage. This certainly shows that the protein in the broiler litter was efficiently utilized, and there was no need for additional protein supplement for the animals fed this forage.

The cattle fed the corn silage-litter ate considerably more silage than those fed regular corn silage. We had observed this in previous trials with cattle and sheep. The amount of corn silage per pound of gain was a little higher for the animals fed the corn silage-litter rations. However, amount of concentrates per pound of gain was considerably lower for the cattle fed these particular rations.

Carcass grades and dressing percent were similar for cattle on the various rations. There was a trend for the grades to be a little higher for the cattle fed the ensiled corn silage-litter.

Thus, it appears that ensiling broiler litter with corn forage would be a good method to process the waste. The use of litter in high corn silage fattening rations would result in similar performance as the use of protein supplement at a substantial savings in feed cost.

TABLE 1. CHEMICAL COMPOSITION OF FEEDS

Feed	Dry matter	Composition of dry matter				
		Crude protein	Crude fiber	Ether extract	Ash	NFE
	%	%	%	%	%	%
Corn silage	42.6	8.0	18.9	3.0	2.4	67.8
Corn-litter silage	52.9	15.7	20.1	2.9	9.1	52.3
Corn grain	87.3	9.6	3.6	4.2	1.4	81.2
Soybean meal	89.7	52.4	7.2	1.9	6.2	32.3

TABLE 2. FEEDING ENSILED CORN-BROILER LITTER SILAGE TO FATTENING HEIFERS

Item	Corn silage		Corn silage-litter	
	No SBM[a]	SBM[a]	No SBM[a]	SBM[a]
Initial wt., lb.	554	564	557	553
Final wt., lb.	858	918	937	941
Daily gain, lb.	1.78	2.07	2.23	2.27
Feed/head/day, lb.				
Silage	18.7	18.9	25.5	25.5
Grain	8.3	6.8	8.8	6.8
Soybean meal		2.0		2.0
Feed/lb. gain, lb.				
Silage	10.6	9.2	11.5	11.3
Grain	4.7	3.3	4.0	3.0
Soybean meal		1.0		.9
Carcass quality grade[b]	11.6	10.9	12.5	11.8
Dressing %	58.1	60.0	60.7	59.9
Loineye muscle area, sq. in.	9.85	10.90	10.81	10.36
Backfat thickness, in.	.65	.80	.75	.82

[a]Soybean meal
[b]Code: 11=high good; 12=low choice; 13=average choice; etc.

FEEDING VALUE OF SOYBEAN HULLS AS INFLUENCED BY PROTEIN LEVELS

E. T. Kornegay

Soybean hulls as they are known in feed trade are a by-product of the processing of soybeans. In the past they have been used primarily in ruminant diets due to their high fiber content.

In last year's Livestock Research Report, I presented results of feeding trials with growing and finishing pigs and a digestion trial with 100 lb pigs. Results of the feeding trials suggested that up to 12% soybean hulls could be included in growing-finishing diets without a reduction in average daily gain. However, the optimal level may be nearer to 6 to 7% where average daily gain was increased slightly and feed efficiency was equal to that of pigs fed the basal diet. In the digestion trial the digestibility of soybean hulls in general was less than that of the basal corn-oats-dehydrated alfalfa meal-soybean meal basal diet. Digestion of the non fibrous components including protein was depressed as soybean hulls which were higher in the fibrous components were substituted for the basal ration. The digestibility of the fibrous components was either greater or not changed as soybean hulls were substituted for the basal diet.

The objective of this trial was to compare the performance of finishing pigs fed two levels of soybean hulls in combination with two protein sequences.

Experimental Procedures

Forty-eight finishing pigs averaging 83 lb initially were randomly assigned from outcome groups based on weight and ancestry to the following treatments: 1) 6% soybean hulls with 14-12% protein sequence, 2) 24% soybean hulls with 14-12% protein sequence, 3) 6% soybean hulls with 16-14% protein sequence, and 4) 24% soybean hulls with 16-14% protein sequence. The protein level was reduced when the average pen weight of the pigs was 105 pounds. Composition of the diets is shown in table 1. Pigs were housed in an enclosed building with partially slotted floor pens. Diets were offered free choice in self-feeders and water was supplied by automatic nipple waterers. Body weights and feed consumption were determined biweekly.

Results

Average daily gain was depressed and feed per gain was increased when 24% soybean hulls was included in the diets as compared to 6% hulls (table 2). Average daily gain was less and feed per gain was greater when the 14-12% protein sequence was fed as compared to the 16-14% protein sequence. Average daily gain was similar for both protein sequence diets containing 24% hulls; however, average daily gain was higher for pigs fed the 16-14% protein sequence as compared to the 14-12% protein sequence containing 6% hulls. Feed efficiency followed a similar pattern with the lowest feed per gain obtained with pigs fed the 16-14% protein sequence with 6% hulls. Feed intake was similar for all treatment combinations.

These results suggest that a response to the addition of soybean hulls is more likely when adequate to high protein levels are fed. The high protein sequence used in this trial is recommended for meat type hogs under normal conditions.

Summary

An improvement in average daily gain and feed efficiency was only observed when 6% soybean hulls as compared to 24% hulls was fed in combination with a 16-14% protein sequence. There was little difference in average daily gain and feed efficiency between pigs fed the 14-12% protein sequence with 6 or 24% hulls and pigs fed the 16-14% protein sequence with 24% hulls.

TABLE 1. COMPOSITION OF DIETS.

	Phase 1[a]				Phase 2[a]			
	1	2	3	4	5	6	7	8
Crude protein, %	14	14	16	16	12	12	14	14
Soybean hulls, %	6	24	6	24	6	24	6	24
Ground corn (8.5%), %	77.87	62.29	73.02	57.57	83.43	67.92	78.17	62.59
Soybean meal (48.5%), %	13.53	11.31	18.48	16.13	8.22	5.93	13.53	11.31
Soybean hulls (13.7%), %	6.00	24.00	6.00	24.00	6.00	24.00	6.00	24.00
Vitamin-Se premix, %[b]	.30	.30	.30	.30	.20	.20	.20	.20
Swine T.M. salt, %[c]	.40	.40	.40	.40	.40	.40	.40	.40
Defluorinated phosphate, %	1.05	1.20	1.00	1.15	1.15	1.30	1.05	1.20
Limestone, %	.60	.25	.55	.20	.55	.20	.60	.25
Antibiotic[d]	.25	.24	.25	.25	.05	.05	.05	.05

[a]Calculated to contain .65% Ca and .5% P.

[b]Supplied (per lb of premix): 0.6 g riboflavin, 3.1 g pantothenic acid, 3.1 g niacin, 4.8 mg vitamin B_{12}, 100 g choline chloride, 600,000 I.U. vitamin A, 100,000 I.U. vitamin D, 1,000 I.U. vitamin E, 150 mg MPB and 18 mg Se.

[c]Contained (%): Co 0.01, Cu 0.10, Fe 0.50, I 0.01, Mn 0.80, Zn 1.0, sulfur 0.24, NaCl (balance).

[d]In phase 1, contained (per lb of premix): 20 g chlortetracycline, 10 g penicillin, 20 g sulfamethazine; and in phase 2, contained (per lb of premix): 50 g chlortetracycline.

TABLE 2. AVERAGE DAILY GAIN, FEED INTAKE AND FEED EFFICIENCY OF GROWING - FINISHING PIGS FED TWO PROTEIN LEVELS WITH TWO LEVELS OF SOYBEAN HULLS

	Treatments				Main effects			
	14-12% protein		16-14% protein		Protein Sequence, %		Soybean hulls, %	
Criteria	6% hulls	24% hulls	6% hulls	24% hulls	14-12	16-14	6	24
No. of pigs	12[a]	12	12	12	12	12	12	12
Avg. initial wt, lb	83.8	82.7	83.5	82.7	83.3	83.1	83.7	82.7
Avg. final wt, lb	181.8	181.4	183.0	181.0	181.6	182.0	182.4	181.2
Avg. daily gain, lb	1.50	1.46	1.64	1.46	1.48	1.56	1.57	1.46
Avg. daily feed intake, lb	5.12	5.24	5.17	5.00	5.18	5.09	5.15	5.12
Feed per gain	3.43	3.63	3.17	3.44	3.53	3.31	3.30	3.54

[a]Two pens of 6 females per pen per mean.

EVALUATION OF A FEED FLAVOR IN A STARTER DIET THAT WAS FED IN THE LACTATION DIET

B. O. Ogunbameru, E. T. Kornegay, K. L. Bryant, K. H. Hinkelmann and J. W. Knight

A problem generally observed in early weaned pigs is a postweaning growth "check" which is due primarily to poor consumption of the diet. The earlier pigs are weaned, the more severe the problem. Therefore, it is important to provide a starter diet which will be readily accepted and consumed in adequate quantities during this transition period. Previous attempts to increase postweaning consumption by the addition of feed flavors, sugar, saccharin, ground oats, fat and milk products to starter diets have generally been unsuccessful. The pig may prefer, if he has a choice, certain of the above ingredients, but if not given a choice, there may be little or no difference in diet consumption when compared to a simple corn-soybean meal fortified diet. A recent report showed that postweaning diet consumption could be increased by adding a feed flavor to the starter diet that was incorporated in the lactation diet (Campbell, 1977). It was suggested that weaned pigs more readily accepted the starter diet containing the feed flavor because of their previous conditioning to the flavor, perhaps through the sow's milk.

The objective of this research was to determine if diet intake, and consequently body weight gain and feed efficiency, of pigs weaned at three to four weeks of age could be improved by fortifying the starter diet with the same feed flavor that was fed to sows during lactation.

Experimental Procedures

Two series of trials were conducted. In the first series, three similar trials (1, 2 and 3) were conducted using an equal number of pigs (180) from sows fed either flavor or non-flavor lactation diets. All pigs were fed a flavor starter diet. In the second series, three similar trials (4, 5 and 6) were conducted using an equal number of pigs (48) from sows fed either flavor or non-flavor lactation diets. At weaning one-half of the pigs from each of the two sow groups was fed a starter diet containing a flavor and one-half was fed a non-flavor starter diet.

Pregnant sows and gilts were paired according to number of parities, size, ancestry and farrowing date, and randomly assigned to a flavor or non-flavor (control) diet. The females were moved into the farrowing house 5 days before their expected farrowing date. Each animal was fed 6 lb per day, two equal feedings in the morning and afternoon, of a 15% protein lactation diet either with or without the feed flavor (table 1). The quantity of diet was gradually increased after farrowing according to the following feeding schedule: 6 lb per sow plus one extra lb per pig over 6 pigs with a maximum of 12 pounds. Water was available *ad libitum*. From two weeks of age until weaning, the pigs were given access to a 22%

protein diet containing 10% dried whey as a creep (table 1) either with or without the feed flavor corresponding with their dam's lactation diet. The pigs also had access to their dam's diet.

In trials 4, 5 and 6, pigs within a sow treatment group were randomly assigned from outcome groups based on sex, weight and litter to starter diets either with or without the feed flavor. The 22% protein corn-soybean meal diets containing 10% dried whole whey were fed until the average weight of pigs in a cage was 15 pounds. The diets were then changed to 20% corn-soybean meal diets containing 10% dried whey. At 25 lb, the diets were changed to an 18% corn-soybean meal diet without whey. Composition of the basal diets are shown in table 1. The 22% starter diets were ground with a portable hammer mill with a .065 in screen to prevent sifting which is characteristic of young pigs (i.e., selective eating of the coarse corn at the expense of other equally vital feed ingredients). The same diet schedule was followed in trials 1, 2 and 3, with the exception that all weaned pigs were fed a flavor starter diet.

Initially, to encourage early feed consumption, about .25 lb of feed was spread daily on the rubber mat or piece of plywood in front of each feeder for 3 days. To keep the diet fresh, only enough diet for about 2 days was added to the feeders each time. When the pigs were eating well, the quantity of diet put in the feeder was increased to last for 3 to 4 days. However, feed was not allowed to accumulate in the feeders. Stale and soiled feed was discarded as soon as noticed. Waterers were checked daily to ensure that the pigs had water to drink, and the feeders were checked for proper feed "let down". The pigs were weighed weekly. Total weekly feed consumption was recorded at each weighing, and feed per lb of gain was calculated. The general appearance and behavior of the pigs were observed and recorded twice daily. Each trial lasted for 5 weeks.

In trials 1, 2 and 3, there were 6, 8, 10 or 12 pigs per pen (3 to 4 sq ft per pig). Number of pigs was equal in each replication. The average initial weight (lb) and age (days) for pigs from flavor and non-flavor sows was 16.2 and 26.4, 14.4 and 24.8, 14.7 and 26.8, 14.8 and 27.0, 13.8 and 24.8, 13.2 and 24.0, respectively, for trials 1, 2 and 3.

In trials 4 and 5, there were 3 pigs per cage, while in trial 6 there were 2 pigs per cage. Thus, in trials 4 and 5, there was an average of 2.7 sq ft of floor area per pig and 4 sq ft in trial 6. The average initial weight (lb) and age (days) for pigs from sows which received either flavor or non-flavor diets was 10.0 and 18.1, 11.3 and 19.8, 11.6 and 24.4, 11.3 and 24.0, 11.7 and 22.0, 11.4 and 23.5, respectively, for trials 4, 5 and 6.

All trials were conducted in environmentally controlled nurseries using accepted temperature and ventilation recommendations and other good management practices. The preceeding report included a detailed description of facilities and management of pigs at birth.

Results

Trials 1, 2 and 3. There was no difference in the combined average daily gain, feed intake and feed per gain between pigs from sows fed the flavor lactation diet and pigs from sows fed the non-flavor lactation diet. In these trials all pigs were fed a flavor starter diet. In trials 1 and 2 there was a trend during the first two weeks for pigs from sows fed the flavor lactation diet to gain a little faster, however, over the entire trial there was no significant difference ($P>.10$). This trend was not observed in trial 3.

Trials 4, 5 and 6. Average daily gain, feed intake and feed per gain combined for the three trials revealed no significant ($P>.10$) effects of sow diets on pig performance with one exception. During the 15-21 day period, pigs from sows fed the non-flavor lactation diet gained faster ($P < .05$) than pigs from sows fed the flavor lactation diet.

There was no difference in average daily gain, feed intake and feed per gain between pigs fed the flavor and non-flavor starter diets. Also, there were no sow diet times pig diet interactions.

Farrowing performance of sows. There were no significant ($P>.10$) differences in number of live and total pigs farrowed, average birth weight, number of pigs at two weeks and average pig weight at two weeks of age between sows fed the flavor and non-flavor lactation diets (table 3).

Results of this study are in agreement with results of Hodson and Snyder (1977) and Orr (1977) and in contrast to the report of Campbell (1977). Weaning pigs from sows fed a flavor lactation diet had similar over-all performance to those from sows fed non-flavor lactation diets whether fed a flavor or non-flavor starter diet. Addition of a feed flavor to the sow's and/or pig's diet was not shown to be beneficial.

Summary

In two series of feeding trials, using pigs weaned from three to four weeks of age and fed for five weeks in environmentally controlled nurseries, the addition to a corn-soybean meal starter diet containing 10% dried whey of a feed flavor which had previously been fed in the sow lactation diet was not effective in stimulating intake and thus performance. Also, performance was similar for pigs fed flavor and non-flavor starter diets regardless of whether pigs were from sows fed flavor or non-flavor lactation diets. Pig performance was good in all treatment groups.

References

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Hodson, H. H. and R. A. Snyder. 1977. Use of feed flavors in swine starter rations. Agric. Review Southern Illinois University, Carbondale, Illinois. pp. 48-49.

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TABLE 1. COMPOSITION OF THE STARTER DIETS

Ingredients	Inter'l Ref. no.	Lactation diet[a]	Starter diets 22% CP[b]	20% CP[c]	18% CP[b]
Ground corn	4-02-931	78.70	49.70	55.50	70.55
Soybean meal	5-04-604	18.30	37.10	31.40	26.47
Dry whole whey[e]	4-01-604	---	10.00	10.00	---
Defluorinated phosphate	6-01-780	1.20	1.23	0.77	0.77
Limestone		.80	0.76	0.96	0.96
Swine trace mineral salts[f]		.60	0.50	0.50	0.50
Vitamin premix[g]		.40	0.50	0.50	0.50
Antibiotics[h]		---	0.25	0.25	0.25
Feed flavor[i]		---	---	---	---

[a]Calculated to contain 15% crude protein, .75% Ca, .55% total P.

[b]Contained .9% Ca and .7% P - fed from weaning to 15 pounds. Reground using .065 in screen.

[c]Contained .8% Ca and .6% P - fed from 15 to 25 pounds.

[d]Contained .7% Ca and .5% P - fed from 25 to 45 pounds.

[e]Dry whole whey contained 12% crude protein, .5% crude fat, 9.0% ash, 5.0% moisture, 68.0% lactose, 0.0% crude fiber. Supplied by Kraft Food Dist., Chicago, Illinois 60690.

[f]Contained (%): Co 0.01, Cu 0.10, Fe 0.50, I 0.01, Mn 0.80, Zn 1.0, Sulfur 0.24, NaCl (balance).

[g]Supplied (per lb of premix): .6 g riboflavin, 3.1 g pantothenic acid, 3.1 g niacin, 4.8 mg Vitamin B_{12}, 100 g choline chloride, 600,000 I.U. Vitamin A, 100,000 I.U. Vitamin D, 1000 I.U. Vitamin E, 150 mg menadione dimethylprimidinol bisulfite (MPB), and 11.3 mg Se.

[h]Contained (per lb of premix): 20 g chlortetracyline, 10 g penicillin, and 20 g sulfamethazine.

[i]Added at a rate of .05%. Contained 10% Firanor concentrate 52.824T, 13% Zeofree 80, 5% Stearin, 72% cobmeal. Firanor is a proprietory name of Firmenich, Inc., Geneva, Switzerland and denotes flavoring substances composed of alcohols, esters, aldehydes and terpines. The feed flavor was supplied by SYNTEX Agri Business Inc., Nutrition and Chemical Division, Springfield, MO 65805.

TABLE 2. AVERAGE DAILY GAIN, FEED INTAKE AND FEED PER GAIN OF PIGS FROM SOWS FED FLAVOR OR NON-FLAVOR DIETS AND PIGS FED FLAVOR OR NON-FLAVOR STARTER DIETS

Postweaning	Trials 1,2&3		Trials 4,5&6			
period, days	SF[a]	SNF[a]	SF[a]	SNF[a]	PF[b]	PNF[b]
Avg init wt, lb	14.8[c]	14.0[c]	11.1[d]	11.3[d]	11.2[d]	11.2[d]
Avg final wt, lb	40.8	39.5	35.5	37.0	36.4	36.1
Avg age, days	26.0	25.3	21.5	22.4	21.8	22.1
Average daily gain, lb						
0-7	.25	.19	.19	.18	.19	.18
8-14	.66	.63	.58	.61	.60	.59
15-21	.76	.77	.75	.84	.81	.77
22-28	.91	.92	.98	1.04	1.00	1.02
29-35	1.13	1.10	.98	1.01	1.01	.99
0-14	.45	.40	.39	.39	.39	.39
0-21	.55	.52	.51	.54	.53	.51
0-28	.64	.63	.63	.67	.65	.64
0-35	.74	.72	.70	.73	.72	.71
Average daily feed intake, lb						
0-7	.41	.37	.25	.24	.24	.25
8-14	.89	.87	.70	.72	.72	.70
15-21	1.36	1.35	1.06	1.16	1.13	1.08
22-28	1.74	1.72	1.59	1.69	1.63	1.64
29-35	2.11	2.16	1.65	1.74	1.67	1.71
0-14	.65	.62	.48	.48	.48	.48
0-21	.89	.86	.67	.71	.70	.68
0-28	1.11	1.08	.91	.95	.94	.92
0-35	1.31	1.30	1.06	1.11	1.09	1.08
Feed per gain						
0-7	1.64	1.95	1.32	1.33	1.26	1.40
8-14	1.36	1.39	1.25	1.30	1.31	1.23
15-21	1.89	1.79	1.43	1.40	1.40	1.42
22-28	1.99	1.90	1.64	1.65	1.66	1.63
29-35	1.90	1.99	1.71	1.80	1.71	1.80
0-14	1.47	1.57	1.39	1.31	1.36	1.35
0-21	1.64	1.67	1.35	1.32	1.33	1.34
0-28	1.76	1.75	1.46	1.44	1.45	1.44
0-35	1.79	1.82	1.52	1.52	1.51	1.53

[a]SF = pigs from sows fed the flavor diet, SNF = pigs from sows fed the non-flavor diet.

[b]PF = pigs fed the flavor diet, PNF = pigs fed the non-flavor diet.

[c]There were 10 pens with an average of 10 pigs per pen per mean. All pigs fed flavor starter diet.

[d]There were 12 cages of 3 pigs per cage in trials 4 and 5 and 6 cages of 2 pigs per cage in trial 6 per mean.

TABLE 3. FARROWING PERFORMANCE OF SOWS FED FLAVOR AND NONFLAVOR DIETS

Sets of sows	Trt.[a]	No. live pigs	Total pigs	Avg. birth wt., lb	No. live 14 days	Avg. pig wt. 14 days
1	SNF	10.9	11.8	2.8	9.4	8.7
1	SF	9.3	9.9	3.0	8.4	9.5
	SD[b]	2.7	2.9	.5	2.2	1.7
2	SNF	10.3	11.8	2.7	9.9	8.0
2	SF	11.1	11.8	2.8	10.2	7.8
	SD	1.0	1.5	.4	1.2	1.2
3	SNF	11.7	12.0	2.7	9.9	8.4
3	SF	10.1	11.1	2.9	10.8	8.4
	SD	2.1	1.6	.4	1.9	1.5
4	SNF	9.3	9.7	3.1	7.7	8.9
4	SF	9.3	10.8	2.7	8.0	7.9
	SD	3.0	3.6	.5	1.9	1.6
5	SNF	10.4	11.2	2.7	10.2	7.5
5	SF	11.7	12.8	2.8	10.7	8.0
	SD	.9	1.2	.3	1.1	.8
1-5	SNF	10.9	11.5	2.8	9.5	8.4
1-5	SF	10.1	11.0	2.9	9.6	8.6
	SD	2.3	2.4	.4	2.1	1.5

[a]SNF = nonflavor and SF = flavor lactation diets.
[b]Standard deviations.

FURTHER STUDIES TO EVALUATE HIGHER THAN RECOMMENDED LEVELS OF CALCIUM AND PHOSPHORUS FOR FINISHING SWINE

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

A number of swine specialist in other states are recommending Ca and P levels for finishing swine which are 25 to 50% higher than currently suggested by the National Research Council (NRC) based upon the thesis that the faster growing, more efficient modern hog requires a higher level of Ca and P especially when higher protein levels are fed. In an experiment with finishing gilts and barrows reported in last year's Livestock Research Report, a small increase in average daily gain was observed for gilts when 25% higher than NRC suggested levels of Ca and P were fed, but no improvement was observed for barrows. In another experiment reported last year with boars and gilts, it appeared that 25% higher than NRC suggested levels of Ca and P provided a small increase in overall feedlot performance. However, in both of the above experiments there appeared to be no influence of dietary Ca and P levels on feet and leg, pad and structural soundness scores.

The objective of these trials was to further evaluate higher than NRC suggested Ca and P levels for growing and finishing barrows and gilts.

Experimental Procedures

In trial 1, crossbred pigs were weaned at 6 weeks of age and divided by sex and fed according to NRC recommendations (18% protein diet) until the average age was 8.5 weeks. At that time, growth rate from birth was calculated and 192 pigs (equal barrows and gilts) were divided by sex into a fast and a slow group. Four dietary Ca and P combinations shown below were assigned at that time to weight outcome groups (4 pigs/pen) and the pigs were placed in the appropriate pens. Dietary treatments were started if the average pen weight was from 50 to 60 lb, and if not, the previous ration was continued until the pen average was about 55 lbs. The dietary Ca and P combinations were: 1) National Research Council recommended (NRC rec.) level of both Ca and P, 2) 25% higher than NRC rec. level of both Ca and P, 4) NRC rec. level of Ca and 25% higher than NRC rec. level of P and 5) NRC rec. level of Ca and 25% lower than NRC rec. level of P. The composition of the diets is shown in table 1.

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In trials 2 and 3, which were similar, 72 crossbred pigs in each trial which had previously been fed NRC recommended nutrient levels were randomly assigned from outcome groups based on sex, weight and ancestry to the following dietary Ca and P levels: 1) NRC Ca and P, 3) 25% higher than NRC rec. Ca and P, and 6) 50% higher than NRC rec. Ca and P (table 1).

In all trial, diets containing 16% protein with the appropriate levels of Ca and P were fed until the average weight of pigs in a pen was about 100 lbs at which time 14% protein diets with the appropriate levels of Ca and P were fed during the remainder of the test. The other minerals and vitamins were added to meet NRC recommended levels. Pigs were housed in partially slotted floored pens in an enclosed building. Feed was available *ad libitum* and pigs had free access to automatic waterers. Body weight and feed consumption were determined biweekly.

In trial 1, when body weight of the pigs was about 225 lb, the barrows were slaughtered and the right leg and the mandible were taken and frozen for later determination of bone breaking strength, bone ash and other bone measurements. However, prior to slaughter of the barrows, all animals were visually evaluated by the committee that evaluate boars for the Virginia Boar Testing Station. Pads were scored at the beginning and end of the experiment. The scoring system for pads and skeletal soundness was based on a scale of 1 to 5 with 1 being the best and 5 the poorest.

Results

Trial 1. During phase 1 (60 to 100 lb) barrows and gilts had similar performance; however, during phase 2 (100 to 226 lb) barrows ate more, gained faster and had higher feed per gain (table 2). Growth rate from birth to 8.5 weeks of age had no overall influence on performance, although the fast group had a larger average daily gain in phase 1 and ate more feed in phase 2. Barrows had higher pad and committee scores and serum Ca, P and Mg levels than gilts. Growth rate had no influence on pad and committee scores; serum Ca, P and Mg; metacarpal and mandible breaking strength and ash; tooth ash.

Average daily gain, feed intake and feed per gain were not significantly different between pigs fed NRC Ca and P, 25% higher Ca and P and NRC Ca and 25% higher P, during either phase 1 or 2 and overall. However, pigs fed NRC Ca and 25% lower P had a lower average daily gain and higher feed per gain than pigs fed all other combinations during all phases. Feed intake was only significantly less for pigs fed NRC Ca and 25% lower P during phase 2.

Dietary Ca and P combinations had no influence on pad and committee scores and tooth ash. Serum Ca, P and Mg levels were not different between pigs fed NRC Ca and P, 25% higher than NRC Ca and P and NRC Ca and 25% higher P, but serum Ca and Mg levels were higher and P level was lower for pigs fed the NRC Ca and 25% lower P level than for pigs fed all other combinations.

Metacarpal and mandible ash were largest for pigs fed 25% higher than NRC Ca and P, followed by pigs fed NRC Ca and P and NRC Ca and 25% higher P with pigs fed NRC Ca and 25% lower P having much lower values. Breaking strength of metacarpal and mandible was much lower for pigs fed the NRC Ca and 25% lower P than pigs fed the other combinations. Pigs fed 25% higher than NRC Ca and P had the largest breaking strength values for metacarpal and mandible although the magnitude of the difference was not large, compared to pigs fed NRC Ca and P and NRC Ca and 25% higher P.

Trials 2 and 3. There were no significant differences in average daily gain, feed intake and feed per gain between pigs fed NRC Ca and P, 25% higher than NRC Ca and P and 50% higher than NRC Ca and P (table 3). Committee soundness score were not influenced by dietary Ca and P combinations.

Summary

Three feeding trials involving 336 crossbred pigs were conducted to evaluate the following dietary calcium and phosphorus combinations: 1) NRC Ca and P, 2) 25% higher than NRC Ca and P, 3) 50% higher than NRC Ca and P, 4) NRC Ca and 25% higher P and 5) NRC Ca and 25% lower P. A 16% protein corn-soybean meal diet was self fed to about 100 lb and a 14% was fed for the remainder of the test. Barrows ate more, grew faster and were less efficient than gilts. Average daily gain and feed efficiency was poorest for pigs fed the diet containing NRC Ca and 25% lower P with no difference between the other diets. Feed intake was similar for all diets. Pad and committee scores and tooth ash were not influenced by any of the diets. Serum P level and metacarpal and mandible breaking strength and ash were lowest for pigs fed the diet with NRC Ca and 25% lower P with only small differences between the other diets which were always in favor of pigs fed the diet containing 25% higher than NRC Ca and P. Although bone density and serum P values were slightly higher for pigs fed the 25% higher than NRC Ca and P levels, there was no evidence that growth rate, feed efficiency and structural soundness were improved by feeding Ca and P levels higher than currently suggested by the National Research Council.

TABLE 1. COMPOSITION OF DIETS FOR PHASES 1 AND 2 IN TRIALS 1, 2 AND 3.

		Diets									
		Phase 1[a]					Phase 2[b]				
Ingredients	IRN	1 NRC Ca NRC P	2 25%↑ Ca 25%↑ P	3 50%↑ Ca 50%↑ P	4 NRC Ca 25%↓ P	5 NRC Ca 25%↓ P	1 NRC Ca NRC P	2 25%↑ Ca 25%↑ P	3 50%↑ Ca 50%↑ P	4 NRC Ca 25%↓ P	5 NRC Ca 25%↓ P
Ground corn	4-03-005	78.65	78.00	77.32	78.58	78.73	84.55	84.25	83.68	84.60	84.64
Soybean meal	5-04-600	18.40	18.55	18.63	18.40	18.40	13.20	13.20	13.34	13.20	13.20
Limestone	6-02-632	.70	.52	.45	.09	1.32	.85	.65	.52	.35	1.30
Defluorinated P	6-01-780	.95	1.63	2.30	1.63	.25	.50	1.00	1.56	1.00	---
Swine trace min. salt[c]		.50	.50	.50	.50	.50	.50	.50	.50	.50	.50
Vitamin-Se premix[d]		.30	.30	.30	.30	.30	.20	.20	.20	.20	.20
Antibiotic[e]		.50	.50	.50	.50	.50	.20	.20	.20	.20	.20

[a]Diets in phase 1 were calculated to contain 16% crude protein. Calculated calcium and phosphorus (total) levels, respectively, were (%): diet 1 - .65 and .50; diet 2 - .81 and .60; diet 3 - .97 and .75; diet 4 - .65 and .63; diet 5 - .65 and .38. These diets were fed from 55 to 100 pounds.

[b]Diets in phase 2 were calculated to containe 14% crude protein. Calculated calcium and phosphorus (total) levels, respectively, were (%): diet 1 - .50 and .40; diet 2 - .60 and .50; diet 3 - .75 and .60; diet 4 - .50 and .50; diet 5 - .50 and .30. These diets were fed from 100 to 225 pounds.

[c]Contained (%): .01 Co, .10 Cu, .50 Fe, .01 I, .80 Mn, 1.0 Zn and .24 sulfur.

[d]Supplied (per lb of premix): .6 g riboflavin, 3.1 g pantothenic acid, 3.1 g niacin, 4.8 mg vitamin B_{12}, 100 g choline chloride, 600,000 I.U. vtiamin A, 100,000 I.U. vitamin D, 1,000 I.U. vitamin E, 150 mg menadione dimethylprimidinol bisulfite (MPB) and 11.3 mg selenium.

[e]Tylosin or chlortetracycline (10 g/lb).

TABLE 2. AVERAGE DAILY GAIN, AVERAGE DAILY FEED INTAKE, FEED PER GAIN, PAD AND STRUCTURAL SOUNDNESS SCORES, SERUM CA, P AND MG LEVELS, AND METACARPAL AND MANDIBLE BREAKING STRENGTH AND ASH AS INFLUENCED BY SEX, GROWTH RATE AND DIETARY CALCIUM AND PHOSPHORUS TREATMENTS. TRIAL 1

	Sex		Growth Rate		Dietary Calcium and Phosphorus Treatments[a]			
					1	2	4	5
					NRC Ca	25%↑ Ca	NRC Ca	NRC Ca
Items	Barrows	Gilts	Fast	Slow	NRC P	25%↑ P	25%↑ P	25%↓ P
No. of animals	96	96	96	96	48	48	48	48
Avg. daily gain from birth, lb	.63	.65	.71[b]	.57	.64	.64	.64	.64
Avg. age, days[d]	60.9	60.3	60.5	60.4	59.9	60.9	61.0	60.0
Avg. initial weight, phase 1, lb[e]	49.0	51.8	47.6	48.5	50.0	50.6	49.9	51.1
Avg. daily gain, phase 1, lb[f]	1.76	1.74	1.78[c]	1.71	1.76[g]	1.79[g]	1.81[g]	1.63[h]
Avg. daily feed intake, phase 1, lb	4.61	4.40	4.49	4.51	4.37	4.56	4.61	4.47
Feed per gain, phase 1	2.59	2.57	2.55	2.60	2.50[g]	2.52[g]	2.52[g]	2.78[h]
Avg. daily gain, phase 2, lb	1.81[j]	1.59	1.73	1.67	1.76[g]	1.75[h]	1.71[g]	1.58[h]
Avg. daily feed intake, phase 2, lb	6.39	5.46	5.98[c]	5.88	5.96[g]	5.98[g]	5.97[g]	5.81[h]
Feed per gain, phase 2	3.56[j]	3.48	3.52	3.52	3.40[g]	3.42[g]	3.50[g]	3.76[h]
Avg. daily gain, overall, lb	1.80[j]	1.64	1.76	1.68	1.76[g]	1.75[g]	1.77[g]	1.61[h]
Avg. daily feed intake, overall , lb	5.88[j]	5.25	5.62	5.51	5.49	5.56	5.73	5.49
Feed per gain, overall, lb	3.29[j]	3.23	3.24	3.27	3.14[g]	3.17[g]	3.23[g]	3.50[h]
Committee scores, avg.[l]	3.0[k]	2.7	2.8	2.9	2.8	2.9	2.8	2.8
Pad score final,[l]	2.9[k]	2.6	2.8	2.7	3.0	2.6	2.8	2.7
Serum Ca, mg/100 ml	12.6	11.9	12.3	12.3	12.2[g]	12.2[g]	12.1[g]	12.7[h]
Serum P, mg/100 ml	7.7[k]	7.4	7.5	7.6	7.9[gh]	7.8[h]	8.1[g]	6.5[i]
Serum Mg, mg/100 ml	2.2[j]	2.1	2.2	2.2	2.2[g]	2.1[g]	2.1[g]	2.3[h]
Metacarpal[m]								
Breaking strength, lb	300	---	300	301	315[g]	346[g]	328[g]	228[h]
Dried fat free ash, %	58.8	---	58.7	58.7	59.1[h]	59.8[g]	59.1[h]	57.2[i]
Mandible[m]								
Breaking strength, lb	549	---	526	573	586[h]	694[g]	595[gh]	330[i]
Dried fat free ash, %	66.5	---	66.4	66.5	67.1[h]	67.8[g]	67.1[h]	63.1[i]
Tooth dried fat free ash, %[m]	76.7	---	76.9	76.6	76.8	76.7	76.9	76.7

[a]Calcium and phosphorus (total) levels, respectively, for phase 1 and phase 2; diet 1-.65 and .50% Ca and .50 and .40% P; diet 2-.81 and .60% Ca and .63 and .50% P; diet 4-.65 and .50% Ca and .50 and .50% P; diet 5-.65 and .50% Ca and .38 and .30% P.

[bc]Significant growth rate effect, $P < .001$, .01, respectively.

[d]Age at the time pigs were allotted to pen and at which time the average daily gain from birth was calculated.

[e]Average weight at the end of phase 1 was 100.6 lb and at the end of phase 2, 226.5 lb. All means adjusted for final weight of that phase.

[f]Growth rate times phosphorus level interaction ($P < .05$).

[ghi]Within dietary calcium and phosphorus treatments, means on the same line with different superscript letters are significantly different ($P < .05$).

[jk]Significant sex effect, $P < .001$, .01, respectively.

[l]Based on a visual score system with a scale of 1 to 5, with 1 being good and 5 very poor.

[m]Barrows only.

TABLE 3. AVERAGE DAILY GAIN, FEED INTAKE, FEED EFFICIENCY COMMITTEE AND STRUCTURAL SOUNDNESS SCORE OF GROWING - FINISHING BARROWS AND GILTS FED THREE DIETARY CALCIUM AND PHOSPHORUS LEVELS. TRIALS 2 AND 3.

	Ca and P Combinations		
	NRC Ca NRC P	25% Ca 25% P	50% Ca 50% P
No. of pigs	48	48	48[a]
Avg. initial wt., lb	80.5	80.7	80.4
Avg. final wt., lb	189.9	188.7	189.5
Avg. daily gain, lb	1.74	1.71	1.72
Avg. daily feed intake, lb	5.40	5.42	5.33
Feed per gain	3.10	3.16	3.10
Committee scores[b]	3.0	3.1	3.3

[a]Four pens of 6 pigs per pen in each trial. Equal barrows and gilts in each pen. Each trial lasted for 63 days.
[b]Based on a visual score system with a scale of 1 to 5, with 1 being good and 5 very poor. Scored only in trial 3.

AVAILABILITY OF PHOSPHORUS FROM THREE SOURCES FOR PONIES[1]

T. Aldred, J. P. Fontenot and K. E. Webb, Jr.

Phosphorus in cereal grains exists as phytic acid, an organic source of phosphorus. It can complex with a variety of other minerals such as calcium, phosphorus, magnesium, iron and zinc. Although organic phosphorus is readily available to ruminants because they possess ruminal phytase, it is less available to monogastrics, especially poultry.

High performance horses are commonly fed high concentrate diets which are consequently high in phytin phosphorus. If phytin phosphorus is less available to the horse than the inorganic form, this may help explain some of the bone problems associated with horses on very high concentrate diets.

Experimental Procedure

Eight mature gelding ponies of mixed Hackney breeding were used in a series of three digestion trials. An incomplete Latin square design was used. For each trial two ponies were fed each of the following rations: (1) unsupplemented basal, (2) basal and dicalcium phosphate, (3) basal and sodium phytate and (4) basal and wheat bran (table 1). The basal ration was formulated to contain .3% calcium and .2% phosphorus. The other three rations contained .6% calcium and .4% phosphorus. The additional .2% phosphorus was supplied by dicalcium phosphate, sodium phytate or wheat bran, thus representing sources of inorganic phosphorus, purified organic phosphorus, and feed organic phosphorus, respectively. The amounts of ingredients were the same for all rations except the supplemental sources of calcium and phosphorus, and the purified ingredients added to the rations. The ponies were fed 1.5 kg of diet twice daily (total of 3.0 kg/day). The amounts of calcium per day were 9 grams for the basal ration and 18 grams for the supplemented rations. Corresponding values for phosphorus were 6 grams for the basal and 12 grams for the supplemented rations.

Trials consisted of a 14-day adjustment, a 7-day preliminary and a 7-day collection period. Specifically designed harnesses and canvas bags were used to collect the feces. The bags were changed twice a day, and daily fecal collections for each pony were weighed, mixed, and a 5% sample was taken. At the completion of each trial, the composited samples were mixed, a fresh sample taken for protein analysis, and frozen, and the rest of each sample was dried and ground. Feed and fecal samples were analyzed for proximate components, calcium, phosphorus and magnesium. Blood samples were taken at the end of each trial. Serum samples were analyzed for calcium, phosphorus and magnesium.

[1]Appreciation is expressed to the Virginia Agricultural Foundation for a grant-in-aid in support of the research reported herein.

Results

The rations were palatable and ponies maintained their weight during the trials.

The apparent absorption of phosphorus was negative for all rations (table 3). This was due, at least partly to a high excretion from the body (endogenous). The true absorption of phosphorus from the basal ration was approximately 12%. Values were a little higher for the rations supplemented with dicalcium phosphate and wheat bran. True absorption was about 13% for the dicalcium phosphate ration and 14% for the wheat bran ration.

In table 4 are shown the values for apparent and true absorption of phosphorus from the three supplements, dicalcium phosphate, wheat bran and sodium phytate. These values were calculated by difference from the values obtained from the ponies fed the basal and supplemented rations. The apparent absorption of phosphorus from dicalcium phosphate and wheat bran was similar, the values being 15.5 and 14.3%, respectively. Sodium phytate did not appear to be utilized in this trial. The values for true absorption of phosphorus were similar as those for apparent absorption. The values were 13.9% from dicalcium phosphate and 15.8% from wheat bran. Again, negative values were observed for sodium phytate.

The blood serum mineral levels are given in table 5. The calcium values tended to be on the high side and the magnesium levels were low. The inorganic phosphorus levels appeared normal. The values for the ponies fed the supplemented rations were a little higher than for those fed the basal, indicating some utilization of phosphorus. The data for absorption of calcium and magnesium are not presented. These were highly negative, apparently due to consumption of coarse limestone used for bedding.

Apparent digestibility data are given in table 6. Dry matter digestibility tended to be lower for the rations supplemented with dicalcium phosphate and sodium phytate, compared to the basal, but differences were small. However, the dry matter digestibility of the wheat bran ration was considerably lower than for the other rations. Ether extract (crude fat) digestibility was somewhat lower for the rations supplemented with dicalcium phosphate and sodium phytate, and was lowered further for the ration supplemented with wheat bran. The digestibility of all components was lower for the wheat bran ration than for the other rations. This may be due to the known laxative effect of wheat bran on horses.

TABLE 1. INGREDIENT COMPOSITION OF RATION USED IN METABOLISM TRIALS

Ingredient	Source of supplemental phosphorus: None		Dicalcium phosphate		Sodium phytate		Wheat bran	
	g/day	%	g/day	%	g/day	%	g/day	%
Shelled corn	1103	38.2	1103	37.8	1103	37.5	1103	36.8
Hay, mixed grass-clover	915	31.7	915	31.3	915	31.1	915	30.5
Barley grain	200	6.9	200	6.8	200	6.8	200	6.7
Dry molasses	120	4.2	120	4.1	120	4.1	120	4.0
Wheat bran							577	19.2
Corn sugar	311.6	10.8	311.6	10.7	311.6	10.6		
Cellulose	51.7	1.8	51.7	1.8	51.7	1.8		
Purified protein	89.7	3.1	89.7	3.1	89.7	3.0		
Corn oil	60	2.1	60	2.1	60	2.0	34	1.1
Limestone	1.3	.05	5.8	.2	24.5	.8	23.2	.8
Iodized salt	15	.5	15	.5	15	.5	15	.5
Sodium monophosphate	2.8	.1	2.8	.1	2.8	.1	2.8	.1
Magnesium oxide	4.3	.15	4.3	.15	4.3	.15		
Dicalcium phosphate			32.4	1.1				
Sodium phytate					35.6	1.2		
Vitamin A & D premix	10	.35	10	.34	10	.34	10	.33

[1]To supply 1,000 IU vitamin A and 1650 IU vitamin D per head daily.

TABLE 2. CHEMICAL COMPOSITION OF RATIONS USED IN METABOLISM TRIALS

Component	Source of supplemental phosphorus			
	None	Dicalcium phosphate	Sodium phytate	Wheat bran
Dry matter, %	89.77	90.07	89.97	89.79
Composition of dry matter, %				
Crude protein	12.44	12.20	11.90	11.90
Ether extract	5.18	5.17	5.15	4.66
Crude fiber	14.50	13.88	14.60	13.68
Ash	3.93	4.83	5.32	4.81
Nitrogen-free extract	63.95	63.92	63.03	64.95
Calcium	0.49	0.81	0.84	0.76
Phosphorus	0.25	0.46	0.45	0.44
Magnesium	0.23	0.24	0.23	0.22

TABLE 3 . APPARENT AND TRUE ABSORPTION OF PHOSPHORUS BY PONIES FROM RATIONS SUPPLEMENTED WITH DIFFERENT SOURCES OF PHOSPHORUS

Source of supplemental phosphorus	Apparent absorption	True absorption
	%	%
None (basal)	-25.15	11.95
Dicalcium phosphate	- 6.04	12.88
Sodium phytate	-15.97	4.11
Wheat bran	- 7.59	13.66

TABLE 4. APPARENT AND TRUE ABSORPTION OF PHOSPHORUS BY PONIES FROM DIFFERENT SOURCES OF SUPPLEMENTAL PHOSPHORUS[a]

Source of supplemental phosphorus	Apparent absorption	True absorption
	%	%
Dicalcium phosphate	15.50	14.94
Sodium phytate	-4.82	-5.42
Wheat bran	14.30	15.81

[a]Calculated by difference.

TABLE 5 . EFFECT OF SOURCE OF SUPPLEMENTAL PHOSPHORUS ON BLOOD SERUM LEVELS OF CALCIUM, INORGANIC PHOSPHORUS AND MAGNESIUM

Component	Source of supplemental phosphorus			
	None (basal)	Dicalcium phosphate	Sodium phytate	Wheat bran
	mg/100 ml.	mg/100 ml.	mg/100 ml.	mg/100 ml.
Calcium	11.75	2.01	12.38	12.31
Inorganic phosphorus	2.93	3.46	3.55	3.25
Magnesium	1.49	1.55	1.55	1.57

TABLE 6 . EFFECT OF SOURCE OF SUPPLEMENTAL PHOSPHORUS ON APPARENT DIGESTIBILITY OF RATION COMPONENTS

Component	Source of supplemental phosphorus			
	None (basal)	Dicalcium phosphate	Sodium phytate	Wheat bran
	%	%	%	%
Dry matter	68.8	66.8	66.7	62.7
Crude protein	72.2	70.3	69.9	64.1
Ether extract	69.8	62.9	61.9	54.3
Crude fiber	55.0	55.0	56.2	45.2
NFE	83.25	83.89	83.14	80.95

ENSILING CHARACTERISTICS AND UTILIZATION BY SWINE OF ENSILED SWINE WASTE AND GROUND CORN GRAIN[1]

J. Berger, E. T. Kornegay, J. P. Fontenot and K. E. Webb, Jr.

The increasing number of swine total confinement operations in the last 10 years has made the problem of swine waste disposal a major one. Increased public awareness and government regulations have contributed much to this problem, too. Recent interest in alternate methods of waste disposal has generated interest in waste feeding. Feeding of waste could be a way in which to alleviate some of the waste disposal problems and be an inexpensive source of feed.

Recycling broiler litter and cattle waste have been investigated. Previous work at V.P.I. & S.U. with the feeding of poultry wastes and the feeding of cattle wastes at Auburn University have shown this to be a feasible method of handling animal wastes. Virginia Tech scientists have shown that fresh and dried swine feces contain significant amounts of nutrients and that these nutrients are available to pigs, although not as readily available as the nutrients in a commercial ration. Quality and acceptability of the ration were reduced when feces were added. Australian work has shown that dried swine waste fed to ruminants was very poorly utilized.

The increased cost of energy has made the drying of swine waste prohibitive. In work reported previously we found ensiling of swine waste and grass hay to be a very practical way to handle swine waste and an inexpensive practical method of destroying potentially dangerous pathogens. Several research reports have demonstrated that good fermentation (ensiling) takes place if the proper ratio of cattle manure and hay or grain is used. The resultant product is very acceptable by ruminants and it appears that the nutritive value may be improved. More important, previous work at Virginia Tech conducted with laboratory and intermediate-size silos to study fermentation characteristics of waste ensiled with other feedstuffs showed ensiling destroyed pathogenic bacteria such as salmonella.

The objectives of this study were to determine fermentation (ensiling) characteristics of different levels of swine feces when ensiled with ground corn grain, and the acceptability and nutritive value of swine waste and ground corn grain silages fed to swine.

Experimental Procedure

In the initial experiment a small silo study was conducted, in which various proportions of swine waste and ground corn grain were ensiled to determine the most desirable combinations. This was followed by a large

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[1]Appreciation is expressed to the Virginia Agricultural Foundation for financial support of this research.

silo study, in which a larger amount of the two best combinations was ensiled and fed to gilts to determine digestibility and acceptability.

Small Silo Study

Ground corn grain was ensiled with fresh swine waste collected under slotted floors of growing-finishing pigs fed a typical 16% protein corn-soybean meal ration. Fresh waste and ground corn grain were ensiled in small laboratory silos in proportions of 80:20, 70:30, 60:40, 50:50, 40:60, 30:70 and 20:80. Six laboratory silos of each treatment were packed and allowed to ensile for a minimum of 45 days. Initial samples of each mixture were taken and frozen for laboratory analysis. Microbiological samples were placed in sealed autoclaved jars and analyzed the day the silos were opened. Upon opening of silos, pH, lactic acid, volatile fatty acids and microbial parameters were determined. Following the initial opening of the ensiled material, all silos were frozen to prevent spoilage and, proximate analysis was conducted later.

Digestibility and Acceptability Trials (Large Silo Study)

Swine waste was collected from sloped solid concrete floors at 3-day intervals, mixed with ground corn grain, and ensiled in 55 gal. drums lined with double thickness plastic liners, and sealed. The combinations used for the digestibility and acceptability trials were 60:40 and 40:60 mixtures of waste and ground corn grain. Three digestion trials were run with 10 crossbred gilts weighing approximately 200 lb. All gilts were blocked by weight and randomly assigned to treatments and pens. A typical corn-SBM diet (14% protein) was used as the basal diet. Diets for the digestion and acceptability trials were 1) Basal, 2) 75% basal + 25% 40:60 silage, 3) 50% basal + 50% 40:60 silage, 4) 75% basal + 25% 60:40 silage and 5) 50% basal + 50% 60:40 silage. Each trial consisted of a 2-day transition, 7 day preliminary, and 5 day collection period. Following the digestion trials a palatability trial was conducted with 30 crossbred gilts weighing approximately 200 lb. The gilts were blocked by weight, randomly paired, assigned to diet, and allotted to pens.

Results and Discussion

Small Silo Study

Good ensiling occurred in mixtures of 40:60 to 80:20 of swine waste to ground corn grain. The pH values of all ensiled mixtures were below 5.0 which indicates good ensiling (table 1). Lactic acid values of the ensiled mixtures decreased with decreasing amounts of swine waste in the mixture (table 1). There was a reduction in soluble carbohydrates with ensiling (table 1). Total bacteria were reduced and both total and fecal coliforms were completely destroyed by the ensiling process (table 2). Salmonella, shigella and proteus organisms were not present in the ensiled material. Crude protein, ether extract and crude fiber all decreased with decreasing levels of swine waste in the mixture (table 3).

Digestibility and Acceptability Trials

The apparent digestibility of dry matter, organic matter and crude protein for the basal and diets containing the 40:60 silage were significantly higher ($P<.05$) than diets containing the 60:40 silage (table 4). Nitrogen intake ranged from 39.4 g/day to 44.4 g/day (table 5). There was no significant difference in nitrogen retained expressed as percent of intake between the gilts fed any of the diets. Acceptability as measured by the dry matter intake ($g/w^{.75}$/day) showed no significant difference between treatments, although intake of the basal and diets containing the 40:60 silage tended to be higher (table 6).

TABLE 1. EFFECT OF ENSILING VARYING PROPORTIONS OF SWINE WASTE WITH GROUND CORN GRAIN ON PH AND LACTIC ACID

Mixture of waste:corn	pH		Lactic acid[c]		Water soluble carbohydrates[c]	
	Initial[a]	Ensiled[b]	Initial[a]	Final[b]	Initial[a]	Final[b]
80:20	6.85	4.44[d]	2.37	15.01[d]	3.52	1.76[d]
70:30	6.84	4.32[f,g]	3.12	13.37[d]	4.33	1.55[d]
60:40	6.42	4.21[f,g]	1.80	11.06[e]	4.26	1.31[d]
50:50	6.84	4.31[e]	.70	7.60[f]	4.57	1.55[d]
40:60	6.90	4.28[e,f]	.87	5.50[g]	4.58	1.66[d]
30:70	6.81	4.19[g]	.70	4.41[g]	3.52	1.23[d,e]
20:80	6.60	4.42[d]	.06	1.91[h]	2.91	.84[e]

[a]Each value represents a mean of two samples.
[b]Each value represents a mean of six samples.
[c]Percent of dry matter.
[d,e,f,g,h]Means in the same column with different superscript letters are significantly different ($P<.01$).

TABLE 2. EFFECT OF ENSILING VARYING PROPORTIONS OF SWINE WASTE WITH GROUND CORN GRAIN ON MICROBIAL NUMBERS

	Initial[a]			Ensiled[b]		
		Coliforms			Coliforms	
Waste:Corn	Bacteria	Total	Fecal	Bacteria	Total	Fecal
	10^5/g	10^3/g	10^3/g	10^3/g	10^3/g	10^3/g
80:20	112.0	53.5	50.0	84.5[c]	0	0
70:30	100.0	109.0	13.5	62.6[c,d]	0	0
60:40	28.50	187.0	71.0	58.2[d,e]	0	0
50:50	.495	20.8	16.6	37.0[e,f]	0	0
40:60	.48	17.5	6.3	18.9[f,g]	0	0
30:70	.87	10.9	1.5	13.1[f,g]	0	0
20:80	.935	5.8	1.0	10.8[g]	0	0

[a] Each value represents a mean of two samples.
[b] Each value represents a mean of six samples.
[c,d,e,f,g] Means in the same column with different superscript letters are significantly different (P<.01).

TABLE 3. PROXIMATE COMPONENTS OF VARIOUS ENSILED MIXTURES OF SWINE WASTE AND GROUND CORN[a]

	Mixture (waste:corn)						
	80:20	70:30	60:40	50:50	40:60	30:70	20:80
Dry matter, %	34.92[b]	42.00[c]	49.00[d]	55.92[e]	63.42[f]	70.25[g]	76.92[h]
Composition of dry matter %							
Crude Protein	21.41[b]	17.98[c]	15.38[d]	13.73[e]	12.08[f]	11.23[g]	10.53[h]
Ether extract	10.03[b]	8.89[b,c]	7.65[c,d]	6.42[d,e]	5.67[e,f]	4.70[f,g]	4.25[g]
Crude fiber	8.70[b]	8.04[b]	6.24[c]	5.17[c,d]	4.41[d,e]	3.95[d,e]	3.75[e]
Ash	10.25[b]	7.23[c]	5.74[d]	4.56[e]	3.55[f]	2.91[g]	2.58[h]

[a]Each value represents a mean of six samples.

[b,c,d,e,f,g,h]Means in the same row with different superscripts are significantly different (P<.01).

TABLE 4. APPARENT DIGESTIBILITY OF ENSILED SWINE WASTE AND GROUND CORN GRAIN WHEN FED TO GILTS

	Diets[a]				
		Level of 40:60 silage		Level of 60:40 silage	
Component	Basal	25%	50%	25%	50%
Dry matter	90.0[b]	90.4[b]	89.2[b]	86.7[c]	86.3[c]
Crude protein	88.5[b]	87.6[b,c]	84.5[c,d]	82.7[d]	82.8[d]
Ether extract	83.4[b]	84.9[b]	77.8[c]	78.5[d]	79.1[d]
Crude fiber	70.8[b]	75.1[b]	70.5[b]	69.6[b]	61.3[c]
Organic matter	92.8[b]	92.0[b]	91.2[b]	88.6[c]	88.3[c]

[a]Each value represents a mean of six animals.

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

TABLE 5. NITROGEN UTILIZATION OF GILTS FED ENSILED SWINE WASTE AND CORN

	Diets[a]				
		Level of 40:60 silage		Level of 60:40 silage	
	Basal	25%	50%	25%	50%
Nitrogen intake (g/day)	42.1[d,e]	39.4[b]	44.4[f]	41.2[c,d]	40.0[b,c]
Fecal nitrogen (g/day)	4.9[b]	4.9[b]	5.6[b]	7.1[c]	6.9[c]
Urinary nitrogen (g/day)	26.9[b]	21.3[b]	20.6[b]	22.8[b]	22.9[b]
Retained nitrogen (g/day)	10.3[b]	13.2[b,c]	18.2[c]	11.2[b]	10.3[b]
Retained nitrogen, % of intake	24.5[b]	33.5[b]	41.0[b]	27.3[b]	25.7[b]

[a]Each value represents a mean of six animals.

[b,c,d,e,f]Means in the same row with different superscripts are significantly different ($P<.05$).

TABLE 6. DAILY DRY MATTER INTAKE BY GILTS

	Diets[a]				
		Level of 40:60 silage		Level of 60:40 silage	
Item	Basal	25%	50%	25%	50%
Kilograms per day	4.7	4.5	3.9	3.8	3.1
Grams per $W_{kg}^{0.75}$ per day	83.6	80.3	70.0	68.0	63.3

[a]Each value represents a mean of six animals.

IMMUNOGLOBULIN IgG, IgA AND IgM FORMATION AND ANTIBODY RESPONSE IN SOW-REARED AND ARTIFICIALLY REARED PIGS

S. N. Haye and E. T. Kornegay

The development of practical rearing systems for early weaned pigs could increase the number of pigs weaned per sow and reduce the farrowing interval. However, the younger the pigs are at weaning, the greater are the nutritional, managerial, environmental and disease control needs of the rearing system.

In addition, all pigs including thos early-weaned experience a period of immunological insufficiency as their initial circulating immunity acquired from colostrum decreases before significant antibody production occurs at about 3 weeks of age. It is during this time that prevention and control of disease is very difficult, especially in the early-weaned or artificially-reared pig.

Identification of factors responsible for the development of immunity in artificially-reared pigs could increase survival rate and boost the number of pigs per sow as well as improve growth rate, feed efficiency and disease control.

The study reported herein was conducted to compare the development of circulating immunity when pigs were artificially-reared in a mechanical feeder vs conventionally-reared on the sow.

Experimental Procedures

Two trials were conducted utilizing 99 crossbred pigs from sows farrowing at similar times in each trial. Pigs within each litter were randomly allocated from groups based on weight and sex to the following treatments: (1) artificially-reared on mechanical feeders after 12 hours of age, (2) sow-reared on their respective dams and weaned at 20 days of age.

At the time of birth, pigs were removed from the sow, dried off, ear notched for identification and held in a heated container until 8 or more pigs had been collected. Pigs were then returned to the sow for 12 hours of colostral nursing to ensure equal and adequate levels of immunoglobulins and then assigned to treatments. During the first few days postpartum litter size was adjusted to eight pigs nursing the sow by moving pigs of similar ages from litters not on test. All animals regardless of treatment were moved to a nursery with flat deck cages upon reaching 20 days of age and fed a 22% crude protein corn-soybean meal starter diet containing 10% dried whole whey.

Blood samples were taken and body weights were recorded after 12 hours of colostral nursing and at 5, 10, 15, 20, 25 and 30 days of age. Blood (3-6 ml) was collected via vena cava puncture with a 20 gauge needle. Serum was harvested after allowing the blood clot to contract at 4° Celsius. The serum was frozen in plastic tubes until needed.

Artificial-rearing was done with a mechanical-feeder[1] housed in an environmentally-controlled room previously cleaned and fumigated. The room was isolated by an anteroom from other personnel and animals to avoid overt contamination from outside sources. The humidity remained at about 40% and temperature was maintained at 36.6 C during the first few days and decreased about 3 C weekly thereafter. Two air changes per hour were maintained with a ventilation rate of 102 ft^3 per minute.

Artificially-reared pigs were taught to drink from feeding cups. They were initially fed 3 gm of a commercial milk substitute[2] mixed with 12 ml of water. The mechanical feeder fed each pig 16 times daily a predetermined amount which was adjusted with the appetite of the animals. A prestarter[3] diet was offered *ad libitum* at 2 weeks of age.

In trial 1, pigs received an intraperitoneal injection (1 ml per 100 ml of estimated blood volume) of a 10% sterile suspension of sheep red blood cells. The antibody titer was determined 5 and 10 days following immunization by the 50% unit of hemolysin titration. The titer was expressed as the number of 50% hemolysin units/ml of serum. In trial 2, a sterile suspension of a Salmonella H antigen (Paratyphoid A) was used for immunization. The antigen was diluted 20 times prior to injection to yield a density of a No. 3 McFarland Barium Sulfate Standard (1.8×10^8 organisms per ml). One ml of the antigen suspension was injected per 100 ml of estimated blood volume. Tube agglutination titer, expressed as the reciprocal of the highest dilution giving approximately 75% agglutination, was determined 5 and 10 days following immunization.

Serum levels of immunoglobulins were determined by a modification of the radial immunodiffusion technique by Mancini *et al*. (1965) and Fahey and McKelvay (1965). The immunoglobulins used as radial immunodiffusion standards and as antigens in the production of antisera were prepared by gel filtration chromatography and ion exchange chromatography. IgG and IgM were prepared from porcine serum while IgA was prepared from sows' milk. The isolated proteins were identified and confirmed pure by immunoelectrophoresis and double immunodiffusion.

Data were analyzed statistically by least squares analysis of variance using the full model with all possible interactions for least squares means.

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[1]Fairfield Engineering Co., Fairfield, IA.

[2]Formost Foods, San Francisco, CA

[3]Triple F Feeds, Des Moines, IA

Results

Growth. In general, sow-reared pigs gained at a faster rate during the first 10 days of Phase I than artificially-reared pigs. However, during the last 10 days of Phase I artificailly-reared pigs had the faster growth rate (figure 1). In both trials artificially-reared pigs grew slower ($P < .01$) over the first 5-day period. During the next period, 5-10 days, growth was again slower for artificially-reared pigs in trials 1 ($P < .01$) and 2 ($P < .10$). However, pigs artificially-reared grew at a faster rate in trial 2 ($P < .05$) from 10-15 days and in trial 1 ($P < .01$) from 15-20 days.

Both rearing groups experienced a check or set-back in growth when moved to the flat deck cages in Phase II. The set-back was greater for artificially-reared pigs in both trial 1 ($P < .10$) and trial 2 ($P < .01$). The effect of rearing was not significant during the last 5 days of Phase II.

Serum Proteins. The artificially-reared pigs had lower ($P < .01$) total serum protein levels at 10, 15 and 20 days of age during trial 1 (table 1). After moving to the flat deck cages at 20 days of age, serum proteins of the artificially-reared pigs remained lower than those of sow pigs, although nonsignificant.

Unexplanably, in trial 2 the pigs randomly assigned to be artificially-reared had lower ($P < .05$) serum protein levels than littermates remaining on the sow after 12 hours of colostral nursing. These levels remained significantly ($P < .05$) depressed during Phase I for the artificially-reared pigs. After movement to the flat deck cages no significant differences were observed between the two rearing groups during Phase II.

Antibody Response. The production of antibodies following immunization with sheep red blood cells in trial 1 and a Salmonella antigen in trial 2 are presented in table 2 and 3, respectively. Immunization at 12 hours, 5 days or 10 days of age did not illicit a measurable antibody response at 5 or 10 days post-injection in pigs from either rearing sysem.

In trial 1, when sow-reared pigs were injected at 15 days of age there was s small but significant ($P < .05$) antibody response 5 days later (table 2). The artificially-reared pigs did not respond at detectable levels at 5 days post-injection. A larger response was observed at 10 days post-injection for both groups. At this time the sow-reared pigs were also able to respond to a greater ($P < .01$) degree than artificially-reared pigs.

When the antigen was administered to another group of pigs at 20 days of age, the response 5 days later was low and similar for both sow-and artificially-reared pigs. The sow-reared pigs has higher titers ($P < .01$) when determined 10 days post-injection than artificially-reared pigs. It was also observed that the titers were similar when the antigen was administered either on day 15 or day 20 of age for both rearing systems. It was expected that the antibody response would be higher in the older (20 vs 15 day immunization) pigs. This apparently lowered response of the 20 day old pigs may be the result of a post-weaning shock since the antigen was administered at the time of weaning. On artificially-reared pigs this post-weaning shock had a greater effect which was also observed for growth rate.

Antigen administration to a third groups of pigs at 25 days of age demonstrated again a significant ($P < .05$) rearing effect with the sow-reared pigs responding to a greater degree 5 days post-injection.

In trial 2, when sow-and artificially-reared pigs were immunized with a Salmonella antigen at 15 days of age antibody titers were detected 10 days but not 5 days later in both rearing groups (table 3). The pigs reared on the sow tended ($P < .10$) to respond to a greater degree than artificially-reared pigs. Animals given the antigen at 20 days of age had measurable titers 5 and 10 days later. Again the response of sow-reared pigs was greater ($P < .05$) than artificially-reared pigs 5 and 10 days post-injection. A similar pattern was observed when the antigen was administered at 25 days of age.

No post-weaning effect on antibody response after injection at 20 days of age was observed in trial 2.

There was no relationship between antibody titer (at 10 days post-injection on 20 days of age) and overall average daily gain for either sow-reared ($r = .07$ and $r = .05$, for trials 1 and 2, respectively) or artificially-reared ($r = .21$ and $r = .20$ for trials 1 and 2, respectively) in both trials.

Serum Immunoglobulins. The serum immunoglobulin concentration is presented in figures 2, 3 and 4. Sow- and artificially-reared pigs had similar levels of immunoglobulin G, A and M following 12 hours of colostral nursing for both trials which suggests all pigs had equal nursing opportunities.

In trial 1 artificially-reared pigs had higher levels of serum IgG at 5, 10 and 15 days of age ($P < .01$, $P < .05$ and $P < .10$, respectively), but there was no rearing effect on IgG levels at any of the sampling times in trial 2 (figure 2). There was a steady decline in IgG levels as pigs became older. The mean half-life of IgG for both trials was 10.0 and 11.0 days for sow- and artificially-reared pigs, respectively.

The effect of rearing on serum IgA levels is shown in figure 3. The decline of the maternal derived IgA is similar to that observed for IgG for both trials. Artificially-reared pigs had higher IgA levels than sow-reared pigs at every sampling age starting at 5 days of age. The apparent reduced rate of catabolism is evidenced as IgA levels of artificially-reared pigs decline at a slower rate. The rate of IgA decline for both rearing systems appears to reach a minimum at 15 days of age. Over the next 15 days an upward trend develops, indicating production of IgA at a greater rate than the decline of maternally derived IgA. The mean half-life of IgA was 3.2 and 3.9 days for sow- and artificially-reared pigs, respectively.

The effect of rearing system on IgM levels is shown in figure 4. A pattern of higher ($P < .01$) immunoglobulin levels for artificially-reared pigs was observed at 5 days of age. A minimal levels of IgM was observed at 10 days of age. During the remainder of the experimental period both rearing groups demonstrated increased production of IgM. However, the sow-reared pigs were able to produce significantly higher ($P < .05$) levels at 20, 25 and 30 days of age. The mean half-life for both trials was 4.2 and 5.5 days for sow- and artificially-reared pigs, respectively.

Summary

Two trials utilizing 99 crossbred pigs from sows farrowing at similar times were conducted to compare the development of humoral immunity when pigs were artificially-reared in a mechanical feeder vs conventionally-reared on the sow. Newborn pigs within each litter were allowed 12 hr of colostral nursing before assignment to the rearing systems. Blood samples and body weights were recorded at 12 hr and 5, 10, 15, 20, 25 and 30 days. Pigs from both rearing systems were weaned at 20 days of age and moved to a nursery with flat deck cages. Average daily gain during the first 10 days was less ($P < .05$) for artificially-reared pigs (102 g) compared to sow-reared pigs (158 g), but rearing system did not significantly affect the overall average daily gain of pigs at the end of the 30-day study. Serum proteins were lower ($P < .05$) at 10, 15 and 20 days of age when pigs were artificially-reared. An antibody response was apparent 10 days after an intraperitoneal injection of a 10% sheep red blood cell suspension or a Salmonella antigen at 15 days of age for both rearing systems. Antibody titers 10 days after injection were lower ($P < .05$) when the pigs were artificially-reared. After 12 hr of colostral nursing serum IgG, IgA and IgM levels as determined by radial immunodiffusion were 12.5, 4.4 and 2.4 mg/ml, respectively. Rearing system had no effect on IgG levels which continued to decline over the 30-day study to 2.93 and 2.56 mg/ml for artificially and sow-reared pigs, respectfully. IgA levels decreased to a minimum at 15 days of age for sow-reared pigs (.21 mg/ml) whereas, the minimum was at 25 days of age for artificially-reared pigs (.22 mg/ml). IgM levels increased after 10 days of age for both rearing systems but sow-reared pigs (1.43 mg/ml) had higher ($P < .01$) levels at 30 days of age than artificially-reared pigs (1.26 mg/ml). The artificially rearing of 12 hr-weaned pigs resulted in a slightly reduced antibody response and lower serum IgM levels but not IgG and IgA.

TABLE 1. EFFECT OF REARING SYSTEMS ON SERUM PROTEINS — TRIALS 1 AND 2[a]

Age	Trial	Rearing System		SEM[b]
		Sow	Artificial	
12 hours	1	6.73	6.83	
	2[c]	6.74	6.08	
	Mean	6.62	6.34	.11
5 days	1	4.92	5.10	
	2[c]	6.75	6.14	
	Mean[d]	5.82	5.66	.08
10 days	1[e]	5.88	4.91	
	2[e]	7.46	5.48	
	Mean[d,e]	6.68	5.25	.10
15 days	1[e]	6.16	4.08	
	2[e]	6.49	5.80	
	Mean[e]	6.43	5.04	.05
20 days	1[e]	6.18	4.68	
	2[e]	6.57	5.24	
	Mean[e]	6.37	4.98	.06
25 days	1	6.03	5.27	
	2	6.28	5.21	
	Mean	6.15	5.26	.08
30 days	1	4.74	4.69	
	2	4.52	4.82	
	Mean	4.71	4.71	.10

[a]Data presented as least squares means.

[b]Standard error of the mean for 30 and 23 pigs per mean for sow and artificial rearing systems respectively, in Trial 1; 23 and 24 pigs per mean for sow and artificial rearing systems, respectively, in Trial 2.

[c]Rearing system effect ($P<.05$).

[d]Rearing system x trial interaction ($P<.05$).

[e]Rearing system effect ($P<.01$).

TABLE 2. EFFECT OF REARING SYSTEMS ON PRODUCTION OF ANTIBODIES (TITER) TO SHEEP RED BLOOD CELLS — TRIAL 1[a]

Age, days		Rearing System		
Antigen injection	Bleeding	Sow	Artificial	SEM[b]
15	20[c]	2.2	nil	.3
	25[d]	30.8	12.2	2.3
20	25	2.9	2.8	1.6
	30[d]	26.2	6.1	3.5
25	30	9.8	3.2	2.2

[a]Data presented as least squares means.

[b]Standard error of the mean for 5 and 4 pigs per mean for sow and artificial rearing systems, respectively.

[c]Rearing system effect (P<.05).

[d]Rearing system effect (P<.01).

TABLE 3. EFFECT OF REARING SYSTEM ON PRODUCTION OF ANTIBODIES (TITER) TO SALMONELLA H ANTIGEN — TRIAL 2[a]

Age, days		Rearing System		
Antigen injection	Bleeding	Sow	Artificial	SEM[b]
15	20	nil	nil	
	25[c]	70	31	2
20	25[d]	57	25	1
	30[d]	311	172	2
25	30[d]	343	47	2

[a]Data presented as least squares means.

[b]Standard of the mean for 10 and 8 pigs per mean at 15 days of age; 6 and 7 pigs per mean at 20 days of age; 7 and 5 pigs per mean at 25 days of age for sow and artificial rearing systems, respectively.

[c]Rearing system effect ($P<.10$).

[d]Rearing system effect ($P<.05$).

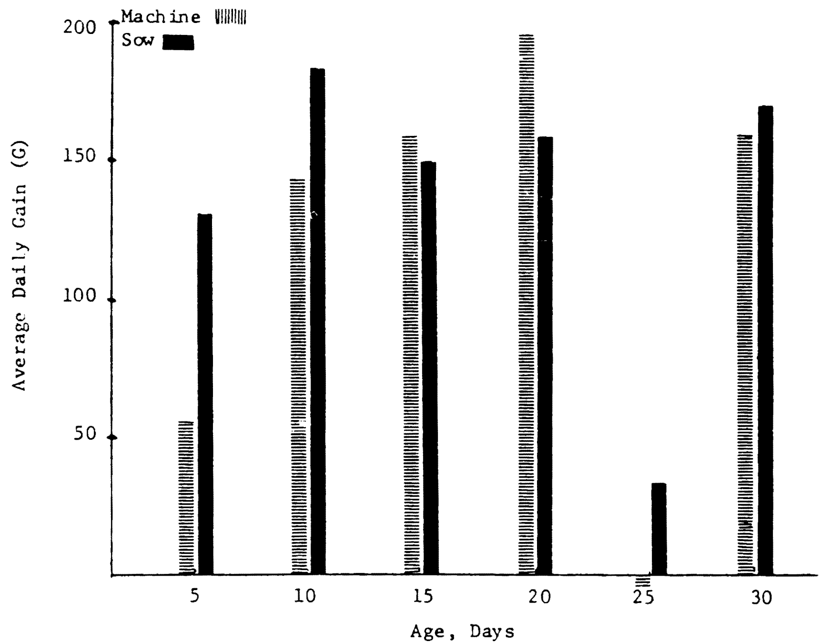

Figure 1. Effect of rearing systems on average daily gain (g) -- Trials 1 and 2.

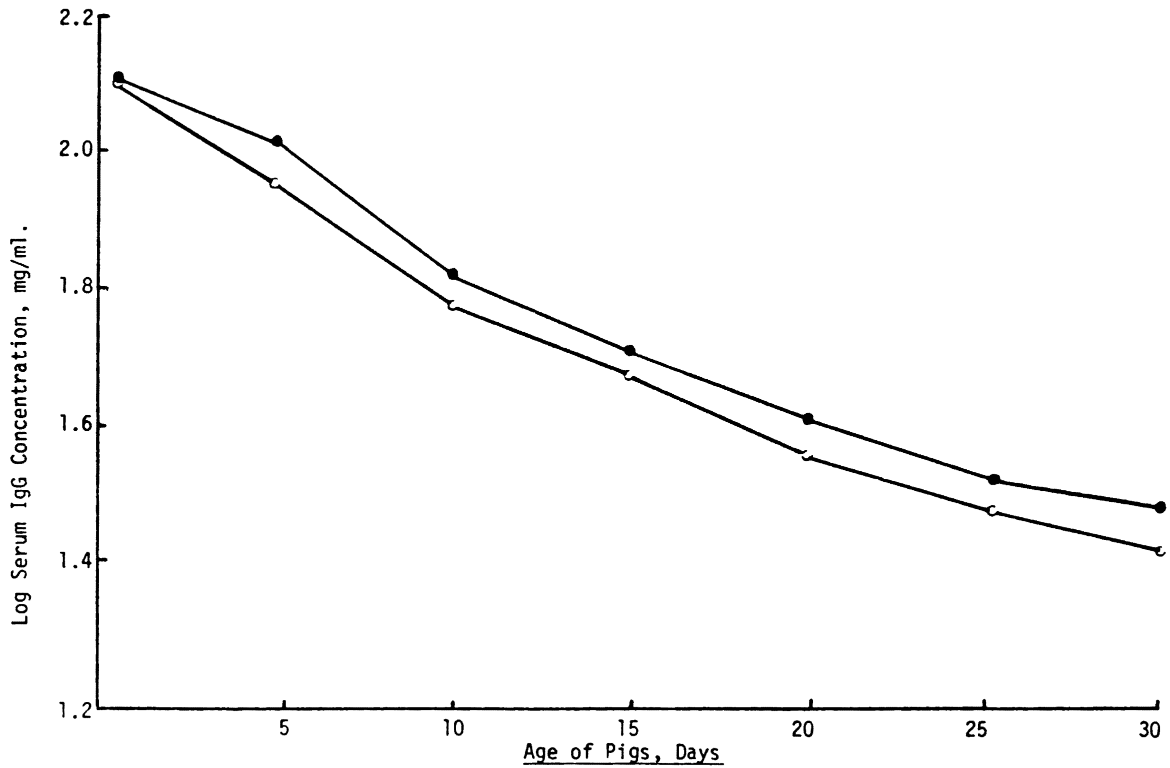

Figure 2. Serum IgG concentration of artificially (●) and sow (○) reared pigs. Trials 1 and 2.

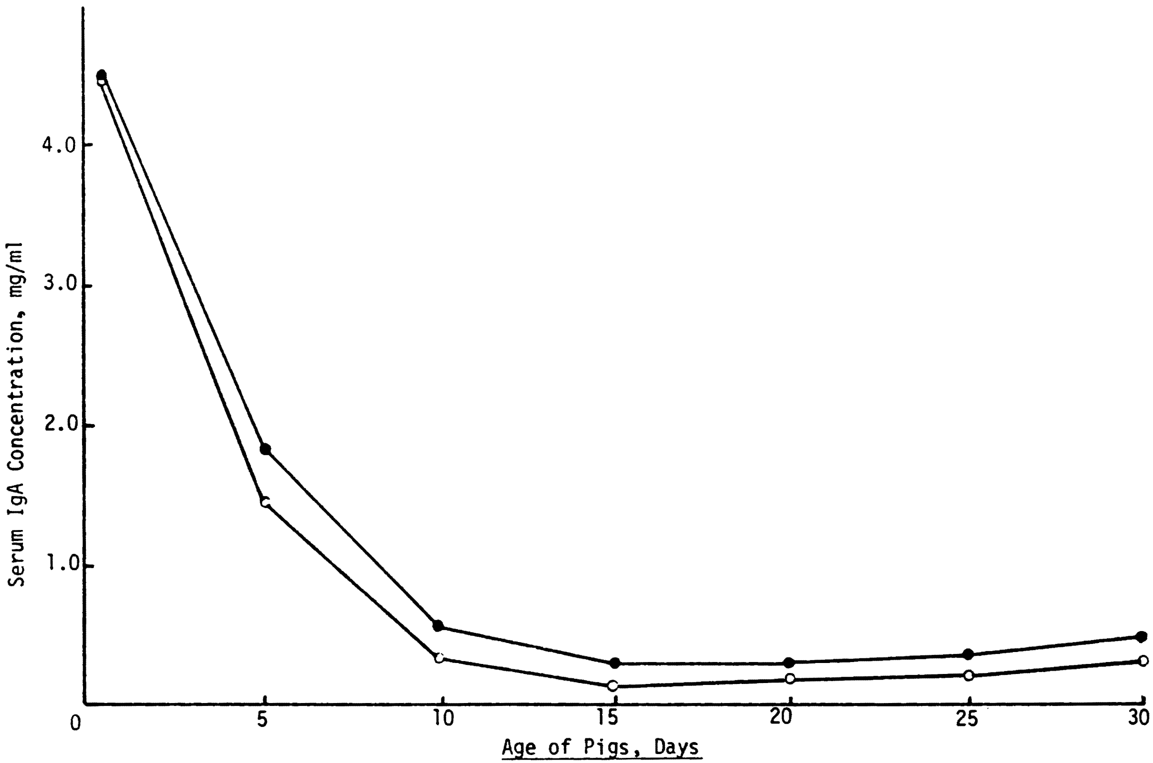

Figure 3. Serum IgA concentration of artificially (●) and sow (○) reared pigs. Trials 1 and 2.

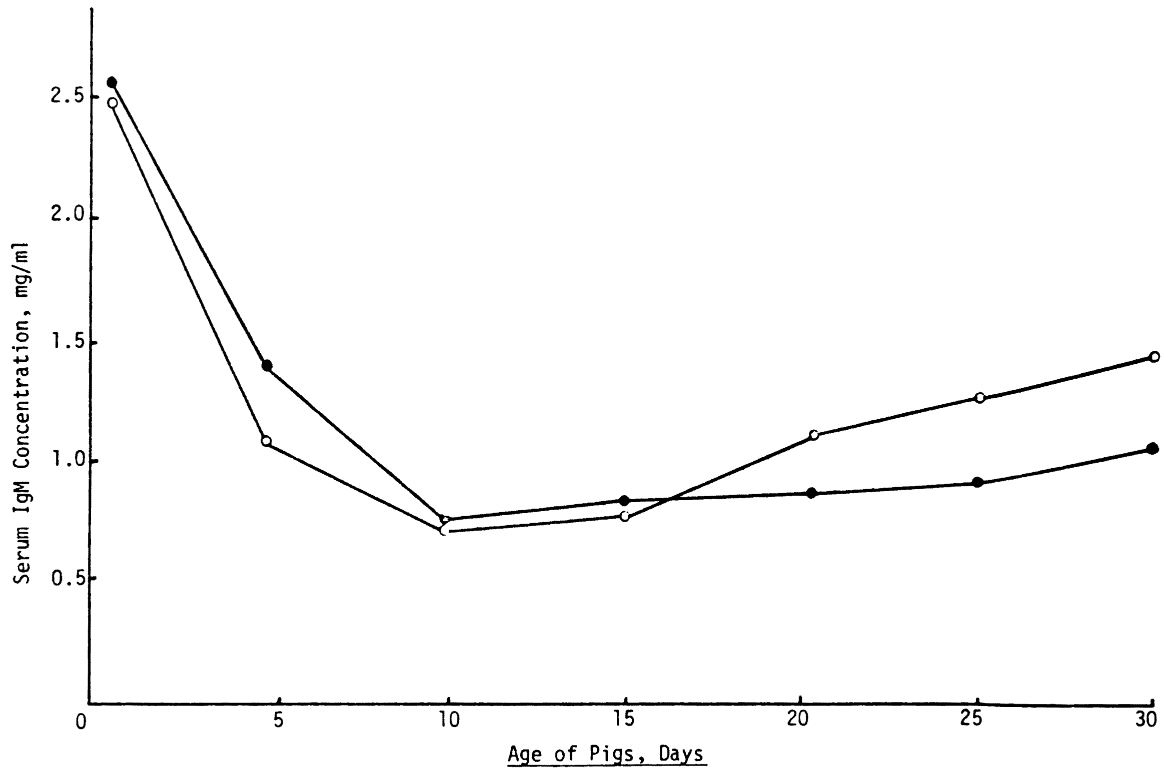

Figure 4. Serum IgM concentration of artificially (●) and sow (o) reared pigs. Trials 1 and 2.

PELLETED COMPLETE RATIONS CONTAINING DIFFERENT ROUGHAGE BASES FOR HORSES[1]

V. A. Bowman, T. N. Meacham, G. R. Dana and J. P. Fontenot

Due to the high cost and limited supply of conventional roughages, alternative sources of roughage for horses need to be evaluated. Some horse owners prefer to feed a complete feed with the roughage incorporated in the feed. Alfalfa meal has usually been used as the source of roughage in these complete rations. Corn cobs and soybean hulls have potential as replacements for conventional sources such as alfalfa meal.

This research was conducted to compare corn cobs and soybean hulls with alfalfa meal as roughage sources in pelleted complete rations for horses.

Experimental Procedure

Two trials of 60 days each were conducted with six mature geldings weighing approximately 1000 lb. Prior to each trial the horses were paired according to body weight, and the two horses within each pair were allotted to two experimental rations. Chemical composition of rations is shown in table 1. Horses were fed twice daily at approximately 7 a.m. and 4 p.m. The horses were individually fed in box stalls and were turned out after each feeding into a large dry lot. Feed consumption times were measured periodically during the trials for both the A.M. and P.M. feedings. Fecal samples were collected weekly for dry matter determinations in both trials. Animals were weighed weekly to monitor body weight changes. Horses were observed for abnormal ingestive behavior including wood chewing, hair chewing and coprophagy. The rations and feeding levels for each trial were as indicated below.

Trial 1

Experimental rations contained alfalfa meal or corn cobs as the roughage base. Feeding levels were calculated to meet maintenance requirements, which was 1.22% of body weight.

Trial 2

The rations contained alfalfa meal or soybean hulls as the roughage source. The feeding level was raised to 1.34% of body weight since results from the previous trial indicated 1.22% of body weight was not adequate to maintain body weight.

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[1]Appreciation is expressed to Dr. G. E. Poley, Southern States Cooperative, Richmond, Virginia, for formulating and supplying the pelleted feed.

Results

Trial 1

Animals on both rations consumed the quantity of feed offered. As shown in table 2, consumption time was similar for both rations. The animals receiving alfalfa pellets consumed the feed in approximately 32 minutes per feeding, compared to 39 minutes for horses receiving the corn cob base pellets. One animal on the corn cob ration consistently had a longer consumption time throughout the trial, which was the reason for the longer mean consumption time for the horses fed the corn cob ration. Feeding at 1.22% body weight was not adequate to maintain body weight. The horses receiving alfalfa based pellets lost an average of 42 lb during the 60-day trial, while those on corn cob based pellets lost an average of 34 lb during this same period.

The feces of horses fed both rations were noticeably soft. Fecal dry matter content was 32% for horses on alfalfa pellets and 36% for those on corn cob pellets.

Trial 2

Alfalfa and soybean hull based pellets were readily consumed by all animals, with no refusals. Average consumption times were lower, 27 minutes per feeding, for the soybean hull pellets (table 2). Horses on the alfalfa based pellets required 34 minutes per feeding, similar to consumption times of alfalfa pellets in trial 1. One horse on the alfalfa pellets was a consistently slow eater and was primarily responsible for the increased mean consumption time of this ration. This animal was also a slow eater in trial 1.

Increasing the feed intake to 1.34% of body weight resulted in essentially maintenance of body weight for horses on the soybean hull pellets. This level of feeding was not adequate to maintain horses on the alfalfa base pellets, which lost an average of 23 lb over 60-day period.

The fecal dry matters were similar for horses on both rations, 27.5% for alfalfa and 27.9% for soybean hull ration.

Feces of horses on both rations in both trials tended to be rather soft and was not in pellet form. This was reflected by the low fecal dry matter. Throughout both trials considerable amounts of wood chewing and some coprophagy were observed in all animals. These behavior patterns have been frequently reported in horses fed completely pelleted rations.

TABLE 1. CHEMICAL COMPOSITION OF RATIONS

	Trial 1		Trial 2	
	Alfalfa	Corn cobs	Alfalfa	Soyhulls
	%	%	%	%
Acid detergent fiber	23.8	23.7	19.29	25.83
Crude protein	15.2	12.2	14.2	13.2
Calcium	1.3	1.5	1.3	1.6
Phosphorous	0.5	0.5	.51	.57

TABLE 2. BODY WEIGHT CHANGE, FEED CONSUMPTION TIME AND FECAL DRY MATTER CONTENT, TRIALS 1 AND 2[a]

	Trial 1		Trial 2	
	Alfalfa	Corn cobs	Alfalfa	Soybean hulls
Initial wt., lb.	955	1050	999	925
Final wt., lb.	913	1016	976	930
Change lb.	-42	-34	-23	5
Feed consumption min./feeding	32.2	38.7	34.7	27.2
Fecal dry matter, %	32.0	36.0	27.5	27.9

[a]Observations are the mean of 3 horses.