4-1-1999

Arkansas Animal Science Department Report 1998

Stacey Gunter
University of Arkansas, Fayetteville

Arkansas

Animal Science

DEPARTMENT REPORT • 1998

Stacey Gunter, editor

ARKANSAS AGRICULTURAL EXPERIMENT STATION
Division of Agriculture University of Arkansas
April 1999 Research Series 464

Editing and Cover Design by Karen Eskew

Agricultural Experiment Station, University of Arkansas Division of Agriculture, Fayetteville. Milo J. Shult, Vice President for Agriculture and Director; Charles J. Scifres, Associate Vice President for Agriculture-Research. Western Newspaper Publishing Co., Inc. 1.4M 0499 PM6.5.
The Arkansas Agricultural Experiment Station follows a nondiscriminatory policy in programs and employment. ISSN:0099-5010 CODEN: AKAMA6

ARKANSAS ANIMAL SCIENCE

Arkansas Animal Science is a publication of the Department of Animal Science, Arkansas Agrigultural Experiment Station, and the Animal Science Section of the Cooperative Extension Service. It provides a summary of the most recent scientific and educational accomplishments by the Animal Science units of the University of Arkansas Division of Agriculture. This publication is to be distributed among persons with an interest in the Arkansas livestock industry.

Arkansas Agricultural Experiment Station

Fayetteville, Arkansas 72701

FOREWORD

We are proud to introduce this first edition of Arkansas Animal Science. The department is in its third year of a major rebuilding program with over $10 million in state, federal, and private funds invested in facilities alone. We hope that this publication will show the results of this investment.

Our goal is to be nationally recognized for our teaching, research, and extension. With this goal in mind, several new faculty appointments are joint between teaching, extension and (or) research. We believe that close coordination of the three functions of the department is essential to our success.

KEY DEVELOPMENTS TO BE COMPLETED OR UNDERWAY INCLUDE:

- **Hiring of new faculty**. The faculty now number 18 on the Fayetteville campus, two at the Southwest Research and Extension Center in Hope and 10 at the Extension Center in Little Rock.
- **The Whitaker Animal Science Center**, with its classrooms, arena, and livestock barn is finished.
- **Renovation of the Animal Science Building** is scheduled to begin this spring and be completed over a 2-year period.
- **New beef cattle research and teaching facilities** that include a cow / calf unit designed for reproduction and nutrition research and a stressed cattle unit designed for studies with stockers and weaned calves. These facilities located at Fayetteville opened last fall.
- **A new consortium** has been formed with certain Arkansas community colleges that allow students to take two years of study at the community colleges and then transfer to the University of Arkansas Animal Science Department. The curriculum at the department has been modernized.
- **The swine research and teaching unit** has been re-equipped and refurbished. Work is progressing on the design of a new Swine Center. A new off-site nursery, donated by the swine industry opened last summer.
- **A total renovation of the abattoir** is complete.
- **A grant of $440,000** was provided by the Carl B. and Florence E. King Foundation to create an equine teaching and service program at the University of Arkansas. Equine facilities will be constructed this summer to complement the new Animal Science Center.
- **Improvements at the Livestock and Forestry Branch Station** at Batesville now total over $800,000 and include a new office and conference center, as well as new livestock and pasture systems. The Batesville station is now one of the most beautiful beef and forage research facilities in the country.

The goal of the Animal Science Extension Section is to provide research-based information that will improve the economic well-being and the quality of life of Arkansans. Animal Science Extension programs utilize a number of educational methods to assist Arkansas producers with livestock management, primarily beef cattle and dairy cattle. Sheep, beef cattle, dairy cattle, swine, and horse projects are used in the 4-H livestock programs to teach lifetime skills to Arkansas' youth.These programs are designed to help Arkansas livestock producers with production information while also investing in the future of Arkansas.

This past year saw a number of changes in the Animal Science Section. The forage specialists, formally in the Agronomy Section were moved into the Animal Science Section. This allowed for more livestock-forage integrated programming. Forage demonstrations which look at both forage and livestock production were initiated this past year, allowing us to look at forage and livestock production in a more systems-oriented approach. Additional forage specialists were hired to better address the educational needs of the Arkansas livestock industry.

The Arkansas Beef Improvement Program (ABIP) took on a different direction. In the past, the program involved a total ranch-management concept. This limited the number of producers and county agents that could participate in the program. With a desire to reach more producers, five ABIP projects were introduced. These projects included stocker cattle programs, breeding and calving season, cow herd performance, pasture renovation and hay quality, and supplemental feeding. Thirteen producers were added to the ABIP effort to look at these projects. This change in program direction should allow us to look at specific management situations.

The livestock 4-H program is very important to the future of Arkansas. Arkansas youth participated in beef cattle, dairy, swine, horse, and sheep livestock projects. The Arkansas 4-H program is supported by 7,619 volunteer leaders, as well as county extension faculty, and many allied industries. Enrollment in 4-H livestock and poultry projects totals 22,245. This number represents 24.4% of the total state 4-H enrollment (91,020). The horse, beef, and dairy projects are the three largest within the Animal Science Section.

The extension and the teaching / research faculty are working together to better serve the livestock industry in Arkansas. Identifying, managing, and preventing sickness in calves was the major topic at a producer program held this past year in Fayetteville. Arkansas producers participated in an informal hands-on program delivered by leading experts in the field of calf health.

We hope you will find the information in this report to be useful. We encourage you to contact any of the faculty or staff of the Animal Science Program for any information service that we may provide to you.

Sincerely,

Keith Lusby
Department Head
Fayetteville

Tom Troxel
Section Leader
Little Rock

INTERPRETING STATISTICS

Animal scientists use statistics in the design and analysis of experiments in order to separate effects likely caused by the applied treatments from the background noise attributable to random occurrence (chance) and individual animal variation. Experiments are always conducted using multiple "experimental units" (animals, pastures, pens) per treatment, and these units are referred to as replications. Because animals by their nature exhibit a wide range of individual performance potentials, a large number of replications are usually required to obtain reliable data. If the number of replications is small and animal variation is large, relatively large numerical differences between treatments may fail to pass tests of statistical significance. When a result is referred to as statistically significant or sometimes simply as significant, the author is stating that the data has passed a mathematical test designed to identify a true treatment effect from one due solely to chance.

The level of significance is usually stated in text and tables as a probability value and will look like ($P<.05$), ($P<.01$), or ($P<.001$). These mean that the probability (P) that any two treatment means differ solely due to chance is less than 5, 1, or .1%, respectively, and therefore there is a high probability (greater than 95, 99, or 99.9%) that the two treatments are truly different. Convention dictates that only probabilities less than .05 are defined as "statistically significant." Higher probabilities are sometimes presented and discussed and should be evaluated cautiously according to their probability levels.

Values reported in tables are presented as "means," or averages across all replications of that treatment. Statistical differences are often indicated in tables by use of superscript letters. Treatments with the same letter are not different, while treatments with no common letters are. An alternative presentation is to report means in the format: 16.0 ± 2.3. The first number is the mean and the second is the "standard error of the mean" and can be designated either SE or SEM. The SEM is a measure of the range of the data values - the larger the SEM, the greater the spread in the data. If the ranges reported by the SEM of two treatments overlap, the treatments are usually not significantly different. The coefficient of variation, or CV, is the standard error expressed as a percentage of the mean, and is another estimate of the amount of spread in a data set.

Some experiments use procedures known as regression analysis to determine treatment differences. This is used when treatments are set up to use an increasing amount of an experimental substance such as a feed supplement fed at different levels or doses of a drug. This analysis allows researchers to determine how much change in performance is caused by each increment of increase in the treatment and to determine the optimum level of the treatment. The proportion of the variation in performance that can be accounted for by the treatment is often denoted as r^2 and is called the coefficient of determination. This quantity, which may vary from 0 to 1, is a measure of the degree of relationship between the treatment level and performance. A value of zero indicates no relationship, and a value of 1.0 indicates a perfect relationship where performance increases with increasing treatment levels. Probability values are also used with regression to determine statistical significance.

Correlation analysis is similar to regression and uses a similar statistic, the correlation coefficient (r). This quantity may vary from -1.0 to + 1.0 and indicates the strength of the relationship between treatments and performance. However, correlation does not measure cause and effect directly.

-Kimberly Cassida

COMMON ABBREVIATIONS

ADG = average daily gain	°C = degrees Celsius	kg = kilogram(s)	ppm = parts per million
avg = average	°F = degrees fahrenheit	L = liter(s)	r = correlation coefficient
BW = body weight	F/G = feed:gain ratio	LH = lutenizing hormone	r^2 = simple coefficient of determination
cc = cubic centimeter	FSH = follicle stimulating hormone	m = meters	RNA = ribonucleic acid
cm = centimeter	ft = foot/feet	mg = milligram(s)	s = second(s)
CP = crude protein	g = gram(s)	mcg = microgram(s)	SD = standard deviation
CV = coefficient of variation	gal = gallon(s)	mEq = milliequivalent(s)	SE = standard error
cwt = 100 pounds	h = hour(s)	min = minute(s)	SEM = standard error of the mean
d = day(s)	in = inch(es)	N = nitrogen	wk = week(s)
DM = dry matter	IU = international units	NS = not significant	wt = weight
DNA = deoxyribonucleic acid	kcal = kilocalorie(s)	ppb = parts per billion	yr = year(s)

TABLE OF CONTENTS

continued

Table of Contents continued

Animal Science Teaching Program

Charles Rosenkrans, Jr.[1]

Mission Statement

We are training students to become successful members of our society, by empowering them with technical, thinking, and communication skills. Strategies associated with that mission include: 1) offer courses that present cutting edge material, 2) test in a manner that challenges students to think about real-world problems (i.e. management of people and livestock, and application of technologies) 3) offer curricula to meet the needs of an increasingly diverse student clientele. Our success in this mission is linked by three critical factors: faculty, facilities, and a flexible degree program.

Faculty

During the last three years we have seen a rebirth of the Animal Science teaching faculty. Our forages and nutrition group has more than doubled with the hiring of Drs. Coblentz, Coffey, Kegley, and Maxwell. These professors join Drs. Kellogg and Daniels in instruction of nutrition, and production and management courses. Our next largest group of faculty is the physiologists, Drs. Kreider, Piper, Rorie, and Rosenkrans. The breeding and genetics group has grown by the addition of Dr. Johnson, and Mr. Kutz to join Dr. Brown. Dr. Hellwig, again doubling our faculty in that area, joined Dr. Yazwinski in the animal health and diseases area. Drs. Apple and Pohlman now serve the critical meats and food safety area. We believe that we now have the necessary faculty to complete our teaching mission. This mission is further strengthened by involvement by Drs. Gunter and Cassida who will be teaching Animal Science courses at the University of Arkansas Community College at Hope.

Facilities

Extensive renovation and new construction of virtually all departmental facilities has greatly enhanced our capacity for teaching. The opening this spring of the new Animal Science Center with its 54,000 square feet of arena, classrooms, and animal handling facilities opens many doors for the teaching, extension, and outreach programs. Anticipated completion in the winter of 1999 of the Dorothy E. King Equine Pavilion to be located at the Animal Science Center, will expand the numbers of students learning about Animal Science.

Flexible Degree Program

The Animal Science Department recently implemented a 124-hour Bachelor of Science in Agriculture degree. That program offers our students an unprecedented amount of flexibility in course choices. In addition, that program is designed to give the department more quality assurance in what talents our graduates offer potential employers.

Our curriculum includes requirements imposed by the University of Arkansas, the Dale Bumpers College of Agricultural, Food and Life Sciences, and the Animal Science Department. Those requirements are distributed as follows:

Physical and Biological Sciences	20 hours
Communications	15 hours
Fine Arts and Humanities	6 hours
Social Sciences	9 hours
American History or Government	3 hours
Animal Science core	22 hours
Animal Science electives	13 hours
Discipline-related electives	15 hours
and General electives	21 hours

The Animal Science Core consists of Introductory Animal Science and Laboratory, Feeds and Feeding, Animal Genetics and Breeding, Livestock and Meat Evaluation, Fundamentals of Reproductive Physiology, and a choice of production and management courses. Those core courses are aimed at giving our students a broad survey of disciplines with the production and management courses designed to be capstone integrated courses.

[1] Department of Animal Science, Dale Bumpers College of Agricultural, Food and Life Sciences, University of Arkansas, Fayetteville.

Animal Science electives are more advanced science-based courses offered by our department. Those electives are designed to give the student the opportunity to tailor his / her degree with added emphasis in physiology, genetics, nutrition, meats, and (or) health (parasitology and diseases).

Discipline-related electives consist of supporting courses within and outside of our department. Those 15 hours can be used for specific experiential learning such as judging activities, internships, and special problems and topics courses. In addition, many of the courses needed for those students interested in business-related careers are included in this block. This block also includes the pre-professional courses needed for application to various professional programs.

General elective hours are for those students who wish to pursue a minor in another discipline or to generally broaden their college experience. Typically, minors are 18 to 22 hours; therefore, our program between discipline-related and general electives actually allows our students the potential to graduate with an Animal Science major and two minors. We believe that offers our students great flexibility in designing their education and subsequent careers.

With the faculty, facilities, and academic program now in place, we are confident that we offer students a first-rate opportunity for learning. Our program can accommodate students with a wide variety of interests, and ultimately prepares them for employment and successful careers.

Effects of Providing Balanced, Least-Cost Winter Feed Supplements to Arkansas Beef Cattle Improvement Herds

George Davis, Tom Troxel, Shane Gadberry, William Wallace,
Stan McPeake, and John Jennings[1]

Story in Brief

The University of Arkansas Cooperative Extension Service in conjunction with 10 beef cattle producers located in 10 counties throughout the state conducted Arkansas Beef Improvement Program (ABIP) demonstrations. The objectives were to determine: (1) nutrient deficiencies of hay produced on 10 ABIP farms and (2) the effects of providing the beef herds with balanced, least-cost feed supplements based on the nutrient composition of the hay fed. Nutrient composition was determined on 276 hay samples collected from 1992 through 1996 on the 10 ABIP farms. Total digestible nutrients (TDN) deficiencies in hays were more prevalent than crude protein (CP) deficiencies for both dry and lactating beef cows. Forage species (bermudagrass, fescue, mixed grass) did not affect whether hay was adequate or deficient in CP levels required for dry or lactating cows, but species did affect the adequacy or deficiency of TDN levels required for dry and lactating cows. When least-cost feed supplements were formulated based on composition of the hay fed, supplement cost/animal unit (AU) was reduced by 50% from 1993 ($48.19/AU) to 1995 ($24.32/AU). Also, calf crop percentage increased 7.8% from 1993 (85.6%) to 1996 (92.3%). Cost per pound of beef produced declined from $0.54/lb in 1993 to $0.32/lb in 1996.

Introduction

Arkansas beef cattle producers provide hay and supplemental feed to cattle herds for 120 to 150 days during the winter and early spring. Because most cow herds calve in the late winter and early spring, feed supplementation is often necessary to maintain or bring the cows to a moderate body condition (body condition score of 5 on a scale of 1 to 9) by the start of the breeding season.

Very few producers test their hay for nutrient composition prior to the hay feeding season. Many producers provide the same feed supplement to their herds each winter regardless of the quality of the hay provided. Protein feed sources are commonly used and are usually more expensive than total digestible nutrients (TDN) energy feed sources. Therefore, supplemental feed costs in many herds are greater than necessary. Deficiency of TDN leads to thin body condition, which results in lower conception rates and lightweight calves.

The objective of this demonstration was to determine the nutrient deficiencies in hay produced on 10 ABIP farms and the effects of providing the beef herds with balanced feed supplements based on the nutrient composition of the hay fed.

Experimental Procedures

University of Arkansas Cooperative Extension Service county agents and specialists consulted with 10 beef cattle producers located in 10 counties throughout the state to establish farm goals, inventory cattle herds, determine soil fertility and forage quality, and establish yearly management recommendations for these herds. To improve winter supplementation programs, nutrient composition was determined on 276 hay samples collected from 1992 through 1996 on 10 ABIP farms. Hay samples were collected for analyses before the hay feeding season. Samples were analyzed by the University of Arkansas Agricultural Diagnostic Laboratory.

In 1993, beef producers fed their herds hay and the same feed supplements they had used during previous years. In most cases, the supplemental feeds were primarily protein-type feed sources. From 1994 through 1996, the composition of hays produced on the farms was used to formulate least-cost, balanced supplements for the herds. In each herd, cattle were separated into groups based on the nutrient requirements of the animals.

[1]All authors are associated with the Animal Science Section, Cooperative Extension Service, Little Rock.

During the winter feeding period, cattle with low nutrient requirements were provided the lowest quality hay, and the highest quality hay was fed to the animals with the highest nutrient needs. The hay and a mineral supplement were fed on a free-choice basis. When needed to balance the ration, a feed supplement was provided. Generally corn, which is high in TDN content, was used to balance the rations. Very little, if any, protein was needed to balance rations for most of the herds.

Supplemental feed costs and calving percentage were determined from 1993 to 1996. Supplement feed cost was based upon an animal unit (AU) with an animal unit being equivalent to a 1,000-pound cow (last third of pregnancy). Nutrient requirements of dry and lactating cows (Table 1) were used to determine nutrient deficiencies in hays.

Results and Discussion

Bermudagrass, fescue, and mixed grass (mixture of cool- and warm-season species) hays make up most of the hay produced and fed to Arkansas beef cattle herds. Composition of 276 hay samples collected from 1992 through 1996 on the 10 ABIP farms is shown in Table 2. Average crude protein (CP) content of the hays ranged from 10.6% for mixed grass to 12.3% for fescue. Bermudagrass hays had the highest content and mixed grass had the lowest content of TDN on the average. Large differences existed in the ranges (lowest value to highest value) observed for both TDN and CP composition of the hays. These wide ranges indicate that a forage test is vital for determining the nutrient deficiencies of forage to prevent overfeeding or underfeeding cattle.

Traditionally, most cattle producers throughout the state choose a protein-type feed to supplement their forage. Seldom do they consider the TDN concentration of the feed supplement or of the diet. For purchased feeds, it is easier to obtain CP values than TDN values because CP is printed on feed labels. The TDN content of commercial feeds is not shown on feed labels because it is an estimated value obtained with prediction equations. Producers could use the crude fiber value shown on feed labels to estimate TDN content of feeds, but if the feed is diluted with minerals, urea, etc., those estimates are not valid.

Figure 1 and Fig. 2 show the percentage of the bermudagrass, fescue, and mixed grass hay samples that were deficient in CP and TDN for dry and lactating cows.

For dry cows (Fig. 1), only 6% (fescue and mixed) to 10% (bermudagrass) of the hays were deficient in CP, but 7% (bermudagrass) to 50% (mixed) of the hays were deficient in TDN. The TDN deficiency was also the most prevalent in hays for lactating cows with a range of 57 to 99% of the hays deficient. Results are similar to previous observations with limited forage analyses that indicate TDN is typically deficient in a higher percentage of hay produced in the state than is CP. Also, these results show the fallacy of assuming that average nutrient values of forages as those shown in Table 2 can be used to accurately balance rations for beef cattle. The average TDN value for mixed grass hay (Table 2) was 51.9% which is almost identical to the TDN requirement of 52.1% for dry cows. However, 50% of the mixed grass hay samples were deficient in TDN content for dry cows.

Mineral deficiencies in the hays for dry and lactating cows are shown in Table 3. As Table 1 indicates, the nutrient requirement for several of the minerals is the same for both dry and lactating cows. Therefore, the percentage of hays deficient in various minerals for dry and lactating cows was about the same except for magnesium and phosphorus. The magnesium requirement for lactating cows (0.20%) is almost twice that of dry cows (0.12%). Therefore, the percentage of hays deficient for lactating cows was greater.

Sodium was deficient in the highest percentage of the hay samples. Trace minerals - selenium, copper, and zinc - were also deficient in a large percentage of the samples.

Table 4 shows the winter feed supplement cost, calf crop percentage, and cost of beef production from 1993 to 1996 for the 10 ABIP farms. In 1993, ABIP producers used their traditional feed supplement program by providing primarily protein-type feed sources to cow herds. Feed cost that year was $48.19/AU. In 1994, least-cost feed supplements were formulated based on the composition of hays. Cattle were fed balanced rations and feed cost/AU decreased. By 1995, supplemental feed cost had decreased by 50% of the 1993 cost. Feed cost increased in 1996 due to the drastic increase in the cost of corn.

Calf crop percentage increased in 1994 and 1995. In general, cattle were fed more TDN and less CP. Also, cost/lb of beef produced declined from 1993 to 1996. The lower feed cost and improved calving percentage contributed to improved beef production efficiency which lowered cost of production.

Implications

Hay is highly variable in nutrient composition. For beef cows, TDN deficiency is usually more prevalent in hays than CP deficiency. A large percentage of hays may be expected to be deficient in sodium, magnesium (for lactating cows), selenium, copper, and zinc. A balanced, least-cost winter feed supplementation program, based on the composition of hay, should improve beef production efficiency.

Table 1. Nutrient requirements of diets for 1,100-lb beef cows.*

Nutrient	Dry, Gestating, 11 mo Since Calving	Lactating, 2 mo Since Calving, 20 lb Peak Milk
Dry matter, lb/day	22.5	26.4
Crude protein, %	7.7	10.9
TDN,%	52.1	60.4
Calcium, %	.25	.31
Phosphorus, %	.16	.21
Potassium, %	.60	.70
Magnesium, %	.12	.20
Sulfur, %	.15	.15
Sodium, %	.08	.10
Iron, ppm	50	50
Manganese, ppm	40	40
Zinc, ppm	30	30
Copper, ppm	10	10
Selenium, ppm	.10	.10

* All values except dry matter are shown on a dry matter basis.

Table 2. Composition of hays from 10 ABIP farms, 1992-1996.

Item	Item	Bermudagrass	Fescue	Mixed Grass	All Hay[1]
Dry matter, %	avg	85.8 (61)[2]	88.1 (18)	85.1 (140)	85.4 (276)
	range	70.2-93.5	80.5-92.9	60.4-93.8	54.3-93.8
	SD[3]	5.5	2.9	6.1	6.4
Crude protein, %	avg	11.1 (61)	12.3 (18)	10.6 (140)	11.2 (276)
	range	5.6-18.1	7.0-16.2	5.4-18.7	5.4-19.6
	SD	2.7	2.4	2.3	2.7
TDN, %	avg	59.1 (61)	56.3 (18)	51.9 (140)	55.1 (276)
	range	48.3-66.7	48.0-63.4	42.4-61.7	42.4-69.6
	SD	4.4	4.3	3.3	5.3
Calcium, %	avg	0.53 (55)	0.55 (16)	0.61 (114)	0.59 (223)
	range	0.17-0.96	0.28-0.74	0.23-1.35	0.17-1.43
	SD	0.16	0.14	0.19	0.20
Phosphorus, %	avg	0.28 (55)	0.29 (16)	0.30 (114)	0.29 (223)
	range	0.13-0.61	0.22-0.39	0.11-0.66	0.11-0.66
	SD	0.08	0.06	0.09	0.09
Potassium, %	avg	1.75 (55)	2.02 (16)	1.81 (114)	1.85 (223)
	range	0.79-3.40	1.09-3.09	0.61-5.03	0.61-5.03
	SD	0.57	0.51	0.68	0.63
Magnesium, %	avg	0.22 (55)	0.28 (16)	0.26 (114)	0.25 (223)
	range	0.12-0.46	0.18-0.45	0.13-0.47	0.12-0.47
	SD	0.07	0.08	0.07	0.07
Sulfur, %	avg	0.22 (55)	0.40 (16)	0.21 (114)	0.22 (223)
	range	0.14-0.39	0.18-2.99	0.12-0.44	0.10-2.99
	SD	0.06	0.69	0.05	0.19
Sodium, %	avg	0.03 (17)	0.01 (3)	0.03 (36)	0.03 (62)
	range	0.01-0.17	.01-.02	0.007-0.15	0.00-0.17
	SD	0.04	.0067	0.03	0.03
Iron, ppm	avg	214 (42)	195 (11)	261 (90)	231 (171)
	range	29-1037	79-653	56-3982	29-3982
	SD	170	163	445	342
Manganese, ppm	avg	204 (42)	213 (11)	202 (90)	197 (171)
	range	11-709	103-584	38-1125	11-1125
	SD	144	155	146	143
Copper, ppm	avg	10.6 (53)	9.4 (16)	10.2 (101)	10.2 (208)
	range	1.4-18.9	4.8-17.5	1.1-27.6	1.1-27.6
	SD	3.4	4.0	4.0	3.7
Zinc, ppm	avg	32.7 (42)	31 (11)	35.3 (90)	24.3 (171)
	range	17.8-66.5	19.9-55.5	15.4-184.5	15.4-184.5
	SD	12.5	10.6	19.7	16.3
Selenium, ppm	avg	0.060 (3)	0.017 (3)	0.086 (11)	0.085 (19)
	range	0.03-0.12	0.01-0.02	0.04-0.25	0.01-0.36
	SD	0.052	0.006	0.063	0.087

[1] All ABIP hays include the following species: bahiagrass, bermudagrass, bluestem, clover, fescue, johnsongrass, legume-grass mixture, mixed grass, native grass, orchardgrass, rye, ryegrass, sorghum-sudangrass, and wheat.
[2] Number of hay samples included in the average.
[3] Standard deviation.

Table 3. Percentage of ABIP hay samples deficient in mineral content for 1,100-lb cows.[1]

	Percentage of Deficient Hay Samples	
Mineral (No. samples)	Dry, Gestating, 11 mo Since Calving	Lactating, 2 mo Since Calving, 20 lb Peak Milk
Calcium (185)	3.2	4.9
Phosphorus (185)	5.4	12.4
Potassium (185)	0	0.5
Magnesium (185)	0	22.2
Sulfur (185)	5.4	5.4
Sodium (56)	92.9	94.6
Iron (143)	0.7	0.7
Manganese (143)	1.4	1.4
Zinc (143)	50.3	50.3
Copper (170)	56.5	56.5
Selenium (19)	73.7	73.7

[1]Bermudagrass, fescue, and mixed grass.

Table 4. Winter feed supplement cost, calf crop percentage, and cost per lb beef produced for ABIP herds, 1993-1996.

Year	Supplement Cost/AU, $	Calf Crop Percentage	Cost Per lb Beef Produced, $*
1993	48.19	85.6	0.54
1994	31.59	90.2	0.60
1995	24.32	96.2	0.43
1996	31.46	92.3	0.32

*Includes variable costs only.

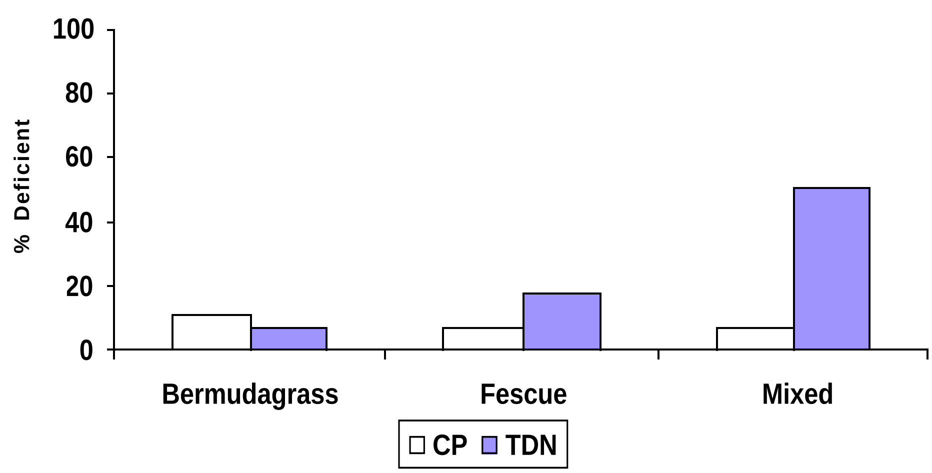


Fig. 1. Percentage of hay samples deficient in crude protein (CP) and total digestible nutrients (TDN) for 1,100-lb dry, gestating beef cows, 11 months since calving.

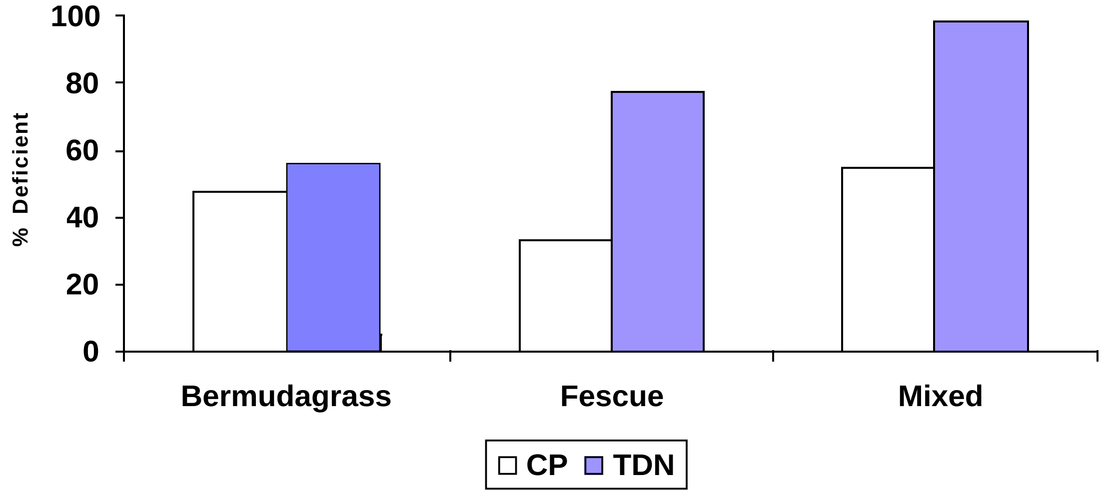


Fig. 2. Percentage of hay samples deficient in crude protein (CP) and total digestible nutrients (TDN) for 1,100-lb lactating beef cows, 2 months since calving, 20 lb peak milk.

Performance and Economic Comparisons Between Small, Moderate, and Large Cows Enrolled in the Arkansas Beef Improvement Program

Stan McPeake, Tom Troxel, William Wallace, and George Davis[1]

Story in Brief

Data from 643 cows and their calves were analyzed to compare the performance and economic efficiency of small- (<1,000 lbs), moderate- (1,000 to 1,200 lbs), and large-size cows (> 1,200 lbs). Cows were represented in both spring (n=478) and fall (n=165) calving systems. Cow size was significant ($P < .01$) for cow efficiency (adjusted 205-day weaning weight / cow body weight [BW]), adjusted 205-day weaning weight / animal unit, ratio of adjusted 205-day weaning weight to cow $BW^{.75}$ and break-even price (variable cow production cost / adjusted 205-day weaning weight of calf). No significant differences were found among different sized cows for adjusted 205-day weaning weight. Cows that calved in the spring had higher ($P < .01$) adjusted 205-day weaning weights, higher ($P < .01$) adjusted 205-day weaning weight / animal unit, and a lower ($P < .01$) break-even price compared to fall-calving cows.The interaction of cow size by calving season influenced adjusted 205-day weaning weight. These results indicate that spring calving is advantageous to fall calving when utilizing a winter hay feeding system. These results also imply as cow size increases, the break-even price increases. Cow size by calving season interactions indicate a need to consider the environment and production management system when selecting the appropriate cow size.

Introduction

Most cattle producers are interested in maximizing profits. Beef cattle producers basically market forage or grass and should, therefore, be interested in efficient forage utilization. Proper cow size or body weight (BW) has an impact on efficiency of utilization of the forage available. Proper cow size varies by environment depending on the amount and quality of available forage. Cow herd performance data utilized in the Arkansas Beef Improvement Program (ABIP) were analyzed to provide information on performance and economic comparisons between three cow sizes.

Experimental Procedures

Six hundred forty-three cow / calf pairs' records were analyzed to compare differences in performance levels and economic efficiency among different sized cows. Break-even cost was determined by dividing cow production cost by the adjusted 205-day weaning weight. Cow production cost was assigned to each cow based on average cow cost / animal unit within a year. Cow production cost was constructed from an enterprise budget that each ABIP participant reported yearly.

Included in the enterprise budget are variable cost items (Table 1); as well as fixed cost items. Average cow production cost / animal unit is presented in Table 2. Cows were assigned to BW groups as follows: small (<1,000 lbs), moderate (1,000 to 1,200 lbs) and large (>1,200lbs). Cow BW distributions are presented in Table 3. The data set included only cows that were three years of age or older.

Ten farms were utilized in this analysis. Cows were assigned to either spring (January through May) or fall (September through December) calving groups. Most farms had a wide range of calving dates, and calves were assigned to calving seasons based on birth dates. All cows used in the analysis were primarily of mixed-breed composition. Sire breed and individual sire effects could not be accounted for because of multiple sires breeding in one pasture on most of the farms.

General linear model procedures were used to analyze the data. Independent variables included in the models were BW group, sex of calf, county (herd), year, calving season, and appropriate two-way interactions. Least squares means and standard errors for each trait examined are presented.

[1] All authors are associated with the Animal Science Section, Cooperative Extension Service, Little Rock.

Results and Discussion

Performance and economic traits for small-, moderate-, and large-sized cows are presented in Table 4. There were no significant differences between cow size for adjusted 205-day weaning weight. Cow size was significant ($P < .01$) for traits associated with efficiency. Small-sized cows had greater cow efficiency than large-sized cows. Also, small-sized cows weaned more pounds of calf/animal unit than large-sized cows. Large-sized cows had lower ratios of adjusted 205-day weaning weight/cow $BW^{.75}$ indicating a lower efficiency. Small-sized cows also had lower break-even cost than large-sized cows.

Adjusted 205-day weaning weight, cow efficiency, pounds of calf weaned/ animal unit, adjusted 205-day weaning weight/cow $BW^{.75}$, and break-even cost were significantly ($P < .01$) affected by season of calving (Table 5). Spring-calving cows had higher ($P < .01$) adjusted 205-day weaning weights and cow efficiency than fall-calving cows; furthermore spring-calving cows had a higher ($P < .01$) ratio of pounds of calf weaned/animal unit and adjusted 205-day weaning weights/cow BW^{75}. Fall-calving cows had a higher ($P < .01$) break-even costs than spring-calving cows.

Adjusted 205-day weaning weight was significantly ($P < .05$) affected by the interaction between cow size and season of calving (Table 6). Among spring-calving cows, calves from large-sized cows had the highest numerical ranking for adjusted 205-day weaning weight followed by moderate-sized and small-sized cows respectively. However, among fall-calving cows, small cows had the highest ranking for adjusted 205-day weaning weight followed by moderate-sized and large-sized cows, respectively.

Implications

Spring-calving cows seem to have higher calf weaning weights and are more efficient than fall-calving cows. Large-sized cows may be at a larger disadvantage in a fall-calving season than smaller-sized cows. Cow size by calving season interactions indicate a need for considering the maintenance requirements of different size cows when matching cow size to forage quality and availability.

Table 1. Components of enterprise budgets.

Salt and mineral	Pregnancy test cost	Grazing lease cost
Supplemental feed	Bull cost	Fertilizer cost
Veterinary and medicine	Fertility testing bull cost	Lime cost
Growth implants	Replacement heifer cost	Hay cost
Fly control		Herbicide cost
Sale commission		Miscellaneous cost
Hauling cost		
Day labor		

Table 2. Distribution of herds by number of cows.

No. of Cows	Percentage
< 50 cows	48%
50-100 cows	36%
101-200 cows	14%
>200 cows	2%

Table 3. Cow weight group distributions.

Size	Average	Range	n
small	930 lbs	750 - 996	117
moderate	1101 lbs	1000 - 1200	358
large	1291 lbs	1202 - 1550	168

Table 4. Least squares means (+SE) for weaning and economic traits of small-, moderate-, and large-size cows.

	Cow Size			P value for
Item	Small	Moderate	Large	Cow Size
Adjusted 205-day weaning weight (lb)	481.1 ± 9.5	478.5 ± 6.4	491.8 ± 11.5	.58
Cow efficiency	51.0 ± .9	44.0 ± .6	38.8 ± 1.1	.001
Pounds of calf weaned/ per animal unit	497.5 ± 8.8	455.1 ± 6.2	424.1 ± 11.1	.001
Adjusted 205-day weaning weight/ cow body weight $^{.75}$	2.82 ± .05	2.53 ± .03	2.31 ± 2.31	.001
Break even costs($)[1]	.46 ± .01	.49 ± .01	.52 ± .01	.001

[1]Variable cow production cost/adjusted 205-day weaning weight of calf.

Table 5. Least squares means (+SE) for weaning and economic traits of spring- and fall-calving cows.

Item	Spring	Fall	P value
Adjusted 205-day weaning weight, (lb)	511.5 ± 6.6	456.1 ± 9.4	.001
Cow efficiency	46.9 ± .6	42.3 ± .9	.001
Pounds of calf weaned per animal unit	483.3 ± 6.3	434.4 ± 9.0	.001
Adjusted 205-day weaning wt/ cow weight $^{.75}$	2.69 ± .04	2.42 ± .05	.001
Break even costs ($)[1]	.46 ± .01	.52 ± .01	.001

[1]Variable cow production cost/adjusted 205-day weaning weight of calf.

Table 6. Least squares means (+SE) for adjusted 205-day weaning weight (lb).

	Season of Calving	
Cow Size	Spring	Fall
Small	496.5 ± 10.4	465.6 ± 13.9
Moderate	509.8 ± 6.9	447.2 ± 10.6
Large	528.2 ± 11.2	455.5 ± 16.6

Arkansas Dairy Farm Survey

Jodie Pennington[1], Charles Rosenkrans[2], Jr., Zelpha Johnson[2], C. Tarn[2], and M. Scott[2]

Story in Brief

A survey of Arkansas dairy producers indicated an average of 65.7 milking cows, 14.5 dry cows, and 44.9 heifers / herd. In the survey, owners were also managers on 97.4% of the farms, and owners averaged 47.4 years of age. Almost 75% of the farms had been in operation over seven years, averaged 1.5 people milking at one time, and hired the equivalent of .9 people to milk. Most of the employees (59%) were members of the family. During the owners' youth, 38% were involved in a 4-H program and 66% were involved in Future Farmers of America (FFA). Of the owners' children, 34% were involved in 4-H now or previously and 54% were involved in FFA. The type of educational programs most likely to be attended by herd owners varied considerably, but consisted of herd health programs including; mastitis control, ration balancing programs, methods to improve conception rate, financial information, and forage testing. The most common problems on farms were obtaining quality forages and solving financial problems. Heifers calved at an average body weight (BW) of 983 lbs, while milking cows averaged 1,241 lbs. The major breed on 92% of the farms was Holstein; while Jersey cows ranked second, being the major breed on 6% of farms and the second breed on 9% of the farms. Forty-one percent of the cows were bred artificially. Over 87% of the herds reported less than 10% retained placentas and less than 5% reported milk fever cases. On 90% of the farms, the cattle were maintained on pasture with trees for shade. Pasture was used by 70% of the producers for calving, plus 17% used a combination of pasture with box stall or dry lot for calving.

Introduction

A survey of Arkansas dairy farms was conducted to determine human resources, herd characteristics, and dairy management practices on the farms. The survey was to not only establish base-line parameters of the dairy industry in Arkansas, but also to obtain producers' opinions on their educational needs to determine why producers were or were not using the Dairy Herd Improvement (DHI) records. The survey could also be used to assess outcome of selected dairy extension programs such as production testing (DHIA) and youth programs.

Experimental Procedures

A 16-page survey was mailed in February through June of 1994 to all 749 Grade A dairy producers in Arkansas as of July 1, 1993. The survey contained 97 questions, including 7 questions with multiple parts, for a total of 110 responses. Questions were: (a) yes or no (b) short answers, or (c) check as appropriate.

Results and Discussion

Survey Response: Of the 749 dairy producers contacted, 450 (60%) returned the survey; 437 (58%) were used in the analyses. Average time to complete the survey was 23.7 ± 8.5 minutes. Younger producers completed the survey more rapidly than did older producers.

Personnel Characteristics: Owners were 47.4 ± 11.5 years old and 75% owned the herd for more than seven years (Table 1). Herd size averaged 65.7 ± 45.4 milking cows, 14.5 ± 127 dry cows, and 44.9 ± 55.3 heifers (Table 2). Of the herds surveyed, 97.4% were managed by the owner, 2.3% by a hired herdsman, and 0.2% by someone else. The average farm hired 0.8 ± 1.2 employees and had 1.4 ± 0.5 people milking at one time. Total full-time employees (not including the owner) were 0.6% ± 1.0 and part-time employees averaged 0.6 ± 1.1. Most of the employees (59%) were family members. Average gross income from milk and cull cow sales averaged $116,000 ± $60,000 and 12.9% of additional income came from supplemental part-time jobs. During their youth, 38% of producers

[1] Animal Science Section, Cooperative Extension Service, Little Rock.
[2] Department of Animal Science, Fayetteville.

were involved in 4-H, while 68% were in Future Farmers of America (FFA). Of the producers with children, 34% had their children in 4-H and 45% had had their children in FFA. Computers were used by 32% of producers (140 of 437). These computers were primarily used for financial and herd management information (Table 3). The primary reasons stated for not using a computer on the farm were; no need, could not use, or high cost (Table 3).

Herd Characteristics: Cattle were predominantly Holstein (Table 4). Most dairy cattle were maintained on pasture with trees, while 6.6% housed in free stalls (Table 5). Almost 70% of cows calved on pasture (Table 6). At calving, over 87% of producers had no or slight occurrences of retained placentas, while 90% had no or slight problems with milk fever (Table 7). Calves were introduced to grain at 10.9 ± 11.2 days and to hay at 25.3 ± 25.3 days. Heifer calves were weaned at 10.5 ± 9.1 weeks, while bull calves were weaned at 10.7 ± 5.8 weeks. Bull calves were raised by 60% of producers. Some producers had more than one type of housing for calves (Table 8). Heifers were first bred at 16.9 ±3.1 months and calved at 26.8 ± 3.8 months, with a BW of 983 ± 134 lbs. Average BW of cows in the milking herd was 1,241 ± 410 lbs. Of the milk cows, 41% ± 45% were bred artificially. Average dry period was 65.4 ± 23.7 days. Of herds responding to survey, 28.1 % were enrolled in DHIA . Table 9 includes the perceived advantages and disadvantages for not being enrolled in DHIA.

Management Practices: Management practices and feed for calves varied (Table 10), as did frequency of worming heifers (Table 11) and methods of fly control in heifers (Table 12). Management for heifer reproduction is shown in Table 13. Heat detection aids were used by 31% of producers, and the primary aids used (Table 14) were tail head chalking (79%) and Kamar heat patches (62%). Average frequency of estrus (heat) detection in cows was 2.5 ± 0.9 times / day (Table 15). Average time watching for heat was 40 ± 18 minutes / day (Table 16). Most producers observed for heat at milking time (Table 17). Of 54% of producers who utilized artificial insemination (A.I.), 83% inseminated cows themselves; 7% had used embryo transfer. Of the farms surveyed, 77% of producers kept at least one bull. The average purchase price for the bulls was $1,082 ±305; bulls were bought every 1.6 ± 2.1 years.

Grain or concentrate for milking cows was fed by 84% of producers in the milking parlors (Table 18). Producers balanced rations for milk cows (62%), dry cows (42%), and heifers (46%). Grass pasture was the primary forage (Table 19). Commodity feeds varied (Table 20). The most common waste management practiced was concrete lot with scraping (Table 21).

Education aspects: The most common problems on dairies were lack of forages and financial difficulties (Table 22). The types of educational programs most likely to attend varied considerably (Table 23).

Implications

This survey indicates the need for educational programs emphasizing quality forages; financial records, and factors, such as milk marketing and level of production that affect income on farm as well as continuing programs related to ration balancing; herd health, breeding, and other traditional dairy management areas.

Table 1. Age of owners and length of ownership for dairy farms.

Age	Percentage	Length of Ownership	Percentage
under 31	4.5%	< 1 year	1.8%
31-40	25.6%	1 - 2 years	5.3%
41-50	31.6%	3 - 4 years	9.7%
51-60	23.4%	5 - 7 years	8.3%
> 60	14.9%	> 7 years	74.8%

Table 2. Distribution of herds by number of cows.

No. of Cows	Percentage
< 50 cows	48%
50-100 cows	36%
101-200 cows	14%
>200 cows	2%

Table 3. Reasons for using or not using computers.

Number	Primary Reason for Use
57	Financial records
52	Herd management information
14	Herd too large to keep records by other methods
17	Other

Number	Reasons Why Not Used
162	I do not see a need at present time
127	I am not computer literate
107	Computers cost too much
45	I do not have the time
24	Other

Table 4. Breeds of dairy cattle in herds.

Major Breed in Herd	Percentage	Number	Other Breeds in Herd	Percentage	Number
Holstein	91.7%	39	Jersey	9.4%	41
Jersey	5.5%	24	Brown Swiss	5.5%	24
Brown Swiss	1.4%	6	Holstein	1.8%	8
Guernsey	0.5%	2	Guernsey	0.9%	4
Milking Shorthorn	0.2%	1	Other	6.6%	29
Other	0.7%	3	None	75.7%	331

Table 5. Type of shelter provided for cows.

Type	Percent Using	Number
Free stall	6.6%	29
Loose corral	8.5%	37
Stanchion	1.1%	5
Pasture with trees	91.5%	400

Table 6. Areas for calving.

Area	Percentage
Pasture (P)	69.8%
P + dry lot	8.4%
P + box stall	8.1%
dry lot	4.9%
P + other	2.3%
box stall	2.1%
other combinations	2.8%

Table 7. Health problems at calving.

Problems with Retained Placenta	Percentage
None (< 5%)	43.8%
Slight (5 - 10%)	43.6%
Moderate (11 - 20%)	9.5%
Severe (> 20%)	2.1%

Problems with Milk Fever	Percentage
None (0 - 2%)	43.4%
Slight (2 - 5%)	46.2%
Moderate (6 - 10%)	7.9%
Severe (7 - 10%)	1.8%

Table 8. Types of housing for baby calves.

Types of Housing	Percent Using	Number
Group pens	45.8%	200
Individual floor-level plans	28.1%	123
Hutches	27.5%	120
Other	6.9%	30
Raised stalls	5.0%	22
Tie stalls	3.9%	17

Table 9. Benefits of and reasons for not being a DHIA member

Main Benefits of DHIA
1st Individual cow production
2nd SCC data
3rd Reproductive records
4th Income over feed information

Not Being a DHIA Member
1st Cost of program (n = 148)
2nd Inconvenient to test (n = 93)
3rd Little information of benefit to producer (n = 3)
4th Lack of dependable supervisor (n = 39)
5th Other (n = 43)

Table 10. Management practices for baby calves and types of milk fed to calves.

Practice	Percent Using	Number
Colostrum within 6 hours	95.4%	417
Dip umbilical cord	38.5%	168
ID within 30 days	55.8%	244
Dehorn by 60 days	36.7%	160

Type of Milk	Percent Using	Number
Whole cow's milk	66.1%	289
Milk replacer	51.5%	225
Antibiotic milk	37.7%	165
Colostrum	36.2%	158
Mastitis milk	32.7%	143
Sour colostrum	6.2%	27

Table 11. Frequency of worming heifers.

Frequency	Percentage
Two times/year	59.5%
Once/year	23.3%
Three times/year	15.5%
Four times/year	1.5%
Five times/year	0.2%

Table 12. Methods of fly control in heifers.

Method	Percent Using	Number
Fly dust or powder	49.9%	218
Pour on	35.2%	154
Fly tags	27.9%	122
Other	14.4%	63
None	5.7%	25

Table 13. Management of heifer production.

Management Practice	Percent Using
Using A. I. in heifers	28.1%
Of producers using A.I. (n = 108)	
Heifers bred A. I.	74.4%
Using estrous synchronization	7.9%

Table 14. Heat detection aids.

Type	Percent Using	Number
Tailhead chalking	78.8%	73
Kamar heat patches	61.8%	39
Gomer bull	44.4%	9
Pedometer	50.0%	1
Milk progesterone test	16.0%	5
Electronic probe	0.0%	0
No aid used	98.1%	300

Table 15. Frequency of heat detection in cows[1].

Frequency	Percentage	Number
1 time	3.5%	13
2 times	61.5%	235
3 times	21.2%	81
4 times	8.2%	29
> 4 times	6.1%	23

[1] Average was 2.52 ± 0.93 times per day.

Table 16. Total time per day spent watching cows for heat[1].

Total Time	Percentage	Number
< 30 min	47.6%	176
30 - 40 min	30.5%	113
40 - 50 min	21.2%	22
> 60 min	8.2%	58
Other	6.1%	1

[1] Average frequency was 39.7 ± 17.7 times per day.

Table 17. When cows observed for heat.

When	Percentage	Number
At milking	88.3%	386
At feeding	62.0%	271
In between management practices	41.6%	182
Never	1.6%	7
Other	6.9%	30

Table 18. Location of grain feeding.

Location	Percentage	Number
Milking parlor	84.2%	368
Free-stall barn	2.3%	10
TMR	6.4%	28
TMR and barn	7.5%	33
Bunk and barn	11.7%	51
Other	3.7%	16

Table 19. Type of forage fed to (1) heifers and/or dry cows and (2) milk cows.

	Heifers and/or Dry Cows		Milk Cows	
Forage	(1)Percent Using	(1)Number	(2)Percent Using	(2)Number
Grass pasture	81.7%	357	70.2%	307
Fescue pasture	43.9%	192	35.2%	154
Bermuda pasture	52.6%	230	50.0%	258
Mixed pasture	66.6%	291	54.0%	263
Other pasture	5.7%	25	4.8%	21
Clover pasture	11.2%	49	15.8%	69
Sorghum-sudan pasture	6.6%	29	14.2%	62
Oak pasture	4.1%	18	6.6%	29
Wheat pasture	19.7%	86	31.4%	137
Milo pasture	0.2%	1	1.6%	7
Other	8.7%	38	15.6%	68

Table 20. Commodity feeds fed.

Feed	Percent Using	Number
Brewer's grains	6.9%	36
Hominy	4.8%	21
Maltlage	1.6%	7
Sprouts of some type	1.4%	8
Soybean hulls	9.6%	42
Cottonseed hulls	16.0%	70
Whole cottonseed	16.9%	74
Rice millfeed	4.1%	18
Rice bran	2.3%	10

Table 21. Type of waste management practiced at the dairy.

Type	Percent Using	Number
Concrete lot with scraping	81.5%	355
Loose housing and haul manure in manure spreader	42.1%	184
Lagoon	22.7%	99
Compost	10.1%	44
Concrete lot with flush system	9.8%	43
Other	5.7%	25
None	1.1%	5

Table 22. Producer ranking of biggest problems on the farm (ranking of 1 to 5).

Problem	Average Rank	Number Ranking First
Quality forages	2.16	102
Financial	2.17	86
Other	2.23	13
Mastitis	2.27	89
Breeding cows	2.32	77
Labor (personal)	2.67	37
Personal problems	3.09	19
Balancing ration	3.39	20

Table 23. Educational programs producers are most likely to attend (ranking of 1 to 3).

Program	Average Rank	Number Ranking first
Other	1.41	17
Herd health programs including mastitis control	1.51	205
Ration balancing	1.74	160
Financial information for dairy farm	1.82	140
Forage testing programs	1.83	140
Methods to improve conception rate	1.86	159
Use of records in the dairy operation	1.95	118
Calf raising programs	1.95	118
Housing and waste management	2.02	128

Dairy Herd Improvement (DHI) Herds in Arkansas

Jodie Pennington[1]

Story in Brief

In 1997, 74 herds supervised using Dairy Herd Improvement (DHI) records averaged 102 cows / herd, 15,988 lbs of milk / cow, 561 lbs of fat / cow, and 524 lbs of protein / cow, and 85% days in milk. Raw somatic cell count averaged 372,000. The value of milk sold / cow was $2,175; income over feed costs / cow was $1,171. Feed cost / cwt of milk was $6.31 with an average blend price of $13.59 / cwt. Nineteen herds on private records (unsupervised) averaged 85 cows / herd, 13,241 lbs of milk / cow, and income over feed costs of $1,225. For the 93 herds on either supervised or private DHI records, milk / cow averaged 15,504 lbs with 99 cows in the herd. The state average for milk / cow is 12,094 lbs / year. Herds not on DHI records average about 11,500 lbs compared to the 15,504 lbs for herds on DHI. This difference of approximately 4,000 lbs / cow annually affects income / cow by over $500 / cow or approximately $50,000 / year. Other records for health, reproduction, genetics, and inventory as well as production contribute to this difference in income / cow. Since less than 20% of the state's herds are enrolled in the DHI record-keeping program, opportunities exist for raising the level of milk production in the state by encouraging more producers to use DHI records.

Introduction

Successful dairy producers must have accurate and reliable records to make sound management decisions. The Dairy Herd Improvement (DHI) program provides a comprehensive herd analysis and management report that includes information concerning production, reproduction, genetics, herd health, animal and feed inventory, and finances. These data can be used to improve efficiency of milk production by (1) identifying least profitable cows for culling, (2) feeding for most efficient production, (3) selecting animals with the greatest genetic potential for production as replacements, and (4) utilizing summaries of data to make precise management decisions to improve net income.

Typically, herds on DHI produce 3,500 to 4,500 lbs, more milk annually than herds not on DHI. This difference in production has a significant effect on net income for the dairies, as greater net income / cow, and greater income over feed costs are associated with greater milk production / cow. The dairy herd summaries also allow a dairy producer to compare production, health, reproduction, and financial aspects of his dairy to other dairies, so that areas of management that need improvement can be detected.

Experimental Procedures

Dairy cattle herds on supervised test (n = 74) and private herds (n = 19) utilizing DHI records were tested every 37 and 40 days throughout the year, respectively. The test milking (or day) for each cow included weighing milk, taking a sample of milk to be analyzed for percent of fat, protein, and somatic cell count (SCC), plus recording of other management parameters as indicated in Table 1. Milk samples were analyzed at the Heart of America DHI Lab in Manhattan, Kansas. Records were processed at Dairy Records Management Services (DRMS) in Raleigh, North Carolina, for most of the year. Some of the records collected before May 1, 1997, were processed at Mid-States Dairy Records Processing Center (DRPC) in Ames, Iowa, during a transition period of switching all records to Raleigh, North Carolina.

Results and Discussion

Rolling herd averages for DHI supervised or private (unsupervised) herds are in Table 1. The weighted average milk / cow for the 93 herds was 15,504 lbs annually. Private herds had a greater income over feed costs than supervised herds in

[1]Animal Science Section, Cooperative Extension Service, Little Rock.

spite of less production / cow. This difference between private and supervised herds resulted from a greater milk price / cwt ($14.00 vs. $13.59) and lower feed costs ($633 vs. $1,004, respectively).The feed costs for this group of private herds were unusually lower than supervised herds, primarily because of lower forage costs reported ($213 vs. $607, respectively).

Table 2 shows the DHI averages for the different breeds of cattle and registration status for supervised herds. There were also two goat herds that averaged 64 does with 1,639 lbs of milk annually, 57 lbs of fat, and 49 lbs of protein. Averages for the does were $336 product value, $63 concentrate costs, $169 total feed costs, and $167 income over feed costs.

The 93 dairy cow herds reported in this report is less than the 110 herds that have been reported on DHI records through other summaries. No explanation can be given for the discrepancy, but it may have related to the transition from Mid-States DRPC to DRMS. Still, less than 20% of the 620 herds in the state were on DHI test. Herds on DHI averaged 15,504 lbs milk annually compared to the state average of 12,009 lb milk annually. Omitting DHI herds from the state average indicates that the non-DHI herds averaged less than 11,500 lbs milk / year. The difference of 4,000 lbs milk / cow annually affects income by over $500 / cow if the mailbox price of milk is $12.50, which is lower than the price reported for herds this year. This difference in milk income is $50,000 / year for a 100-cow herd.

Implications

Participation in the DHI program affords dairy producers an opportunity to maintain milk production records on individual cows as well as records of other management practices. Herds using DHI records averaged 15,504 lbs milk / cow annually compared to approximately 11,500 lbs / cow for herds not on DHI test. The University of Arkansas Cooperative Extension Service needs to continue encouraging producers to enroll in the DHI test program.

Table 1. 1997 DHI comparisons for herds in Arkansas.

Rolling Herd Averages	Supervised Herds n = 74	Private Herds n = 19
Milk, lb	15,988	13,241
Fat, %	3.5	3.5
Fat, lb	561	460
Protein,%	3.3	3.4
Protein, lb	524	456
Days in milk, %	85	79
Number cows/herd	102	85
Days dry	79	78
Peak test day milk, lb	68	63
1st Lactation, lb (index slightly)	56	40
2nd Lactation, lb (index slightly)	69	57
$\geq$ 3rd Lactation, lb (index slightly)	75	66
Projected calving interval, months	15.1	16.2
Raw SCC[a], count/mL (x1,000)	372	440
Linear SCC[a], count/mL	3.4	3.7
SCC[a], % $\geq$ 566,000	14	18
Services/conception - all cows	2.9	2.0
Services/conception - pregnant cows	2.0	1.5
Days to 1st service	94	47
Sire PTA[b], $	$76	$93
Service Sire PTA[b],$	$175	$179
Cows entering herd, %	35	28
Cows leaving herd, %	34	37
BW	1,190	1,170
Pound milk/lb grain	2.3	2.3
Feed cost/cwt milk (% of price)	$6.31	$4.81
Milk price/cwt	$13.59	$14.03
Forage costs/year	$607	$213
Feed costs/year	$1,004	$633
Income-over-feed/cow, $	$1,171	$1,225

[a] Somatic cell count.
[b] Predicted transmitting ability for dollars.

Table 2. DHI averages by breed of cow for supervised herds.

	Grades				Registered				All Cows				
Breed	# Cows	Milk	Fat	Protein	# Cows	Milk	Fat	Protein	# Cows	Milk	Fat	Protein	# Herds
Ayshire					10	11,336	414	364	10	11,336	414	364	1
Guernsey	21	13,514	538	469	58	13,033	525	462	79	13,161	528	464	1
Holstein	4,273	17,200	589	539	1,801	19,056	623	590	6,074	17,751	599	554	62
Jersey	193	11,619	525	433	310	13,003	559	480	503	12,472	546	462	4
Brown Swiss	10	14,632	535	506	137	15,633	536	537	147	15,565	536	535	2
Mixed	48	15,387	552	513	27	18,970	551	590	75	16,677	551	541	4

Managing Phosphorus Levels in Arkansas Pasture Soils to Improve Water Quality

Larry Sandage and Douglas Kratz[1]

Story in Brief

Arkansas ranks first in broiler production in the United States and produces approximately one million tons of litter annually. Studies have shown that dissolved phosphorus (P) concentration in runoff water appears to be related to soil test P. To address this environmental concern of water quality and stream eutrophication, a three-year forage / broiler litter application management field study was initiated. Two sets of site-specific best management practices (BMPs) were developed. One set of BMPs utilized practices to reduce soil test P levels on sites testing more than 300 lbs P / acre (high P). The second set of BMPs was developed to maintain acceptable soil test P levels on sites testing less than 150 lbs P / acre (low P) that received annual applications of litter. After two years of study, soil test P levels were reduced an average of 77 lbs / acre at high P sites using site specific (high P) BMPs. During the same time, three low P sites received an average of 2.5 tons litter / acre annually and soil test P levels were reduced by 5 lbs P / acre on average utilizing site specific BMPs.

Introduction

Broiler litter contains approximately 56 lbs of nitrogen (N), 21 lbs phosphorus (P), and 30 lbs of potassium (K) per ton (Chapman and Snyder, 1992). Forage yield improves markedly when N fertilizer is applied. Therefore, N content of litter has historically been used to determine its application rate. Plants remove N rapidly, but remove P more slowly from the soil. One ton of forage may remove 40 to 60 lbs of N but only 10 to 15 lbs of P (Ball et al., 1996). Soil test results from counties where litter applications have been applied annually reflect that 21 to 40% of the pastures tested had a soil test P value greater than 300 lbs / A which is considered high (Chapman, 1993).

Several field studies have demonstrated that dissolved P concentration in runoff water, which can lead to water quality and stream eutrophication concerns, appears to be related to soil test P (Sharpley et al., 1996). Demonstrations on changing soil P levels by using combinations of BMPs on a site specific basis based on soil P monitoring were conducted during 1996 and 1997.

Experimental Procedures

The first set of BMPs was developed to demonstrate how to lower the available soil P. Demonstrations on three fields whose P levels were above 300 lbs / acre were conducted (high P). One BMP was the use of forage species that may be considered phosphorus accumulators. Bermudagrass was chosen because there are roughly two million acres grown in Arkansas. Yields of 6 to 9 tons / acre of bermudagrass forage are achievable. Therefore, its propensity to remove P is comparatively great. A second BMP used was pasture over-seeding to maximize forage growth (and hence P removal) throughout a larger portion of the growing season. Rye, wheat, and ryegrass are examples of forage species that were used. The third BMP consisted of using commercial fertilizer rather than litter for N and K sources to maximize forage yield. By using plant species known to potentially remove the largest amount of P on that specific site and by encouraging stands of these species to produce large tonnages of forage over perhaps a 285-day growing season, the removal of 25 to 40 lbs P / acre annually from these fields was expected. The fourth BMP utilized the forage produced on high soil P sites as hay. The hay was fed on other pastures having moderate or low soil P levels to prevent recycling of P through the manure of grazing animals, back onto the high P soil.

The second set of BMPs was developed to demonstrate the use of soil P levels to determine whether poultry lit-

[1]Both authors associated with the Animal Science Section, Cooperative Extension Service, Little Rock.

ter can be applied to certain fields, and if so, at what rate. Best management practices were implemented on three littered fields with available soil P levels below 150 lbs / acre (low P). Best management practices were (1) the use of P accumulator and high-yielding forage species and (2) the application of poultry litter based on the P content of the soil, the P content of the applied litter, and the amount of P removed by forage (P budget).

A conventional 3-ft soil auger or soil tube was used for 0- to 6-in topsoil sampling. A modified version of the grid sampling design described by Wallenhaupt and Wolkowski (1994) was used for topsoil sampling. A hydraulically operated probe truck was used for deep 0- to 30-in sampling when soil structure permitted, otherwise hand augers were used. Topsoil samples were collected from March through May and September through October each year. An average of 45, 0- to 6-in samples were taken per field each fall and each spring. Deep soil samples were collected in September and October to reduce the masking effect of P mineralization over winter. Six permanently marked sampling points were used for deep sampling on each field. Five sub-samples were collected from a 2.75-square yard section at each of these six sampling points. This sampling design was used to reduce the interaction of location with available soil P contents measured each year. To determine whether true changes occurred in soil P levels over the three-year duration of this demonstration, topsoil samples were taken on approximately the same date (plus or minus three weeks) each year. Also, 0- to 30-in soil samples were collected each year from the permanently located sites within each field during a similar three-week period in the fall.

During the fall of 1995, soil samples were taken at all six demonstration sites to determine benchmark soil P levels (Table 1). A nutrient management plan for each site was developed and implemented for 1996. Bermudagrass was used as the base perennial forage at all three high P sites. Nitrogen and K were applied based on soil test recommendations coded for moderate to high levels of production. Rye was seeded with a no-till drill at the Pope and Howard County sites. No winter annuals were seeded at the Washington County site. All forage was harvested as hay and fed in another pasture at each demonstration site. Bermudagrass was also used as the base perennial forage at all three low P sites. Two tons of litter / acre were applied at the Washington County low site, 5.1 tons litter / acre at Pope County low site and only commercial N and K were applied at the Howard County low site. Forage at all three low P sites were used through grazing.

Soil samples were subsequently taken in the spring and fall of 1996. All soil, forage, and litter samples collected in 1996 were analyzed in December 1996. Best management practices for each site were re-evaluated in January 1997 after reviewing all 1996 sample data. Adjustments were made in litter application rates at the low P sites. Soil, forage, litter, and water samples collected for 1997 were sent to the University of Arkansas Diagnostic Laboratory for analyses. After 1997 results are received, BMPs for each site will be reviewed for 1998.

To ensure that precision was used in calculating P removed from the soil of each field by forages, three composite forage samples were taken from each hay harvest. Each of these composite samples consisted of five sub-samples taken from five large (approximately 1,000 lbs each) bales of hay. Average P values, from the three composite samples, were used in calculating P removal by the forage. All calculations were made on a dry matter (DM) basis. Moisture content of the hay was determined by weighing before and after drying all sub-samples in a forced air oven heated to a temperature of 55° to 60°C for 96 hours. Forage utilized by grazing was recorded from four randomly placed 4- x 8-ft wire panel cages that were used to restrict grazing. Forage from these cages was mechanically harvested every 30 days during the growing season and yield calculated on a DM / acre basis.

Poultry litter samples were taken by either randomly collecting six samples in the poultry house to make one composite sample or directly from the applicator truck. Samples were collected from the truck as applications were made to the pasture at six locations in the field. One composite sample was made for each field application. A 20- x 20-ft drop canvas was used as a catch-sheet to collect litter from three locations in the field to calculate actual application rates per acre.

One of the initial high P level fields was instrumented for the measurement of total runoff volume. This site is composed primarily of Johnsburg silt loam soil with a slope of 0 to 2%. Composite water samples from major storm events were collected and measurements of total suspended solids, ortho-P, and total-P were made. The selected field has topography that facilitates collection of runoff from within the field boundaries and the exclusion of runoff from outside the field boundaries. All runoff from this area was diverted through a flume equipped with a piezio-electric depth sensor and an automatic water sampler. After each storm event (approximately 15 / year), a flow weighted composite sample was prepared with sub-samples collected and prepared for analysis at the Arkansas Water Resources Laboratory. Recording of precipitation and stage from the flume was accomplished using an electronic datalogger. Data were downloaded after each storm event and processed to compute precipitation and runoff rates versus time for the duration of each storm event. Total runoff volume multiplied by the measured P concentrations in the runoff was used to estimate the transport of P from the field through surface water movement.

Sample procedures were used as described in Snedecor (1961). Available soil test P was monitored each year to measure the success of implemented BMPs in lowering or maintaining soil P levels. Phosphorus content of the soil, applied litter, rainfall runoff water from one high P site, and harvested forage were measured and used in developing a P budget for each field.

Results and Discussion

Analysis of the first two years of soil test data indicated available soil P levels were reduced at high P sites on average by 77 lbs / acre over two years. During the same time period available soil P levels were reduced at low P sites on average by 5 lbs / acre.

Results at the Howard and Pope County high P sites have been positive. Results at the Washington County high P site have not been as successful. Low forage yields were measured two years in a row at the Washington County site. Extreme drought and a very low soil K level were the two factors primarily responsible for these poor yields and subsequent low levels of P removal.

Results at the low P sites have been favorable. The Washington County site has retained the same soil P level even though an average of 2 tons of litter / acre was applied each year. The Pope County low P site has increased from 59 lbs P to 100 lbs P, which is very acceptable considering 7 tons of litter / acre have been applied during the past two years. The Howard County low P site was virtually 30 lbs available P / acre over the 150 lbs / acre criterion for low sites when this project began. This cooperator has lowered annual litter applications to 2 tons / acre starting in 1997. Soil test P is now at 127 lbs / acre.

Implications

Two years of data indicated that use of site-specific BMPs and soil P budgeting resulted in very acceptable responses at five of the six demonstration sites involved in this project. Continued soil P monitoring at these sites is warranted to record future trends related to the site-specific BMPs and P budgeting.

References

Ball, D. M., et al. 1996. Southern Forages. Potash and Phosphate Inst. and the Foundation for Agron. Res., p 82.

Chapman, S. L. and C. S. Snyder, 1992. Soils and Fertilizers Information Article 2-92. Cooperative Extension Service, University of Arkansas, Fayetteville.

Chapman, S. L., 1993. Soils and Fertilizer Article 1-93. Cooperative Extension Service, University of Arkansas, Fayetteville.

Sharpley, A., et al. 1996. Soil and Water Conser. 6:160-166.

Snedecor, G., 1961. Statistical Methods. Iowa State University Press, Ames, Iowa, p 490-517.

Wallenhaupt, N. C. and R. P. Wolkowski, 1994. Better Crops With Plant Food, Fall, p 6-9.

Table 1. Summary of soil P data 1995 - 1997.

	Soil P Levels (Grid Samples - Fall)			
Site	Fall 1995	Fall 1996	Fall 1997	Total P Change
Washington - high[a]	292	268	283	-9
Washington - low[b]	152	134	157	+5
Pope - high	521	456	415	-106
Pope- low	59	47	100	+41
Howard - high	389	270	272	-117
Howard - low	180	127	119	-61

[a] Total average change high sites -77 lb P/acre.
[b] Total average change low sites -5 lb P/acre.

Arkansas Beef Improvement Program
Whole Farm Project

Shane Gadberry, Tom Troxel, George Davis, William Wallace,
Stan McPeake, and John Jennings[1]

Story in Brief

From 1992 to 1996, the Arkansas Beef Improvement Program used 10 demonstration farms to identify management practices that increased the efficiency and profitability of beef production, in addition to educating Arkansas beef cattle producers regarding improved management practices. Implementing cost-effective management practices and cutting unnecessary costs reduced production costs 35.4% from 1993 to 1996. Mature cow/calf crop percentage increased from 85% in 1993 to 92% in 1996 helping increase the total pounds of beef sold/animal unit 10% from 1993 to 1996. Average gross margin was similar in 1996 ($99.60) compared to 1993 ($100.37) even though producers received $0.23/lb less for beef in 1996. And 5 of the 10 participating farms increased gross margin.

Introduction

The Arkansas Beef Improvement Program (ABIP) began in 1992 with a goal to increase the efficiency and profitability of beef cattle production in Arkansas. The program emphasized a decision-making process in which producers identified their goals and evaluated resources. Once a producer determined the goals of an operation and the resources available, cost-effective management practices were implemented.

The ABIP approached beef production with the Integrated Resource Management (IRM) philosophy of bringing together individuals specialized in different areas of beef production and management to assist the producer in identifying and implementing management technologies to reach farm goals. The specialist team consisted of Cooperative Extension Service specialists from the University of Arkansas, and a local county agent. The team met with participating producers annually to discuss farm goals and develop a plan of action to achieve those goals.

Experimental Procedures

The Arkansas Beef Improvement Program used participating farms throughout the state to demonstrate cost-effective management technologies. Producers were selected through an application process. The whole farm project required a five-year commitment by the producer.

Ten initial farms were selected from Boone, Columbia, Faulkner, Hempstead, Independence, Little River, Marion, Pike, Sebastian and Van Buren counties. The farms varied in size and scope. All farms were cow/calf operations; however, 3 of the 10 farms were purebred operations. Six of the farms completed their fifth year in 1996.

Data collected on the ABIP farms included soil tests, forage tests, cow/calf enterprise budget, pasture inventories, cow herd performance tests, blood and forage copper and selenium tests, a yearly production calendar, and special demonstrations. Recommendations to improve production were based upon collected data.

For comparison purposes, data collected in the enterprise budget were based upon an animal unit (AU) with one AU being equivalent to a 1,000-lb cow (last third of pregnancy). The animal unit value of an animal is determined by its metabolizable energy requirement. The metabolizable energy requirement of a 1,000-lb cow is 17.1 Mcal. The animal unit value of a 1,200-lb cow is 1.15 (19.6 / 17.1). Therefore, a herd of 100, 1,000-lb cows was equivalent to a herd of 87

---

[1] All authors are associated with the Animal Science Section, Cooperative Extension Service, Little Rock.

(100 / 1.15) 1,200-lb cows. The total number of animal units on an operation was calculated based on the January 1 herd inventory each year. Descriptive statistics, means, and standard deviations were used to summarize data.

Results and Discussion

One goal that was consistent across all 10 farms was to increase the gross margin of the cattle operation. Table 1 summarizes the results of the cow/calf enterprise budget from 1993 until 1996. During the first three-year period, like many cattle producers across the United States, ABIP farms were in an expansion phase. The average number of mature cows on ABIP farms increased 51.7%, and the number of animal units on the farms increased 13%.

ABIP producers averaged a 85% mature cow/calf crop in 1993. By culling unproductive cattle and supplementing the herd according to their nutritional requirements, calf crop percentage increased to 92% in 1996. Improved calf crop percentage also helped increase the total pounds of cattle/AU 10% from 1993 to 1996.

The average price/pound of cattle sold off ABIP farms decreased from 1993 ($ 0.75) to 1996 ($ 0.52). Lower cattle prices were most likely due to the cyclical increase in beef output across the United States. The 1996 price of cattle was also affected by elevated grain prices because of a poor corn crop in 1995.

Production cost decreased 35.4% from 1993 to 1996 across the 10 farms. By forage testing and developing a least-cost supplement based upon forage test results, supplemental feed cost/animal unit decreased from $48.19/AU in 1993 to $24.32/AU in 1995. Feed cost increased in 1996 to $31.46/AU at least, in part, because of higher grain prices. Replacement heifer cost decreased from $58.47/AU in 1993 to $5.49/AU in 1996. This reflected that the ABIP farms were about finished with the expansion of herd size. Money spent on grazing leases decreased on 4 of the 10 ABIP farms. Many producers found that leasing was not cost-effective when cattle prices were low.

In 1993, herd break-even cost on direct cow cost was $0.54/lb and calves sold for $0.75/lb, and resulted in a $0.21/lb return. By 1996, ABIP producers had eliminated unnecessary costs and reduced herd break-even cost to $0.37/lb. Although cattle prices dropped to $0.52/lb in 1996, decreased costs provided a $0.15/lb return. The gross margin/animal unit was similar in 1993 ($100.37) and 1996 ($99.60). If ABIP producers received the same price/pound of cattle sold in 1996 that was received in 1993, reduced costs and implementation of cost-effective management practices would have increased the gross margin/animal unit by $113.

Five of the 10 ABIP farms were able to complete their goal of increasing gross margin. If the price/pound of cattle sold was the same in 1996 as the price in 1993, 7 of the 10 farms would have accomplished their goal.

Implications

This analysis of results of the ABIP implementation on 10 Arkansas farms from 1993 to 1996 indicates that producers can improve their current production situation, by establishing goals for their operation and evaluating the resources available. Once goals and resources are identified, producers can determine which management technologies and practices will increase the opportunity to attain established goals.

Table 1. Summary of the production information, income, and expenses for the 10 ABIP farms from 1993 to 1996 (values shown are means ± standard deviation).

Production Information					
Item	1993	1994	1995	1996	4 - Year Average
Number of mature cows	55.3 ± 38.5	63.9 ± 43.2	71.2 ± 78.0	83.9 ± 73.4	68.6 ± 61.7
Number of animal units	109.6 ± 77.3	116.9 ± 71.1	126.0 ± 84.1	123.9 ± 89.5	119.1 ± 81.0
Mature calf crop percent	85.6 ± 10.7	90.2 ± 7.4	96.2 ± 1.9	92.3 ± 5.3	91.0 ± 8.1
Mature cow culling percent	19.2 ± 27.8	21.3 ± 11.6	9.6 ± 10.3	16.0 ± 22.1	16.6 ± 20.1

Production Income ($)					
Item	1993	1994	1995	1996	4 - Year Average
Total pounds of beef sold per AU	461.6 ± 160.5	455.7 ± 202.1	365.5 ± 153.6	507.1 ± 366.5	447.48 ± 242.39
Gross income per AU	347.00 ± 128.32	338.30 ± 173.70	217.50 ± 108.74	259.10 ± 161.48	290.48 ± 155.18
Price per pound received	0.75 ± 0.04	0.74 ± 0.12	0.59 ± 0.09	0.52 ± 0.07	0.65 ± 0.13

Production Expenses ($)					
Item	1993	1994	1995	1996	4 - Year Average
Salt and mineral	9.20 ± 8.00	9.84 ± 6.96	10.55 ± 9.66	8.43 ± 6.43	9.51 ± 7.90
Supplemental feed	48.19 ± 49.81	31.59 ± 11.86	24.32 ± 12.77	31.46 ± 16.69	33.89 ± 29.03
Veterinary and medicine	13.48 ± 8.46	11.80 ± 9.22	12.87 ± 12.78	10.39 ± 7.83	12.13 ± 9.83
Growth implants	0.21 ± 0.28	0.35 ± 0.36	0.51 ± 0.45	0.45 ± 0.45	0.38 ± 0.41
Fly control	1.74 ± 2.48	1.37 ± 1.93	0.65 ± 0.67	1.26 ± 1.23	1.25 ± 1.76
Sales commission	8.61 ± 5.18	11.02 ± 11.83	5.91 ± 5.07	8.72 ± 9.01	8.57 ± 8.47
Hauling	1.27 ± 1.21	1.90 ± 2.10	2.39 ± 5.06	1.00 ± 1.13	1.64 ± 2.91
Day labor	3.57 ± 3.61	7.31 ± 10.21	1.34 ± 2.02	2.89 ± 4.67	3.78 ± 6.37
Pregnancy test	2.04 ± 3.22	2.07 ± 5.29	0.62 ± 1.14	1.42 ± 3.54	1.54 ± 3.66
Bull	13.02 ± 18.19	6.64 ± 11.52	11.79 ± 19.83	3.38 ± 7.54	8.71 ± 15.61
Bull fertility test	0.42 ± 0.46	0.44 ± 0.51	0.24 ± 0.40	0.45 ± 0.56	0.39 ± 0.49
Replacement heifer	58.47 ± 119.73	77.46 ± 141.12	16.28 ± 35.08	5.49 ± 16.46	39.42 ± 99.05
Grazing lease	19.57 ± 19.70	25.04 ± 26.84	15.52 ± 22.48	16.20 ± 26.50	19.08 ± 24.35
Fertilizer	29.94 ± 25.01	37.65 ± 24.61	26.84 ± 23.55	34.47 ± 35.22	32.22 ± 27.82
Lime	0.00 ± 0.00	3.04 ± 5.09	3.92 ± 7.87	1.35 ± 4.06	2.08 ± 5.33
Hay	13.47 ± 15.33	25.56 ± 21.27	14.70 ± 17.68	22.03 ± 22.73	18.94 ± 20.11
Herbicide	4.40 ± 5.96	2.89 ± 3.60	3.07 ± 3.20	3.93 ± 5.63	3.57 ± 4.79
Miscellaneous	8.57 ± 6.94	14.40 ± 13.94	5.05 ± 6.29	6.06 ± 10.49	8.52 ± 10.55
Total cost per AU	246.70 ± 106.51	271.40 ± 202.23	156.64 ± 66.41	159.36 ± 65.71	208.53 ± 133.69

Return Over Specified Cost ($)					
Item	1993	1994	1995	1996	4 - Year Average
Herd break-even per pound	0.54 ± 0.11	0.60 ± 0.25	0.50 ± 0.26	0.37±0.19	0.50±0.23
Gross margin	13,068.07 ± 14,070.68	8,036.70 ± 13,013.11	13,690.08 ± 21,694.32	12,615.12 ± 12,175.08	11,852.49 ± 15,860.31
Gross margin[1]	13,068.07 ± 14070.68	7,258.99 ± 15876.19	22,035.30 ± 28,275.63	24,241.01 ± 18,264.24	16,650.84 ± 21,040.30
Gross margin/AU	100.37 ± 58.71	66.90 ± 110.81	60.94 ± 104.28	99.60±129.75	81.95±105.77
Gross margin/AU[1]	100.37 ± 58.71	73.87 ± 149.56	118.60 ± 120.67	213.37±206.17	126.55±153.25

[1]Value based on 1993 price per pound received.

Arkansas Steer Feedout Program 1996-1997

Tom Troxel, Shane Gadberry, Stan McPeake, and William Wallace[1]

Story in Brief

The objective of the Arkansas Steer Feedout Program is to provide cow/calf producers information about the postweaning and carcass performance of their calves. Steers that were composed of more than 50% English, less than 50% Exotic, and less than 25% Brahman breeding had a higher percentage grading Choice than steers failing to conform to the breed type requirement (73% vs. 32%). Dressing percentage, quality grade, average daily gain (ADG), percentage English breeding, medicine costs, backfat thickness, and feed cost/gain were significant factors that affected net return. With the information gained from this program, cow/calf producers can better evaluate the breeding program of their cattle.

Introduction

The University of Arkansas Cooperative Extension Service Steer Feedout Program allows producers to learn more about their calf crop and the factors that influence calf value beyond the weaned calf phase. The Steer Feedout Program is not a contest to compare breeds or breeders, and it is not a retained ownership promotion program. It creates an opportunity for producers to determine how their calf crop fits the needs of the beef industry and provides information needed to determine if changes in genetics and (or) management factors are warranted.

Experimental Procedures

During the week of October 7, 1996, entries from 109 ranches (1,097 head) were placed on feed at Randall County Feedyard at Amarillo. Steers came from Texas, New Mexico, Oklahoma, Arkansas, and Florida. Arkansas had 140 (13%) of the steers. The Steer Feedout Program was held in cooperation with the Texas A&M Ranch to Rail program to compare Arkansas steers with steers from other states. Upon arrival, steers were eartagged, weighed, and processed. Each steer was assigned a per hundred weight value based on current local market conditions by Federal-State Livestock Market News Service personnel. This served as a basis for calculating theoretical break-even costs and the financial outcome of the program. The steers were sorted into 11 feeding groups based upon body weight (BW), frame, condition, and biological type. Management factors such as processing, medical treatments, and diets were the same as the other cattle in the feedyard. Individual animals were selected for slaughter by the feedyard manager when they reached the BW and condition regarded as acceptable for the industry and market conditions. The cattle were sold on a carcass basis with premiums and discounts for various quality grades, yield grades, and carcass weights. Feed, processing, and medicine costs were financed by the feedyard. All expenses were deducted from the carcass income and proceeds were subsequently sent to the owner.

Results and Discussion

On the average, Arkansas steers had a higher net return ($22.71/steer) than the mean from steers from Texas, New Mexico, Oklahoma, and Florida (Table 1). The range in average returns per Arkansas ranch varied from $60.11 to $159.04/steer. No Arkansas ranch had an average negative net return.

The average off the truck BW for the Arkansas and remaining steers were 599 lbs and 624 lbs, respectively. The average daily gain (ADG) for the Arkansas steers was 2.95 lbs (range = 1.61 to 4.14). Feed cost/steer was similar for the Arkansas ($54.79/cwt.) and the remaining steers ($54.76/cwt.)

[1] All authors are associated with the Animal Science Section, Cooperative Extension Service, Little Rock.

which resulted in similar total cost ($60.25/cwt. and $60.22/cwt., respectively).

There was very little difference in carcass characteristics between Arkansas steers and the remaining steers. There was a tendency for the Arkansas steers to have a higher percentage grading Choice than the remaining steers (43% vs 35%, respectively). The higher percentage grading Choice was probably the major factor contributing to the higher net return of the Arkansas steers compared to the remaining steers ($99.57 vs. $76.86, respectively).

The breed type of each calf was separated into percent English, Exotic, and Brahman. It has been recommended that the ideal feeder calf should be at least 50% English, no more than 50% Exotic, and less than 25% Brahman. Using these guidelines, the Arkansas steers were separated into two groups (Table 2). The calves that fit the proposed breeding requirement graded 73% Choice compared with the calves that did not fit the breed requirement (32% Choice). After reviewing the data, there appears to be enough evidence to support the recommendation that market cattle should be composed of at least 50% English, no more than 50% Exotic and less than 25% Brahman.

There were seven significant factors that affected steer net returns. These factors are listed in the level of importance:

1. Dressing Percent. Dressing percent is determined by dividing the hot carcass weight by the slaughter weight times 100. Dressing percent is a function largely of fill and fat. Muscling, however, can also affect dressing percent. Thickness, depth and fullness of quarter, and width (without excessive fat) of back, loin, and rump are indications of muscling.

Muscling or natural fleshing is inherited through the sire and dam. The current USDA Feeder Cattle Grades use three muscle thickness scores (1 = slightly thick or thicker, 2 = narrow, 3 = very narrow). Thickness is related to muscle-to-bone ratio and at a given degree of fatness to carcass yield grade. Thicker muscled animals will have more lean meat. "Double-muscled" animals are included in the U.S. Inferior grade (unthrifty animals).

Although such animals have a superior amount of muscle, they are graded U.S. Inferior because of their inability to produce acceptable degrees of meat quality. The ideal calf should be Feeder Cattle Grade U.S. 1. Number 1 is thrifty and slightly thick throughout. They show a full forearm and gaskin, showing rounded appearance through the back and loin with moderate width between the front and rear legs.

2. Quality Grade. Cattle that graded Choice, Select, and Standard had an average net return of $143.19, $92.22, and $48.40, respectively. Marbling is the main factor that affects a steer's ability to grade Choice, and there are three main factors that affect marbling. These factors are: 1)a calf must have the genetic ability to marble 2)physiological maturity and 3) a high energy diet. Carcass characteristics such as marbling are highly heritable; therefore, selecting bulls with high marbling early progeny differences (EPDs) can impact the ability of their progeny to marble. Breed type can also influence a calf's ability to grade Choice. A calf with at least one-half English breeding has an increased probability of grading Choice.

The difference between physiological age and chronological age (measures of maturity) has to do with frame score. Large-framed cattle must be older (chronological) to reach the same physiological age needed to express marbling as compared to smaller-framed cattle. Therefore, feeding large-framed cattle results in excessive feeding and heavy carcasses.

Frame score is a convenient way of describing the skeletal size of cattle. The current USDA Feeder Cattle Grades utilize independent evaluations of three frame sizes (Small, Medium, and Large). These USDA Grades define a Medium-Frame feeder steer as projected to finish at 1,000 to 1,200 lbs. Frame score 5.0 slaughter steers are estimated to average 1,150 lbs at slaughter. Therefore, USDA Feeder Cattle Grade Medium is equal to frame scores 4 through 6, Small at frame scores 1 through 3, and Large at frame scores 7 through 9. The ideal calf should be between frame scores 4 through 6. That means at seven months of age the calf should be 42 to 46 inches tall at the hip.

Cattle are more likely to grade Choice when fed a high concentrate diet versus a high forage diet. Successful feedlots know how to feed cattle; therefore, the cattle diet is rarely a factor.

3. Average Daily Gain. Feedlot ADG was the third most important factor affecting net returns. Average daily gain should usually be above 3 lbs/animal/day. It can be improved by selecting sires with excellent yearling EPDs. This selection process should infuse additional growth potential resulting in a faster growing calf. Selecting bulls with high yearling EPDs will also increase birth weight and frame size. If calves are smaller than a Medium frame size (frame score 4 to 6) then increasing frame size would be necessary. Calves that are over conditioned (fat) when they enter the feedlot phase generally have lower ADG than calves in moderate body condition. This is one reason why fat stocker cattle are discounted. Many times these over conditioned calves are early maturing and short framed. In addition, calves also have a lower feedlot ADG than yearlings.

4. Percent English Breeding. As the percent English breeding increased net returns decreased. Steers can get too much English breeding which may increase backfat (see number 6). What also may be occurring is as English breeding increases, the advantage of hybrid vigor is reduced.

5. Medicine Cost. Healthy calves outperformed sick

calves. A good pre-conditioning vaccination program will not guarantee a healthy feedyard calf, but it is the best management tool available.

6. Backfat. Backfat is the number one factor that determines yield grade. Cattle that have excessive backfat at slaughter will be discounted.

7. Feed cost/gain. Feed cost/gain is inversely related to ADG. As ADG increase, feed cost/gain decrease.

Table 3 summarizes the performance and carcass data from the steers that were in the bottom 25% and top 25% (based on net returns) and the average of all the steers. There were five significant factors that caused steers to fall into the bottom 25% based upon net returns. They were feed cost, quality grade, dressing percent, medicine cost, and percent English breeding. In summary, the calves in the bottom 25% had higher feed and medicine cost, low dressing percent, and (or) failed to grade Choice. There were only three significant factors that placed steers in the top 25% based upon net returns. They had a higher yield grade, ADG, and (or) quality grade than the bottom 25%.

Steers that graded Choice had a net return of $143.19 compared with a net return of $81.81 for steers that did not grade Choice. Ninety-six percent of the Arkansas steers had a yield grade of 3.5 or better, and 99% of the steers had a hot carcass weight between 550 and 950 lbs. The steers within the carcass weigh slot limit had a net return of $110.72 as compared with a net return of -$44.03 of those that fell outside the acceptable limits. Comparing the steers that fit all three criteria (39%) to those that did not fit all three criteria, those that did fit had an average net return of $144.62 and those that did not fit had an average net return of $84.61. Therefore, steers that did it all – graded Choice, yield graded 3.5 or better, and had a hot carcass weight within the acceptable range (550 to 950 lbs) – had the highest return.

Implications

Extremes in net return, health costs, performance factors, and carcass parameters exist in the beef industry. A producer's goal should be to reduce these variables and produce a product that meets the needs of all segments of the beef industry. Value-based marketing at all levels of the industry is rapidly becoming a reality. Ranchers who produce a product that meets the demands will be more competitive in the marketplace.

Table 1. 1996-97 Steer feedout summary of financial results.

	Steers	
	Arkansas	Remaining Steers
Income	$770.72	$777.21
Expenses		
Feeder Steer Value	352.70	376.30
Feed	286.93	288.59
Medicine	3.61	4.64
Processing	10.46	10.46
Death Loss	3.71	6.56
Fees	1.40	1.40
Interest	7.20	7.26
Freight	4.50	4.50
Insurance	.64	.64
	$671.15	$700.35
Total Net Return	$99.57	$76.86

Table 2. Performance and carcass data of Arkansas steers that fit the breed requirement[1] and those that did not fit the breed requirement.

	Fit The Requirement	Did Not Fit The Requirement	Significance
Percent Grading Choice	73%	32%	P<.01
Yield Grade	2.54	2.38	NS[2]
Ribeye Area	12.4 sq in	13.7 sq in	P<.001
REA per 100-lb. carcass weight	1.72	1.86	P<.01
Average Daily Gain	3.19	2.90	P<.01
Dressing Percent	63.7%	64.1%	NS
Backfat	.47	.35	P<.001
Net Return	$117.68	$105.98	NS

[1]At least 50% English, no more than 50% Exotic, and less than 25% Brahman.
[2] Not significant.

Table 3. The performance of the bottom 25%, average and top 25% steers based upon net return.

	Bottom 25%	Average	Top 25%
Number of steers	34	137[1]	34
In BW, lb	580	600	595
Value/cwt.	$59	$59	$59
In value	$344	$354	$349
Muscle score	1.5	1.6	1.6
Frame score			
Large	71%	64%	50%
Medium	29%	36%	50%
Final BW, lb	1,045	1,1461	1,223
Average daily gain, lb	2.40	2.96	3.46
Gross income, $	$685	$778.76	$854
Hot carcass weight, lb	665	735	796
Dressing percentage	64	64	65
Interest	$7.61	$7.22	$7.07
Medicine	$7.29	$3.03	$ .72
Total feed cost/steer	$300.66	$288.48	$284.47
Total expense	$332.63	$315.78	$309
Net	$9.11	$109.23	$196
Days on feed	194	185	182
Feed cost/gain	$ .66	$ .54	$ .46
Total cost/gain	$ .74	$ .60	$ .49
Ribeye area, in[2]	12.9	13.3	13.7
Backfat, in	.30	.38	.40
Quality grade, %			
Prime	0	.7	3
Choice	15	43	74
Select	62	48	21
Standard	18	7	3
Dark cutter	6	1	0
Yield grade	2.2	2.4	2.6

[1]Three calves were not used in this data set. One calf died and the other two were railed.
[2]Ribeye measured in square inches i.e. in^2.

Changes over the Grazing Season in Crude Protein and Digestibility of Fertilized Bermudagrass

Glen Aiken[1]

Story in Brief

Bermudagrass is the most widely grown warm-season perennial grass in Arkansas. This popularity is, in part, due to its productivity when grown in well-drained soils with moderate fertility. A problem with bermudagrass, however, is that forage quality can decline substantially in the middle to late summer. Digestibility and crude protein (CP) of bermudagrass pasture were measured every two weeks during a two-year grazing study to relate changes in CP and digestibility with the nutrient needs of feeder steers. Nitrogen (N) fertilization was split applied to pastures each year at the start and middle of the experimental period. Crude protein was high (> 12%) in the early season, but quickly declined below values needed to maintain moderate weight gains. However, CP levels increased following the second application of N to acceptable levels. Digestibility steadily declined during both seasons and was consistently below a level that is required for moderate weight gain. Split application of N fertilizer kept CP above an acceptable level for most of the two seasons; however, low digestibilities in the middle to late summer indicate that animal performance on bermudagrass during this time is limited by inadequate energy.

Introduction

Animal performance on bermudagrass typically declines during the middle to late summer. Studies at Booneville have shown that the average daily gain (ADG) of feeder steers grazing common bermudagrass pastures can approach 2 lbs / day in the early growing season, but short-term ADG generally falls to less than 1.25 lbs / day between late June and August. Daily gains over the entire season average between 1.25 to 1.5 lbs / day. Although the summer slump in calf weight gains can be partially attributed to the adverse effects of high ambient temperature and humidity on forage intake, these climatic conditions can also negatively affect forage quality.

It is possible that feeding small amounts of supplemental grains could cost-effectively boost the ADG of calves on bermudagrass pasture, but studies are needed to determine the extent that protein and (or) energy of bermudagrass forage are deficient and further determine when these deficiencies occur during the grazing season. Therefore, digestibility and crude protein (CP) were monitored during a two-year grazing study with common bermudagrass. Pastures were grazed with variable stocking rates to maintain high forage availability (2500 to 3000 lbs dry matter [DM] / acre).

Materials and Methods

The grazing study was conducted in 1993 and 1994 near Booneville in northwest Arkansas. Three treatments (1 lb / steer / day of a protein supplement, 1 lb / steer / day of a protein supplement plus Bovatec®[2], or no supplementation) were assigned to six 1.7-acre pastures of common bermudagrass in 1993 and to nine pastures in 1994 in a randomized complete block design. Three tester steers were assigned randomly to each pasture (initial body weight [BW] = 625 lbs in 1993 and 587 lbs in 1994). Put-and-take steers were used to vary stocking rate in order to maintain total forage availability between 2500 and 3000 lbs DM / acre so that steer ADG would not be limited by low forage availbility.

Nitrogen (N) was split applied to the pastures at the start and midpoint of the study at a rate of 75 lbs N / acre. Fertilizer was applied on June 7 and August 12, 1993, and on May 10 and July 22, 1994. Phosphorus (P) and potassium (K) were not applied because soil tests indicated these nutrients were not deficient for moderate bermudagrass growth. Grazing was initiated on June 17, 1993, and May 27, 1994, and was terminated in both years after 112 days of grazing.

---

[1] USDA-ARS, Dale Bumpers Small Farms Research Center, Booneville.

[2] The use of trade names in this manuscript does not imply endorsement by the USDA or ARS of the products named, or criticism of similar ones not mentioned.

Forage samples were taken from each pasture within a week after placing steers on pasture and then at two-week intervals by clipping herbage from three randomly placed quadrats (194 in^2) to a 3-inch height. These samples represented the upper layer of the pasture that is readily accessible for grazing. The remaining forage was clipped to ground level to represent forage in the lower layer that is less accessible. Wet chemistry procedures were used to determine CP and in vitro organic matter digestibility on 25% of the samples. These analyses were used to develop calibration equations for estimating CP and in vitro organic matter (OM) digestibility for the remainder of the samples by near infrared reflectance spectroscopy.

Nutritive value data were averaged over treatments and replications, and analyzed for each forage canopy layer with a split plot in time model that evaluated year, the linear, quadratic, and cubic terms for days on pasture, and interactions between year and regression terms. Higher order terms were removed from the model if shown to be not significant ($P > .10$).

Results and Discussion

Seasonal trends for CP in upper and lower pasture layers were similar ($P > .10$) between the two years (Fig. 1). Crude protein in the upper layer was initially above NRC (1996) requirements for 600-lb steers gaining 1.8 lbs / day (9.5 %), but declined (linear: $P < .001$) towards the middle part of the season to deficient levels for that level of production. It did, however, gradually increase (quadratic and cubic: $P < .01$) to sufficient levels in the second-half following the second application of ammonium nitrate. Although CP appeared to be deficient for a part of the season, over the entire grazing season it averaged .4 percentage units higher than the animal requirement. The second application of ammonium nitrate apparently provided enough nitrogen to boost the CP status of the pastures above steer needs.

Crude protein in the lower pasture layer followed a similar trend over the season to that of the upper layer; however, CP was consistently lower than the animal requirements. Over the entire grazing season, CP in the lower layer averaged 1.3 percentage units lower than the specified NRC requirement. The lower layer contained primarily mature leaf and stem tissues that contain less nitrogen than the immature leaf that comprised the upper layer.

Seasonal trends in digestibility for the upper pasture layer were similar ($P > .10$) between the two years (Fig. 2). Digestibility declined gradually in the first half of the season, but stabilized or slightly increased in the second half (quadratic: $P < .01$). For most of the season, digestibility averaged 8.7% lower than the NRC requirement for total digestible nutrients (TDN) in 600-lb steers gaining 1.8 lb / day (60.0%).

Seasonal trends in digestibility for the lower pasture layer were different ($P < .10$) between the two years. Digestibility in 1993 declined linearly ($P < .05$) over the season, but in 1994 it stabilized in the latter part of the season. Low rainfall in July and August in 1993 (2.6 in.), as compared to 1994 (9.1 in.), probably reduced growth in this layer. Digestibility of forage in the lower layer was substantially lower than the previously specified requirement for TDN. Digestibility over the season averaged 13.3% lower than required. Low nutritive value of forage in this layer agrees with work by Aiken (1998) that showed reductions in CP and digestibility over time during the grazing periods for rotationally stocked paddocks of bermudagrass.

Protein supplementation in this study provided an increase in steer performance (Aiken and Brown, 1996), ADG being 1.34, 1.50, and 1.58 lbs / day, respectively, for no supplementation, protein supplementation, and protein supplementation plus Bovatec® treatments. Grigsby et al. (1989) also reported slight increases in steer ADG on bermudagrass pastures with various protein supplements. Aiken and Brown (1996) concluded, however, that the response to protein supplementation was probably because most of the protein supplement served as a source of energy rather than protein.

Implications

Split application of ammonium nitrate kept CP of the bermudagrass at levels close to those required for moderate weight gain. Bermudagrass digestibility declined to inadequate levels to support desired weight gains, indicating that energy is a major limiting factor in producing moderate steer weight gain on bermudagrass in middle to late summer.

References

Aiken, G. E. and M. A. Brown. 1996. Prof. Anim. Sci. 12:109-113.

Aiken, G. E. 1998. J. Prod. Agric. (in press)

Grigsby, K. N., F. M. Rouquette, Jr., W. C. Ellis, and D. P. Hutcheson. 1989. J. Prod. Agric.

NRC. 1996. National Academic Press. Washington D. C.

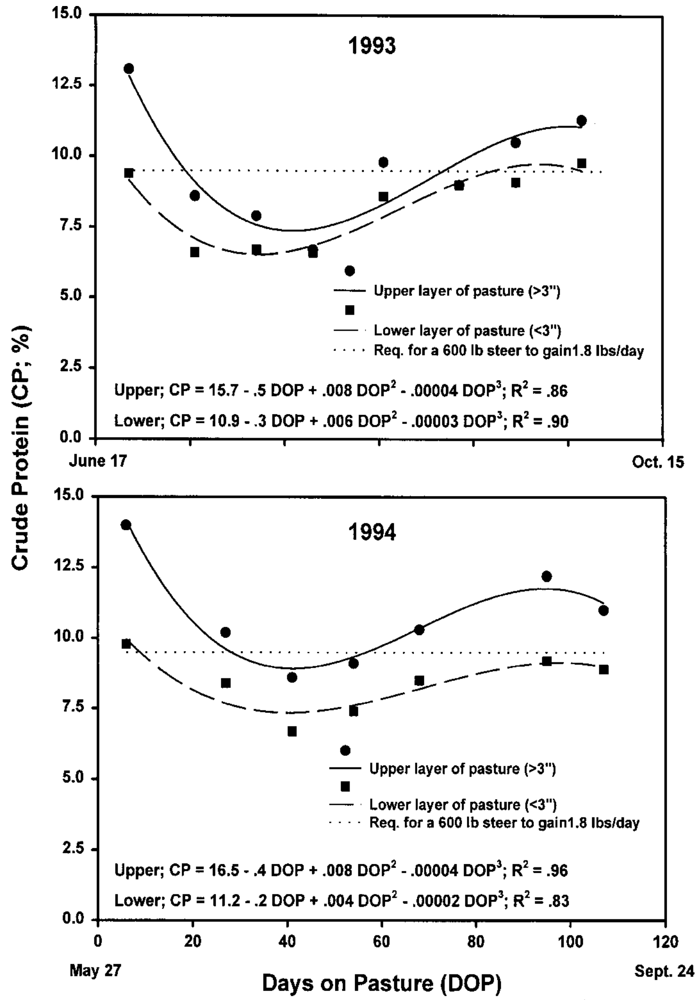


Fig. 1. Regressions (trends) between crude protein and days on pasture for the upper layer and lower layers of bermudagrass pasture in 1993 (grazing initiated on June 17) and 1994 (grazing initiated on May 29). A reference line shows the requirement for a 600-lb steer to gain 1.8 lbs/day (NRC, 1996).

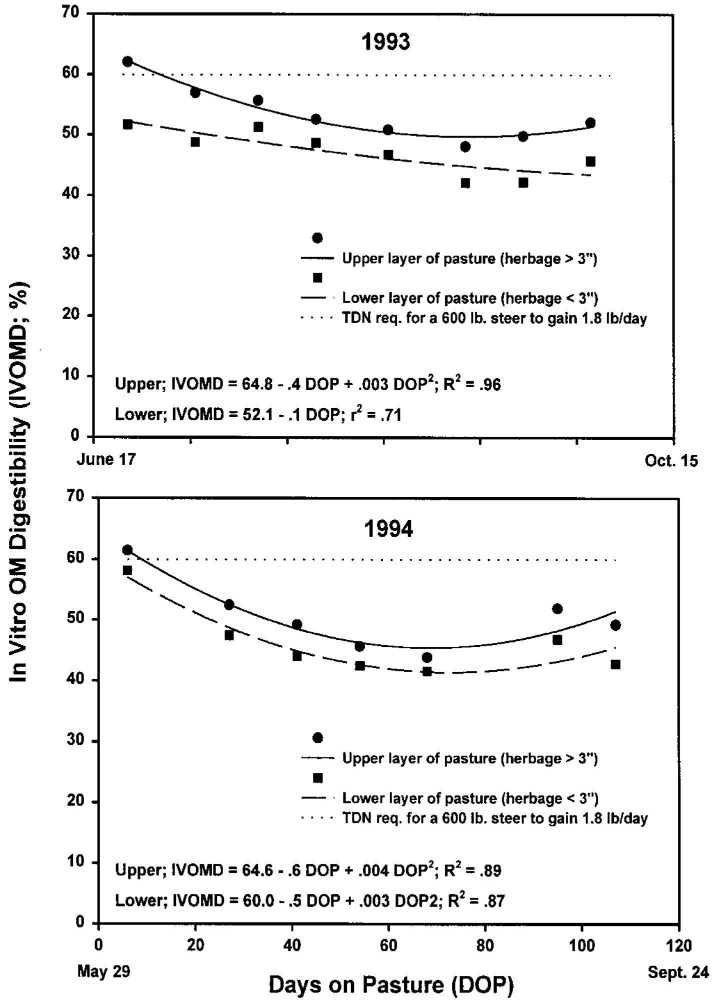


Fig. 2. Regressions (trends) between digestibility and days on pasture for the upper layer and lower layers of bermudagrass pasture in 1993 (grazing initiated on June 17) and 1994 (grazing initiated on May 29). A reference line shows the total digestible nutrients (TDN) requirement for a 600-lb steer to gain 1.8 lbs/day (NRC, 1996).

Evaluation of Stockpiled Bermudagrass After Hay and Pasture Summer Management

Wayne Coblentz[1], Ken Coffey[1], George Davis[2], and James Turner[1]

Story in Brief

Stockpiled 'Greenfield' bermudagrass was evaluated at two sites for forage availability, height, utilization, and quality between October 17, 1997, and January 9, 1998. At one site, forage was stockpiled following summer hay production and high nitrogen fertilization. At the second site, forage was stockpiled following a summer pasture management scheme with modest fertilizer inputs. Forage availability under cages reached a high of 9,319 lbs / acre on November 14 in the hay pasture; the maximum forage availability was 4,286 lbs / acre on January 9 in the pasture system. The relationship between forage availability and plant height for all forages was close ($r^2 = .80$). Slightly better relationships, however, were observed within sampling date ($r^2 > .83$). Crude protein and total digestible nutrient concentrations in all forages under cages exceeded the minimum requirements for dry mature cows (>900 lbs of body weight [BW]) at all sampling dates.

Introduction

Intensively managed bermudagrass hay has become an important cash crop for many producers in northwest Arkansas. Producers frequently utilize improved bermudagrass varieties coupled with short harvest cycles and heavy fertilization with poultry litter and (or) commercial products to maximize yields for hay production. There is increased interest in stockpiling fall growth of bermudagrass after this type of summer management providing both a forage source and alternative management option for wintering beef cows which relies less on stored forages.

A demonstration project was initiated in the fall of 1997 on the farm of Gary Proctor, near Lincoln, that evaluated stockpiled bermudagrass forage following two diverse summer management systems. One system utilized the intense summer management program with multiple hay harvests described below (hay management system), while the other system was based on modest applications of soil amendments and continuous grazing at a modest stocking rate throughout the growing season (pasture management system). The initial goal of this demonstration was to monitor the availability and utilization of stockpiled bermudagrass forage that had previously been managed under these diverse summer strategies. Additional goals were to (1) evaluate the relationship between plant height and forage availability and (2) evaluate the deterioration of forage quality occurred in response to dormancy, weathering, and grazing in the late fall and early winter.

Experimental Procedures

Hay Management System. A 12-acre hay meadow with a well-established stand of 'Greenfield' bermudagrass was selected for the demonstration. On March 25, one quart / acre of Gramoxone was applied to the site to provide control of grassy winter annual and broadleaf weeds. Poultry litter was applied at 2.5 tons / acre on May 2; this was followed by applications of commercial ammonium nitrate fertilizer (34-0-0) at rates of 300 and 150 lbs / acre on June 23 and August 18, respectively. On June 18, a first harvest of hay was removed from the site; the overall yield totaled 127 small square bales / acre (average weight 50 lbs at 90% dry matter [DM]) or approximately 5,715 lbs of forage DM / acre. Similarly, a second har-

[1] Department of Animal Science, Fayetteville.
[2] Animal Science Section, Cooperative Extension Service, Little Rock.

vest was made on July 26 that yielded 153 bales / acre (6,885 lbs forage DM / acre); therefore, the total amount of bermudagrass removed as hay (before stockpiling) was approximately 12,600 lbs of DM / acre.The forage was then stockpiled until October 18, when the grazing portion of the demonstration was initiated. On this date, 65 mature cows (average body weight [BW] = 1,200 lbs) and 25 calves (average BW = 300 lbs) were allowed to graze the stockpiled forage until December 15 (60 days). All cattle management decisions were left to the producer. Cows were supplemented at a daily rate of 2 lbs / head. The supplement was a mixture of 70% cottonseed meal and 30% salt.

Pasture Management System. A 14-acre pasture with a well-established stand of 'Greenfield' bermudagrass was selected for the companion demonstration. Producer inputs at this site included 2 tons of poultry litter / acre in mid-April and 200 lbs / acre of ammonium nitrate fertilizer (34-0-0) in late June. In April, grazing was initiated with 25 heifers (average BW = 650 lbs) and one bull (1,000 lbs). These cattle remained on the pasture throughout the study. Cattle were supplemented daily with 1 lb / head of a commercial grain mix.

Sampling. On October 17, a date that roughly coincides with the onset of fall dormancy for bermudagrass in northwest Arkansas, both pastures were visually subdivided into four blocks; forage availability at the initiation of both demonstrations was determined by clipping two 2.7-ft^2 frames at a representative site within each block. Cages (38 x 38 inches), which denied cattle access to stockpiled forage, were set in each block close to these representative sites. Forage was clipped with garden shears at ground level. As interest increases in pasture systems that require more management by the producer, the potential for estimating forage availability from plant height becomes increasingly important. Therefore, immediately prior to clipping, extended forage height (from the ground) was measured at three random points within each frame to determine the relationship between forage availability and plant height. On November 13, December 12, and January 9, one-third the measured area under each cage was clipped as described above. In addition, two 2.7-m^2 frames were clipped from a site located 30 feet from the cages in a direction (north, south, east, or west) randomly selected before clipping. Forage height was measured as described above prior to clipping inside and outside of each cage. Forages were dried to constant weight at 122°F and forage availability was subsequently reported as lbs of forage DM / acre. The amount of forage removed from the plot was calculated as the difference between forage availability inside and outside the cages. Percentage of forage utilization was calculated as (forage removed ÷ forage availability under the cages) x 100%.

Laboratory Analysis. All forages were dried as described and ground through a shear mill equipped with a 1-mm screen. Forages were analyzed for CP, neutral detergent fiber (NDF) and acid detergent fiber (ADF) by standard laboratory methods. The percentage of total digestible nutrients (TDN) was calculated from prediction equations developed for the Arkansas Agricultural Extension Service.

Statistics. The demonstrations were analyzed as a randomized complete block design with four replications, and harvest date was the treatment variable. Hay and pasture summer management sites were analyzed independently. Multiple observations within the same block were averaged prior to statistical analysis. In this demonstration, forage availability was related to plant height by appropriate linear regression techniques.

Results and Discussion

Forage Height, Availability, and Utilization. At the site with summer pasture management, plant height did not differ significantly ($P > .10$) inside the cages across harvest dates (Table 1). Pasture availability increased ($P < .10$) after the initial October 17 sampling date. This was likely related to both continued accumulation of bermudagrass DM during the first month of the study and presence of some actively growing contaminant broadleaf weeds and grasses, which were not present at the hay site. Outside the cages, plant height and forage availability decreased ($P < .10$) in response to grazing. No significant differences were observed across harvest dates with respect to estimates of total forage removed or forage utilization, although the trends observed were consistent with increased removal of available forage over time.

At the site with summer hay management, forage availability under the cages was high (>6,442 lbs / acre) reflected the heavy nitrogen fertilization (Table 1). Unlike the pasture site, there was little evidence of any contaminant species; therefore, the significant increase in forage availability under the cages between the first and second harvest dates likely reflected a true increase in bermudagrass DM. Forage availability and plant height declined significantly over time outside the cages, and forage utilization increased as well.

Relating Plant Height and Forage Availability. Flexible pasture management systems rely heavily on the ability of producers to quickly and easily estimate forage availability. The simplest method to aid producers in estimating forage availability is to measure plant height with a ruler and then convert inches of height to lbs / acre. Close relationships between plant height and forage availability would therefore provide a valuable tool for managing stockpiled bermudagrass. Linear regression analyses (Table 2) indicate that plant height is potentially a good predictor of forage availability. The slope for the relationship (Table 2; Fig. 1) indicated that there were 431 lbs of forage DM / inch of plant height in this study. The associated r^2

statistic indicated that 80% of the total variability in available forage was explained solely on the basis of plant height. It was evident that the linear relationship relating forage availability and plant height was poorest when plant height was highest. Specifically, this may have been related to leaf senescence, which did not change stem height, but reduced forage availability on a DM basis as the leaves of the plant were dropped to the ground. This was clearly demonstrated by the relatively poor fit (r^2 = .65) that was observed in the linear regression limited to forages clipped under cages. These ungrazed forages reached considerably greater plant heights (19.1 inches) than grazed forages at any date. When forages were grouped by harvest date, linear relationships improved substantially (r^2 = .83 to .96).

Evaluation of Forage Quality. For the pasture summer management system, ADF concentrations of stockpiled bermudagrass forage inside the cages increased ($P < .05$) about 12%; TDN concentrations declined from 62.5 to 57.2% over the same time period (Table 3). The CP and NDF concentrations did not change ($P > .05$). Similar responses over time were observed outside the cages. The TDN concentrations decreased by approximately 5% between November 14 and January 9 and ADF concentrations increased from 36.8 to 46.5% during the same time period. The CP and NDF concentrations did not change ($P > .05$).

For the hay summer management system, NDF and ADF concentrations increased ($P < .05$) in forage under the cages during the study. Respective increases were about 6 to 8%, indicating that the proportion of plant cell wall components increased in response to weathering. These changes were reflected in the estimated TDN levels for these forages, which declined ($P < .05$) from 64.3 to 56.5% over the 85-day study. Crude protein declined ($P < .05$) between October 17 (13.4%) and December 12 (11.9%), but the magnitude of these decreases was relatively small and concentrations of CP on the initial and final sampling dates were not different ($P > .05$). Although there was a general tendency for CP concentrations to decline over time, these responses indicate that CP concentrations are relatively stable in heavily fertilized stockpiled bermudagrass. This is consistent with the results of Taliaferro et al. (1987). In that study, several varieties of bermudagrass were stockpiled and evaluated for quality over the winter after high nitrogen fertilization management during the preceding summer. Similar variability across sampling dates was observed at several locations; however, CP concentrations remained high enough to meet the requirements of pregnant or nursing cows. The TDN and CP concentrations of all the stockpiled bermudagrasses under cages that were evaluated in our study exceeded the nutritional requirements of dry mature cows (>900 lbs).

Implications

Stockpiled bermudagrass under the cages maintained adequate forage quality to meet the nutritional demands of dry mature cows. This management scheme appears promising. However, this study did not evaluate dry matter intake by dry mature cows or animal performance. These considerations must be evaluated before a strong endorsement of this management scheme is possible.

References

Taliaferro, C.M., S.W. Coleman, and P.L. Claypool. 1987. Relative winter forage quality of selected bermudagrass cultivars. Crop Science. 27:1285-1290.

Table 1. Height, availability, and utilization of fall-stockpiled bermudagrass forage after hay and pasture summer management.

Summer Management	Harvest Date	Inside Cage: Plant Height	Inside Cage: Forage Availability	Outside Cage: Plant Height	Outside Cage: Forage Availability	Forage Removed	Forage Utilization
		inches	lbs/acre	inches	lbs/acre	lbs/acre	%
Pasture							
	October 17	6.4	2,740[b]	—	—	—	—
	November 14	8.0	3,973[ab]	4.8[a]	1,825[a]	2,295	46
	December 12	6.5	3,662[ab]	4.3[ab]	1,808[a]	1,854	50
	January 9	8.7	4,286[a]	3.2[b]	1,168[b]	3,118	69
	SE	1.5[1]	791[1]	0.7	326	1,040	20
Hay							
	October 17	12.1[c]	6,569[b]	—	—	—	—
	November 14	15.9[b]	9,313[a]	10.1[a]	4,116[a]	5,197	56[b]
	December 12	15.2[b]	6,642[b]	3.6[b]	1,541[c]	5,101	76[a]
	January 9[2]	19.1[a]	6,442[b]	3.9[b]	2,307[b]	4,135	63[b]
	SE	0.8[1]	653[1]	0.5	395	856	6

[a, b, c] Means in a column within a summer management system differ ($P < 0.1$).
[1] Analysis includes October 17 harvest date.
[2] Cattle removed following the December 12 harvest date.

Table 2. Linear regressions of forage availability (lbs/acre) on plant height (inches) for stockpiled bermudagrass.

Description	n	Slope	SE_{slope}	Intercept	$SE_{intercept}$	r^2
All forages	56	431	29	283	296	0.80
<u>By sampling date</u>						
October 17[1]	8	642	105	-1290	1023	0.86
November 14	16	663	37	-1617	393	0.96
December 12	16	431	35	225	312	0.91
January 9	16	295	35	982	387	0.83
<u>Grazed vs. ungrazed</u>						
Inside cages[2]	32	377	50	1123	627	0.65
Outside cages	24	400	38	134	210	0.84
<u>By summer management</u>						
Pasture system	28	484	48	-118	321	0.79
Hay System	28	403	49	681	620	0.72

[1]Forages were clipped on October 17 immediately prior to setting cages.
[2]Includes October 17 harvest date.

Table 3. Measures of forage quality for stockpiled bermudagrass.

Summer Management	Harvest Date	Inside Cage NDF	Inside Cage ADF	Inside Cage CP	Inside Cage TDN[1]	Outside Cage NDF	Outside Cage ADF	Outside Cage CP	Outside Cage TDN
		– – – – – – – – – – – – –	–	–	% of DM	– – – – – – – – – – – – – – –			
Pasture									
	October 17[2]	71.6	32.9[b]	13.3	62.5[a]	—	—	—	—
	November 14	70.7	34.0[b]	12.5	61.9[a]	73.5	36.8[c]	11.8	58.3[a]
	December 12	73.4	36.4[b]	13.2	59.9[ab]	75.4	39.3[b]	11.3	55.6[ab]
	January 9 71.4	45.1[a]	12.2	57.2[b]	73.4	46.5[a]	10.2	53.4[b]	
	SE	2.0	1.8	0.8	1.7	1.9	0.9	0.7	1.3
Hay									
	October 17[2]	69.9[c]	31.5[d]	13.4[a]	64.3[a]	—	—-	—	—-
	November 14	72.0[b]	33.9[c]	12.6[ab]	61.2[b]	73.8	37.1[b]	10.0[b]	56.4[a]
	December 12	75.7[a]	36.9[b]	11.9[b]	56.8[c]	75.2	44.4[a]	10.3[ab]	53.0[b]
	January 9[3]	75.8[a]	39.7[a]	12.6[ab]	56.5[c]	76.2	45.2[a]	11.6[a]	53.2[b]
	SE	0.8	0.7	0.5	0.9	1.4	0.4	0.6	1.2

[a, b, c, d] Means in a column within a summer management system differ ($P < 0.05$).
[1]TDN = 111.8 + 0.95 x (% CP) - 0.36 x (% ADF) - 0.7 x (% NDF).
[2]Forages were clipped on October 17 immediately prior to setting cages.
[3]Cattle removed following the December 12 harvest date.

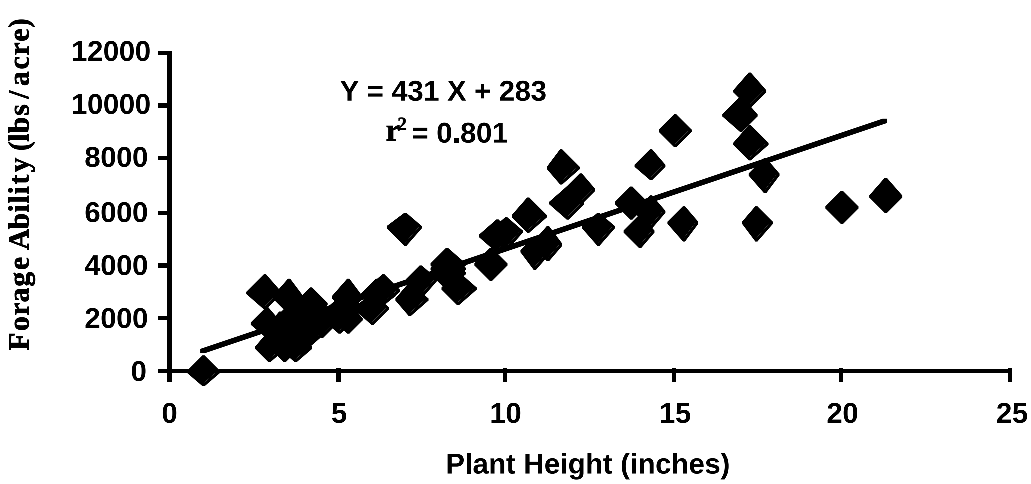


Fig. 1. Relationship between stockpiled bermudagrass height and forage availability (n=56).

Effect of Magnesium Sources on Performance by Stocker Cattle Grazing Wheat Forage[1]

Ken Coffey[2], Whitney Ratchford[2], Beth Kegley[2],
Don Hubbell[3], and Stacey Gunter[4]

Story in Brief

Forty-eight stocker steers (607 lbs) were offered supplements containing magnesium oxide (MgO), weathered Magnesium-Mica (WMM), unweathered Magnesium-Mica (UMM), or no additional magnesium (CONT) for 50 days while they grazed wheat pasture. Steer body weight (BW) gains did not differ ($P < .10$) among treatments. Serum magnesium (Mg) was lower ($P < .05$) and serum copper was higher from steers fed MgO but did not differ ($P > .10$) among those fed CONT, UMM, or WMM. All serum levels were within expected normal physiological ranges. Therefore, either WMM or UMM appears to adequately meet the supplemental magnesium needs for stocker cattle grazing wheat pasture. However, considering performance and serum Mg levels of steers fed CONT, supplemental Mg may not always be necessary for stocker steers grazing wheat pasture.

Introduction

Numerous winter and early spring programs for stocker cattle involve the use of winter annual forages to provide an excellent source of protein and energy while reducing feed costs. Wheat pasture is typically very lush and is rapidly digested. These types of lush forages typically have a preferential uptake of monovalent cations such as potassium rather than divalent cations such as magnesium (Mg); therefore Mg deficiencies may occur in cattle grazing these forages. Commercial minerals formulated for cattle grazing wheat pasture typically contain 4 to 14% Mg to insure that adequate amounts are presented to the animal to prevent grass tetany. This experiment was conducted to evaluate the potential of weathered Magnesium-Mica (WMM) and unweathered Magnesium-Mica (UMM) for maintaining adequate Mg levels and preventing grass tetany in stocker calves grazing wheat forage.

Experimental Procedures

Forty-eight mixed-breed stocker calves (607 lbs) were used in a 50-day grazing trial at the University of Arkansas Livestock and Forestry Branch Experiment Station near Batesville. Steers were received on February 5, vaccinated against eight clostridial strains, *Pasteurella hemolytica* and *multocida*, IBR, BVD, PI3, BRSV, and *Haemophilus somnus*, were dewormed with ivermectin, implanted with 36 mg zeranol, and were castrated and dehorned if needed. Following a 29-day receiving period, calves were assigned by weight to one of 12, four-acre wheat pastures, and rotated to a different pasture at 14-day intervals to reduce the impact of pasture variability. Each group of four calves was assigned randomly to receive one of four corn-based supplements. Supplements contained either no additional Mg (CONT), or WMM, UMM, or magnesium oxide (MgO); Mg fortified supplements were formulated to provide 6.1 g / head daily of additional Mg (Table 1). Supplements were fed at 2 lbs / head daily Monday through Friday. Calves were weighed on two consecutive days without prior removal from water and pasture at the beginning and end of the 50-day study and a single weight was measured on day 27. Blood was drawn via jugular puncture on day 0, 27,

---

[1] Appreciation is expressed to Micro-Lite, Inc., Chanute, Kansas, for donation of Magnesium-Mica and partial financial assistance, to Schering-Plough for providing zeranol implants, to Elanco Animal Health for providing monensin, and Ft. Dodge Animal Health for providing Synanthic dewormer.
[2] Department of Animal Science.
[3] Livestock and Forestry Branch Experiment Station, Batesville.
[4] Southwest Research and Extension Center, Hope.

and 50 for mineral analyses. Wheat forage samples were collected on day 0, 27, and 50 to determine available forage and for determination of various forage quality measurements.

Results and Discussion

No treatment x date interactions were detected (P<.10) for serum mineral concentrations. Therefore, only main effects are presented in Table 3. Serum calcium, potassium, or zinc concentrations did not differ (P > .10) among calves fed the four supplements and all concentrations were within normal ranges (Table 3). Serum Mg was lower (P < .05) and serum copper was higher (P < .05) in steers fed MgO than in steers fed the other supplements, however, none of the values were below acceptable levels. Body weight gain did not differ (P > .10) among treatments.

In the United States, grass tetany occurs more commonly in beef cows, and MgO supplementation has been reported to prevent this mineral imbalance. It is probable that growing calves under these conditions did not require Mg supplementation in addition to that provided through natural feedstuffs. This is supported by calves on control diets failing to show declines in Mg levels compared with calves fed Mg supplements. Therefore, none of the calves fed control supplements experienced signs of Mg deficiency, such as grass tetany, retarded growth, anorexia, or convulsions.

Magnesium-Mica (MM) contains high levels (4%) of iron. Concerns have been raised because of the possible effect of high iron levels on copper (Cu) absorption. Calves fed MgO had higher serum Cu concentrations than calves fed CONT, WMM, or UMM. Serum copper levels also decreased over time, which might have been due to declining forage copper levels over the grazing period. Normal serum levels range from 0.5 to 1.5 ppm for copper and 0.7 to 1.0 ppm for zinc. Serum concentrations for all calves were within these ranges. Considering this information, we conclude that higher levels of iron in Magnesium-Mica are not interfering with copper or zinc and should not be of concern during short-term feeding periods such as during the spring grass tetany season. However, longer term safety should be evaluated.

Implications

Because Mg supplementation is often necessary for cattle and sheep, particularly when grazing lush, green forages during early spring, producers should consider availability and cost of various Mg products. Magnesium-Mica is generally a less expensive source of Mg than MgO and has been shown to have similar availability when fed to ruminants. In this study, MM was substituted for feedstuffs having similar energy values without having a negative impact on animal gains. Therefore, when supplementation of Mg is necessary, MM may be used to replace MgO without concerns of low Mg availability or reduced animal performance.

Table 1. Ingredient composition of supplements offered to stocker calves grazing wheat pasture.[a]

Ingredient	Control[b]	MgO	WMM	UMM
Corn	90.3	89.0	82.35	84.65
MgO		1.2		
WMM			7.93	
UMM				5.63
TM Salt[c]	1.55	1.55	1.55	1.55
Dicalcium phosphate	2.53	2.65	2.53	2.53
Limestone	4.85	4.85	4.85	4.85
Molasses	.65	.65	.65	.65
Rumensin 80	.125	.125	.125	.125

[a] Ingredient composition is on an as-fed basis.
[b] Control = no added magnesium; MgO = magnesium oxide; WMM = weathered Magnesium-Mica; UMM = unweathered Magnesium-Mica
[c] TM Salt contained not less than 96% NaCl, 0.35% Zn, O.2% Mn, 0.2% Fe, 0.03% Cu, 0.007% I, and 0.005% Co.

Table 2. Nutrient composition (% of DM) of wheat pasture and magnesium supplements.

	Percent CP	Percent NDF	Percent IVDMD	Percent Mg	Percent Ca	(ppm) Zn	(ppm) Cu	(ppm) Fe
Supplements								
Control[a]	7.3	——-	91.0	.16	2.24	33.1	5.3	693
MgO	6.8	——-	90.7	.95	2.08	40.6	7.5	1210
WMM	5.9	——-	86.6	1.00	2.15	35.5	7.7	4940
UMM	6.2	——-	88.1	1.04	2.01	36.6	7.5	3820
Wheat forage								
3/6/97	27.8	39.7	91.3	.11	.42	22.4	7.5	95
4/2/97	15.1	51.9	74.0	.12	.34	17.2	5.3	127
4/25/97	12.7	59.4	60.1	.14	.47	17.4	4.6	431

[a]Control = no added magnesium; MgO = magnesium oxide; WMM = weathered Magnesium-Mica; UMM = unweathered Magnesium-Mica

Table 3. Serum mineral concentrations and pasture weight gain from stocker steers fed a either a low-magnesium control supplement or supplements with different magnesium sources while grazing wheat pasture.

Item	Control[a]	MgO	WMM	UMM	SE
Serum					
Mg, mg/dl	2.32[b]	2.22[c]	2.39[b]	2.33[b]	.034
Ca, mg/dl	9.86	9.77	9.90	9.95	.118
K, mg/dl	18.75	17.94	19.47	18.77	.425
Cu, ppm	.76[c]	.87[b]	.74[c]	.74[c]	.031
Zn, ppm	.88	.88	.90	.89	.033
Initial Wt, lb	607	605	608	609	1.4
Final pasture wt, lb	781	775	774	778	13.1
Gain, lb	174	170	166	169	12.9
Daily gain, lb	3.35	3.27	3.20	3.26	.248

[a]Control = no added magnesium; MgO = magnesium oxide; WMM = weathered Magnesium- Mica; UMM = unweathered Magnesium-Mica.
[b,c]Means within row without common superscript letter differ ($P < .05$).

Effect of Dried Molasses with Bermudagrass Silage for Dairy Cows

Venerand Nayigihugu, D. Wayne Kellogg, Zelpha B. Johnson, Michael L. Scott, and Karen Anschutz[1]

Story in Brief

Dried molasses was added to freshly chopped bermudagrass forage before ensiling to determine if the sugar would aid silage fermentation. The pH of all silage in 5-gallon containers decreased to below 4.0 by day 3 and stabilized at 3.7 after day 15; therefore inoculated grass silage was preserved well with, or without, molasses. Silage dry matter percentage increased with the addition of 4, 8, or 12% dried molasses. The protein content was not changed, but fiber content was reduced in silage with addition of molasses. In a second experiment dried molasses was added to bermudagrass silage before feeding to lactating Holstein cows. Milk production was similar for treatment groups and averaged 57.9, 52.1, 56.1, and 57.2 lbs / day for cows receiving 0, 4, 8, and 12% dried molasses in silage. Intake of silage was lower for the five cows fed 8% dried molasses (22 lbs / day) compared to controls (27.7 lbs / day), but the lower intake did not seem related to milk yield. There was no apparent advantage to adding dried molasses to bermudagrass forage, either at time of ensiling or at time of feeding silage.

Introduction

Fiber content is often higher in bermudagrass than in cool-season grasses. As a result of the high fiber content, dry matter (DM) intake, and digestibility of harvested bermudagrass by lactating dairy cows are reduced. Small amounts of readily fermented carbohydrates have improved intake and digestibility of fibrous feeds, although greater quantities of sugars and starches had the opposite effect and reduced digestibility of forages. Also ensiling grasses is difficult partly because low amounts of soluble carbohydrates limit microbial production of lactic acid and pH of grass silage remains higher than corn or sorghum silage. Recent improvements in microbial products to inoculate forages have made it easier to ensile grasses. Anderson and Jackson (1970) found that adding molasses to freshly chopped or wilted grass crops increased residual soluble carbohydrate content, but final pH was unaffected by molasses unless grass was wilted to 40% dry matter. The current experiments determined effects of adding molasses 1) to inoculated, fresh bermudagrass forage on nutrient composition during ensiling or 2) to silage prior to feeding on milk production of Holstein cows.

Experimental Procedures

'Greenfield' bermudagrass at the University of Arkansas Dairy Research Farm was the forage source for these experiments. The field had been sprayed with Ally (0.0038 lbs / acre) on March 23 to remove other plant species. On April 20 the bermudagrass received 250 lbs / acre of fertilizer (30 nitrogen [N], 60 potassium [K]). After first and second cuttings of hay (early June and July), another 150 lbs / acre fertilizer (34 N) was applied. In early August (1994), bermudagrass was cut and chopped (approximately 1-inch length). The fresh forage was inoculated (1.6 quarts / ton) with 1174 Pioneer® microbial product and mixed thoroughly in a mechanical wagon.

For Experiment 1, control (0% molasses) forage was removed and packed in three 5-gallon plastic containers that

[1] All authors are associated with the Department of Animal Science, Fayetteville.

were double-lined with polyethylene bags (0.025 mm thick). Vacuum (about 15 pounds / square inch) was applied using a milking machine vacuum pump, and the two bags were sealed separately. While mixing in the wagon, inoculated forage was treated with 4, 8, or 12% (dry matter basis) levels of dried molasses, and the treated forage was removed from the mixer wagon, and vacuum-packed in triplicate five-gallon plastic containers as described above. Each container was labeled and the weight of forage was recorded before storage in the laboratory at room temperature. Samples were taken initially (day 0) and on days 3, 5, 15, 33, and 60 after ensiling and after each sampling vacuum was again applied and laboratory silos were resealed. Forage samples were frozen after pH was determined. Dry samples were ground through a 1.0-mm mesh screen in a conventional Wiley mill and subdivided into 32 g amounts for chemical analyses. Crude protein (CP) was determined by using a Kjeltec analyzer. Neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose, and lignin were determined as described by Goering and Van Soest (1970). Amino acids were analyzed using an LKB 4400 amino analyzer on samples taken after 5, 15, and 33 days of ensiling. The general linear model (GLM) procedures of SAS (SAS, 1985) were used for analysis of variance using a split-plot design with repeated measures over time.

During Experiment 2, 20 Holstein cows in mid-lactation received inoculated bermudagrass silage from a concrete stave silo after about three months of storage. After a two-week adjustment period, the silage was top-dressed with 0, 4, 8, or 12% dried molasses. A grain mixture was fed according to milk production to meet nutrient requirements (NRC, 1989). Also, cows had access to a very limited amount of fescue in an exercise area. Intake of the molasses-silage mixture and yield of milk were weighed daily. Milk samples were taken after the adjustment period and at two-week intervals for analyses of fat, protein, solids-not-fat (SNF), and somatic cell count (SCC) determinations by the Heart of America Dairy Herd Improvement Laboratory (Manhattan, Kansas). Milk production data were averaged by weeks and analysis of covariance was used with preliminary means as independent variables (Federer et al., 1988) to adjust for initial differences among cows. Analysis of variance was used for other data. Means of SCC were converted to logarithm values before data analysis. Differences reported were significant ($P < 0.05$).

Results and Discussion

In Experiment 1, the laboratory silos produced typical silage based on observations of color and odor. The pH values were similar among containers as pH dropped from 6.0 at harvest (day 0) to 3.9, 3.7, and 3.6 on days 3, 15, and 60, respectively. There was no effect on pH due to addition of molasses, indicating that control conditions were adequate for the production of good silage. It was hypothesized that the soluble carbohydrates in molasses would enhance fermentation and the formation of acetic and lactic acids by bacteria; thereby, reducing pH more rapidly and / or keeping pH lower during storage. Apparently, inoculation of direct-cut bermudagrass with 1174 Pioneer® microbial product was sufficient treatment of the forage.

Although DM of silage changed less than 0.5% during storage days, DM was increased somewhat by each increment of dried molasses. After 60 days, silage was 32.3, 33.3, 34.1, and 34.5% DM for control, 4, 8, and 12% molasses treatments. Molasses addition decreased NDF (69.4, 68.9, 67.4, and 65.9%), ADF (35.6,35.0, 34.7, and 34.0%), and lignin (8.3, 8.1, 8.2, and 7.8%) content of silage for control, 4, 8, and 12% molasses treatments. The CP content of silage increased from 13.3 to 14.3% during 60 days of ensiling, but there was no change in CP attributed to molasses. Although CP content was similar for all molasses treatments, some amino acids varied as molasses increased. Glutamic acid content increased from 0.7% in control silage to 0.8% with 12% molasses, and the effect was consistent among the sampling dates. Alanine declined from 0.97 to 0.90% and threonine declined from 0.40 to 0.38% with 0 and 12% molasses in silage, respectively. Phenylalanine decreased (0.64, 0.51, 0.44 and 0.43% in silage with 0, 4, 8, and 12% molasses, respectfully) on sample day 5 of ensiling, but there were no differences observed on other sample times. The percentage of lysine and methionine in silage was not affected by addition of molasses. Nutritive quality of the bermudagrass was high, based on chemical evaluation, compared to typical bermudagrass forage (NRC, 1989).

In Experiment 2, there was no consistent trend observed in the intake of bermudagrass silage as levels of dried molasses increased. The intake of 22 pounds / day for the group receiving 8% molasses was lower compared to 28 pounds / day for controls, but did not appear related to milk yield. Milk yield was similar for treatment groups with 57.9, 52.1, 56.1, and 57.2 pounds / day for 0, 4, 8, and 12% molasses, respectively.The fat, protein, SNF, and lactose content of milk did not vary significantly among treatment groups.

Implications

There was no apparent advantage to adding dried molasses to bermudagrass forage, either at time of ensiling or at time of feeding silage. Molasses usually improves intake and digestibility of lower-quality roughage, but bermudagrass used in these experiments was higher in protein and lower in fiber content than typical bermudagrass.

References

Anderson, B.K., and N. Jackson. 1970. Conservation of wilted and unwilted grass in air-tight metal containers with or without the addition of molasses. J. Sci. Food Agric. 21:235.

Federer, W.T., M.P. Meridith, and Z.D. Feng. 1988. The analysis of covariance for split unit and repeated measures experiments using the GLM procedure in SAS / STAT software (part 1). SUGI 13, SAS Inst. Inc., Cary, North Carolina.

Goering, H.K., and P. J. Van Soest. 1970. Forage fiber analysis (apparatus, reagent, procedures and some application). In Agriculture Handbook 379. Agric. Res. Sci., USDA, Washington, D.C.

NRC. 1989. Nutrient Requirements of Dairy Cattle, 6th Revised ed. Nat. Res. Council/Nat. Acad. Sci., Washington,D.C.

SAS. 1985. SAS User's Guide: Statistics. SAS Inst., Inc., Cary, North Carolina.

Cooking and Shearing Methodology Effects on Warner-Bratzler Shear Force Values in Pork

Jason Apple, Lillie Rakes, and Butch Watson[1]

Story in Brief

Pork loin chops (6 chops / carcass) from a subsample of 50 carcasses were used to evaluate the effect of cookery method and shearing method on Warner-Bratzler shear (WBS) force values. Chops were weighed, cooked to an internal temperature of 160° F on either an electric, open-hearth grill or in a commercial convection oven, and reweighed. After a two-hour cooling period five .5-in diameter cores were removed parallel with the muscle fiber orientation, and sheared once through the center of the core with either: 1) a Warner-Bratzler machine; 2) an Instron Universal Testing Machine with a WBS device in compression; or 3) an Instron Universal Testing Machine with a WBS device in tension. There were no significant ($P > .05$) cookery method x shearing methodology interactions; however, chops cooked in the convection oven had lower ($P < .03$) shear force values than chops cooked on an open-hearth grill (6.13 vs. 6.63 lbs, respectively). Shear force values obtained with the Instron WBS device in compression were higher (7.95 lbs; $P < .0001$) than those from either the original Warner-Bratzler machine (4.16 lbs) or the Instron WBS device in tension (7.04 lbs). Furthermore, shear force values from the original Warner-Bratzler machine were lower ($P < .0001$) than those obtained from the Instron WBS device in tension. Cooking loss percentage was not ($P > .05$) affected by cookery method nor shearing methodology. Thus, shear force values for pork chops were affected by both cookery method and shearing methodology.

Introduction

The objective measurement of meat tenderness was the brainchild of K. F. Warner and his associates in the 1920's (Warner, 1952). Since its invention, researchers have shown that shear force values could be affected by core orientation with respect to muscle fibers, initial temperature at cooking, end-point temperature, core-removal methodology, heating rate, and chilling time after cooking (reviewed by Wheeler et al., 1997). Because of recommendations of the National Tenderness Conference (NCA, 1994), attempts are being made to standardize Warner-Bratzler shear (WBS) force methodology in order to reduce variation and improve repeatability among research institutions.

As technology advanced, many research institutions replaced the original Warner-Bratzler machine with a Warner-Bratzler shear force device attached to an Instron universal testing unit. Although information is available showing minimal effects of shearing methodology and cookery choice for beef steaks, a limited number of studies have tested the relationship of these factors on WBS force values for pork. Therefore, the aim of this study was to test the effect of meat cookery method and shearing methodology on Warner-Bratzler shear force values from pork.

Experimental Procedures

Pork chops were obtained from a subsample of carcasses from a study evaluating magnesium supplementation on growth performance and pork quality. Carcasses were allowed to age at 34° F for 10 days, and then a 10-in section of the longissimus muscle (LM) was removed posterior to the 10th thoracic vertebra from left sides of 50 carcasses. Starting at the anterior end of the LM, six 1-in thick chops were cut, wrapped in commercial freezer paper, and frozen at -20° F for two months before WBS force determinations.

Chops were assigned randomly to one of six treatments of a 2 x 3 factorial arrangement. Main effects included cookery method and shearing methodology. Chops were thawed for 16 hours at 34° F, then weighed and cooked to an internal

[1] All authors are associated with the Department of Animal Science, Fayetteville.

temperature of 160° F on either an electric, open-hearth grill (Sunbeam Products, Inc., Delray Beach, Florida) or in a commercial convection oven (Zephaire E model, Blodgett Oven Co., Burlington, Vermont). Endpoint temperature was monitored using a multichannel data logger with teflon-coated thermocouple. Each thermocouple was placed into the geometric center of each chop. Chops were turned once, at 80° F, during the cooking process. The differences between precooked and cooked weight were divided by the precooked weight to determine the percentage of cooking loss.

Chops were reweighed and allowed to cool to room temperature for 2 hours, and five .5-in diameter cores were removed parallel to the muscle fiber orientation with a mechanical coring device. Each core was sheared once through the center with either: 1) a Warner-Bratzler machine (G. R. Electric, Manhattan, Kansas); 2) an Instron Universal Testing Machine (110-lbs tension / compression load-cell) with a WBS device in compression (model 2830-013, Instron, Canton, Massachusetts); or 3) an Instron Universal Testing Machine with a WBS device in tension (model 2830-0002, Instron, Canton, Massachusetts). The original Warner-Bratzler machine was designed to shear at a crosshead speed of 229 mm / min; however, the measured crosshead speed of our machine was approximately 234 mm / min; therefore, the crosshead speed of the Instron was arbitrarily set at 250 mm / min. Moreover, most research institutions measure Instron WBS force in compression; however, the latest loadcells are programmed for both compression and tension measurements which facilitated using both types of WBS device in this study. Finally, the blade and design of the WBS device in tension more closely resembles the original Warner-Bratzler machine, which also is measured in tension.

Data were analyzed using the GLM procedure of SAS (1990) with a model that included cookery method, shearing method, and the cookery x shearing method interaction. Least squares means were separated statistically using the least significant difference procedure (SAS, 1990).

Results and Discussion

No significant ($P > .05$) cookery method x shearing methodology interactions were noted for WBS force values, raw and cooked chop weight, or cooking loss percentage. Cookery method had no ($P > .05$) affect on chop weights (neither raw nor cooked weight) or percent cooking loss. However, chops cooked in the convection oven had lower ($P < .0265$) shear force values than chops cooked on an open-hearth grill (6.13 vs 6.63 lb, respectively). Our results are contradictory to Wheeler et al. (1996) who found that when beef steaks from the LM or semitendinosus were cooked to a constant internal temperature of 158° F, no differences could be distinguished between broiling on open-hearth grills or broiling in a convection oven.

Raw or cooked chop weight, or the percent loss associated with cooking was not affected ($P > .05$) by shearing methodology. However, shear force values, obtained with the Instron WBS device in compression, were almost 3 lbs greater ($P < .0001$) than those obtained from the original Warner-Bratzler machine, and almost 1 lb greater ($P < .0001$) than shear force values measured with the Instron WBS device in tension. Furthermore, shear force values from the original Warner-Bratzler machine were lower ($P < .0001$) than those obtained from the Instron WBS device in tension. This information conflicts with results of Wheeler et al. (1994), who found no difference in WBS force values between the Warner-Bratzler machine and the WBS device attached to an Instron Universal Testing Machine.

Implications

Research has shown that, when degree of doneness is held constant, cookery method has little effect on WBS force values of beef steaks, yet results from the present study indicate that cookery method has a significant effect on shear force values for pork LM chops. The disturbing observation was the difference in shear force values obtained from the different shearing methodologies. Even if cookery and sampling protocols are standardized, variability in shear force values may remain between research institutions unless the shearing methodology is also standardized. Moreover, the difference between the present study and previous projects may dictate that a completely different set of standards be developed to measure shear force values on pork cuts.

References

NCA. 1994. National Beef Tenderness Conference. National Cattlemen's Assoc., Englewood, Colorado.

SAS. 1990. SAS / STAT® User's Guide (Version 6, 4th Ed.). Statistical Analysis Systems Institute, Inc., Cary, North Carolina.

Warner, K. F. 1952. Proc. Recip. Meat Conference. 5:156.

Wheeler, T. L., et al. 1997. Proc. Recip. Meat Conference 50:68.

Wheeler, T. L., et al. 1996. J. Anim. Sci. 74:1553.

Wheeler, T. L., et al. 1994. J. Anim. Sci. 72:2325.

Table 1. Warner-Bratzler shear force values and cooking loss percent as affected by either cookery or shearing methodology.

Item	WBS, lb	Raw wt, lb	Cooked wt, lb	Cooking loss, %
Cookery method[a]	6.63[c]	.36	.26	28.06
Grill	6.13[d]	.36	.25	28.55
Oven	.16	.005	.004	.38
Standard Error				
Shearing Methodology[b]				
Original	4.16[e]	.36	.26	28.55
Instron-compression	7.95[f]	.36	.26	28.57
Instron-tension	7.04[g]	.35	.25	27.80
Standard error	.20	.006	.005	.46

[a] Cookery method: grill = electric open-hearth grill, and oven = commercial convection oven.
[b] Shearing methodology: original = Warner-Bratzler machine; Instron - compression = Instron Universal Testing Machine with a WBS device in compression; and Instron - tension = Instron Universal Testing Machine with a WBS device in tension.
[c,d] Within a column, least squares means for cookery method lacking a common superscript letter differ (P < .0295).
[e,f,g] Within a column, least squares means for shearing methodology lacking a common superscript letter differ (P < .0001).

Influence of Body Condition Scores on By-Product Yields and Value From Beef Cows[1]

Jason Apple, J. Clint Davis, and Jerry Stephenson[2]

Story in Brief

Mature beef cows (n = 111) from the University of Arkansas Beef Research Unit at Fayetteville, and the Southwest Research and Extension Center in Hope, were weighed and assigned body condition scores (BCS), based on the 9-point scale, 24 hours before slaughter. By-product weights were obtained during the slaughter process, and percentage of body weight (BW) for each by-product was calculated. Slaughter weight and the weight of the hide, cheek meat, gullet, liver, oxtail, large intestines, and mesenteric fat increased as BCS increased from 2 to 8. Condition score 2 cattle had the greatest percentage of their BW as hide, skull, feet and hooves, and lungs. Body condition score 8 cows had lowest yields of head meat, and had a lower tongue yield than BCS 2, 3, 4, and 5 cows. Additionally, BCS 2 cows had the highest percentage and BCS 8 cows had the lowest percentage of their BW as edible by-products, feet and hooves, lungs, and large intestines. The percentage of mesenteric fat increased as BCS increased from 2 to 8. By-products from condition score 2 cows were the least valuable; by-product value was similar among cows assigned BCS of 3, 4, 5, and 6, and cows with BCS of 7 and 8 had the highest by-product value.

Introduction

Organs, fatty tissues, bones and blood make up approximately 39% of the body weight (BW) of young slaughter cattle (Goldstrand, 1988). Terry et al. (1990) conducted a comprehensive study investigating the by-product yields from young steers and heifers representing several different cattle types. More recently, Jenkins and Ferrell (1997) reported the weights of the heart, lungs, liver, kidneys, rumen complex, and small intestine from mature cows, yet no comparisons were made between body condition scores (BCS) or beef cattle breeds.

Beef by-products are an economically important contribution to the beef industry. Exports of edible by-products totaled approximately $334 million in 1986 (Johnson, 1988). Moreover, Goldstrand (1988) estimated that the value of the edible and inedible beef by-products accounted for between 9 and 11.5% of gross farm value in the U. S., and between 7 and 12% of the income from slaughter. Very little is known, however, about yields and value of by-products from cows culled from breeding herds. Therefore, the objective of this study was to determine the effect of BCS on by-product yields and the value of these by-products from culled beef cows.

Experimental Procedures

One hundred eleven mature beef cows from the University of Arkansas Beef Research Unit at Fayetteville and the Southwest Research and Extension Center at Hope, were weighed and assigned BCS, based on the 9-point scale of Wagner et al. (1988), 24 hours before slaughter. By-products weights were obtained during the slaughter process, and included blood, feet (with hooves attached), oxlips, tongue, gul-

[1] The authors would like to express their sincere appreciation to the Arkansas Beef Council for financial support of this project. Additionally, the authors would like to thank Pete Hornsby and Gary Murphy for care of cows and assigning body condition scores, and Sherry Beaty, Lillie Rakes, John Hankins, Jesse Davis, Buck Boger, Chris Boger, and Denise Moore for assistance in cattle harvest, carcass fabrication, and data collection.

[2] Department of Animal Science, Fayetteville.

let, trachea, cheek meat, head meat, skull, tripe, honeycomb-tripe, large and small intestines, spleen, mesenteric fat, weasand meat (esophagus), kidneys, heart, lungs, and oxtail.

Blood was recovered during exsanguination by placing a large container under the animal for approximately 5 minutes. Foreshanks were removed at the metacarpal bones and the hindshanks were removed at the tarsal bone joint separating the metatarsal and the tibia. The hide was manually removed on a hiding-cradle. The head was removed between the axis and atlas joints, and presented for FSIS inspection. The tongue was then removed from the head at the root, and the epiglottis (gullet) was also removed. The head was reduced into its parts by removing the masseter muscle (cheek meat) and oxlips, and the rest of the lean removed from the skull was head meat.

The muscular tissue surrounding the esophagus (weasand meat) was removed, and the stomach was separated from the remainder of the viscera by cutting between the anterior end of the duodenum and the posterior end of the abomasum. The stomach compartments (rumen, reticulum, omasum, and abomasum) were split and all contents were removed. The reticulum (honeycomb-tripe) was separated from the rumen at the rumenoreticular groove, and the remainder of the rumen-complex (tripe) were cleansed with high-pressure, hot water. The small intestine (duodenum, ileum, and jejunum) was removed from the large intestine at the ileo-cecal valve, and the large intestine (consisting of the cecum, colon, and rectum) was removed at the posterior end of the rectum. Mesenteric fat surrounding the digestive tract was removed, washed, and weighed. The liver was removed from the viscera by severing the posterior vena cava and hepatic veins at the base of the liver. The gall bladder was removed at the cystic duct connecting the gall bladder to the liver and discarded. Kidneys were removed by cutting the ureter and renal vein and artery at the base of their attachment.

The heart was separated from the pluck by removing the pericardium surrounding the heart, then severing the superior vena cava, aorta, and pulmonary arteries; the heart was split in order to facilitate FSIS inspection of the interior chambers. The trachea was removed posterior to the epiglottis, and separated from the lungs approximately two inches anterior to the main bronchi. Finally, the switch of the tail was removed near the 16th coccygeal vertebra, and the oxtail was separated from the carcass at the intervertebral disk between the fifth and sixth sacral vertebrae.

Each by-product was weighed during the slaughter process, and yields were calculated as a percentage of the animal's BW taken 24 hours before slaughter. Prices used for calculating the value of by-products were obtained from the USDA National Carlot Meat Report (USDA, 1997). By-product values were computed by multiplying the weight of each piece removed during the slaughter process by the 1997 average price. All data were analyzed by one-way analysis of variance using the GLM procedure of SAS (1990), with BCS as the main effect. Least squares means were separated using the least significant difference procedure (SAS, 1990).

Results and Discussion

Live BW increased ($P < .05$) from 838-lb cows with a BCS of 2 to 1403 for BCS 8 cows (Table 1). Hide weights and hide weights expressed as a percentage of BW, are reported in Table 1. Hide weight increased ($P < .05$) as BCS increased from 2 to 8; however, cows with a BCS of 2 had a higher ($P < .05$) percentage of their BW as green hide than cows with BCS of 3 or greater.

Weights and percentages of various by-products from the head are reported in Table 1. Condition score 8 cows had higher ($P < .05$) cheek meat and gullet weights than cows with a BCS of 7 or less; however, the percentage of gullet was similar ($P > .05$) among all BCS. Although there were no differences ($P > .05$) in the weights of the skull, head meat, oxlips, and tongue among BCS, condition score 2 cows had a higher ($P < .05$) percentage of their BW in skull and tongue than cows with a BCS of 4 or higher. In addition, BCS 8 cows had the lowest ($P < .05$) percentage of head meat when compared to all other BCS.

Edible by-product weights and percentages are listed in Table 2. Condition score 7 and 8 cows had heavier ($P < .05$) liver and oxtail weights than all other BCS, but there were no differences ($P > .05$) when liver and oxtail were expressed as percentages of the BW. In general, percentages of tripe, honeycomb-tripe, kidneys, and heart increased ($P < .05$) as BCS increased from 2 to 8. No differences ($P > .05$) were noted between BCS for the weight or percentage of weasand meat. Our results are consistent with those of Jenkins and Ferrell (1997), who showed that as feed intake and BCS increased, so too did the weight of the heart, lungs, liver, and kidneys from mature cows.

Weights and percentages of inedible beef by-products from culled beef cows are presented in Table 3. Blood comprised between 2.47 and 3.35% of the live weight of beef cows in this study. In addition to blood weight and percentage, BCS had no ($P > .05$) effect on either weight or percentage of trachea, small intestines, or spleen. Condition score 2 cows had the highest ($P < .05$) percentage of their BW as feet and hooves, while BCS 7 and 8 cows had the lowest ($P < .05$) percentages. The large intestines from BCS 7 and 8 cows were heavier ($P < .05$) than cows assigned a BCS of 6 or less; however, when expressed as a percentage of the animal's BW, BCS 4, 5, and 6 cows had lower ($P < .05$) large intestine yields than

BCS 2 and 3 cows, as well as BCS 7 and 8 cows. As BCS increased from 2 to 8, the weight and percentage of mesenteric fat increased ($P < .05$) in near linear fashion. The exception was that BCS 4 cows were intermediate to BCS 2 and 3 cows in weight and percentage of mesenteric fat. This is an excellent example of the relationship between BCS and fat deposition, whether it is deposited externally or internally.

The gross value of the hide and by-products recovered during the slaughter process are reported in Table 4. The value of the hide, cheek meat, gullet, liver, oxtail, large intestine, and inedible tallow increased ($P < .05$) as BCS increased from 2 to 8. This is a reflection of the observed increase in BW and individual by-product weights associated with increasing BCS. Moreover, the total by-product value, expressed as U. S. dollars per cwt of BW, increased ($P < .05$) from a low of $73.89, for BCS 2 cows, to a high of $112.46, for BCS 8 cows, with cows assigned BCS of 3, 4, 5, and 6 having intermediate values. Interestingly, the value of the hide comprised almost 60% of the total by-product value for BCS 2, and the value of the feet and hooves and bone meal accounted for an additional 15% of the total by-product value. On the other hand, value of the hide, feet and hooves, and bone meal accounted for only 64% of the total by-product value of BCS 8 cows.

Cow/calf producers typically use BCS as a tool to ensure reproductive efficiency of their cow herd and as a culling criteria. Yet, results from this study also imply that by-product yields and their value are affected by changes in BCS. This information shows that BCS can be used as an indicator of by-product value, and in turn, be used as a tool in the value-discovery process and marketing of cull cows.

Implications

Beef by-products play an important role in the value-discovery of young fed cattle, and appear to have a similar economic impact in mature cows culled from the breeding herd. Results from this study indicate that by-products from cows in relatively thin condition (BCS of 2 or 3) are of less value than those from cows in relatively heavy condition (BCS 7 or 8), with moderately-conditioned cows being intermediate in value. This information may aid cow/calf producers in the decision-making process on when, and in what condition, to market culled breeding stock. On the other hand, cow/beef packers can use this data to improve the quality and consistency of the cows they slaughter, and the products they market from these cows.

References

Goldstrand, R. E. 1988. In: A. M. Pearson and T. R. Dutson (Eds.) Advances in Meat Science. Vol. 5. Ch. 1. p. 1. Elsevier Applied Science Publishers, Essex, United Kingdom.

Jenkins, T. G., and C. L. Ferrell. 1997. J. Animal Science 75:95.

Johnson, A. S. 1988. In: A. M. Pearson and T. R. Dutson (Eds.) Advances in Meat Science. Vol. 5. Ch. 17. p. 409. Elsevier Applied Science Publishers, Essex, United Kingdom.

SAS. 1990. SAS/STAT® User's Guide (Version 6, 4th Ed.). Statistical Analysis Systems Institute, Inc., Cary, North Carolina.

Terry, C. A., et al. 1990. J. Anim. Science. 68:4200.

USDA. 1997. National Carlot Meat Report. Livest. and Grain Market News, Des Moines, Iowa.

Wagner, J. J., et al. 1988. J. Anim. Sci. 66:603.

Table 1. Least squares means (± SE) for weight and percentage of live weight of hide and various by-products from the head.

Item		Body Condition Scores 2	3	4	5	6	7	8
Live weight	lb	838^{a}±61	1033^{b}±56	1164^{bc}±35	1115^{b}±23	1198^{cd}±33	1284de±43	1403^{e}±61
Green hide	lb	61.50^{a}±4.67	65.14^{ac}±3.95	75.52^{bd}±2.46	68.39^{ac}±1.61	73.13^{bc}±2.33	80.78^{d}±3.01	84.73^{d}±3.01
	%	7.58^{a}±.34	6.35^{b}±.28	6.49^{b}±.18	6.17^{b}±.12	6.11^{b}±.17	6.32^{b}±.22	6.10^{b}±.31
Skull	lb	26.57±1.67	25.81±1.54	28.37±.96	27.03±.63	26.95±.91	24.88±1.18	26.30±1.67
	%	3.20^{a}±.11	2.50^{b}±.10	2.44^{b}±.07	2.44^{b}±.04	2.25^{c}±.06	1.95^{d}±.08	1.90^{d}±.11
Head meat	lb	1.45±.35	1.89±.33	1.84±.21	2.26±.13	2.20±.19	2.15±.26	1.30±.36
	%	.18^{ab}±.03	.18^{ab}±.03	.16^{a}±.02	.20^{b}±.01	.18^{ab}±.02	.17^{ab}±.02	.09^{c}±.03
Cheek meat	lb	1.77^{a}±.29	2.41^{a}±.27	2.07^{a}±.17	2.20^{a}±.11	2.05^{a}±.16	2.26^{a}±.21	3.42^{b}±.29
	%	.21^{ab}±.02	.23^{a}±.02	.18^{b}±.01	.20^{ab}±.01	.17^{b}±.01	.18^{b}±.01	.24^{a}±.02
Oxlips	lb	1.42±.23	2.07±.23	1.73±.13	2.03±.09	1.93±.13	1.68±.16	1.82±.23
	%	.17^{abc}±.02	.20^{ac}±.02	.15^{ab}±.01	.18^{c}±.01	.16^{abc}±.01	.13^{b}±.01	.13^{b}±.02
Tongue	lb	2.47±.20	2.97±.18	2.93±.12	2.76±.08	2.80±.11	2.86±.14	2.88±.20
	%	.30^{a}±.01	.29^{a}±.01	.25^{b}±.01	.25^{b}±.01	.23^{bc}±.01	.22^{c}±.01	.20^{c}±.01
Gullet	lb	1.90^{a}±.36	2.53^{ab}±.33	2.54^{ab}±.21	2.53^{ab}±.14	2.75^{b}±.20	2.49^{ab}±.25	3.90^{c}±.39
	%	.23±.03	.25±.03	.22±.02	.22±.01	.23±.02	.19±.02	.27±.03

^{a,b,c,d,e} Within a row, means lacking a common superscript letter differ (P < .05).

Table 2. Least squares means (± SE) for weight and percentage of live weight of different edible by-products.

Item		Body Condition Scores 2	3	4	5	6	7	8
Weasand meat	lb	1.15±.25	1.23±.23	1.52±.15	1.48±.09	1.47±.14	1.73±.17	1.75±.25
	%	.14±.02	.12±.02	.13±.01	.13±.01	.12±.01	.14±.01	.12±.02
Tripe	lb	16.85±1.18	18.27±1.09	18.58±.68	18.45±.44	17.86±.64	19.52±.83	20.63±1.18
	%	2.02^{a}±.09	1.77^{b}±.08	1.62^{bc}±.05	1.66^{b}±.03	1.49^{c}±.05	1.52^{c}±.06	1.47^{c}±.09
Honeycomb-tripe	lb	3.58±.36	4.07±.33	3.93±.21	3.55±.13	3.58±.19	3.55±.25	4.62±.36
	%	.43^{a}±.03	.40^{ab}±.03	.34^{bc}±.02	.32^{cd}±.01	.30^{cd}±.02	.28^{d}±.02	.33^{bcd}±.03
Liver	lb	10.27^{a}±.77	11.09^{ab}±.71	11.59^{ab}±.44	11.22^{a}±.29	12.31^{bc}±.42	13.03^{cd}±.54	14.68^{d}±.77
	%	1.23±.06	1.08±.06	1.00±.04	1.01±.02	1.03±.03	1.02±.04	1.05±.06
Kidneys	lb	2.45±.23	2.50±.21	2.62±.13	2.51±.09	2.62±.12	2.68±.16	2.98±.23
	%	.29^{a}±.02	.24^{b}±.02	.23^{b}±.01	.23^{b}±.01	.22^{b}±.01	.21^{b}±.01	.21^{b}±.02
Heart	lb	3.73±.27	3.94±.25	3.98±.16	3.91±.10	3.98±.15	3.95±.19	4.32±.27
	%	.45^{a}±.02	.38^{b}±.02	.34^{bc}±.01	.35^{bd}±.01	.34^{bc}±.01	.31^{c}±.02	.31^{cd}±.02
Oxtail	lb	2.07^{a}±.27	2.01^{a}±.25	2.37^{ab}±.16	2.43^{ab}±.10	2.71^{b}±.15	3.25^{c}±.19	3.47^{c}±.27
	%	.25±.02	.20±.02	.20±.01	.22±.01	.23±.01	.25±.01	.25±.02

^{a,b,c,d} Within a row, means lacking a common superscript letter differ (P < .05).

Table 3. Least squares means (± SE) for weight and percentage of live weight of inedible by-products.

Item		Body Condition Scores						
		2	3	4	5	6	7	8
Blood	lb	27.53±2.74	30.74±2.54	31.35±1.63	32.48±1.05	34.38±1.50	34.88±1.94	34.75±2.74
	%	3.35±.23	2.97±.22	2.74±.14	2.92±.09	2.88±.13	2.73±.17	2.47±.23
Feet & hooves	lb	20.77±1.26	20.19±1.17	22.46±.73	20.04±.48	20.39±.69	20.23±.89	20.23±1.26
	%	2.50^{a}±.07	1.96^{b}±.07	1.92^{b}±.04	1.80^{c}±.03	1.70^{d}±.04	1.58^{e}±.05	1.45^{e}±.07
Trachea	lb	2.13±.30	1.73±.28	2.11±.18	1.70±.12	1.89±.17	2.00±.22	2.35±.30
	%	.26±.03	.17±.02	.18±.01	.15±.01	.16±.01	.15±.02	.17±.03
Lungs	lb	12.30±.96	13.27±.89	11.01±.56	11.66±.36	11.59±.53	11.45±.68	11.25±.96
	%	1.47^{a}±.09	1.29^{a}±.08	.96^{bc}±.05	1.05^{b}±.03	.97^{bc}±.05	.90^{c}±.06	.80^{c}±.09
Small intestines	lb	13.43±1.31	13.04±1.21	14.03±.76	13.70±.49	14.86±.72	15.02±.93	15.88±1.31
	%	1.59±.11	1.27±.10	1.21±.06	1.23±.04	1.25±.06	1.17±.08	1.14±.11
Large intestines	lb	10.45^{a}±1.45	14.51^{b}±1.33	13.94^{b}±.84	13.19^{ab}±.55	13.81^{b}±.79	18.66^{c}±1.02	21.23^{c}±1.45
	%	1.26^{ab}±.11	1.40^{ac}±.10	1.18^{bc}±.06	1.19^{b}±.04	1.16^{b}±.06	1.45^{a}±.07	1.49^{a}±.11
Spleen	lb	1.25±.14	1.43±.13	1.65±.08	1.46±.05	1.61±.08	1.65±.10	1.60±.14
	%	.15±.01	.14±.01	.14±.01	.13±.00	.13±.01	.13±.01	.12±.01
Mesenteric fat	lb	5.98^{a}±2.11	11.83^{b}±2.11	9.62^{ab}±1.22	13.53^{c}±.80	18.23^{d}±1.16	24.49^{e}±1.49	30.33^{f}±2.11
	%	.72^{a}±.16	1.15^{ab}±.16	.86^{a}±.09	1.20^{b}±.06	1.52^{c}±.09	1.92^{d}±.12	2.15^{d}±.16

[a,b,c,d,e,f] Within a row, means lacking a common superscript letter differ ($P < .05$).

Table 4. Least squares means (± SE) for gross value of the hide and by-products from culled beef cows.

Item	Price[a]	Body Condition Scores						
		2	3	4	5	6	7	8
Hide	71.50	43.97^{e}±3.34	46.58^{eg}±2.82	54.00^{fh}±1.76	48.90^{eg}±1.15	52.29^{fg}±1.67	57.76^{h}±2.15	60.59^{h}±3.05
Head meat	54.00	.78±.03	1.02±.18	.99±.11	1.22±.07	1.19±.11	1.16±.14	.70±.19
Cheek meat	69.00	1.22^{e}±.20	1.67^{e}±.19	1.43^{e}±.12	1.52^{ef}±.08	1.41^{e}±.11	1.56^{e}±.14	2.36^{f}±.20
Oxlips	68.00	.17±.02	.20±.02	.15±.01	.18±.01	.16±.01	.13±.01	.13±.02
Tongue	152.00	3.75±.30	4.52±.28	4.46±.17	4.20±.11	4.25±.17	4.34±.21	4.38±.30
Gullet	6.00	.12^{e}±.02	.15^{ef}±.02	.15^{ef}±.01	.15^{ef}±.01	.17^{f}±.01	.15^{ef}±.02	.23^{g}±.02
Weasand meat	70.00	.81±.17	.86±.16	1.07±.10	1.03±.07	1.03±.09	1.21±.12	1.23±.17
Tripe[b]	25.00	2.53±.18	2.74±.16	2.79±.10	2.77±.07	2.68±.10	2.93±.12	3.10±.18
Honeycomb-tripe[b]	51.00	1.10±.11	1.25±.10	1.20±.06	1.09±.04	1.10±.06	1.09±.08	1.41±.11
Liver	37.00	3.80^{e}±.28	4.10^{ef}±.26	4.29^{ef}±.16	4.15^{e}±.11	4.56^{fg}±.16	4.82^{gh}±.20	5.43^{h}±.28
Kidneys	15.50	.38±.04	.39±.03	.41±.02	.39±.01	.41±.02	.42±.02	.46±.04
Heart	27.00	.45±.02	.38±.02	.34±.01	.35±.01	.34±.01	.31±.02	.31±.02
Oxtail	147.00	3.04^{e}±.40	2.96^{e}±.37	3.49^{ef}±.23	3.57^{ef}±.15	3.98^{f}±.22	4.78^{g}±.28	5.09^{g}±.40
Blood meal[c]	28.00	1.54±.15	1.72±.14	1.76±.09	1.82±.06	1.92±.08	1.95±.11	1.95±.15
Feet & hooves	37.00	7.68±.47	7.47±.43	8.31±.27	7.41±.18	7.54±.26	7.49±.33	7.49±.47
Trachea	6.00	.13±.02	.10±.02	.13±.01	.10±.01	.11±.01	.12±.01	.14±.02
Lungs	3.25	.40±.03	.43±.03	.36±.02	.38±.01	.38±.02	.37±.02	.37±.03
Large intestine	35.00	3.66^{e}±.51	5.08^{f}±.47	4.88^{f}±.29	4.62^{ef}±.19	4.84^{f}±.28	6.53^{g}±.36	7.43^{g}±.51
Spleen	5.00	.06±.01	.07±.01	.09±.00	.08±.00	.08±.00	.09±.01	.08±.01
Inedible tallow	14.00	.84^{e}±.30	1.66^{ef}±.30	1.35^{e}±.17	1.89^{f}±.11	2.55^{g}±.16	3.43^{h}±.21	4.25^{i}±.30
Bone meal[d]	13.00	3.46±.22	3.36±.20	3.69±.13	3.51±.08	3.50±.12	3.24±.15	3.42±.22
Total value		73.89^{e}±4.90	88.15^{f}±4.53	96.91^{f}±2.83	91.10^{f}±1.85	96.35^{f}±2.68	105.54^{g}±3.46	112.46^{g}±4.90

[a] U. S. dollars/cwt.
[b] Values for tripe and honeycomb-tripe are based on estimated 60% yield after the scalding process (Terry et al. 1990).
[c] Value of blood meal is based on estimated 20% yield after processing fluid blood.
[d] Value of bone meal is based on estimated 80% yield after processing raw bones.
[e,f,g,h,i] Within a row, means lacking a common superscript letter differ ($P < .05$).

Influence of Body Condition Scores on Carcass Composition of Culled Beef Cows[1]

Jason Apple , J. Clint Davis, Jerry Stephenson, Sherry Beaty, and Lillie Rakes[2]

Story in Brief

One hundred eleven mature cows were weighed and assigned body condition scores (BCS) 24 hours before slaughter. After a 48-hour chilling period, USDA quality and yield grade data were collected on the left side of each carcass. The right side was broken down into primal cuts, and each primal cut was further fabricated into boneless subprimal cuts and lean trimmings trimmed to .25 in of external and visible seam fat, fat trim, and bone. Subsequently, all cuts and lean trimmings were then trimmed of all visible fat. Weights were recorded at all stages of fabrication, and primal yields were calculated as percent of chilled carcass weight. Body weight, hot carcass weight, dressing percentage, fat thickness, percent internal fat, longissimus muscle area, marbling score, and USDA quality grade increased ($P < .05$) as BCS increased from 2 to 8. Conversely, USDA yield grade and cutability decreased ($P < .05$) as BCS increased. Fat yield from each primal cut increased and bone yield from the primal cuts decreased as BCS increased from 2 to 8. Body condition scores had a pronounced affect on primal yields and total lean product and total bone yields, as well as subprimal, lean trimming, fat trim, and bone yield from various primal cuts from culled beef cows.

Introduction

The economic significance of external fatness on reproductive efficiency has been well documented for live cows. Moreover, thin-conditioned cows require high levels of concentrate feeding after calving to ensure the occurrence of estrus during the rebreeding period, thereby resulting in the largest out-of-pocket expense incurred by the cow/calf producer.

Body condition scores (BCS) were developed to visually appraise the external fatness of cows. These scores have been shown to accurately predict carcass fat content (Tinker et al., 1990), live and carcass weight and dressing percentage (Shemeis et al., 1994), proportions of carcass lean and bone (Shemeis et al., 1994; Wagner et al., 1988), and marbling (Houghton et al., 1990) of mature cows.

The complex task of determining carcass value, and ultimately live value, is no longer based on the carcass, rather "pieces" (primal and subprimal cuts) of the carcass. Prices for each boneless subprimal cut fabricated from cow carcasses can be easily obtained; however, very little information is available concerning primal/subprimal cut yields from cow carcasses. This information gap poses a major problem in determining the carcass and live values of culled breeding stock. Therefore, the primary aim of this study was to determine the effect of BCS on primal cut yields from carcasses of culled beef cows.

Experimental Procedures

One hundred eleven beef cows, culled from the University of Arkansas Beef Research Unit at Fayetteville, and the Southwest Research and Extension Center at Hope, were weighed and assigned BCS, based on the 9-point scale of Wagner et al. (1988), 24 hours before slaughter. All cows were slaughtered at the University of Arkansas Red Meat Abattoir according to industry-accepted procedures, and the hide and by-product weights were obtained from each animal during slaughter.

Carcasses were placed in the chill cooler (34° F) for 48 hours. After chilling, the left side of each carcass was ribbed between the 12th and 13th ribs, and USDA yield and quality

[1] The authors would like to express their sincere appreciation to the Arkansas Beef Council for financial support of this project. Additionally, the authors would like to thank Pete Hornsby and Gary Murphy for care of cows and assigning body condition scores, and John Hankins, J. Clint Davis, Buck Boger, Chris Boger, and Denise Moore for assistance in cattle harvest, carcass fabrication, and data collection.

[2] All authors are associated with the Department of Animal Science, Fayetteville.

grade data (USDA, 1989) was collected by a trained, experienced evaluator. Following a 45-minute "bloom" period, the longissimus muscle (LM) was visually evaluated for color (1=black; 2=very dark red; 3=dark red; 4=moderately dark red; 5 =slightly dark red; 6 = cherry red; and 7=very light cherry red), firmness (1=extremely soft; 2=very soft; 3=soft; 4=slightly soft; 5=moderately firm; 6=firm; and 7=very firm), and texture (1=very coarse; 2=coarse; 3=slightly coarse; 4=slightly fine; 5=moderately fine; 6= fine; and 7=very fine).

After grading, the right side from each carcass was fabricated according to USDA (1988) Institutional Meat Purchase Specifications (IMPS). Each side was broken down into the following primal cuts: square-cut chuck (IMPS #113), brisket (IMPS #118), foreshank (IMPS #117), short plate (IMPS #121), rib (IMPS #107), loin (IMPS #172, round (IMPS #158), and flank. Each primal cut was weighed (kidney and pelvic fat were removed from the wholesale loin before being weighed, and the internal fat was weighed separately), and further processed into boneless subprimal cuts trimmed to a maximum of .25 in of external and visible seam fat, lean trimmings, fat trim, and bone. For each primal cut, lean trimmings were not adjusted for fat content, trimmed bruises were included in fat trim weights, and bone weights include any heavy connective tissue. Subsequently, all cuts and lean trimmings were further trimmed free (designated as .00 in of fat trim) of all external and visible seam fat.

All components were individually weighed at all stages of fabrication. Mean yields of all cuts were computed as a percentage of chilled carcass weight for each cow. For each side, total lean product was calculated as the sum of all boneless subprimal cuts and lean trimmings at each fat trim level divided by the chilled side weight. Total fat trim was calculated as the sum of all fat trim weights, at a specific fat trim level, divided by the chilled side weight. Total percent bone was calculated as total bone weight divided by the chilled side weight. All data were analyzed by a one-way analysis of variance using the GLM procedure of SAS (1990), with BCS as the main effect. Least squares means were separated statistically using the least squares difference procedure (SAS, 1990).

Results and Discussion

Live and carcass characteristics of culled beef cows are presented in Table 1. As expected, fat thickness and actual percent of internal fat increased ($P < .05$) as BCS increased from 2 to 8. Body weight, hot carcass weight, dressing percentage, and LM area also increased ($P < .05$) with increasing BCS. Yield grades were similar ($P > .05$) for carcasses from BCS 2, 3, 4, 5 and 6 cows; however, carcasses from BCS 8 cows had a higher ($P < .05$) numerical yield grade than carcasses from cows assigned a BCS of 7 or less. Our results are consistent with those of Hilton and co-workers (1996), who reported that BW and hot carcass weights, all fat indicating characteristics, and LM area increased with increasing body condition class, and USDA yield grade and cutability decreased with increasing body condition class.

No differences ($P > .05$) were noted between BCS for skeletal maturity, lean maturity, or overall maturity. However, marbling score was lowest ($P < .05$) for carcasses from BCS 2 cows, and increased ($P < .05$) as BCS increased to 8. This resulted in an improvement ($P < .05$) in USDA quality grade from a low of U. S. Cutter^{72} for BCS 2 carcasses to a high of U. S. Utility^{99} for BCS 8 carcasses. Body condition scores had no affect ($P > .05$) on subjective measurements of color, texture, and firmness.

Primal yields, expressed as a percentage of hot carcass weight, are reported in Table 2. Carcasses from BCS 8 cows had the lowest ($P < .05$) percentage of their carcass weight as wholesale round and chuck. On the other hand, BCS 2 carcasses had the lowest ($P < .05$) and BCS 8 carcasses had the highest ($P < .05$) wholesale flank yields. Although the percentage of brisket, plate, and foreshank was similar among BCS 2, 3, 4, and 5 carcasses, there was a decrease in yields from BCS 2 to BCS 5, then a significant increase ($P < .05$) to BCS 7 and 8 carcasses. Body condition score had no affect ($P > .05$) on the yield of middle-meats (wholesale rib and loin).

Yield of total lean product, trimmable fat, and bone are presented in Table 3. Total lean product yield at .25 in of visible fat tended to increase from BCS 2 to 6, and declined to the lowest level at a BCS of 8. In fact, carcasses from BCS 2 had similar ($P > .05$) total lean product yields to those from BCS 7 and 8 cows. The same trend was observed for total lean product yields at the .00-in fat-trim level; total lean product yields increased from 60.80%, at a BCS of 2, to a high of 63.02% at BCS 4, then decreased dramatically to 54.14% at a BCS of 7 and 49.41% at a BCS of 8. This finding is in disagreement with Hilton et al. (1996), who showed that the percent of total boneless product, trimmed to .25 in of surface fat, actually increased as condition class increased.

Total trimmable fat yields were highest ($P < .05$), at both fat-trim levels, for carcasses from BCS 8 cows, and lowest ($P < .05$) for carcasses from BCS 2 cows. At both the .25-in and .00-in fat-trim levels, total trimmable fat yield increased from 1.40 and 7.09%, respectively, for BCS 2 cows to 14.90 and 30.01%, respectively, for BCS 8 cows. These results lend further support to the conclusions of Tinker et al. (1990) that the body condition scoring system, routinely used by cattlemen, is an accurate method of assessing body fat content of cows.

Almost 32% of the chilled carcass weight of carcasses from BCS 2 carcasses were comprised of bone. The percentage of total bone decreased ($P < .05$) as BCS increased from 2 to 8. This finding is in agreement with Hilton and co-workers

(1996), who reported that the percent of total bone decreased as body condition class increased from thin- to fat-condition.

Implications

Body condition scores are a subjective measurement of external fatness, and observed increases in fat thickness, percent internal fat, and total trimmable fat yields were expected. However, BCS had a pronounced affect on primal yields,total lean product, and total bone yields, as well as subprimal, lean trimming, fat trim, and bone yields from various primal cuts from culled beef cows. This information can serve cow/calf producers in their decision-making process on when, and in what condition, to market their culled breeding stock to optimize economic returns to their operation. Furthermore, information from this study can assist cow/beef packers when purchasing cows for slaughter. The ability to segregate cows into predictable groups can aid these packers/processors in improving the quality and consistency of beef products processed from culled cows.

References

Hilton, G. G., *et al.* 1996. Final Report: Development of Scientific Data-Base for Possible Use in Revising Present U. S. Standards for Grades of Mature Cows and Their Carcasses. Colorado State University, Ft. Collins.

Houghton, *et al.* 1990. J. Anim. Sci. 68:1428.

SAS. 1990. SAS/STAT® User's Guide (Version 6, 4th Ed.). Statistical Analysis Systems Institute, Inc., Cary, North Carolina.

Shemeis, A. R., *et al.* 1994. Livest. Prod. Sci. 40:165.

Tinker, E. D., *et al.* 1990. Oklahoma Agricultural Experiment Station Research Report MP-129:14.

USDA. 1988. Institutional Meat Purchase Specifications for Fresh Beef. AMS, USDA, Washington, DC.

USDA. 1989. Official United States Standards for Grades of Carcass Beef. AMS, USDA, Washington, DC.

Wagner, J. J., *et al.* 1988. J. Animal Science. 66:603.

Table 1. Least squares means (± SE) for carcass data from cull beef cows.

	Body Condition Scores						
Item	2	3	4	5	6	7	8
Live wt, lb	838^{h}±61	1033^{i}±56	1164^{ij}±35	1115^{i}±23	1198^{jk}±33	1284^{kl}±43	1403^{l}±61
Hot carcass wt, lb	406^{h}±38	503^{hi}±35	576^{ij}±22	553^{i}±14	613^{jk}±21	677^{k}±27	771^{l}±38
Dressing percentage	48.7^{h}±1.6	48.8^{h}±1.5	49.3^{h}±.9	49.4^{h}±.6	51.2^{hi}±.9	52.8^{i}±1.1	55.1^{i}±1.6
Fat thickness, in	.02^{h}±.06	.05^{hi}±.06	.13^{hi}±.04	.15^{i}±.02	.29^{j}±.03	.53^{k}±.04	1.14^{l}±.06
LM[a] area, in^2	7.3^{h}±.7	9.6^{ij}±.7	10.0^{ij}±.5	10.3^{ij}±.3	10.9^{jk}±.4	11.6^{k}±.5	12.2^{k}±.7
Internal fat, %	.50^{h}±.38	1.37^{hi}±.35	1.21^{hi}±.22	1.39^{i}±.14	2.24^{j}±.21	3.24^{k}±.27	3.54^{k}±.38
USDA yield grade	1.9^{h}±.3	1.8^{h}±.3	2.0^{h}±.2	2.0^{h}±.1	2.5^{i}±.2	3.3^{j}±.2	5.1^{k}±.3
USDA cutability	52.6^{h}±.6	52.8^{h}±.6	52.1^{h}±.4	52.3^{h}±.2	51.1^{i}±.4	49.1^{j}±.5	44.9^{k}±.6
Skeletal maturity[b]	497±41	524±38	473±24	550±16	514±23	527±29	537±41
Lean maturity[b]	420±36	396±33	389±21	398±14	383±20	333±25	353±36
Overall maturity[b]	461±31	471±29	435±18	481±12	458±17	459±22	474±31
Marbling score[c]	192^{h}±52	297^{hij}±48	247^{hi}±30	308^{ij}±20	337^{j}±29	442^{k}±37	598^{l}±52
USDA quality grade[d]	272^{h}±31	313^{hi}±29	339^{hij}±18	314^{hi}±12	326^{hi}±17	373^{jk}±22	399^{k}±31
LM color score[e]	3.5±.5	4.0±.5	4.2±.3	4.3±.2	4.5±.3	4.9±.4	5.0±.5
LM texture score[f]	3.7±.4	3.3±.4	3.1±.3	2.9±.2	2.7±.2	3.7±.3	3.5±.4
LM firmness score[g]	4.3±.5	4.7±.4	4.9±.3	4.9±.2	5.0±.3	5.2±.3	5.8±.5

[a]LM = longissimus muscle.
[b]300 = C^{00}; 400 = D^{00}; and 500 = E^{00}.
[c]100 = Practically Devoid^{00}; 200 = Traces^{00}; 300 = Slight^{00}; 400 = Small^{00}; and 500 = Modest^{00}.
[d]200 = U. S. Cutter^{00} and 300 = U. S. Utility^{00}.
[e]1 = black; 2 = very dark red; 3 = dark red; 4 = moderately dark red; 5 = slightly dark red; 6 = cherry red; and 7 = very light cherry red.
[f]1 = very coarse; 2 = coarse; 3 = slightly coarse; 4 = slightly fine; 5 = moderately fine; 6 = fine; and 7 = very fine.
[g]1 = extremely soft; 2 = very soft; 3 = soft; 4 = slightly soft; 5 = moderately firm; 6 = firm; and 7 = very firm.
[h,i,j,k,l] Within a row, least squares means lacking a common superscript letter differ ($P < .05$).

Table 2. Least squares means (± SE) for primal yields expressed as a percentage of hot carcass weight stratified across body condition scores.

	Body Condition Scores						
Primal cut	2	3	4	5	6	7	8
Chuck	26.32^{a}±.75	26.06^{a}±.69	25.97^{a}±.43	26.34^{a}±.28	25.48^{a}±.41	23.80^{b}±.53	23.48^{b}±.75
Rib	6.82±.28	7.37±.26	6.51±.16	6.84±.11	6.82±.15	6.83±.20	7.25±.28
Brisket, plate & shank	16.55^{abc}±.68	16.31^{abc}±.63	16.19^{ab}±.39	15.80^{a}±.26	16.72^{bc}±.37	17.59^{c}±.48	18.10^{c}±.68
Flank	3.71^{a}±.36	4.34^{ab}±.34	4.32^{ab}±.21	4.59^{b}±.14	5.64^{c}±.20	5.90^{cd}±.26	6.63^{d}±.36
Loin	15.33±.46	16.03±.43	15.61±.27	16.00±.17	15.61±.25	16.27±.33	16.61±.46
Round	24.54^{ab}±.67	24.41^{ab}±.62	24.58^{a}±.39	23.57^{b}±.25	23.73^{ab}±.37	22.11^{c}±.48	20.52^{d}±.67

[a,b,c,d] Within a row, least squares means lacking a common superscript letter differ ($P < .05$).

Table 3. Least squares means (± SE) for total lean product, trimmable fat and bone yields, expressed as a percentage of chilled carcass weight, stratified across body condition scores.

		Body Condition Scores						
Item[a]		2	3	4	5	6	7	8
Total lean product	.25 in	66.42^{cd}±.95	70.49^{b}±.88	71.17^{b}±.55	71.70^{b}±.36	71.73^{b}±.52	68.06^{c}±.67	64.06^{d}±.95
	.00 in	60.80^{bc}±1.35	62.07^{b}±1.25	63.02^{b}±.78	61.69^{b}±.51	58.66^{c}±.74	54.14^{d}±.96	49.41^{e}±1.35
Total trimmable fat	.25 in	1.40^{b}±.95	1.98^{b}±.88	3.09^{b}±.55	3.09^{b}±.36	5.71^{c}±.52	9.17^{d}±.67	14.90^{e}±.95
	.00 in	7.09^{b}±1.61	10.45^{bc}±1.49	11.25^{c}±.93	13.12^{c}±.61	17.78^{d}±.88	23.08^{e}±1.14	30.01^{f}±1.61
Bone		31.58^{b}±1.09	26.09^{c}±1.01	24.70^{cd}±.63	23.71^{d}±.41	21.22^{e}±.59	19.39^{ef}±.77	16.92^{f}±1.09

[a]Yields are reported at both the .25-in and .00-in fat-trim level.

[b,c,d,e,f] Within a row, least squares means lacking a common superscript letter differ ($P < .05$).

Influence of Body Condition Scores on the Carcass And Live Values of Culled Beef Cows[1]

Jason Apple[2]

Story in Brief

Hide and by-product weights were obtained during the slaughter of 111 cull beef cows. After a 48-hour chilling period, right sides from each carcass were fabricated into boneless subprimal cuts progressively trimmed to .25 in, then .00 in, of external and visible seam fat. Weights were recorded at all stages of fabrication, and yields of cuts, lean trimmings, fat trim, and bone were used to calculate values for each carcass component. Live values were calculated after slaughter and fabrication costs and by-product value credits were considered. The thinnest condition (body condition score [BCS] 2) cows had a higher (P = .0001) total by-product value than all other BCS. Gross value, at both fat trim levels, was lowest (P = .0001) for carcasses from BCS 2 cows, while carcasses from BCS 8 cows had the highest (P = .0001) gross value. Fabrication costs and net value increased (P = .0001) as BCS increased from 2 to 8. Live value of BCS 2 cows was lower (P = .0001) than the live value of BCS 6, 7, and 8 cows when carcasses were trimmed to .25 in of visible fat. Results indicate that BCS has a significant impact on carcass and live value of culled beef cows.

Introduction

Over three million beef cows are slaughtered annually as a by-product of the cow/calf industry. In Arkansas, between 111,000 and 185,000 beef cows are marketed because of age, reproductive failure, poor feeding conditions, and structural malfunctions. More importantly, sales receipts from these culled females represent a yearly cash return of $50.3 to $79.3 million, or between 15 and 25% of the annual gross revenue of Arkansas cow/calf producers.

Previous research has shown that external fatness, or body condition scores (BCS), greatly influences reproductive efficiency, productivity, and longevity of the cow, the carcass weight, dressing percentage, and USDA quality and yield grades of their carcasses; and the palatability of beef from these carcasses. One would then hypothesize that external fatness also influences the value of the carcass, which, in turn, influences live animal value; however, very little information, if any, is available to corroborate this assumption. Therefore, the objective of this study was to determine the economic relationship between BCS and carcass and live values of culled beef cows.

Experimental Procedures

One hundred eleven beef cows, culled from the University of Arkansas Beef Research Unit at Fayetteville, and the Southwest Research and Extension Center at Hope, were weighed and assigned BCS, based on the 9-point scale of Wagner et al. (1988), 24 hours before slaughter. All cows were slaughtered at the University of Arkansas Red Meat Abattoir according to industry-accepted procedures. Hide and by-products weights were obtained during the slaughter process.

After a 48-hour chilling period, the left side of each carcass was ribbed between the 12th and 13th ribs, and USDA yield and quality grade data (USDA, 1989) was collected by a trained, experienced evaluator. Right sides from each carcass were fabricated according to USDA (1988) Institutional Meat

[1] The author would like to express his sincere appreciation to the Arkansas Beef Council for financial support of this project. Additionally, the author would like to thank Pete Hornsby and Gary Murphy for cattle care and assigning body condition scores to cows, and Jerry Stephenson, Lillie Rakes, Sherry Beaty, J. Clint Davis, John Hankins, Jesse Davis, Buck Boger, Chris Boger, and Denise Moore for assistance in cattle harvest, carcass fabrication, and data collection.

[2] Department of Animal Science, Fayetteville.

Purchase Specifications (IMPS). Primal cuts were processed into boneless subprimal cuts trimmed to a maximum of .25 in of external and visible seam fat, lean trimmings, fat trim, and bone. Subsequently, all cuts and lean trimmings were further trimmed free of all external and visible seam fat (designated as .00 in of fat trim).

Carcass and by-product values were calculated using prices obtained from the USDA National Carlot Meat Report (USDA, 1997). Prices used for boneless subprimal cuts were for either U. S. Utility or U. S. Cutter grade carcasses. Carcasses were sorted by USDA quality grade, and weights of each subprimal cut at .25 in of fat trim were multiplied by the 1997 average market price of each cut. Price adjustments were made to compensate for trim losses and added labor expenses incurred with removing all visible external and seam fat. It is important to understand that the subprimal cuts marketed from U. S. Utility carcasses are not the same as those from U. S. Cutter carcasses; therefore, where the USDA Carlot Meat Report did not report a subprimal cut or a price for the subprimal cut, it was assumed that it was marketed as lean trimmings.

Drop value is the summation of values for beef byproducts removed during the slaughter process. Gross value is the sum of all component values from the carcass, and net value is the gross value and drop value minus a slaughter fee of $28.00 per cow and a fabrication fee of $7.50 per cwt of hot carcass weight. Live value was calculated by dividing the net value by the live weight of each cow. All data were analyzed by a one-way analysis of variance using the GLM procedure of SAS (1990), with BCS as the main effect, and least squares means were separated using the least squares difference procedure (SAS, 1990).

Results and Discussion

The thinnest condition (BCS 2) cows had the highest ($P = .0001$) total by-product value (Table 1), also referred to as drop value, and values were similar ($P > .05$) for all other BCS. The gross and net value of carcasses from culled cows, as well as the calculated live value, are presented in Table 1. Gross value, at both fat trim levels, was lowest ($P = .0001$) for carcasses from BCS 2 cows, and carcasses from BCS 8 cows had the highest ($P = .0001$) gross value. The cost to fabricate carcasses into boneless subprimal cuts increased ($P = .0001$) as BCS increased from 2 to 8. This is a reflection of the increases in hot carcass weight associated with increasing external fatness.

When by-product value and carcass value were combined, and net value was calculated, cows assigned a BCS of 2 had lower ($P = .0001$) net values than all other BCS. Additionally, the net value of BCS 8 cows was higher ($P = .0001$) than that of BCS 3 through 6 cows. Even though the gross and net values for BCS 4 and 5 cows were similar ($P > .05$), carcasses from BCS 5 cows had lower values than those of BCS 4 cows. This may be explained by the fact that BCS 5 cows weighed, on average, 49 lbs less than BCS 4 cows.

The live value of BCS 2 cows was lower ($P = .0001$) than the live value of BCS 6, 7, and 8 cows (Table 1). Interestingly, live value tended to increase from a low of $35.00 / cwt, for BCS 2 cows, to a high of $41.28 / cwt cows assigned BCS of 7, and then tended to decline. No differences ($P = .35$) in live value were observed among BCS when cuts were trimmed completely free of visible fat.

Most beef cows are typically in poor condition when they are culled and sent to slaughter. These cows inevitably produce carcasses with a lower percentage of marketable subprimal cuts, and a majority of the carcass components are destined for ground beef and sausage production. Conversely, carcasses from cows in moderate to fat condition possess acceptable quality and palatability attributes, and a higher percentage of their carcasses can be fabricated into boneless subprimal cuts for commercial trade. This is reflected in the price differences between U. S. Utility and Cutter grade carcasses. In this study, the mean quality grade for carcasses from BCS 2 cows was U. S. Cutter, while carcasses from BCS 7 and 8 cows had a mean quality grade of U. S. Utility. Thus, external fatness, as measured by BCS, dictates product utilization and obviously impacts the carcass and live value of culled beef cows.

Implications

Body condition at the time of slaughter impacts product value, carcass value, and live value. Cow / beef packers may receive their greatest returns from cows with body condition scores of 7 or 8, and this is primarily a result of improvements in carcass quality associated with increased fat deposition. Information from this study may be used to assist cow / calf producers in the decision-making process on when, and in what condition, to market their culled breeding stock to optimize economic returns to their operation.

References

SAS. 1990. SAS/STAT® User's Guide (Version 6, 4th Ed.). Statistical Analysis Systems Institute, Inc., Cary, North Carolina.

USDA. 1997. National Carlot Meat Report. Livest. and Grain Market News, Des Moines, Iowa.

USDA. 1989. Official United States Standards for Grades of Carcass Beef. AMS, USDA, Washington, DC.

USDA. 1988. Institutional Meat Purchase Specifications for Fresh Beef. AMS, USDA, Washington, DC.

Wagner, J. J., et al. 1988. J. Anim. Sci. 66:603.

Table 1. Least squares means (+SE) for drop, gross, net, and live values of cows stratified across body condition scores.

	Body Condition Scores						
	2	3	4	5	6	7	8
Drop value[a]	$73.89^{e}\pm4.90$	$88.15^{f}\pm4.53$	$96.91^{f}\pm2.83$	$91.10^{f}\pm1.85$	$96.35^{f}\pm2.68$	$105.54^{g}\pm3.46$	$112.46^{g}\pm4.90$
Gross value[b]							
.25 in fat trim	$276.05^{e}\pm31.67$	$371.27^{f}\pm29.32$	$423.40^{fg}\pm18.28$	$406.68^{f}\pm11.97$	$459.46^{gh}\pm17.35$	$502.36^{hi}\pm22.39$	$547.34^{i}\pm31.67$
.00 in fat trim	$331.74^{e}\pm36.12$	$417.13^{ef}\pm33.44$	$475.81^{fg}\pm20.86$	$454.85^{f}\pm13.65$	$509.10^{gh}\pm19.79$	$565.71^{hi}\pm25.54$	$610.20^{i}\pm36.12$
Fabrication fee	$30.47^{e}\pm2.81$	$37.73^{ef}\pm2.60$	$43.17^{fg}\pm1.62$	$41.44^{f}\pm1.06$	$45.98^{g}\pm1.54$	$50.78^{h}\pm1.99$	$57.85^{i}\pm2.81$
Net value[c]							
.25 in fat trim	$291.47^{e}\pm32.44$	$393.70^{f}\pm30.03$	$449.14^{fg}\pm18.73$	$428.35^{f}\pm12.26$	$481.83^{gh}\pm17.77$	$529.12^{hi}\pm22.94$	$573.95^{i}\pm32.44$
.00 in fat trim	$347.16^{e}\pm36.79$	$439.55^{ef}\pm34.05$	$501.24^{fg}\pm21.23$	$476.65^{f}\pm13.90$	$531.47^{gh}\pm20.15$	$592.47^{hi}\pm26.01$	$636.81^{i}\pm36.79$
Live value[d]							
.25 in fat trim	$35.00^{e}\pm1.64$	$38.07^{efg}\pm1.52$	$38.47^{efg}\pm.95$	$38.19^{ef}\pm.62$	$40.22^{fg}\pm.90$	$41.28^{g}\pm1.16$	$40.91^{fg}\pm1.64$
.00 in fat trim	41.80 ± 2.00	42.51 ± 1.85	43.16 ± 1.16	$42.45\pm.76$	44.43 ± 1.10	46.20 ± 1.42	45.31 ± 2.00

[a] Drop value (expressed in U. S. dollars) is the sum of all by-products recovered during the slaughter process.
[b] Gross value (expressed in U. S. dollars) is the sum of all component values from the carcass.
[c] Net value (expressed in U. S. dollars) is the gross value and by-product value minus a slaughter fee of $28.00/cow and a fabrication fee of $7.50/cwt of hot carcass wt.
[d] Live value (expressed as U. S. $/cwt live wt) is the net value divided by the live wt.
[e-i] Within a row, least squares means lacking a common superscript letter differ ($P < .05$).

Effect of Growth Type on Tenderness and Chemical Composition of Beef from Pasture- or Feedlot-Developed Steers

Peter Camfield, Hayden Brown, Jr., Zelpha Johnson, Paul Lewis, Lillie Rakes, Connell Brown, and Eric Oxford[1]

Story in Brief

Steers of four growth types: 1) large-framed, slow maturing (LS), 2) intermediate-framed, slow maturing (IS), 3) intermediate-framed, fast maturing (IF) and 4) small-framed, fast maturing (SF) were developed either on pasture or in a feedlot to study differences in tenderness and chemical composition. Calves from each growth type were randomly assigned to both development regimens in each year of a nine-year study (n=342). Data collected were cooking loss percentage (CL) and Warner-Bratzler shear force (WBS) for the longissimus (LD), psoas major (PM) and quadriceps femoris (QF) muscles from the left side of the carcass, and chemical composition was determined on the right side of the carcass. Among the pasture-developed steers, carcasses from the SF steers had significantly lower WBS force values for the LD and the LS steers had significantly higher WBS force values for the QF. Lean muscle tissue from the pasture-developed LS steers, as well as the feedlot-developed LS steers, had significantly higher moisture, protein, and ash content in addition to lower fat for both the forequarter and hindquarter when compared to the other growth types.

Introduction

Due to relative cost inputs for developing cattle, alternative feeding systems will likely involve the utilization of large quantities of forages. These systems may range from finishing on grass, growing on grass and then finishing in drylot or feeding high roughage rations in drylot. Unfortunately, packers have traditionally discriminated against pasture-fed slaughter cattle, finding them less acceptable because of lower dressing percentage, higher cooler shrinkage, and lower quality grade. Bowling et al. (1977), Kropf et al. (1975) and Skelley et al. (1978) reported that beef from grain-fed cattle was more tender and had a more desirable flavor than beef from grass-fed cattle. The objective of this study was to evaluate cooking loss, Warner-Bratzler shear force (WBS [tenderness]), and chemical composition of four fundamentally different growth types of steers developed on either forage or grain diets.

Experimental Procedures

Forty feeder steers from documentable genetic backgrounds were studied each year over a nine-year period. Steers were classified into 1 of 4 growth types: 1) large-framed, slow maturing (LS); 2) intermediate-framed, slow maturing (IS); 3) intermediate-framed, fast maturing (IF); and 4) small-framed, fast maturing (SF). Five spring-born calves from each growth type were assigned to each development regimen in each year. The LS steers were either Chianina, Charolais, or crosses between these breeds. The IS steers were either Red Poll or Hereford breeds.The IF steers were the modern pedigree Angus, and the SF steers were developed from a line of small Angus cattle which were popular in the United States in the 1950's. The frame size and maturing rate of the SF steers are described in detail by Brown et al. (1991).

All steers received no creep feed and were weaned at approximately seven months of age. In the cool seasons, pasture-developed steers grazed on tall fescue that was overseeded with rye, annual ryegrass, and red clover, respectively. Warm season grazing consisted of tall fescue and bermudagrass overseeded with sudan in addition to some millet. The other calves were developed on a feedlot ration that contained 33%

[1] All authors are associated with the Department of Animal Science, Fayetteville.

cottonseed hulls, 43% cracked corn, 9.5% crimped oats, 14.5% soybean meal and 2.2% calcium carbonate. Also, 1000 IU of vitamin A was added per pound of feed. All cattle had free access to fresh water and a commercial mineral mixture containing 12.5 to 15% calcium and 12% phosphorus. Pasture-developed steers were allowed to graze for approximately 330-days and slaughtered at 20 months of age. Feedlot-developed steers were allowed to eat *ad libitum* for 210 days and slaughtered at 14 months of age because they reached the desired weight and finish at a younger chronological age.

Individual muscle samples (longissimus [LD], psoas major [PM], and quadriceps femaris [QF]) were removed from the left side four days after slaughter. Duplicate steaks were cooked and cookingloss percentage calculated from raw and cooked weights. Tenderness was determined by the Warner-Bratzler method using 1/2-in cores.

The lean component from the right forequarter and hindquarter was hand-mixed and ground three times to ensure uniformity. An 8-lb subsample was vacuum-packed and frozen until proximate analysis could be completed. For moisture determination, samples were taken from the center of the subsample and freeze-dried until the weight did not decrease over a 12-hour period.The percentage of moisture was calculated from weight loss.

After moisture determination, dried samples were pulverized, mixed, and freeze-dried for an additional 12 hours before proximate analysis. The amounts of protein, fat, and ash were determined by accepted laboratory procedures. The individual percentages were calculated for each forequarter and hindquarter.

Data were analyzed by least squares analysis of variance with unequal subclass numbers with the GLM procedure of SAS. Included in the model were the dependent variables for cooking loss, Warner-Bratzler shear force, percent moisture, protein, fat and ash and the independent variables of year, growth type, and the residual. Least squares means were separated by repeated t-test.

Results and Discussion

Although no direct comparisons could be made between pasture-developed and feedlot-developed steers because of the large age differences, generally, the pasture-developed steers had higher cooking loss (CL) and WBS force values than feedlot-developed steers. Also, the pasture-developed steers had more moisture and ash content, but less fat content than feedlot-developed steers.

Pasture-developed steers. Differences existed ($P < .05$) between years for all traits analyzed. Effect of growth type was important ($P < .05$) for all traits except the WBS force of the PM for the pasture-developed steers.

Pasture-developed, SF steers had the lowest ($P < .05$) CL for the LD (Table 1). The IS steers had the highest ($P < .05$) CL for the PM and both the slow maturing growth types had higher ($P < .05$) CL for the PM than the fast maturing growth types. The SF steers had lower ($P < .05$) CL for the QF when compared to either LS or IS steers. Pasture-developed, LS and IS steers had a higher ($P < .05$) CL for the QF than either IF or SF steers.

Pasture-developed, SF steers had lower ($P < .05$) WBS force values for the LD, than did the LS, IS and IF steers. There were no differences ($P > .05$) among the four growth types for WBS force values for the PM. Pasture-developed, SF steers had lower ($P < .05$) shear force values for the QF when compared to either LS or IS steers. Large-frame, slow maturing steers had a higher ($P < .05$) WBS force value for the QF than either IF or SF steers.

In the pasture-developed steers, both the forequarter and hindquarter of the LS steers had the highest ($P < .05$) percentage of moisture, protein, and ash and the lowest ($P < .05$) percentage of fat. In the forequarter, SF steers had lower ($P < .05$) percentages of moisture and protein and a higher ($P < .05$) percentage of fat than IS steers. In the hindquarter, no differences in percentage of protein were seen among IS, IF, or SF steers; however, SF steers had lower ($P < .05$) percentage of moisture and a higher ($P < .05$) percentage of fat.

Feedlot-developed steers. Differences existed ($P < .05$) between years for all traits analyzed except for percent ash. Effect of growth type was important ($P < .05$) for all traits studied in the feedlot-developed steers.

Feedlot-developed, LS steers had the highest ($P < .05$) CL for the LD of all growth types (Table 2). The IF and SF steers had a lower ($P < .05$) CL value than either LS or IS steers. The LS and IS steers had higher ($P < .05$) CL for the PM than IF or SF steers. The two slow maturing growth types (LS and IS steers) had a higher ($P < .05$) CL for the QF than either of the fast maturing growth types (IF or SF steers).

Feedlot-developed, SF and IF steers had the lowest ($P < .05$) WBS force for the LD, while carcasses from the LS steers had the highest ($P < .05$) WBS force for the LD of all growth types. Gregory et al. (1994) found that Angus, Pinzgauer, and Red Poll (small-frame) cattle had lower shear force values for the longissimus muscle than Limousin and Simmental (large-frame) cattle. For the PM muscle, the SF steers had the lowest numerical WBS force and the LS steers had the highest numerical WBS force. Even though differences ($P < .05$) in WBS force existed among growth types, these differences were small with PM shear force means ranging from 3.81 lbs for LS steers to 3.23 lbs for SF steers. Feedlot-developed, SF steers had the lowest ($P < .05$) shear force value for the QF and the LS steers had the highest ($P < .05$) WBS force value for the QF.

In the feedlot-developed steers, the forequarter and hindquarter of the LS steers had the highest (P < .05) percentage of moisture, protein, and ash, but the lowest (P < .05) percentage of fat. The forequarter and hindquarter of the feedlot-developed IF and SF steers had lower (P < .05) percentage of moisture and protein but higher (P < .05) percentage of fat when compared to IS steers. Even though there are differences in percentage of ash in both the forequarter and hindquarter, these differences are small with forequarter ash means ranging from .96% for LS steers to .91% for the SF steers and the hindquarter ash means ranging from 1.05% for the LS steers to 1.00% for the SF steers.

Implications

As the cattle industry moves closer to a value-based marketing system, these results could aid producers in selecting the proper growth type, within development regimen which they should use to achieve maximum quality without excessive fat.

References

Bowling, R.A., et al. 1977. J. Animal Science. 45:209.
Brown, A.H. Jr., et al. 1991. J. Animal Science. 69:451.
Gregory, K. E., et al. 1994. J. Animal Science. 72:1174
Kropf, D.H., et al. 1975. Kansas Agricultural Experiment Station, Report of Progress. 230:728.
Skelley, G.C., et al. 1978. J. Animal Science. 47:1102.

Table 1. Least squares means and standard errors for the effect of growth type on cooking loss, shear force and lean trim composition of pasture-developed steers.

	Large Slow[a]	Intermediate Slow	Intermediate Fast	Small Fast	SE
No. of Steers	43	54	42	36	
Cooking Loss, %					
LD[b]	29.03[e]	29.80[e]	29.32[e]	28.43[f]	.37
PM[c]	26.87[e]	27.69[e]	26.28[f]	26.27[f]	.31
QF[d]	33.90[e]	34.42[e]	33.41[fg]	33.03[g]	.29
Shear Force, lb					
LD[b]	4.88[e]	4.88[e]	4.97[e]	3.94[f]	.11
PM[c]	4.60	4.53	4.64	4.51	.06
QF[d]	6.05[e]	5.68[ef]	5.43[fg]	5.13[g]	.10
Forequarter					
Moisture, %	71.57[e]	68.89[f]	68.47[fg]	67.99[g]	.31
Protein, %	20.48[e]	19.53[f]	19.39[fg]	19.21[g]	.11
Fat, %	7.23[e]	10.76[f]	11.45[fg]	12.05[g]	.30
Ash, %	1.01[e]	.97[f]	.94[g]	.96[fg]	.01
Hindquarter					
Moisture, %	73.00[e]	71.28[f]	71.05[f]	70.57[g]	.19
Protein, %	21.47[e]	20.67[f]	20.64[f]	20.51[f]	.10
Fat, %	4.72[e]	7.05[f]	7.44[f]	8.06[g]	.21
Ash, %	1.08[e]	1.04[f]	1.03[f]	1.03[f]	.01

[a] Large, intermediate, and small = frame size. Slow and fast = maturing rate.
[b] = Longissimus muscle.
[c] = Psoas major.
[d] = Quadriceps femoris.
[efg] = Means within same row with different superscripts differ (P < .05).

Table 2. Least squares means and standard errors for the effect of growth type on cooking loss, shear force and lean trim composition of feedlot-developed steers.

	Large Slow[a]	Intermediate Slow	Intermediate Fast	Small Fast	SE
No. of Steers	38	53	50	26	
Cooking Loss, %					
LD[b]	28.36[e]	27.54[f]	26.51[g]	26.09[g]	.32
PM[c]	24.83[e]	24.56[e]	23.18[f]	23.09[f]	.29
QF[d]	33.31[e]	32.96[e]	31.90[f]	31.86[f]	.29
Shear Force, lb					
LD[b]	3.74[e]	3.23[f]	2.79[g]	2.49[g]	.07
PM[c]	3.81[e]	3.41[g]	3.65[ef]	3.23[g]	.05
QF[d]	4.97[e]	4.31[f]	4.03[f]	3.61[g]	.07
Forequarter					
Moisture, %	67.42[e]	65.29[f]	64.27[g]	64.12[g]	.31
Protein, %	19.92[e]	19.51[f]	18.75[g]	18.69[g]	.13
Fat, %	11.87[e]	14.72[f]	16.22[g]	16.52[g]	.39
Ash, %	.96[e]	.91[f]	.93[f]	.91[f]	.01
Hindquarter					
Moisture, %	70.43[e]	68.53[f]	67.90[g]	67.61[g]	.25
Protein, %	21.22[e]	20.56[f]	20.16[g]	20.00[g]	.10
Fat, %	7.37[e]	9.75[f]	10.80[g]	11.32[g]	.31
Ash, %	1.05[e]	1.02[ef]	1.01[f]	1.00[f]	.01

[a] Large, intermediate, and small = frame size. Slow and fast = maturing rate.
[b] = Longissimus muscle.
[c] = Psoas major.
[d] = Quadriceps femoris.
[efg] = Means within same row with different superscripts differ ($P < .05$).

Relationships of Estimated Mature Weight and Maturing Rate to Reproductive Status of Young Beef Cows

Hayden Brown, Jr. , Zelpha Johnson, Charles Rosenkrans, and Eric Oxford[1]

Story in Brief

These data suggest that both mature body weight (BW) and maturing rate are related to reproductive status of Angus, Charolais, and Hereford cows calving first at either two or three years of age. Growth curves and reproductive status data were available on 771 cows born from 1968 to 1987 bred to calve first at three years of age and on 131 cows born from 1988 to 1992 bred to calve first at two years of age. Breed and reproductive status had significant influence on mature BW and maturing rate for both the cows bred to calve first as two-year-olds and the cows bred to calve first as three-year-olds. In the cows calving first at two years of age, reproductive status 4 (cows calving three consecutive years, as two-, three-, and four-year-olds) was associated with the smallest mean mature weight ($P < .05$) and with the highest mean maturing rate ($P < .05$). In cows calving first at three years of age, reproductive status 1 (cows calving two consecutive years, as two- and three-year-olds) was associated with the smallest mean mature weight ($P < .05$) and with the highest mean maturing rate ($P < .05$).

Introduction

Growth curves have been used by many workers to describe growth and development of beef cattle. Two parameters of these growth curves are very important to beef production. Mature body weight (BW) provides an estimate of mature size that is relatively free of temporary environmental effects. Maturing rate indicates how rapidly mature size is approached and therefore describes earliness of maturing. Although these two parameters have the disadvantage of being estimated in retrospect they are important biologically for adaptation, feed resources, seasonal grazing, and marketing. Early estimation of these parameters could be of importance for selection purposes, given their association with other traits and efficiency of production. Therefore, growth curve parameters of maturing rate and mature BW and reproductive status of young beef cows were studied.

Experimental Procedures

Cow breed groups were maintained separately and managed similarly on Ozark Mountain Range. Cows were bred in an annual breeding season from May 15 to July 15 and calved in the spring. Calves were weaned in October each year. Cows in each of the breed groups were fed supplemental prairie hay and 20% range cubes through the winter feeding period to maintain moderate body condition.

The three breeds of spring-born heifers were developed as contemporaries each year from herds with a history of known reproduction under adequate management. Replacement heifers were added to the cow breed groups about May 1 each year. Heifers were pastured on Ozark Mountain Range consisting of mixed stands of tall fescue and bermudagrass plus some native grasses. Heifers bred to calve first at three years of age received supplemental feed in the winter that consisted of prairie hay and 20% protein range cubes. Heifers bred to calve first at two years of age received supplemental feed in the winter that consisted of prairie hay and a corn / soybean mixture at an average daily rate of approximately two pounds per head per day from about November 1 to May 1 each year. In some years, pastures which contained the cows bred to calve first at two years of age were overseeded with a warm-season annual to aid in summer grazing, in addition winter pastures

[1] All authors are associated with the Department of Animal Science, Fayetteville.

were overseeded with cool-season annuals to aid in winter nutrition. Heifers were evaluated at 365 days of age and again before breeding and the poorest quality heifers in the contemporary group were culled.

Data were weight-age and calving records from Angus, Charolais, and Hereford cows born between 1965 and 1994 on the Arkansas Agricultural Experiment Station, at Savoy. Heifers were developed as contemporaries with approximately 80% started as potential replacements. Growth curves and reproductive status data were available on 771 cows born from 1968 to 1987 bred to calve first at three years of age, and on 131 cows born from 1988 to 1992 bred to calve first at two years of age. Thus, these data did not include all heifers produced in the breeding/management programs. Each reproductive status represented in these data was required to have growth curves on at least seven cows. Their reproductive status was designated 1 to 7 from calving records. For cows calving first at three years of age, reproductive status 1 calved two consecutive years, as a three- and four-year-olds; reproductive status 2 calved one year, as a four-year-old; and reproductive status 3 calved one year, as a three-year-old. For cows calving first at two years of age, reproductive status 4 calved three consecutive years, as a two-, three-, and four-year-old; reproductive status 5 calved two consecutive years, either as a two- and three-year-old or as a three- and four-year-old; reproductive status 6 calved as a two- and four-year-old; and reproductive status 7 calved only one year, either as a two-, three-, or four-year-old. Growth curve parameters mature weight and maturing rate were calculated for each cow using Brody's equation (1945). Variances for mature weight and maturing rate were partitioned with a model that included year, breed, reproductive status, all 2- and 3-way interactions and residual. Data for cows calving first at three years of age and data for cows calving first at two years of age were analyzed separately.

Results and Discussion

Breed and reproductive status were important sources of variation ($P < .05$) in mature BW and maturing rate for both cows bred to calve first as a two-year-old and those bred to calve first as a three-year-old. Similar results were reported by Tawah et al. (1985) where cow breed type, age at first calf, and mean weaning rate differed by mature BW and maturing rate. The year x breed interaction was significant for mature BW and maturing rate of cows calving first as a three-year-old and for mature weight but not for maturing rate for cows calving first as a two-year-old. Other 2- and 3-way interactions were nonsignificant. The interactions involving year were thought not important and the main effect means are presented. Mean mature weight and maturing rate for Angus, Charolais, and Hereford cows bred to calve first at three and two years of age are in Table 1. Mean mature BW for Charolais was larger ($P < .05$) than mean mature BW for Angus and Hereford in both cows calving first as two-year-olds and those calving first as three-year-olds. Angus cows which calved first as two- or three-year-olds had the highest mean maturing rate of the breeds studied ($P < .05$). These results are in agreement with those reported by Brown et al. (1972b), where Angus and Hereford cattle were bred to calve first at 30 months of age. In their study mean values of maturing rate for Angus were higher than mean values of maturing rate for Hereford. Maturing rate for Hereford was intermediate in the cows calving first as two-year-olds but was slowest in the cows calving first as three-year-olds. Mean growth curve parameters mature BW and maturing rate by reproductive status for cows calving first at two and three years of age are in Table 2. In the cows calving first as a two-year-old, reproductive status 4 was associated with the smallest mean mature BW ($P < .05$) and with the highest mean maturing rate ($P < .05$). In cows calving first as three-year-olds, reproductive status 1 was associated with the smallest mean mature BW ($P < .05$) and with the highest mean maturing rate ($P < .05$). These data suggest that both mature BW and maturing rate are related to reproductive status of cows calving first at either two or three years of age.

In comparing developmental growth patterns of cows; cows with faster maturing rates have higher nutrient requirements at earlier ages. This fact, coupled with the negative genetic correlation between mature size and rate of maturing; leads to natural selection for adaptation to the level of nutrients provided by the environment (Butts, 1986). In environments in which nutrients are limited to the extent that puberty and recycling following the first calf are delayed, there is natural selection in favor of slower maturing females (Brown, 1972a,b). But, cattle of similar mature BW can vary in rate of maturing. In a study by Brown and others (1972a) selection for heavier, immature BW in Angus heifers had almost no effect on mean BW in the herd, but did increase rate of maturing. Failure to consider genetic differences in maturing rate and mature size in selection of beef heifer replacements and management of young cows can result in conception failure and reduced weaning rates. This is critical in production situations involving low quality forages because mature size and maturing rate have a direct affect on the energy requirements of the cow. Cows that have faster maturing rates reach heavier weights earlier and therefore have higher energy requirements when compared to cows with slower maturing rates. Knowing the forage resources on no two farms are identical the producer must adjust the supplemental feed that is fed to cows according to the available forage resources.

This study was unique in that genetically similar cows were compared in management situations to calve first as two-year-olds and to calve first as three-year-olds. In both management situations, cows with faster maturing rates and smaller mature weights were the most persistent in calving. Age at first calving was considered separately, so these results should be of interest to producers as well as scientists.

Implications

In these data calving rate was most persistent for cows with the fastest maturing rate and estimated mean BW of 1,166 and 1,071 pounds for cows calving first at two and three years of age, respectively. Mature size and maturing rate also influence carcass composition and marbling at acceptable slaughter weights.

References

Brody, S. 1945. Bioenergetics and Growth. New York: Reinhold Publishing Co.

Brown, J.E., et al. 1972a. J. Animal Science. 34:525.

Brown, J.E., et al. 1972b. J. Animal Science. 35:507.

Butts, W.T. 1986. In: Proceedings 35th Annual University of Florida Beef Cattle Short Course. pp. 47.

Tawah, et al. 1985. Abstracts: J. Animal Science. 61:Supp1. pp. 8.

Table 1. Mean mature weight (+SE) and mean maturing rate (+SE) for Angus, Charolais, and Hereford. Cows by Age at First Calving

	Growth Curve Parameters	
Breed	Mature Weight (lb)	Maturing Rate (Rate/Month)
	Bred to calve first at 3 years of age	
Angus	997 ± 7[c]	.0506 ± .0008[a]
Charolais	1265 ± 13[a]	.0403 ± .0015[b]
Hereford	1122 ± 3[b]	.0367 ± .0008[c]
	Bred to calve first at 2 years of age	
Angus	1115 ± 15[b]	.0599 ± .0013[a]
Charolais	1445 ± 24[a]	.0481 ± .0020[b]
Hereford	1148 ± 20[b]	.0545 ± .0016[c]

[abc] Column means within calving groups with different superscripts differ (P < .05).

Table 2. Mean mature weight (+SE) and mean maturing rate (+SE) for reproductive status of cows by age at first calving.

	Growth Curve Parameters	
Reproductive Status [a]	Mature Weight (lb)	Maturing Rate (Rate/Month)
	Bred to calve first at 3 years of age	
$1_{(3,4)}$	1071 ± 7[d]	.0479 ± .0006[b]
$2_{(4)}$	1190 ± 13[b]	.0399 ± .0014[c]
$3_{(3)}$	1122 ± 11[c]	.0425 ± .0012[c]
	Bred to calve first at 2 years of age	
$4_{(2,3,4)}$	1166 ± 18[c]	.0618 ± .0015[b]
$5_{(2,3/3,4)}$	1241 ± 24[b]	.0519 ± .0021[cd]
$6_{(2,4)}$	1241 ± 20[b]	.0545 ± .0016[c]
$7_{(\text{only 1 yr}/2,3,4)}$	1298 ± 26[b]	.0484 ± .0022[d]

[a] Cows calving first at three years of age: 1= calved two consecutive years, as a three- or four-year-old; 2= calved one year, as a four-year-old; and 3= calved one year, as a three-year-old. Cows calving first at two years of age: 4= calved three consecutive years, as a two-, three-, and four-year-old; 5= calved two consecutive years, either as a two- and three- or three- and four-year-old; 6= calved two years, as a two- and four-year-old; and 7=calved only one year, either as a two-, three-, or four-year-old.

[bcd] Column means within calving groups with different superscripts differ (P < .05).

Comparison of Magnesium Sources in Diets of Finishing Lambs[1]

Harold Watson, Ken Coffey, Beth Kegley, Jason Apple and Whitney Ratchford[2]

Story in Brief

Magnesium-Mica (MM) is a mined mineral supplement that has improved carcass quality grade in beef cattle in limited studies, but concerns have been raised about its long-term use because of its high iron concentration. Twenty Rambouillet wether lambs were housed in individual pens and fed one of four high-concentrate finishing diets consisting of a control (no supplemental Mg), magnesium oxide at 0.16% and iron sulfate (FeS) at 0.18% of the diet (MgO + FeS), unweathered MM (UMM) at 0.9% of the diet, or weathered MM (WMM) at 1.0% of the diet for 95 days. Four lambs per treatment were used to measure digestibility of diets. Gain, efficiency, and digestible organic matter (OM) intake did not differ ($P > .10$) among diets. However, liver iron (Fe) concentrations (ppm) were higher ($P < .05$) from lambs fed MgO + FeS than from lambs fed the other diets. Liver copper (Cu) concentrations (ppm) were higher ($P < .05$) from lambs fed WMM than from those fed UMM and control, and liver Cu concentration from lambs fed MgO + FeS did not differ ($P < .10$) from those of lambs fed the other diets. Therefore, it appears that Magnesium-Mica may be included at concentrations up to 1% in finishing diets of lambs fed without any adverse effects on lamb performance, health, or trace mineral status.

Introduction

Magnesium oxide (MgO) is most often used as the magnesium (Mg) supplement of choice because of its high Mg content (53.9%), buffering capacity, and Mg availability. Another Mg supplement is Magnesium-Mica (MM), a silica-based product, having a Mg content of 8.9%. Magnesium-Mica has similar Mg bioavailability as MgO and is less expensive to the producer, but it also has a relatively high iron (Fe) concentration (4%). High levels of available iron in the diet can lead to copper (Cu) and zinc (Zn) deficiencies. The objective of this study was to compare effects of supplemental magnesium sources in lamb finishing diets on animal weight gains, diet digestibility, carcass quality, and liver mineral concentrations.

Materials and Methods

Twenty Rambouillet wether lambs (79.6 lbs) were placed in individual pens and randomized to one of four ground corn-based diets for a 95-day finishing study. Treatment groups consisted of a control (no supplemental source of Mg or Fe), MgO at 0.16% and iron sulfate at 0.18% of the diet, unweathered MM (UMM) at 0.9% of the diet, or weathered MM (WMM) at 1.0% of the diet (Table 1). In the geological formations from which MM is mined, weathered MM lies close to the surface and has undergone weathering. Unweathered MM is located beneath WMM and has been protected from environmental exposure.

We used a typical step-up program to increase the proportion of concentrate in the diet from 45% initially to a final diet of 85% concentrate plus 15% roughage. On day 1 all lambs were weighed, wool samples were clipped, and lambs received ivomectin liquid drench for sheep (0.08% solution). At the termination of the study the lambs were weighed, wool samples were clipped, and lambs were slaughtered for subsequent carcass and tissue measurements. Livers were obtained at slaughter to determine liver mineral concentrations.

Four lambs from each dietary treatment were selected randomly to determine diet digestibility. These lambs were fitted with fecal collection bags and allowed a 2-day adjustment period followed by a 5-day fecal collection period at 0730 and

[1] Appreciation is expressed to Micro-Lite, Inc. for providing Magnesium-Mica and partial financial assistance.
[2] All authors are associated with the Department of Animal Science, Fayetteville.

1600 hours daily. Feed samples were collected daily for 5 days beginning 48 hours prior to each fecal collection.

Results and Discussion

Total weight gain, dry matter (DM) intake, gain: feed and wool production did not differ (P > .10) among diets (Table 2). Lambs fed MgO + FeS and UMM had greater DM (P < .05) and organic matter (OM [P < .10]) digestibilities (%) than those fed WMM, but digestible DM and OM intake (lb / day) did not differ (P > .10) among diets. Dry matter and OM digestibilities (%) by lambs fed the control diet did not differ (P > .10) from those by lambs fed the other diets.

Hot and cold carcass weights, dressing percentage, fat thickness, loin eye area, and USDA yield grade did not differ (P > .10) among diets (Table 3). Marbling scores did not differ (P > .10) among diets but lambs fed MgO +FeS and WMM tended (P < .10) to have greater flank streaking and quality grade than those fed UMM. Quality grade of control did not differ (P > .10) from that of the other diets and all lambs graded USDA Choice.

Liver concentrations of Calcium(Ca), Phosphous (P), Potassium (K), Mg, manganese (Mn), did not differ (P > .10) among diets (Table 4). Liver iron concentrations (ppm) were higher (P < .05) from lambs fed MgO + iron sulfate (FeS) than from lambs fed the other diets. This is possibly due to the addition of iron sulfate, a soluble source of iron, to that diet. Liver copper concentrations (ppm) were higher (P < .05) from lambs fed WMM than from lamb fed UMM and control, and liver Cu concentrations from lambs fed MgO + FeS did not differ (P < .10) from those of lambs fed the other diets. Normal liver Cu concentrations range between 100 and 400 ppm. Therefore, none of the diets fed in this study appeared to impact copper status. Liver zinc concentrations (ppm) were higher (P < .05) from lambs fed control compared with lambs fed UMM and WMM, and did not differ from lambs fed MgO, and liver Zn concentrations from lambs fed MgO did not differ (P < .05) from those of lambs fed the other diets.

Implications

Since no adverse effects were found on weight gain, efficiency, carcass measurements, or liver mineral content, when Magnesium-Mica was included in diets, it does not appear to be of concern. Substituting MM for other feed components in the diet did not negatively impact animal performance. Also, the high iron content of WMM and UMM did not impact the trace mineral status of lambs during the 95-day feeding trial. Therefore, Magnesium-Mica may be included in diets as economics warrant.

Table 1. Composition (% as fed) # of finishing diets with different supplemental sources of magnesium fed to lambs.

	Dietary treatment[1]			
Item	Control	MgO + FeS	UMM	WMM
Cottonseed hulls	15.00	15.00	15.00	15.00
Corn	78.87	78.53	77.97	77.87
Soybean meal	0.73	0.73	0.73	0.73
Liquid molasses	3.00	3.00	3.00	3.00
Urea	1.00	1.00	1.00	1.00
Ground limestone	0.87	0.87	0.87	0.87
Trace mineral salt[2]	0.50	0.50	0.50	0.50
Magnesium oxide	-	0.16	-	-
WMM	-	-	-	1.00
UMM	-	-	0.90	-
Iron sulfate	-	0.18	-	-
Copper sulfate	0.005	0.005	0.005	0.005
Bovatec-68®	0.022	0.022	0.022	0.022

[1] MgO + FeS= Magnesium oxide + Iron sulfate; UMM = Unweathered Magnesium-Mica; WMM = Weathered Magnesium-Mica.
[2] Contained not less than: 96.0% of salt; 0.35% zinc; 0.2% manganese; 0.2% iron; 0.03% copper; 0.007% iodine; 0.005% cobalt.

Table 2. Gain, wool production, intake and digestibilities from lambs fed different supplemental sources of magnesium in a finishing diet.

	Dietary Treatment[1]					
Item	Control	MgO + FeS	UMM	WMM	SE	P-value
Gain, lb	40.5	36.6	38.3	39.8	5.17	0.9519
Total DM intake , lb	275.1	253.7	260.6	271.9	12.30	0.5932
Gain:Feed, lb:lb	0.15	0.14	0.14	0.15	0.014	0.9883
Wool production, g/in^2	0.71	0.84	0.77	0.71	0.071	0.4705
DM Digestibility, %	73.6[ab]	76.3[a]	75.6[a]	71.8[b]	0.996	0.0285
OM Digestibility, %	74.6[cd]	76.9[c]	76.6[c]	72.9[d]	1.05	0.0634
Digestible DM intake, lb/day	2.3	2.3	2.5	2.3	0.13	0.5932
Digestible OM intake, lb/day	2.3	2.3	2.4	2.2	0.13	0.5932

[1] MgO + FeS = Magnesium oxide + Iron sulfate; UMM = Unweathered Magnesium-Mica; WMM = Weathered Magnesium-Mica.
[ab] Means within row without a common superscript letter differ (P < .05)
[cd] Means within row without a common superscript letter differ (P < .10)

Table 3. Carcass measurements from lambs fed different supplemental sources of magnesium in a finishing diet.

	Dietary Treatment[a]					
Item	Control	MgO+FeS	UMM	WMM	SE	P-value
Hot carcass wt, lb	68.2	66.3	66.5	68	3.27	0.9638
Cold carcass wt, lb	64.7	63.1	63.8	65.1	3.33	0.9760
Dressing percent	57	57	56	57	0.009	0.9916
Adjusted fat thickness, in	0.18	0.22	0.13	0.21	0.037	0.3635
LEA[b], in^2	2.68	2.65	2.76	2.68	0.686	0.8884
Marbling[c]	502	524	486	472	44.10	0.856
Flank streaking[c]	284[ef]	424[d]	256[f]	390[de]	51.08	0.0947
USDA Quality grade[g]	336[de]	384[d]	308[e]	372[d]	20.25	0.066
USDA Yield grade[h]	2.18	2.58	1.74	2.54	0.37	0.364

[a] MgO + FeS= Magnesium oxide + Iron sulfate; UMM = Unweathered Magnesium-Mica; WMM = Weathered Magnesium-Mica.
[b] LEA= Loin Eye Area
[c] Practically devoid = 100; Trace = 200; Slight = 300; Small = 400; Modest = 500
[def] Means within rows differ (P < .10)
[g] Utility = 100; Good = 200; Choice = 300; Prime = 400
[h] Yield grade = 10 X adjusted fat + 0.4

Table 4. Liver mineral concentrations from lambs fed different supplemental sources of magnesium in finishing diets.

	Dietary Treatment[1]					
Item	Control	MgO +FeS	UMM	WMM	SE	P-value
Calcium, ppm	163.5	141.1	165.1	150.2	12.96	0.5161
Phosphorus, %	8.12	8.98	8.53	8.27	0.38	0.3963
Potassium, %	5.92	6.48	6.57	6.55	0.32	0.4404
Magnesium, ppm	170.1	232.6	231.3	210.3	33.08	0.5143
Iron, ppm	49.7[b]	153.3[a]	81.5[b]	57.5[b]	24.06	0.0174
Copper, ppm	308.8[b]	414.4[ab]	313.2[b]	437.3[a]	39.03	0.0459
Manganese, ppm	4.2	5.9	4.8	5.2	0.53	0.1674
Zinc, ppm	129.9[a]	116.3[ab]	96.1[b]	92.5[b]	8.23	0.0082

[1]MgO + FeS= Magnesium oxide + Iron sulfate; UMM = Unweathered Magnesium-Mica; WMM = Weathered Magnesium-Mica.
[abc] Means within rows without a common superscript letter differ (P < .05)

Comparison of Winter Backgrounding Programs for Stocker Calves in Southeast Arkansas[1]

Ken Coffey[2], David Shockey[3], Wayne Coblentz[2], Charles Rosenkrans, Jr.[2], and Stacey Gunter[4]

Story in Brief

Sixty crossbred calves (591 lbs) were used to compare winter backgrounding programs in southeastern Arkansas. Calves were fed bermudagrass hay and a grain sorghum - based supplement or grazed pastures of bermudagrass and dallisgrass that were overseeded with 1) annual ryegrass, 2) wheat and ryegrass, or 3) rye and ryegrass for 112 days beginning December 18. Calves fed the hay + supplement treatment gained less weight (P < .05), and had a higher cost of gain, and lower return / head than calves grazed on the winter annual forages. Therefore, winter annual forages offer potential to increase the profitability of stocker calves in southern Arkansas by allowing products to retain ownership until spring, but programs involving grain and hay are probably not profitable.

Introduction

Winter background programs involving hay and supplemental grain are expensive both per day and per pound of gain produced. An alternative to this approach might be to overseed existing warm-season grass pastures with winter annuals. Although much work has been conducted with winter annuals, work in southeastern Arkansas has been limited. The objective of this study was to evaluate calf performance and economic return from calves grazing pastures overseeded with annual ryegrass, wheat and ryegrass, or rye and ryegrass and compare these with feeding bermudagrass hay and supplemental grain in drylot.

Materials and Methods

Sixty crossbred calves (591 lbs) were weighed on December 14 and 15 and allocated randomly by body weight (BW) and sex to 1 of 12 groups of five calves each. Calves were grouped such that 4 groups were heifers and 8 groups were steers. One group of heifers and 2 groups of steers each were placed on one of four backgrounding programs. These consisted of grazing 5-acre bermudagrass / dallisgrass pastures that were overseeded with 1) 30 lbs / acre of 'Marshall' ryegrass, 2) 30 lbs / acre of 'Marshall' ryegrass plus 120 lbs / acre of wheat (variety not stated), or 3) 30 lbs / acre of 'Marshall' ryegrass plus 100 lbs / acre of 'Bonel' rye. In a fourth backgrounding program, calves were placed on dormant bermudagrass pastures and fed bermudagrass hay (11.7% crude protein, 58% total digestible nutrients [TDN]) plus a grain sorghum supplement at 1% of BW.

Pastures were disked lightly with the set removed from the disk and were overseeded by broadcasting the respective forages on September 24 and 25. Pastures were then harrowed lightly to help incorporate seed. Pastures received 50 lbs / acre of nitrogen, phosphate, and potash on November 20 and an additional 50 lbs / acre of nitrogen on February 5.

Calves grazing the winter annual pastures were fed a grain sorghum-based supplement containing trace mineralized salt, necessary minerals, and monensin (200 mg / animal) at a rate of two lbs / day. Calves fed bermudagrass hay were fed a

[1] Appreciation is expressed to Boehringer Ingelheim Vetmedica, Inc. for providing cattle vaccinations and to Ft. Dodge Animal Health, Inc. for providing dewormer.

[2] Department of Animal Science, Fayetteville.
[3] Southeast Research and Extension Center, Monticello.
[4] Southwest Research and Extension Center, Hope.

ground grain sorghum based supplement at 1% of BW plus cottonseed meal at .65 lbs / day. The supplement contained trace mineralized salt, necessary minerals, and monensin (200 mg/ animal). Square bales of bermudagrass hay were fed daily in feed bunks.

All calves were weighed without prior removal from feed and water on April 8 and 10 to determine ending weights. Economic return was determined using the costs presented in Table 1.

Results and Discussion

Cost of gain was greater (P < .05) and return / calf and BW gains were lower (P < .05) from calves fed hay and grain compared with those grazing annual forages (Table 2). Those same measurements did not differ (P > .10) among the annual forage treatments. Gain during the first 28 days of the experiment were lower (P < .05) from calves fed hay and grain compared with those grazing annual forages. Calf gain during the remaining 28-day periods did not differ (P > .10) among treatments. Overall gain by calves grazing winter annual pastures are comparable to those from other studies. Diets for calves fed hay and grain were formulated based on feeding 1% of BW as ground grain sorghum and were estimated to produce 1.5 lbs / day gain. Exceeding 1% of BW in supplemental grain has been shown to have a negative impact on forage intake and cost efficiency.

Average available forage ranged between 800 and 1,250 lbs / acre. Although 800 lbs / acre is considered somewhat limiting for optimal forage intake by grazing cattle, BW gains did not reflect a restriction in intake. Therefore, the annual forage treatments offer the potential to provide economical gain by calves weaned in the fall and held through the winter.

Implications

Winter annual grazing programs have been tried in various locations with variable success. One key to success for these programs is to have adequate forage to graze as early as possible in the fall. This may be difficult to achieve in sod-seeding situations. However, the options evaluated in this study demonstrate that disking pastures and using annual ryegrass alone or in combination with rye or wheat may provide winter grazing for fall-weaned calves to improve sale weight and profitability for cattle producers in southeastern Arkansas.

Table 1. Costs used in calculating economic returns for different backgrounding programs in southeast Arkansas.

Item	Cost/unit
Cattle processing	$10.00/head
Grain sorghum supplement	$ 4.75/cwt.
Hay	$ 2.00/cwt.
Cottonseed meal	$ 10.00/cwt.
Ammonium nitrate	$ 9.45/cwt.
19-19-19 fertilizer	$ 7.50/cwt.
Spreading cost (each spreading)	$ 2.50/acre
Rye seed	$ 17.00/cwt.
Wheat seed	$ 6.00/cwt.
Ryegrass seed	$ 38.00/cwt.
Seeding cost	$ 10.00/acre
Interest rate	9 %
Assumed death loss	1 %

Table 2. Weight and gain by steers on different backgrounding programs in southeast Arkansas.

	Hay + Supplement	Ryegrass	Rye + Ryegrass	Wheat + Ryegrass	SE
Initial wt., lb.	590	588	595	589	6.0
Weight at:					
d 28	581[b]	622[a]	639[a]	617[b]	9.8
d 56	638[d]	714[c]	723[c]	693[c]	20.7
d 84	710	790	824	766	27.7
d 112	756[b]	860[a]	874[a]	842[a]	20.8
Gain, lb.	166[b]	272[a]	279[a]	253[a]	16.9
Daily gain, lb.	1.49[b]	2.43[a]	2.48[a]	2.26[a]	.151
Cost, $/cwt. gain	66.15[a]	33.78[b]	39.60[b]	39.11[b]	5.616
Return, $/head	-38.94[b]	41.84[a]	29.25[a]	22.91[a]	11.072
Gain, lb					
d 0-28	-9[b]	35[a]	44[a]	29[a]	7.0
d 29-56	57	91	84	76	15.1
d 57-84	73	76	101	73	9.1
d 85-112	46	70	51	76	14.7

[ab] Means within a row without a common superscript letter differ ($P < .05$).
[cd] Means within a row without a common superscript letter differ ($P < .10$).

Effect of Magnesium Sources on Performance by Stocker Cattle Grazing Bermudagrass / Dallisgrass Pastures Overseeded with Wheat[1]

Ken Coffey[2], Whitney Ratchford[2], Beth Kegley[2], David Shockey[3], and Stacey Gunter[4]

Story in Brief

Stocker calves (533 lbs) were offered supplements containing magnesium oxide (MgO), weathered Magnesium-Mica (WMM), or unweathered Magnesium-Mica (UMM) for 112 days beginning on December 10. Calves grazed wheat that was overseeded into pastures of dallisgrass and bermudagrass. Neither animal body weight (BW) gain, nor serum magnesium (Mg), calcium, potassium, copper, or zinc levels differed ($P > .10$) among supplemental treatments. Serum copper levels declined ($P < .05$) across all treatments from levels of .9 ppm on December 10 to levels of .6 ppm on April 1, but no treatment x date interaction was detected. Therefore, neither weathered nor unweathered Magnesium-Mica appears to adequately meet the supplemental Mg needs for stocker cattle grazing wheat pasture.

Introduction

Wheat pasture is typically very lush and is rapidly digested. These types of lush forages typically have a preferential uptake of monovalent cations such as potassium rather than divalent cations such as magnesium (Mg).Therefore Mg deficiencies may occur in cattle grazing these forages, possibly resulting in grass tetany. Commercial minerals formulated for cattle grazing wheat pasture typically contain 4 to 14% Mg to insure that adequate Mg is presented to the animal to prevent grass tetany. These commercial high-Mg minerals are often more expensive than conventional minerals because of their special use and because of the costs associated with supplemental Mg sources. Magnesium-Mica (MM) is a considerably less expensive Mg source. Magnesium-Mica is a mined mineral formation with having layers close to the surface and exposed to environmental weathering (weathered Magnesium-Mica; WMM) or layers beneath the surface protected from weathering (unweathered Magnesium-Mica; UMM). Magnesium availability of WMM has been shown to be similar to that of magnesium oxide (MgO) in ruminants. This experiment was conducted to evaluate the potential of a weathered and an unweathered Magnesium-Mica for maintaining adequate Mg levels and prevention of grass tetany in stocker calves grazing wheat forage.

Experimental Procedures

Stocker calves from the University of Arkansas - Monticello cow herd, were weighed without prior removal from feed and water on December 9 and 10, 1997. Calves were blocked by weight within breed and sex and allotted randomly to one of nine pastures of wheat overseeded into bermudagrass and dallisgrass sod. Pasture groups were allotted randomly to receive one of three different ground grain sorghum-based supplements containing monensin (Table 1). Supplements were formulated to provide 6.1 g of Mg daily from either magnesium oxide, a weathered Magnesium-Mica product or an unweathered Magnesium-Mica product. Supplements were fed at a rate of 2 lbs / head daily on Monday through Friday and were formulated to meet the animal's requirements for calcium (Ca), phosphorus (P), potassium (K), and Mg (Table 2).

---

[1] Appreciation is expressed to Micro-Lite, Inc., Chanute, Kansas for donation of Magnesium-Mica and partial financial assistance, to Schering-Plough for providing zeranol implants, to Elanco Animal Health for providing monensin, and Ft. Dodge Animal Health for providing oxfendazola dewormer.

[2] Department of Animal Science, Fayetteville.
[3] Southeast Research and Extension Center, Monticello.
[4] Southwest Research and Extension Center, Hope.

Pastures were disked lightly with the set removed from the disk and were overseeded with 120 lbs / acre of wheat on October 8. Pastures also received 50 lbs / acre of nitrogen (N), phosphate, and potash on October 21 and an additional 50 lbs N / acre on February 6. Wheat forage samples were clipped from random areas in each pasture every 28 days of the study for forage quality and availability determination.

All cattle were rotated throughout the nine pastures at 14-day intervals to minimize the effects of pasture variation on animal performance. Blood samples were collected via jugular puncture on days 0, 28, 56, and 112 to determine treatment effects on serum mineral levels. All calves received a 36-mg implant of zeranol on days 0 and 56 of the study. Calves were weighed without prior removal of feed and water on March 31 and April 1 to determine final weights. Calves were held off water and feed and weighed at 2-hour intervals for 8 hours on April 1 to determine the impact of supplements on steer shrinkage. Wheat forage samples were collected randomly on days 0, 27, and 50.

Results and Discussion

Chemical composition of supplements and wheat pastures are reported in Table 2. No treatment by date interaction was detected ($P > .10$) for serum mineral concentration, so only main effects are presented in Table 3. Serum concentrations of Mg, calcium, potassium, copper (Cu), and zinc (Zn) did not differ ($P > .10$) among calves fed the three treatments. Likewise, BW gain and percentage of shrink did not differ ($P > .10$) among treatments.

Forage Mg levels exceeded the 0.1% Mg required by growing and finishing cattle. With wheat pastures achieving this level of Mg, supplementation might not have been necessary for these cattle.

Magnesium-Mica contains high levels (4%) of iron (Fe), consequently, concerns have been raised about the possible effect of high iron levels on copper absorption. No differences among serum copper (Cu) concentrations were found among calves fed MgO compared with calves fed WMM or UMM. Over time, Cu levels declined slightly, yet no treatment x time interaction was detected. The decrease over time might have been as a result of declining forage Cu levels over time. Normal serum levels range from 0.5 to 1.5 ppm for Cu and 0.7 to 1.0 ppm for Zn. Serum concentrations for all calves were within these ranges. Based on this, we conclude that higher levels of Fe in MM are not interfering with Cu or Zn and should not be of concern.

Implications

Because Mg supplementation is often necessary for cattle and sheep, particularly when grazing lush, green forages during early spring, producers should consider availability and cost of various Mg products. Magnesium-Mica is generally a less expensive source of Mg than MgO and has been proven to have similar availability to MgO when fed to ruminants. In these studies, MM was substituted for feedstuffs having similar energy values without having a negative impact on animal gains. Therefore, when supplementation of Mg is necessary, MM may be used to replace MgO without concerns of low Mg availability or reduced animal performance.

Table 1. Ingredient composition of supplements offered to stocker calves grazing wheat pasture.[a]

Ingredient	MgO[b]	WMM	UMM
Grain sorghum	75.0	75.0	75.0
Corn	14.0	7.35	9.65
MgO	1.2	——	——
WMM	——	7.93	——
UMM	——	——	5.63
TM Salt[c]	1.55	1.55	1.55
Dicalcium phosphate	2.65	2.53	2.53
Limestone	4.85	4.85	4.85
Molasses	.65	.65	.65
Rumensin 80®	.125	.125	.125

[a] Ingredient composition is on an as-fed basis.

[b] MgO = Magnesium oxide; WMM = weathered Magnesium-Mica; UMM = unweathered Magnesium-Mica

[c] TM Salt contained not less than 96% sodium chloride (NaCl), 0.35% zinc (Zn), 0.2% manganese (Mn), 0.2% iron (Fe), 0.03% copper (Cu), 0.007% iodine (I), and 0.005% cobalt (Co).

Table 2. Nutrient composition (% of DM) of wheat pasture and magnesium supplements.

Item	CP,%	NDF,%	IVDMD,%	Mg,%	Ca(ppm)	Zn(ppm)	Cu(ppm)	Fe
Supplements								
MgO[a]	8.0	——	91.5	.98	2.51	62.6	11.8	983
WMM	7.4	——	85.6	1.06	2.61	73.6	14.6	4082
UMM	7.6	——	86.7	.95	2.64	62.7	13.1	3288
Wheat forage								
12/10/96	16.2	47.3	79.8	.16	.45	32.1	6.9	432
1/7/97	20.5	48.0	80.6	.17	.40	23.4	6.7	1098
2/4/97	16.6	55.1	69.2	.14	.34	30.3	6.3	1590
3/4/97	22.7	50.0	80.5	.16	.36	40.3	6.8	1514
4/1/97	16.4	47.8	84.0	.16	.41	24.3	5.0	243

[a]MgO = Magnesium oxide; WMM = weathered Magnesium-Mica; UMM = unweathered Magnesium-Mica.

Table 3. Serum mineral concentrations, weight gain, and % shrink by stocker calves fed different supplemental magnesium sources while grazing wheat pasture.[a]

Item	MgO[b]	WMM	UMM	SE
Serum				
Mg, mg/dl	2.20	2.24	2.21	.068
Ca, mg/dl	9.58	9.75	9.81	.121
K, mg/dl	19.24	20.02	19.59	.448
Cu, ppm	.76	.80	.76	.031
Zn, ppm	.89	.88	.90	.036
Initial wt, lb	526	537	537	6.5
Final wt, lb	695	717	717	17.9
Gain, lb	169	180	180	18.4
Daily gain, lb	1.51	1.61	1.61	.165
Percent Shrink at:				
2 hours	1.4	1.5	1.7	.24
4 hours	2.5	2.3	2.7	.19
6 hours	3.5	3.7	3.7	.17
8 hours	4.9	4.3	5.5	.53

[a]No significant differences were detected ($P < .10$).
[b]MgO = magnesium oxide; WMM = weathered Magnesium-Mica; UMM = unweathered Magnesium-Mica.

Effect of Revalor-G Implants on Weight Gains of Steers Grazing Bermuda Plus Dallisgrass Pastures[1]

David Shockey[2], Ken Coffey[3], and Charles Rosenkrans, Jr.[3]

Story in Brief

Sixty-four crossbred steers (512 lbs) were placed on common bermudagrass / dallisgrass (BD) pastures on May 9, 1997, that had been previously overseeded with wheat on October 8, 1996. Steers were allowed to graze wheat residue until the BD pastures were fully established June 10, 1996. Half of the steers were given Revalor-G, a growth implant (GI) containing 20 mg trenbolone acetate plus 4 mg estradiol, and half received no implant (NI). Steers were allowed to graze continuously for 113 days. At the end of the study, GI steers were 44 lbs heavier ($P < .10$) than NI steers; the average daily gain for GI steers was 0.40 lbs / day greater ($P < .01$) than for NI steers.

Introduction

Bermudagrass and dallisgrass are well adapted to climates of the southeastern United States. These grasses can provide profitable livestock enterprises on marginal ground. These forages can also persist under constant grazing pressure with stocker cattle. Growth promoting implants have been used to improve weight gains by stocker cattle, but the use of implants containing trenbolone acetate in stocker cattle grazing bermudagrass / dallisgrass (BD) pastures has not been evaluated. The objective of this experiment was to evaluate the potential growth and economic benefits of implanting stocker cattle grazing bermudagrass / dallisgrass pastures with a trenbolone acetate / estradiol implant.

Experimental Procedures

Sixty-four 512-lbs crossbred steers having 1 / 4 to 3 / 8 Brahman breeding were delivered to the University of Arkansas at Monticello, on May 9, 1997. All steers were weighed off the truck and vaccinated against IBR, BVD, PI_3, five strains of leptospirosis and seven strains of clostridial organisms. All steers were checked for implants, dehorned if necessary, and dewormed. Sick cattle were treated for respiratory problems as needed. Steers were placed on a 5-acre BD pasture holding pen for a 5-day receiving period. Steers were weighed May 13 and 14 without prior shrink and allocated to one of two treatments growth implant (GI) or no implant (NI). On May 14, steers were turned onto 40 acres of BD pastures that had previously been overseeded with wheat (120 lbs / acre on October 8, 1996). Some wheat residue was still available to steers until the BD pasture was fully established. The stockpiled wheat residue was mature; the steers did not graze all of it. On June 20, pastures were mowed for hay with a sickle bar haybine at six inches of stubble height. Twenty-two tons of forage were baled into 1000-lb rolls and removed from the field. Fertilizer was applied on July 7 at 50 lbs nitrogen (N) per acre. Excess grass was again harvested at the conclusion of the study with a disk mower leaving a 2-inch stubble height. An additional seven tons of forage were harvested at this time. Steers were fed a supplement that consisted of defatted rice bran, ground grain sorghum, and a mineral mix containing salt at a rate of 4.2 lbs / head / day. Cattle were supplemented five days / week. All steers

[1] Appreciation is expressed to Riceland Foods, Inc. for providing ricebran, Hoeschst-Roussel Agri-Vet. Co., for providing Revalor -G implants, and Ft. Dodge Animal Health for providing Synanthic.

[2] Southest Research and Extension Center, Monticello.
[3] Department of Animal Science, Fayetteville.

were gathered on 28-day intervals and weighed individually. On day 56 of the study, steers were dewormed with Synanthic (oxfendazole). Steers were shipped out on September 8, 1997.

Results and Discussion

Steers implanted with Revalor-G were 44 lbs heavier (P < .10) at the end of the study than non-implanted steers (Table 1). Weight gains were consistently higher for GI steers at each weighing interval (P < .05). The average final weight for GI steers was 766 lbs compared to 722 lbs for NI steers. All steers were sold at $0.68/lb. Therefore, GI steers were valued at $29.92 more at the time of sale than NI steers. Revalor-G implants cost $1.25 per dose; the net return for GI steers was $28.63 greater than for NI steers.

Table 1. Weight and gain by steers fed a control supplement and not implanted or implanted with Revalor-G.

	Treatment		
Observation	Revalor-G	Control	SE
	- - - - - - - Weight, lb - - - - -		
Day 0	516.6	515.9	5.1
Day 28[a]	606.9	591.3	6.6
Day 56[b]	654.9	627.5	7.5
Day 85[c]	703.1	668.4	7.7
Day 113[c]	766.0	722.0	8.5
	- - - - - - Gain, lb - - - - - - - -		
Day 0-28[b]	90.3	75.3	4.2
Day 28-56[c]	48.0	36.3	3.0
Day 56-85[b]	48.2	40.9	2.5
Day 85-113[b]	62.9	53.8	3.0
Day 0-113[c]	249.4	206.1	8.0
	- - - - - - Daily Gain, lb - - - - -		
Day 0-113[c]	2.21	1.82	.07

[a]Means for implanted vs. non-implanted steers differ (P < .10).
[b]Means for implanted vs. non-implanted steers differ (P < .05).
[c]Means for implanted vs. non-implanted steers differ (P < .01).

Evaluation of Alpha CD Injected in the Base of the Ear in Baby Calves[1]

Ken Coffey[2], Tom Troxel[3], and Don Hubbell[4]

Story in Brief

Forty fall-born calves received an injection containing Alpha CD in the base of the ear on September 18, 1997. Knots developed in 78% of the calves by two weeks following injection. Knot size and frequency diminished somewhat by two months following injection. Therefore, injection with Alpha CD may result in knots, but the size of the knots should shrink over time.

Introduction

Blackleg or clostridial vaccines have received considerable negative publicity over the last few years for causing knots that ultimately result in costs to the packer through potential trim losses. Although clostridial vaccines given properly (subcutaneously) do not result in loss from meat trim, accidental injections into the muscle may cause losses. Furthermore, knot formation from injection with clostridial vaccinations may indicate greater immune response from the vaccination. Injecting clostridial vaccines in the ear offers the potential to prevent trim losses and unsightly blemishes. The purpose of this study was to determine the incidence and severity of knots following injection of Alpha CD in the ear of baby calves.

Experimental Procedures

A total of 40 fall-born crossbred calves ranging in age from 1 to 10 days old received a 2-ml injection containing Alpha CD in the base of the ear on September 18, 1997. All calves remained with their dams on a common pasture during the observation period. General observations were made on September 22. Knot occurrence and size were measured on September 25, October 2, October 16, and November 21.

Results and Discussion

Knots were observed at or near the injection site and many of the ears appeared stiff and rigid on September 22, but calves were not gathered and handled on that date. Seventy-eight percent of the calves (n=32) developed knots by September 25 and the average knot size was .6 x 2.1 in (height x length). On October 2, 68% of the calves still displayed knots with the average knot size being .5 x 1.6 in. On October 16, 54% of the calves displayed knots having an average size of 1.2 x 2.4 in and 63% of the calves displayed knots on November 21, with the average size being .7 x .9 in. No permanent damage to the ear was apparent at the end of the study, and no animals died as a result of clostridial organisms. Based on these observations, we conclude that cattle producers injecting Alpha CD in the base of the ear of suckling calves should expect knots to form in a high percentage of the exposed calves with the frequency and extent of knot formation diminishing with time.

Implications

Cattle producers injecting calves with Alpha CD should expect knots to appear at the injection site that will eventually diminish. Since knots are formed, injecting in the ear would result in reduced potential discounts by packers. Whether actual clostridial protection is affected by injecting in the ear vs. in the neck was not determined.

[1] Appreciation is expressed to Boehringer Ingelheim Vetmedica, Inc. for providing vaccinations and partial financial assistance.
[2] Department of Animal Science, Fayetteville.
[3] Animal Science Section, Cooperative Extension Service, Little Rock.
[4] Livestock and Forestry Branch Experiment Station, Batesville.

Performance of Cows Grazing Fescue and Fed Zeolite[1]

Ken Coffey[2], Ted Holt[3], and Don Hubbell[3]

Story in Brief

Sixty-four cow / calf pairs grazing tall fescue pastures were allocated to supplements containing either no supplemental zeolite, or zeolite supplemented at .3 or .6 lbs / day during a 56-day winter grazing study. Supplements were fed Monday through Friday. No treatment differences were observed for cow or calf gain, or milk production. Therefore, zeolite does not appear to positively impact production by cows grazing endophyte-infected fescue pastures in the winter.

Introduction

Infection of tall fescue with the endophytic fungus *Neotyphodium coenophialum* causes reduced production by cows. Certain mined clays have been shown to bind the toxins produced by this endophytic fungus. The objective of this study was to determine the effect of feeding different levels of a zeolite that was shown to bind fescue toxins on performance by cows and calves grazing endophyte-infected stockpiled fescue.

Experimental Procedures

Sixty-four, fall-calving cows and their calves were assigned randomly by weight and age to one of eight groups. Groups were assigned randomly to one of eight endophyte infected fescue pastures (12.3 to 14.5 acres each). Pasture groups were assigned randomly to the following treatments: 1) 3 lbs / day of a rice bran-based control supplement (two groups), 2) the rice bran supplement with the addition of .3 lbs of zeolite added daily (three groups), or 3) the rice bran supplement with the addition of .6 lbs of zeolite added daily (three groups).The supplements were fed Monday through Friday. Milk production was measured by the weigh-suckle-weigh technique on day 28 of the study. Cattle groups were moved throughout the eight pastures at 14-day intervals to minimize the impact of pasture variation on animal production.

Results and Discussion

No differences were detected for cow or calf body weight (BW) or milk production (Table 1). Possible reasons for this are 1) the zeolite may not be effective in binding sufficient quantities of toxins; 2) the fescue toxicity problem may not have been severe enough during the winter period to illicit a gain response, 3) the fescue toxicity problem was manifested in other symptoms not measured in this experiment, or 4) the zeolite may have some detrimental effects by binding beneficial nutrients, thus off-setting any beneficial aspects. In either case, zeolite was ineffective in increasing weight gain by cows and calves grazing winter fescue.

Implications

Numerous products are available that have shown potential to offset fescue toxicity in controlled laboratory situations. To date, most of these have failed to benefit animals in production situations. Specific zeolites may have potential to reduce the impact of tall fescue toxins, but should be evaluated during late spring and summer grazing to determine its full efficacy.

---

[1] Appreciation is expressed to Armbruster Consulting, Amarillo, Texas, for providing the experimental zeolite and to Riceland Foods, Stuttgart, Arkansas for providing rice bran for the study.
[2] Department of Animal Science, Fayetteville.
[3] Livestock and Forestry Branch Experiment Station, Batesville.

Table 1. Effect of zeolite supplementation on cow and calf performance[a]

Item	Control	.3 lbs/day	.6 lbs/day	SE
Cows:				
Initial wt., lb	996	991	984	14.8
Final wt., lb	1029	1016	1012	18.0
Gain, lb	33	25	28	8.0
Initial body condition score	5.3	5.4	5.2	.11
Body condition score change	.02	.13	.06	.119
Milk production, lb	6	8	8	1.1
Calf:				
Initial wt., lb	298	296	299	8.7
Final wt., lb	402	403	401	10.5
Gain, lb.	104	107	102	3.4
Daily gain, lb.	1.86	1.91	1.84	.060

[a]No significant differences were detected ($P < .10$).

Shrink by Stocker Calves Fed Different Ionophores[1]

Ken Coffey[2] and Don Hubbell[3]

Story in Brief

Forty-eight weaned, crossbred heifer calves (467 lbs) were allocated randomly to receive 2 lbs / day of corn-based supplements either without an ionophore, or containing lasalocid or monensin (200 mg/ head daily) for 12 days. On day 13, calves were held in pens without feed and water for 24 hours. On day 24, calves were weighed before and following a 7-hour transit. Body weight (BW) at the time of removal from pasture (T0) on day 13 tended (P < .10) to be greater from heifers fed ionophores than from those not fed ionophores. Cumulative BW change and percentage of shrink by heifers fed lasalocid was greater (P < .05) at 6 hours and tended (P = .05) to be greater at 2 and 12 hours following T0 than that by heifers fed no ionophore or monensin. Transit shrink did not differ (P > .10) among treatments. Therefore, feeding ionophores for a short period of time before periods of shrink may increase animal BW but may have little or even a negative effects on shrink.

Introduction

Shrink represents an economic loss for both buyers and sellers of stocker cattle. Previous work has shown that lasalocid may reduce shrink in stocker cattle. This experiment was conducted to compare weight loss of stocker heifers fed either lasalocid or monensin with those fed no supplemental ionophore.

Experimental Procedures

Forty-eight weaned, crossbred heifer calves (467 lbs) were weighed without prior removal from feed and water on two consecutive days and allotted by weight into 12 groups of four heads each. The groups were then allocated randomly to receive 2 lbs / day of corn-based supplements either without an ionophore, or containing lasalocid or monensin to provide 200 mg of the respective ionophore daily. Following allotment, heifers were placed on pastures containing predominantly tall fescue and fed their respective supplement for 12 days. On day 13, heifers were removed from pasture, placed in small pens without feed and water for a 24-hour period, and weighed every 2 through 12 hour and again at 24 hours. On day 24 of the study, heifers were weighed before and following a transport of approximately 7 hours.

Results and Discussion

On day 13, body weight (BW) tended (P < .10) to be greater for heifers fed lasalocid and monensin than for those fed no ionophore at the time of removal from pasture (T0), (Table 1). Weight change and percentage of shrink by heifers fed lasalocid was greater (P < .05) at 6 hours and tended (P < .10) to be greater at 12 hours following T0 than that by heifers fed no ionophore or monensin. The greatest total shrink (lb, %, or % / hour) occurred during the first 2 hours following T0 (Table 2). Heifers fed lasalocid tended (P < .10) to have greater shrink (lb, %, and % / hour) during this time than those fed no ionophore or monensin. Shrink during the other 2-hour periods of the day did not differ (P > .10) among treatments. Transit shrink did not differ (P > .10) among dietary treatments (Table 3), but was numerically greater than the shrink that occurred during a 24-hour holding period in pens without feed and water. Therefore, in this study, lasalocid had a negative impact on cattle shrink when heifers were held in pens without feed and water, but not when transportation was involved.

Implications

Previous studies have reported that ionophores improve BW gain when fed for extended periods (100 + days) of

[1] Appreciation is expressed to Hoffmann-La Roche for providing lasalocid and to Elanco Animal Health for providing rumensin to conduct the experiment.
[2] Department of Animal Science, Fayetteville.
[3] Livestock and Forestry Branch Experiment Station, Batesville.

time, and that feeding lasalocid may reduce shrink. Based on these results, feeding calves ionophores during a short feeding period may result in improved BW gain, but feeding lasalocid may result in increased shrink.

Table 1. Cumulative drylot shrink by stocker heifers fed supplements containing no ionophore or ones containing monensin or lasalocid.

Item	Lasalocid	Control	Monensin	SE
Initial BW,lb	467	466	469	1.6
BW at T0, lb	473[a]	458[b]	472[a]	4.7
Cumulative BW loss, lb				
2 hour	13[a]	9[b]	10[b]	1.0
4 hour	17[c]	13[d]	14[cd]	1.2
6 hour	19[c]	16[d]	15[d]	0.9
8 hour	21	17	19	1.4
10 hour	20	17	19	1.8
12 hour	20[a]	16[b]	17[b]	1.2
24 hour	29	27	27	1.7
Cumulative shrink, % of initial BW				
2 hour	2.8[a]	2.0[b]	2.2[b]	0.21
4 hour	3.5[c]	2.4[d]	2.9[cd]	0.24
6 hour	4.1[c]	3.5[d]	3.3[d]	0.16
8 hour	4.4	3.6	4.1	0.30
10 hour	4.2	3.6	4.0	0.37
12 hour	4.3[a]	3.4[b]	3.5[b]	0.26
24 hour	6.1	5.9	5.7	0.32

[a,b] Means within a row without a common superscript letter differ ($P < .10$).
[c,d] Means within a row without a common superscript letter differ ($P < .05$).

Table 2. Drylot shrink during 2-hour periods by stocker heifers fed supplements containing no ionophore or ones containing monensin or lasalocid.

Item	Lasalocid	Control	Monensin	SE
Weight change, lb				
0-2 hours	13.1[a]	9.4[b]	10.3[b]	0.99
2-4 hours	3.4	1.9	3.4	1.45
4-6 hours	2.8	4.7	1.6	1.11
6-8 hours	1.6	0.6	4.1	1.36
8-10 hours	-0.9	0.0	-0.6	1.44
10-12 hours	0.3	-0.9	-2.2	1.64
12-24 hours	8.8	11.3	10.6	1.57
Shrink, %				
0-2 hours	2.8[a]	2.0[b]	2.2[b]	0.21
2-4 hours	0.7	0.4	0.7	0.32
4-6 hours	0.6	1.0	0.3	0.24
6-8 hours	0.3	0.1	0.9	0.30
8-10 hours	-0.2	0.0	-0.1	0.32
10-12 hours	0.1	-0.2	-0.5	0.36
12-24 hours	1.9	2.5	2.3	0.33
Shrink, %/h				
0-2 hours	1.4[a]	1.1[b]	1.1[b]	0.11
2-4 hours	0.4	0.2	0.4	0.16
4-6 hours	0.3	0.5	0.2	0.12
6-8 hours	0.2	0.1	0.4	0.14
8-10 hours	-0.1	-0.0	-0.1	0.17
10-12 hours	0.0	-0.1	-0.2	0.18
12-24 hours	0.2	0.2	0.2	0.03

[a,b] Means within a row without a common superscript letter differ ($P < .10$).

Table 3. Transit shrink by stocker heifers fed supplements containing no ionophore or ones containing monensin or lasalocid.[a]

Item	Lasalocid	Control	Monensin	SE
Preship wt., lb	494	480	493	6.8
Postship wt., lb.	460	448	459	4.7
Wt. loss, lb.	34	32	34	3.0
Shrink, %	6.9	6.6	6.8	.54

[a]No significant differences were detected ($P < .10$).

Season-Long Versus Intensive-Early Stocking with Stocker Cattle Grazing on Bermudagrass Pasture[1]

Stacey Gunter and Mike Phillips[2]

Story in Brief

Our objective was to compare the performance of weaned fall-born calves managed under intensive-early (IES; 5 steers / acre for 70 days) or season-long stocking (SLS, 2.5 steers / acre for 140 days). Beginning on May 15, 105 steer calves (body weight [BW] = 479 ± 3.6 lbs) were randomly assigned to 1 of 15, 2-acre common bermudagrass pastures fertilized with 150 lbs of nitrogen (N) / acre. One of the following five treatments was randomly assigned to three pastures: SLS plus no supplement (NS), SLS plus 1.0 lb of ground corn / steer / day, SLS plus 1.1 lbs of cottonseed meal (CSM) / steer / day, IES plus NS, and IES plus corn. Steer BW did not differ ($P > .26$) among treatments on day 0; however, by day 70 SLS-corn steers (654 lbs) averaged 25 lbs heavier than SLS-NS ($P < .02$) or SLS-CSM ($P < .12$) steers. The IES-NS (582 lbs) and IES-corn steers (579 lbs) on day 70 averaged 42 lbs lighter ($P < .01$) than the SLS-NS steers. By day 140, SLS-corn (740 lbs) and SLS-CSM (702 lbs) steers were heavier ($P < .02$) than SLS-NS steers (667 lbs). When using SLS, corn increased the BW gain .50 lb / lb of corn fed; however, when IES was used no benefit was received from corn. Furthermore, CSM supplementation with SLS increased total BW gain .21 lb / lb of CSM fed. Total BW gain / acre differed ($P < .05$) among treatments with SLS-corn producing the most (648 lbs). Grazing system did not effect feedlot average daily gain (ADG [$P > .44$]), but IES (175 days on feed) calves did have a greater ($P < .10$) feedlot total gain than SLS (154 days on feed). Carcass quality was positively increased by using IES over SLS probably as a result of the longer feeding period.

Introduction

Spring and early summer average daily gains (ADG) by stocker cattle grazing common bermudagrass pasture is almost always excellent (> 2.25 lbs / day); however, late summer ADG without the use of supplementation can be somewhat disappointing (< .5 lbs / day). One grazing system that may help overcome this situation is intensive-early stocking (IES). The principle behind IES is to stock the pasture at twice the normal rate in the first half of the grazing season when animal performance is exceptionally good then move the cattle to the feedlot in July before forage quality declines. The regrowth that occurs during July through September could be harvested as hay or grazed with cows. The potential advantages to IES are a shorter grazing season, greater body weight (BW) gain / acre, higher forage utilization in the spring, and more flexibility in market timing and (or) feedlot placement. Some disadvantages for IES are lower individual animal BW gain and greater variable cost. Our objective in this trial was to compare the performance of weaned fall-born calves grazing common bermudagrass managed under IES or season-long stocking (SLS) systems.

Materials and Methods

This experiment was conducted at the Southwest Research and Extension Center in Hope, on 30 acres divided into 2-acre pastures. The soil type of the 15 pastures was a Sawyer Loam which consist of deep, moderately well drained soil that is nearly level to gently sloping (slopes, 3 to 8%) to nearly level. Published soil survey data indicate that this soil is capable of producing approximately 7.0 animal-unit-months / acre / year with common bermudagrass pasture. These swards were primarily common bermudagrass (75.7%), but also contained dallisgrass (5.2%), tall fescue (4.3%), other grasses (8.1%), white clover (4.2%), plus other forbs (2.5%).

One hundred five steer calves (average BW = 450 lbs) were obtained through a local cattle buyer (F & F Cattle Company; Hope). After a 21-day receiving period, the steers were stratified by BW and randomly divided into 15 groups. One of the following five treatments was randomly assigned to three pastures: SLS plus no supplement (NS), SLS plus 1.0 lb of ground corn / steer / day, SLS plus 1.1 lbs of cottonseed meal (CSM) / steer / day, IES plus NS, and IES plus corn. Corn and CSM were fed in isocaloric amounts.The fertilizer was applied

[1] The authors would like to thank Ivy Laboratories, Inc. for partial support of this research by way of product donations.

[2] Southwest Research and Extension Center, Hope.

as ammonium nitrate three times (in equal amounts) during the grazing season at 52-day intervals beginning on May 2. A total of 150 of nitrogen (N)/acre was applied during the experiment. The grazing season began on May 15. Steers were weighed on May 15 and at 35-day intervals unshrunk at 0630. On May 15 and August 21, the steers were implanted with Implus-S®. On a weekly basis, cattle were provided 1.67 lbs/steer of a mineral/salt mixture[1].

After completion of the grazing phase (IES, 7/24; SLS, 10/2), steers were shipped to a commercial feedlot in northeast Oklahoma (Neil Cattle Company; Welch, Oklahoma). After cattle arrived at the feedlot, they were weighed, dewormed, revaccinated for IBR, BVD, BRSV, and PI_3, and the seven *Clostridial* diseases. At the time of arrival, cattle were implanted with Synovex-S (Fort Dodge Animal Health, Overland Park, Kansas) and 120 days before slaughter were implanted with Revalor (Hoechst Roussel Vet, Warren, New Jersey). Cattle were fed a high concentrate corn-based diet (65.5 Mcal of NEg/lb of dry matter [DM]) in two pens (1 for IES, 1 for SLS) until deemed finished by the feedlot manager. The morning before shipping to a commercial slaughter plant, cattle were weighed to determine final BW. After slaughter, carcasses were weighed hot. After chilling, rib-eye area, percentage kidney-pelvic-heart fat (KPH), backfat thickness, USDA yield grade, marbling score, and quality grade score were recorded.

The data were analyzed as a split-plot design with grazing system/supplement (treatment) in the main plot and day in the sub plot. Pastures were used as experimental units and main plots were arranged in a randomized fashion. Least squares means were separated using the least significant procedure.

Results and Discussion

Grazing phase. On May 15, beginning BW did not differ (P > .70) among the treatments with an average BW of 479 ± 9.0 lb (Table 1). On July 24 (day 70), BW differed (P < .05) among grazing systems and supplements. Steers managed with SLS averaged 57 lbs greater (P < .002) than steers managed with IES (Table 1). With SLS, steers receiving corn gained 33 lbs more (P = .01) by day 70 than NS steers. By day 70, the steers supplemented with CSM tended to gain (P = .18) more than NS steers (difference = 17 lbs) and was not different (P = .21) from the BW of steers supplemented with corn (Table 1). On October 2, the BW of SLS steers supplemented with corn was 73 lbs greater (P < .01) than NS steers. Steers supplemented with CSM also were 35 lbs greater (P = .01) then NS steers, but 38 lbs less (P < .01) then the corn supplemented steers (Table 1).

Between 0 and 70 days, ADG by steers managed with SLS averaged .8 lbs greater (P < .01) than steers managed with IES (Table 1). This difference was probably the result of the IES decreasing the daily forage allowance for each steer because of the increased stocking density. Within the SLS treatment groups, ADG did not statistically differ (P > .20), but the differences among ADG do reflect a difference in BW on day 70 (Table 1). Between days 70 and 140, ADG by steers supplemented with corn was .5 lbs greater (P = .02) than NS steers; the ADG of steers supplemented with CSM was gain .3 lbs greater (P = .05) than that of NS steers. These data indicate that when using SLS over the entire grazing season, corn increased the BW gain by .5 lb/lb of supplement fed; however, CSM only increased the BW gain by .25 lb/lb of supplement fed.

The only treatment that significantly (P = .02) increased total gain/acre relative to SLS with NS was corn supplementation with cattle managed with SLS (Table 1). All other treatments did not differ (P > .20) from SLS with NS (average = 512 lbs/acre). Increased variable costs are associated with IES because of the greater number of animals; this fact calls into question the profitability potential of IES with cattle grazing common bermudagrass. Hay harvested from IES pastures in the late summer averaged 3,869 lbs of DM/acre and did not differ (P > .20) between supplementation treatments (NS vs. corn; Table 1). The value of the hay produced by using IES may offset some of the higher variable cost associated with the increased number of cattle.

Feedlot phase. On the first day at the feedlot (7/25, IES; 10/3, SLS), beginning BW differed (P < .01) among the treatments (Table 2). On July 25, beginning BW for IES steer did not differ (P = .96) between NS and corn. Steers managed with SLS at the feedlot on October 3. Upon arrival, corn steers weighed 81 lbs more (P = .006) than NS steers; CSM steers had an intermediate BW. When the cattle were deemed finished (174 days, IES; 154 days, SLS), BW did not differ between treatments (Table 2). During their respective feeding periods, SLS steers consumed 21.3 lbs of feed DM/day (pen average) and the IES steers consumed 22.5 lbs of feed DM/day (pen average). Season-long stocking and IES steers had a feed DM/gain conversation factor of 6.0 and 6.5, respectively (pen averages). Total feedlot gain was 14% greater (P < .09) for the IES steers than the SLS steers (Table 2). As a result of the SLS plus corn steers entering the feedlot at a heavier BW, corn steers tended (P < .11) to gain less weight at the feedlot than SLS plus NS or SLS plus CSM steers. Average daily gains at the feedlot did not differ (P = .44) among treatments but did reflect difference in total gain.

[1] Vigortone No. 32S®. Contained (% as-fed): 18.2% NaCl, 13.6% Ca, 7.0% P, .01% I, .0026% Se, trace minerals (Co, Cu, Fe, Mn, and Zn), 300,000 IU of vitamin A/lb, 30,000 IU of vitamin D_3/lb, and 100 IU of vitamin E/lb.

Hot carcass weight did not differ (P = .29) among treatments, but dressing percentage did (P < .01; Table 2). Steers managed with IES had a higher (P < .04) dressing percentage than SLS steers, which can probably be explained by the tendency (P < .15) of IES steers to have thicker fat cover over the carcass. There was a tendency (P < .13) for IES plus corn steer to have a larger rib-eye area (Table 2). Yield grade did differ (P = .02) by treatment. The SLS plus CSM and IES plus corn steers had the lowest yield grade, which indicates a higher percentage of lean cuts. Kidney-pelvic-heart fat, marbling code, and quality grade code did not differ (P > .20) by treatment (Table 2).

Implications

Intensive-early stocking failed to provide greater total gain / acre relative to SLS, but its production was equivalent to SLS. Corn supplementation was the best supplement with SLS, but no benefits to supplementation were detected with IES. Cattle grazed under IES management provided the best carcasses, but required a longer feed period to reach acceptable finished weights.

Table 1. The effect of grazing system and supplements on animal performance.

	Treatment					
Item	SLS-NS	SLS-Corn	SLS-CSM	IES-NS	IES-Corn	SE[a]
Initial grazing date	5/15	5/15	5/15	5/15	5/15	—
Days on pasture	140	140	140	70	70	—
BW, lb						
Beginning	478	479	478	479	482	9.0
Day 70	621[b]	654[c]	638[bc]	582[d]	579[d]	9.0
Day 140	667[b]	740[c]	702[d]	—	—	9.4
ADG, lb						
Days 0 to 70	2.0[b]	2.5[b]	2.3[b]	1.5[c]	1.4[c]	.23
Days 71 to 140	.7[b]	1.2[b]	.9[bc]	—	—	.23
Gain/acre, lb	473[b]	648[c]	560[bc]	525[bc]	490[b]	3.7
Hay production, lb of DM/acre	—	—	—	3,837	3,900	335

[a] SLS, n = three pastures of five steers/treatment; IES, n = three pastures of 10 steers/treatment.
[b-d] Means with uncommon superscripts within a row differ (P < .05).

Table 2. The effect of prior grazing system and supplements on feedlot performance and carcass quality.

	Treatment					
Item	SLS-NS	SLS-Corn	SLS-CSM	IES-NS	IES-Corn	SE[a]
Date entering feedlot	10/3	10/3	10/3	7/25	7/25	—
Days on feed	154	154	154	174	174	—
BW, lb						
Beginning	629[b]	710[c]	663[bc]	569[d]	569[d]	16.4
Ending	1,218	1,237	1,251	1,213	1,219	19.3
Total gain, lb	589[bc]	527[b]	589[bc]	645[c]	650[c]	25.0
ADG, lb	3.82	3.45	3.82	3.71	3.73	.15
Carcass quality						
Hot carcass wt, lb	721	733	750	747	750	11.1
Dressing percentage	59.2[b]	59.3[b]	59.9[b]	61.6[c]	61.5[c]	.56
Fat thickness, in	.41[bc]	.41[bc]	.38[b]	.44[c]	.44[c]	.19
Rib-eye area, in^2	12.5[a]	12.2[a]	12.9[ab]	12.8[a]	13.5[b]	.33
Kidney-pelvic-heart fat, %	2.1	2.3	2.1	2.1	2.0	.11
USDA Yield grade	2.7[bd]	2.9[c]	2.6[d]	2.8[bc]	2.5[d]	.08
Marbling code	434	411	413	412	406	22.1
Quality grade code	304	282	293	290	284	12.0

[a] SLS, n = three pastures of five steers/treatment; IES, n = three pastures of 10 steers/treatment.
[b-d] Means with uncommon superscripts within a row differ (P < .05).
[e] 300 = slight, 400 = small, and 500 = modest.
[f] 100 = Standard, 200 = Select, 300 = Choice, and 400 = Prime.

A Comparison of Mass Antibiotic Treatments on Arrival with Regards to Morbidity, Mortality, and Performance in Arkansas Stocker Cattle[1]

Dianne Hellwig, Beth Kegley, and Sally Silzell[2]

Story in Brief

The objectives of this study were to examine economical and easily implemented methods of preventative antibiotic treatment for stressed calves that will be entering a stocker or backgrounding facility. Eighty-eight crossbred heifer calves (400 to 500 lbs) were used to compare the feeding of chlortetracycline in the receiving diet from days 2 to 6 after arrival, with a single injection of tilmicosin phosphate. The animals were allocated randomly to treatment groups, and placed in one of 16, 1.1-acre grass lots. Group 1 received chlortetracycline (1 g / 100 lbs body weight [BW] / day), top-dressed on the supplement from days 2 to 6. Group 2 was mass medicated with tilmicosin phosphate (4.5 mg / lbs BW) at processing. The probability of being treated for respiratory disease (morbidity) in the tilmicosin group was significantly lower than in the chlortetracycline group. While medication cost and number of treatment failures were not significantly different between groups, the tilmicosin group had average lower medication costs than the chlortetracycline group ($1.62 / pen vs. $ 2.51 / pen). In addition, the number of animals that were treated for respiratory disease more than once was lower in the tilmicosin group than in the chlortetracycline group (5 vs. 14). Highly stressed calves may not begin eating soon enough to allow antibiotic in the feed to reach effective levels in the body. The use of an injectable antibiotic at arrival in calves that are at high risk for developing respiratory disease will result in lower medication cost and decrease the labor involved with treatment.

Introduction

The production of stocker cattle continues to be a viable alternative to the traditional cow / calf operations in Arkansas. The state's climate and terrain are well suited for grazing calves before entry into the feedlot. In order to foster the continued growth of this industry in Arkansas, it is important to look for management practices for this production system that are easily implemented and economically sound. These 400- to 600-lb calves are often purchased from the southeastern United States and shipped long distances to their destination. Bovine respiratory disease is a common sequel to the shipping and co-mingling of calves at the salebarn. Researchers have reported that mass anti-microbial medication of southern-source, highly-stressed cattle can reduce morbidity and the medication costs associated with bovine respiratory disease. Several methods have been tried, including feed grade antibiotics (Perry et al., 1971, 1986) and those that are administered by injection (Schumann et al., 1991; Gaylean et al, 1995; Brazle et al., 1997). The antibiotics should reach therapeutic levels by the time the animal begins to show signs of disease. In several trials antibiotic treatment has also resulted in improved performance (Perry et al., 1971; Galyean et al., 1995). The objectives of this study were to compare the use of different methods of mass medication in calves that are at high risk for the development of bovine respiratory disease. The effectiveness and cost of using each of these methods were examined.

Experimental Procedures

Eighty-eight, cross-bred heifer calves (400 to 500 lbs) were purchased at several salebarns in south central Arkansas and delivered as one group to the University of Arkansas Beef Research Facility in Savoy. The animals were weighed and processed within 24 hours. Processing included injections with

[1] The authors wish to acknowledge the generous contributions of product by the following companies: Merial Animal Health, Rahway, New Jersey; Roche Animal Health, Paramus, New Jersey; Bayer Corporation, Shawnee Mission, Kansas; and Elanco Animal Health, Indianapolis, Indiana.

[2] All authors are associated with the Department of Animal Science, Fayetteville.

a 7-way clostridial vaccine (Vision-7®, Bayer Corporation, Shawnee Mission, Kansas), and a 3-way modified-live viral vaccine containing infectious bovine rhinotracheitis virus, bovine viral diarrhea virus, and parainfluenza$_3$ virus (Fusion-3®, Merial Animal Health, Rahway, New Jersey). In addition, they received an injection with a bacterin containing *Pasteurella multocida, Pasteurella haemolytica, Haemophilus somnus*, and *Salmonella typhimurium* (Poly-Bac HS®, Texas Veterinary Labs, San Angelo, Texas) and a dose of Ivomec® pour-on (Merial Animal Health, Rahway, New Jersey). All vaccinations were boosted 14 days after the initial vaccination. All animals were given access to round bales of mixed-grass hay and a corn-soybean meal supplement (4 lbs / head / day). The animals were blocked by body weight (BW), allocated randomly to treatment groups, and placed in 1 of 16, 1.1-acre grass lots. Animals in the lower BW blocks were placed in groups of six, whereas the animals in the heavier BW blocks were placed in groups of five. Treatments were assigned randomly to the lots, with each BW group having an equal representation across treatments and resulting in 44 animals in each treatment group. Group 1 received chlortetracycline (Aureomycin 50®, Roche Animal Nutrition and Health, Paramus, New Jersey; 1 gm / 100 lbs BW / day), top-dressed on the grain supplement from days 2 to 6. Group 2 was mass medicated with tilmicosin phosphate (Micotil®, Elanco Animal Health, Indianapolis, Indiana; 4.5 mg/ lb BW) at processing.The groups were compared with regards to morbidity (treatment for respiratory disease), mortality, number of days to first treatment for respiratory disease, and number of re-treatments for respiratory disease. Animals were observed daily at feeding. Animals showing clinical signs of respiratory disease and had a body temperature of 104^0 F or greater were treated with antibiotics according to established protocol for the facility. Body weights were taken on arrival, day 14, 28, and 41. Chi-square analysis was used to compare morbidity, mortality, number of days to first treatment, and number of relapses. Analysis of variance was used to compare medication cost and average daily gain (ADG).

Results and Discussion

The probability of treatment for respiratory disease (morbidity) in the tilmicosin group was significantly lower than in the chlortetracycline group ($P < 0.05$) (Table 1). There were no significant differences with regards to mortality and ADG. While medication costs and number of relapses was not significantly different between groups, the tilmicosin group had lower average medication costs than the chlortetracycline group ($1.62 / head vs. $2.51 / head). In addition, the data suggests that there is an advantage to using injectable antibiotic mass treatment over mass treatment with antibiotics in the feed when cattle are at high risk for respiratory disease.

Implications

Lighter weight, highly-stressed cattle will take longer to consume adequate amounts of medicated feed, giving injectable antibiotics the edge for reaching therapeutic levels in the face of respiratory challenge. It is important to also consider the cost of each treatment with respect to the risk for respiratory disease in a given group of cattle. The cost for using tilmicosin phosphate is approximately $9.00 to $10.00 / head. The cost for using chlortetracycline in the feed is less than $ .50 / head / day ($ 2.50 for 5 days of treatment). In cattle that are less stressed and at lower risk for respiratory challenge, it may be more cost effective to use antibiotics in the feed. The antibiotic and labor costs with a group of high-risk cattle that will not consume enough antibiotic in the feed, may far exceed the initial cost of injectable antibiotic.

References

Brazle, F. K. 1997. Prof. Animal Science. 13:141.
Galyean, M. L., et al. 1995. 73:1219.
Perry, T. W., et al. 1971. 32:137
Perry, T. W., et al. 1986. 62:1215
Schumann, F. J., et al. 1991. 128:278

Table 1. Health and production data.

	Treatments	
	Micotil®	Aureomycin 50®
Morbidity, %[1]	44	47
No. of re-treats, %	5	14
Medication cost, average	$ 1.62	$ 2.51
ADG, lb	1.5	1.5

[1]($P < 0.05$).

The Immune Response and Performance of Calves Supplemented with Zinc from an Organic and an Inorganic Source

Beth Kegley and Sally Silzell[1]

Story in Brief

Two experiments were conducted to determine the effect of supplemental zinc from organic and inorganic sources on performance, zinc status, and immune response. Treatments consisted of 1) control (no supplemental zinc), 2) zinc sulfate, or 3) zinc amino acid complex. Zinc was added to provide 360 mg of zinc / day. Experiment 1 was a 28-day study using eighty-four steers. Steers were fed bermudagrass hay (21 ppm zinc) with 4 lbs / animal / day of supplement. Experiment 2 used seventy-five heifers for a 140-day trial, the bermudagrass hay used contained 39 ppm zinc. In Experiment 1, average daily gain (ADG) was increased ($P < .04$) from day 15 to 28 in calves fed supplemental zinc amino acid, but ADG was not affected for the entire study. In Experiment 2 there was no effect on ADG as a result of zinc supplementation. Serum zinc levels did not differ because of dietary treatment. In Experiment 2, the zinc-supplemented heifers had a greater response ($P < .07$) to phytohemagglutinin 24 hours after an intradermal injection. There was a tendency for a benefit of supplemental zinc amino acid complex during the receiving study with zinc-deficient hay. However, there was no benefit of supplemental zinc on calf growth when the hay contained adequate zinc.

Introduction

Backgrounding stocker calves is a growing industry in Arkansas. Sick calves are a costly economic problem for cattle feeders. The stress associated with weaning and shipping calves increases their susceptibility to infection. Nutritional modification of the immune response of newly received cattle may be beneficial. More information is needed regarding the level and type of trace minerals to include in diets. Supplementing zinc methionine to cattle has improved immune response, performance, and carcass quality in research trials. Research data from chicks indicated that a zinc amino acid complex was equal in bioavailability to zinc methionine, and both were more bioavailable than zinc sulfate. Zinc methionine is a complex containing a 1:1 ratio of zinc and methionine, while zinc amino acid complex is a 1:1 ratio of zinc with a non-specified amino acid. The bioavailability of zinc amino acid complex has not been assessed in cattle. The objective of the following studies was to determine the effect of supplemental zinc from organic and inorganic sources on performance, zinc status, and immune response of calves.

Experimental Procedures

Experiment 1. This receiving trial was conducted at the Livestock and Forestry Branch Station in Batesville, and began on February 6. Eighty-four bulls and steers were obtained from an order buyer. Calves were assigned to the following treatments: 1) control (no supplemental zinc), 2) zinc sulfate, or 3) zinc amino acid complex. Zinc was added to provide 360 mg of zinc / day. The composition of the supplements is shown in Table 1. Each treatment had four replicates with each replicate consisting of seven animals.

On day 0, calves were injected with the following vaccines: an eight-way clostridial vaccine; a modified-live infectious bovine rhinotracheitis (IBRV), parainfluenza$_3$, bovine viral diarrhea, and killed bovine respiratory syncytial virus vaccine; and a *Pastuerella hemolytica* toxoid vaccine. Calves were implanted and dewormed. Bulls were castrated and calves with horns were tipped. Steers were kept in five-acre mixed grass pastures and fed bermudagrass hay with 4 lbs / animal / day of supplement (Table 1), which served as the carrier of the treatments. Body weights (BW) were obtained on two consecutive

[1] Both authors are associated with the Department of Animal Science, Fayetteville.

days at the beginning and end of the 28-day study. An interim weight was taken on day 14. Steers were observed daily for signs of illness and steers with a body temperature greater than 104° F were treated with antibiotics. Total white blood cell counts were determined on day 14 and 28. Blood was obtained on day 28 and analyzed for serum zinc concentrations.

Experiment 2. Seventy-five Angus crossbred heifers were obtained from the Livestock and Forestry Branch Station at Batesville and the Southwest Research and Extension Center at Hope. Heifers were shipped on November 18 to the Stocker Receiving Research and Teaching Facility at Savoy, where this receiving and growing trial was conducted. Heifers were assigned the same dietary treatments, processing, and feeding procedures as in Experiment 1. Heifers were held in 1.1-acre pastures.

Weights were obtained at the beginning and end of the 140-day study, and on days 14, 28, 56, 84, and 112. Samples for serum zinc determinations were taken at 28-day intervals. Total white blood cell counts were done on day 28. In addition, cell-mediated immunity was measured on day 71 by determining the heifers' ability to respond to an intradermal injection of 150 Mg of phytohemagglutinin (PHA). Differences in skinfold thickness at the injection site were reported.

Results and Discussion

The requirement for zinc in beef cattle diets is estimated to be 30 ppm (NRC, 1996). However, the zinc requirement may be increased by stress (estimated to be 75 to 100 ppm). One contributing factor is that stressed calves typically reduce their feed intake, so the concentration of zinc needed in the diet would be increased. The hay used in Experiment 1 contained 21 ppm zinc and 38 ppm zinc in Experiment 2. Therefore, using estimates for hay intake, the control diet in Experiment 1 contained 23 ppm zinc and the control diet in Experiment 2 contained 38 ppm zinc. The supplemental zinc diets added approximately 24 ppm of zinc.

In Experiment 1, ADG (Table 2) was increased ($P < .04$) from day 15 to 28 in calves fed supplemental zinc amino acid complex compared to calves fed zinc sulfate. However, ADG for the 28-day receiving period was not affected by supplemental zinc in either trial. In Experiment 2, supplemental zinc level or source did not affect ADG throughout the 140-day growing trial. The control diet in Experiment 2 did contain a higher concentration of zinc than the estimated requirement.

Normal serum zinc concentrations for cattle are between 0.8 to 1.2 mg/L. In Experiment 2, the dietary treatment means for serum zinc concentrations (Fig. 1) were within the normal range and did not differ due to dietary treatment at any sampling time. In Experiment 1, serum zinc concentrations were not affected by supplemental zinc on day 28 (Table 2).

The percentage of calves in Experiment 1 that were treated with antibiotics during the receiving phase (Table 2) did not differ significantly due to supplemental zinc. Although numerically fewer calves on the supplemental zinc diets required antibiotic treatment, some calves on the supplemental zinc treatments did require multiple treatments of antibiotic. There were no calves observed sick in Experiment 2. There was no effect of dietary treatment on total white blood cell counts on day 14 or 28 in Experiment 1 or on day 28 in Experiment 2. Zinc supplemented heifers in Experiment 2 did have a greater response ($P < .07$) to the intradermal injection of PHA at 24 hours after injection (Fig. 2). This would indicate a more responsive cell mediated immune system.

Implications

Hay at the Agricultural Experiment Station in Batesville, was deficient in zinc and when used in a short study, supplementing zinc amino acid complex had a slight positive effect on growth. Hay at the Agricultural Experiment Station in Savoy, contained adequate zinc, and there was no effect on growth of adding zinc to supplements.

References

NRC. 1996. Nutrient Requirements of Beef Cattle 7th rev. Ed. National Academy of Science. Washington, D.C.

Table 1. Composition of supplements fed in experiments[a].

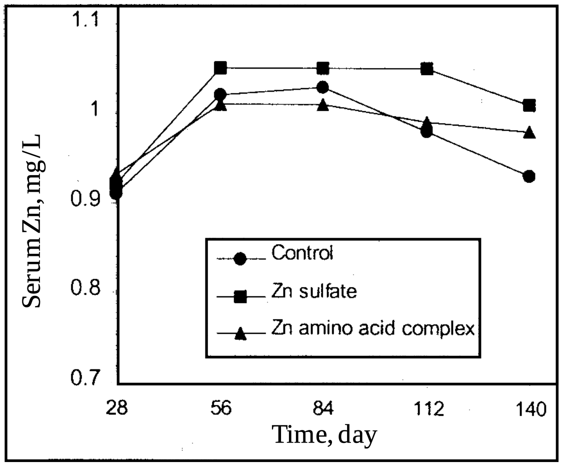
Ingredient	Control	Supplement Zinc Sulfate,%	Zinc Amino Acid Complex
Corn	82	82	82
Wheat middlings	14.25	14.25	14.25
Molasses	2	2	2
White salt	1	1	1
Limestone	0.5	0.5	0.5
Vitamin premix[b]	0.18	0.18	0.18
Rumensin 80	0.0625	0.0625	0.0625
Trace mineral premix[c]	0.0617	0.0617	0.0617
Zinc sulfate	0	0.0552	0
Availa®Zn 100	0	0	0.199

[a] Fed 4 lbs/calf/day, supplements were pelleted.
[b] Vitamin premix supplied in IU/lb of supplement: 7,200 Vitamin A, 1,440 Vitamin D_3, and 0.9 Vitamin E.
[c] Trace mineral premix supplied in ppm of supplement: 66.3 copper from copper sulfate, 158 manganese from manganese oxide, 0.83 selenium from sodium selenite, 4.14 iodine from calcium iodate, and 0.83 cobalt from cobalt carbonate.

Table 2. Effect of supplemental zinc level and source on performance of calves.

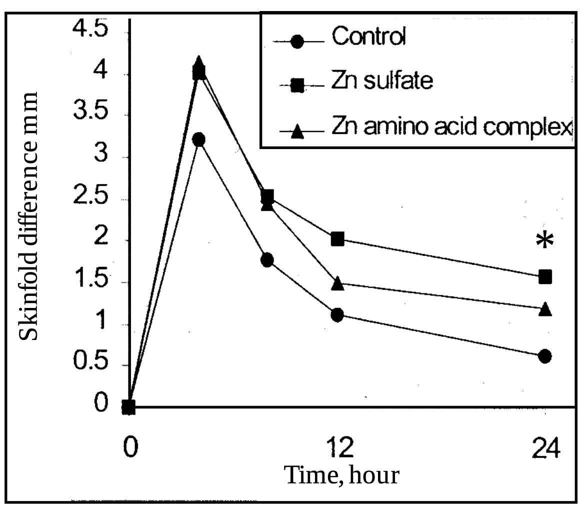
Item	Control	Zinc sulfate[a]	Zinc amino acid complex[a]	SE
Experiment 1				
Initial wt, lb	529	529	531	1.1
Final wt, lb	591	591	600	5.3
Average daily gain, lb				
Days 1 to 14	2.78	3.02	2.58	0.324
Days 15 to 28	1.68	1.30[b]	2.36[b]	0.269
Days 1 to 28	2.23	2.16	2.47	0.161
Calves treated/total calves	7/28	6/28	5/28	
Treatments/treated calf	7/7	8/6	7/5	
Day 28 serum zinc,mg/L	0.84	0.83	0.91	0.046
Experiment 2				
Initial wt, lb	396	395	396	0.46
Final wt, lb	577	567	579	6.3
Average daily gain, lb				
Days 1 to 28	2.49	2.25	2.47	0.11
Days 1 to 140	1.30	1.23	1.30	0.04
Calves treated/total calves	0/25	0/25	0/25	

[a] Zinc supplemented at 360 mg/d as zinc sulfate or zinc amino acid complex.
[b] Significant difference ($P < .05$) between zinc sulfate and zinc amino acid complex supplementation.



Pooled SE = 0.031 mg/L

Fig. 1. Effect of supplemental zinc level and source on serum zinc in Experiment 2.



Pooled SE = 0.416 mm

Fig. 2. Effect of supplemental zinc level and source on resonse to an intradermal injection of phytohemagglutinin.
***Control vs. supplemental zinc (P<.07).**

Effects of Long-Term Low Level Infusion of Gonadotropin Releasing Hormone (GnRH) on Postpartum Reproduction in Suckled Beef Cows

David Kreider, Rick Rorie, Heather Gadberry, Jason Martin, and Frank Miller[1]

Story in Brief

Two experiments were conducted on suckled beef cows to determine the effects of 14-day low level infusions of gonadotropin releasing hormone (GnRH) on length of postpartum anestrus period. In Experiment 1, 40 crossbred cows were randomly assigned to one of four treatments at 21 to 27 days after calving. Osmotic minipumps implanted at the base of the ear delivered: control, .5 uL saline/hr; Treatment 2, 125 ng GnRH/hr; Treatment 3, 250 ng GnRH/hr; and Treatment 4, 250 ng GnRH/hr, plus IM injection of 300 ug of GnRH (Cysterelin) at pump removal. Initial body weight (BW) and body condition score (BCS), pregnancy rates, and days to conception were not different between treatments ($P > .10$). Days to first postpartum estrus determined by serum progesterone (P4) were reduced in all treatments vs. controls ($P < .05$). Treatments in Experiment 2 were as in Experiment 1, except treatment 4 was deleted and pumps were implanted 14 to 20 days after calving. Initial BW and BCS, and pregnancy rates were not different ($P>.10$) and infusion of GnRH at 14 to 21 days after calving did not alter the postpartum interval. This study suggests length of postpartum anestrus in suckled beef cows can be reduced by infusion of GnRH for 14 days beginning at 21 to 27 days after calving. Infusions started at 14 to 20 days after calving did not affect length of anestrus.

Introduction

Arkansas ranks 12th nationally in beef cows on farms with the majority of producers involved in cow/calf production. Reproduction has long been recognized as the most important factor affecting economic efficiency of beef cattle production, and long postpartum anestrus periods are a major cause of low reproductive efficiency (Casida, 1971). Assuming a gestation length of 283 days, a cow must cycle and rebreed within 82 days after calving to calve each year. A 65-day interval from calving to first estrus will allow a cow only one chance to rebreed. Thus, the interval to first estrus can have a major impact on reproductive efficiency.

Ovulation and estrus can be induced in anestrus cattle by frequent low level injections of gonadotropin releasing hormone (GnRH) (Edwards et al., 1983). It has been suggested that the pulsatile GnRH pattern is necessary for ovarian activity to begin. It is possible however, that the postpartum interval can be reduced by continuous infusion of low levels of GnRH. Use of a slow-release injectable product, or an implant to release low levels of GnRH over a prolonged period would be more practical than frequent injections. This study was conducted to determine if length of the postpartum anestrus period of suckled beef cows can be reduced by low level infusions of GnRH.

Materials and Methods

Experiment 1. Experiment 1 was conducted to determine if 14-day infusions of low levels of GnRH initiated at 21 to 27 days after calving would improve reproductive function in postpartum suckled beef cows. Forty crossbred beef cows from the University of Arkansas Beef Research herd at Savoy were used. During the experiment, cows and calves were maintained in one group on the same mixed fescue *(Festuca arundinacea)* and clover *(Trifolium repens* and *Trifolium dubium)* pasture, with free access to a mineral supplement and water. Cows received 2 lbs/head/day of 20% crude protein (CP) range cubes and were supplemented with hay as needed.

At 21 to 27 days postpartum cows were weighed, body condition scored (BCS of 1 to 9 with 1 being extremely emaciated and 9 being extremely obese) and then randomly assigned to one of four treatment groups, (10 cows/group). Cows were implanted (subcutaneously) with an osmotic mini-pump (Alzet model 2002, Alza Corp., Palo Alto, California) at the base of the right ear according to the following treatment groups. Control cows were implanted with pumps that delivered .5 uL of saline/hour/day. Treatment 2 cows were implanted with pumps that delivered 125 ng GnRH/hour/day. Treatment 3 cows were implanted with pumps that delivered 250 ng GnRH/hour/day.

[1]All authors are associated with the Department of Animal Science, Fayetteville.

Treatment 4 cows were implanted with mini-pumps that delivered at 250 ng GnRH/hour/day and then received a single intramuscular injection of 300 ug of Cysterelin (Gonadorelin Diacetate Tetrahydrate, Sanofi Animal Health Inc., Overland Park, Kansas) on the day the implant was removed. Mini-pumps were designed to function for 14 days and then were removed from cows, regardless of treatment.

Blood samples were collected via tail vein puncture on the day treatments were started and every 7 days thereafter until the start of the breeding season. Blood samples were allowed to clot and centrifuged at 2000 x g for 30 minutes. Serum was removed and stored frozen at -20°C until assayed for P4 by radioimmunoassay (RIA).

Estrus was determined by two out of three consecutive weekly serum P4 concentrations greater than or equal to 1 ng/ml. Estrus was assumed to occur before the first elevated progersterone (P4) concentration greater than or equal to l ng/ml (Stabenfeldt et al., 1969; Wettemann et al., 1972).

Experiment 2. Experiment 2 was similar to Experiment 1 except that cows were implanted with mini-pumps at 14 to 20 days after calving to determine if cows would respond favorably to low level GnRH infusion earlier in the postpartum period. Treatments were identical to those in Experiment 1 except that Treatment 4 was not included. All other factors were similar to Experiment 1.

Statistical Analysis. Mean differences in postpartum interval, beginning body weight (BW) and BCS of cows, pregnancy rates 60-90 days after the breeding season, and days to conception were evaluated by analysis of variance using GLM procedure of SAS (1988). Least squares means were separated by the least significant difference procedure.

Results

Experiment 1. Data for Experiment 1 is summarized in Table 1. Average BW and BCS at the start of the experiment were not different among treatment groups. Average days to first estrus determined by the first 2 of 3 elevated P4 concentrations greater than or equal to l ng/ml was significantly (P<.05) reduced in all treatment groups versus controls, but was not different (P>.05) between any of the GnRH infused treatments. The number of cows judged to be pregnant by rectal palpation at 60 to 90 days after the end of the breeding season (Table 1) was not significantly different between treatments (P>.10).

Average days from calving to conception (calculated from calving date) is also given in Table 1. All treatment groups had numerically shorter average intervals from calving to conception as compared to controls but differences were not significant (P>.10).

Experiment 2. Data for Experiment 2 is summarized in Table 2. As in Experiment 1, average BW and BCS at the beginning of the experiment were similar (P>.10) between treatment groups.

In contrast to the data in Experiment 1, days to the first estrus determined by P4 concentrations in Experiment 2 were not significantly different between treatment groups (P>.10).

The number of cows pregnant 60 to 90 days after the breeding season by treatment is also presented in Table 2. Pregnancy rate for controls was 50%, whereas, Treatment 2 and Treatment 3 had pregnancy rates of 82% and 90% respectively. However, these differences between treatments were not statistically (P>.10) valid, due to the small number of animals per treatment group.

Discussion

The BCS scores in Experiment 1 (Table 1) as well as those in Experiment 2 (Table 2), are comparable to the minimum BCS of 5 at calving suggested by Dzuik and Bellows (1983) to ensure that body stores of nutrients are adequate to support postpartum reproduction.

The procedures used in Experiment 1 successfully shortened the postpartum anestrous period through the use of low level infusions of GnRH over a 14-day period. In Experiment 2 of this study however, infusions at 14 to 20 days postpartum were not effective initiating cycling versus controls. The findings in Experiment 2 are in contrast to the findings of Roberge et al. (1994) who was able to shorten the postpartum anestrous period in suckled beef cows by using a microencapsulated lutenizing hormone releasing hormone analog injected at 5 days postpartum. It is possible that the slow release preparation used by Roberge et al. (1994) may have released different amounts of GnRH than the osmotically driven devices used in our study. Our study is in agreement with Short et al. (1990) who observed that the functional competence of the hypothalamus and pituitary is decreased for a 10- to 20-day period after calving. During this time, the amount of lutenizing hormone (LH) in the pituitary is lower, less LH is released in response to either estradiol or GnRH, and the bioactivity of LH is lower.

Low level infusions of GnRH in this study did not significantly affect pregnancy rates or days to conception in either Experiment 1 or 2. The control group in Experiment 2 had a pregnancy rate of only 50% at 60 to 90 days after the breeding season, but this was most likely due to random variation and relatively small numbers of animals per group and was not statistically significant.

Implications

Results of the Experiment 1 indicate that the postpartum period in suckled beef cows can be shortened by the infusion of low level GnRH over a 14-day period at 21 to 27 days postpartum. Further research is needed to determine the optimal postpartum dosage of GnRH and the time of infusion which is most effective in improving reproductive performance.

References

Casida, L.E. 1971. J. Anim. Sci. (Suppl 1):66.
Dzuik, P.J., and R.A. Bellows. 1983. J. Anim. Sci. 57 (Suppl 2):355.
Edwards, S., et al. 1983. J. Reprod. Fertil. 69:65.
Roberge, S., et al. 1992. J. Anim. Sci. 70:3825-3830.
SAS. 1988. SAS/STAT User's Guide (Release 6.03). SAS Inst., Inc. Cary, North Carolina.
Short, R.E., et al. 1990. J. Anim. Sci. 68:799-816.
Stabenfeldt, G.H., et al. 1969. J. Reprod. Fertil. 19:433.
Wettemann, R.P., et al. 1972. J. Anim. Sci. 34:1020

Table 1. Summary of reproductive performance for cows in Experiment 1.

	Treatments			
Variable: (Mean ± SE)	1 (Control)	2 (125 ng/h)	3 (250 ng/h)	4 (250 ng/h +)
Number of cows	10	10	10	10
Initial BW, lb	1089± 62	1061 ± 45	1117 ± 39	1044 ± 27
BCS	5.1 ± .2	5.3 ± .2	5.3 ± .2	5.1 ± .2
Days to estrus determined by P4[1]	59.8 ± 3.3[a]	41.3 ± 6.0[b]	41.3 ± 5.2[b]	39.2 ± 6.4[b]
Number Pregnant	8	7	7	8
Days to conception	83.1 ± 9.1	76.8 ± 7.3	80.3 ± 8.2	75.5 ± 15.2

[ab]Means in the same row with different superscripts are significantly different (P > .05).
[1]P4 concentration greater than 1 ng/ml in any two of three consecutive weekly serum samples.

Table 2. Summary of reproductive performance for cows in Experiment 2.

	Treatments		
Variable: (Mean ± SE)	1 (Control)	2 (125 ng/h)	3 (250 ng/h)
Number of cows	11	11	10
Initial BW, lb	1104 ± 115	1094 ± 90	1181 ± 139
BCS (1-9)	4.9 ± .7	5.0 ± .5	5.4 ± .5
Days to estrus determined by P4[1]	55.8 ± 6.5	56.6 ± 6.8	57.4 ± 2.6
Number Pregnant	5	9	9

[1]P4 concentration greater than 1 ng/ml in any two of three consecutive weekly serum samples.

Effect of Fescue Endophyte Toxins on Conception Rate, Embryo Development, and Reproductive Tract Function in Beef Cattle

Rick Rorie, David Kreider, Ed Piper, and David Hazlett[1]

Story in Brief

The effect of feeding endophyte-infected fescue seed on conception rate and embryonic development through the second week of gestation was evaluated. Crossbred beef heifers (n = 20) were individually fed supplements containing either oats, or endophyte-infected fescue seed for 100 days. The heifers were synchronized and inseminated. Non-surgical embryo collections were performed 15 to 16 days after estrus. After each embryo collection, the heifers were injected with Lutalyse® and inseminated at the induced estrus. The procedures above were repeated, allowing for embryo recoveries to be performed on the heifers at approximately 20-day intervals for the duration of the study. Heifers fed fescue seed gained less body weight (BW) and had reduced serum prolactin, as has been noted for animals grazing endophyte-infected fescue. The percentage of heifers observed in estrus after Lutalyse® treatment and overall conception rates were similar between treatments. Embryo development, as measured by embryo protein content, was not affected by treatment. Serum progesterone levels were not affected by treatment diet. Serum insulin growth factor I was reduced in heifers fed fescue seed as compared with control animals. The results of this study indicate that fescue endophyte toxins do not adversely affect reproductive function in cattle during the first two weeks of gestation.

Introduction

Tall fescue (*Festuca arundinacea*) is grown on over 34 million acres in the United States. There is no acceptable, alternative cool-season forage source available for many livestock producers. Most of the fescue acreage is infected with the systemic endophyte *Neotyphodium coenophialum*. Ergopeptide alkaloids (toxins) produced by the endophyte have a number of detrimental effects on the performance of cattle, including a reduction in body weight (BW) gains, milk production, and reproductive performance. Reproductive losses in cattle because of consumption of endophyte-infected fescue are well documented and estimated at 354 million dollars annually. Pregnancy failure attributed to endophyte-infected fescue typically occurs before the second month of gestation, but little is known about what factors may contribute to this loss. If the factors contributing to this pregnancy failure could be identified, then strategies could be developed to alleviate the loss. We have tried to take a systematic approach to identifying these factors, starting at fertilization. Our previous studies indicate that significant reproductive loss does not occur until after fertilization and the first week of embryo development. The present study was conducted to evaluate the affect of endophyte-infected fescue on embryo development and reproductive tract function through the second week of development.

Experimental Procedures

During April through mid-July of 1996, a study was conducted to evaluate the effects of feeding endophyte-infected fescue seed on embryonic development through the second week of gestation. Twenty cycling, crossbred beef heifers weighing between 650 to 800 lbs were placed in drylot and fed bermudagrass hay. The heifers were also individually fed supplements containing either oats (control) or endophyte-infected fescue seed (treatment) for approximately 100 days. The supplements were formulated to provide equal levels of protein and energy. The fescue seed supplement contained

[1] All authors are associated with the Department of Animal Science, Fayetteville.

enough seed to provide approximately 10 mg of ergopeptide alkaloid, ergovaline daily. Throughout the study, the daily high and low temperature as well as humidity were recorded. The heifers were weighed at 30, 60, and 90 days of the study.

At the start of the study, the reproductive cycles of the heifers were synchronized with Lutalyse® and the heifers were artificially inseminated at 12 hours after the onset of estrus (heat). Non-surgical embryo collections were performed 15 to 16 days after estrus. Before each embryo recovery, ultrasonography was used to confirm the presence of a corpus luteum and to record the size of the ovaries, corpus luteum, and antral-stage follicles. The size of recovered embryos was determined based on their protein content. After embryo collection, the heifers were injected with Lutalyse® and again artificially inseminated at estrus. The procedures above were repeated, allowing for embryo recoveries to be performed on the heifers at approximately 20-day intervals for the duration of the study (potential of five embryo recoveries per heifer). Blood samples were collected at each embryo collection and serum analyzed for prolactin, progesterone, and insulin growth factor (IGF) I and II levels. Saline used for embryo recovery was also analyzed for IGF I and II.

Results and Discussion

Data comparing the average daily gain (ADG), percentage of heifers expressing estrus and conceiving, embryo size (protein content) and number of follicles present on the ovaries of control and treatment heifers are presented in Table 1. Heifers fed the control (oat) supplement gained approximately 0.5 lbs more BW per day than the heifers fed the fescue seed supplement, but this difference was not statistically significant (P = .255). The mean high temperature during the first, second, and third 30-day weighing periods of the study were 71, 75, and 84° F, respectively. The difference noted in BW gain was a result of the heifers fed fescue seed gaining no BW during the third 30-day period, when the high temperature averaged 84° F. The difference in BW gain observed in this study is typical of that seen in cattle grazing endophyte-infected fescue. Previous studies comparing BW gain of cattle which grazed either endophyte-infected or endophyte-free fescue have shown that the reduction in BW gain in cattle grazing endophyte-infected fescue is most dramatic during hot weather. This effect has been attributed to fescue endophyte toxins which constrict peripheral circulation, resulting in the animal retaining more body heat and becoming more prone to heat stress.

Across replicates (embryo collections), 78 and 84% of the heifers fed fescue seed or control supplements, respectively, were observed in estrus after Lutalyse® treatment and were inseminated. Overall conception rates (based on embryo recovery rates) of heifers observed in estrus and bred were similar (P = .697) for the heifers fed control and fescue seed supplements (74 and 78%, respectively). These results confirm our previous study that indicated fertilization and early development are not effected by endophyte-infected fescue. The protein content of embryos recovered from the heifers in this study was determined as a basis for comparing embryo size. This was of interest because embryos that are smaller or retarded in development may not produce adequate amounts of protein signal necessary for pregnancy recognition. Mean protein content of embryos recovered from heifers fed control and fescue seed supplements was similar (P = .509), indicating that embryo development during the second week of gestation appeared to be normal.

A previous study has reported that the number of follicles present on the ovaries of heifers on endophyte-infected fescue is reduced by 50% or more. A reduction in the number of follicles could result in extended or erratic estrous cycles and lower fertility. In the present study, the number of medium and large follicles on the ovaries was determined by ultrasonography at each embryo collection. The mean number of medium (5 to 7 mm) and large (> 8 mm) follicles present on the ovaries of heifers fed the fescue seed and control supplements were found to be similar (P = .552). Therefore, our results do not support the previous report that fescue endophyte toxins reduce follicular development.

Data comparing serum prolactin, progesterone, IGF I and II, and uterine IGF I and II levels between the control and treatment heifers are presented in Table 2. Consumption of endophyte-infected fescue is known to reduce serum prolactin levels and thus, serum prolactin is routinely used as an indicator that cattle are affected by fescue endophyte toxins. Throughout the study, serum prolactin was reduced (P =.008) in the heifers fed the fescue seed supplement compared to the control heifers. There has been speculation that altered luteal function, resulting in inadequate progesterone to maintain pregnancy, could be a consequence of cattle consuming endophyte-infected fescue. Therefore, we measured corpus luteum size and serum progesterone after each embryo recovery. Mean serum progesterone was similar (P = .688) at 6.6 ng/ml for the control heifers and 6.9 ng/ml for the heifers fed fescue seed, while *corpora lutea* diameters averaged approximately 2 cm for heifers on both groups. These results would indicate that luteal insufficiency does not contribute to reproductive failure associated with endophyte-infected fescue.

Insulin growth factor I and II together have been shown to enhance the production of the pregnancy recognition protein by elongating embryos. Also, maternal IGF I levels have been reported to be correlated with bovine fetal size. Therefore, the effect of endophyte-infected fescue on serum and uterine levels of IGF I and II, and possible implications on pregnancy establishment were investigated in this study. Overall, serum IGF I levels were reduced (P = .059) in heifers fed fescue seed as compared with control animals, but IGF II levels were not affected (P = .917) by treatment. The reduction in serum IGF I in the heifers fed fescue seed is likely a reflection of the reduction in ADG for this group. Uterine IGF I and II were compared on the basis of ng/ml of protein in the flush medium. Both uterine IGF I and II were similar (P = .263) between heifers fed fescue seed or oat supplements.

Implications

This study indicates that the reproductive function of heifers on endophyte-infected fescue is normal for at least the first two weeks of gestation. The effects of endophyte-infected fescue on embryo-maternal interaction necessary for pregnancy recognition and establishment merits further investigation.

Table 1. Effect of fescue endophyte toxins on weight gain, conception rate, embryo development, and ovarian follicular development.

	Treatment group	
Item	Control	Fescue
ADG, lb	2.16	1.63
Heifers observed in estrus, %	84	78
Overall conception rate, %	74	78
Mean protein content of embryos, µg	518	444
Number of small follicles, 5-7 mm	3.2	3.3
Number of large follicles, over 8 mm	1.6	1.8

Table 2. Effect of fescue endophyte toxins on mean prolactin, progesterone, and insulin growth factor I and II.

	Treatment group	
Item	Control	Fescue
	– – – – – – – – – – – ng/ml[e] – – – – – – – – – –	
Prolactin	98.2[b]	19.6[a]
Progesterone	6.6	6.9
Serum IGF I	100.7[d]	84.9[c]
Serum IGF II	57.3	57.1
Uterine IGF I	0.50	0.38
Uterine IGF II	1.41	1.07

[ab] Numbers within rows with differing superscripts are significantly different (P = .008).
[cd] Numbers within rows with differing superscripts are significantly different (P = .059).
[e] Prolactin, progesterone, and IGF values are ng/ml

Clostridial Vaccination Efficacy on Stimulating and Maintaining an Immune Response in Preweaned Beef Calves

Tom R. Troxel[1], Gary Burke[1], William Wallace[1], Larry Keaton[1], Stan McPeake[1], Dudley Smith,[2] and Ivan Nicholson[2]

Story in Brief

The objective of this experiment was to determine the efficacy in stimulating and maintaining an immune response in the presence of maternal antibodies and compare the extent of the responses to revaccination. One hundred eighteen nursing calves were randomly assigned to receive Alpha-7® (A7) or Ultrabac® 7 (UB7) at 50.4 days of age (day 0 = date of birth). Calves were revaccinated with the same treatment on day 170. Blood samples were collected from 10 calves of each treatment group on day 50, 170 (before revaccination), and on day 191 to determine antibody titers for overeating disease (*Cl. perfringens* type C), pulpy kidney (*Cl. perfringens* type D), and blackleg (*Cl. chauvoei*). The A7 treated calves tended to have higher antibody titers for overeating disease on day 170. The rate of change in pulpy kidney antibody titers from day 170 to day 191 tended to be higher for the UB7 treated calves compared with the A7 treated calves. There was also a tendency for enhanced blackleg antibody titers on day 191 for the A7 treated calves than for the UB7 treated calves.

Introduction

Clostridial diseases are a concern of cattle producers. Because clostridial diseases are often rapidly fatal and usually affect cattle six months to two years of age, most producers view vaccination as cheap insurance. Many clostridial vaccines require revaccination four to six weeks following the initial treatment (Compendium of Beef Products, 1993), but many cow/calf producers fail to revaccinate their calves at that time.

The objective of this experiment was to compare the effectiveness of a single injection of a 2-ml (Alpha-7®) vaccine with a single injection of a 5-ml (Ultrabac® 7) vaccine in stimulating and maintaining an immune response in the presence of maternal antibodies.

Experimental Procedures

Nursing crossbred beef calves (n = 118, from multiparous beef cows) born in February and March were used. At the time of treatment, the average calf age was 50.4 ± 15.30 days (mean ± standard deviation). All calves were individually identified and randomly assigned to receive Alpha-7® (A7) or Ultrabac® 7 (UB7). Alpha-7® (Boehringer-Ingelheim) bacterium-toxoid uses an oil adjuvant and is labeled for a single 2- ml injection. Ultrabac® 7 (SmithKline Beecham) is labeled for a 5-ml injection with revaccination in four to six weeks and uses an aluminum hydroxide adjuvant. Calves assigned to UB7 were not revaccinated four to six weeks following day 50. Revaccination was not completed because many cow/calf producers fail to revaccinate their calves according to label directions. This revaccination treatment schedule was conducted under veterinarian supervision. Both products protect beef cattle against *Cl. chauvoei* (blackleg), *Cl. septicum* (malignant edema), *Cl. novyi* (black disease) and *Cl. perfringens* types C (overeating disease) and D (pulpy kidney) according to the Compendium of Beef Products (1993). All injections were administered subcutaneously in the neck region using the tented technique. Sixty calves received A7 and 58 calves received UB7. Day 50 was used to designate the time of the initial clostridial treatment (day 0 = date of birth). All calves were revaccinated subcutaneously in the neck region with their assigned treatment onday 170. The dams of these calves do not receive annual clostridial vaccinations. They did, however, receive clostridial vaccinations as preweaning calves.

[1]Animal Science Section, Cooperative Extension Service, Little Rock.
[2]Boehringer-Ingelheim Animal Health, Inc., St. Joseph, Missouri.

Blood was collected via jugular vein puncture from 10 randomly selected calves of each treatment group immediately before each clostridial treatment (day 50 and 170) and on day 191. The same calves from each treatment group were sampled throughout the experimental period. Blood samples were placed in crushed ice immediately after collection. The serum was harvested and stored at -20° C until analyzed. Antitoxin units were determined for overeating disease and pulpy kidney by the antitoxin neutralization test as described by USDA:APHIS:VS (1985 and 1993, respectively), and agglutination titers were determined for blackleg by the serum agglutination test modified from Claus and Macheak (1972).

Calves served as experimental units. The data were analyzed as a complete randomized design. The data were tested for normality by the Shapiro-Wilk test (SAS, 1992). The null hypothesis was rejected ($P < .05$). Therefore, we concluded that the data were not normally distributed. Data within each time period were ranked, and ANOVA procedures were used to perform the Krushal-Wallis test (SAS, 1994). Ratio between two time periods were determined and ranked for analysis. If data were below detectable levels (1, .1, and 10 for overeating disease, pulpy kidney, and blackleg, respectively), the mid-point between the detectable level and 0 was assigned (.5, .05 and 5 for overeating disease, pulpy kidney, and blackleg, respectively). Because the data were not normally distributed, the variation around each mean value is not reported.

Results and Discussion

The average overeating disease antibody titer level was 12.1 on day 50 (probably as a result of maternal antibodies) and was not different across treatments (A7 or UB7, Table 1). The A7 treated calves had a tendency ($P < .10$) to have higher overeating disease serum antibody titers on day 170 than the UB7-treated calves (1.7 vs. 1.2). There also was a tendency ($P < .10$) for the change in overeating disease antibody titer levels of the UB7 treated calves from day 170 to day 191 to be greater than the A7 treated calves (1.2 to 7.6 and 1.7 to 4.3). This interaction was partially caused by the lower antibody titer levels of the UB7 treated calves on day 170; however, the overeating disease antibody titer levels on day 191 were not different ($P > .10$) across treatment groups. Overeating disease causes severe enteritis with diarrhea and dysentery in young lambs, calves, pigs, and foals. Usually calves 7- to 10-days-old are affected by overeating disease, but calves up to 10 weeks of age may also be affected. In very acute cases, death occurs in a few hours, sometimes without diarrhea being evident (Radostits et al., 1994).

Antibody titer levels for pulpy kidney were below detectable levels (<.1) on d 50, and the average antibody titer levels across treatment groups on day 170 were still very low. Pulpy kidney can cause sudden death in calves between one and four months of age. It is a short-term inhabitant that does not usually persist in the soil for more than one year (Radostits et al., 1994). The UB7 treated calves had a greater antibody titer increase ($P < .06$) from day 170 to day 191 than the A7 treated calves (.03 to 7.20 and .23 to 6.52).

Antibody titers for blackleg were similar for treatment groups on day 50 and day 170. There was a tendency ($P < .10$) for the A7 treated calves to have higher antibody titers on day 191 as compared to the UB7 treated calves (153.5 vs. 75.8). Blackleg affects growing cattle six months to two-years-old on good nutritional plans. It is a soil-borne infection which causes severe death losses unless cattle are vaccinated (Radostits et al., 1994).

Because calves were not sampled from day 50 to day 170, it is not known if antibody titers increased following the first treatment (day 50) and then decreased, or if maternal antibodies prevented response of the calves' immune system. Twenty-one days following revaccination (day 191) antibody titer levels for overeating disease and pulpy kidney increased compared with day 170 levels, but this was not the case for antibody titers for blackleg. Kennedy et al. (1977) reported an enhanced response to the second injection for blackleg in yearling calves when the time between injections was four or six weeks. This may suggest that waiting 120days (over 17 weeks) may be too long for an enhanced blackleg response to the second injection.

Implications

Many producers vaccinate suckling beef calves for clostridial diseases with one injection even though many vaccination labels state that two injections should be given. The data implied that vaccinating calves at 50 days of age and not again until weaning may not provide adequate protection against clostridial diseases. With proper management and vaccination timing, calf losses as a result of clostridial diseases may be prevented.

References

Claus, K. D., and M. E. Macheak. 1972. Am. J. Vet. Res. 33:1045.

Compendium of Beef Products. 1993. North American Compendiums, Inc. Port Huron, Michigan.

Kennedy, K. K., et al. 1977. Am. J. Vet. Res., Vol. 38, No. 10:1515-1517.

Radostits, O.M., et al. 1994. Bailliere Tindall, London NW1 7DX, England, Eighth Edition.

SAS. 1992. SAS Inst. Inc., Cary, North Carolina.

SAS. 1994. SAS Inst. Inc., Cary, North Carolina.

USDA:APHIS:VS. 1985. 9CFR 113.111.

USDA:APHIS:VS. 1993. 9CFR 113.112.

Table 1. The average antibody titers for overeating disease and pulpy kidney, and antibody titers for blackleg in serum of beef calves.

	Overeating Disease		Pulpy Kidney		Blackleg	
Day of Sampling	A7[a]	UB7[a]	A7	UB7	A7	UB7
Day 50	12.1	12.0	0[b]	0	22.0	46.0
Day 170[e, f]	1.7[c]	1.2[d]	.23	.03	34.0	16.5
Day 191	4.3	7.6	6.52	7.20	153.5[c]	78.5[d]

[a] Alpha-7® or Ultrabac® 7

[b] Below detectable levels (P< .1)

[c, d] Within rows, means not followed by a common superscript differ (P < .10); in the absence of superscripts, means are not different.

[e, f] Means change across sampling period day 170 to day 191 due to treatment effects: e: overeating disease, (P < .10); f: pulpy kidney, (P < .06).

Stimulating a Clostridial Immune Response in Beef Cattle

Tom Troxel[1], Gary Burke[1], William Wallace[1], Larry Keaton[1],
Stan McPeake[1], Dudley Smith[2] and Ivan Nicholson[2]

Story in Brief

One hundred nine pregnant cows and 83 pregnant heifers were randomly assigned a treatment of either Alpha-7® (A7) or Ultrabac® 7 (UB7). Dams were vaccinated with A7 or UB7 on day124 pr epartum (day -124) and day 53 postpartum. Blood samples were collected from 10 dams / treatment group on day -124, 53, and 173, and from their calves on day 53. Cows had higher antibody titer levels for overeating disease (*Clostridium perfringens* type C) and pulpy kidney (*Clostridium perfringens* type D) than heifers. The A7 treated dams had higher pulpy kidney antibody titers on day 53 and day 173 and blackleg (*Clostridium chauvoei*) antibody titers on day 173 than did UB7 treated cows. Calves from A7 treated cows had higher pulpy kidney antibody titers on day 53 than calves from UB7 treated dams. In conclusion, antibody titers for clostridial diseases in 53-day-old calves can be enhanced if dams are vaccinated approximately four months before calving with Alpha-7®.

Introduction

Clostridial diseases are a concern for cattle producers. Because clostridial diseases are often rapidly fatal and usually affect cattle six months to two years of age, most producers view vaccination as cheap insurance. A previous study of the cow / calf segment revealed that approximately 60% of producers vaccinated calves for clostridial diseases before weaning (Beef Cow / Calf Health and Productivity Audit, 1994). The effects of maternal antibody on active immunizations and the period of time between injection of vaccines that require multiple doses are reasons for immune failure (Schultz, 1994).

The objective of this experiment was to compare the effectiveness of a single injection of a 2-ml vaccine (Alpha-7®) with a single injection of a 5-ml vaccine (Ultrabac® 7) in pregnant dams in stimulating an enhanced passive immunity response in their calves.

Experimental Procedures

One hundred nine pregnant multiparous crossbred cows and 83 pregnant crossbred heifers were used. On approximately day-124 prepartum, beef females were randomly assigned to receive Alpha-7® (Boehringer-Ingelheim) or Ultrabac® 7 (SmithKline Beecham). On day -124, 56pregnant cows and 39 pregnant heifers received A7, and 53 pregnant cows and 44 pregnant heifers received UB7. All injections were administered subcutaneously in the neck region using the tented technique. Dams were revaccinated with their assigned treatment on day 53 postpartum.

Blood samples were collected from 10, A7 treated and 10, UB7 treated cows and heifers. The same cattle were sampled throughout the experiment. Blood samples were collected immediately before each clostridial treatment (day -124 and day53) and on day 173. On day 53 after birth, blood samples from the nursing calves (10 per treatment) were collected. All blood samples were placed in crushed ice immediately after collection. The serum was harvested and stored at -20° C until analyzed. Antitoxin units were determined for overeating disease and pulpy kidney by the antitoxin neutralization test as described by USDA: APHIS:VS (1985 and 1993, respectively), and agglutination titers were determined for blackleg by the serum agglutination test modified from Claus and Macheak (1972).

Cows and calves served as experimental units. The data were analyzed as a complete randomized design and as a 2 x 2 x 2 randomized factorial design, respectively. The data

[1] Animal Science Section, Cooperative Extension Service, Little Rock.
[2] Boehringer-Ingelheim Animal Health, Inc., St. Joseph, Missouri.

were tested for normality by the Shapiro-Wilk test (SAS, 1992). The null hypothesis was rejected (P < .05). Therefore, we concluded that the data were not normally distributed. Data within each time period were ranked, and ANOVA procedures were used to perform the Krushal-Wallis test (SAS, 1994). Ratio between two time periods were determined and ranked for analysis. If data were below detectable levels (1, .1, and 10 for overeating disease, pulpy kidney and blackleg, respectively), the midpoint between the detectable level and 0 was assigned (.5, .05 and 5 for overeating disease, pulpy kidney and blackleg, respectively). Because the number of animals assigned to each treatment group was not the same, the general linear model procedure (Type III SS) was used. One calf in the A7 cow sub-treatment group died at birth. Therefore, the cow and calf data from this sub-treatment group were removed from the experiment. All other sub-treatment groups had five treated cows and five treated calves. Because the data were not normally distributed, the variation around each mean value is not reported.

Results and Discussion

Dam's age had a significant effect on the overeating disease and pulpy kidney antibody titer response to dam treatment (Table 1). Regardless of treatment, cows had higher (P < .01) overeating disease antibody titer levels for all three sampling periods (day -124, 53 and 173) and higher pulpy kidney antibody titer levels for day-124 and 53 (P < .05) with a tendency on day 173 (P < .11) compared with heifers. There were no differences detected with the main effect of age on the blackleg response (P > .10). The response to overeating disease and pulpy kidney antibody titers to dam's age may be a result of cows being exposed to more annual vaccinations (on the average) throughout their lifetime than the heifers. There also were no differences detected due to the dam's age in the relative changes in overeating disease, pulpy kidney, or blackleg antibody titers from one sampling period to another (P > .10).

Even though the A7 treated females had lower overeating disease antibody titers than UB7 treated females on day -124, the relative changes from day -124 to day 53 (P < .01) and from day -124 to day 173 (P < .01) were greater for the A7 treated females than for the UB7-treated females (Table 2). There were no treatment effects on the relative change from day 53 to day173. Ther e was an age by treatment interaction on day 173 for the overeating disease antibody titer response. The A7 treated cows and heifers had antibody titer responses of 13.9 and 3.8 compared with the UB7 treated cows' and heifers' responses of 6.5 and 5.6. Therefore, to obtain higher antibody titer levels based upon this treatment schedule, different clostridial vaccines could be selected based upon dam's age. Additional blood samples were not collected after day 173 to determine how long the enhanced antibody titer response was maintained in the UB7-treated heifers.

There were significant pulpy kidney and blackleg antibody titer responses due to treatment. Pulpy kidney antibody titer response was higher (P < .01) for the A7 treated females than for the UB7 treated females on day 53 and day 173. Unlike the overeating disease antibody titers, there was no difference for pulpy kidney antibody titers on day -124 by treatment groups. The relative change for the dam pulpy kidney antibody titer response for all three time periods was different due to treatment (A7 vs UB7). The change from day -124 to day 53 (P < .05), from day -124 to day 173 (P < .01), and from day 53 to day 173 (P > .01), was greater for the A7 treated females.

The only sampling period where blackleg antibody titers were different (P < .01) due to treatment was day 173. The A7 treated females had a mean blackleg antibody titer of 249.2 compared with UB7 treated females' blackleg antibody titer of 66.5. Although there was no difference in the blackleg antibody titer response from day -124 to day 53 (P > .10) due to A7 or UB7 treatment, there was a difference (P < .01) increased in the A7 treated dams from the time period of day -124 to day 173 and from day 53 to day 173 .

A possible explanation for the A7 treated females having a greater response for overeating disease, pulpy kidney, and blackleg antibody titers may have been because A7 was used in this cow herd for the first time whereas UB7 had been used in previous years. A second possible explanation for the enhanced response to A7 may have been a result of the different adjuvants used by A7 and UB7. Alpha-7® uses an oil adjuvant with a gentimicin as a preservative, and UB7 uses aluminum hydroxide as an adjuvant. The A7 oil-based adjuvant may cause a slower and longer release of the bacterium-toxoid, resulting in the enhanced immune response.

The main effects of dam treatment or dam's age were not significant for overeating disease antibody titers as measured by the serum of the suckling calf (Table 3). Other research reports that overeating disease does produce measurable antibody titer levels in the colostrum of pigs (Djurickovie et al., 1975) and cows (Lozano et al., 1971). One would have suspected a higher level of overeating disease antibody titer levels in the suckling calves from the cows because the cows had higher response rate to the treatment.

There were detectable levels of pulpy kidney antibody titer levels in the serum of suckling calves on day 53, suggesting higher calf pulpy kidney antibody titers because of dam treatment. Calves of A7 treated dams had higher levels of pulpy kidney antibody titers on day 53 than calves of UB7 treated dams (P < .05). Transfer of maternal antibody to lambs via the colostrum has been demonstrated by Oxer et al. (1971). Vaccinating pregnant dams with A7, 124 days before calving increased the pulpy kidney maternal response in the suckling calf compared with UB7 treatment, and therefore vaccinating calves at 50 days of age may not be necessary. Age of dam or dam treatment had no effect on calf blackleg serum antibody titers on day 53.

The interaction of dam treatment by the dam's age was significant for overeating disease, pulpy kidney, and blackleg antibody titers in the serum of suckling calves. Calves that came from A7 treated cows had higher overeating disease antibody titers on day53 than calves of UB7 treated cows ($P < .01$), but there were no differences between calves of A7 or UB7 treated heifers ($P < .01$). The same antibody titer response was detected with pulpy kidney and blackleg antibody titers for day53.

Vaccinating cows with A7 approximately 124 days before calving provided enhanced maternal antibody protection in the suckling calf for pulpy kidney compared with UB7 cow vaccination. The older dams (>3years of age) showed an increased response to clostridial vaccination compared with younger dams (< 3 years of age).

Implications

These data indicate that antibody titers against clostridial diseases in 53-day-old calves can be enhanced if their dams are vaccinated approximately four months before calving with Alpha-7®. Even if pregnant females are vaccinated approximately day 124 before calving, vaccinating calves around 50 to 60 days of age is necessary. With proper management and vaccination timing, losses due to clostridial diseases may be prevented.

References

Claus, K. D. and M. E. Macheak. 1972. Am. J. Vet. Res. 33:1045.

Djurickovie, S. M. et al. 1975. Veterinary Medicine/Small Animal Clinician: 283-285.

Lozano, E. A. et al. 1971. The Cornell Veterinarian, Vol. LXI: No. 2.

Beef Cow/Calf Health and Productivity Audit. 1994. USDA:APHIS:VS. Fort Collins, Colorado.

Oxer, D. T. et al. 1971. Australian Veterinary Journal, Vol. 47:134.

SAS. 1992. SAS Inst. Inc., Cary, North Carolina.

SAS. 1994. SAS Inst. Inc., Cary, North Carolina.

Schultz, R. D. 1994. The Bovine Proceedings, No. 26:19-26.

USDA:APHIS:VS. 1985. 9CFR 113.111.

USDA:APHIS:VS. 1993. 9CFR 113.112.

Table 1. The average antibody titer levels for overeating disease, pulpy kidney, and blackleg in serum of cows and heifers.

	Overeating Disease		Pulpy Kidney		Blackleg	
Day of Sampling	Cows	Heifers	Cows	Heifers	Cows	Heifers
Day -124[a]	9.2[b]	6.0[c]	.71[d]	.23[e]	57.3	59.8
Day 53	15.3[b]	8.7[c]	.70[d]	.32[e]	244.3	187.8
Day 173	10.0[b]	4.7[c]	1.10	.61	142.7	172

[a] Calving = day 0.
[b, c] Within rows, means not followed by a common superscript differ ($P < .01$); in the absence of superscripts, means are not different.
[d, e] Within rows, means not followed by a common superscript differ ($P < .05$); in the absence of superscripts, means are not different.

Table 2. The average antibody titer levels for overeating disease, pulpy kidney, and blackleg due to Alpha-7® or Ultrabac® 7 treatment in serum of beef females (cows and heifers).

	Overeating Disease		Pulpy Kidney		Blackleg	
Day of Sampling	A7[a, c]	UB7[a, c]	A7[f]	UB7[f]	A7[g]	UB7[g]
Day -124[b]	6.3	8.8	.68	.29	63.3	53.8
Day 53	13.8	10.1	.87[d]	.19[e]	241.3	179.3
Day 173	8.6	6.1	1.49[d]	.29[e]	249.2[d]	66.5[e]

[a] Alpha-7® or Ultrabac® 7.
[b] Calving = day 0.
[c] Means change across sampling period day -124 to day 53 and day 124 to day 173 due to treatment ($P < .01$).
[d, e] Within rows, means not followed by a common superscript differ ($P < .01$); in the absence of superscripts, means are not different.
[f] Means change across sampling period day -124 to day 53 ($P < .05$), day -124 to day 173 ($P < .01$) and day 53 to day 173 ($P < .01$).
[g] Means change across sampling period day -124 to day 173 and day 53 to day 173 ($P < .01$).

Table 3. The average antibody titer levels from passive immunity for overeating disease, pulpy kidney, and blackleg in serum of 53-day-old calves.

	Cows		Heifers	
Disease	A7[a]	UB7[a]	A7	UB7
Overeating Disease	23.3	6.5	8.5	13.0
Pulpy Kidney	2.70[b]	.10[c]	.64[b]	.36[c]
Blackleg	121.1	27.5	79.0	77.5

[a] Alpha-7® or Ultrabac® 7
[b, c] Within rows, dam treatment means not followed by a common superscript differ ($P < .05$); in the absence of superscripts, means are not different.

Effects of Magnesium-Mica on Performance and Carcass Quality of Growing-Finishing Swine

Charles Maxwell, Harold Watson, Brenda de Rodas, Jason Apple, and Zelpha Johnson[1]

Story in Brief

Magnesium-Mica is utilized primarily in the feed industry as a pellet binder and as a carrier for micro premixes. Some studies, however, indicate that Magnesium-Mica may have additional nutritional benefits beyond the excellent physical characteristics. A total of 120 crossbred gilts and barrows were utilized in this study to determine the effect of feeding Magnesium-Mica during the growing-finishing period on gain, efficiency of gain, and on carcass yield and quality. Inclusion of Magnesium-Mica in the diet at 1.25 or 2.50% had no deleterious effect on average daily gain (ADG), average daily feed intake (ADFI), or gain:feed (G:F) and decreased cost of gain. In addition, color score measured at the 10th rib was improved in pigs fed Magnesium-Mica when compared to those fed the control diet devoid of Magnesium-Mica. This study suggests that Magnesium-Mica addition to swine diets at low inclusion levels may reduce cost of gain and provide ingredients which impact color score.

Introduction

Magnesium-Mica (MM) is utilized primarily in the feed industry as a pellet binder and as a carrier for micro premixes. Some studies, however, indicate that Magnesium-Mica may have additional nutritional benefits beyond the excellent physical characteristics. In two studies with feedlot cattle, inclusion of Magnesium-Mica in the diet at a level of 0.45% had no deleterious effects on gain or efficiency and decreased cost of gain (Coffey et al., 1995ab). In addition, marbling scores were improved in one study and tended to be higher in a second study in steers fed Magnesium-Mica when compared to steers fed the control diet devoid of Magnesium-Mica. No studies have been reported with Magnesium-Mica in growing-finishing swine. Therefore, the objective of this study was to determine the effect of feeding Magnesium-Mica during the growing-finishing period on gain, efficiency of gain, and on carcass yield and quality of swine.

Experimental Procedures

A total of 120 crossbred gilts and barrows (Yorkshire x Landrace x Duroc x Hampshire) with an average initial body weight (BW) of 53 lbs were utilized in this study. Pigs were moved from the nursery, blocked by BW and allotted within block into equal subgroups based on sex and litter. Treatments were then assigned randomly to pens (five pigs / pen) within each of the BW groups with a total of eight pens / treatment. Pigs were fed a three-phase diet with transition from starter to grower and from grower to finisher occurring when the mean weight of each block reached 76 and 146 lbs, respectively. The Control starter, grower, and finisher diets met or exceeded NRC (1988) requirements. Treatments were: 1) a negative control corn-soybean meal starter, grower, and finisher diet devoid of Magnesium-Mica (Table 1), 2) the control starter grower and finishing diets with 25 lbs / ton of Magnesium-Mica (1.25%) added at the expense of corn, and 3) the control starter, grower, and finisher diets with 50 lbs / ton of Magnesium-Mica (2.5%) added at the expense of corn. Diets were formulated to contain 1.10, 0.95, and 0.85% lysine during the starting, growing, and finishing periods, respectively. Calcium and phosphorus were maintained at 0.80 and 0.65%, respectively during the starter and grower periods, and were reduced to 0.70 and 0.60%, respectively during the finishing period.

Weight gain and feed intake were determined during each phase to permit determination of average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F) during the starter, grower, and finisher periods. Pigs were removed from the experiment and slaughtered weekly as blocks

[1] All authors are associated with the Department of Animal Science, Fayetteville.

reached an average minimum weight of 225 lbs. Carcass weight, backfat, and length were determined. At 24 hours postmortem, the right side of the carcasses were ribbed at the 10th and 11th rib interface, and 10th rib fat thickness, loin eye area, marbling, and color score were determined after a 30-minute bloom period.

Data were analyzed as a randomized complete block design with pen as the experimental unit and blocks based on initial body weight. Analysis of variance was performed using the GLM procedures of SAS (1988). Linear and quadratic polynomials were used to detect the response to inclusion level of Magnesium-Mica in the diet (0,1.25 and 2.5%). Frequency of color score was analyzed by chi-square.

Results and Discussion

Inclusion of Magnesium-Mica in the diet at 1.25 or 2.5% had no effect ($P > .10$) on ADG, ADFI, or feed efficiency (gain:feed) during the starter, grower, or finisher periods, or for the overall growing-finishing period when compared to pigs fed the control diet (Table 2).This is consistent with the observations in two feedlot cattle studies that inclusion of Magnesium-Mica had no deleterious effects on gain or feed efficiency (Coffey et al., 1995a,b). Similarly, cost of gain was reduced in pigs fed Magnesium-Mica in this study during the growing and finishing phases, although differences were not significant. It is interesting to note that while inclusion of Magnesium-Mica of the diet decreased in proportion to the addition of Magnesium-Mica from an average of 1,570 kcal/lb in the control diet (average ME for starter, grower, and finisher diets) to 1,531 kcal/lb in the diet with 2.50% Magnesium-Mica for an estimated reduction in ME of 2.48%. Since there was no reduction in overall feed intake or feed efficiency in pigs fed diets with Magnesium-Mica, this suggests that the small reduction in energy intake may have resulted in improved efficiency. Since Magnesium-Mica addition reduced diet costs (Table 1), cost of gain was reduced by $0.57 and $0.33 per hundred pounds of gain in pigs fed diets containing 1.25 and 2.50% Magnesium-Mica, respectively when compared to those fed the control diet devoid of Magnesium-Mica. This is consistent with the observations in two feedlot cattle studies that inclusion of Magnesium-Mica decreased cost of gain (Coffey et al., 1995ab).

The effects of Magnesium-Mica on carcass characteristics are presented in Table 3. Hot carcass weight, chilled carcass weight, dressing percentage, carcass length, backfat, loin eye area and marbling score were not affected ($P > .10$) by inclusion of Magnesium-Mica in the diet. However, the mean American color score increased with increasing Magnesium-Mica in the diet (linear effect, $P < .01$). The increase in American color score was because of a decrease in the percentage of carcasses receiving an undesirable color score of 1 and an increase in the percentage of carcasses receiving a desirable color score of 3 in pigs fed diets containing Magnesium-Mica (Table 4; $P < .14$). The magnitude of response was substantial with a decrease in carcasses with a color score of 1 from 15.4% in pigs fed the control diet to only 2.5% of the carcasses in pigs fed the diet containing 2.5% Magnesium-Mica. Similarly, the percent of carcasses with a color score of 3 increased from 10.26% in pigs fed the control diet to 25% in pigs fed the diet containing 2.5% Magnesium-Mica. The percentage of carcasses receiving a color score of 2 remained relatively constant.

The magnitude of changes in mean Japanese color score were similar to those observed for the mean American color score at the 1.25% inclusion level of Magnesium-Mica. The increase in the mean Japanese color score (Table 3) was due to a decrease in the percentage of carcasses receiving an undesirable color score of 1 and an increase in the percentage of carcasses receiving a desirable color score of 4 in pigs fed diets containing Magnesium-Mica (Table 5; $P < .04$). In addition, there was a tendency for a reduction in the percentage of carcasses with a color score of 3 and an increase in the percentage of carcasses with a color score of 2 as level of Magnesium-Mica increased. The magnitude of response was substantial with a decrease in carcasses with an undesirable color score of 1 from 12.8% in pigs fed the control diet to 0% of the carcasses in pigs fed diets containing 1.25% or 2.5% Magnesium-Mica. Similarly, the percent of carcasses with a desirable color score of 4 increased from 12.8% in pigs fed the control diet to 22.2% in pigs fed the diet containing 1.25 or 2.5% Magnesium-Mica.

D'Souza and co-workers (1998) have reported that dietary supplementation of Magnesium Aspartate in swine diets prior to slaughter improved color and reduced drip loss. This suggests that the effect of Magnesium-Mica on color score may be related to the high magnesium content (8.00% magnesium).

Implications

This study suggests that inclusion of Magnesium-Mica in the diet of growing-finishing swine at a level of 1.25 or 2.5% has no deleterious effects on gain or efficiency of gain and may decrease cost of gain. In addition, color score measured at the 10th rib improved in pigs fed Magnesium-Mica.

References

Coffey, K. P., and F. K. Brazle. 1995a. Agric. Res. Center, Agric. Exp. St., Kansas State Univ., Manhattan. Prog. Rep.733:15.

Coffey, K. P., et al. 1995b. Southeast Agric. Res. Center, Agric. Exp. St., Kansas State Univ., Manhattan. Prog. Rep.733:20.

D'Souza, D. N., et al. 1998. J. Anim. Sci. 76:104.

SAS. 1988. SAS Inst. Inc., Cary, North Carolina.

Table 1. Composition of experimental diets.

	Starter			Grower			Finisher		
	Treatment 1	Treatment 2	Treatment 3	Treatment 1	Treatment 2	Treatment 3	Treatment 1	Treatment 2	Treatment 3
Ingredient, %	Control	25 lb MM/ton	50 lb MM/ton	Control	25 lb MM/ton	50 lb MM/ton	Control	25 lb MM/ton	50 lb MM/ton
Corn	61.775	60.275	59.095	66.975	65.725	64.295	71.115	69.865	68.615
Soybean Meal, 48%	30.75	31.00	30.90	25.60	25.60	25.75	21.90	21.90	21.90
Fat, An & Veg	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Phosphate, Dical	1.55	1.55	1.60	1.65	1.65	1.70	1.45	1.45	1.50
Calcium Carbonate	0.82	0.82	0.80	0.77	0.77	0.75	0.68	0.68	0.63
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Mineral Premix	0.15	0.15	0.15	0.15	0.15	0.15	0.10	0.10	0.10
Vit TM Premix	0.25	0.25	0.25	0.15	0.15	0.15	0.125	0.125	0.125
Tylosin - 40	0.125	0.125	0.125	0.125	0.125	0.125	0.05	0.05	0.05
Copper Sulfate	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Ethoxyquin	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Magnesium-Mica[a]	0.00	1.25	2.50	0.00	1.25	2.50	0.00	1.25	2.50
Composition Calculated, Total									
Protein, crude, %	20.17	20.16	20.01	18.11	18.00	17.95	16.67	16.56	16.45
Lysine, %	1.10	1.10	1.10	0.95	0.95	0.95	0.85	0.85	0.85
Methionine, %	0.32	0.32	0.32	0.29	0.29	0.29	0.27	0.27	0.27
Met & Cys, %	0.67	0.67	0.67	0.61	0.61	0.61	0.57	0.57	0.57
Threonine, %	0.78	0.78	0.78	0.70	0.70	0.70	0.64	0.64	0.64
Tryptophan, %	0.24	0.24	0.24	0.21	0.21	0.21	0.19	0.19	0.19
Calcium, %	0.80	0.80	0.80	0.80	0.80	0.80	0.70	0.70	0.70
Phosphorus, %	0.65	0.65	0.65	0.65	0.65	0.65	0.60	0.60	0.60
Energy, kcal, ME/lb	1566.82	1547.34	1527.45	1568.47	1549.03	1529.10	1575.94	1556.50	1537.07
Diet Ingredient Costs									
$ per cwt.	9.204	9.183	9.122	8.806	8.772	8.723	8.072	8.038	7.941

[a] MM, Magnesium-Mica, Micro-Lite, LLC.

Table 2. Effect of Magnesium-Mica level on performance of growing-finishing[a].

	Magnesium-Mica, %			
Item	0	1.25	2.50	SEM
Starter (53-76 lb)				
ADG, lb	1.40	1.38	1.36	.06
ADFI, lb	3.17	3.21	3.10	.16
Gain:feed	.45	.43	.44	.02
Grower (76-146 lb)				
ADG, lb	2.15	2.15	2.11	.06
ADFI, lb	5.38	5.23	5.24	.12
Gain:feed	.40	.41	.40	.007
Finisher (146-233 lb)				
ADG, lb	2.09	2.17	2.07	.04
ADFI, lb	6.69	6.84	6.65	.11
Gain:feed	.31	.32	.31	.005
Overall (53-233 lb)				
ADG, lb	1.98	2.00	1.96	.03
ADFI, lb	5.57	5.52	5.51	.09
Gain:feed	.36	.36	.36	.005
Feed cost, $/cwt gain				
Starter (53-76 lb)	20.84	21.59	21.04	.09
Grower (76-146 lb)	22.13	21.39	21.73	.04
Finisher (146-233 lb)	25.89	25.38	25.75	.46
Overall (53-233 lb)	23.76	23.19	23.43	.42

[a] Data are means of eight pens of five pigs each. Average initial and final body weight (BW) were 53 and 233 lbs, respectively.

Table 3. Effect of Magnesium-Mica on carcass characteristics[a].

	Magnesium-Mica, %			
Item	0	1.25	2.50	SEM
Live carcass WT, lb	232.2	237.6	230.0	2.52
HLCWT, lb	86.4	85.6	86.4	.44
HRCWT, lb	85.5	85.4	85.3	.69
DP, %	73.7	73.4	73.4	.38
Carcass length, in	30.9	30.9	30.6	.18
Fat first rib, in	1.44	1.46	1.47	.02
Fat last rib, in	.89	.87	.90	.03
Fat LBV, in	.84	.87	.82	.02
Avg. backfat, in	1.05	1.07	1.06	.02
LEA, in^2	4.77	4.57	4.69	.11
Marbling 10th rib score	2.19	2.27	1.90	.16
ACS[b]	1.95	2.13	2.23	.06
JCS	2.72	3.03	2.93	.11

[a] Data are means of eight pens of five pigs each. Average initial and final weights were 53 and 233 lb, respectively. Live carcass weight was used as a covariant for HLCWT, HRCWT, carcass length, fat first rib, fat last rib, fat LBV, average back fat, and LEA. HLCWT = hot left carcass weight; HRCWT = hot right carcass weight; DP = dressing percentage; LBV = last lumbar vertebra; LEA = loin eye area; ACS = American color score (1 to 5); JCS = Japanese color score. (1 to 6).
[b] Linear effect of increasing Magnesium-Mica in the diet ($P < .01$).

Table 4. Percent of carcasses with American color scores of 1, 2, and 3 for each treatment.

	Treatment		
	Control	1.25% Magnesium-Mica	2.5% Magnesium-Mica
American Color Score[a]			
1	15.40	5.60	2.50
2	74.36	75.00	72.50
3	10.26	19.44	25.00

[a] x^2 statistic = 6.94; ($P < .14$).

Table 5. Percent of carcasses with Japanese color scores of 1, 2, 3, and 4 for each treatment.

	Treatment		
	Control	1.25% Magnesium-Mica	2.5% Magnesium-Mica
Japanese Color Score[a]			
1	12.82	0.0	0.0
2	15.38	19.44	30.00
3	58.97	58.33	47.50
4	12.82	22.22	22.50

[a] x^2 statistic = 13.64; ($P < .04$).

Potential for ProBlend™-65 as a Substitute for Plasma Protein (AP-920) in Phase-1 Off-Site Nursery Diets

Charles Maxwell, Chris Wright, and Brenda de Rodas[1]

Story in Brief

An experiment involving 216 weanling pigs was conducted to evaluate the feeding value of ProBlend™-65 (PB) relative to spray-dried plasma protein (SDPP) in segregated early weaned (SEW) pig diets. ProBlend™-65 is a blend of porcine plasma protein and high quality hydrolyzed porcine proteins derived from the packing industry. During Phase 1 (day 0 to 10 postweaning), pigs fed diets containing 3.75% SDPP, 50% replacement of SDPP lysine or 100% replacement of SDPP lysine with PB had improved average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency when compared with pigs fed a negative control diet containing 18.7% soybean meal and devoid of SDPP or PB. Average daily gain and gain:feed (G:F) were similar among pigs fed a diet containing SDPP or diets with 50% or 100% replacement of SDPP lysine with PB. Average daily feed intake, however, increased with increasing replacement of SDPP lysine with PB. During the Phase-2 and Phase-3 periods, performance was similar among the treatment groups. These data indicate that performance was improved in SEW pigs fed diets containing SDPP or SDPP replaced with 50% or 100% PB when compared to pigs fed the negative control diet, and that PB can replace 50% or 100% of the SDPP lysine in Phase 1 diets without affecting performance of SEW pigs.

Introduction

Pigs produced in conventional intensively managed swine production systems are routinely weaned as early as 19 to 21 days of age and as early as 10 to 14 days of age in off-site segregated early weaning systems. At this age, pigs are very sensitive to the source of dietary protein. Many dietary proteins produce allergic reactions, in which diarrhea, reduced growth, and increased mortality can occur (Bimbo and Crowther, 1992). Various protein sources have been tested in early weaned pig diets in an attempt to overcome these problems and to decrease diet cost. Spray-dried plasma protein (SDPP) is the protein source of choice and has consistently been shown to improve performance of early-weaned pigs when included in Phase-1 (days 0 to 14 postweaning) diets. However, the supply of plasma protein is limited and, therefore, expensive. ProBlend™-65 (PB) is a blend of plasma protein and high quality hydrolyzed proteins derived from the packing industry. The replacement potential of ProBlend™-65 for plasma protein has not been investigated in independent studies and may be an alternative to decrease diet cost without decreasing performance in Phase-1 nursery diets. The objective of this study was to determine the potential of ProBlend™-65 as a replacement for plasma protein in Phase-1, off-site nursery diets.

Experimental Procedures

This study was conducted to determine the efficacy of ProBlend™-65 as a replacement for plasma protein in pigs weaned at 21 ± 2 days of age and reared in an off-site nursery. A total of 216 weanling barrows (Yorkshire x Duroc x Landrace from a commercial operation; 13.7 lbs body weight [BW]) were obtained from a single source. Pigs were transported to the University of Arkansas off-site nursery facilities, sorted by weight, and divided into nine weight groups (blocks). Pigs within each weight group were allotted into four equal subgroups (six pigs per pen). Then treatments were randomly assigned to pens (subgroups) within each of the weight groups.

[1]All authors are associated with the Department of Animal Science, Fayetteville.

Diets during the first 10 days postweaning (Phase 1) consisted of the following: 1) a negative control diet devoid of AP-920 (Table 1), 2) a positive control Phase-1 diet containing 3.75% AP-920 with plasma protein added at the expense of soybean meal (48% crude protein [CP]) on an equal lysine basis, 3) the positive control diet with ProBlend™-65 replacing 50% of the plasma protein lysine (2.53% ProBlend™-65), and 4) the positive control diet with ProBlend™-65 replacing 100% of the plasma protein lysine (5.10% ProBlend™-65). Substitutions in all diets were made at the expense of corn. Diets were formulated to contain 1.50% lysine, .87% methionine plus cystine, .90% calcium (Ca), .80% phosphorus (P), and 14.53% lactose.

Upon completion of the Phase-1 diet, common Phase-2 (Table 2, 1.35% lysine) and Phase-3 diets (1.20% lysine) were fed for 14 days each. Pigs were housed in an off-site nursery facility in pens with two nipple waterers, a four-hole feeder, and Maxima nursery flooring (Double L Group, LTD.). Pigs had *ad libitum* access to feed and water. For the first week of the trial, the nursery was maintained at 83° F and decreased 2° F per week. Pig BW and feed intake were determined at initiation, at the end of Phase 1 and weekly thereafter to evaluate average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (gain:feed).

Data were analyzed as a randomized complete block design with pen as the experimental unit and blocks based on initial BW. Analysis of variance was performed using the GLM procedures of SAS (1988). Orthogonal polynomials were used to test for linear and quadratic effects of replacing plasma protein with ProBlend™-65. In addition, a contrast statement comparing the negative control versus the average of the other diets was included.

Results and Discussion

During Phase 1 (days 0 to 10 postweaning), pigs fed diets containing spray-dried plasma protein, 50% replacement of spray-dried plasma protein lysine, or 100% replacement of spray-dried plasma protein lysine with ProBlend™-65 had improved ADG ($P<.05$), and feed efficiency (gain: feed; $P<.01$) when compared with pigs fed a negative control diet devoid of spray-dried plasma protein or ProBlend™-65 (Table 2). Average daily feed intake, however, was greater ($P < .05$) in pigs fed the negative control diet when compared with the average intake of pigs fed the spray-dried plasma protein and (or) ProBlend™-65 based diets. Average daily gain, and gain:feed were similar among pigs fed a diet containing 3.75% spray-dried plasma protein or diets with 50 or 100% replacement of spray-dried plasma protein lysine with ProBlend™-65. Average daily feed intake, however, increased linearly ($P<.07$) with increasing replacement of spray-dried plasma protein lysine with ProBlend™-65. During the Phase-2 and Phase-3 periods, no significant differences were observed in performance among the treatment groups.

Pig weight at the end of Phase 1 was greater (Table 3, $P < .05$) in pigs fed diets containing spray-dried plasma protein, or 50% or 100% replacement of spray-dried plasma protein lysine with ProBlend™-65 than weight of pigs fed the negative control diet. Pig weight at the end of Phase 2 or Phase 3, however, was similar among the dietary treatments.

Implications

These data indicate that performance was improved in segregated early weaned (SEW) pigs fed diets containing SDPP or SDPP replaced with 50 or 100% ProBlend™-65 when compared to pigs fed a diet devoid of spray-dried plasma protein or ProBlend™-65, and that ProBlend™-65 can replace 50% or 100% of the spray-dried plasma protein lysine in Phase-1 diets without affecting performance.

References

Bimbo, A. P. and J. B. Crowther. 1992. J. Am. Oil Chem. Soc. 69:221.

SAS. 1988. SAS Inst. Inc., Cary, North Carolina.

Table 1. Composition of experimental diets (as-fed basis).

Item, %	Phase 1				Phase 2	Phase 3
	Negative Control	Positive Control	ProBlend™ 65/AP-920	ProBlend™ 65		
Yellow corn	33.75	38.83	38.26	37.69	47.74	62.305
Steam rolled oats	5.00	5.00	5.00	5.00	0.00	0.00
Dep. whey	17.50	17.50	17.50	17.50	10.00	0.00
Proc. soy protein	6.75	6.75	6.75	6.75	0.00	0.00
Soybean meal, 48% CP	18.85	10.00	10.00	10.00	28.30	30.00
AP-301	2.00	2.00	2.00	2.00	2.00	0.00
AP-920	0.00	3.75	1.87	0.00	0.00	0.00
ProBlend™-65	0.00	0.00	2.53	5.10	0.00	0.00
Sel. Menhaden fish meal	8.50	8.50	8.50	8.50	4.00	0.00
Soybean oil	4.00	4.00	4.00	4.00	4.00	0.00
Ethoxyquin	0.03	0.03	0.03	0.03	0.03	0.03
Methionine	0.11	0.12	0.11	0.09	0.08	0.02
Lysine	0.00	0.00	0.00	0.00	0.00	0.16
Neo-Terromycin 10/5	1.00	1.00	1.00	1.00	1.00	0.00
Zinc oxide	0.30	0.30	0.30	0.30	0.30	0.00
$CuSO_4$	0.07	0.07	0.07	0.07	0.07	0.07
Mineral premix (NB-8557B)	0.15	0.15	0.15	0.15	0.15	0.15
Vitamin premix (NB-6157B)	0.25	0.25	0.25	0.25	0.25	0.25
Dicalcium phosphate	1.35	1.30	1.05	0.75	1.40	1.88
Fat	0.00	0.00	0.00	0.00	0.00	4.00
Calcium carbonate	0.03	0.10	0.28	0.49	0.38	0.61
Tylan 40	0.00	0.00	0.00	0.00	0.00	0.125
Threonine	0.06	0.05	0.05	0.05	0.00	0.00
Salt	0.30	0.30	0.30	.30	0.30	0.40
Calculated composition						
Lysine	1.50	1.50	1.50	1.50	1.35	1.20
Threonine	.98	.98	.98	.98	.88	.77
Tryptophan	.27	.27	.27	.27	.26	.24
Met + Cys	.87	.87	.87	.87	.78	.67
Ca	.90	.90	.90	.90	.80	.80
P	.80	.80	.80	.80	.70	.70
Metabolizable energy, kcal/lb	1534	1533	1530	1528	1542	1557
Lactose	14.53	14.53	14.53	14.53	8.30	0.00

Table 2. Effect of replacing spray-dried plasma protein (SDPP) with ProBlend™-65 on performance of segregated early weaned pigs[a].

	Diets				
	Negative	Percent Replacement[b]			
Item	Control	0	50	100	SEM
Days 0 to 10					
ADG, lb[c]	.77	.84	.89	.85	.035
ADFI, lb[cef]	1.43	1.17	1.26	1.35	.069
Gain:feed[df]	.54	.72	.70	.65	.03
Days 10 to 24					
ADG, lb	1.32	1.28	1.29	1.27	.031
ADFI, lb	1.86	1.79	1.81	1.85	.060
Gain:feed	.71	.72	.72	.69	.02
Days 24 to 38					
ADG, lb	1.63	1.65	1.64	1.61	.027
ADFI, lb	3.03	3.09	2.98	3.06	.141
Gain:feed	.55	.54	.56	.53	.02
Days 0 to 38					
ADG, lb	1.29	1.30	1.31	1.28	.026
ADFI, lb	2.18	2.10	2.10	2.16	.081
Gain:feed	.60	.62	.63	.60	.02

[a] Data are means of nine pens of six pigs each. Pigs averaged 13.7 and 63.1 lb at initiation and termination, respectively.
[b] ProBlend™-65 replaced 0, 50, and 100% of the SDPP lysine.
[c] Negative control vs others ($P < .05$).
[d] Negative control vs others ($P < .01$).
[e] Linear effect of increasing ProBlend™-65 in the diet ($P < .07$).
[f] Negative control vs SDPP ($P < .05$).

Table 3. Weight of segregated early-weaned pigs fed increasing levels of ProBlend™-65[a].

	Diets				
	Negative	Percent Replacement[b]			
Item	Control	0	50	100	SEM
BW, lb					
Initial	13.76	13.73	13.76	13.76	.008
Day 10 postweaning[c]	21.52	22.11	22.66	22.22	.344
Day 24 postweaning	40.04	39.97	40.57	40.08	.703
Day 38 postweaning	62.92	63.03	63.56	62.57	1.001

[a] Data are means of nine pens of six pigs each.
[b] ProBlend™-65 replaced 0, 50, and 100% of the SDPP lysine.
[c] Negative control vs others ($P < .05$).

Prediction of Early Onset of Puberty in Crossbred Gilts

C. F. Woods, D.L. Kreider, and R.W. Rorie[1]

Story in Brief

This study investigated the use of serum lutenizing hormone (LH) and vulva size as a predictor of early cyclicity in gilts. Blood samples were collected at 70, 80, and 90 days of age from three or four littermate gilts selected from each of 15 litters (n=55 total gilts). At 155 days of age, gilts were weighed, given a subjective vulva size score of 1 (infantile), 2 (normal) or 3 (large) and relocated to outside pens. Gilts were exposed to boars and observed twice daily for onset of estrus until 200 days of age. Luteinizing hormone at 70, 80, or 90 days of age was not found to be correlated with age at puberty ($P = 0.43$). However, more gilts with a vulva score of 2 or 3 (normal or large) achieved puberty by 200 days of age than gilts with a vulva score of 1 ($P < 0.03$). Forty-one percent of the gilts with a vulva score of 1 were cyclic before 200 days of age, compared with 78 and 77% of the gilts with vulva scores of 2 and 3, respectively. In summary, the results of this study indicate that vulva size at 155 days of age is indicative of early sexual maturation in gilts.

Introduction

It is important that gilts achieve puberty at an early age since each 30-day delay in breeding requires about one extra piglet per litter to recover feed costs. Also, early cyclicity allows producers to delay breeding to the second or third estrous cycle, when ovulation rate is higher and embryos are more viable. The onset of puberty is known to be affected by photoperiod, age, breed (heterosis), nutrition, body weight and physical environment. However, there are no reliable means of predicting when individual gilts will achieve puberty. For that reason, swine producers often keep at least 40 to 50% more gilts than are required for herd replacements in order to ensure that adequate numbers of replacement animals are available. For several years, it has been known that a small, infantile vulva is a good indicator of an underdeveloped reproductive tract and possible infertility. It has been reported in the literature that gilts with lutenizing hormone (LH) concentrations above 1 ng/ml by 80 days of age were those most likely to reach puberty before 200 days of age. Both vulva size and LH might be useful as predictors of early puberty.

Experimental Procedures

The objective of this study was to evaluate whether LH concentrations at 80 days of age can be used to predict normal sexual maturation in gilts and to determine if LH concentrations of a single gilt from a litter could be used to predict when puberty would occur in the majority of gilts of that particular litter. Vulva size was also evaluated as a phenotypic indicator of early puberty.

Three or four littermate, crossbred gilts from each of 15 litters (n=55 total gilts) were used in this study. The animals were maintained in a confinement grow-out facility, under natural light conditions and provided *ad libitum* access to feed and water. Blood samples were collected at 70, 80 and 90 days of age by anterior vena cava puncture for analysis of serum LH. At 155 ± 2 days of age, vulva size was evaluated as 1 (infantile), 2 (normal), or 3 (large). Blood samples were collected again to confirm prepubertal status (based on low progesterone concentrations) and gilts were relocated to outside dirt pens with continuous fenceline boar exposure.

Gilts were observed twice daily for signs of impending estrus (reddening and swelling of the vulva); only gilts that would stand immobile when mounted were considered to be in estrus. Onset of puberty was recorded as the first day of standing estrus. All gilts were observed through at least one estrous cycle to confirm postpubertal status. At 200 days of age, estrus detection was discontinued on gilts failing to exhibit estrus; blood samples were collected on these gilts and analyzed for progesterone to confirm prepubertal status. Serum LH and progesterone concentrations were determined by radioimmunoassay.

[1] All authors are associated with the Department of Animal Science, Fayetteville.

Results and Discussion

All gilts were prepubertal at relocation as confirmed by blood samples assayed for progesterone concentration (progesterone < 1 ng/ml). At the end of 200 days, two gilts that had not been detected in estrus were in fact pubertal as determined by progesterone concentrations above 1 ng/ml. These two gilts were dropped from the study.

As shown in Table 1, there was no effect of LH concentration on age at puberty (P = 0.682). Sixty-five percent of gilts with LH concentrations > 1.0 ng/ml reached puberty before 200 days of age, whereas 60% of gilts with LH concentration < 1.0 ng/ml reached puberty before 200 days of age. Table 1 also shows that 34.8% of gilts with LH concentrations > 1.0 ng/ml exhibited puberty before 170 days of age. In comparison, 40% of gilts with LH concentrations < 1.0 ng/ml reached puberty before 170 days of age.

Vulva score (Table 2) was found to be related to age at puberty (P = 0.033). Approximately 78 and 77% of gilts with normal (score 2) or large (score 3) vulvas, respectively, reached puberty before 200 days of age, as compared with 41% of gilts with infantile (score 1) vulvas. There was also a significant difference in gilts reaching puberty before 170 days of age, based on vulva score as an indicator (P = 0.011). Fifty-five percent of gilts with normal vulvas and 54% of gilts with large vulvas exhibited puberty before 170 days of age compared to 13% for gilts with infantile vulvas.

Results of this study do not agree with those reported previously where gilts with LH concentrations > 1.0 ng/ml at 80 days of age were those that attained puberty before 200 days of age. One reason for differences between results of this study and the previous one could be sampling frequency. The previous study did not report the schedule for collecting blood samples (one sample or extended sampling intervals), or whether LH measured was basal or peak concentrations. Single samples might be adequate for basal LH, but not for peak LH concentrations. Blood samples in the present study could have been taken between LH peaks which occur at approximately four-hour intervals. Only 20% of the variation in age at puberty could be accounted for by litter mates. Even if LH concentrations were correlated with age at puberty, it would not be valid to test one gilt per litter to determine possible age at puberty for all gilts in that litter.

The findings in our study show that vulva size may be used as a practical means of selecting gilts for early puberty. Seventy-seven percent of gilts with large vulvas and 77.8% of gilts with normal vulvas attained puberty before 200 days of age, and 53.9% and 55.6% before 170 days, respectively. Only 40.9% of gilts with infantile vulvas reached puberty before 200 days of age and only 13.6% before 170 days. Further research is necessary to determine any relationship between age at puberty and LH concentrations. However, vulva size should prove to be an indicator of early puberty in gilts.

Implications

A small infantile vulva is a good indicator of an underdeveloped reproductive tract and is associated with delay in onset of puberty. Screening of potential replacement gilts for vulva size and eliminating those gilts with small vulvas should result in a higher percentage of gilts achieving puberty at an early age and reduce the number of extra gilts required for potential herd replacements.

Table 1. Effect of prepubertal lutenizing hormone (LH) concentrations on subsequent age at puberty.

LH (ng/ml)*	Total Gilts	Number (%) of Gilts Achieving Puberty: Before 170 Days of Age	170 to 200 Days of Age	After 200 Days of age
Less than 1 ng/ml	30	12 (40.0)	6 (20.0)	12 (40.0)
Greater than 1 ng/ml	23	8 (34.8)	7 (30.5)	8 (34.8)

* LH concentrations at 70, 80, and 90 days of age had no effect on subsequent age at puberty (P=0.682).

Table 2. Effect of vulva size on subsequent age at puberty.

Vulva Score*	Total Gilts	Number (%) of Gilts Exhibiting Puberty: Before 170 Days of Age	170 to 200 Days of Age	After 200 Days of Age
1	22	3 (13.6)[a]	6 (27.3)	13 (59.1)[d]
2	18	10 (55.6)[b]	4 (22.2)	4 (22.2)[c]
3	13	7 (53.9)[b]	3 (23.1)	3 (23.1)[c]

* 1 = infantile, 2 = normal, 3 = large.
[ab] Percentages in column with different superscripts were significant (P = 0.011).
[cd] Percentages in column with different superscripts were significant (P = 0.033).

A Study to Demonstrate the Efficacy and Safety of Permectrin CDS® Pour-on When Used on Horses

Steven Jones and Shane Gadberry[1]

Story in Brief

Thirty-eight mature quarter horses were used to evaluate the effectiveness of Permectrin CDS® Pour-On when used as a fly repellant on horses. Horses were divided into control (non-treated) and treated groups. The control group consisted of 15 geldings in adjacent pastures. The treatment group consisted of 22 mares and one stallion pastured together (body weight [BW] = 1,140 ± 126, lb ± SE). Fly counts were taken for treatment and control groups on day –7, 0 (day 0 = day of treatment), 1, 3, 7, 21, and 30 at approximately 2:00 pm. Total fly counts on the treatment group averaged 10 ± 1 while the control group averaged 39 ± 2. Product effectiveness was evaluated by calculating the percentage of control on treated horses relative to control horses. Treatment was considered ineffective when fly control dropped below 50%. By day 30, average fly counts on the treatment group was 50% of the control group. Permectrin CDS® Pour-On for horses was successful without any visual adverse effects. This product has potential for horse owners that need an insecticide with a 30-day control period.

Introduction

The principal reasons for controlling blood-feeding insect pests on horses are to reduce disease transmission, maintain animal health and vigor, and improve economic returns to the horse owner. Other reasons for insect control includes concern for health of humans, fear of stings and bites, and consideration that some insect species are condsidered public nuisances. During the past several decades, the use of insecticides has been the primary technology for reducing and(or) eliminating insect populations. Many products have been developed that are effective, relatively inexpensive, and easy to administer. However, most of the common insecticides are sprays, wipes, or dusts that require daily application and are effective for only a short period of time. For horses that are handled often, this presents little problem. For the horse owner that has his herd on pasture, it may be a challenge to effectively control biting insects using the basic sprays, dusts, or wipes. Some horse owners desire an insecticide that will provide control of biting insects for a longer duration of time and still be easy to apply. This study was conducted to study the efficacy, safety and duration of control for various flies for Permectrin CDS® Pour-On for horses.

Materials and Methods

Thirty-eight mature quarter horses were used to evaluate the effectiveness of Permectrin CDS® Pour-On for horses. The study was conducted from May 20 until June 26, 1997, the onset for fly season in much of the Southeast. Horses were divided into two groups: control and treatment. The control group consisted of 15 geldings in adjacent pastures. The treatment group consisted of 22 mares and a stallion pastured together. The mares in this study consisted of 6 non-pregnant mares, 5 pregnant mares, and 11 lactating non-pregnant mares.

Average fly counts were taken for the treatment and control groups on day -7, 0 (day 0 = day of treatment), 1, 3, 7, 14, 21, and 30. The average fly count consisted of horn flies, deer flies, stable flies, heel flies, and horse flies. The percentage of fly control was determined by using this formula (g):

$$g(\%) = \frac{(\text{Avg.\# flies on controls}) - (\text{Avg.\# flies on treatment})}{(\text{Avg. \# flies on controls})} \times 100.$$

The insecticide application consisted of Permectrin CDS® Pour-On applied at a rate of 2 ml/100 lbs body weight (BW), up to a maximum of 16 ml. Application rate was as-

[1] Both authors are associated with the Animal Science Section, Cooperative Extension Service, Little Rock.

sessed individually by BW using a standard horse weight tape. Horse BW ranged from 900 to 1,330 lbs (1,138 ± 126, lb ± SE). The pour-on product was applied by pouring a strip down the backline starting at the poll, down the mane, and then from the withers to the rump. Rainfall was monitored and recorded during the study as to the days and amount of rainfall.

Results and Discussion

Permectrin CDS® Pour-on was effective in controlling horn fly (100%), stable flies (92%), and total flies (98.6%) by 24 hours after application (Table 1). Permectrin CDS® Pour-On treatment, however, reached 100% control for horse and heel flies by three and four days post-treatment, respectively. Fly control remained above 50% control for all flies and total fly count until day 30 except for horse flies on day 7 (50%). Horse fly control improved for day 14 (75%) to day 30 (60%). Rainfall did not appear to adversely impact the effectiveness of fly control exhibited by Permectrin CDS® Pour-On (Table 2).

Fly control by Permectrin CDS® Pour-On for horses was successful without any visual adverse effects noted. This product has potential for horse owners that have a need for an insecticide with a 30-day control period.

Table 1. Average horn, stable, deer, horse, heel, and total fly counts per horse and percentage of flies controlled by Permectin CDS® pour-on.

	Horn Fly Count/Horse[b,c]		Stable Fly Count/Horse[b,c]		Deer Fly Count/Horse[b,c]	
Day	Control	Permectin CDS®	Control	Permectin CDS®	Control	Permectin CDS®
-7	8.3	34.2	1.5	0	0	0
0	37.5	35.0	2.8	3.7	.5	.3
1	36.6	0 (100)[a]	2.4	.2 (92)[a]	0	0 (100)[a]
3	28.1	.3 (99)	7.8	.4 (95)	0	0 (100)
7	18.1	.2 (99)	1.7	0 (100)	.6	.1 (83)
14	20.0	4.2 (79)	5.6	2.3 (59)	.5	0 (100)
21	26.5	5.9 (78)	8.1	2.7 (67)	1.6	.3 (81)
30	62.9	30.6 (51)	3.6	1.9 (47)	.9	.7 (22)

	Horse Fly Count/Horse[b,c]		Heel Fly Count/Horse[b,c]		Total Fly Count/Horse[b,c]	
Day	Control	Permectin CDS®	Control	Permectin CDS®	Control	Permectin CDS®
-7	0	0	0	0	9.7	34.2
0	.7	0	0	0	41.5	39.0
1	.6	.4 (33)[a]	0	0	39.5	.6 (99)[a]
3	2.0	0 (100)	0	.1	37.9	.8 (98)
7	.4	.2(50)	.2	0 (100) [a]	20.9	.6 (97)
14	1.2	.3 (75)	.2	0 (100)	27.4	6.9 (75)
21	2.7	.5 (82)	.9	0 (100)	39.4	9.4 (77)
30	1.0	.6 (60)	0	0	68.4	33.7 (51)

[a] Percentage of fly control.
[b] Treatment effect ($P < .001$).
[c] Treatment by time interaction ($P < .01$).

Table 2. Daily rainfall recorded during the experimental period.

Date	Inches	Date	Inches
May 20	.22	June 10	1.20
May 21	.95	June 11	0.0
May 22	.09	June 12	0.0
May 23	0.0	June 13	.26
May 24	.21	June 14	.09
May 25	.07	June 15	0.0
May 26	0.0	June 16	2.33
May 27	.17	June 17	1.63
May 28	0.0	June 18	.08
May 29	0.0	June 19	0.0
May 30	.70	June 20	0.0
June 1	0.0	June 21	0.0
June 2	0.0	June 22	0.0
June 3	0.0	June 23	0.0
June 4	0.0	June 24	0.0
June 5	.05	June 25	0.0
June 6	0.0	June 26	.05
June 7	0.0		
June 8	0.0		
June 9	0.0	TOTAL	8.10

UofA

UNIVERSITY OF ARKANSAS

DIVISION OF AGRICULTURE