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Table of Contents

1. **Comparison of Different Management Techniques on Hay Wastage in Horses Fed Alfalfa Hay**
   M. McMillan, K. Wilson, W. Golden, L. Rakowitz
2. **Warm-Season Forages for Free-Ranging White-tailed Deer in South Texas**
   D.Kunz, W.Ocumpaugh, F.Bryant, T.Ginnett
3. **Cotton By-Products Supplementation for Steers Grazing Tobasagrass (hilaria mutica [buckl.] Benth.) Rangeland**
   C. Villalobos, C. Britton, M. Avila, R. Richardson, G. Holt, G. Bezanilla
4. **Texas Legislators' Perceived Trust, Bias, and Fairness of Biotechnology Information Sources**
   G. Wingenbach
5. **Evaluation of a Total Ranch Management Workshop as an Educational Tool to Transfer Technology in Mexico**
   R.Teliz-Triujeque, R. Williams, J. Alfonso Ortega-S., C. W. Hanselka, E. Gonzalez-Valenzuela, R. Stanko, J. Antonio Hinojosa
6. **Effects of Intermittent Suckling on Sow and Piglet Performance**
   Erin G. Brown, Lindsey B. Krebs, Chris L. Boone, Ty Cauthen
7. **Evaluating Herbicidal Injury to St. Augustine Grass in Sod Production**
   W. James Grichar, Roger D. Havlak
8. **Influence of Hay Ring Presence on Waste in Horses Fed Hay**
   Matthew L. McMillan, Kristopher R. Wilson, William C. Golden, Lesley A. Rakowitz
9. **Temperature Influence on Seeded Bermudagrass Germination**
   Gerald W. Evers, Margaret J. Parsons
10. **Market Valuation for Attributes of Female Beef Cattle Replacements**
    Lawrence Falconer, Jerry Gray, Donnie Montemayor, Brian

COMPARISON OF DIFFERENT MANAGEMENT TECHNIQUES ON HAY WASTAGE IN HORSES FED ALFALFA HAY

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ABSTRACT

Two studies were conducted to determine waste of alfalfa hay when fed to horses. In study one, four quarter/paint horse open mares (*Equus caballus*) between the ages of four and seven years old were used to determine hay wastage on round baled alfalfa (*Medicago* sativa) (ALF) hay when hay rings were present or absent. Average daily gain (ADG), dry matter intake (DMI), and DMI as a percentage of body weight were also collected. Results indicated that percent wastage was higher ($P<0.001$), for horses fed hay without rings (WOR) than those fed hay with hay rings (WR). No differences ($P>0.05$) were found in ADG. Furthermore, there were no differences ($P>0$ .05) in dry matter intake or DMI as a percent of body weight in horses between treatments. In study two, fifteen long yearling quarter horses were used to determine square bale waste in a stall setting while feeding in a feeder versus on the ground. DMI and ADG were also collected. Results indicated that percent wastage was higher ($P<0.05$), for horses fed hay on the ground versus in the feeder. No differences ($P>0.05$) were found in DMI or ADG.
KEYWORDS: alfalfa, waste, horses

INTRODUCTION

The price of hay in the U.S. has drastically increased in recent years due to increased fuel costs and lack of supply due to drought. To compound the problem, feeding and storage practices of hay have also contributed to large annual economic losses (Gibbs, 2007). The combination of these variables has made horse ownership become increasingly more expensive. General horse hay feeding practices include either pasture feeding or feeding while housed in stalls. Pasture feeding generally includes the use of round baled hay. In general, it has been thought that the cost of hay fed as round bales is typically lower on a per pound basis than hay purchased as small square bales. This, combined with ease of feeding, is a large factor in some horse owners' decisions when deciding to feed round baled hay. However, the percentage of hay that is wasted when fed as round bales is poorly understood and may not be as economical as feeding conventional bales

(Lawrence and Coleman, 2000). Likewise, mold spores can contribute to colic in horses (Collins et al., 1997), and mold formation is likely when round bales are exposed to the elements for extended periods not only during storage, but feeding as well (Lawrence and Coleman, 2000).
While pasture feeding is common, stall feeding is also very common and generally includes the use of conventional baled hay that is fed either in a feeder or on the stall floor. Some horse owners believe feeding hay on the ground is a more natural way to feed, is safer, and helps reduce ingestion of foreign materials. However, many scientists believe that by feeding hay in feeders, chance of colic may be reduced, waste may be reduced, and internal parasite incidence may not be as high (NRC, 1989). Therefore, a better understanding of wastage and consumption of hay being fed to horses is needed. These studies were conducted to determine the amount of hay wastage when horses are fed both round baled hay with and without the use of hay rings and square baled hay fed either on the ground or in a commercial feeder.

MATERIALS AND METHODS

Study 1
This experiment was conducted simultaneously at Texas Tech University Lubbock, Texas and Sam Houston State University Huntsville, Texas. At each research facility, four paint/quarter horse mares (*Equus caballus*) 4 – 7 years of age were rotated through treatments consisting of ALF round baled hay without ring (WOR) and with hay ring (WR). Nutrient analysis of ALF round baled hay is listed in Table 1. The experiment was designed as a completely randomized design with two replications per treatment at each site and four replications per treatment total. Horse Round Bale Feeders measuring eight feet in diameter and two feet nine inches in height were used in the study and were provided by Priefert® Manufacturing Mount Pleasant, Texas. Horses were placed in an enclosed dry-lot setting where ALF hay was the only available source of nutrient consumption. Throughout the experimental period all horses remained indoors, removing any influence of wind, precipitation, or other environmental factors. Horses were provided free access to water and a trace mineralized salt block. Prior to the beginning of the first treatment cycle, horses were placed in the treatment area for three days and fed an ad libitum amount of ALF hay. Prior to the start of the trial, hay was weighed and core samples (Han et al. 2004) were taken and analyzed for dry matter and nutrient composition. During each treatment replication, horses were allowed to consume all hay that was not ruined by fecal or urine contamination. At the end of each treatment replication, unconsumed hay was collected, sorted from soil and fecal material, weighed, and a representative sample was analyzed for dry matter analysis and nutrient composition. Additionally, all horses were weighed at the beginning and end of each treatment replication. All data were analyzed using the Mixed procedure of SAS (SAS). Pen was the experimental unit. Treatment was the fixed effect, and the LSMEANS statement of SAS was used to obtain standard errors.

Table 1. Nutrient analysis of ALF round and conventional baled hay[a]

Item	Round	Small Square
DM, %	91.27	90.25
ADF[b],%	34.24	35.87
CP[c], %	19.7	22.77
TDN[d], %	60.91	62.15
Ca, %	1.05	1.97
P, %	0.52	0.55

[a]All values except DM, % are expressed on a DM basis

[b]ADF = acid detergent fiber

[c]CP = crude protein

[d]TDN = total digestible nutrients

Study 2

Fifteen long-yearling Quarter Horses in training were used to determine hay waste when fed ALF hay on the ground or in hay feeders while being housed in 10' x 10' stalls. Nutrient analysis of ALF conventional baled hay is listed in Table 1. On day 0 horses were de-wormed with a common commercial anthelmentic, placed in stalls, and offered ALF hay at 2% of their body weight in a common commercial feeder. Horses were fed for 7 days before collection began to allow for any adjustment necessary to the ALF hay. Horses were fed at approximately 7 am and 5 pm daily. On day 7, horses were weighed and placed back in stalls. Horses then received ALF hay at 2% of their body weight in hay feeders for 35 continuous days. Upon completion of the 35 days, horses were de-wormed, weighed, and placed back in stalls. On day 35, horses were fed ALF on the ground for another 35 continuous days. Daily collection of wasted hay occurred two hours post feeding. Stalls were cleaned of urine and fecal material daily. Clean, fresh water was provided free choice. Upon placing hay in stalls, each flake of hay was sampled for dry matter analysis and nutrient composition. After trial was completed, statistical analysis was performed to determine differences amongst treatments. All data were analyzed using the Mixed procedure of SAS (SAS).

RESULTS

Study 1

There were no differences in data by research site ($P>0.05$). Hay wastage and feed intake data are presented in Table 2. Percent wastage on a DM basis was higher ($P<0.003$) for horses fed ALF hay WOR than for those fed hay WR. Mean wastage for ALF when fed WR was 9.10% whereas WOR was 31.50%. Percent wastage on an OM basis followed the same pattern as DM wastage, indicating that sampling techniques were effective in removing soil from the orts and correcting for percentage ash in the offered hay. All unspoiled hay had been consumed at day 7 of the WOR treatment, and day 9 of the WR treatment. No differences were seen ($P>0.05$) in DMI or ADG between the treatments. Mean ADG for the treatment WOR was 1.42 lbs/day and for the treatment WR was -0.33 lbs/day.

Table 2. Effects of feeding method on round baled ALF hay wastage, ADG and feed intake[a,b]

	Treatments[a]			
	ALF			P-value[b]
Item	WR	WOR	SEM	Ring
DM waste[c]	9.10	31.50	3.20	<0.003
OM waste[d]	7.25	28.63	2.94	<0.002
ADG[e], lbs	-0.33	1.42	1.81	0.47
DMI[f], lbs	21.95	23.05	2.46	0.76
DMI, %BW[g]	2.29	2.38	0.19	0.75

[a]Feeder: WR = with hay ring; WOR = without hay ring
[b]Observed significance level: Ring = hay ring effect
[c]Percentage waste on dry matter basis
[d]Percentage waste on organic matter basis
[e]Average daily gain
[f]Dry matter intake per day
[g]Dry matter intake as a percent of body weight, per head

Study 2

Hay wastage on a DM basis was higher (P<0.05) when hay was fed on the ground rather than when fed in a feeder (Table3). The mean wastage for ALF when fed in a feeder was 1.3% whereas when fed on the ground, 7.3% was wasted. DMI was lower (P<0.05) for horses consuming hay from the ground in the stall. DMI intake for horses fed hay on the ground was 14.9 pounds versus 15.9 pounds for those consuming hay in the feeders. No differences were seen in (P>0.05) in ADG between the treatments. Mean ADG while fed in feeder was 1.9 lbs/day and 1.8 lbs/day when fed on the ground.

Table 3. Effect of Feeding Method in a Stall Setting on ALF Hay Wastage

Item	In Feeder	On Ground	SEM
DM waste[c]	1.3[a]	7.3[b]	1.98
DMI[d], lbs	15.9[a]	14.9[b]	0.37
ADG[d], lbs	1.9[a]	1.8[a]	0.64

[a,b] Means in same column with different letter superscripts differ (P < .05)
[c]Percentage waste on dry matter basis
[d]Dry matter intake per day
[e]Average daily gain

DISCUSSION

The results of this study confirm that feeding ALF hay without the use of hay rings or common commercial feeders results in a high percent of wastage. This appears to be primarily because hay rings and commercial feeders help reduce waste caused by urine and fecal contamination, trampling, and hay used for bedding.

When round baled hay was fed without a ring, horses tended to peel off a large section of the outermost portion of the bale in order to gain access to the center of the bale and cause waste, which is a similar result communicated by Lawrence and Coleman (2000). The hay that was discarded in this manner was trampled during feeding and soiled with urine and fecal matter, thus spoiling it. When hay was fed on the ground inside the stall, the hay was many times distributed throughout the stall and mixed with urine and fecal material while also being trampled.

Additionally, when round baled hay was fed without a ring, horses used the hay lying around the bale as bedding. By comparison, hay rings appear to reduce waste primarily by protecting the round bale from being trampled and contaminated with urine and feces. This was most apparent when collecting and measuring waste hay. Waste hay from all treatments was sorted from fecal material and soil by hand. Although the quantity and concentration of fecal material present in waste hay before sampling was not measured or recorded, it was observed to be lower in hay collected from WR treatments, which is a potential economic savings. Furthermore, hay collected from the WR treatments typically appeared to be less contaminated by urine.

In the stall, hay fed in a commercial feeder also reduced waste when compared to being fed on the ground and again is a similar finding to the reported results from Lawrence and Coleman (2000). When comparing hay fed in the feeder versus hay being fed with a round bale ring, it was observed that the feeder had a lower wastage on a percent basis. This was somewhat expected due to the much smaller amount that was fed in the stall.

When considering initial cost and labor, round bales are generally cheaper per pound and labor is much less. However, feeding hay from round bales has also shown to increase the risk of colic in horses (Hudson et. al, 2001), and forcing horses to consume spoiled hay will likely exacerbate that risk. Hay spoilage was the factor used in determining when to end each treatment. Treatments were ceased when it appeared unlikely that the horses on trial could consume fresh, unspoiled hay. It is possible that the treatments conducted without a hay ring could have been continued for another day, but not without forcing the animals to consume contaminated hay and therefore increasing the risk of colic.

In this study, the use of hay rings or round bale feeders appears to reduce hay wastage to a greater degree than was expected. Moreover, the use of hay rings reduces the quantity of spoiled hay available to horses being fed round bales. This could be of benefit in reducing the incidence of colic associated with the consumption of spoiled or moldy hay as well as provides economic values that may offset additional cost of hay rings. This experiment did not consider the role of environmental factors such as drainage and precipitation in round bale wastage, and this is an area that needs further study to be completely understood. It appears that when fed under the right conditions, round baled hay may be an acceptable alternative to conventionally baled hay when considering colic and digestive upsets associated with hay spoilage. However, in this study it was found that waste is reduced the greatest by feeding in the stall with common commercial feeders. However, stall feeding increases labor and potential costs due to more frequent feeding schedules. Therefore, labor, initial cost of hay, and amount of waste are all considerations when determining the best management technique.

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Warm-Season Forages for Free-Ranging White-tailed Deer in South Texas

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ABSTRACT

Several warm-season forages were planted in irrigated food plots in 1999 and 2000 on high pH soils in semi-arid south Texas. Objectives were to test different warm season forages for utility in south Texas food plots based on agronomic and nutritional attributes and deer use. Nutritional profiles were collected bi-weekly in 1999 and monthly in 2000. Least squares means and 95% confidence intervals for production, nutritional, and mineral values were calculated. Variables recorded included biomass, and concentration of crude protein, detergent fiber, tannin, Cu, Zn, Na, Mg, K, Ca, and P. Lablab (*Lablab purpureus* (L.) Sweet), cowpeas (*Vigna unguiculata* (L.) Walp), and 'BeeWild' bundleflower (*Desmanthus bicornutus* S. Watson) produced the most biomass and the highest crude protein in both years of the study. Low concentrations of tannins were recorded in the bundleflower. BeeWild bundleflower was lower in fiber content in both years of the study when compared to the other forages tested. Every mineral tested met or exceeded established minimum requirements for maintenance in white-tailed deer. We recommend lablab, Iron & Clay cowpeas, and BeeWild bundleflower for irrigated warm season food plots in south Texas.

Key words: Food plot, white-tailed deer, nutrition, forage.

INTRODUCTION

Planting food plots to supplement white-tailed deer (*Odocoileus virginianus*) diets is a common practice in the southeastern USA. Precipitation fluctuations in south Texas directly influence the quality and quantity of deer populations, as native forages are often nutritionally inadequate for growth and maintenance in drought conditions (Varner et al., 1977; Teer et al., 1991; Ginnett and Young, 2000). Nutritional stress for females occurs in the summer due to lactation demands and recovery from parturition. Fawns are susceptible to summer stress when lactation demands are not met and when the nutritional value of native forages is poor at weaning (Keegan et al., 1989). Research in other areas of the white-tailed deer's range indicate

supplemental feeding can be effective at providing nutrition for deer in times of stress. Page and Underwood (2006) reported supplemental feed can significantly influence the protein and energy status of white-tailed deer in the winter stress period in the northeastern United States. Smith et al. (2007) found that crops from food plots in North Dakota made up a high proportion of deer diets in the winter stress period, reduced depredation on adjacent agricultural lands, and reported high survival of females, although the authors noted a consequence could be overpopulation.

Examining the nutritional profiles of potential forages is very important in determining if the potential forage will be beneficial to targeted species, and if the forage will help supplement the diet in times of stress. Analysis of crude protein, fiber content, secondary compounds, and mineral content of potential forages are important in determining which forages will best meet the needs of a manager. Nutritional values of native forages in south Texas are often lowest in summer, when females and males are already under stress due to lactation and antlerogenesis demands, and protein and energy may be lacking (Meyer et al. 1984, Soltero-Gardea et al. 1994). Zaiglin and DeYoung (1989) found deer use of pelleted feed increased when native forages protein levels decreased. Asleson et al. (1997) noted that deer raised on a high protein diet gained weight faster than deer fed a lower protein diet. High levels of tannins can deter herbivory and be nutritionally detrimental (McArthur et al. 1991, Van Soest 1994), but Campbell and Hewitt (2000) found that secondary compounds in browse dominated diets in south Texas did not affect antler growth or composition. Although livestock show deleterious effects to non-protein N in secondary compounds, Mayfield et al. (2004) concluded deer fed a diet of guajillo did not absorb large amounts of non-protein N that must be detoxified and excreted. Fiber content can also influence intake by deer, since deer have a relatively quick passage rate compared to other ruminants. Waer et al. (1992) found deer shifted to less fibrous species as some forages increased in fiber content.

Hunting produces a significant amount of revenue for Texas landowners (Adams et. al., 2004). Many landowners strive to improve antler size and the quantity of white-tailed deer for economical and aesthetic purposes. Often, nutrition is a limiting factor in deer populations, leading many landowners to provide supplemental feed in the form of food plots or protein pellets. Food plots can be an important management tool for improving the deer diet in times of stress, increasing recruitment, and attracting deer for hunting or observational purposes. According to Thigpen et al. (1990) and Adams et al. (1992), 22 and 23% respectively, of ranches surveyed in Texas planted food plots for white-tailed deer. In a survey conducted by Bryant et al. (1999) in south Texas, more than 56% reported planting food plots, and of these, 41% planted both summer and winter plots. Although risky, food plots can be more cost effective than feeding a pelleted protein ration (McBryde, 1995). Males often dominate protein feeder sites and not all females may use feeders (Bartoskewitz et al., 2003). Food plots can provide more access to sub dominant animals than feeders, allowing a greater percentage of the deer population to benefit from supplemental feeding. However, in semi arid environments dry-land farming practices and possibly irrigation are needed for successful propagation, which may take considerable expense. We also caution landowners not to plow up their most diverse woody plant communities to plant food plots, as native plants provide numerous benefits to wildlife other than nutrition.

Research is needed to evaluate alternative forages for their use in food plots. Forage growth, and utilization differ with climatic and soil conditions. In south Texas, important forage attributes include tolerance to drought and periodic flooding rains, adaptation to high pH soils, productivity, ease of establishment, perennial traits, and palatability to white-tailed deer.

The objectives of this study were to evaluate several forages in south Texas, and ascertain which forages have good agronomic, forage production and nutritional traits and are well utilized by White-tailed deer.

MATERIALS AND METHODS

The study was conducted on the 20,200 ac. West Wind Ranch, located in Zavala County, 7 miles southeast of La Pryor, TX. Average annual rainfall is 22 inches, with 60% falling between April and September (Soil Conservation Service, 1981). Four different food plots were used in the study. These food plots had been established on the ranch prior to this research, so food plot size, irrigation system layout, fencing design, and soil type were pre-determined on this working game ranch. All food plots were cleared blocks of land surrounded by native mixed brush. Soil types differed among plots. Plot 1 was a clay loam of the Chacon series, a fine, montmorillonitic, hyperthermic Torrertic Argiustolls with a pH of 8.3. Plot 2 was 4 miles from Plot 1 and was a sandy clay loam of the Brundage series, a fine-loamy, mixed, hyperthermic Ustollic Natrargids, with a pH of 8.4. Plot 3 was a loam of the Conalb series, a coarse-silty, carbonatic, hyperthermic Fluventic Ustochrepts with a pH of 8.6. Plot 4 was a clay loam of the Bookout series, a fine-silty, mixed, hyperthermic Aridic Ustochrepts, with a pH of 8.4 (Soil Conservation Service, 1981). Plots 1 and 2 were used in 1999, while Plots 3 and 4 were used in 2000. Soil fertility tests recommended no fertilizer for planting legumes. Surveys indicated deer density surrounding all food plots was 1 deer per 20 ac. (Larry Martin and George Hundley, personnel communication).

Plot Establishment and Maintenance

Forages evaluated under irrigation included 12 different legumes and two perennial sunflowers (Table 1). The four bundleflower lines were not released at the time of this research but have since been released as 'BeeTAM-06', 'BeeTAM-08', 'BeeTAM-37', and 'BeeTAM-57' and are being marketed as a mechanical blend of all four cultivars under the trademarked name of 'BeeWild' bundleflower, (Ocumpaugh et al., 2004a,b,c & d). For simplicity we will use the released cultivar names when discussing specific lines, but will use "BeeWild" when talking about their general performance.

Ten different annual and perennial forages were planted in two separate food plots in each year of the study. Prior to planting, a seedbed was prepared by disking. Forages were planted utilizing a split-plot field design. A grain drill was used to plant forages in strips 14 feet wide and 160 to 260 feet long, depending on the width of each existing food plot. Forages were planted with a 10 foot gap of bare ground between the planted strips to allow deer free access to all forages and to aid in visual determination of deer utilization of the planted forages (data not reported here). Weeds in the 10 ft. buffer zone between the planted strips were sprayed with Roundup® (N-(phosphonomethyl) glycine) herbicide at a rate of 24 oz/A.

Table 1. Description and characteristics for forages planted in Zavala Co., Texas.

Forage	Scientific name	Year planted	Longevity
Rongai lablab	*Lablab purpureus*	1999, 2000	Annual
Iron & Clay cowpeas	*Vigna unguiculata*	1999, 2000	Annual
Mung beans	*Vigna radiata*	1999, 2000	Annual
BeeTAM-06 bundleflower	*Desmanthus bicornutus*	1999, 2000	Perennial
BeeTAM-08 bundleflower	*Desmanthus bicornutus*	2000	Perennial
BeeTAM-37 bundleflower	*Desmanthus bicornutus*	2000	Perennial
BeeTAM-57 bundleflower	*Desmanthus bicornutus*	1999, 2000	Perennial
Sabine Illinois bundleflower	*Desmanthus illinoensis*	2000	Perennial
Rio alfalfa	*Medicago sativa*	1999, 2000	Perennial
Comanche partridge pea	*Chamaecrista fasciculate*	1999	Annual
Laredo soybeans	*Glycine max*	1999	Annual

Padre soybeans	*Glycine max*	2000	Annual
Plateau awnless bush sunflower	*Simsia calva*	1999	Perennial
Aztec maximilian sunflower	*Helianthus maximiliani*	1999	Perennial

planted strips to allow deer free access to all forages and to aid in visual determination of deer utilization of the planted forages (data not reported here). Weeds in the 10 ft. buffer zone between the planted strips were sprayed with Roundup® (N-(phosphonomethyl) glycine) herbicide at a rate of 24 oz/A. Each food plot contained 3 to 4 strips (replications) of each forage. In most cases, we planted 4 replications of most of the forages, but to make the experiment fit within the existing food plot, some forages could only be replicated 3 times. An existing 8-foot fence surrounded each food plot. The fences were constructed so the top 4 ft of the fence could be folded down to allow deer access to the plots as desired. Forages were protected from grazing for 9 weeks after planting in each year. Irrigation was accomplished with the use of irrigation guns spaced about 130 feet apart. The guns covered a circular pattern 100- 150 feet in radius, and delivered approximately ½ in/hr.

Plots 1 (4.7 ac) and 2 (5.7 ac) were planted on 7 April 1999. Eight of the ten forages planted were legumes (Table 1). All legumes were inoculated with appropriate rhizobia immediately before planting. Due to the poor emergence of BeeTAM-06 bundleflower (planted too deep) and maximilian sunflower (poor seed quality), were replanted in their designated strips on 29 April. Black-tailed jackrabbits (*Lepus californicus* Gray) grazed heavily on the soybean and alfalfa in Plot 2, forcing us to replant the soybeans on 20 May. Jackrabbits within 0.5 miles of the plot were harvested intensely for two weeks. Plots were irrigated as needed to supplement rainfall, generally about once per week for 3.5 to 4.5 hours per riser, for a total amount of about 1.75 to 2.25 inches per week in 1999.

In 2000, two new food plots in different locations from 1999 were used. Plots 3 and 4 were approximately 1 mile apart. Plot 3 was separated from the rest of the ranch by a fixed 8-foot high fence. Species which did not establish or proved unpalatable to deer in 1999, were replaced with alternate species in 2000 (Table 1) Four species of annual legumes and six perennial legumes were planted in 2000 (Table 1). The planting procedures and experimental layout in 2000 were similar to that used in 1999. Planting was initiated on 11 April in Plot 3 (3.4 ac), but rain and mechanical problems delayed completion until 17 April 2000. All of Plot 4 (6 ac) was planted on 17 April. In 2000, an intense drought and high temperatures required a much more rigorous irrigation schedule than for 1999. Irrigation time per riser was increased to 6 hr to increase moisture depth and account for evaporation (about 3 in. of water applied per week). Soon after planting in 2000, an infestation of Johnson grass (*Sorghum halepense* (L.) Person) and croton (*Croton capitatus* Michx. Var. *lindheimeri* (Engelm. & Gray) Muell. Arg.) was evident in both plots. These two weeds greatly reduced growth of mung beans, alfalfa, soybean, and Illinois bundleflower. Johnson grass was controlled with two applications of Fusillade® (R-2-[4-[[5-(Trifluoromethyl)-2-pyridinyl]oxy] phenoxy]propanoate) at 16 to 24 oz/ac. Croton was controlled by mowing and manual removal, as no herbicide was available which would not also harm the planted forages. Diazonon® (O,O-Diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl)phosphorothioate) was used to control harvester ants. The high pH soils induced chlorosis in mung beans, Iron & Clay cowpeas, and Padre soybean, so a mixture of liquid Fe and Zn was applied during the first week of June in 2000.

Deer Herbivory Observations

Deer were observed with night vision binoculars in an attempt to determine preference. Additional confirmation of herbivory was evaluated with plant use observations. (For the purposes

of this report, relative herbivory will be limited to observation of use vs. complete rejection of a forage.)

Biomass Production Sampling

Protective cages were used to prevent grazing and evaluate total biomass of the forage. For the first year, one cage was placed randomly in each strip. Biomass production was estimated by clipping the forages in the protective cages to within 2 in. of the soil with hand shears. Each forage sample was weighed in the field, recorded as fresh weight, and discarded. Biomass samples were converted to dry weights by correcting for moisture content from a subsample dried at 130° F. After each clipping, the protective cages were moved to a new, randomly determined location within each forage strip. Samples were collected every other week in the 1999 season. In the 2000 season, sample collection was reduced to once per month. For the second year, each planted strip was divided into three zones (based on distance from the side fence), because deer began feeding at the outside of the plot and worked their way inward as forage biomass was depleted. A paired plot system was established in order to sample a representative portion of each zone. Caged and unprotected clippings were taken from random paired locations in a different zone each collection period, beginning with the zone nearest the fence. Forage collection began before the fence was lowered and continued until the end of September for both years.

Nutritional Sampling and Analyses

Nutritional samples were collected from unprotected plants in each forage strip using a "grab" sampling technique to simulate herbivory by taking approximately four inches of the top portion of each forage within reach of deer. Samples were dried as above and ground through a 1 mm stainless steel screen. Nitrogen was determined using the micro-Kjeldahl method, and then multiplied by 6.25 to estimate crude protein (AOAC, 1990). Samples were analyzed for fiber content using the neutral detergent fiber (NDF) and acid detergent fiber (ADF) procedures of Goering and Van Soest (1970). Biologically important tannin levels were assessed by the bovine serum albumin (BSA) precipitation procedure (Martin and Martin, 1982). The atomic absorption spectrophotometer method was used for analysis of K, Ca, Cu, Na, Mg, and Zn, and a colorimetric method was used to determine inorganic P levels (Fick et al., 1979).

Statistical Analyses

Seasonal means and 95% confidence intervals were calculated using Statistical Analysis Software (SAS, 1989) for all measured attributes. The data presented here was averaged across both food plots for each season.

RESULTS AND DISCUSSION

Forage Use by White-tailed Deer. Close inspection of the maximilian sunflower, bush sunflower, and partridge pea in 1999 revealed no evidence of herbivory on any of the plots. Therefore, we replaced these forages in the 2000 planting. In both seasons, deer grazed all other forages.

Biomass Production and Nutritional Profiles. All minerals evaluated were at or above the reported requirements for White-tailed deer, in both years so will not be reported. For those interested in knowing specific responses, please see (Kunz, 2002)

Iron & Clay cowpeas, lablab, BeeTAM-06 and BeeTAM-57 bundleflower, and mung beans produced the most biomass in 1999 (Table 2). With the exception of mung beans, these

forages also contained the highest protein levels.

Tannin levels might be greater than reported, because drying samples at 130° F is less desirable than freeze drying, or drying samples at 104°F, (Servello et al., 1987). However, identical methods were used, so differences should be relevant. Both bundleflowers contained low to moderate levels of tannin, which could have reduced the amount of protein available for digestion. Partridge pea was the only other forage in 1999 found to contain tannins. Partridge pea tannin levels were greater than the bundleflowers in 1999 (Table 2). The NDF and ADF values were lower for both BeeTAM-06 and BeeTAM-57 bundleflowers than all other forages in 1999 (Table 2).

Lablab and BeeWild bundleflower produced the most biomass in the 2000 season (Table 3), indicating these forages would be desirable when cultivated in warm-season food plots.

Table 2. Means and 95% confidence intervals for production & nutritional content of forages evaluated in 1999.

Forage	Biomass	CP	NDF	ADF	Tannin
	(lb/A)	(%)			(ppm) precipitated
Rongai lablab	3222 ± 555	21 ± 2	36 ± 3	26 ± 3	0
Iron & Clay cowpeas	3413 ± 396	23 ± 2	33 ± 3	21 ± 2	0
Mung beans	2442 ± 344	13 ± 1	37 ± 3	26 ± 3	0
Rio alfalfa	789 ± 153	17 ± 1	37 ± 3	27 ± 2	0
Laredo soybeans	720 ± 221	17 ± 1	38 ± 3	29 ± 2	0
BeeTAM-06 bundleflower	2060 ± 614	20 ± 1	29 ± 2	17 ± 2	130 ± 25
BeeTAM-57 bundleflower	3083 ± 590	22 ± 1	27 ± 3	17 ± 2	100 ± 25
Plateau bush sunflower	1184 ± 391	15 ± 2	42 ± 3	31 ± 2	0
Aztec maximilian sunflower	20 ± 20	17 ± 1	35 ± 2	24 ± 2	0
Comanche partridge pea	1870 ± 418	19 ± 1	33 ± 2	24 ± 1	200 ± 25

Iron & Clay cowpeas produced more biomass than the remaining forages, but produced much less biomass than in 1999 (Tables 2 & 3). Iron & Clay cowpeas peak production in August 2000 was still less than the lowest production values in any sampling period of 1999 (data not shown). Several factors might have influenced Iron & Clay cowpeas reduced growth including weed competition, soil type, and a high soil pH which induced chlorosis.

Table 3. Means and 95% confidence intervals for production & nutritional content of forages evaluated in 2000.

Forage	Biomass	CP	NDF	ADF	Tannin
	(lb/A)	-%			(ppm) precipitated
Rongai lablab	1909 ± 1381	20 ± 2	41 ± 3	27 ± 3	0
Iron & Clay cowpeas	916 ± 326	20 ± 3	39 ± 4	25 ± 4	0
Mung beans	297 ± 142	13 ± 2	38 ± 4	26 ± 4	0
Rio alfalfa	550 ± 230	19 ± 2	40 ± 2	26 ± 2	0
Padre soybeans	580 ± 378	18 ± 2	39 ± 4	25 ± 4	0
BeeTAM-06 bundleflower	2041 ± 977	21 ± 1	35 ± 3	19 ± 2	140 ± 25
BeeTAM-08 bundleflower	2060 ± 1412	20 ± 2	36 ± 3	20 ± 2	140 ± 25
BeeTAM-37 bundleflower	1356 ± 708	20 ± 2	36 ± 4	21 ± 3	150 ± 30
BeeTAM-57 bundleflower	1423 ± 681	19 ± 2	38 ± 4	22 ± 3	110 ± 25

Illinois bundleflower	275 ± 106	16 ± 2	41 ± 3 24 ± 3 80 ± 10

The infestation of croton (*Croton* sp.) may have affected biomass and nutritional profiles of forages in 2000. Most forages with growth forms less than 3 ft. in height, including mung beans, Padre soybean, and Illinois bundleflower, had sporadic stands and were uneven in stature. The soil pH in both plots (pH of 8.6 and 8.4 in Plot 3 & 4, respectively), was high and may limit productivity of many legumes (Martin, 1987). Additionally, because the cages were moved to a new location after each sampling period forages that experienced heavy utilization, such as lablab and Iron & Clay cowpea, recorded low biomass due to grazing.

BeeWild bundleflower, lablab, and Iron & Clay cowpeas maintained the highest protein levels in 2000, with levels close to or exceeding 20% (Table 3). For gestation, lactation, and maximum antler growth, deer require 16 to 18 % protein. Requirements for maintenance and growth during antler genesis (5.7 – 9.9%) are considerably lower (Asleson et al., 1996). Illinois bundleflower and mung beans contained less crude protein than other forages, but with the exception of mung beans in the final sampling period (data not shown), still maintained protein levels exceeding the requirements for growth and maintenance in deer.

BeeWild bundleflowers and Illinois bundleflower did contain tannins in 2000, which could affect the amount of protein available to deer (Table 3). BeeTAM-57 bundleflower and Illinois bundleflower contained less tannin than the remaining bundleflowers, but tannin levels for all the bundleflowers were low to moderate. Many mammals, including deer, have evolved physiological responses to tannins, so the effects of low to moderate levels of tannins could be further reduced in the rumen (Robbins et al., 1991). The presence of low levels of tannin may be beneficial to ruminants. Binding with tannins may inhibit the deleterious effects of viruses and other pathogens in the gastrointestinal tract (Keating et al., 1988).

MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

For the environmental conditions present in south Texas, we found that lablab, Iron & Clay cowpeas, and BeeWild bundleflower are desirable forages for planting in irrigated food plots for free-ranging white-tailed deer.

BeeWild bundleflowers exhibit several qualities that are desirable in white-tailed deer food plots, including good drought tolerance, good productivity and nutritional values, and tolerance to alkaline soils common in south and central Texas (Grichar et al., 1998). BeeWild bundleflower is perennial, and will re-grow to productive levels in the spring if adequate moisture is available. Multiple other plantings of BeeWild bundleflower in south Texas indicates that it can be established without a high fence to protect it from grazing during the seedling stage. None of the other useful forages can be established without a high fence. Rongai lablab, Iron & Clay cowpeas, and BeeWild bundleflower show good potential for successful utilization in irrigated food plots in south Texas.

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COTTON BY-PRODUCTS SUPPLEMENTATION FOR STEERS GRAZING TOBOSAGRASS (*Hilaria mutica* [Buckl.] Benth.) RANGELAND.

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ABSTRACT

The objective of this research was to compare the performance of growing cattle fed COBY-processed (CBP) or a commercial supplement during winter and spring. In addition, forage utilization was also measured. Three treatments were evaluated: (1) control (CON), no supplement, (2) commercial supplement (COMM), and (3) starch coated and extruded cotton gin by-products (CBP). Commercial supplements and CBP were fed three times a week at a rate of 1.0 lbs/head/day. We used a total of 197 British and Continental crossbred steers with an average initial weight of 366 lb/hd (SD ± 17 lbs). Steers that were fed with the COMM supplement gained 35 lbs/head more than the control, whereas steers fed with CBP gained 20 lbs/head more than the controls. In contrast, steers fed with the COMM supplement gained 15 lbs/head more than those fed with CBP. Forage utilization for CBP treatment was 37%, while COMM steers achieved 63%, and CON 52%. The research confirmed that CBP as a supplement was palatable but incomplete on nutritional value to support cost effective performance in growing cattle grazing tobosagrass rangeland.

Key words: Cotton gin by-products, stockers, cattle, summer weight gain, tobosagrass

INTRODUCTION

Supplementation in most areas where domestic ruminants graze is a major factor to consider when making management decisions (Caton and Dhuyvetter, 1997). Providing nutrients to offset deficiencies or to meet production demands is more often practiced during periods of summer dormancy or during the fall and winter months (Caton and Dhuyvetter, 1997).

A significant residual of the cotton lint ginning process is cotton gin by-product (CBP). CBP is composed of leaves, stems, burrs, immature seed, and lint fibers, stripped from the plant along with the cotton lint during harvest (Baker et al,. 1994; Middleton and Elam, 2002). These

components of CBP consist mostly of lignified cellulose, hemicellulose, and minerals, which can be improved by chemical processing techniques (Holt et al., 2003; Arndt and Richardson, 1985; Conner, 1985).

Several by-product feeds are also available in Texas and often are lower-cost sources of energy and other nutrients. Many of these feeds do not require processing but may have limitations for handling, storage and feeding. Such is the case of CBP sometimes referred to as "gin trash." CBP is a relatively cheap and abundant by-product available from gins in the Southern High Plains of Texas.

Gin trash is palatable to ruminants and can produce acceptable diets if supplemented with a protein or energy source (Erwin and Roubicek, 1958; Sagebiel and Cisse, 1984; Hill et al., 2000). A feeding performance test by Sherrod et al., (1970) indicated that the intake of cotton burr pellets offered free choice to beef steers was only 49.5% that of alfalfa pellets offered free choice. Thompson et al. (1976) reported that ground cotton burrs, whole burrs, and cotton seed hulls have comparable acceptability. In the case of some feedlot users, molasses is mixed with gin trash to increase acceptability and also furnish additional energy in rations.

Several techniques for upgrading the quality of CBP for ruminant feed have been developed and tested over the past three decades; most of these techniques involve a combination of both chemical and physical effects (Holt et al., 2003). Benefits of these techniques are usually reflected in less sorting of the CBP in diets, increased consumption when compared with unprocessed CBP, and improved animal performance (Holt et al., 2003). Although various techniques have been developed in an attempt to improve the economic feasibility of using CBP as a ruminant feedstuff, no single technique has been accepted for practical use in various animal production situations (Holt et al., 2003). However, the extrusion of CBP in combination with the application of gelatinized starch slurry (COBY process) is different and offers new potential (Holt et al., 2003).

Some studies have been conducted on feeding CBP to steers under feedlot conditions; however, minimal data is available with regard to the feeding value of extruded CBP and the application of gelatinized starch, when fed to steers grazing on a tobosagrass rangeland. Therefore, the objective of this research was to compare the performance of growing cattle fed COBY-processed CBP vs. commercial (common) supplement during winter and spring. In addition forage utilization was measured through each one of the grazing periods. Diets over the treatments were not isonitrogenous; therefore it cannot be concluded that the response to supplementation resulted entirely from protein. The experiment was developed to evaluate CBP as an alternative to more expensive (traditional) protein supplement.

Materials and Methods

Study Area

This research was conducted at a ranch near Justiceburg in Garza County, Texas. Vegetation consisted mainly of tobosagrass (*Hilaria mutica* [Buckl.] Benth.) and mesquite (Prosopis glandulosa var glandulosa Torr.) range. Other species included alkali sacaton (Sporobolus airoides [Torr.] Torr) in depressions, and buffalograss (Buchloe dactyloides [Nutt.] Engelm.) on upland. The area is dominated by a clay flat range site with gently sloping Stamford Clay soils (fine, montmorillonitic, thermic typic Chromusterts) (Richardson et al., 1965). The climate is warm, temperate and subtropical; with an average daily minimum of 27º F in January and an average daily maximum temperature in July of 95º F. Periods of drought occur frequently. The average annual rainfall of 19 inches occurs mainly from April through July (Richardson et al.,

1965). According to previous studies at the same site (Britton and Pitts, 1988, Villalobos et al., 1997), average C.P. diet content during the winter season varied from 4-6%.

Sampling periods and Animal Performance

To determine the effect of supplementation on animal gain; this experiment was divided in 7 grazing periods. Grazing periods were February 24 to March 24 (P1), March 25 to April 20 (P2), April 21 to May 18 (P3), May 19 to June 15 (P4), June 16 to July 13 (P5), July 14 to August 10 (P6) and August 11 to Sept 8 (P7); each one of the periods covered about 28 days. On their arrival, steers were held in a small pasture of dormant old world bluestem. Cattle were watched closely for signs of sickness and were given the supplement. Steers were moved to the tobosagrass study site after 2 weeks and started on the supplement for about one month.

Response of steers grazing tobosagrass to the supplementation was evaluated using 197 crossbred Bos taurus x Bos indicus steers with a mean initial live weight of 366 lb/hd (SD ± 17 lbs). Forage yield was estimated by randomly clipping 20, 0.25 m^2 quadrants in each pasture at the end of the growing season. Stocking rate for each pasture was based on standing crop at the start of grazing trial and estimated yield for the current year, assuming removal of 50% of available forage and average forage intake of 3.0 % of body weight based on 400 pound steers, was used to calculate stocking rates. Pasture areas were 82, 85, 108, 115, 131, and 104 acres, all pastures were not previously used for almost 18 months. In an attempt to maintain similar forage allowances in all pastures, the amount of animals allocated in each pasture-treatment was calculated based on 180 days of use.

Experimental protocol was approved by the Texas Tech University Animal Care and Use Committee. Steers were randomly allocated to each of 3 treatments. (1) Control (CON) no supplement, (2) Commercial Supplement (COMM), and (3) Starch coated and extruded cotton by-products (CBP). Commercial supplements and CBP were fed three times a week at a rate of 1.0 lb/head/day. Two replications per treatment were used. The 6 herds were composed of 15 to 41 steers for an average stocking rate of 1 steer/4.0 acres for the 7 months of study. Cattle were group-fed 3 days per week, between 1100 and 1200 h to avoid grazing interruption. Free choice mineral (7% P, 13% Ca, 50% NaCl) was available at all times. Steers were weighed initially before entering the pastures and then every 28 days. Liveweights were obtained following an overnight period without water and feed.

Cost of additional weight gain by supplemented steers was estimated using CBP and COMM supplement costs ($ 45 and $180/ton) respectively. These costs were derived for the period of December to September from sales reports during the 10 years average and were calculated using the following equation: Cost of additional gain = feed cost ($/hd/day)/gain (lb/hd/day above control).

To estimate the effect of supplementation on herbage standing crop (forage use) and forage quality, vegetation was clipped in 20 randomly selected quadrants per paddock per period using a 0.25 m^2 quadrats. Clippings were conducted every 26 days approximately at the middle of each period. Herbage was clipped about 2 cm above the soil surface and old material and litter were removed from the samples. Herbage samples were dried in a lab at 60ºC for 72 hours. Dry weight was measured to the nearest 0.01 g and recorded. Dried forage samples were ground in a Thomas-Wiley Laboratory Mill™ Model 4 using a 1 mm screen. The ground material was stored in Ziploc plastic bags in a dark dry place prior to laboratory analysis.

To estimate forage quality, a composite of all samples per paddock was analyzed. Crude protein content of forage samples was estimated using a LECO CHN-2000 Series Elemental Analyzer (LECO Corp St. Joseph. MI). Four replications from the forage sample composite were analyzed. *In vitro* dry matter digestibility (IVDMD) was determined using the ANKOM Daisy II

incubator (ANKOM Techno Corp, Fairport, NY. All CBP used in this study was of similar quality and was obtained from cotton grown and ginned on the Texas South Plains. Composition of the supplements is shown in Table 1.

Table 1. Composition (% dry matter) of Ingredient and Nutrient.

Content of Supplements fed to steers grazing Tobosagrass Rangeland

Item	Commercial Supplement	Composition of Cotton Byproducts
Protein	20	7.7
Fat	2.3	1.4
Acid Detergent Fiber	-	52.0
Neutral Detergent Fiber	-	56.6
Calcium	1.5	.81
Phosphorus	1.1	.14
Starch	-	11.2
Magnesium	0.3	.22
Ash	-	10.23
Potassium	1.3	2.71
Total Digestible Nutrients	73.1	40.0

Statistical Analysis

Average Daily Gain and forage use (availability) was analyzed as a completely randomized (CRD) design, with periods (PER) as repeated measurements, to evaluate changes in steer weights every (28 days) throughout the supplementation period. Pastures (REP) were the experimental units. Mean separation was accomplished using Least Significant Difference (LSD) at 0.05 significant level.

Results and Discussion

Rainfall and Herbage Mass

Rainfall in 2000 was below (53%) of the 50-year average in April, June, July, and August (Fig. 1). Thus, standing crop and quality forage was far below the normal values reported in previous studies conducted using this same area during the same months of evaluation. During the length of the experiment, February and March were the only months were precipitation was above the long term average. However, adequate temperatures for plant growth were present just at the end of March. June precipitation was similar to the long-term average, while May, July and August received only 63, 45, and 7.0% from the long-term average respectively.

All the pastures in this research were at rest for more than 18 months; therefore herbage standing crop availability at the beginning was high but mainly composed from old material of low quality. Although these forage masses provided sufficient forage for diet selection so that forage quality was likely the major limitation on steer performance, composition was primarily of stem with minimal leaf material (Fig. 2). Average forage standing crop was similar (P>.05) for all treatments, with 1974 lb/acre for the CON pastures, 2095 lb/acre for the COMM treatment and 2129 for the CBP. Herbage standing crop availability at the beginning of the supplementation average 3000 lb/ac and average residual standing crop was 1157 lb/ac 1446 lb/ac and 1876 lb/ ac, for COMM, CON and CBP respectively.

Standing forage biomass showed a similar pattern to our supplement treatment and the periods of evaluation. Standing crop decreased on all treatments from February to May, increasing again in June and July and decreasing to the lowest values in August. Standing crop drop was more noticeable for the CON treatment with 54% from February to May, while COMM and CBP standing crop decreased 42 and 38% during the same period of time respectively. During April standing crop was 778 lb/ac higher for steers grazing on the COMM treatment and 1092 lb/ac higher for the CBP treatment than the CON. Forage utilization was 63, 54 and 37% for COMM, CON and CBP respectively. Our results agree with Kartchner (1980), who mentioned that the effect of supplemental feeding on forage intake can be positive, negative or null depending on forage quality and the composition of the supplement. Reductions in forage intake in response to supplementation have been termed substitution. This resulted in our CBP treatment, where forage utilization was less than in the CON and COMM treatments. Generally, substitution is considered to be a negative phenomenon; however, depending on the availability, quality, and cost of the supplement, substitution may represent the most economical means of meeting the nutritional demands of the cowherd, especially during a drought situation.

Dietary Nutritive Values

Forage CP and IVOMD was used as an index of plane of nutrition. Forage samples used to analyzed quality were obtained by clippings rather than by the grazing animals which show high selectivity for particular plant parts. It is recognized that selective grazing improves nutrient value of diets compared to available forage. However, forage CP is relatively easy to measure and is frequently used in the field to monitor plane of nutrition (Pitts et al. 1992).

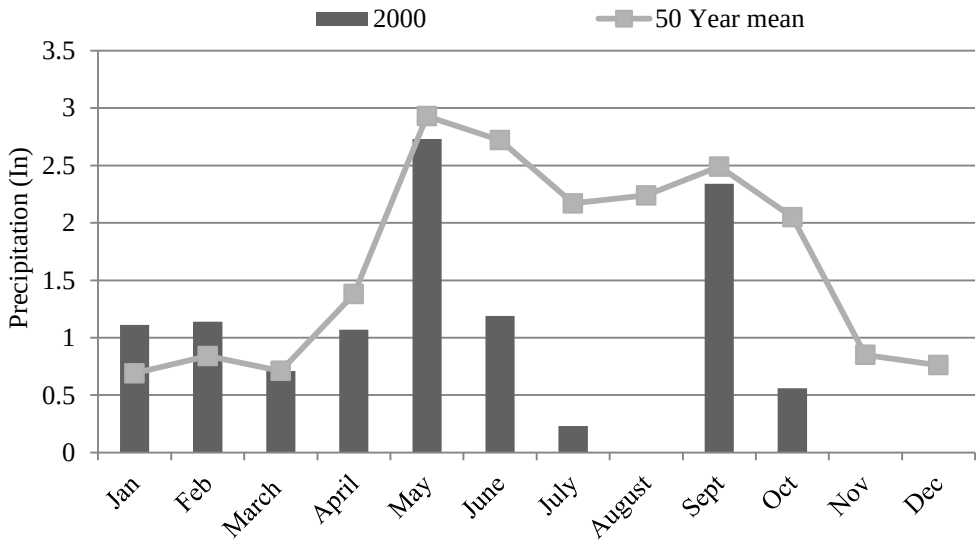

Fig. 1. Precipitation at the Texas Tech Experimental Ranch during 2000 and long term average. Average precipitation is taken from the Garza County Soil Survey.

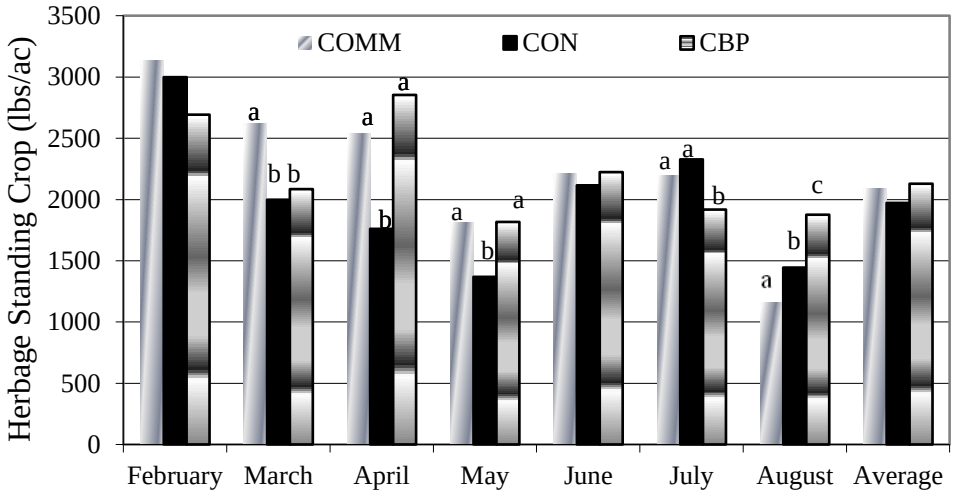

Figure 2. Herbage standing crop for steers grazing Tobosagrass fed 2 sources of protein supplementation in Garza County Texas. CON=Control (no supplement), COMM = Commercial Supplement, CBP = Starch coated and extruded cotton by-products. Means followed by the same letters are not significantly different (P≤0.05).

Crude protein and IVOMD values from clipped samples are shown in Figures 3 and 4, exhibited similar trend. Crude protein and IVOMD values were really close among all treatments. The highest CP levels and IVOMD values from clipping samples were measured around May whereas the lowest values were detected in the rest of the sampling periods (Fig.3 and 4). Protein content increased 28% from the first three months of evaluations to May, where the highest value was detected (Fig 3). Protein content declined about 30% from May to June and July (Fig 3). The CP values measured 6 out of 7 months in this type of vegetation ranged from 4.0% to 5.0%. These very low nutritional values from tobosagrass don't meet the maintenance requirements for steers and without supplementation it is impossible to obtain weight gain. Any ruminant requires at least a 6 to 7 % crude protein diet to maintain rumen function and 45-50% IVOMD.

Substantial declines in CP and dry matter digestibility have been reported with tobosagrass maturation (Britton and Steuter 1983). CP in mature tobosagrass can drop below 5.0% which is an unacceptable nutritional level (Nelson et al. 1970). During the dormant period, tobosagrass CP was found below 4.5%, and dry matter digestibility below 35% (Britton and Pitts, 1988). Forage protein content of this study was close to those reported by (Britton and Steuter 1983; Pitts el al. 1992) and Villalobos et al., 1997). They reported an average of 5.0% CP in tobosagrass during February and March, which covers the months in our sampling periods. In contrast, from April to July tobosagrass ranged from 16.0% to 5.0% protein concentration (Britton and Steuter 1983). Pitts (1989) reported a range from 10.0% to 13.0% in CP and 36.0% to 60.0% for IVDMD during the same season. Our values are similar to July but different for April where our CP content was 5.0%.

Values for IVOMD followed a pattern similar to protein content in the forages with values ranging from 23.0% to 30.0 % (Fig. 4). Other research has noted similar relationship between in vitro digestibility and diet crude protein content (Campbell, 1989; Brandyberry et al., 1992; Park et al., 1989; Gunter 1993). Lower IVOMD and CP values were found at the beginning

of this study, increased to the highest values during May and dropped again during June, July and August.

The amount of soil moisture available for plant growth affects both the yield and chemical composition of plants (Laycok and Price, 1970). Early in the growing season, if soil moisture is abundant, most plants are green and rapidly growing; the moisture, protein, phosphorous, and carotene content of such plants generally is high; whereas, the fiber and lignin contents are low. During the middle and latter part of the growing season in temperate regions with continental climate, precipitation and soil moisture decreases, temperature increases, and plants grow to maturity and became dry. Therefore, forage quality will decrease (Laycok and Price, 1970).

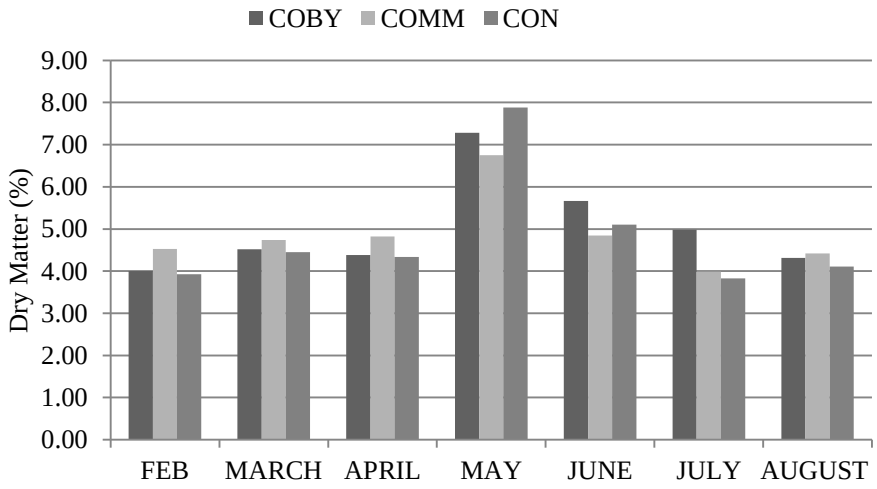

Figure 3. Dietary crude protein (% of dry matter) for steers grazing Tobosagrass fed 2 sources of protein supplementation in Garza County Texas. CON=Control (no supplement), COMM = Commercial Supplement, CBP = Starch coated and extruded cotton by-products. Means followed by the same letters are not significantly different ($P \leq 0.05$).

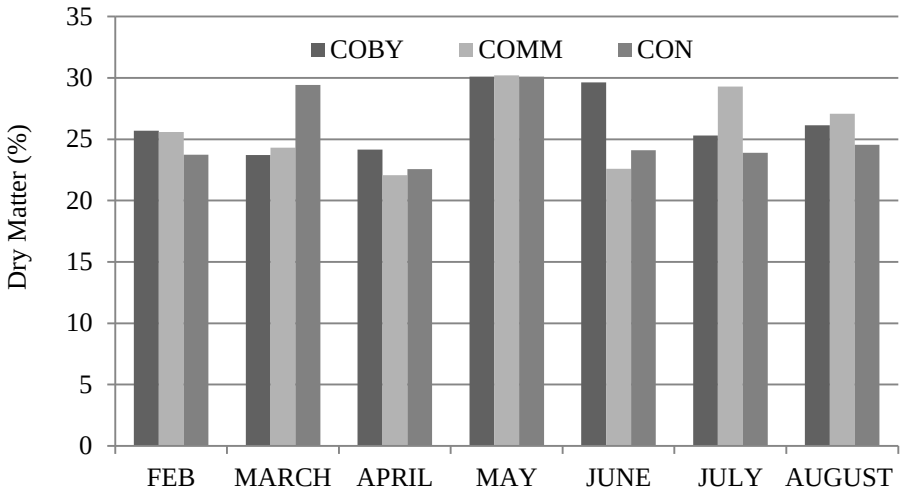

Figure 4. *In Vitro* Organic Matter Digestibility (% of dry matter) for steers grazing Tobosagrass fed 2 sources of protein supplementation in Garza County Texas. CON=Control (no supplement), COMM = Commercial Supplement, CBP = Starch coated and extruded cotton by-products. Means followed by the same letters are not significantly different (P≤0.05).

Steer Performance

Average daily gain (ADG) was different (P≤0.05) between sources of supplementation (Fig. 5). Steers on the CBP and CON treatments had a similar (P≥0.05) gain. Steers that were fed with the COMM supplement gained 35 lbs/head more than the CON, whereas steers fed with CBP gained 20 lbs/head more than the CON. In contrast, steers fed with the COMM supplement gained 15 lbs/head more than those fed with CBP. In contrast, steers receiving no supplemental protein averaged only 0.75 lb/hd/day, essentially maintaining body weight. This low gain was a result of weight lost during the June period.

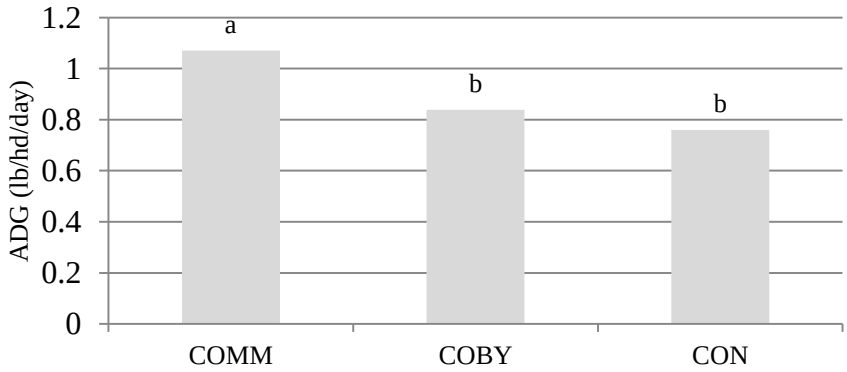

Figure 5. Average daily gain (ADG) of steers fed 2 sources of protein supplementation while grazing dormant tobosagrass. CON=Control (no supplement), COMM = Commercial Supplement, CBP = Starch coated and extruded cotton by-products. Means followed by the same letters are not significantly different ($P \leq 0.05$).

ADG showed a larger variation between grazing periods (Fig 6). The ADG of CON steers ranged from 1.13 to -0.23 lb/hd. Steers on the COMM treatment gained from 1.50 to 0.49 lb/hd while CBP steers ADG range from 1.42 to 0.23 lb/hd. (Fig 6). ADG showed a similar pattern seen in the CP and IVOMD data. The highest average daily gain for CBP and CON treatments was detected during May and the lowest for CON group was during June, during this month animals in the CON group lost weight. In the similar way the highest CP and IVOMD values from clipping samples were measured around May, whereas the lowest values were detected in the rest of the sampling periods. Judkins et al. (1987) and McCollum (1983) reported weight loss by unsupplemented cattle grazing dormant blue grama rangeland during time periods similar to those in the present study. Lantow (1930) reported gains of 0.06, 0.17, 0.24, 0.29 and 0.34 kg/hd/day for heifers grazing dormant tobosagrass supplemented at the rates of 0.0, 0.28, 0.45, 0.68, and 0.90 kg/hd/day of cottonseed meal during the winter in New Mexico.

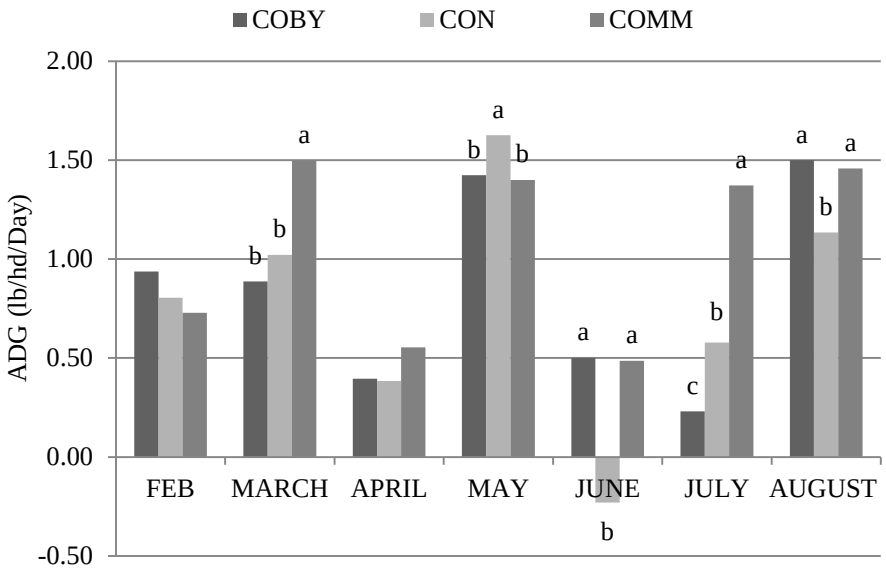

Figure 6. Average daily gain (ADG) of steers fed 2 sources of protein supplementation while grazing dormant tobosagrass. CON=Control (no supplement), COMM = Commercial Supplement, CBP = Starch coated and extruded cotton by-products. Means followed by the same letters are not significantly different (P≤0.05).

Steers receiving the COMM supplement protein on average gained more during the entire experiment. Gain obtained from this treatment was really consistent, steers gained close to a 1.5 lb/hd/day during four months out of seven of evaluation. Our research agrees with Parker et al. (1966), who described increased weight gains of supplemented weaning calves. Bellido et al. (1981) and Smith (1981) also reported improved weight gains of range livestock as a result of protein supplementation. Soybean meal cubes fed at 1.10 lb/hd/day increased gains by 0.50 lb/hd/day for supplemented versus non-supplemented steers according to Cantrell et al. (1985). Judkins et al. (1987) observed increased weight gains by supplemented heifers compared to non-supplemented heifers.

Usually spring gains are more closely related to rainfall quantity and distribution (Villalobos. et al, 1997). In this year, rainfall was 53% below the long term average, thus, low ADG, as well as poor forage quality and lower yield were the result of the low soil moisture available for plants. One particular interest of this research was the incorporation of CBP as a potential supplement with the possibilities to decrease the cost of gain in grazing situations. The research confirmed that CBP as a supplement was palatable but incomplete on nutritional value to support cost effective performance in growing cattle grazing tobosagrass rangeland (Table 2). There appears to be a marginal advantage to CBP, although this slight advantage did not significantly affect average daily weight of steers. When economically feasible situations arise, CBP can be used as an effective supplement for mature cows. Lack of improved steer performance during supplementation indicated that a CBP supplement, regardless of processing, was not effective in improving nutritional status during the treatment period. CBP fed alone was relatively low quality and was inadequate to meet the nutritive needs of growing cattle, for CBP to be effective supplement; it should be fortified with an N source. In addition, one of the limitations of using CBP as a supplement is its bulky presentation, increasing transportation and storage costs.

Table 2. Supplement cost ($/lb), average daily gain (ADG), extra gain and profit by steers grazing tobosagrass supplemented with 2 sources of supplementation.

Amount Supplement (lbs/day)	Cost/Day	ADG	Extra Gain With Supplement	Profit/Day ($1.00/lb.calf)
0.00 (Control)	0	0.75		
1.0 CBP[a]	0.02	0.84	0.09	0.09
1.0 COMM[b]	0.09	1.07	0.32	0.32

a Feed cost ($/lb) $0.02/lb CBP
b Feed cost ($/lb) $0.09/lb COMM

Despite inconsistent responses, producers commonly supplement grazing cattle to achieve maximum animal performance while effectively utilizing the forage resource base. Common reasons for feeding supplements to cattle include improving forage utilization and correcting nutrient deficiencies to increase economic return (Lusby, 1990). Supplementation may be used to enhance the quality of forage-based diets, and may also serve as a forage substitute when forage availability is limiting (Bowman and Sanson, 2000), also to relieve grazing pressure when range conditions are poor, or during periods of reduced forage growth (typically drought).

The effect of supplemental feeding on forage intake can be positive, negative or null depending on forage quality and the composition of the supplement. (Kartchner 1980). Energy supplementation is often practiced during summer dormancy and in winter to maintain desired production levels or minimize weight losses. Providing additional energy in the form of supplement has often produced reductions in intake of grazed forage. Chase and Hibberd (1987) fed incremental levels of corn to cows consuming low-quality forage and reported linear decreases in forage OM intake. These results support observations from earlier work on energy supplementation (Lusby and Wagner, 1986). More recently, Pordomingo et al. (1991) reported that cattle supplemented with corn while grazing summer pasture in New Mexico had reduced forage intakes. One important finding of this study was that averaged forage utilization during the study period from steers on CBP treatment was 37%, In contrast, COMM steers achieved 63%, and CON 52%. The effect from CBP on forage use was null, this is an example where a supplement can be use to stretch forage particularly during a drought and maintain the condition of the animals at a minimum cost. During periods of reduced forage growth (typically drought), livestock must have an alternative source of feed. However, producers spend an extraordinary amount of money on providing these alternative feeds. The use of CBP may be beneficial to livestock, especially for dry cows during periods of reduced forage growth (i.e., drought, winter). The source of supplementation should be determined by expected response coupled with economic and management considerations.

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Texas Legislators' Perceived Trust, Bias, and Fairness of Biotechnology Information Sources

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ABSTRACT

Elected leaders' perceptions of agricultural biotechnology issues can be influenced by their information sources prior to the legislative process. This study examined information source trustworthiness, bias, and fairness in communicating agricultural biotechnology issues, as perceived by Texas' legislators. Thirty-six House and Senate legislators perceived university scientists/researchers as trustworthy, unbiased, and fair in communicating agricultural biotechnology issues; activist groups were viewed as untrustworthy, completely biased, and unfair on the same issues. Texas' legislators were most concerned about the economic implications of agricultural biotechnology. They held negative attitudes toward public participation in making scientific decisions, regardless of people's knowledge of the issues involved. A positive association existed between legislators' attitudes toward democratic processes in science and 1) concerns about agricultural biotechnology issues, and 2) trust in the Internet. Texans who work with or are affected by agricultural biotechnology issues should become active participants in the legislative processes for these issues. Elected leaders and their constituents should continue to examine their information sources in terms of trustworthiness, bias, and fairness in reporting agricultural biotechnology issues, and how those sources may impact future agricultural biotechnology policies.

Key words: Agricultural Biotechnology, Elected State Leaders, Information Sources

INTRODUCTION

The origin of agricultural policy resides with persons entrusted by audiences who may or may not be directly linked to such policies. However, agricultural biotechnology policies will affect all consumers. Policymakers do not have adequate time to study all issues prior to crafting and passing laws affecting agricultural biotechnology practices. "Social values and attitudes, of course, influence government regulation" (Kalaitzandonakes, 2000, p. 76). A lack of time and social values may force policymakers to rely on interest groups' viewpoints and agendas. Whether pro or con, interest groups are information sources that can influence agricultural biotechnology policy. What do we know about policymakers' perceptions of information source trustworthiness, bias, and fairness in communicating agricultural biotechnology issues? For that matter, what do we know about public perception of elected leaders who write legislation that affects agricultural biotechnology policy?

Esposito and Kolodinsky (2007) found Vermonters "viewed government as a culpable party…more than half the respondents (54.4%) agreed that the US government (specifically the US Department of Agriculture) should bear legal liability for the spreading of GM [Genetically Modified] pollen to organic, non-GM crops" (p. 89). In the same study, Vermonters with higher education levels did not think the Vermont government should be held liable for pollen drift. Such

findings demonstrate public viewpoints that could negatively affect future agricultural biotechnology legislation. It is easy to blame others when food safety issues arise, but we must remember that "we" are the government; policymakers will defend their positions as being representative of the people, even if the public majority has inadequate education to fully understand agricultural biotechnology issues. Indeed, most policymakers may lack sufficient agricultural biotechnology understanding, which could hyper-sensitize the information roles played by special interest groups, prior to establishing biotechnology legislation.

Public trust of government officials is essential to establishing proactive policies for agricultural biotechnology. Several studies (Curtis, McCluskey, & Wahl, 2004; Harrison, Boccaletti, & House, 2004; Hu & Chen, 2004) found that as consumers' confidence in government agencies (ability to control and monitor GMOs) increased, their willingness to buy GM products also increased. Lang, O'Neill, and Hallman (2003) discovered that when asked whom consumers "should" trust for information about food biotechnology, one-third of the experts (scientists and professionals in food biotechnology) believed it should be government or academics as the one main source. However, even consumer confidence in its own government is affected by public opinion of government regulations affecting food biotechnology (Zhong, Marchant, Ding, & Lu, 2002).

Previous studies (Wingenbach, Rutherford, & Dunsford, 2003; Wingenbach & Rutherford, 2005) found agricultural college students and journalists (agricultural vs. mass media) trusted university scientists' statements about biotechnology, but did not trust the same statements made by activist groups/celebrities, supporting the findings from earlier studies (Hoban, 1999; Vestal & Briers, 2000). Typically, the public has trusted mass media sources such as newspapers, Internet, and magazines for its biotechnology information (Wingenbach & Rutherford, 2007; Fritz, Ward, Byrne, Harms, & Namuth, 2004).

Brossard and Shanahan (2003) ascertained reliable associations between "citizens' media use and their views of democratic processes in science by measuring institutional trust, scientific knowledge, and fears and concerns related to science and biotechnology" (p. 291). A democratic process in science, according to Brossard and Shanahan, refers to the extent that public opinion is considered in scientific decision making. Brossard and Shanahan found increased education (in New York) lead to mistrust of activist groups and less fear of science in general. New Yorkers who were more educated watched less television, but paid more attention to biotechnology from television and newspapers, mirroring the National Science Foundation's (NSF, 2000) finding that "most of what Americans know about science and technology comes from watching television or reading a newspaper" (p. 25).

Despite the public's reliance on mass media as a source for scientific information, biased reporting has been documented. Bias leads to mistrusting an information source. Marks and Kalaitzandonakes (2001) confirmed media bias (in reporting agrobiotechnology events) "in so far as media coverage emphasized different frames (biosafety and food safety) at different points in time" (p. 206). However, readers should consider Logan's (2001) view that "food biotechnology news often has been perceived as an agriculture food or business story, instead of a science…story" (p. 194).

Do trust issues exist between the public and its elected leaders? How can these issues be resolved? Barling et al. (1999) believed that government makes policy based on science. Science can be uncertain at times, but the aforementioned studies showed the public trusts scientists when communicating about biotechnology issues. Maybe scientists need to become better communicators of agricultural biotechnology to our elected leaders. Jenkins (1999) supported this opinion, finding that scientists were seen as trustworthy information sources, but they did not do enough to inform the public. Consumers want scientists to be more open and share their

knowledge through mass media information sources. Do selected Texas legislators share consumers' reliance on mass media information sources? Do those elected leaders consider their sources as trustworthy, unbiased, and fair in communicating agricultural biotechnology issues?

The purpose of this study was to examine information source trustworthiness, bias, and fairness in communicating agricultural biotechnology issues, as perceived by Texas' legislators. This research was accomplished by collecting legislators' perceptions of information source trustworthiness, bias, and fairness in communicating agricultural biotechnology issues; levels of concern about agricultural biotechnology issues; attitudes toward democratic processes in science; and exploring relationships between their perceptions of information source trustworthiness, bias, and fairness and their concerns about agricultural biotechnology issues, or attitudes toward democratic processes in science.

MATERIALS AND METHODS

A descriptive correlational design (Field, 2000; Ott & Longnecker, 2001) was used in this study. The population of interest (N=181) included all elected Texas members of House (n=150) and Senate (n=31) districts. The population of House and Senate members was derived from the Texas Legislature Online (http://www.capitol.state.texas.us/). A proportional stratified random sample (Borg & Gall, 1989) using methods from Bartlett, Kotrlik, and Higgins (2001) to ensure proportionally representative numbers of Texas House of Representatives and Senators, produced a sample of Texas House (n=68) and Senate (n=20) members.

Modified versions of two instruments, *Journalists' Perceptions about Biotechnology Issues* (Wingenbach & Rutherford, 2005) and *Media, Agricultural Biotechnology and Authoritarian Views of Democratic Processes in Science* (Brossard & Shanahan, 2003), were used to create the research instrument; wording changes and question sequencing constituted the modifications. Content validity was established by a panel of agricultural journalism experts from Texas A&M University.

The instrument, Texas *Legislature Members' Perceptions about Biotechnology Issues Reported in the Mass Media*, contained four multi-part questions (for the results in this paper) measuring Texas House and Senate members' perceptions of information source trustworthiness, bias, and fairness in communicating agricultural biotechnology issues; concerns about agricultural biotechnology issues; and attitudes toward democratic processes in science. A final section of the instrument collected demographic information.

Trustworthiness, bias, and fairness scales each included nine sources (activist groups, biotechnology industry representatives, farmer/rancher groups, government officials, Internet, newspapers, retail food companies, television, and university scientists/researchers) and had four-point Likert scales (descriptors changed between scales). Reliability analyses for the scale measuring information source trustworthiness (1=Completely Untrustworthy…4=Completely Trustworthy) had a Cronbach's alpha coefficient of .89 (.74 in Wingenbach & Rutherford, 2005); information source bias scale (1=Completely Biased…4=Completely Unbiased) had a Cronbach's alpha coefficient of .76 (.64 in Wingenbach & Rutherford, 2005); and information source fairness scale (1=Completely Unfair…4=Completely Fair) had a coefficient of .79 (.84 in Wingenbach & Rutherford, 2005). The scales used in this study provided reliable data for analyses and interpretation. Three scales (trustworthiness, bias, and fairness) were transformed into single additive indices so an overall trust indicator could be determined for information sources (Brossard & Shanahan, 2003). Information source trust indicators were used in bivariate analyses.

Concerns about agricultural biotechnology issues were measured with eight, four-point items ranging from 1 (Very Unconcerned) to 4 (Very Concerned) and were transformed into a

single additive index for bivariate analyses. A Cronbach's alpha coefficient of .84 (.86 in Wingenbach & Rutherford, 2005) was produced for the concerns scale. The scale (four-point) measuring attitudes toward democratic processes in science had four items, from 1 (Strongly Disagree) to 4 (Strongly Agree), with a Cronbach's alpha coefficient of .69 (.71 in Wingenbach & Rutherford, 2005), and was similarly converted to a single additive index for bivariate analyses.

Dillman's *Tailored Design Method* (2000) was modified for this study. Data collection was achieved using paper survey and regular postal delivery methods. Pre-notice letters describing the study were mailed via regular postal delivery to all participants in the stratified random sample. One week later, a personalized cover letter, survey, and self-addressed, stamped envelope was mailed to the sample. Follow-up postcard and personalized letters were sent to non-respondents every two weeks, with a replacement survey sent every third mailing. Some House and Senate members responded by e-mail that they wished to complete the survey electronically, which they were allowed to do (an e-survey was sent and returned to the researcher via e-mail). Reminders continued for three months through regular postal delivery.

Sixteen House and six Senate members chose not participate in the study, reducing the sample to 66. The response rate was 54.55% (N=36), represented by 28 House and 8 Senate members. Babbie (2001) suggested a 50% response rate for adequate statistical analyses.

Non-respondents are similar to late respondents (Goldhor, 1974). According to Lindner, Briers, and Murphy (2001), one method of to determine that "nonresponse is not a threat to external validity" (p. 51) is to compare early to late respondents' scores for significant differences on the variables of interest. Insufficient responses from successive waves of stimuli resulted in late respondents being defined as the latter 50% (n=18). No significant differences were found when comparing early-late respondents' summed scores for importance of biotechnology research, biotechnology effects, or levels of trustworthiness, bias, and fairness of information sources. Non-respondents were equivalent to respondents. The findings may be generalized to the population of interest.

Descriptive analyses were used to describe the data. Bivariate analyses were conducted to determine if significant relationships existed between selected variables. Significance levels were set *a priori* at α=0.05. Relationships between variables with continuous scores were analyzed using Pearson's product-moment correlations (Borg & Gall, 1989).

RESULTS

Responses (N=36) were received from 28 House and 8 Senate elected Texas legislators (Table 1). The majority of respondents were male and ranged from 41 to 60 or more years old. Most (n=17) had served four or more terms in the Texas legislature.

Table 1. Demographic frequencies of respondents.

Variables		*f*	%
Status:	House member	28	77.8
	Senate members	8	22.2
Gender:	Male	30	83.3
	Female	5	13.9
Age:	31-40	5	13.9
	41-50	11	30.6
	51-60	10	27.8

	61 or more	10	27.8
Service:	1st term	6	16.7
	2nd term	8	22.2
	3rd term	4	11.1
	4th or more terms	17	47.2

Note. Frequencies may not equal 100% because of missing data.

Perceptions of Information Source Trustworthiness, Bias, and Fairness

Texas' legislators responded to three multi-part questions about their perceptions of information sources' trustworthiness, bias, and fairness in communicating agricultural biotechnology issues (Table 2). Texas' legislators perceived university scientists/researchers as trustworthy (M=3.03, SD=.45), unbiased (M=2.82, SD=.63), and fair (M=3.06, SD=.42) in communicating agricultural biotechnology issues. They felt essentially the same about farmer/rancher groups and government officials as being trustworthy, unbiased, and fair. However, they viewed activist groups as untrustworthy (M=1.94, SD=.74), completely biased (M=1.47, SD=.51), and unfair (M=1.91, SD=.67) in communicating agricultural biotechnology issues.

In terms of mass media information sources, Texas' legislators viewed newspapers, Internet, and television as untrustworthy (M=1.51-2.50) and biased (M=1.51-2.50), but mostly fair (M=2.51-3.50; television was deemed unfair, M=2.40) in communicating agricultural biotechnology issues.

Table 2. Texas politicians' perceived information source trustworthiness, bias, and fairness.

Information Source Trust Indicators		M	SD
Trustworthy†	University scientists/researchers	3.03	.45
	Farmer/rancher groups	2.94	.55
	Government officials	2.68	.53
	Biotech industry representatives	2.57	.70
	Retail food companies	2.42	.69
	Newspapers	2.31	.63
	Internet	2.21	.60
	Television	2.20	.63
	Activist groups	1.94	.74
Biased‡	University scientists/researchers	2.82	.63
	Farmer/rancher groups	2.56	.69
	Government officials	2.53	.61
	Newspapers	2.26	.62
	Television	2.24	.61
	Internet	2.20	.58
	Retail food companies	1.94	.55
	Biotech industry representatives	1.78	.54
	Activist groups	1.47	.51
Fairness††	University scientists/researchers	3.06	.42
	Farmer/rancher groups	3.03	.51
	Government officials	2.89	.40
	Biotech industry representatives	2.57	.65
	Retail food companies	2.54	.61

Internet	2.52	.62
Newspapers	2.51	.61
Television	2.40	.65
Activist groups	1.91	.67

† Four-point scale: 1.00-1.50=completely untrustworthy, 1.51-2.50=untrustworthy, 2.51-3.50=trustworthy, 3.51-4.00=completely trustworthy.
‡ Four-point scale: 1.00-1.50=completely biased, 1.51-2.50=biased, 2.51-3.50=unbiased, 3.51-4.00=completely unbiased.
†† Four-point scale: 1.00-1.50=completely unfair, 1.51-2.50=unfair, 2.51-3.50=fair, 3.51-4.00=completely fair.

Concerns about Agricultural Biotechnology Issues

Texas elected leaders also rated their levels of concern about agricultural biotechnology issues. They were concerned (M=2.51-3.50) about six of the eight issues identified by Brossard and Shanahan (2003; see Table 3). Their greatest concerns were about the economic implications (M=3.03, SD=.66), human health risks and safety issues (M=2.97, SD=.81), and consequences that agricultural biotechnology would have in farming and food production (M=2.97, SD=.77). Respondents were unconcerned (M=1.51-2.50) with the low level of public knowledge (M=2.44, SD=.73) and ethical implications (M=2.39, SD=.73) of agricultural biotechnology issues.

Table 3. Texas legislators' concerns about agricultural biotechnology issues.

Issues	M	SD
Economic implications	3.03	.66
Human health risks and safety issues	2.97	.81
Consequences for farming and food production	2.97	.77
Scientific uncertainty about biotechnology's consequences	2.86	.77
Potential risks for the environment	2.80	.72
International and global implications	2.61	.73
Low level of public knowledge	2.44	.73
Ethical implications	2.39	.73

Note. Four-point scale: 1.00-1.50=very unconcerned, 1.51-2.50=unconcerned, 2.51-3.50=concerned, 3.51-4.00=very concerned.

Attitudes toward Democratic Processes in Science

Texas' legislators reported their levels of agreement with four statements measuring authoritarian attitude toward democratic processes in science (Brossard & Shanahan, 2003; see Table 4). They disagreed (M=1.80-2.42) with all four statements and were most opposed to the idea that it is important to have public participation in making scientific decisions, regardless of people's knowledge of the issues involved (M=2.42, SD=.73). They were least opposed to the thought of the scientific community's actions always reflecting the will of the majority (M=1.80, SD=.47).

Table 4. Texas legislators' attitudes toward democratic processes in science.

Statements	M	SD
It is important to have public participation in making scientific decisions, regardless of people's knowledge of the issues involved.	2.42	.73
Scientists should pay attention to the wishes of the public, even if they think citizens are mistaken or do not understand their work.	2.33	.53
Public opinion is more important than scientists' opinions when making decisions about scientific research.	1.89	.52
The actions of the scientific community should always reflect the will of the majority.	1.80	.47

Note. Four-point scale: 1.00-1.50=strongly disagree, 1.51-2.50=disagree, 2.51-3.50=agree, 3.51-4.00=strongly agree.

Relationships between Information Source Trust and Concerns and/or Attitudes

Respondents' perceptions of information source trust were transformed into single additive indices so trust indicators could be determined for each source. Also, summed scores for their concerns about agricultural biotechnology issues (M=21.83, SD=3.99), and attitudes toward democratic processes in science (M=8.39, SD=1.32) were converted into single additive indices, and correlated with their information source trust indices (Table 5). Relationships were described using the standards developed by Davis (1971).

A significant moderate relationship existed between respondents' concerns about agricultural biotechnology issues and their attitudes toward democratic processes in science ($r=.34$, $p < .05$). Another significant moderate relationship existed between Texas legislators' attitudes toward democratic processes in science and trust in the Internet ($r=.41$, $p < .01$).

Table 5. Pearson correlations between Texas legislators' concerns about agricultural biotechnology issues, attitudes toward democratic processes in science, and information source trust indicators.

	r†	
Variables	1	2
1. Concerns about agricultural biotechnology issues‡	—	
2. Attitudes toward democratic processes in science††	.34*	—
Information source trust indicators‡‡		
Activist groups	.19	.10
Biotechnology industry representatives	.08	.11
Farmers/ranchers	-.18	.31
Government officials	-.05	.32
Internet	-.15	.41*
Newspapers	.07	.22
Food retail companies	.03	-.08
Television	.03	.27
University scientists/researchers	-.14	.21

Note. Four-point scales were summed to determine legislators' perceptions of information source trust, concerns about agricultural biotechnology issues, and attitudes toward democratic processes in science.

† Interval variables; reported as Pearson correlations.

‡ Concerns about biotechnology issues ranged from 10-29.

†† Attitudes toward democratic processes in science ranged from 4-11.

‡‡ Information source trust indicators ranged from 2-12.

* Significant at the 0.05 probability level.

DISCUSSION

Elected Texas legislators perceived university scientists/researchers as trustworthy, unbiased, and fair in communicating agricultural biotechnology issues, which agreed with the findings (Wingenbach & Rutherford, 2005) about journalists' perceptions of agricultural biotechnology information sources. Both, Texas' legislators and journalists surveyed held similar disdain for activist groups, finding this information source as untrustworthy, completely biased, and unfair on the same issues.

It is not surprising that Texas' legislators perceived government officials as being trustworthy, unbiased, and fair, but further research may reveal why they think of themselves in such light. Are these factors synonymous with bearing the outcomes of biotechnology legislation (Esposito & Kolodinsky, 2007)? Do Texas legislators consider all sides of an issue (agricultural biotechnology) before creating policy? If so, why did this group not support the idea that it was important to have public participation in making scientific decisions, regardless of people's knowledge of the issues involved? Scientists, communicators, and government officials alike should be concerned about the "disconnect" between Texas legislators' perceived value of information sources and stakeholders who have the power of placing elected leaders in their respective state and national policymaking roles.

A larger disconnect existed between Texas legislators' views about mass media sources and the public's reliance on using those sources for their biotechnology information. Texas' legislators viewed newspapers, Internet, and television as untrustworthy, biased, but mostly fair (television was deemed unfair) in communicating agricultural biotechnology issues. Surprisingly, even journalists perceived "television as untrustworthy and biased in communicating agricultural biotechnology issues" (Wingenbach & Rutherford, 2005, p. 218). Other research (Blaine, Kamaldeen, & Powell, 2002; Macer, 2001; NSF, 2000) found that consumers got their biotechnology information from television and newspapers. If our nation's public accepts the fact that most only keep abreast of scientific and technological advances through mass media (radio and television news broadcasts or newspapers), why then do elected leaders and journalists not place more trust in our mass media? Additional research is needed to determine the underlying factors for elected leaders' and journalists' distrust of mass media.

A new finding in this study showed that Texas' legislators were most concerned about the economic implication of agricultural biotechnology, revealed new insights into the debate on legislation affecting biotechnology. Previous studies (Wingenbach et al., 2003, Wingenbach & Rutherford 2005; Blaine et al., 2002; Vestal & Briers, 2000) showed respondents were most concerned about the consequences that agricultural biotechnology would have in farming and food production or risks to the environment. Texas' legislators think about state budgets, industrial growth, and economic impact more so than human health risks, safety issues, or agricultural production consequences when considering agricultural biotechnology issues. With that knowledge, scientists should focus their communication efforts on the economic implications of agricultural biotechnology, but not at the sake of ignoring public health and environmental concerns, when speaking to legislative panels, boards or inquiry, or through personal communications with their elected leaders.

Brossard and Shanahan (2003) found "respondents were not positive that public opinion is important in decision making related to scientific research" (p. 301). Texas legislators in this study confirmed Brossard and Shanahan's findings. Barling et al. (1999) believed that government officials craft legislation based on science. Although Texas legislators perceived university scientists/researchers as trustworthy, unbiased, and fair in communicating agricultural biotechnology issues, we cannot lose sight of the importance of public opinion in decision making.

Texas legislators held negative attitudes toward public participation in making scientific decisions and scientists paying attention to the wishes of the public, despite a positive association between their overall attitudes toward democratic processes in science and concerns about agricultural biotechnology issues. Texans who work with or are affected by agricultural biotechnology issues should become active participants in the legislative processes for these issues through active communications with their elected leaders. To become indifferent or ignorant of the policies affecting scientific processes, especially those policies most related to agricultural biotechnology, is to willingly accept policies crafted by elected leaders who do not respect public opinion.

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Evaluation of a Total Ranch Management Workshop as an Educational Tool to Transfer Technology in Mexico

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ABSTRACT

To improve management and achieve goals, ranchers must make critical decisions. The total ranch management (TRM) planning process is an approach to help ranchers maintain better control of the ranch and its future, and is based on the idea of management achievements rather than specific practices. The objectives of this study were to 1) evaluate the effect of a TRM workshop as a method of technology transfer, 2) determine impressions of participants, 3) determine extent of learning, and 4) determine comprehension and utilization of information. Mexican ranchers (n=20) interested in technology transfer attended a 6-d workshop taught by 1 Mexican and 5 U.S. instructors in 2 sessions. The information was divided into 8 themes and adapted from Texas Cooperative Extension's Total Ranch Management program. Participants were asked to complete a confidential 45-question survey to identify demographics and background knowledge of TRM issues and elements, a 9-question evaluation of each session and instructor, and a 13 question evaluation of the entire workshop. Eleven mo. after the workshop, ranchers were revisited to apply a 26-question, post evaluation survey. Workshop evaluations were analyzed using descriptive statistics and t-Tests. Major enterprises of workshop participants included: cow/calf (63%), stockers (13%), registered cattle (57%), and wildlife (40%). Participants affirmed (61%) they learned the ability to analyze their ranch situation and make better ranch management. Level of understanding of all topics was greater (P<0.01) after as compared to before the workshop. Total mean change in understanding concepts of strategic planning, economics, livestock production, wildlife management, and grazing management were, 48, 39, 54, and 54%, respectively. The TRM program has been proven to be a platform to convey and continue education and improve decision making processes in ranch

management. Mexican ranchers are welcoming through TRM technology transfer mechanism that was not in place.

Key words: Technology transfer, total ranch management, Mexico, Ranch management, technology transfer, agricultural education, Mexico.

INTRODUCTION

Technology transfer is often considered to be the adoption of proven techniques and practices for specific enterprises rather than meeting the needs for ranch sustainability and success. Total Ranch Management (TRM) workshops have been conducted to teach ranchers and extension personnel how to better understand, manage and use ranch decisions, and organize the total ranch to better evaluate and select management decisions (Troxel & White, 1990). White (1988) recognized a need for education in ranch management and began development of a TRM course that teaches planning strategies and concepts of ranching ecosystems. The value of this approach to a TRM program is that it is not necessary to teach all of the specific principles of ranch management. Rather, what is taught is a *new* thought process from which ranchers can approach all decision-making.

Teaching programs are needed to educate, inform, and train ranchers and extension employees on the importance and value of ranch resources. In addition, teaching programs should be focused on better understanding, management and utilization of resources to optimize production, organization of the ranch enterprise for effective management, and improving evaluation of management decisions through use of a strategic management approach (Troxel & White, 1990; White, 1999).

Technology transfer in Mexico is an area that can be developed in a systematic approach to improve rangelands for livestock and wildlife production. Few landowners in Mexico are using integral management programs to improve animal production and natural resource conservation (Hanselka *et al*., 2005). Mexican cattle ranchers are especially interested in raising their level of technology. The Mexico TRM workshop is an all-encompassing, holistic approach to ranch management using the viewpoint of the ranch as an enterprise and includes economic information, and cattle and wildlife management (Hinojosa, 2005). Moreover, this educational program was developed to increase or confirm the knowledge base of resources managed and implement a more organized ranch planning methodology.

A TRM workshop, as a strategy of technology transfer, should have more impact if it is conducted in the natural environment of the participants. These TRM efforts need to be evaluated to determine how this information impacts the participants. Timely evaluation provides useful input to refine program design and improve performance (Alex & Byerlee, 2000).

The objectives of this study were (1) to evaluate the effect of the TRM workshop on participants as a strategy of technology transfer, (2) to determine the impressions of the participants concerning the workshop, (3) to determine the extent of learning by the participants, and (4) to determine to what extent the presented information was comprehended and thus utilized, applied, and incorporated into their ranch management program. We hypothesized that the TRM workshop can be used as a tool to accomplish change in the decision making process for ranch management activities in Mexico.

MATERIAL AND METHODS

Two, 3-d training sessions were conducted spring 2005 in Reynosa, Tamaulipas, MX. They included lectures and two field exercises at a participant's ranches. During the first field exercise instructors demonstrated how to conduct spotlight surveys to determine wildlife inventories. The second field exercise concentrated on training and practical activities for range inventory and evaluation, animal reproduction, and cattle management. The TRM teaching materials were adapted from the Department of Rangeland Ecology and Management, Texas A&M University and Texas Cooperative Extension TRM program, and translated into Spanish.

To better understand the concepts of TRM, the workshop was divided into eight themes: introduction, strategic planning, resource capabilities and limitations on management, using and understanding budgets, livestock enterprises, wildlife management, grazing management, and management implementation. Six instructors were involved with the TRM workshop; three of them were simultaneously translated from English to Spanish, and all instructors used power point presentations in Spanish. The participants (n=20) were invited to the workshop through direct contact and (or) via the newspaper.

During the second 3-d workshop session, participants were asked to answer a 45-question, confidential survey. The objective was to identify participant demographics (name, age, sex, occupation, previous schooling, and interests) in order to serve as background reference of the group. The questionnaire also included other background information and knowledge related to topics, issues, and elements of TRM that would be included in the course.

Evaluation. Participants of the TRM workshop were asked to evaluate the teaching sessions of each instructor and provide feedback to improve future workshops. An additional 9-question survey was designed to evaluate participant opinions of each instructor. Evaluated items included: subject presentation, holding interest of participants, organization, response to the participants, visual aids, clear and accurate examples, motivation of participation, presentation duration, and how well the subject was covered (data not shown).

On the last day of the workshop, participants were asked to evaluate the entire TRM workshop experience. This evaluation was 13-question instrument; some questions followed the Likert scale and others were short answer or answered by yes or no. All participants completed each of the three instruments and they were used for data analysis.

Eleven months after the TRM workshop, participants were revisited in Reynosa, Tamaulipas, MX to apply a final evaluation instrument designed to determine the level of understanding of workshop topics. During this post-workshop meeting, 75% (15/20) of the participants were in attendance. The survey instrument was divided into sections representing the subjects taught and each section had four or six questions. The retrospective, post-evaluation instrument had 26 questions that followed the Likert scale, as described previously, and one short answer question. This instrument was used to evaluate participant knowledge before and after the TRM workshop.

Statistical Analysis

All TRM participants were kept anonymous to encourage truthful and to unbiased responses. The instruments were directly and personally applied during and after the TRM workshop. Descriptive statistics were employed to produce tables and figures for the general information, and evaluation of instructors and the TRM workshop. The SAS V8 was used to make the Dependent Samples t-Test in order to determine differences between the level of understanding before and after the TRM workshop (Herrera & Barreras, 2000; Kaps & Lamberson, 2004).

RESULTS

The age of the participants of the TRM workshop was from 29 to 66 yr; the mean age was 47 yr, and the mode was 37 yr. The occupations of the participants were rancher (50%), administrator (30%), extension agent (5%), researcher (5%), consultant (5%), and student (5%). The level of schooling of the participants was: middle school (15%), high school (10%), bachelors degree (45%), and graduate degree (20%). The main enterprises of the participant's ranches were: cow/calf (63%), stockers (13%), cow/calf and stockers (13%), registered breeds (57%), and wildlife (40%). The livestock on their ranches were: cattle, sheep, goats, horses, and poultry.

Regarding the knowledge of the workshop content, 99% responded that they had a high level of knowledge. The subjects referred are mentioned in order by frequency of reference: Economics (administration, use and understanding of budgets, accounting, financial projects) (16), Ranch management (resources capabilities and limitations) (11), Wildlife Management (8), Livestock Management (8), Range Management (6), Grazing management (2), Strategic planning in ranching (2), Agriculture (1), Cattle vaccination (1), and Functions of cattle digestion system (1). Participant expectations were as follows: Learn new techniques of ranch management (5), understand and improve ranch management (3), improve administration of the ranch (1), and to practice the learning (1).

Concerning the strategic planning concept, 44% affirmed to know this concept, and 50% presently ignored it. Twenty five percent said that they actually apply strategic planning, while the others did not. Ninety percent of the participants indicated they will apply this concept in the future, and all of the participants were interested in this kind of information.

Evaluation of the workshop

The first question evaluated the cost of the course in terms of money investment. Eleven percent rated it as good, 42% very good and 42% was excellent. Concerning benefits obtained from the workshop, 52% of the participants considered the benefits as excellent and 47% considered them good. All of the participants felt that their expectations were accomplished.

The subjects that the participants suggested to be included in the future TRM workshop were: introduction to new methodologies, commercialization, more emphasis in cattle and grazing, exportation, alternatives to obtain utilities, breeding, medicines, techniques related to wildlife, ranch management, more information about rangeland, management and wildlife studies, and operation cost of pasture maintenance.

Some of the elective topics that participants liked most in the workshop were: wildlife management, rangeland management, carrying capacity, reproduction, cattle and pasture. In addition other items included practical knowledge, knowledge of the instructors, interaction and group integration /comradeship and positive attitude help to accomplish the activities, the way the information was communicated, discussions on different points of views and experiences.

Areas for improvement of TRM workshop included: more time to evaluate wildlife, more complete themes, divide by themes, economic information presented in more practical examples, change of some instructors, more time for each theme, less themes but more time to accomplish the objectives, precise and short time to apply and practice knowledge, improve the visual material, courses for ranch hands.

When asked about how they can apply the principles learned in their specific situation, they expressed: using of the information step by step trying to do the best under my circumstances, improving enterprise management, sharing and communicating this information to my workers, talking with my clients, interaction with other ranches, practicing to have profitability in my ranch,

incorporating most of the information learned in the workshop, doing adjustments to correct what we do wrong or in a less productive way.

A majority of the participants (77%) rated the TRM workshop as very good to excellent; the remainder did not provide an answer. Most participants (61%) affirmed the workshop gave them the tools to analyze their ranch situation, 21% said it did not, and 28% did not answer. Seventy two percent of the participants agreed to participate in an organized group of technology transfer, 28% did not answer.

Finally, some suggestions or comments expressed by participants about the TRM workshop were: "These workshops should continue because there are people interested in improving their ranches", "To keep in touch with the instructors"; "Ask for the botanical inventory of the native species of Northeast of Mexico", "We are going to be organized".

The "before" and "after" survey

Effective ranch management requires a tremendous amount of information. The purpose of this Mexican TRM workshop was to consolidate some of the basic information ranch managers need for proper decision making.

The levels of probability for the "before" and "after" understanding survey or retrospective-post evaluation, were statistically different for every subject included in the survey (Table 1). The Dependent Sample t-Test analysis showed significant differences ($p<.001$ to $p<.01$) in the level of understanding of all topics before compared to after the TRM workshop. The mean level of understanding before and after the TRM workshop for each subject taught is shown in Figures 1 to 5.

The total mean change in the level of understanding in the concept of strategic planning subject was 48% (Figure 1). The greatest increase was observed in the understanding of using strategic planning in ranching (64.9%); lower levels of increased understanding were observed in identifying available ranch resources (47.5%), decision making (44.2%), and setting and accomplishing ranch goals (35.6%).

Table 1. Level of probability for the "before" and "after" understanding survey of TRM workshop

SUBJECT	CALCULATED t VALUE	p
Strategic planning		
Understanding of using strategic planning in ranching	6.8	<.0001
Understanding of decision making	4.7	0.0003
Setting and accomplishing goals	3.8	0.0021
Identifying available resources	4.7	0.0003
Budget		
Planning with budget	5.5	<.0001
Reviewing budget	3.4	0.0044
Modifying budget	3.6	0.0028
Information of costs	3.8	0.0021
Livestock enterprises		
Inventory of resources	4.8	0.0003
General production plan	5.5	<.0001
Yearly calendar	5.3	0.0001
Ranching as a business	4.0	0.0012

Wildlife management		
Setting wildlife goals	4.8	0.0003
Inventory of wildlife resources	4.2	0.0009
Identifying wildlife habitats	5.0	0.0002
Managing wildlife enterprises for profit	4.5	0.0005
Grazing management		
Range goals in a total ranch context	4.8	0.0004
Grazing control	7.8	<.0001
Planned grazing	7.8	<.0001
Range inventory	5.5	0.0001
Balancing animal numbers with forage supply	5.0	0.0002
Matching animal nutrient demand and supply cycles	8.0	<.0001

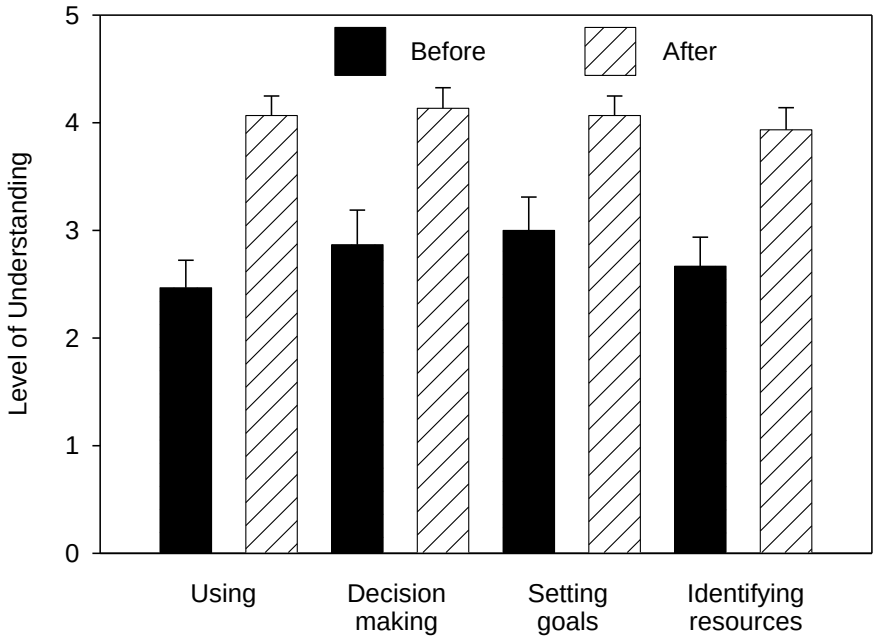

Figure 1. Mean (± SEM) level of understanding before and after the TRM workshop for topics within the strategic planning subject.

The total mean change in the level of understanding for the economics subject was 38.8% (Figure 2). The greatest change was observed in the understanding of economic planning (47.5%); lower levels of change occurred in the understanding of costs records (38.1%), modifying planning with budget (37.5%), and reviewing the budget (32.5%).

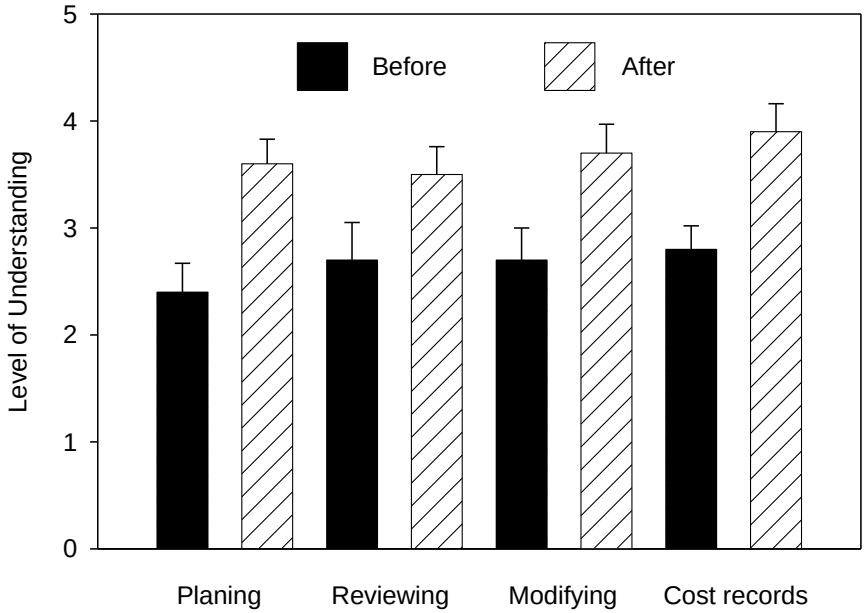

Figure 2. Mean (± SEM) level of understanding before and after the TRM workshop for topics within the economics subject.

The total mean change in the level of understanding for the livestock enterprises subject was 54.1% (Figure 3). The greatest change was observed in the understanding of developing a production plan (65.8%); lower levels of change in understanding were observed in developing a yearly calendar (59.0%), resource inventory (53.5%), and understanding ranching as a business (35.6%).

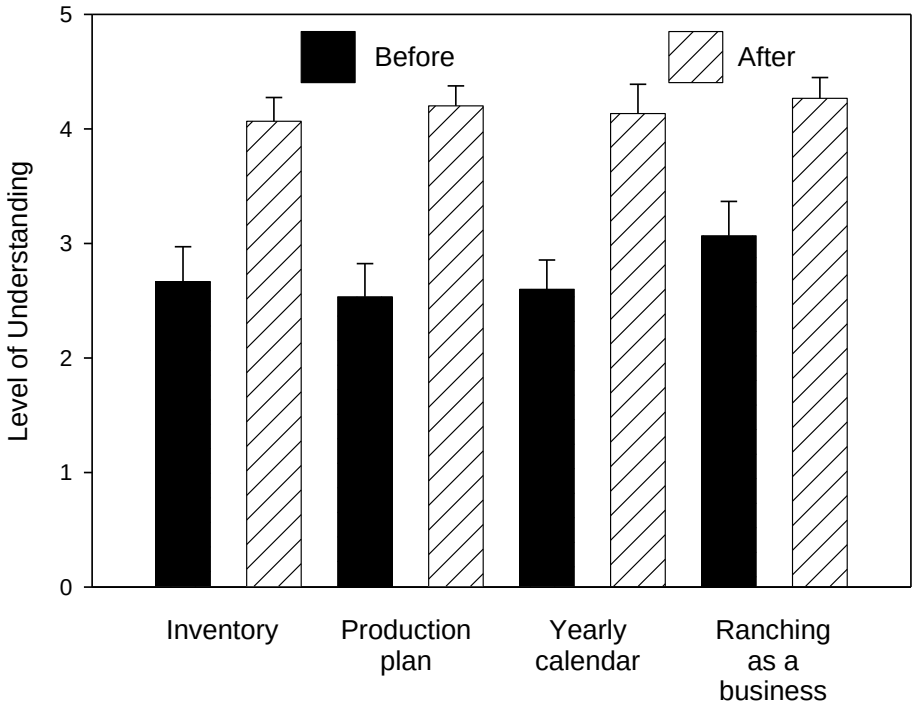

Figure 3. Mean ($\pm$ SEM) level of understanding before and after the TRM workshop for topics within the livestock enterprises subject.

The overall mean change in the level of understanding for the wildlife management subject was 63.0% (Figure 4). The greatest change was observed in the understanding of setting wildlife goals (69.7%); lower levels of change in understanding were observed in identifying wildlife habitats (68.6%), managing wildlife enterprises for profit (59.4%), and inventory of wildlife resources (54.3%).

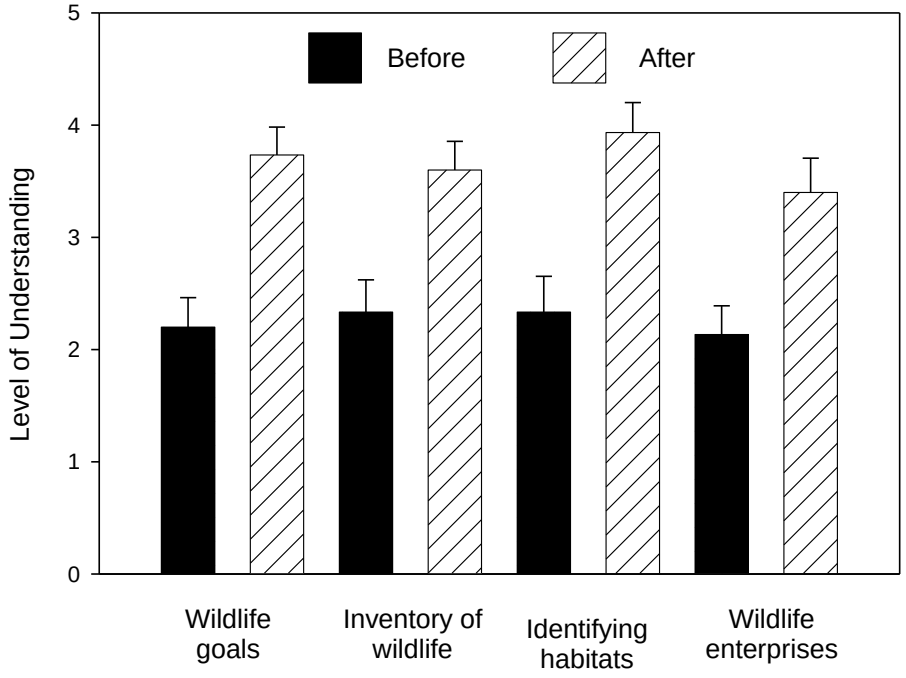

Figure 4. Mean ($\pm$ SEM) level of understanding before and after the TRM workshop for topics within the wildlife management subject.

The total mean change in the level of understanding for the topic in grazing management subject was 54% (Figure 5). The greatest change was observed in the understanding of setting range goals (60.0%); lower levels of change in understanding were observed in planned grazing (55.0%), balancing animal numbers with forage supply (53.8%), grazing control (53.7%), matching animal nutrient demand and supply cycles (52.6%), and range inventory (48.8%).

All of the participants responded that they learned the ability to analyze their ranch situation and make better ranch management decisions after participating in this workshop.

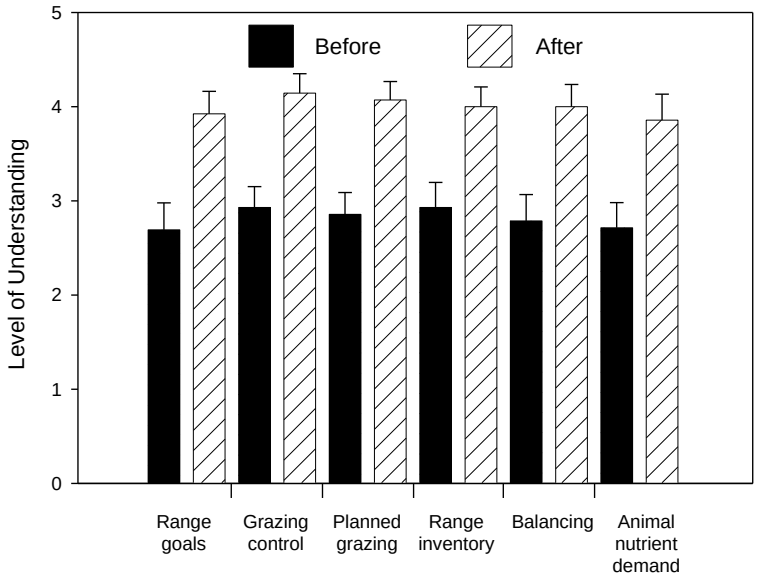

Figure 5. Mean ($\pm$ SEM) level of understanding before and after the TRM workshoptopics in the grazing management subject

DISCUSSION

Through the use of strategic management concepts centered upon the strategic planning process, TRM provides educational programs that integrate multi-level planning to provide a tool for rangeland managers to use in the decision-making process (Fox & Carpenter, 2004).

Based on the results of this study we can conclude that the TRM workshop proved to be a tool to accomplish change in the decision making process for ranch management activities. The TRM workshop participants increased the levels of understanding for all the subjects taught in. The greatest change after the TRM workshop was observed in the understanding of the subjects related to livestock enterprises, wildlife management and grazing management. An intermediate level of understanding was observed in the strategic planning in ranching. The lowest level of understanding was for the economics subject.

The participants made some judgment about changes they applied in their operations from the knowledge attained from the TRM workshop. For a better understanding the opinions were organized and synthesized in groups as follows:

1. Efficient management of all the ranch resources.
2. More efficient use of forage in the range and grazing management. Shift to a proper stocking rate in accordance with the forage resources in the ranch. Better control of this during the dry season. In one case it was mentioned this was carried out to favor wildlife populations. Also, to monitor wildlife for adjusting stocking rate.
3. Proper water supply to cattle.
4. Feeding supplements and minerals.
5. Brush control.

6. A different cattle management, including better health and weight to wean; early weaning and cattle genetic improvement for better commercialization.
7. Better budgeting. Costs reduction and better commercialization.
8. Improvement in the human resources management.

The "before" and "after" survey allowed knowing the opinion of the participants in reference to the changes and decisions made in their ranches. In the future, is necessary to reinforce the economics information, because the change in the level of understanding before the workshop and after the workshop was not as dramatic as in other subjects and the participants considered this subject as an important topic to make decisions in their ranches.

The TRM program has provided a valuable platform to continue the education and assistance to landowners and managers. The need to manage natural resources for sustainable use will continue and the current TRM program will continue to provide assistance to not only professionals, but also the general public (Fox & Carpenter, 2004). In this context, education and training are no longer seen simply as processes of transferring knowledge or information, but rather as means to help people to become critical thinkers and problem solvers in order to learn, share information and address problems and priorities (FAO, 2000; Freire, 2005).

Implications

As a program, TRM has been proven to be a platform to convey and continue education for ranchers and operators as well as to improve the decision making process in the ranch management activity. This program will provide Mexican ranchers with additional critical knowledge which in turn will generate focal points of technology transfer that allows the economic development process to be easier and in an economically affordable manner for both large and small ranchers. Mexican ranchers are welcoming, through TRM, a technology transfer mechanism that was not in place. The next level of TRM is to allow and help ranchers to organize themselves into information sharing clubs, providing a domino effect in the technology transfer action as economic development.

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Effects of Intermittent Suckling on Sow and Piglet Performance

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ABSTRACT

The objective of this study was to evaluate effects of intermittent suckling on sow and litter performance. Seventeen crossbred sows and litters were randomly assigned to treatment groups seven days prior to weaning: continuous suckling (CS) and intermittent suckling (IS; litters removed for 6 hr each from day 21 to 28). Litters were weaned at 28 days of age. Feed and water were available to litters and sows at all times. Feed intake was recorded. Body condition scores were collected on sows before farrowing and at weaning. Number of days to return-to-estrus for the sows was also recorded. Litters were weighed at birth and on days 7, 14, 21, 28, 35, and 42 of age. Litter weights were not different ($P > 0.15$) between CS and IS pigs before or after weaning. No difference ($P > 0.10$) was observed for feed intake between CS and IS litters before or after weaning. Body condition score at weaning was not different ($P = 0.30$) between CS and IS sows. Intermittent suckled sows returned-to-estrus in fewer days than CS sows ($P < 0.05$). Results suggest that intermittent suckling did not alter average daily gain in litters, but reduced the number of days to return-to-estrus in sows.

KEY WORDS: intermittent suckling, litter performance, return-to-estrus

INTRODUCTION

Weaning is a stressful time for all species of animals and can result in negative effects on the neonate after weaning. Stressful events such as weaning can weaken immune function (Hickey et al., 2003) and reduce growth rates (Kuller et al., 2004). In the modern swine industry, piglets are weaned before 30 days of age. The abrupt removal from the highly-digestible sow's milk to a less digestible pig starter can result in low feed intake and poor growth rates after weaning (Kuller et al., 2004). During this time, piglets are also more susceptible to illness due to a compromised immune system and insufficient nutrient intake. Establishing higher levels of feed intake prior to weaning can potentially reduce stress associated with weaning.

It is difficult to encourage starter intake in suckling piglets when the sow is present 24 hours a day providing nourishment in the milk she produces. However, starter consumption can be encouraged in suckling piglets by limiting nursing time. Several studies have reported an increase in starter intake when piglets were separated from the sow for lengthy periods of time each day (Thompson et al., 1981; Kuller et al., 2004).

Along with an increased piglet performance, the sow can benefit from separation. Sows often lose a considerable amount of body condition due to the high nutrient demands of lactation (Foxcroft, 1992). The loss of body condition can result in greater number of days until return-to-estrus after weaning. Sows with litters that were separated each day returned-to-estrus sooner than

sows that nursed litters all day (Newton et al., 1987). Kuller et al. (2004) observed sows separated from their litters returning-to-estrus while still nursing. The return-to-estrus while lactating could increase the number of litters born each year. The objectives of this study were to examine the effects of intermittent suckling on sow and piglet performance.

MATERIALS AND METHODS

The study was conducted at Stephen F. Austin State University Swine Center in Central Heights, Texas. Seventeen cross-bred gilts all of seedstock quality were used. Each of these females was selected at random.

All females at time of selection were correct in their structure, an appropriate age and body weight for breeding and appeared to have maternal characteristics. These gilts were selected following a market show and were all 6 to 7 months of age. Each gilt had attained puberty and was cycling at regular intervals (every 18 to 24 days). Prior to the study, all females met a body condition score (BCS) of at least four.

The study was conducted in two replicates, one in the spring of 2008 and the second in the fall of 2008. Females were placed in a free roaming pen approximately 225' by 243'. During this time the gilts were fed 5 pounds (as-fed) of a commercial corn-based ration.

The gilts were monitored and allowed to cycle three estrus cycles prior to breeding. This allowed each female to adjust to their surrounding. After the observation of the 3rd estrus cycle, the females were bred on the 4th observation of estrus. All of the gilts were bred using artificial insemination. Gilts returning to estrus were exposed to a boar for natural service.

The gilts were monitored each day throughout gestation. Five weeks prior to expected farrowing date 5 cc of Sow Bac E (Novartis, Larchwood, IA) was administered to each gilt. Prior to entering the barn (2 weeks prior to farrowing), each gilt was washed with a low concentrate iodine shampoo. At this time the gilts were given a second injection of Sow Bac E and an injectable dewormer. Gilts were housed in gestating pens until farrowing (10' by 10').

Gilts were moved to the farrowing crates (5' by 7') when milk was present or one day prior to expected farrowing date. Each farrowing crate was equipped with an automatic drinker. Gilts were fed free choice a commercial lactating sow ration following parturition. They were monitored during farrowing and were only assisted if problems occurred. Body condition score was assessed at farrowing.

At one day of age, piglets are weighed, ears notched, and needle teeth clipped, and were administered 1.5 cc of injectable iron and antibiotics. At 10 days of age, the piglets received another injection of iron and antibiotics and had their tails docked. Each litter received free choice pre-starter (total of 25 lbs as-fed) beginning at day 3 (20% CP, 9.0% CF, 1.6% lysine).

Piglets were weaned at 28days of age and placed in the nursery. The litters were placed in elevated crates (4' by 8'). Pens were fitted with automatic drinkers and self feeders. Each litter was administered 50 lbs (as-fed) of a pig starter ration (20% CP, 7.5% CF, 1.6% lysine). The litter finished the study on grower (19% CP 5.5% CF, 1.4% lysine). At weaning, piglets were weighed and given 3cc of a combination vaccine for mycoplasmal pneumonia, swine influenza, erysipelas, and circovirus. They were also administered an injectable dewormer. At 42 days of age pigs received a second injection of mycoplasmal, swine influenza, erysipelas, and circovirus vaccine.

At weaning, sows received 5cc of Farrow Sure Plus B (Novartis, Larchwood, IA) or Parvo Shield (Novartis, Larchwood, IA), and 6 cc of a combination porcine reproduction and respiratory syndrome, circovirus, and swine influenza vaccine. Body condition score was also assessed. The sows were then penned in groups based on this score to ensure their ability to

recuperate back to original BCS. Sows were observed five times daily for signs of estrus until strong evidence of heat was present. These were assessed as a boar was presented to the sow.

Treatment. Litter sizes were not standardized among sows due to the overall goal of the university swine center program. If a sow had more pigs than available teats, then pigs were move within three days of age. Half of the litters were assigned to a treatment group (IS) and the other portion was assigned to a control group (CS). Intermittent suckling piglets were removed from the sow and placed in a nursery crate with free choice feed and water for six hours, beginning at 0800 and returning at 1400 hours. Separation began at three weeks of age (one week prior to weaning). During the separation period, sow remained in the farrrowing crate with access to feed and water. The sows were not exposed to boars at this time.

Each pig was weighed at birth and every seven days until day 42. Both the control and the intermittent suckling groups were handled and managed in the same manner during the study.

Data Analysis. Effects of intermittent suckling on feed intake, body weight, body condition score, and return-to-estrus were analyzed using the GLM procedure of SAS. The model contained the effects of treatment, replicate, and the treatment × replicate interaction.

RESULTS

Initial body condition score of sows prior to farrowing was not different (P = 0.09) between the IS and CS sows (Table 1). However, a difference in initial body condition score was observed (P = 0.0001) between the two replicates. Final body condition score was not different (P = 0. 30) between the CS and IS treatment sows, but a difference between replicates was observed for final body condition score. Differences in the replicates could be attributed to a change in personnel collecting the body condition score measurements for each replicate. Replicate two had a higher body condition score for both the initial and final scores.

The IS sows returned-to-estrus sooner (P < 0.05) than the CS sows (Table 1). The IS sows returned-to-estrus seven days sooner than the CS sows. It should be noted that there were two CS sows that did not show signs of estrus until 15 or more days after weaning. These sows had adequate body condition at the time of weaning. Those sows rebred and have had litters since the study was conducted. There were no replicate or replicate by treatment effects (P > 0.50).

DISCUSSION

Differences in body condition were not observed between IS and CS sows in this study. It is not uncommon for sows to lose a considerable amount of body condition due to the high nutrient demands of lactation (Foxcroft, 1992). The loss of body condition can result in greater number of days until return-to-estrus after weaning. Kuller et al. (2004) reported that sows that intermittently suckled pigs retained a greater portion of body weight through weaning. They attributed the lower weight loss due to a reduction in the demand for milk. Although the intermittent suckled sows lost less weight, they did not observe a relationship with sow weight and weaning-to-ovulation interval.

Table 1. Sow initial and final body condition score[a] and days to return-to-estrus

Treatment	CS	IS	SE	*P*-value
Initial Body Condition Score	4.25	4.50	0.09	0.09
Final Body Condition Score	2.50	2.51	0.01	0.30
Return-to-estrus (days)	12.23	5.13	2.34	<0.05

[a] Body condition score (1 = thin, 5 = obese)

Feed intake for each week was not different ($P > 0.10$) between the CS and IS litters (Table 2). No significant interaction ($P > 0.10$) was observed for feed intake for the CS and IS litters.

Table 2. Mean feed intake[a] for litters during each week of the study

Treatment	CS	IS	SE	*P*-value
Feed intake week 1	0.23	0.00	0.10	0.13
Feed intake week 2	0.92	0.93	0.36	0.98
Feed intake week 3	3.04	2.44	0.91	0.64
Feed intake week 4	5.85	7.76	1.20	0.27
Feed intake week 5	66.89	59.14	8.94	0.54
Feed intake week 6	94.61	93.87	12.5	0.96

[a] Intake as-fed (lb)

A significant interaction ($P < 0.05$) was observed for individual piglet body weight during the study for birth weight, and weights on days 7, 21, 28, 35, and 42 (Table 3). No interaction ($P = 0.09$) was observed for day 14 body weight data.

Table 3. Body weight[a] for piglets during the study

Treatment	CS	IS	SE	*P*-value
Birth weight	2.72	2.67	0.63	0.52[b]
Day 7	5.09	4.99	0.15	0.62[b]
Day 14	7.64	7.46	0.23	0.61
Day 21	10.86	10.51	0.33	0.44[b]
Day 28	14.47	13.71	0.41	0.19[b]
Day 35	18.94	18.55	0.52	0.59[b]
Day 42	25.29	24.66	0.71	0.52[b]

[a] Individual piglet body weight (lb)

[b]Significant replicate × treatment interactions ($P < 0.05$)

In our experiment, we reported fewer days to return-to-estrus in intermittent suckled sows. This is similar to other studies (Kuller et al., 2004; Newton et al., 1987). Kuller et al.

observed 22% of the intermittent suckling sows returning-to-estrus while lactating. Intermittent suckling reduces the demand for nutrients due to less milk production. It also reduces total suckling time on a sow. Suckling action has been shown to reduce GnRH secretion and block follicular development (Britt et al., 1985; Armstrong et al., 1988). Intermittent suckling resulted in an increase in LH secretions which increased the chances of ovulation in sows (Langendijk et al., 2007). Since we did not observe differences in body condition in our sows, it is likely that the reduction in days to return-to-estrus were the result of suckling action.

Differences in piglet body weight or average daily gain were not observed before or after weaning. This is in contrast to results reported by Kuller et al. (2004). They reported a reduction in average daily gain during the intermittent suckling period. Their results were similar to that observed by Thompson et al. (1981). These two studies separated their piglets for 12 hours each day. In our study, the piglets were only separated from the sow for six hours each day. It is possible that this amount of time was not enough to reduce weight gain. Both studies also observed an increase in average daily gain shortly after weaning in the intermittent suckling piglets compared to the control litters. This increase in weight gain could be attributed to better preparation for weaning. The intermittent suckled litters were acclimated to being away from the sow and had increased their feed intake. Kuller et al. (2004) and Thompson et al. (1981) reported an increase in feed intake both pre- and post-weaning in the intermittent suckling piglets. We did not observe an increase in feed intake in our intermittent suckling litters pre- or post-weaning. The intermittent suckling piglets did appear to be more acclimated to weaning based on visual observations. It was noticed that the intermittent suckling piglets did not vocalize or pace the nursery crate to the extent that we observed in the control litters. The intermittent suckled piglets appeared to be more content at weaning. Berkeveld et al. (2007) reported that eating behavior was increased shortly after weaning in intermittent suckled piglets compared to control litters. This behavior will lead to increased average daily gain and is an indicator of less stress associated with weaning which are beneficial to the piglets.

CONCLUSION

Results from this study demonstrate that intermittent suckling did not increase feed intake or growth rate compared to continuous suckling. Less pacing and squealing at weaning was visually observed for intermittent suckling piglets suggesting that these litters were less stressed and accustomed to being removed from their sow. Intermittent suckling reduced the days to return-to-estrus in the sows. This suggests that the removal time was long enough to stimulate return-to-estrus. Longer separation time may facilitate increased feed intake in the piglets during separation, but could lead to decreased milk intake and reduced body weight gain. However, the data may suggest that intermittent suckling may have an effect if more litter data was collected. Additional research is warranted to further evaluate intermittent suckling effects in sows and pigs.

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Evaluating Herbicidal Injury to St. Augustine Grass in Sod Production

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ABSTRACT

Studies were conducted at three locations (Burleson, Matagorda, and Wharton Counties) in south and central Texas to evaluate 25 commonly used herbicides for their effect on regrowth or re-establishment of St. Augustine grass [*Stenotaphrum secundatum* S. (Walt.) Kuntz] after sod had been harvested. Fenoxaprop-ethyl, metsulfuron-methyl, MSMA, and quinclorac caused significant injury (yellowing) at all three locations when rated 10 days after herbicide application. Benefin, imazapic, metolcachlor, triclopyr plus clopyralid, and 2,4-D plus MCPP plus dicamba caused injury to St. Augustinegrass at two of three locations while atrazine, bensulide, bentazon, bromoxynil, imazaquin, halosulfuron, oxadiazon, prodiamine, and simizine caused injury at one location. For St. Augustine grass regrowth, imazapic and metsulfuron-methyl resulted in reduced growth at all three locations while bensulide, fenoxaprop-ethyl, imazaquin, halosulfuron, and oryzalin caused considerable reduction in regrowth at two locations. Bromoxynil, dithiopyr, prodiamine, and quinclorac reduced St. Augustine regrowth at only one location.

Key Words: turf injury, regrowth

INTRODUCTION

St. Augustine grass (*Stenotaphrum secundatum)* is a warm-season turfgrass commonly used in home lawns, athletic fields, and some golf courses throughout the southern United States (Carroll et al., 1996; Fagerness et al., 2002; Fry et al., 1986; Johnson, 1995). Due to the high demand for this grass, turf farms must produce a large amount of quality turfgrass and this requires the use of preemergence and postemergence herbicides to control troublesome weeds. Some of these herbicides may injure the turf (Bridges et al., 2001; McCarty et al., 1991; Murdoch et al., 1997) and the extent of this injury varies among species and cultivars within a species (Johnson, 1983, 1994; McCarty et al., 1991). For sod producers, the questions that must be asked are first, will the herbicide control the weeds in question and secondly, and perhaps more importantly, will it do so without adversely affecting the regrowth or re-establishment of grass in a

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recently harvested field. Herbicides used in sod production must control the weed(s) in question, but must do so very selectively so as not to cause long-term injury to the turf being produced. This study was conducted to evaluate 25 commonly used turfgrass herbicides for their effect on regrowth or re-establishment of St. Augustinegrass following sod harvest.

MATERIALS AND METHODS

Studies were conducted at three locations in central and south Texas to evaluate herbicides applied to 'Raleigh' St. Augustinegrass for turfgrass injury and subsequent regrowth. Studies were conducted in Burleson County, Matagorda County, and Wharton County, Texas. Herbicides were applied May 21, 30, 2002 and July 26, 2002 for Burleson, Matagorda, and Wharton Counties, respectively. Soils for the three locations were as follows: in Burleson County, the soil was a Ships clay (fine, mixed, thermic Vertic Haplustolls) with a pH of 7.5. In Matagorda County, the soil was a Laewest clay (fine, mixed, thermic Udertic Haplustolls) with a pH of 6.9. In Wharton County, the soil was a Silty clay loam (fine-silty, mixed, thermic Fluventic Haplustolls) with a pH of 7.8.

Treatment techniques were essentially the same regardless of the location. Table 1 includes herbicides applied, mode of action, trade name, common name, and rate of herbicide applied. All herbicides were applied using a hand-held CO_2 pressurized plot sprayer that was calibrated to apply the equivalent of 40 gallons per acre. Three replications of each treatment were arranged according to a randomized, complete block design with plot sizes of 6 ft by 8 ft. Treatments at each location were applied within two weeks following sod harvest where a 1 to 4 inch ribbon of grass was left between harvested strips. Each treatment plot was monitored and evaluated for herbicide phytotoxicity (0 to 5, 0 = no injury; 5 = severe injury) to the St. Augusine grass and percent regrowth from the ribbons and/or stolons. Phytotoxicity ratings were based on plant chlorosis, necrosis, and stunting. Initial ratings taken 10 days after herbicide application are presented since this rating was representative of the turf phytotoxicity. Percent vegetative cover was evaluated periodically throughout the growing season using a visual scale and this continued until the untreated check plots were 100 percent re-established and harvestable (data not presented).

Visual ratings of percent cover of St. Augustine grass in Burleson County were concluded in October 2002. In Matagorda County, visual ratings on the St. Augustine grass were completed in November 2002, while in Wharton County St. Augustine grass regrowth was slower due to later harvest and ratings continued until May 2003. Prior to termination of the study, harvestability ratings (0 to 5, 0 = zero percent coverage, 5 = 100 percent ready to harvest) were taken at each location for each herbicide treatment. Statitistical analysis for phytotoxicity and harvestibility ratings in the study was accomplished using Fisher's Protected LSD test at the five percent level of significance.

RESULTS AND DISCUSSION

Phytotoxicity. Phytotoxicity ratings from the herbicide treatments were made at the three locations 10 days after the herbicide treatments (DAT) were applied. Phytotoxicity consisted of leaf yellowing and chlorosis in most instances.

Phytotoxicity on St. Augustine grass was significantly higher from the untreated check with fenoxaprop-ethyl, metsulfuron-methyl, MSMA, and quinclorac at all three locations (Table 2). Johnson (1994) reported quinclorac injured established tall fescue, (*Festuca arundinacea* Schreb.), when applied at the same rate used in our study. He attributed the injury to heat and

drought stress in Georgia. Our studies were not exposed to the drought stress noted in Georgia, but summer temperatures were just as high.

Table 1. Herbicide mode of action, treatments, and the treatment rates for each herbicide.

Mode of action	Trade name	Common name	Rate (product/A)
Growth regulators	Confront 3EC	Triclopyr + clopyralid	1.5 pt
	Drive 75DG	Quinclorac	1.0 lb
	Lontrel 3EC	Clopyralid	0.5 pt
	Trimec Southern	2, 4-D + MCPP + dicamba	1.5 pt
Photosynthesis inhibitors	Atrex 4L	Atrazine	3.0 pt
	Basagran 4EC	Bentazon	2.0 pt
	Buctril 4EC	Bromoxynil	0.6 pt
	Princep 90DF	Simazine	2.8 lb
Amino acid synthesis inhibitors	Image 70DG	Imazaquin	0.54 lb
	Manage 75DG	Halosulfuron	0.05 lb
	Manor 60DG	Metsulfuron-methyl	0.5 oz
	Plateau 70DG	Imazapic	1.44 oz
Lipid synthesis inhibitors	Acclaim Extra	Fenoxaprop-ethyl	20 fl oz
Organic arsenicals	MSMA 6EC	Monosodium acid methanearsonate	2.7 pt
Seedling growth inhibitors-	Asulam 3.3L	Asulam	5.0 pt
	Balan 2.5G	Benefin	1.2 lb
	Barricade 65 WDG	Prodiamine	1.2 lb
	Betasan 3.6G	Bensulide	8.0 lb
	Dimension 1 EC	Dithiopyr	3.0 pt
	Gallery 75DF	Isoxaben	1.0 lb
	Pendilum 60 DG	Pendimethalin	3.3 lb
	Pennant 8E	Metolachlor	2.0 pt
	Prograss 1.5 EC	Ethofumesate	4.0 qt
	Ronstar 50 WSP	Oxadiazon	5.0 lb
	Surflan 4AS	Oryzalin	2.0 qt

Benefin, imazapic, metolachlor, triclopyr plus clopyralid, and 2,4-D plus MCPP plus rating was representative of the turf phytotoxicity. Percent vegetative cover was evaluated

periodically throughout the growing season using a visual scale and this continued until the untreated check plots were 100 percent re-established and harvestable (data not presented).

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Benefin, imazapic, metolachlor, triclopyr plus clopyralid, and 2,4-D plus MCPP plus dicamba resulted in significant toxicity at Matagorda and Wharton Counties but not Burleson County, while atrazine, bensulide, bentazon, bromoxynil, imazaquin, halosulfuron, oxadiazon, prodiamine, and simazine caused significant phytotoxicity only at the Matagorda County site. Clopyralid and ethofumesate caused significant injury at the Wharton County location only (Table 2). Asulam, dithiopyr, isoxaben, oryzalin, and pendimethalin did not cause any St. Augustine injury at any location, and this agrees with previous research on cool-season turfgrasses (Chism and Bingham, 1991; Enache and Ilnicki, 1991; Reicher et al., 1999). Of the herbicides causing damage, bentazon, clopyralid, dithiopyr, ethofumesate, halosulfuron, isoxaben, metsulfuron-methyl, metolachlor, pendimethalin, prodiamine simazine and imazaquin are the only products currently labeled for use on St. Augustine grass (Anonymous, 2006).

Re-establishment or Percent Cover/Harvestability. Herbicide treated plots at all locations were evaluated at various dates for regrowth from the ribbons and/or stolons. Grass growth ratings continued until the untreated check plots were completely established and harvestable (a rating of 5). Results are presented from the last rating.

Table 2. Herbicide phytotoxicity when rated 10 days after application to St. Augustine.[a]

	Location		
Herbicide	Burleson	Matagorda	Wharton
Asulam	0	0.3	0.3
Atrazine	0	1	0
Benefin	0.3	1.3	1
Bensulide	0	1	0.7
Bentazon	0	1	0.3
Bromoxynil	0	1.3	0
Clopyralid	0	0.3	1.3
Dithiopyr	0	0	0.3
Ethofumesate	0	0.7	1.3
Fenoxaprop-ethyl	2.3	2.3	2
Halosulfuron	0.7	1.7	0.7
Imazapic	0.3	3.3	2
Imazaquin	0.3	3	0.7
Isoxaben	0.3	0.3	0.3
Metolachlor	0	1	1
Metsulfuron-methyl	1	1.7	1.3
MSMA	3	4	3.7
Oryzalin	0.7	0.7	0.3
Oxadiazon	0	1	0.7
Pendimethalin	0	0.7	0.3
Prodiamine	0	1	0.3
Quinclorac	2	3	2.7
Simazine	0	3.3	0.3
Triclopyr + clopyralid	0	1	3.3
2,4-D + MCPP + dicamba	0	1.7	1.3
Untreated check	0	0	0
LSD (0.05)	0.9	1	0.9

[a]Phytotoxicity ratings: 0 = no injury, 5 = severe injury.

At the Burleson County location, bensulide, fenoxaprop-ethyl, imazapic, halosulfuron, metsulfuron-methyl, and oryzalin were herbicides that differed significantly from the untreated plot for harvestability by November (Table 3). During re-establishment, these herbicides differed in their effects on grass regrowth for the growing season. Metsulfuron-_methyl was the only herbicide that showed substantial injury throughout the growing period (data not shown), while bensulide, halosulfuron, and imazapic only affected the grass at the end of the growing season. In addition, imazaquin, fenoxaprop-ethyl, and quinclorac hindered recovery or establishment during the growing season (data not shown) but only fenoxaprop-ethyl affected harvestability in November.

At the Matagorda location, bromoxynil, imazapic, imazaquin, metsulfuron-methyl, oryzalin, and quinclorac all affected harvestability ratings as compared to the untreated plot

(Table 3). Blum et al. (2000) reported that imazaquin injured common Bermuda grass [*Cynodon dactylon* (L.) Pers] slightly but injury was transient, lasting not more than 14 d. In other studies, imazaquin and imazapic have suppressed vegetative and reproductive growth on common Bermuda grass (Goatley et al., 1993; Peacock and Flanagan, 1987).

Table 3. St. Augustine harvestability rating as influenced by herbicide.[a]

	Location		
Herbicide	Burleson	Matagorda	Wharton
Asulam	5	4.7	5
Atrazine	4.3	4.3	4.7
Benefin	4.7	4.3	4.7
Bensulide	3.7	4.3	3
Bentazon	4.3	4.3	5
Bromoxynil	5	3.7	5
Clopyralid	5	4	5
Dithiopyr	4.3	4.7	3
Ethofumesate	4.3	4.3	4.3
Fenoxaprop-ethyl	4	4.3	3.7
Halosulfuron	3.7	4.3	3.7
Imazapic	3.7	3	2
Imazaquin	4.7	3.3	3.7
Isoxaben	4.7	4.3	4.3
Metolachlor	5	4.3	5
Metsulfuron-methyl	3	3.7	3.7
MSMA	4.7	4.7	4.3
Oryzalin	4	3.3	4.3
Oxadiazon	5	4.3	5
Pendimethalin	4.7	4.7	4.3
Prodiamine	4.7	4	4
Quinclorac	4.3	3.3	4.3
Simazine	4.7	4	4.7
Triclopyr + clopyralid	4.7	4	4.7
2,4-D + MCPP + dicamba	5	4	4.7
Untreated check	5	5	5
LSD (0.05)	1	1.3	1

[a] Harvestability ratings: 0 = no coverage, 5 = 100% coverage, ready to harvest. Ratings taken in October, 2002 in Burleson County; November 5, 2002 in Matagorda County; and May, 2003 in Wharton County.

The Wharton County site showed similar results as compared to the other locations with the exception of several herbicides (Table 3). The applications were made during the summer (July 26) and dithiopyr significantly affected the harvestability ratings when compared with the untreated check. No negative response with dithiopyr was seen at the other two locations. Other herbicides that hindered harvestability were bensulide, fenoxaprop-ethyl, imazapic, imazaquin, halosulfuron, metsulfuron-methyl, and prodiamine. Each of these herbicides also produced considerable injury to regrowth during the growing season. In addition, oryzalin, isoxaben, MSMA, triclopyr + clopyralid, and pendimethalin caused damage at times during the growing period (data not shown), but recovered with no effect on harvestability. Bromoxynil and quinclorac caused a reduction in harvestibility rating at the Matagorda location, but no negative response was seen at the Burleson or Wharton locations.

CONCLUSIONS

Sod growers need to be aware of potential injury that can occur through use of herbicides for weed control after sod harvest. The results of this study certainly illustrates that certain herbicides can have an effect on St. Augustine grass growth and re-establishment after harvest. Fenoxaprop-ethyl, MSMA, and quinclorac caused the greatest injury at all three locations; however, by sod harvest only MSMA had recovered sufficiently to be considered ready for harvest. Asulam, atrazine, benefin, bentazon, clopyralid, ethofumesate, isoxaben, metolachlor, oxadiazon, pendimethalin, simazine, triclopyr plus clopyralid, and the 3-way combination of 2,4-D plus MCPP plus dicamba resulted in grass growth that was considered ready-for-harvest with the untreated check. Many of the herbicides evaluated in this study are labeled only for use in established turf, and this should be considered when choosing their use on newly harvested sod areas.

Other important factors to consider when using herbicides are application rates, climatic conditions, soil and water pH, soil temperature, soil moisture levels, drought, and overall turfgrass health. Another very important factor is ribbon width. During the study, we discovered that substantial damage and hindered growth occurred on sites with limited ribbon width left after the initial harvest (1-2 inches). Leaving ribbons of at least 4 inches in width appeared to expedite regrowth and harvestability of the sod (authors personal observations). This is another variable that might warrant evaluation in a future research project.

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Influence of Hay Ring Presence on Waste in Horses Fed Hay

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ABSTRACT

Four quarter/paint horse open mares between the ages of four and seven years old were used to determine dry matter (DM) a^{2}nd organic matter (OM) hay wastage on round baled Coastal bermudagrass (*Cynodon dactylon*) and alfalfa (*Medicago sativa*) hay when hay rings were present or absent. Average daily gain (ADG), dry matter intake (DMI), and DMI as a percentage of body weight (BW) were also collected. Results indicated that percent DM wastage was higher ($P < 0.001$), for horses fed hay without rings (WOR) than for those fed hay with hay rings (WR). No differences ($P > 0.05$) were found in ADG. Furthermore, there were no differences ($P > 0.05$) in dry matter intake (DMI) or DMI as a percent of body weight (BW) in horses between hay ring treatments. However, there were increases ($P = 0.03$), ($P = 0.01$) respectively in DMI and DMI as a percentage of BW for horses fed alfalfa (ALF) independent of hay ring. Conclusions indicate that a high percent of wastage occurs when horses are fed either coastal bermudagrass or alfalfa round baled hay without hay rings. Also, when horses are fed alfalfa round baled hay, DMI is likely increased due to increased palatability.

KEY WORDS: bermudagrass hay waste, round bale hay, horse, alfalfa hay waste

INTRODUCTION

Coastal bermudagrass (*Cynodon dactylon*) and alfalfa (*Medicago sativa*) round baled hay is used extensively in the horse industry to provide hay to groups of horses either on poor pasture or in a dry-lot setting. The cost of CBG and ALF hay fed as round bales is typically lower on a per pound basis than when purchased as smaller square bales. This, combined with ease of feeding, is a large factor in some horse owners' decisions when deciding to feed round baled hay. However, the percentage of hay that is wasted when fed as round bales is poorly understood and may not be as economical as feeding conventional square bales (Lawrence et. al., 2000). Likewise, mold spores can contribute to colic in horses (Collins et al., 1997), and mold formation is likely when round bales are exposed to the elements for extended periods not only during storage, but feeding as well (Lawrence et. al., 2000). Thus, a better understanding of wastage and consumption of CBG and ALF round baled hay by horses is needed. The objectives of this study were to determine the amount of CBG and ALF hay wastage when horses are fed round baled hay with and without the

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use of hay rings. In addition, this study measured the average daily gain (ADG), dry matter intake (DMI), and DMI as a percentage of body weight (BW) of horses fed round baled hay with and without the use of hay rings.

MATERIAL AND METHODS

This experiment was conducted simultaneously at Texas Tech University, Lubbock, TX and Sam Houston State University, Huntsville, TX. At each research facility, four paint/quarter horse open mares (*Equus caballus*) four to seven years of age were rotated through treatments consisting of CBG or ALF round baled hay without ring (WOR) and with hay ring (WR). Nutrient analysis of CBG and ALF round baled hay is listed in Table 1. The experiment was designed as a completely randomized design in a 2 by 2 factorial arrangement of treatments with two replications per treatment at each site and four replications per treatment total. Horse round bale feeders measuring 8 ft in diameter and 2 ft 9 inches in height were used in the study and were provided by Priefert® Manufacturing Mount Pleasant, Texas. Horses were placed in an enclosed dry-lot setting where CBG or ALF hay was the only available source of nutrient consumption. Throughout the experimental period all horses remained indoors, removing any influence of wind, precipitation, or other environmental factors. Horses were provided free access to water and a trace mineralized salt block. Prior to the beginning of the first treatment cycle, horses were placed in the treatment area for three days and fed an ad libitum amount of CBG. After all CBG treatments were completed, horses were fed alfalfa hay ad libitum for 14 days before the beginning of the ALF treatments to ease the transition between hay varieties and minimize any potential transitional effects on feed intake.

Prior to the start of each treatment, hay was weighed and core samples (Han et al., 2004) were taken and analyzed for dry matter and nutrient composition. During each treatment replication, horses were left on hay until all unspoiled hay had been consumed. At the end of each treatment replication, unconsumed hay was collected, sorted from soil and fecal material, weighed and a representative sample was analyzed for dry matter, organic matter analysis, and nutrient composition. Additionally, all horses were weighed at the beginning and end of each treatment replication.

All data were analyzed using the mixed (General Linear Models) procedure of SAS (SAS, 2004). Pen was the experimental unit. Treatment was the fixed effect, and the LSMEANS statement of SAS was used to obtain standard errors.

RESULTS

There were no differences in data by research site ($P > 0.05$). Hay wastage and feed intake data are presented in Table 2. The main effect of percent wastage on a DM basis was higher ($P < 0.001$) for horses fed hay WOR than for those fed hay WR. Mean DM wastage for the WOR treatment was 34.8% vs. 5.5% for the treatment WR. There was an interaction ($P = 0.037$) in DM wastage between the effects of hay type and presence of or absence of a hay ring. The mean wastage for ALF when fed WR was 9.10%, where only 1.84% of CBG was wasted when fed WR. Conversely, a lower percentage of ALF (31.50%) than CBG (38.15%) was wasted when fed WOR. For the WOR treatment with CBG all unspoiled hay had been consumed at d 6 of each treatment replication, whereas all unspoiled hay had been consumed at d 8 for three replications and d 9 for one replication of the CBG WR treatment. When ALF was fed all unspoiled hay had been consumed at d 7 of the WOR treatment, and d 9 of the WR treatment. Percent wastage on an OM basis followed the same pattern as DM wastage without the observance of an interaction ($P =$

0.08) of wastage between the effects of hay type and presence of or absence of a hay ring. There was no difference (P = 0.69) in the main effect of DMI in horses fed hay WR compared with horses fed hay WOR. Mean DMI was 8.98 kg/day for the WOR treatment and 9.33 kg/day for the WR treatment.

Table 1. Nutrient analysis of CBR and ALF round baled hay[a]

Item	ALF	CBG
DM, %	91.2	92.8
Ash, %	12.1	6.9
ADF[b],%	34.2	37.9
CP[c], %	19.7	11
TDN[d], %	60.9	58.9
Ca, %	1.05	0.41
P, %	0.5	0.22

[a]All values except DM, % are expressed on a DM basis. Samples collected weekly were composited and assayed by SDK Laboratories (P.O. Box 886, Hutchinson, KS 67504-0996.)
[b]ADF = acid detergent fiber.
[c]CP = crude protein.
[d]TDN = total digestible nutrients.

Likewise, no difference was observed (P = 0.53) in the main effect of DMI as a percent of body weight in horses fed hay WR than for horses fed hay WOR. Mean DMI as a percentage of body weight for the WOR and WR treatments was 2.1% and 2.5% respectively. There was an increase (P = 0.03) in DMI when horses were fed ALF versus CBG independent of hay ring. Additionally, there was similar (P = 0.01) increase in DMI as a percent of body weight when ALF was fed independent of hay ring. There were no differences in the main effect of ADG (P = 0.32) between the presence or absence of hay ring. Mean ADG for the treatment WOR was 0.82 kg/day and for the treatment WR was 0.06 kg/day.

Table 2. Effects of hay type and feeding method on round baled hay wastage, ADG and feed Intake[a,b]

	Treatments[a]							
	ALF		CBG			P-value[c]		
Item[b]	WR	WOR	WR	WOR	SE[d]	Hay	Ring	Hay x Ring
DM Waste[e]	9.1	31.5	1.84	38.14	2.97	0.92	<0.001	0.04
OM Waste[f]	7.25	28.63	1.63	34.87	2.16	0.92	<0.001	0.08
ADG[g], kg	-0.15	0.64	0.28	1	1.61	0.6	0.32	1
DMI[h], kg	9.96	10.46	8.71	7.53	1.86	0.03	0.69	0.37
DMI, %BW[i]	2.29	2.38	2.02	1.73	0.16	0.01	0.53	0.25

a Roughage source: ALF = Alfalfa Hay; CBG = Coastal Bermudagrass Hay
[b]Feeder: WR = with hay ring; WOR = without hay ring

[c]Observed significance level: Hay = hay effect; Ring = hay ring effect; Hay x Ring = hay x ring interaction
[d]Pooled standard error of the treatment means; n = 4 pens per treatment
[e]Percentage waste on dry matter basis
[f]Percentage waste on organic matter basis

[g]Average daily gain
[h]Dry matter intake per day
[i]Dry matter intake as a percent of body weight, per head

DISCUSSION

The results of this study confirm that feeding round baled hay without the use of hay rings results in a high percent of wastage. This appears to be primarily because hay rings reduce a horse's access to the entire bale of hay. When fed round baled hay without a ring, horses tended to peel off a large section of the outermost portion of the bale in order to gain access to the center of the bale. The hay that was discarded in this manner was trampled during feeding and soiled with urine and fecal matter, thus spoiling it. Additionally, when fed hay without a ring, horses used the hay lying around the bale as bedding. By comparison, hay rings appear to reduce waste primarily by protecting the round bale from being trampled and contaminated with urine and feces. This was most apparent when collecting and measuring waste hay. Waste hay from all treatments was sorted from fecal material and soil by hand. Although the quantity and concentration of fecal material present in waste hay before sampling was not measured or recorded, it was observed to be dramatically lower in hay collected from WR treatments. Furthermore, hay collected from the WR treatments typically appeared to be less contaminated by urine.

An interaction between the type of hay fed and presence or absence of a feeder was observed in relation to the percentage of hay wastage. When a ring was used, the percentage wasted when fed alfalfa was 9.10%, compared to only 1.84% when fed CBG. Conversely, a lower percentage of ALF (31.50%) than CBG (38.15%) was wasted when fed WOR. This may be a result of the finer texture of the ALF. A greater amount of hay was dropped outside of the feeder when ALF was fed, exposing a greater percentage to spoilage from trampling and contamination. However, this interaction is more likely due to presence of soil or other contaminants in the collected orts and the higher ash percentage in the ALF hay compared to the costal CBG (Table 1). When hay wastage was corrected for OM, there was no observance of an interaction, thus indicating that our sampling techniques were effective in removing soil from the orts and correcting for percentage ash in the offered hay.

Feeding hay from round bales has been shown to increase the risk of colic in horses (Hudson et al., 2001), and forcing horses to consume spoiled hay will likely exacerbate that risk. Hay spoilage was the factor used in determining when to end each treatment. Treatments were ceased when it appeared unlikely that the horses on trial could consume fresh, unspoiled hay. It is possible that the treatments conducted without a hay ring could have been continued for another day, but not without forcing the animals to consume contaminated hay and therefore increasing the risk of colic.

The absence of variation in DMI between treatments with and without a hay ring supports the observation that the lower percentage of wastage observed with the hay ring was primarily due to a reduced rate of spoilage. There was no observed effect on rate of consumption associated with the use of hay ring. This is further supported by the lack of significant difference in ADG between treatments. Although horses consumed more ALF than CBG, consumption was not increased enough to affect ADG. The variation in DMI and DMI as a percentage of body weight observed between treatments with ALF and CBG was most likely the result of the ALF being higher palatability.

The use of hay rings or round bale feeders appears to reduce hay wastage to a greater degree than was expected. Moreover, the use of hay rings reduces the quantity of spoiled hay available to horses being fed round bales. This could be of benefit in reducing the incidence of

colic associated with the consumption of spoiled or moldy hay. This experiment did not consider the role of environmental factors such as drainage and precipitation in round bale wastage, and this is an area that needs further study to be completely understood. It appears that when fed under the right conditions, round baled hay may be an acceptable alternative to conventionally baled hay. If this is to be determined, more research is needed to compare the wastage of round baled hay to that of conventionally baled hay.

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Temperature Influence on Seeded Bermudagrass Germination

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ABSTRACT

Slow germination of bermudagrass (*Cynodon dactylon* [L.] Pers.) seed causes difficulty in stand establishment because of weed competition and drought. Temperature has a major influence on germination rate and total germination. Hulled and unhulled common bermudagrass seed were placed in a germinator for 28 days at night (12 hr)/day (12 hr) temperatures of 5/15, 10/20, 15/25, 20/30, 25/35, and 30/40°C. Germinated seed were recorded every two days. The best germination of hulled seed was at 20/30°C followed by 25/35°C and 15/25°C temperature treatments. Optimum germination of unhulled seed was more specific with the most rapid and total germination at 25/35°C. Temperature treatments lower than 15/25°C severely reduced germination rate and total germination of both hulled and unhulled seed. In the southeastern US, hulled bermudagrass seed should be planted from mid-April through June and unhulled seed from mid-May through June.

Key words: seeded bermudagrass, bermudagrass germination, bermudagrass establishment

INTRODUCTION

Bermudagrass is the most widely used subtropical perennial grass in the southeastern US (Burton and Hanna, 1995). It has good drought tolerance because of a deep root system, is well adapted to sandy soils, and can tolerate close continuous grazing. Most available cultivars are hybrids that must be established vegetatively (sprigged) because of very poor seed production (Taliaferro et al., 2004). There is a great deal of interest in using bermudagrasses that can be established from seed as opposed to sprigging. In addition to being less expensive and not as burdensome as sprigging, seeded bermudagrass can be used on small acreages that are not economical to sprig, on steep slopes subject to erosion if plowed, and on cut-over timberland where good seedbed preparation necessary for sprigging is not feasible. Approximately 70% of bermudagrass seed production in the United States is common bermudagrass (Tom Bodderij, personal communication). Field trials in recent years have shown that seeded bermudagrass cultivars and blends are as productive as Coastal bermudagrass, the predominant sprigged cultivar in the southeastern United States (Evers et al., 2004; Marsalis et al., 2007; Teutsch et al., 2004).

As a forage class, warm-season perennial grasses, such as bermudagrass, are difficult to establish from seed (Masters et al., 2004). Slow germination and emergence in addition to poor seedling vigor make warm-season perennial grass seedlings vulnerable to competition from annual weeds and drought. Temperature is a major factor to consider when identifying the optimum

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planting date for maximum germination and rapid emergence of warm-season perennial grasses (Masters et al., 2004).

Keeley and Thullen (1989) examined planting date on common bermudagrass establishment for two years at Shafter, CA (35°47´N 119°18´W). Plugs grown in the greenhouse were transplanted monthly from March through October. Emergence began from the March plantings when the soil temperature reached 17°C at the 5 cm depth. Growth was most rapid from plugs planted from May through August when air temperature exceeded 20°C. Seed harvested from the different planting dates were germinated the following spring at night/day temperatures ranging from 10/15 to 32/38°C. Seed germination was very limited at the coldest temperature treatment but increased as the temperature treatments increased.

Bermudagrass seed can be purchased as hulled (lemma and palea removed) or unhulled (lemma and palea attached). Wheeler and Hill (1957) reported that hulled bermudagrass seed germinates more quickly than unhulled seed. There is no available information on the effect of temperature on germination rate of hulled or unhulled bermudagrass seed to determine the optimum planting date for seeded bermudagrass establishment. The International Seed Testing Association (2004) lists alternating temperatures of 20/35 or 20/30°C for seeded bermudagrass with the first count at 7 days and the final count at 21 days. Germination rate and total germination of hulled and unhulled common bermudagrass seed at various temperatures was determined to identify optimum planting time in the southeastern United States.

MATERIALS AND METHODS

Seed of hulled (Lot 14857) and unhulled (Lot 14771) common bermudagrass seed were obtained form Seeds West, Inc. (Yuma, AZ). Seed were stored at -3°C before and during the study from October 2005 to April 2007. Four replications of 100 seed, both hulled and unhulled, were treated with a light dusting of Gustafson Vitavax Captan 20-20 (5,6-dihydro-2-methyl-N-phenyl-1,4-oxathiin-3-carboxamide + N-Trichloromethylthio-4-cyclohexene-1,2-dicarboximide) seed protectant fungicide, and then were placed onto moistened blotter pads in petri dishes. The dishes were covered with lids and then enclosed in plastic food storage bags to retain moisture, and placed in a Model 818 Precision Scientific incubator (Chicago, IL).

Night/day temperature treatments were 5/15, 10/20, 15/25, 20/30, 25/35, and 30/40°C with 12-hr of light to simulate average monthly temperatures from February to July in the southeastern United States. Filtered deionized water was added as needed to keep the germination pads moist. Seed were monitored every 2 days to record germination for 28 days. A seed was counted as having germinated when both a green leaf and a radicle were visible to the naked eye. Germinated seeds were removed as they were counted. The first run of all temperature treatments occurred from October 2005 through March 2006 and a second run occurred from October 2006 through April 2007.

Germination rate index (GRI) was calculated according to Maguire (1962). Germination rate index is a method to calculate the rate of seed germination. The more rapid the germination, the higher the GRI value. The number of germinated seed counted each day is divided by the number of days since the test was started. The values obtained at each count are then summed to obtain the GRI. One hundred percent germination is not necessary for GRI.

$$GRI = \frac{\text{no. of seed germinated}}{\text{day 1}} + \ldots + \frac{\text{no. of seed germinated}}{\text{day 28}}$$

Analysis of variance (SAS, 1996) was conducted on total germination at 28 days and on GRI. Data were analyzed in a split plot design with run as the main plot and temperature treatment as the subplot for both hulled and unhulled seed with four replications. There was no significant difference between runs at the 0.05 level of significance so data were pooled across runs.

RESULTS

Total Germination. Maximum germination was 93.0% at 20/30°C for hulled seed and 77.5% at 25/35°C for unhulled seed (Table 1). Although hulled and unhulled seed were from different seed lots, this is in agreement with Wheeler and Hill (1957) who reported greater germination for hulled then unhulled bermudagrass seed. However within

Table 1. Total germination percentage at 28 days for hulled and unhulled seed of common bermudagrass at different temperatures.

Temperature night/day (°C)	Hulled seed	Unhulled seed
	----------germination %----------	
5/15	0.5 f A†	0.0 e A
10/20	27.8 e A	16.3 d B
15/25	81.5 b A	65.3 b B
20/30	93.0 a A	63.0 b B
25/35	72.0 c A	77.5 a A
30/40	48.0 d A	45.5 c A
LSD (0.05)	4.2	11.3

†Values in a column followed by the same lowercase letter are not significantly different and values in a row followed by the same uppercase letter are not significantly different at the 0.05 level, using Fisher's Protected LSD.

temperature treatments, hulled seed germination was greater than unhulled seed only at temperatures from 10/20 to 20/30°C. Total germination was high for both hulled and unhulled seed at temperature treatments ranging from 15/25° to 25/35°C. The highest temperature treatment reduced germination to 48 and 45.5% for hulled and unhulled seed, respectively. There was essentially no germination at the lowest temperature treatment of 5/15°C with limited germination at 10/20°C. Keeley and Thullen (1989) reported germination of less than 16% at their lowest temperature treatment of 10/15°C with increasing germination as temperature increased. Although they did not report if they used hulled or unhulled seed in their study, their reported seed cleaning procedure indicates the seed were unhulled.

Germination Rate Index. Except for the lowest temperature treatment, hulled seed had greater GRI values than unhulled seed at all temperature treatments (Table 2). Hulled and unhulled seed were from different seed lots but total germination was not different at the 25/35 and 30/40°C treatments (Table 1). This suggests that the lemma and palea on the unhulled seed restricted moisture absorption for germination. This is in agreement with Wheeler and Hill (1957). West and Marowsky (1989) reported that removing the lemma and palea from bahiagrass (*Paspalum notatum* Flugge) seed significantly improved germination. The most rapid germination occurred at 25/35°C for both hulled and unhulled seed. Germination rate decreased as temperature decreased.

For hulled seed, the second greatest GRI was at 20/30°C followed by 30/40°C. The opposite occurred for unhulled seed with a greater GRI at 30/40°C temperature treatment than 20/30°C treatment.

Table 2. Germination rate index (GRI) of hulled and unhulled common bermudagrass seed at different temperatures

Temperature night/day (°C)	Hulled seed	Unhulled seed
	----------GRI----------	
5/15	0.02 f A†	0.00 d A
10/20	2.19 e A	1.03 d B
15/25	11.02 d A	6.69 c B
20/30	19.26 b A	7.65 c B
25/35	23.93 a A	16.26 a B
30/40	17.17 c A	9.86 b B
LSD (0.05)	1.41	1.98

†Values in a column followed by the same lower-case letter are not significantly different and values in a row followed by the same upper-case letter are not significantly different using Fisher's Protected LSD at the 0.05 level.

Germination Over 28 Days. Germination of the hulled seed was most rapid at the three warmest temperatures (Fig. 1). However, total germination decreased as the temperature increased. Seed germination was slower at 15/25°C but total germination reached 82%. Temperatures of 10/20°C delayed germination and reduced total germination.

In contrast to the hulled seed, unhulled seed was more temperature specific with the best combination of germination rate and total germination at 25/35°C (Fig. 2). The 30/40° C temperature treatment had rapid germination but with a drastic reduction in total germination. Unhulled seed at 15/25 and 20/30°C temperature treatments germinated more slowly but reached a higher maximum germination than the highest temperature treatment. The two lowest temperature treatments resulted in very low or no germination.

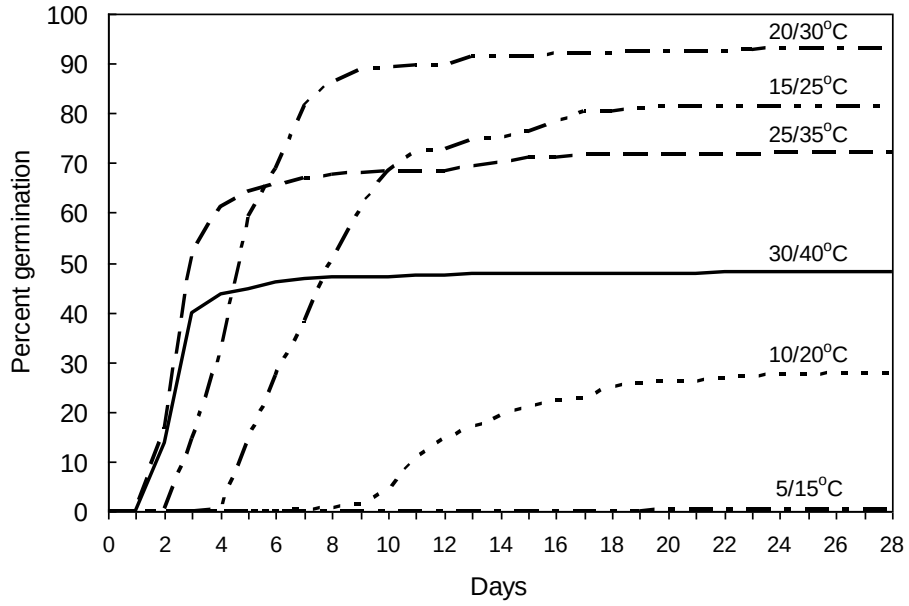

Figure 1. Germination of hulled common bermudagrass seed over 28 days at six night/day temperatures

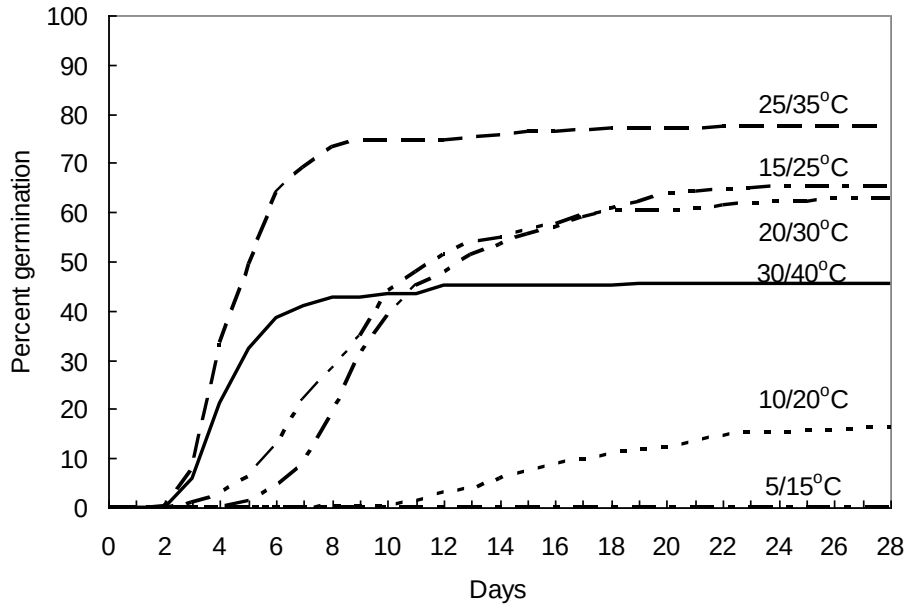

Figure 2. Germination of unhulled common bermudagrass seed over 28 days at six night/day

The best combination of rapid and total germination for hulled and unhulled bermudagrass seed occurred from 15/25 to 25/35°C. In the southeastern United States these

optimum temperatures normally occur from mid-April through July. The mid-April through May time frame would be preferred because of higher probability of rainfall and cooler temperatures which reduces the risk of drought. These temperatures would also maximize bermudagrass growth according to Keeley and Thullen (1989). Germination of unhulled bermudagrass seed was more temperature specific with the best germination at 25/35°C. Therefore, unhulled bermudagrass seed should be planted at warmer temperatures from mid-May through June. Higher temperatures reduced total germination to less than 50%. Lower temperatures resulted in very slow germination, if any, and total germination of less than 30%.

The International Rules for Seed Testing (2004) does not differentiate between hulled and unhulled bermudagrass seed. Temperatures of 20/35 or 20/30°C are recommended for bermudagrass with germination counts taken at 7 and 21 days. Results from this study support the 20/30°C temperature for hulled seed but not unhulled seed. Although 20/35°C was not used in this study, the 25/35°C temperature treatment was optimum for unhulled seed.

Because bermudagrass seed is so small, it is best to broadcast the seed on the soil surface of a prepared seedbed and rolled with a packer to press the seed into the soil surface. This avoids placing the seed too deep and reducing seedling emergence. Summer planting should be avoided because the soil surface temperature will exceed the air temperature in the afternoons and result in lower germination rates according to this study. A disadvantage of a shallow planting depth is the rapid drying of the surface of sandy soils after rainfall which could lead to loss of germinated seed due to lack of soil moisture. Planting a mixture of hulled and unhulled seed may enhance the establishment of a seeded bermudagrass stand.

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Market Valuation for Attributes of Female Beef Cattle Replacements

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ABSTRACT

Previous studies have been carried out to estimate the market value for various traits of feeder cattle, but little work has been done to estimate the market value of various traits for replacement females. This study uses a hedonic price model to estimate the market value for various traits of beef replacement females in South Texas. The results of this study indicate that significant premiums exist for replacement beef cattle females that are first cross Brahman-Herford (F1) or straight Brahman. Quality factors also had a positive impact on price. Lot size was found to be statistically insignificant across all classes of replacement females.

Key words: beef replacement females, hedonic price model

INTRODUCTION

Many studies have been carried out to estimate the market value for various traits of feeder cattle (Buccola, 1980; Faminow and Gumm, 1986; Marsh, 1985; Falconer et al., 1997 and Avent et al., 2004). However, less research has been done to estimate the market value of various traits for replacement females. This study follows the work done in the analysis of feeder cattle prices and uses a hedonic price model to estimate the market value for various traits for replacement females in South Texas.

MATERIALS AND METHODS

The data for this study is taken from three years (2005, 2006 and 2007) of a specialized sale that focuses on replacement females for commercial beef herds. This event is titled the Tri-County Commercial Female Sale and is held at the Beeville Livestock Inc. sales barn in Beeville, TX. This event is part of the educational program provided by Texas AgriLife Extension Service for livestock producers in Bee, Goliad and Refugio counties in Texas. The purpose of this event is to provide area ranchers with an alternative market for both the sale of their raised commercial females, as well as an opportunity to purchase commercial female replacements. In addition, this event also provides area ranchers with an educational opportunity to determine how the market values particular attributes of commercial replacement females.

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For each sale, the entries were divided into three categories which included replacement pairs, bred heifers and open heifers. The total number for each category included 96 lots of pairs, 138 lots of bred heifers, and 178 lots of open heifers. Within each category, a set of three judges ranked every lot with respect to the quality of the replacement females in the lot, and the lots within each category were sold in the order in which the judges ranked them. The quality criteria the lots were judged on included structural correctness, maternal characteristics and confirmation. In addition to the sales price in dollars per head, the number of replacement females in each lot, as well as the predominant color and breed type of the replacement females in each lot was recorded.

The hypothesized hedonic price model for replacement pairs is shown in Table 1.

Table 1. Hedonic Model Variable Definitions and Expected Signs for Pairs

Independent variable	Variable definition	Expected sign
Order	Order in which the lot was sold from lowest to highest	–
OrderSQ	Quadratic term for sales order	+
LotSize	Number of head in the lot sold	+
LotSizeSQ	Quadratic term for number of head in the lot	-
2006	Zero-one dummy variable for the year 2006	-
2007	Zero-one dummy variable for the year 2007	+
Black	Zero-one dummy variable for black cows, one if the cows in the lot were black, zero otherwise	+
F1	Zero-one dummy variable for F1 cows, one if the cows in the lot were F1, zero otherwise	+
MixedLot	Zero-one dummy variable for lots that were not all pairs, one if the lot contained cows other than pairs, zero otherwise	-
ThreeInOne	Zero-one dummy variable for lots that contained pairs that were re-bred, one if the lot contained cows that were re-bred, zero otherwise	+
BraunBray	0-1 dummy variable for lots that were made up of BraunBray cows, one if the lot contained BraunBray cows, zero otherwise	+

The quality of the replacement pairs is represented by the variable titled Order, as the pairs were judged and placed in descending order of quality and sold in that order. Following previous work related to feeder cattle, it was hypothesized that a quadratic relationship between sales order and price existed. In addition, a quadratic relationship between the size of lot and price was included. Zero-one dummy variables were included in the model to identify annual market influences, with 2006 expected to be negative due to extreme drought conditions in the area. Color influences were hypothesized to exist in the data, and a zero-one dummy variable was included in the model to account for the influence of black cows, with an expected positive sign. Breed effects were tested with zero-one dummy variables for first cross Brahman-Herford (F1) and BraunBray pairs, both of which were expected to have positive signs. Inclusion of the BraunBray dummy variable allows for separate testing for a breed effect for a relatively small number of Brahman

cross entries. In addition, zero-one dummy variables were included to measure the influence on the price if the lot was a mixture of pairs and open cows, in addition to lots that contain pairs that were re-bred. This model represents a base lot that was sold in 2005, had no black cows in the lot, had no F1 cows or BraunBray cows in the lot, had no cows without calves, and had no pairs in the lot that were re-bred. The hypothesized hedonic price model for bred heifers is shown in Table 2. The quality of the bred heifers is represented by the variable titled Order, as the pairs were judged and placed in descending order of quality and sold in that order.

Following the model hypothesized for replacement pairs a quadratic relationship between sales order and price was specified. In addition, a quadratic relationship between the size of lot and price was included. Zero-one dummy variables where included in the model to identify annual market influences; again with 2006 expected to be negative due to extreme drought conditions in the area. Color influences were hypothesized to exist in the data, and a zero-one dummy variable was included in the model to account for the influence of black heifers, with an expected positive sign. Breed effects were tested with zero-one dummy variables included for F1s, BraunBray, and Brahman heifers, all of which were expected to have positive signs. This model represents a base lot that was sold in 2005, had no black heifers in the lot, and had no F1, BraunBray, or Brahman heifers in the lot.

The hypothesized model for open heifer prices was the same as the model hypothesized for bred heifer prices.

Table 2**.** Hedonic model variable definitions and expected signs for bred heifers

Independent variable	Variable definition	Expected sign
Order	Order in which the lot was sold from lowest to highest	–
OrderSQ	Quadratic term for sales order	+
LotSize	Number of head in the lot sold	+
LotSizeSQ	Quadratic term for number of head in the lot	-
2006	Zero-one dummy variable for the year 2006	-
2007	Zero-one dummy variable for the year 2007	+
Black	Zero-one dummy variable for black heifers, one if the heifers in the lot were black, zero otherwise	+
F1	Zero-one dummy variable for F1 heifers, one if the heifers in the lot were F1, zero otherwise	+
BraunBray	Zero- one dummy variable for lots that were made up of BraunBray heifers, one if the lot contained BraunBray heifers, zero otherwise	+
Brahman	Zero-one dummy variable for lots that were made up of Brahman heifers, one if the heifers in the lot were Brahman, zero otherwise	+

RESULTS

The model for replacement pairs was estimated using least-squares, with results shown in Table 3. The results indicated that the model is highly statistically significant, given the F-statistic of 17.162. The results yielded an R-squared value of 0.692, comparable to results of previous research on feeder cattle prices.

The results indicated that price was significantly affected by sales order. In this case the measure of quality of the cows in each lot, and the linear and quadratic terms both had the expected sign. However, lot size did not have a significant impact on price. Pairs that were sold in the 2006 sale were discounted by approximately $300 per head, which was expected due to severe drought conditions. The parameter estimate for the dummy variable for 2007 was not significantly different than zero.

Parameter estimates for color, breed, and re-bred cows were statistically significant. Cows that were in lots made up of black cows would be expected to sell for $76.54 more per head than lots of other color. Cows in lots that consisted of F1 cows would be expected to sell for $129.63 more than cows that were not F1s. Cows in lots that contained cows that were re-bred would be expected to sell for $124.14 per head more than lots that were not re-bred. Cows in lots made up of BraunBray cows would be expected to sell for $204.27 per head more than other breed types.

Table 3. Regression Estimates for Model for Pairs

	Beta	S.E.	t-test	Prob(t)
Intercept	1545.1	74.71	20.68	0
Order*	-21.78	4.46	-4.88	0
OrderSQ*	0.39	0.11	3.5	0.001
LotSize	-0.23	21.34	-0.01	0.991
LotSizeSQ	0.23	1.88	0.12	0.903
2006*	-298.79	34.81	-8.58	0
2007	9.01	35.67	0.25	0.801
Black*	76.54	35.23	2.17	0.033
F1*	129.63	42.76	3.03	0.003
MixedLot	-52.63	51.08	-1.03	0.306
ThreeInOne*	124.14	63.33	1.96	0.053
BraunBray*	204.27	66.54	3.07	0.003

* denotes significance at the 0.1 level.

N	96
F-test	17.162
R^2	0.692

The model for bred heifer prices was estimated using least-squares with results shown in Table 4. The results indicated that the model is highly statistically significant, given the F-statistic of 13.147. The results yielded an R-squared value of 0.509, comparable to results of previous research on feeder cattle prices.

As shown in Table 4, prices for bred heifers were significantly affected by sales order. In this case, the measure of quality of the bred heifers in each lot, and the linear and quadratic terms both had the expected sign. As was the case with the model for replacement pairs, lot size did not have a significant impact on price. Bred heifers that were sold in the 2006 sale were discounted by approximately $139 per head, which was expected due to severe drought conditions. The results for bred heifers indicated that there was not a statistically significant premium for lots that were black in color, as opposed to the results for replacement pairs. As was the result with the replacement pairs, there was a statistically significant premium of $152.43 per head estimated for lots made up of F1 heifers. The parameter estimate for BraunBray bred heifers was not statistically significant, which was inconsistent with the result for replacement pairs. The parameter estimate for Brahman bred heifers was statistically significant, and estimated at $239.85 per head for lots made up of Brahman heifers.

The model for open heifer prices was estimated using least-squares with results shown in Table 5. The results indicated that the model is highly statistically significant, given the F-statistic of 26.727. The results yielded an R-squared value of 0.615, comparable to results of previous research on feeder cattle prices.

Table 4. Regression Estimates for Model for Bred Heifers

	Beta	S.E.	t-test	Prob(t)
Intercept*	1283.91	93.58	13.72	0
Order*	-12.01	2.86	-4.2	0
OrderSQ*	0.1	0.04	2.63	0.01
Head	49.25	41.46	1.19	0.237
HeadSQ	-5.8	5.16	-1.12	0.263
2006*	-139.15	48.38	-2.88	0.005
2007	34.25	48.23	0.71	0.479
Black	41.46	39.82	1.04	0.3
F1*	152.43	40.2	3.79	0
BraunBray	36.64	66.5	0.55	0.583
Brahman*	239.85	56.57	4.24	0

* denotes significance at the 0.1 level.

N	138
F-test	13.147
R^2	0.509

The prices for open heifers were significantly affected by sales order, in this case the measure of quality of each lot. However, in this case only the linear component of the model was statistically significant from zero indicating that quality in this case had only a linear impact on price, as opposed to the results obtained for replacement pairs and bred heifers. As expected, open heifers that were sold in the 2006 sale were discounted by approximately $94 per head. The results for open heifers indicated that there was a statistically significant premium for lots that were black in color of $44.83 per head. As was the result with the replacement pairs, there was a statistically significant premium of $135.05 per head estimated for lots made up of F1 heifers. The parameter

estimate for BraunBray open heifers was statistically significant and estimated at $137.45 per head. The parameter estimate for open Brahman heifers was statistically significant, and calculated at $232.33 per head.

In general, these results indicate that Brahman cross replacement females are significantly more highly valued than any other breed type entered in the sales. The Brahman cross replacement females are generally recognized as being better adapted to climactic conditions that exist in South Texas. Both Brahman cross types, the F1s, and BraunBray commanded premiums pairs and open heifers. The premium for straight Brahman replacement females was estimated to be considerably higher than any other breed. It is likely that this occurs for two reasons, the first being the high demand for Brahman cross replacement females that can be produced from the straight Brahman females. The second reason could be that a larger premium needs to exist for production of straight bred Brahman females; as they are male siblings that cannot be retained for breeding purposes and will likely sell at a sizable discount into the feeder cattle market.

Table 5. Regression Estimates for Model for Open Heifers

	Beta	S.E.	t-test	Prob(t)
Intercept*	1050.58	56.03	18.75	0
Order*	-5.09	1.32	-3.86	0
OrderSQ	0.01	0.02	0.63	0.526
Head	-28.37	23.33	-1.22	0.226
HeadSQ	2.24	2.71	0.82	0.411
2006*	-94.18	19.16	-4.92	0
2007	-4.94	17.89	-0.28	0.783
Black*	44.83	18.52	2.42	0.017
F1*	135.05	22.3	6.06	0
BraunBray*	137.45	70.03	1.96	0.051
Brahman*	232.33	45.11	5.15	0

* denotes significance at the 0.1 level.

N	178
F-test	26.727
R^2	0.615

The parameter estimates for the drought year of 2006 may also be of interest to producers who are trying to make reinvestment decisions in breeding livestock after a drought. These results indicate that from drought induced levels, a producer would probably have to pay approximately $95 per head more for an open heifer, $140 per head more for a bred heifer, and approximately $300 per head more for a replacement pair when moisture conditions became more favorable.

CONCLUSIONS

The statistical results indicate that significant premiums exist in South Texas for F1 replacement females across the categories of pairs, bred heifers and open heifers, and straight Brahman breeds across the categories of bred heifers and open heifers that are sold as replacement

beef cattle females. Quality factors also had a positive impact on price. Lot size was statistically insignificant across all classes of replacement females. Drought conditions also had a statistically significant impact on prices.

The results of this study are of interest to both producers of replacement females, as well as commercial cow-calf producers that purchase or raise their replacement females. Producers who are in the business of raising replacement females can use this information when considering how changes in breed type and quality will impact the prices they receive for their replacement females. Conversely, producers who purchase replacement females have better information on which to formulate price expectations relative to their purchase decisions. Further research, with data sets from other regions, is in order to see if the premiums that are paid for beef replacement females, that have a high percentage of Brahman breeding, are specific to the South Texas region.

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