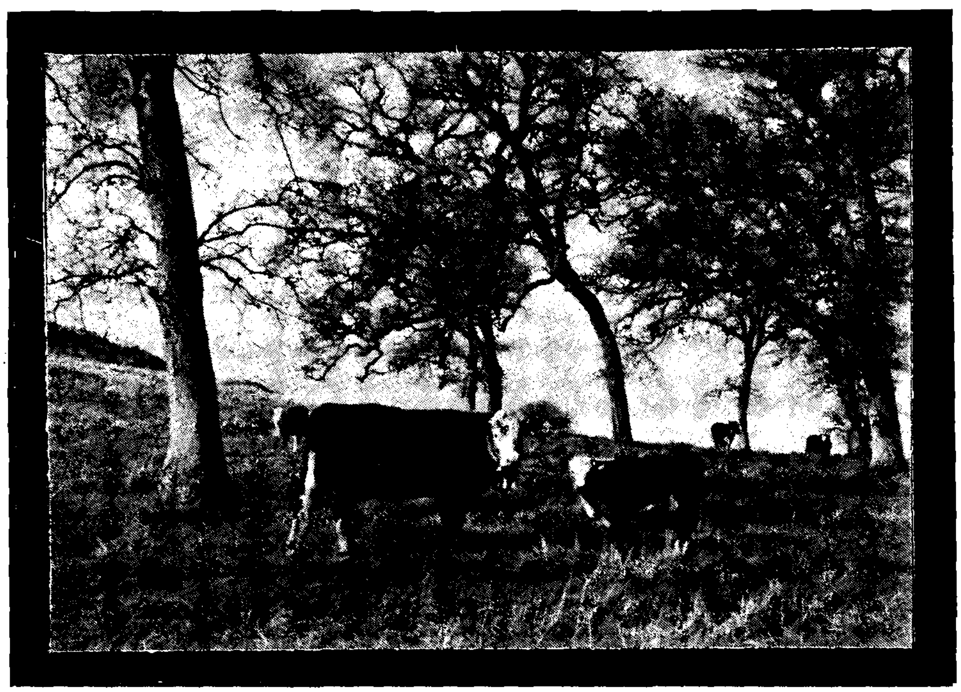
UNIVERSITY OF CALIFORNIA

SIERRA FOOTHILL RESEARCH AND EXTENSION CENTER

Beef & Range Field Day



April 20, 2000

Browns Valley, California

THE UNIVERSITY OF CALIFORNIA
SIERRA FOOTHILL RESEARCH & EXTENSION CENTER

Presents:

Annual Beef & Range Field Day

COSPONSORED BY:

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
DEPARTMENT OF ANIMAL SCIENCE, U.C. DAVIS
SCHOOL OF VETERINARY MEDICINE, U.C. DAVIS

APRIL 20, 2000

BEEF & RANGE FIELD DAY

UC Sierra Foothill Research & Extension Center

APRIL 20, 2000

AGENDA

9:30am	Introductions - Mike Connor, Superintendent, UC-SFREC
9:35am	Welcome - Lanny Lund, Asst. Vice President - Programs, UC Division of Agriculture & Natural Resources (DANR)
9:40am	Pinkeye Prevention and Treatment in Beef Cattle - Lisle George, Professor of Medicine, School of Vet. Med., UC Davis
10:05am	An Alternative Method for Weaning Beef Calves - Ed Price, Professor, UC Davis Animal Science Dept.
10:30am	Selenium Supplementation for Beef Cattle: Environmental Fate of Se Supplements John Maas, CE Veterinarian, Veterinary Medicine Extension Salt as a Se Carrier - Matt Sween, SRA, UC Davis Animal Science Dept.
10:55am	Effect of In Vitro Fertilization on Calf Birth Weight - Marcelo Bertolini, Ph.D. Researcher, UC Davis Animal Science Dept.
11:30am	Meet at corrals: Summary of "Your Beef's at Stake" Carcass Results - James Oltjen, CE Mgt. Systems Specialist, UC Davis Animal Science Dept.
12:00noon	**LUNCH - Tri-tip BBQ** served by Yuba-Sutter Cowbelles & SFREC Staff During lunch: CCA Officers Industry Update
1:45pm	**CONCURRENT SESSIONS** (20 minutes per session plus 5 minutes to get to the next session) Chute-side demo of cattle health techniques: pinkeye injections, calving assistance, sampling or treating via jugular vein, body temperature - Dr. George & Dr. Maas Rice Straw silage for cattle feed - Glenn Nader, Livestock and Natural Res. Farm Advisor, UCCE Butte/Sutter/Yuba Counties and Henry Smith, Local Rancher Banding for castration of beef calves - Demo and discussion by Matt Sween Integration of Grazing and Livestock Management - Wolfgang Pittroff, Asst. Professor, UC Davis Animal Science Dept.

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CONTROL MEASURES FOR PINKEYE IN CATTLE

Prof. Lisle George, Professor, School of Veterinary Medicine,
University of California at Davis

Infectious bovine keratoconjunctivitis (IBK), commonly known as pinkeye, is a serious disease in California beef cattle, affecting more than 90 percent of calves in some herds. IBK causes Red, teary eyes and ocular ulcers. The infection suppresses appetite and weight gain, resulting in economic loss. Healed infections leave scarring, which rarely leads to total blindness but affects the value of purebred breeding animals and those intended for the show ring.

The infectious agent is the bacterium *Moraxella bovis*. Cattle older than one year become mostly resistant to IBK but often harbor the bacterium in their tears and nasal secretions. The disease is often spread by the face fly, which is MOST abundant from midsummer to early autumn. Other factors influencing the seasonal occurrence of pinkeye is a large number of young, susceptible cattle in the herd.

M. bovis can be treated with a number of antibiotics. Most treatment recommendations, however, are based on anecdotal field observations. Over several years, we conducted scientifically-controlled trials to find the most cost-effective way to treat pinkeye. Recently, we also tested a vaccine candidate for IBK developed in our laboratory.

While the laboratory work was carried out at the Davis campus, the Sierra Foothill Research and Extension Center was chosen for the field work because pinkeye is endemic among the SFREC cattle, affecting most of the weanling calves each year. While this high incidence is not welcomed by management, it provided an excellent research opportunity.

We devised four different trials testing different antibiotics and combination of antibiotics as well as different dosages and application methods. Each trial consisted of three groups of about 20 to 40 calves, except where noted. Two groups received treatment and the third group was left untreated as a control. Over the past three years, we have also begun a separate study with our experimental vaccine, whose design and preliminary results are given at the end of our report.

Treatments Studied

1) Oxytetracycline versus furazolidone

a) 2 intramuscular injections of a long-acting oxytetracycline (LA-200, 20mg/kg body weight) 72 hours apart

b) a topical application of furazolidone spray daily for 3 days;

2) Penicillin G versus oxytetracycline/tetracycline

a) injecting Procaine penicillin G just beneath the thin layer of tissue on the surface of both eyeballs; repeated daily until healed

b) injecting oxytetracycline intramuscularly (LA-200, 20mg/kg body weight) on day 1 and 3; also feeding oxytetracycline (2 grams/calf daily) from day 4 to day 14. Re-treated if ulcers recurred or occurred in previously unaffected eye.

3) Penicillin G combined with dexamethasone

a) injecting procaine penicillin G (1 ml) with a fine needle through the skin of the upper eyelid so that a small "blip" was visible just under the tissue of the inner eyelid

b) injecting penicillin G the same way together with 1 ml dexamethasone

4) Florfenicol

a) injecting florfenicol (Nuflor, 20 mg/kg body weight) intramuscularly on days 0 and 2

b) injecting one dose of florfenicol at 40 mg/kg on day 0.

Results

1) The calves treated with oxytetracycline healed faster, had fewer diseased eyes, smaller corneal ulcers and fewer recurrences. We isolated *M. bovis* from ocular secretions less frequently than from the control group. The furazolidone-treated group did better than the control, but did not do as well as the oxytetracycline-injected group.

2) Both penicillin and oxytetracycline /tetracycline combination were similarly effective in treating acute cases. Both treatments resulted in shorter healing times and decreased severity and extent of corneal ulcers over the controls. The tetracycline combination was more effective in preventing recurrences and new cases of the disease than the penicillin.

3) With or without dexamethasone, penicillin neither speeded healing nor reduced the size of corneal ulcers. Injecting the drugs through the upper eyelid seems to be ineffective.

4) Calves in both florfenicol treatment regimes healed faster and had fewer lesions and recurrences than controls.

Recommendations

Injecting 20 mg/kg body weight of long-acting oxytetracycline intramuscularly is the most effective treatment for pinkeye. Two injections over a two- to three-day period are recommended. Long-acting oxytetracycline should be used sparingly in herds with endemic anaplasmosis because treated animals lose their immunity to the disease.

Intramuscular injections of oxytetracycline combined with 10 days of oral tetracycline can reduce the incidence of pinkeye for the entire summer. This long-lasting protection may be desirable in herds with very high incidence of the disease.

Procaine penicillin G is an effective treatment. When using this option, calves should be treated daily for at least 3 days. The penicillin should be injected directly under skin of the eyeball, not into the upper eyelid. Dexamethasone did not improve the effectiveness in our trial.

Florfenicol (at 40mg/kg once or 20mg/kg twice 24 hours apart) is an effective treatment option.

Vaccine Tests and Results

We have isolated and purified in our lab a cellular factor (cytotoxin) from *M. bovis* that may stimulate an immune response and protect calves from infection with the bacterium. We combined the cytotoxin with three different adjuvants -- water-oil emulsion, immunostimulating complexes (ISCOMS) and aluminum hydroxide--into experimental vaccines. Trials have proven the aluminum hydroxide preparation to be ineffective in protecting against pinkeye. At SFREC, the ISCOMS plus the toxin preparation yielded the lowest incidence of corneal ulcers and other clinical scores. Those ulcers that did appear to heal more rapidly after treatment (with oxytetracycline) than those in control animals. However, ISCOMS alone also protected at a low levels. Calves vaccinated with the water-oil vaccine preparation had worse disease than the controls.

In 1998-1999 we made great progress in our investigations of the *M. bovis* cytotoxin and its potential use in a vaccine. Specifically, we successfully cloned the *M. bovis* cytotoxin gene. The vaccine demonstrated effectiveness in lab tests with rabbits. Proposed research will specifically address whether the novel recombinant *M. bovis* cytotoxin vaccine can prevent/reduce the severity of IBK.

FENCELINE CONTACT AT WEANING REDUCES THE NEGATIVE EFFECTS OF COW-CALF SEPARATION.

J. E. Harris, M. L. Sween, R. Borgwardt and E.O. Price

Department of Animal Science, University of California, Davis

Introduction

The purpose of this study was to determine the extent to which fenceline contact between beef cows and their calves at weaning would reduce the negative effects of separation on calf behavior and growth. Nicol (1977) and Stookey et al. (1997) have studied this topic by comparing the behavior and growth of calves that had either fenceline contact with their dams or were abruptly and completely separated at weaning. In both studies the abruptly weaned calves initially gained less weight, but after 2 to 3 days there was no difference between treatments. Using traditional behavioral indicators of comfort, such as eating, lying down and rumination, Stookey et al. (1997) showed that the well being of newly weaned calves was improved if allowed some social contact with their dams. However, in the absence of a non-weaned control group they could not determine the extent to which fenceline contact with the dam at weaning mitigated the negative consequences of total separation.

Methods

Animals. One-hundred Angus/Hereford-cross heifer calves and the respective dams of 40 calves were used in each of two years, 1998 and 1999. The animals were maintained at the UC Sierra Foothill Research and Extension Center (Brown's Valley, CA). In each year, the calves were sorted into 10 equal-size groups based on pre-weaning average daily gain in body weight. Prior to weaning, the calves in five of the ten groups (N=50) received individual identification tags (4 in. high black numbers on a 5 x 18 in. white vinyl strip) glued to the hair (Kamar Heat-Mount Detector adhesive) across the animal's back immediately behind the shoulders. Calves in each group were numbered 0-9. The dams of 20 calves (two groups) received numbers (tags) identical to their own calves. The calves averaged approximately 500 lbs. at the time of weaning.

Treatments. In each year, two groups of 10 calves each were assigned to each of the following five treatments for the first 7 days following weaning: 1) fenceline separation from dams - on pasture (FL); 2) total separation from dams - on pasture (TS); 3) total separation from dams – feedlot for one week - preconditioned to hay (TSP); 4) total separation from dams - feedlot for one week - not preconditioned to hay (TSNP); 5) non-weaned controls - on pasture (CON).

Fences separating cows and calves in the FL treatment groups were wire-mesh with openings too small to accommodate a calf's head. FL calves could possibly touch and lick their dams through the fence, but they could not suckle. From day 7 to day 28 postweaning, calves (from all treatments) were placed into two groups of 50 animals on pasture. The calves were then placed in one group of 100 until day 70. CON calves were weaned (total separation) at eight weeks (56 days).

Procedure. On the day of weaning in each year, calves were weighed and placed in preselected pastures/pens in groups of 10 animals. Starting at weaning, 10 calves from each treatment (N=50) were observed for their behaviors. The remaining 10 calves from each treatment were placed in similar pastures/pens but not observed. Dams of the observed calves in the FL and CON treatments were also observed for behaviors.

Behavioral observations were made over the first five days following weaning and included vocalizations, walking (pacing), standing still, eating, lying down, and proximity (> or < 10 ft.) to either their dam or calf (CON treatment) or the fence (FL treatment).

Calves were weighed at weaning and every 7 days following weaning for 10 weeks to assess the effects of the different weaning treatments on weight gain. Gathering and weighing were conducted in small groups to minimize loss of fill in the holding pens and working chutes/scale area.

Results and Discussion

Behavior. The results of this study support the hypothesis that fenceline contact at weaning results in fewer changes in behavior than total abrupt separation of calves from their dams and minimizes short-term reductions in weight gain often associated with weaning. In general, calves in the fenceline treatment exhibited responses that were intermediate to calves in the total separation treatments and calves in the non-weaned control groups.

Post-weaning calf behavior varied between treatment groups with the FL calves most closely resembling the CON calves. This was particularly evident in time spent walking. During observation periods in the days following weaning, TS calves (on pasture) spent over 40% of their time walking the perimeter of the pasture in contrast to less than 20% for the other four treatments ($P<.05$). Walking time of TS calves was believed to reflect their separation anxiety and the relatively large area available to them. The relatively small, pens (by comparison) of the TSP and TSNP treatments may have discouraged walking (pacing). This high level of locomotor activity by TS calves resulted in decreased grazing and virtually no increase in body weights in the first week post-weaning. Although FL calves initially walked more than CON calves ($P<.05$), they did not differ in time spent grazing and weight gains for the FL calves were very similar to the CON calves for the first three weeks post-weaning. Even though the TSP and TSNP treatments were provided alfalfa hay ad libitum for one week following weaning they ate less often ($P<.05$) than CON and FL calves for the first three days post-weaning. This may have contributed to the lower weight gains of the

TSP and TSNP calves relative to CON and FL calves ($P<.05$). (It is acknowledged that feedlot cattle may eat their fill more quickly than cattle on pasture.)

Lying down was recorded because it is commonly associated with a non-reactive state in animals. On the day of weaning, TS and TSP calves and, to a lesser extent, TSNP calves, spent little or no time lying down. CON calves spent the most time lying on day 1, whereas by day 2, CON and FL calves did not differ. On day 3, calves in the TS, TSP and TSNP treatments spent as much or more time lying down then calves in the CON and FL treatments. Time in proximity to the fence provided important temporal cues regarding the dissolution of social attachment behaviors of cows and calves in the FL treatment. Interestingly, FL calves spent a greater proportion of time within 3 meters of the fence on day 2 than on day 1, and had the highest number of vocalizations on day 2 as well. Fenceline cows remained responsive to their calves through day 2. At that time, it was assumed the udders of the cows were sensitive due to lack of nursing. Between intermittent periods of grazing, cows and calves would approach one another from a distance, vocalizing back and forth until they reached the fence, at which time both calf and dam ceased to vocalize. By days 4 and 5, all FL calves were consistently observed greater than 100 meters from the fence, suggesting the animals were no longer responding to the forced separation. On the day of weaning, TS calves vocalized twice as much as FL calves. The two feedlot treatment groups had relatively high vocalization rates over the first three observation days. It was noted that when one group of calves vocalized, other animals started vocalizing.

FL calves spent 45 to 60 percent of their time within 3 meters of the fence on days 1-3 whereas FL cows spent 30 to 40 percent of their time within 3 meters of the fence on days 1 and 2 followed by a marked decline on day 3 and thereafter. FL cows vocalized frequently during the hours following weaning. Vocalizations declined over observation days so that by days 4 and 5, very few vocalizations were heard during observations. These data suggest that dissolution of the mother-offspring bond in the fenceline treatment progressed rapidly starting on day 3 when the FL cows seldom visited the fenceline separating them from their calves. By day 5, the cows and calves in the fenceline treatment appeared to be relatively independent of one another.

Weight Gain Cumulative post-weaning weight gains for CON calves surpassed ($P<.05$) all but the FL calves for the first 3 weeks in 1998 (Fig. 1). After three weeks, weight gains of the FL calves could not keep up with that of the CON animals possibly because the CON calves had access to both the dam's milk as well as natural forage. Weaning had less effect on the weight gains of FL calves than calves totally separated from their dams. Cumulative weight gains were better for FL calves than for the three total separation treatments for the first 5 to 7 weeks following weaning ($P<.05$). During the last 5 weeks of the study, differences in cumulative weight gains between FL calves and total separation treatments tended to decline. The results suggest that relative to the fenceline treatment, the totally-separated calves were able to partially compensate for the losses in weight gain experienced in the days following weaning. However, even after 10 weeks, the cumulative weight gains of the TSP treatment animals were less than for the fenceline calves ($P<.05$).

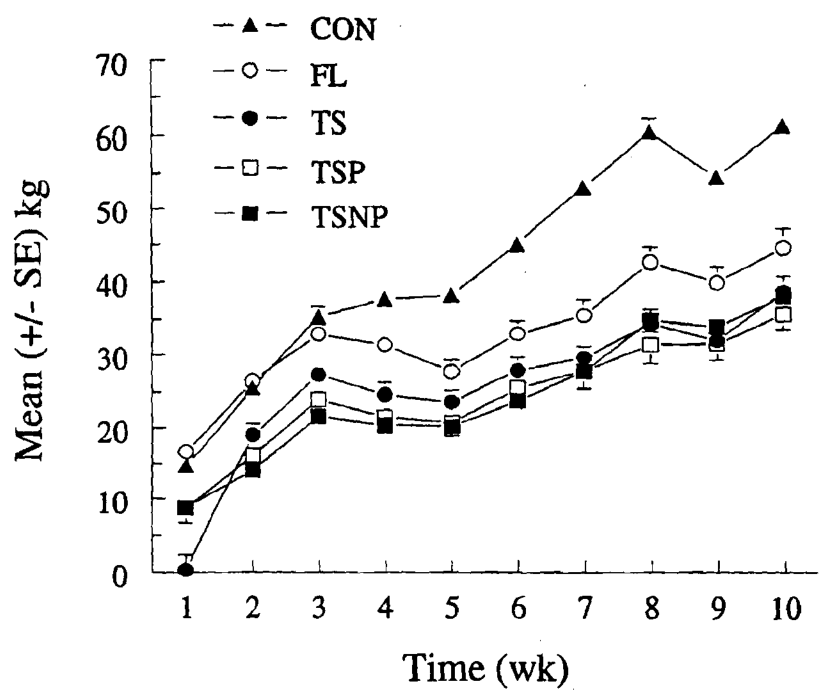

Figure 1. Cumulative Weight Gain of Calves by Group

Relative to abruptly weaning calves on pasture, cumulative post-weaning weight gains were not adversely affected by housing weaned calves in a feedlot setting and feeding alfalfa hay for one week following weaning or by preconditioning calves to hay for 10 days prior to weaning. Cumulative weight gains for the three totally separated treatments did not differ through the 10 weeks of the study.

Over 70% of the calves contracted pinkeye (*Moraxella bovis*) soon after weaning in 1999. Consequently, the weight gain data were highly variable and were not analyzed.

The results of this investigation revealed that fenceline contact between mother and young at weaning can enhance post-weaning performance of calves. The behavior of FL calves at weaning showed less evidence of separation anxiety than was observed in the totally separated calves. We agree with Stookey et al. (1997) that the well-being of newly weaned calves is improved if they are allowed some social contact with their dams. Furthermore, the weight gains of FL calves were similar to CON calves for three weeks post weaning and greater than all totally separated treatments for four weeks post-weaning. It was concluded that fenceline contact between calf and dam reduces the negative effects of weaning on behavior and growth rate. This management technique may economically benefit cattle producers who sell their calves in the days or weeks following weaning.

Literature Cited

Nicol, A.M. 1977. Beef cattle weaning methods. New Zealand J. of Agri., 134:17-18.

Stookey, J.M. et al. 1997. Effects of remote and contact weaning on behavioural and weight gain of beef calves. J. Anim. Sci., 75 (Suppl. 1), 157 (Abstract).

Environmental Fate of Selenium Supplemented to Grazing Beef Cattle

Presented at

Sierra Foothill Research and Extension Center's April 20, 2000 Field Day and Demonstration

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SUMMARY

Selenium deficiency is the number one beef cattle disease problem diagnosed by the University of California's Animal Health and Food Safety Laboratory. Three methods were used to supplement selenium (Se) to cattle in an intensive pasture grazing system. Cattle were supplemented by subcutaneous injection of a commercial Se product (2.5 mg Se/100 lb. body weight), by Se fertilization of the pastures (10 g Se/hectare), and by an oral bolus that released 3 mg Se per day for each animal. A fourth group, Se deficient, control animals was also maintained in these studies. There was no difference in pasture Se concentrations between the control group and the injection or bolus group; however, the Se concentration of the Se fertilization group pastures were significantly higher. In 1997, the pasture Se concentration of the Se fertilization groups averaged 650 parts per billion (ppb), 322 ppb, 162 ppb, 71 ppb, and 54 ppb at five sequential sampling dates over a four month period. The other pasture treatment groups averaged 20 ppb Se or less at all times. In 1998, the Se fertilization pastures averaged 335 ppb, 153 ppb, 27 ppb, and 23 ppb during a similar four month period, while the other groups averaged 20 ppb or less at all times. Soil Se concentrations did not vary between groups at the end of the 4 month study periods in 1997 or 1998. The Se status of the cattle was significantly influenced by treatment and control cattle remained Se deficient. The Se injection cattle showed a slight increase in Se status versus controls for one or two months before returning to control levels. The Se status of both the Se bolus cattle and the Se fertilizer cattle was greatly increased above the control group. The Se bolus group status was higher and more consistent than the Se fertilizer group. The Se status of the cattle in the Se fertilizer group was correlated with pasture Se concentration. There was no difference in the Se concentration of the excreta of the control group, injection group, and fertilizer group at the end of the 4 month periods (10 to 20 ppb); however, the bolus group had higher Se concentrations in the excreta (170 ppb). When the excreta was studied in the

greenhouse experiments, there was no differences observed in the Se concentrations of the various plants species due to Se treatment of the cattle. This indicates that Se bioavailability in the feces and urine of cattle is not affected by Se supplementation methods and remains very low.

Two methods of Se supplementation for cattle look particularly promising from this study. The use of a rumen Se bolus and Se fertilization of pastures for grazing and perhaps forage production appear to be potentially beneficial in preventing Se deficiency. Selenium in the excreta of cattle is not biologically available according to our data and Se supplemented to cattle does not appear to accumulate in pastures or soils. These methods (Se bolus and Se fertilization) appear to be both safe and efficacious for the cattle as well as for the environment.

EXPERIMENTAL METHODS & RESULTS

Selenium-deficient cattle (heifers) owned by the University of California were utilized for this study. They were intensively grazed on pastures (Haworth One pastures) at the UC Sierra Foothill Research and Extension Center (SFREC) for 2 years (1997 and 1998) during the summer of each year. There were two replicates of each treatment group during each year (four replicates total). The treatments were carried out during a 4 month period each year. Each treatment pasture was cross fenced into 3 one acre fields to accommodate intensive grazing management.

Group 1 consisted of 16 weaned heifers supplemented with a sustained-release (osmotic pump) intraruminal (rumen) bolus which releases 3 mg Se per animal per day. Group 2 consisted of 16 weaned heifers supplemented with a single injection on day 0 of a commercial selenium product that provided 2.5 mg Se/100 pounds body weight as sodium selenite. Group 3 consisted of 16 weaned heifers supplemented with Se via fertilization of their pastures with a commercial Se pril applied at the recommended rate of 1.0 kilogram fertilizer/hectare (equivalent to 10 grams of selenium as sodium selenate per hectare). Group 4 consisted of 16 weaned heifers that are Se-deficient and received no Se supplementation.

Samples of blood, soil, pasture plants, and water were collected at each study site on days 0 (time of treatment), and at intervals of approximately 30, 60, and 120 days. Water samples were collected from different areas of each study pasture; (1) irrigation water upstream from the pasture, (2) runoff water or surface water at the downhill edge of the pasture, (3) a downstream site into which the irrigated pastures drained. Water Se concentrations from all water samples were uniformly low (< 3 ug/L (parts per billion) at all collections during the first year and water sample collection was discontinued. Blood samples were collected from all cattle into ethylenediamine tetraacetate (EDTA) vacutainers at each collection date. Additionally, fecal samples and urine samples were collected from the various treatment group animals in the year 1 protocol at the 4 month sampling date and frozen at -60° C until utilized in the year 2 greenhouse study. All samples were analyzed for Se concentration by inductively coupled argon plasma emission spectroscopy using hydride generation.[1]

In year 2, a greenhouse trial was conducted using three plant species grown in pots. Two common grass species, barley and fescue, that are typically subject to natural exposure to cattle manure, plus mustard, which is a Se accumulator plant, were compared. Manure slurries (excreta) from control cattle, injection cattle, bolus cattle, and fertilizer cattle were applied at two rates to the pots at planting. Slurries of feces and urine were combined to approximate normal excreta volumes of 70 percent feces and 30 percent urine by weight. The Se concentrations of slurries were 170 ppb, 10 ppb, 20 ppb, and 10 ppb for the bolus cattle, injection cattle, fertilizer cattle, and control cattle, respectively. Treatment slurries were applied to the soil surface of standard 8-inch plastic greenhouse pots at rates of 5.6 or 22.4 kg/ha (5 Ton/acre and 20 Ton/acre) based on pot surface area (36.3 and 145.2 g per pot, respectively). Additional positive control treatments consisted of excreta from non-supplemented cattle spiked with 22.3 mg sodium selenite or sodium selenate. The spiked slurry was applied only at the 5.6 kg/ha rate. Manure application rates were at maximum anticipated application or natural exposure rates. Pots were arranged on four tables with a border of non-trial pots. A single filter paper liner prevented loss of soil through pot drain holes. Soil was obtained from SFREC control pastures.

Seeds of barley (*Horrdeum vulgare*), Fawn Tall Fescue (*Festuca arundinacea*, cv. Fawn) and black mustard (*Brassica nigra*) were broadcast into pots and lightly compacted. Irrigation was performed approximately every other day. Care was taken to prevent over-watering and leaching. Pots were maintained on saucers to collect any leachate that may have occurred and leaching was minimal. All above-ground plant material was harvested 60 days after planting. Fescue and barley were approximately 5 to 10 cm tall and vegetative. Mustard was slightly more mature with some flowers. Yield, dry matter content and Se concentration was determined on individual samples.

A randomized complete block 4 x 3 x 2 x 4 factorial ANOVA was performed on yield, Se concentration and total Se. Sources of variation were blocks, species of plant, rate of manure application, and source of excreta. Orthogonal contrasts were used in planned tests to separate interactions. Due to large differences in detected Se levels for spiked treatments and resulting lack of homogeneity of variances, spiked samples were statistically evaluated with paired t test to the 5.6 kg/ha control levels.

In 1997, the pasture soil Se concentrations were 289 $\pm$ 14 ppb, 293 $\pm$ 35 ppb, 306 $\pm$ 32 ppb, and 281 $\pm$ 20 ppb for the bolus cattle, the injection cattle, the fertilizer cattle, and the control cattle, respectively. In 1998, the pasture soil Se concentrations were 110 $\pm$ 37 ppb, 116 $\pm$ 19ppb, 144 $\pm$ 60 ppb, and 183 $\pm$ 4 ppb, for the bolus cattle, the injection cattle, the fertilizer cattle, and the control cattle, respectively. There was no difference between the treatment groups in either year.

The 1997 pasture Se concentrations and the blood Se concentrations of the cattle are shown (Figure 1). The blood Se concentration of the injection cattle was slightly higher than the control cattle after 28 days and there was no difference between these two groups after that time. The blood Se concentration of the bolus group and the fertilizer group was significantly greater than the other two groups at all times after treatment. The blood Se concentration of the bolus group was greater than that of the fertilizer group at 4 months after treatment. The Se concentration of the pastures of the fertilizer cattle was significantly greater than all the other groups at all sampling times.

The 1998 pasture Se concentrations and the blood Se concentrations of the cattle are shown (Figure 2). The blood Se concentration of the injection cattle was slightly higher than the control cattle for 2 sampling dates after treatment; however, there was no difference between these two groups after that time. The blood Se concentration of the bolus group and the fertilizer group was significantly greater than the other two groups at all times after treatment. The blood Se concentration of the bolus group was greater than that of the fertilizer group at all times after treatment. This is much different than in the previous year. Also, the blood Se concentration of the fertilizer cattle was much lower in 1998 than in 1997. This is a reflection of the Se concentration of the pastures of the fertilizer cattle. The Se concentration of the pastures of the fertilizer cattle was significantly greater than all the other groups at the initial date and for the next two sampling times. However, there was no difference in pasture Se concentration between the groups at the final two sampling dates.

As noted, the pasture Se concentration was not different between the control group, injection group, or bolus group in either year. These three groups were consistently low at the beginning of each year's study period and remained low throughout. The pasture Se concentration of the fertilizer group was greatly elevated at the beginning of the study period each year and decreased during the 4 month period. The pasture Se concentration of the fertilizer group was about two-fold higher in 1997 than in 1998. In 1997 the experimental fields had recently been replanted and plant growth was slow. Additionally, we started the study period in 1997 eighteen days earlier than in 1998. We may have started the 1997 study period closer to the peak pasture Se concentration in that year versus 1998. Other factors such as temperature or rainfall (El Nino was in 1998) may have significantly influenced the beginning pasture Se concentration in the fertilizer group.

In 1997, the weight gains for the 4 month period for the cattle were 184 $\pm$ 52 lb., 182 $\pm$ 52 lb., 196 $\pm$ 29 lb., and 180 $\pm$ 33 lb. for the bolus cattle, the injection cattle, the fertilizer cattle, and the control cattle, respectively. The weight gains for the fertilizer group was significantly greater than for the other groups. In 1998, the weight gains for the 4 month period for the cattle were 138 $\pm$ 19 lb., 139 $\pm$ 31 lb., 141 $\pm$ 27 lb., and 106 $\pm$ 35 lb. for the bolus cattle, the injection cattle, the fertilizer cattle, and the control cattle, respectively. This second year the weight gains for the control cattle were significantly less than for the other groups. This data, even though with small numbers of cattle, indicates that Se was a limiting nutrient in this study and supplementation increases productivity.

The data from the greenhouse portion of the study is summarized (Tables 1 and 2). The data indicates significant interactions between the plant species, manure amount, and treatment group (method of supplementation). The highest plant Se concentrations were observed in the plants fertilized with the control cattle excreta. All of this statistical difference was due to higher Se concentrations in the barley and mustard plants when fertilized at the lower rate (5 Tons/acre). Otherwise, there was no difference among treatment groups or due to rate of excreta application. One possibility for this is that Se is taken up passively, over time, by plants and that the lower fertilization rate plants grew more slowly and therefore, took up more Se over the study period which was stopped when all plants reached maturity and were harvested. The Se concentration of all plant species for the Se spiked samples were 3,029 $\pm$ 1,160 ppb, and 25,411 $\pm$ 14,862 ppb for the sodium selenite, and sodium selenate spiked samples, respectively. Therefore, it can be concluded the greenhouse system was very sensitive in detecting these forms of Se and the plants accumulate these biologically available forms easily. It is also obvious, that the Se in animal wastes are not biologically available, was not absorbed, and did not accumulate in these species of plants.

DISCUSSION & AGRICULTURAL SIGNIFICANCE

Selenium deficiency in cattle is the number one disease problem diagnosed by the University of California's Veterinary Diagnostic Laboratory System (CVDLS). Previous University of California studies have shown that 65% of beef cattle in northern California and 64% of those in central and southern California are Se deficient.[2,3] Selenium deficient cattle are not economic to raise because of decreased weight gains, decreased feed efficiency, chronic diarrhea, white muscle disease (nutritional myodegeneration), abortions, and increased susceptibility to infectious diseases. The increased susceptibility to infectious diseases (lowered immune system function) results in an increased use of antibiotics for animal health, welfare, and production. Thus, the profitability and sustainability of ranching enterprises will be enhanced by practical methods of Se supplementation such as those tested in this study. Small ranching operations are more adversely affected by Se deficiency than larger operations which can feed total mixed rations and have access to sophisticated and expensive feeding equipment. Also, large operations can take advantage of Se-adequate commodities to help balance rations. Approximately 50% of beef cattle marketed in California come from small scale producers. Many of these producers utilize pasture grazing on a continual basis and these producers are rapidly adopting intensive grazing techniques to increase economic efficiency. If smaller producers were not able to supplement Se it would markedly reduce their ability to maintain economic equity and it would neutralize their inherent efficiencies. Even wildlife species, such as deer, have been shown to benefit greatly from Se supplementation. Fawn survivability increases 2.6 fold when does are supplemented with Se versus non-supplemented deer in California.[5]

Selenium supplemented to livestock and poultry is regulated by the Food and Drug Administration (FDA), the only nutrient to be regulated in this manner. Recent FDA actions have considered the reduction or elimination of the ability of producers to supplement Se. These considerations by the FDA were based entirely on the theoretical potential of environmental accumulation of Se. Because so much of California is Se deficient,[4] it is of strategic importance that livestock producers be able to supplement Se and to be assured that the supplemented Se is not harmful to the environment. Data from this study confirm the importance of Se supplementation as a key element in the sustainability of cattle production systems both from an animal health standpoint and from an environmental health standpoint and supports previous data regarding Se cycling in the environment.[6]

The methods of Se supplementation used in this study are all practical and achievable, particularly for small scale ranchers. Selenium in excreta of supplemented cattle did accumulate in the environment and was not bioavailable in the greenhouse study. The Se supplements were safe for the cattle and were associated with increased productivity. Thus, these methods of Se supplementation were safe and effective for the cattle and we found no evidence of accumulation or risk to the environment.

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Table 1. Mean Selenium Concentration of Plants (dry matter basis) in Greenhouse Study Fertilized with Cattle Excreta from the Treatment Groups.

Se concentration, ppb ± SE (dry matter basis)						
3 way interaction (plant species, manure amount and supplementation method) for Se concentration (P=.01).						
	Fescue		**Barley**		**Mustard**	
	5*	**20***	**5***	**20***	**5***	**20***
Control Group Excreta	40 ± 37.5	52.5 ± 37.5	175 ± 37.5	69.1 ± 37.5	405 ± 37.5	50 ± 37.5
Fertilizer Group Excreta	32.5 ± 37.5	37.5 ± 37.5	22.5 ± 37.5	82.1 ± 37.5	45 ± 37.5	40 ± 37.5
Injection Group Excreta	47.5 ± 37.5	37.5 ± 37.5	25 ± 37.5	20 ± 37.5	99.6 ± 37.5	58.7 ± 43.6
Bolus Group Excreta	47.1 ± 37.5	38 ± 37.5	24.6 ± 43.6	35.1 ± 37.5	75.9 ± 37.5	70 ± 37.5

* The application rates of the excreta (70% manure + 30% urine) were equal to either 5 Tons/acre or 20 Tons/acre.

Table 2. Mean Selenium Concentration in Plants, Plant Yield per Pot (dry matter basis), and Total Se in Plants per Pot for Treatment Group (excreta), Plant Species, and Application Rate

	Plant Se concentration ppb-dry matter	Plant yield gm/pot	Total Plant Se Amount ug
	SE=15.8	SE=.334	SE=.073
Control	131.9	4.5	0.56
Soil	43.3	5.1	0.24
Injection	48	5.6	0.24
Bolus	48	5.3	0.22
P value	0.0002	0.09	0.003

	SE=13.56	SE=.289	SE=.063
Fescue	41.6	4.2	0.18
Barley	56.7	7.3	0.39
Mustard	105.5	3.8	0.36
P value	0.004	0.0001	0.04

	SE=10.99	SE=.236	SE=.051
5 tons	86.6	5	0.37
20 tons	49.2	5.2	0.25
P value	0.02	0.6	0.1

Selenium Supplementation in Beef Heifers

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Introduction

Selenium deficiency is the most commonly diagnosed disease problem in beef cattle as reported by the University of California's (and the California Department of Agriculture's) Animal Health and Food Safety Laboratory System (CAHFS). Previous University of California studies have shown that 65% of beef cattle in northern California and 64% of those in central and southern California are Se deficient. [1,2] Selenium deficient cattle are not economically efficient to raise because of decreased weight gains, decreased feed efficiency, chronic diarrhea, white muscle disease (nutritional myodegeneration), abortions, and increased susceptibility to infectious diseases.[3] The increased susceptibility to infectious diseases (lowered immune system function) results in increased use of antibiotics for animal health, welfare, and production. Thus, the profitability and sustainability of ranching enterprises will be enhanced by practical methods of Se supplementation. Small ranching operations are more adversely affected by Se deficiency than larger operations that can feed total mixed rations and have access to sophisticated and expensive feeding equipment. Approximately 50% of beef cattle marketed in California come from small ranches. Beef cattle producers utilize pasture grazing on a continual basis and if these forages are deficient in Se, the cattle are Se deficient also. Because so much of California is Se deficient, it is very important that livestock producers be able to supplement Se in a practical manner.

Selenium is an essential nutrient for all animals including man and cattle.[4] The nutrient requirements for cattle are between 0.1 and 0.5 ppm (parts per million) of the diet on a dry matter basis. The FDA sets the allowable supplementation level at 0.3 ppm Se of the diet and a maximum of 3 mg Se per day for cattle. The Se status of cattle can be determined by measuring the Se concentration in whole blood.[3,5] Blood Se concentrations of 0.1 ppm to 1.0 ppm are considered normal, with most supplemented or Se-normal ruminants having values of 0.1 ppm to 0.3 ppm.[3] Blood Se concentrations below 0.05 ppm are frankly deficient and can be associated with clinical disease. Blood Se concentrations of 0.05 to 0.1 ppm are considered marginal and subclinical disease can be common in these instances.

As mentioned previously, Se deficiency is widespread in California beef cattle and summary information on Se deficient areas of the state are available on the University of California's website. Selenium deficiency information for California is summarized on a county by county basis at http://animalscience.ucdavis.edu/extension/mineralproject/. It is obvious from the surveys and summarized data the need for Se supplementation continues to be a major concern.

Selenium can be supplemented by a number of methods. Animals in confined feeding operations, such as poultry units, feedlots, and dairies receive a formulated or mixed ration supplemented with Se. However, cattle on range, foothills pastures, or permanent pastures cannot be supplemented in this manner due to economics and logistics. Currently, the only available means to supplement cattle in these extensive grazing units is by the use of salt-mineral mixes. The use of free choice salt-mineral mixes results in variable and sporadic intake due to individual animal intake, varying pasture conditions, and climatic conditions such as temperature, precipitation, and season. Salt mineral mixes are also expensive in terms of cost and labor. Selenium injections can be given to cattle; however, there are limitations on the effectiveness of this method of supplementation. Studies have shown that Se injections give rapid supplementation, of very short duration (< 45 days), and only partially meet the animals' requirements at the label dosage.[6] Therefore, there is a need for Se supplementation for cattle managed in range and pasture situations. The method should be safe for the cattle, provide significant Se in comparison to nutritional requirements, should be practical for cattle producers, and should be cost effective.

Previous trials with intraruminal boluses that provide slow release of Se have demonstrated both safety and efficacy. Pregnant cows and their calves were followed over a period of 220 days in a study performed at Oregon State University in a grazing environment similar to many locales within California.[7] The pregnant cattle in this study were placed in one of four treatment groups. One group was maintained as a Se-deficient, negative control group. A second group was given an osmotic pump bolus (Dura-Se®, Schering-Plough) on day 0 and a third group was given the same bolus on day 0 and on day 119. A fourth group was given two iron-base pellets on day 0 of the study.[7] Both boluses provided significant Se supplementation and there were no untoward reactions observed in the pregnant cows, the calves, or the cows during lactation.[7]

Another study reported on the use of the osmotic bolus in pre-weaned calves.[8] In this study, one treatment group of pre-weaned heifer calves from 83 to 156 days of age were given one osmotic bolus, while a control group was left untreated.[8] This study reported that the bolus was effective in providing Se supplementation and was clinically safe.[8] Additionally, the report found that Se supplemented at 3 mg per day in these young calves did not interfere with copper metabolism or cause any untoward reactions.[8]

From approximately 1980 to 1992, an iron-based, slow release Se pellet was used throughout California. This product was imported from Australia and sold to cattle and sheep producers by the California Woolgrowers. Several research projects were performed in California using these pellets. Under typical production conditions, two of these pellets were administered orally to cattle to provide supplemental Se. One report examined the use of up to 8 of these pellets given to growing steers at one time.[9] These cattle were examined for 300 days after treatment and exhibited no signs of Se toxicity.[9] Additionally, the steers in all the treatment groups remained clinically normal and tissue analysis for Se concentration in these steers did not indicate risk to humans consuming tissues from these animals.[9] Also, this report[9] confirmed previous work that blood Se concentration is useful and adequate for evaluation of clinical cases of chronic Se toxicosis.[10]

Material and Methods

Animals. Fifty-six beef heifers at the University of California's Sierra Foothill Research and Extension Center (SFREC) in Browns Valley, CA were used for this study. All heifers had been weaned for at least 28 days prior to the beginning of the study. The heifers were stratified by age and body weight at weaning and were randomly assigned to one of three treatment groups. All groups were maintained on foothill range at SFREC and did not receive any nutritional supplements. The cattle were managed by the standard operating procedures employed at SFREC. These heifers are future replacement females for the SFREC herd.

Treatments. The cattle were randomly assigned to one of three treatment groups: (1) one sustained release Se bolus (Dura-Se®, Schering-Plough Corp.) given orally, that releases 3 mg Se per day for 120 days, after an initial equilibration period of 14 days, (2) one PTM Moo-Se[1] bolus given orally, and (3) Se-deficient controls which received no treatments. All groups were maintained together as a single management unit on the Se-deficient foothill pastures at SFREC and received no nutritional supplements. Additionally, on day 121 half of the group 1 cattle were given a second bolus (Dura-Se®, Schering-Plough, 3 mg/day Se release) to maintain an internal positive control group receiving 3 mg Se per day.

Measurements. Blood samples were collected at 28 days prior to initiation of study (-28 days) and at 0, 14, 28, 49, 63, 121 and 180 days in EDTA tubes and analyzed for Se concentration by inductively coupled argon plasma emission spectroscopy.[11] The heifers were examined at each sampling date for evidence of alopecia, lameness, coronitis, or other indications of excess Se intake. The cattle were subjected to the standard husbandry procedures, including health observations, vaccinations, dewormings, and weighing, employed at SFREC.

Statistical Analysis. Differences between groups were examined by repeated measures analysis of variance (ANOVA). Differences were considered significant at the $P < 0.05$ level.

Results

There was no evidence of excess Se intake in any of the three treatment groups at any time during the study (lameness, alopecia, brittle hair, coronitis). The blood Se concentrations are summarized in Table 1 and Figure 1. The control heifers continued to be Se deficient and the blood Se concentrations were significantly lower ($P<0.001$) than the blood Se concentrations in the two bolus groups. The group 2 heifers were not different than the group 1 heifers through day 121. Compared to group 1 heifers, the group 2 heifers tended to have lower blood Se concentrations on days 14, 28, and 121 and they were slightly higher on days 49 and day 63; however, these differences between groups 1 and 2 were not significantly different ($P< 0.01$) through day 121.

Table 1. Blood selenium concentration (mean ± std dev) in heifers given Se or left as controls. Blood Se concentration reported as ng/ml (ppb; parts per billion).

Experimental Day

Treatment Group	-28	0	14	28	49	63	121	180*	270
Group 1 Schering-Plough bolus N=18	8.9 ±1.4	8.7 ± 2	87.7 ± 10.8	118.2 ± 12	138.4 ± 13.9	159.3 ± 13.6	203.2 ± 14.8	**1X** 114 ± 16 **2X** 231 ± 23	
Group 2 PTM bolus N=18	8.5 ± 2	8.6 ± 2	78.4 ± 16.5	110.3 ± 12.8	145 ± 16.4	160.4 ± 18.8	173.8 ± 12.6	137 ± 23	
Group 3 Control Heifers N=20	8.7 ± 1.4	7.8 ± 2.1	7.3 ± 1.2	7.7 ± 3.2	7.9 ± 3	9.5 ± 3.1	11.7 ± 4.7	21 ± 2.8	

* On day 121 Group 1 animals were randomly split into two subgroups. One subgroup, 2X, received a second Schering-Plough Dura-Se® bolus and thus continued to be supplemented with 3 mg Se per day. The other subgroup, 1X, received no further Se supplementation.

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STUDY OF THE PHYSIOLOGICAL MECHANISMS UNDERLYING THE APPEARANCE OF THE LARGE CALF SYNDROME IN BEEF CATTLE

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INTRODUCTION

The transfer of *in vitro*-produced (IVP) bovine embryos frequently produces unusually large calves at term, which may or may not exhibit several abnormalities in a set of symptoms collectively called The Syndrome of Large Offspring. Increased birth weight is just one of the usual symptoms associated to this syndrome, being probably just one of the end-points of a multitude of disturbances occurring throughout pregnancy. Neither the environmental factors inducing this syndrome nor the mechanisms causing it have been identified, but it is known that the manipulation of IVP embryos during early stages of development (first week of life) may interfere with embryonic/fetal and placental growth and normal development.

The significance of this syndrome is manifested by increased rates of embryonic and fetal wastage, abortion, particularly in the first half of the pregnancy, dystocia, cesarean section, and fetal and placental abnormalities. Newborn peri- and post-natal distress is frequently associated with breathing difficulties, reluctance to suckle, longer time to standing and sudden death. Interestingly, not all offspring derived from manipulated embryos are affected, including identical clones, demonstrating that the problem is not genetically inherited. Moreover, accelerated growth does not seem to continue after birth. This problem has become an important issue in terms of animal welfare, compromising the commercial or scientific applicability of IVP technologies in cattle, because of the obvious economical loss due to the distress to the dam and neonate. In effect, the financial constraints imposed by the manifestation of the Large Calf Syndrome have become a significant limitation to the transfer of modern reproductive technologies to practical beef cattle production.

No alterations in the embryo prior to the transfer to the surrogate female have been shown to be associated with the syndrome. An understanding of the physiological basis of the syndrome is important for the development of diagnostic methods for predicting the initiation of the syndrome. This study was designed to investigate physiological mechanisms that underlie the appearance of the Large Calf Syndrome, with the examination of aspects that have been shown to influence embryonic, fetal and placental growth.

OBJECTIVES AND PROCEDURES

In vitro-produced embryos were derived from standard procedures for bovine *in vitro* maturation, fertilization and culture. *In vivo*-produced embryos were obtained from superovulated cows at the Sierra Foothill Research & Extension Center (SFREC), for Experiments I and II, and UCD Beef Facility for Experiment III. Day 7 *in vitro*- and *in vivo*-derived blastocysts were non-surgically transferred to synchronous recipients from the SFREC herd.

The authors acknowledge the important contributions of the Sierra Foothill Research & Extension Center to this research project. Without the excellent assistance of Center staff, and the availability of Center cattle and facilities, this research project could not have been conducted.

In Experiment I, the effects of *in vitro* production of bovine embryos on the growth pattern and viability of day-16 embryos were studied. Nine days after the transfer to female recipients (day 16), embryos were retrieved from the uterus for physical analysis.

In Experiment II, the characteristics of fetuses and placentas on days 90 and 180 of gestation of *in vivo* and IVP embryos were investigated to determine deviations in fetal or placental development based on the placental or fetal morphology, histology and functionality.

In Experiment III, the patterns of embryonic/fetal and placental growth from day 30 of pregnancy to term have been monitored by means of ultrasonography. Differential fetal or placental growth and metabolic disorders observed during pregnancy and after delivery were examined, and associations with the metabolic and reproductive hormone profiles in the dam throughout pregnancy and in the newborn during the first 24 hours after birth were considered.

RESULTS

For Experiment I, a complete set of 45 day-16 bovine embryos was successfully collected, including 21 from *in vivo*- and 24 from IVP embryos.

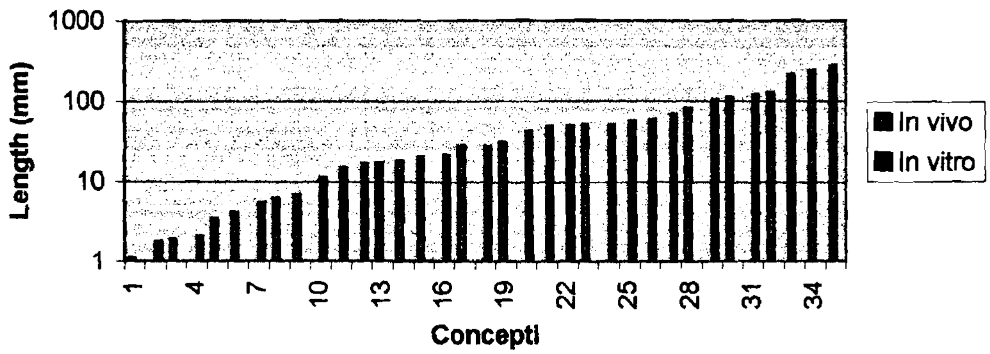

Figure 1: Distribution of the linear length, in mm, of intact day-16 *in vivo*- and *in vitro*-derived bovine concepti

Figure 1 and Table 1 display the distribution and mean length of intact day-16 *in vivo*- and *in vitro*-derived bovine embryos (concepti) obtained after uterine retrieval.

Table 1: Linear measurements (mean ± s.d.), in mm, of day-16 *in vivo*- and IVP bovine concepti

Conceptus	*IN VIVO*	*IN VITRO*
Intact	19	17
Length (mm)	66.99 ± 89.99	41.49 ± 34.88
Width (mm)	1.45 ± 0.51	1.45 ± 0.62

In Experiment II, 27 and 20 pregnancies were established in the IVP and *in vivo* groups, respectively. Significant embryonic and fetal losses (21/47) occurred after the establishment of the pregnancies, mostly in the IVP group (17/27). A total of 5 and 5 IVP, and 4 and 4 *in vivo* pregnancies were terminated on day 90 and 180, respectively, for the allometric and morpho-histologic studies.

Our preliminary results in this experiment revealed significant differences at the level of placentas between *in vivo*- and IVP bovine fetuses on day 90 and 180 days of development. The most remarkable findings relate to the range in size of the placentomes in the IVP group. Similar to the occurrence of giant cotyledons seen in IVP term placentas in Experiment III (Figure 2), the presence of giant placentomes in the IVP group (data not shown), and not in the *in vivo* group, suggests substantial developmental differences in placentation, depending on the origin of the embryos. Such discrepancies may be directly linked to the differential fetal growth pattern seen in this syndrome, as exemplified in Table 2. The remaining analyses to be conduced in this experiment aim to demonstrate whether the ultrastructural and functional aspects of the placental tissue account for the manifestation of the Large Calf Syndrome.

Table 2: Mass, size and some organ and tissues' mass (mean ± s.d.) of day-90 *in vivo*- (n = 4) and *in vitro*-derived (n = 5) bovine fetuses

Group	Fetal weight (g)	Crown-rump length (cm)	Liver (g)	Heart (g)	Lungs (g)	Spleen (g)	B. femoris (g)
In vivo	160.6 ± 34.5	14.15 ± 0.78	5.10 ± 1.34	1.37 ± 0.31	4.61 ± 0.60	0.55 ± 0.47	0.84 ± 0.19
In vitro	177.5 ± 16.8	14.72 ± 0.50	6.90 ± 0.73	1.56 ± 0.27	6.65 ± 0.63	0.20 ± 0.04	0.93 ± 0.19

In Experiment III, 13 IVP calves (7 singlets, 6 twins) and 6 *in vivo* calves (all singlets) were delivered. Eight females lost their pregnancies between days 30 and 60 of gestation. Fetal membranes from IVP pregnancies consistently presented remarkably large or giant cotyledons, as shown in Figure 2. We are now investigating the physiological significance of this phenomenon, relating this finding to the plasmatic profiles of hormones and proteins synthesized by the placental tissue.

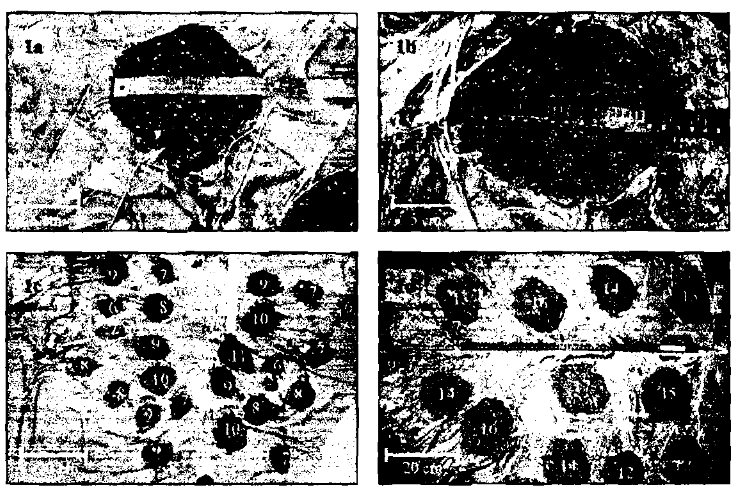

Figure 2: Fetal membranes of *in vivo*- (1a and 1c) and *in vitro*-derived (1b and 1d) calves collected immediately after expulsion, showing the differences in cotyledonary diameters in the fetal horn in the region surrounding the attachment of the umbilical vessels, after the dissection of the fetal membranes. (1a) cotyledon measuring 11 cm in diameter (control); (1b) cotyledon measuring 17 cm in diameter (IVP); (1c) distribution of cotyledonary size in the *in vivo* group, in cm; and (1d) distribution of cotyledonary size in the *in vitro* group, in cm. (UC – umbilical cord)

Table 3 shows some physical, physiological and behavioral characteristics of *in vivo-* and *in vitro*-derived bovine calves (singlets) immediately after birth. IVP calves were heavier and larger at birth than their control counterparts. Moreover, IVP calves took longer to be able to stand and start nursing. Also, the duration of gestation and the time for the release of the fetal membranes after calving were increased.

Table 3: Physical, physiological and behavioral characteristics (mean ± s.d.) of *in vivo-* (n = 6) and *in vitro*-derived (n = 7) bovine calves (singlets) immediately after birth

Group	Release of membranes (h)	Gestation length (days)	Calving ease score (1 to 5)	Birth weight (kg)	Crown-rump length (cm)	Heart girth circumf. (cm)	Scapula to ground (cm)	Femur length (cm)	Standing time (min)	Suckling time (min)
In vivo	4.6 ± 1.8	276 ± 10	2.3 ± 1.2	32.5 ± 5.1	81.8 ± 6.6	72.1 ± 5.0	69.7 ± 3.7	20.9 ± 0.8	70.0 ± 70.4	81.0 ± 54.0
In vitro	8.0 ± 7.6	284 ± 5	2.7 ± 1.5	40.1 ± 10.9	92.0 ± 8.3	76.2 ±6.9	73.8 ± 5.5	22.9 ± 1.7	108.0 ± 107.2	116.6 ± 50.8

Figure 3 shows examples of sonograms obtained during pregnancy. The fetal and placental aspects of interest are linearly measured, and their length, width and surface area are determined and compared, according to each different tissue/organ.

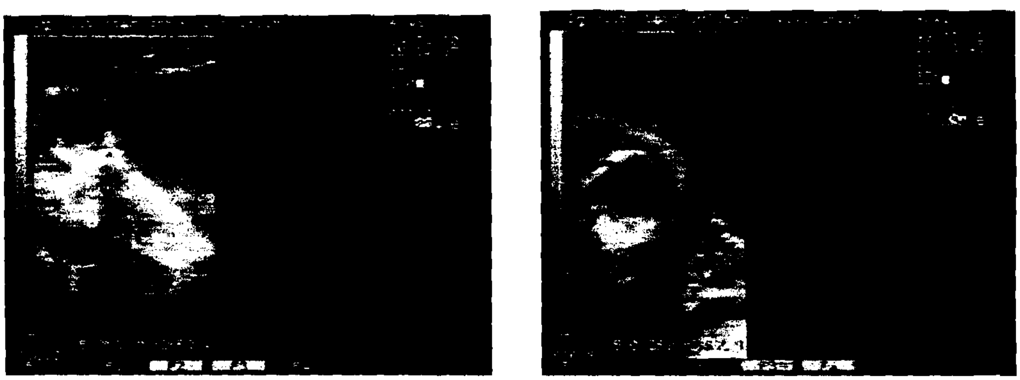

Figure 3: Sonograms of the eye sockets of an IVP (left) and an *in vivo*-derived (right) fetuses at 135 days of gestation

The overall results will be interpreted according to the type(s) of abnormalities observed in all three experiments. Physiological mechanisms believed to lead to this aberration during the different phases of gestation will be individually and collectively characterized in order to clarify some of the major questions on the nature of this syndrome. Ultimately, this project is intended to collect important pieces of information that can be efficiently used for the revelation of the actual hypothetical causes, and the physiological evolution, of this syndrome.

The resolution of the mechanisms leading to this abnormality will be of important for the understanding of the control of embryonic and fetal development and for the development of procedures to manipulate this process. The understanding of these processes also contributes to the identification of diagnostic methods for the predictability of this syndrome. Resolution of the underlying cause(s) of the Syndrome of Large Offspring is essential for *in vitro* technologies to be applied practically to beef cattle production.

Summary of Your Beef's at Stake Carcass Cutout

James W. Oltjen

Introduction

The California Beef Cattle Improvement Association (CBCIA) initiated a producer education program 'Your Beef's at Stake' (YBAS) in 1998. Producers attended a two-day program that included evaluation of live cattle, slaughter, carcass grading and fabrication. Values of the animals live, in the carcass, and as subprimal cuts were estimated. The program was initiated by CBCIA to address producer's needs to know what type of cattle they are producing. Four YBAS sessions have been held in California, with another planned this summer at UC-Davis July 21-22, 2000. This paper describes results from steers chosen for the four programs.

Description of Steers Processed

Steers were weighed before slaughter, and immediately after to obtain the carcass weight. After one day, YBAS participants were divided into groups of six to fabricate one half of the carcass into subprimal cuts. Current live, grid (Table 1), and subprimal (Table 2) market prices were assigned, and animals valued based on carcass weights and grades. To demonstrate the value of the animal to a packer, a total value which included a drop credit ($6.89/cwt, the value of non-carcass components) was estimated.

Analysis of Carcass Data

Steers used in the four YBAS programs averaged 1,254 lb live weight (range 1,061 to 1,390 lb) with a 63% dressing percentage (Table 3). Carcass weights ranged from 640 to 915 lb. Average Yield Grade was 3.0, with over 2/3 of the carcasses between 2.1 and 3.9. Quality Grade ranged from Standard to Mid-Choice, and averaged at the bottom of Low-Choice. Retail Product, the weight of the salable subprimals from the carcass, was quite variable, ranging from 56.7 to 74.9%, generally reflecting the variation in carcass fat content or Yield Grade. Other factors that may have affected Retail Product included dairy or beef type, the inexperience of those cutting the carcass, and a greater proportion of bone in Holstein carcasses.

Values of the live animal or carcasses averaged within $2 ($762 to $764), but the variation was somewhat greater for fabricated carcasses, and much greater for cattle sold on the grid. This may reflect the discontinuous value system used to establish grid carcass price, and demonstrates the potential for financial loss by inexperienced producer's use of the grid.

Perhaps more illustrative is the comparison of the three methods of marketing for steers at the Cal Poly-San Luis Obispo YBAS program (Figure 1). Absolute dollar value comparisons between steers is influenced by live weight, so differences between marketing methods within a steer is of more interest. First note that the Fab+Drop, or total value to the packer is about $90 more than the other methods; this is the margin within which the packer must operate to cover all costs other than the cost of the animal. Within the producer's income (Live, Grid, or Fab) no method is consistently more lucrative. Generally, the live value is either lower than both the Grid and Fab value, or it is higher, meaning that usually the grid and fab values are similar. The significant exception is the Red WF steer with a very low Quality Grade, demonstrating a steep discount for Standard. (No Yellow Sheet values were available for Standard carcasses, so the fabricated value shown here is based on Select prices which overestimate the fabricated value). More importantly, inspection of the graph for patterns show that the Choice Quality Grading cattle were worth more on the grid or when fabricated. Within the Select Quality Grade, the extremely fat Black steer was severely discounted due to low yield. Note that in all but one case (Holstein), the differences between the grid and live values were greater than between the fab and live value, demonstrating the tendency of the grid to overly reward or penalize.

All measures were investigated for correlation with the difference between fabricated and live values (Table 4). Carcass meat yield and fat trim was most related over all the data, followed by its estimator, Yield Grade. Weights, dressing percent, and Quality Grade were much less related, unlike the data in Figure 1, suggesting that results from just a small sample may be misleading.

Table 1. Example of a Carcass Premiums and Discounts Grid.

Quality Grade	Premium or Discount, $/cwt[1]						
	Yield Grade						
	1	2	2.5	3	3.5	4	5
Prime	6.84	5.42	5.42	5.00	4.84	-9.50	-14.50
Mid-Upper Choice	2.92	1.50	1.50	1.08	0.92	-13.42	-18.42
Choice	1.67	0.25	0.25	-0.17	-0.33	-14.67	-19.67
Select	-8.33	-9.75	-9.75	-10.17	-10.33	-24.67	-29.67
Standard	-17.16	-18.58	-18.58	-19.00	-19.16	-33.50	-38.50

[1]Carcasses weighing less than 500, 501-549, 951-1000, or over 1000 lb were discounted 20.67, 17.33, 17.00, or 22.83 $/cwt carcass, respectively.

Table 2. Yellow Sheet of Subprimal Cut Values[1].

		Price per pound	
Subprimal	IMPS[2]	Choice	Select
Ribeye roll < 12 sq in	112A	$4.85	$3.67
Ribeye roll >12 sq in	112A	$4.39	$3.59
Shoulder clod	114	$1.04	$1.03
Chuck Roll, Bnls	116A	$1.20	$1.20
Chuck tender	116B	$1.10	$1.11
Brisket, Bnls, deckle-off	120	$0.83	$0.83
Short Ribs	123	$2.28	$2.28
Knuckle	167A	$1.29	$1.30
Top (inside) Round	168	$1.30	$1.27
Eye of Round	171C	$1.41	$1.38
Bottom Round Flat	171B	$1.06	$1.06
Strip loin, bone in	175	$4.00	$2.92
Top sirloin butt	184	$2.23	$1.75
Bottom sirloin butt, flap	185A	$2.70	$2.65
Bottom sirloin butt, ball tip	185B	$1.86	$1.86
Bottom sirloin butt, tri-tip	185C	$2.01	$2.04
Full tenderloin, defatted	189A	$7.52	$6.60
Flank steak	193	$2.85	$2.85
Lean trimmings		$0.85	$0.85
Back Ribs	124	$0.60	$0.60
Skirt Steak (diaphragm), outer	121C	$3.10	$3.10
Bone		$0.08	$0.08
Fat		$0.11	$0.11
Kidney		$0.14	$0.14

[1]USDA Market News vol. 76, No. 139, July 12, 1999
[2]Industry Meat Processor Standard Cut Number

Table 3. Descriptive statistics for steers in four 'Your Beef's at Stake' Programs.

Trait	Mean	SD[1]	Minimum	Maximum
Live Weight, lb	1254	119	1061	1390
Dressing %	63.0	2.1	59.3	66.2
Carcass Weight, lb	791	91	640	915
Yield Grade	3.0	0.9	1.7	5.9
Quality Grade[1]	3.1	0.8	0.9	4.2
Retail Product % of Carcass	66.3	5.0	56.7	74.9
Trimmed fat, %	17.0	6.5	5.0	33.2
Live Value, $	762	51	673	844
Carcass Grid Value, $	762	108	644	924
Carcass Fab Value, $	764	64	673	908
Total Fab + Drop Value, $	851	68	749	999

[1]Standard Deviation, normally about 2/3 of observations are within the mean ± SD.
[2]Standard <2, Select 2 to <3, Choice 3 to <6, Prime 6 or greater

Table 4. Correlation of traits with the Difference between Fab-Live Steer Value.

Trait	Correlation Coefficient, r
Fat trim, %	-0.57
Retail product, %	0.56
Yield Grade	-0.31
Live weight	-0.14
Carcass weight	-0.12
Dressing, %	0.04
Quality Grade	0.02

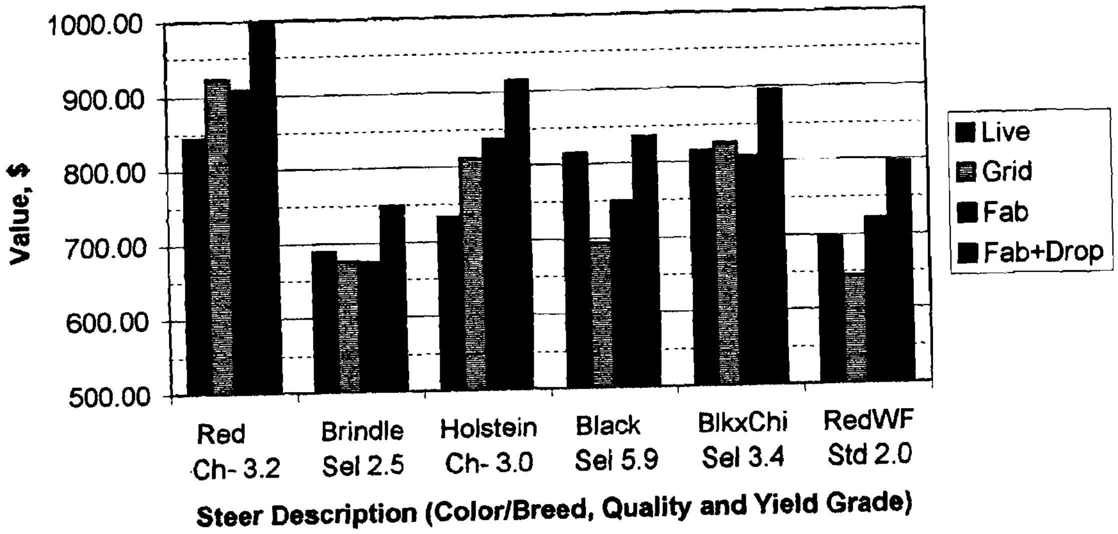

Figure 1. Comparison of Marketing Methods for 'Your Beef's at Stake' Steers at the Cal Poly-San Luis Obispo Program July 1999.

Grazing Management, Monitoring and the Livestock Operation

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The Problem

Conflict surrounding livestock production on public and private rangelands in the western U.S. is increasing. Livestock use of grazing lands is frequently considered detrimental to rangeland health, counter productive to wildlife management, not economically viable because of beef and sheep production loosing market share to other, intensively produced meats, and, in the case of public land use, a hidden form of agricultural subsidies. While most conflicts crystallize on public lands, there is little doubt that these concerns also affect private lands, and will do so much more in the future. In particular, management plans arising from the Endangered Species Act or Clean Water Act directly, and often drastically, affect private agricultural lands. The reach of these public domain interventions is documented in the current Grizzly Bear Management Plan for the Yellowstone Basin, which envisions very substantial restrictions of ownership rights on private lands *after* delisting of the Grizzly bear.

Assessments denouncing livestock production on grazing lands tend to consider a limited number of issues, thus not providing balanced viewpoints. Excessive livestock use of rangelands damages the resource base. Anyone in doubt should consult Will Barnes' account of the abusive range management practices of the 19th century (Barnes, 1913). However, since the early 20th century, the United States have developed a system of research, education and extension which has established livestock production on range as a sustainable agricultural enterprise. As knowledge about livestock effects on plant communities and range ecosystems continues to evolve, management practices are refined. Livestock grazing is an important element in vegetation and water resource management in many countries, and may assume the same role in the U.S. in the future. There are countries in Europe where livestock grazing is considered an economically important - and paid for - service for vegetation management and brush control.

Further, livestock production is an important part of the economy in many western U.S. rural communities. Livestock producers frequently control extensive water rights and important wildlife use zones. As the most stable stakeholders or users in the public land system, they invest in the maintenance and improvement of allotments. They have an intrinsic interest in sustainable grazing and resource management, and play an increasingly active role in resource conservation. Livestock grazing has the potential for controlling noxious weeds in areas where fire, herbicides or mechanical control are not ecologically or economically feasible. Extensive ruminant livestock production, in contrast to intensive dairy, poultry or hog production, has little potential to create acute environmental hazards. As the number of state moratoria on further expansion of intensive livestock production units increases, the role of rangelands as a buffer against over-development of intensive livestock production becomes apparent. Last, but not least, many Americans view traditional livestock production on the western range as an important part of the national cultural heritage.

On the other hand, the rapidly increasing recreational use of western rangelands is frequently viewed as directly detrimental to resource conservation. Because they spend very limited amounts of time on the land, only a small fraction of recreational users will assume an active role in monitoring and resource conservation. Increased demand for recreational use on public rangelands increases development pressure, resulting in continued wildlife habitat fragmentation and urbanization.

The livestock industry operating on rangelands has no authority for self-regulation. All responsibility for monitoring resides with the public land management and regulatory agencies. Budgetary restrictions have led to substantial staff reductions in these agencies and to a policy of shifting responsibility for monitoring to the ranchers – even though there is no legal basis for producer-based monitoring. As a result, monitoring of grazing demand and range condition in many areas is nominal. This development, in conjunction with the more frequent criticism of livestock use by environmental groups, has led to the sharp increase in conflict over resource utilization, and consequently, to strong pressures on western livestock producers. At the same time, public land management agencies as well as federal services such as NRCS are under attack from environmental advocacy groups which frequently launch law suits for alleged non-compliance with federal laws. These conflicts usually end in out-of-court settlements with seemingly inevitable reduction of access to grazing lands for the ranching industry. *It is paramount to realize that out-of-court settlements of legal conflicts over resource use by the livestock industry are the direct result of lack of data.* If appropriate data were available, court cases would be decided based on management data. Possibly more often, they would be rejected because of lack of evidence in support of claims that federal resource protection laws had been violated.

On lands owned by Native American tribes in the western U.S., increased population pressure and changing patterns of livestock production have made resource-protective grazing management increasingly difficult. Traditional permit allocation on tribal lands emphasizes producer involvement. With increasing resource demand, consensus about the adjudication of grazing permits becomes problematic. Thus, Indian tribes need modern support methods for monitoring and allocation planning. Grazing management and resource use monitoring technology available today would be an effective tool for planning fencing, permit adjudication and supervision of permittees. As an example, the Navajo Nation has initiated a range improvement program that will eventually cover the entire reservation of 17 million acres. This program entails fencing, rest of overgrazed allotments, installation of a new monitoring system, and a GIS based resource inventory. The Department of Natural Resources (DNR) of the Navajo Nation collaborates with NRCS and BIA in the design and implementation of this program. The Navajo Nation initiated efforts to acquire technology for the support of producer-based monitoring. This same technology is needed ranchers on public and private lands thoughout the West. Thus, technology for producer-based monitoring is needed to address a pervasive natural resource management problem which is shared by all stakeholders in the grazinglands-based livestock industry in the western United States.

This technology is available today. Harnessing the new technology could facilitate the goal of cost effective, ecologically sound monitoring over extensive landscapes. Better information is the key to reduction of conflict over resource use.

The Technology

The principle. Estimation of utilization is not an end in itself nor should utilization standards be a guiding principle of management. Utilization data are very difficult to measure, and are not even appreciably correlated with ecological trend data. This is so because phenological stage is more important than degree of use for most grazed plants. The scientific debate about appropriate utilization measurement methods is ongoing. However, there is consensus that the basis of sustainable grazing management is balancing forage demand with supply. Long-term range condition maintenance and improvement requires forage budgeting, because all elements of vegetation management –rest-rotation, prescribed burning, prescribed grazing – require the planning of forage use based on a measure of supply and demand. This illustrates the clear need for the integration of grazing with livestock management. The grazing management decision support system *The Grazing Manager* (TGM), developed at Texas A&M University, serves this goal. TGM monitors forage supply and demand on a per pasture or allotment basis. It integrates the livestock management and grazing enterprises to provide a verifiable method for obtaining and consolidating livestock and resource information for timely grazing management decisions. TGM is designed as a tool for use by individual producers. Broad acceptance of TGM by producers (based on proper training) has the potential to facilitate the collection of essential grazing data on the large scale needed. Whether or not producers eventually may be required to adopt monitoring technology to stay in business is irrelevant. What is relevant is the need to provide technology which can be implemented *fast* and *widely* because these data are needed *now*. This can be achieved only if monitoring does not become an additional burden on the producer, but rather, offers economic benefits because of better production management.

The model. TGM was designed to use a small number of highly aggregated variables. It has two components: *planning*, and *monitoring*. The first step in planning is to select the desired intensity of grazing for each pasture (pasture demand ratio, PDR). Planning is completed by developing a grazing plan and scheduling any burning or haying of pastures. TGM is then used to monitor the implementation of the plan. Monitoring data include forage growth adjustments (FGA) and field estimates of PDR. Data entered during planning are updated during monitoring to reflect the current year's conditions. TGM projects daily and cumulative forage production and demand within an annual time frame with a daily time-step. The ratio of demand to production is calculated and used with field monitoring of PDR to validate model inputs. Model projections are used to plan adaptive management responses to the current year's conditions.

Forage variables included in the model are 1) forage-year, 2) normal seasonality of forage growth, 3) current-year's adjustments to normal seasonality of forage growth, and 4) pasture stocking rate. Animal variables are 1) stockflow, 2) animal weights, and 3) feed. Both forage production and animal demand are expressed in DD per pasture. Planning consists of developing a grazing schedule for each herd and a schedule for any burning or haying. Based on these schedules, daily and cumulative DD produced and used are calculated for each pasture. Pasture demand ratio (PDR) is defined as the ratio of DD used to DD produced. Forage demand in TGM is the sum of grazing, burning, and haying.

The forage-year is an important concept for grazing management. The forage-year is a function of the pattern of forage growth and management, not livestock management. In TGM, the forage-year may differ from the animal production year and the calendar year. The forage-year represents an annual cycle of forage production and use. Because TGM analyzes cumulative forage growth and use, it will not function correctly if the forage-year is not set correctly. A decade of experience working with the TGM model in a wide variety of environments has provided insight on when to begin the forage-year in different environments.

Pasture inventory data include the area of the pasture, the average stocking rate, the intensity of use (PDR) associated with that stocking rate, and the seasonality curve for each pasture, which relates the current growth rate to the maximum growth rate possible on the site at any time of the year. These data are used to calculate the productivity of the pasture in demand-days (DD) per day. PDR classes and the associated percentages of total productivity that they are assumed to represent are light (25%), moderate (50%), heavy (75%), and severe (100%). Actual experience and records are the best source for the stocking rate data. However, where these data are not available, other standard range inventory techniques may be used to provide an estimate. Stocking rate and the adjusted seasonality are combined to calculate daily production of demand-days for each day during the forage-year.

Stockflow consists of an annual livestock and wildlife inventory by herd. Herds are comprised of groups of animals that utilize a common area and, if rotated, are moved as a unit. Each entry in a herd is defined by the kind/class, number, beginning date and weight, and the ending date and weight. The form is similar to a tally book that is kept by many stockmen. Initially you project the yearly stockflow and then you edit the data during monitoring to reflect the actual stockflow. TGM calculates the number of days, mean weight and the gain or loss for each kind/class entry. These data are converted to DD assuming that one DD is equivalent to 15 Mcal net energy for maintenance and gain. Data from the stockflow form are used to calculate the DD per day for each class of animal and the total for each herd. Total pounds of feed are entered for each herd with the beginning and ending dates of each feeding period. Daily DD of feed are calculated based on 26 pounds of feed per DD. DD from feed are subtracted from the calculated herd demand. Stockflow provides the manager with a daily record of the forage demand by grazing animals.

If forage is removed as hay, the number and weight of bales harvested from each pasture is entered. Weight of hay is converted to demand using the relationship of 26 lb per DD. Burning can be represented by entering the percentage of the pasture that is burned and the date it is burned. TGM multiplies the percent of the pasture burned by the net DD remaining in that pasture on the date of the burn and enters these DD as demand.

TGM assigns each pasture a planned PDR based on the value entered in the pasture data entry screen. The planned PDR is based on management objectives and is used to calculate the cumulative available DD, which appears in the graph on the grazing scheduler. This calculated variable serves as a reference for evaluating grazing plans.

Grazing schedules should be developed for the complete forage-year for each herd. A pasture may be grazed by more than one herd. Graphical analyses, provided on-screen for daily and cumulative DD produced and used, can be used to evaluate the grazing plan for accuracy as it is being developed. The graphs can be selected for a single pasture, a group of pastures designated as a grazing management unit (GMU), or for the whole operation. To evaluate the grazing plan for effectiveness, observe the amount of forage demand relative to the amount of forage available on the daily and cumulative graphs. An effective grazing plan will keep the DD of grazing below the DD available at the planned PDR until the end of the forage year. If grazing demand ever exceeds total forage production in the cumulative graph, there are incorrect data entries. TGM calculates PDR as the cumulative DD of demand divided by the cumulative DD of production for each day during the forage-year. Field estimates of PDR (none, light, moderate, heavy, severe) should be made for individual pastures at frequent intervals. Important times to make field estimates are when growth rates begin to change rapidly (increasing or decreasing) and before and after grazing periods in rotational or seasonal grazing. Estimates should be based only on use of forage produced during the current forage-year, not on use of forage produced during the previous forage-year. During the first month of the forage-year, animals may be using forage produced during the previous forage-year. If this occurs, enter an estimate of the total amount of carryover forage consumed as feed for the herd.

The normal seasonality of growth is generally used during planning. However, seasonal growth rates can be adjusted to evaluate potential risk or opportunity related to fluctuations in forage growth. During monitoring, forage growth rates should be adjusted to represent the actual growth rates. This will adjust the daily DD of forage production to the current year's production. The structure of TGM greatly facilitates field validation of the model. Field estimates of PDR, as described above, provide the principal means for evaluation of estimates entered in the planning process, and calculations done by TGM. Thus, TGM is a field verifiable method.

It is again emphasized that TGM, while providing an estimate of grazing demand, is not a utilization model in the current or traditional sense because grazing demand is calculated based on animal parameters and nutrients, not consumed biomass per se. The decisive advantage of this approach is that TGM cannot fall victim to changing standards of measurements or interpretation of utilization. *There is no scientific consensus about (a) the usefulness of utilization data for prediction of ecosystem function and trend; (b) appropriate measurement times and methods; (c) appropriate interpretation of results.* However, TGM provides a consistent estimate of intensity and timing of use, and it is designed to be used long-term. It can be easily combined with long term ecological trend studies.

This brief description gives an overview on the tight integration of grazing with livestock management, on which the concept of the *demand model* is based. This concept implements the philosophy that the livestock producer on range can manage *demand* in an economically successful and ecologically sustainable way, but he or she cannot manage *supply* and expect to stay in business. Rangeland-based livestock production requires minimum inputs, and only those who maximize the long-term efficiency of use of their pasture resources will stay in business.

Because TGM produces a record of pasture use for every year a grazing plan is made and executed, it provides a complete grazing record. The next step, the integration of these records on a regional scale, simply requires geo-referencing pastures and uploading pasture coordinates and DD data into GIS databases maintained by land management agencies. It is the prerogative of land management agencies to make the implementation of this technology possible. The direct involvement of livestock producers in the monitoring of grazing resources could afford a realistic opportunity to reduce conflict by making available sound resource use data on a regional scale. It would allow all stakeholders to concentrate on what really matters: further development of adaptive management of western grazingland resources.

Reference:

Barnes, W. C. 1913. Western grazing grounds and forest ranges; a history of the live-stock industry as conducted on the open ranges of the arid West, with particular reference to the use now being made of the ranges in the national forests. Chicago, The Breeder's gazette, 390 p.