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"Water-Belly" (Urolithiasis) in Range Steers in Relation to Some Characteristics of Rangeland[1]

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Water-belly, urinary calculi or urolithiasis, has caused widespread losses among cattle. Cattlemen in the Great Plains of the United States ranked water-belly second in occurrence among all nutritionally sick cattle in 1954 (Ensminger, et al., 1955). In the western states, except the Great Plains, it ranked fifth, and in the southern states it ranked seventh.

Range operators think of water-belly as being strictly a range cattle problem. Livestock feedlot operators think of it as being strictly a feed-lot problem. Actually, it is common to both, but the majority of scientific investigations into the problem have been on feedlot cattle.

This study follows the "range approach" to the problem. It was undertaken to determine relationships of range vegetational types, range condition, range sites, the annual and seasonal incidence of the disease in cattle, and the mineral content of range forages in relation to the incidence of water-belly. It was limited primarily to cattle and the range upon which they grazed. Another purpose of the study was to find practical means by which ranchers might reduce the extensive losses due to water-belly in range cattle.

The study covered a period of two winters, the winter of 1954-55 and the winter of 1955-56.

Mathams and Sutherland (1951) observed that cows coming to an Australian abatoir from the Gympie-Eumundi district had considerable amounts of kidney stones. Analysis showed these stones to be composed almost entirely of silica. Such instances occurred rarely in cattle from other districts. These workers indicated that pastures in the Gympie-Eumundi district have a great deal of "blady grass", (*Imperata cylindrica major*) in the pastures in which the affected cattle grazed. Swingle (1953) analyzed stones from 63 steers. All contained a high percentage of silica.

Jones, Black, Ellis, and Keating (1949) of the Texas Agricultural Experiment Station recognized that urinary calculi condition of steers in feedlots was probably not due entirely to feedlot environment. Madsen (1954), found a high but variable content of silica in certain harvested range forages collected in New Mexico and Texas. These and other workers have speculated on the presence of a relationship between the high silica intake from forage and soil and the later incidence of water-belly in steers on fattening rations. Silica is one of the most abundant single minerals of the soil (Byers, et al., 1938).

Relationships of mineral composition of range plants to the sites in which they grow was suggested in a study by Gordon and Sampson (1939). In their study, it was noted that low soil phosphorus resulted in low phosphorus and high potassium content of plants.

The actual metabolic changes undergone by minerals absorbed from plants by range cattle is not well understood and little research has been done along this line. A mineral balance type of metabolism experiment was conducted in Ohio by Forbes and Beegle (1916). The retention of silicon from rations containing timothy hay and corn silage was surprisingly large.

The Study Area

This study was conducted primarily in the southeastern one-fourth of Montana. The ranches studied were located in Rosebud, Musselshell, Carter, Carbon, and Wheatland Counties. Information from other areas in Montana, Colorado, and Utah was also obtained.

The study area was well suited to investigation of this problem. Most of it is considered to be within the mixed prairie associa-

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tion of the grassland formation. This association or type alternates with the desert shrub and salt desert shrub type. The latter type occupies a much smaller percentage of the study area than does the former.

Most of the study area is in the 10 to 14 inch rainfall belt. Southern Rosebud County is in the 15 to 19 inch rainfall belt. The precipitation in the study area ranged from 8.49 inches to 13.33 inches in 1954, but in 1955 the precipitation was higher, ranging from 10.01 to 17.51 inches. Precipitation was about three inches below normal the first year of the study and two inches above normal the second year.

The average annual temperatures ranged from 41.5 degrees to 46.8 degrees Fahrenheit.

Methods and Procedure

Ranch units were studied in pairs in order to permit clear expression of animal-soil-vegetation-water relationships. Two ranch units for a pair were selected for comparable size, kinds of cattle, climatic conditions, and management. At the same time, these units were selected to provide a degree of contrast in their experience with the incidence of water-belly.

Ranches were visited and data obtained on cattle management, range vegetational types, range sites, range condition, and the incidence of water-belly. Composite samples of range forage plants, supplemental forages, and water utilized by the cattle during the fall and winter months were collected. The estimated utilization of the important range species was recorded at the time of the ranch visits. Practice in estimation of utilization and range condition was gained in a preparatory program which made use of exclosures and clip quadrats.

Range condition and site relationships were determined on the basis of technician's guides to range condition classes, and recommended stocking rates, prepared by the Soil Conservation Service.

FIGURE 1. Steers grazing on high benches selected threadleaf sedge during December, January, and February in the winter of 1954-55. Water-belly incidence was 28.6 percent in this herd.

A corollary study to obtain information on the mineral composition of the important range species was conducted over a period of one year on a ranch near Ashland, Montana. Samples of the important species were taken at two-week intervals May 1954 through January 1955 and once a month during February, March and April, 1955. Species sampled included western wheatgrass (*Agropyron smithii*), bluebunch wheatgrass (*Agropyron spicatum*), blue grama (*Bouteloua gracilis*), Junegrass (*Koeleria cristata*), Sandberg bluegrass (*Poa secunda*), needle-and-thread (*Stipa comata*), green needlegrass (*Stipa viridula*) and threadleaf sedge (*Carex filifolia*).

Forage samples were analyzed by the Chemistry Department of the Montana Agricultural Experiment Station for moisture, protein, calcium, phosphorus, magnesium, silica, and for potassium on some samples. Water samples were analyzed for calcium, phosphorus and silica.

A mail survey of 24 ranches in the northern desert shrub-saltbush type of central Utah was conducted.

Results and Discussion

Vegetational Types and Incidence of Water-belly

Six vegetational types were encountered on rangelands in this phase of the study. They are listed in Table 1.

Only three of twenty-one ranch units had cattle grazing on a single vegetational type. Thus, it was necessary to base this study on the complexes and transitions of type, instead of pure vegetational types. There was a total of 3,451 cattle on these ranch units. The minimum number of cattle grazed on any one of the six vegetational types was 198; the maximum number on any one type was 987.

Cattle herds on vegetational types containing only grass and unpalatable shrubs had ten times as much water-belly as herds on types containing shrubs that were palatable.

Four additional ranch units wintered steers on cultivated crops including cultivated hays and aftermath of legumes, together with small grain stubble. There was no water-belly among these 541 steers.

Eight ranches in the northern desert shrub-saltbush range of

Table 1. Range vegetational types in relation to the incidence of water-belly on selected ranch units in southeastern Montana; winters of 1954-55 and 1955-56.

Vegetational Types	Number of Ranch Units In Which Type Occurred	Number of Water-belly Cases In Herds	Total Number of Cattle In Herds	Percent Water-belly Incidence
Mixed grass—savannah deciduous trees and shrubs	2	1	198	0.51
Desert shrub (silver sagebrush) mixed grass—saltbush complex	5	3	400	0.75
Desert shrub-mixed grass transition (few palatable shrubs)	2	15	367	4.09
Ponderosa pine savannah-mixed grass	6	49	880	5.57
Mixed grassland	3	58	987	5.88
Mixed grass (predominantly)—desert shrub (big sagebrush) complex	3	42	619	6.78
Total	21	168	3,451	

Utah, carrying 876 steers through the fall and winter months, reported no water-belly. Most of the ranchers in that vegetational type range stated that they "have never seen a case of water-belly in cattle."

Range Condition and Water-belly Incidence

Range condition on the units studied was predominantly good (50 to 75%) condition (Dyksterhuis, 1949). Sixteen units had range in the good condition class, nine units had range in the excellent condition class, and only two units had range in the fair condition class. One unit was found to be on the line between good and excellent range condition. No units could be found where steers were carried through the fall and winter months on range that was in poor condition. Table 2 shows data on range condition and the incidence of water-belly on the ranches studied.

The water-belly incidence was slightly lower among cattle wintering on good condition range than on excellent condition range. There were a total of 61 cases of water-belly, or 4.66 percent incidence among 1,310 steers grazing on good condition range, while on excellent condition range there were 55 cases, or 5.13 percent among 1,073 steers. One ranch in fair condition reported no water-belly cases in 28 steers during the two years of the study.

It was noted that where steer cattle were wintered on range and where factors of management and range condition were rather constant, there were wide variations in the percentage of incidence of water-belly on a given ranch unit from one year to the next. This suggests the influence of factors other than range condition.

Range Site and Water-belly Incidence

Generally, cattle on the respective ranches studied were found to be grazing over several different range sites. Therefore, it was a problem to identify the disease directly with certain sites. Site classes of the kind that appeared to be less conducive to water-belly were quite limited in size and number.

In a few instances where overflow and saline upland sites were grazed independently of clayey and savannah sites, there was very little water-belly. On the other hand, where cattle grazed on clayey and savannah (pine) sites continuously in the fall and winter,

Table 2. Range condition in relation to water-belly on selected ranch units in southeastern Montana.

	Winter of 1954-55			Range Condition	Winter of 1955-56			Range Condition
Unit	Number Cattle	Water-belly Cases	%	%	Number Cattle	Water-belly Cases	%	%
I	65	11	16.9	91	—	—	—	—
S	21	6	28.6	87	15	2	13.3	87
U	70	0	0	85	70	1	1.4	85
Q	60	6	10.0	84	60	0	0	84
M	500	9	1.8	83	—	—	—	—
C	212	20	9.4	81	—	—	—	—
O	106	9	8.5	75	106	3	2.8	75
E	175	22	12.6	73	—	—	—	—
K	—	—	—	—	55	14	25.5	66
A	70	8	11.4	60	90	2	2.2	60
P	75	1	1.3	60	75	0	0	60
N	104	0	0	59	—	—	—	—
L	—	—	—	—	60	0	0	57
G	30	7	23.0	55	30	3	10.0	55
H	16	0	0	53	—	—	—	—
F	150	0	0	53	150	1	0.7	53
B	40	0	0	52	100	2	2.0	52
D	90	1	1.1	51	—	—	—	—
V	48	0	0	28	48	0	0	28
Total	1,832*	100	4.37	—	859*	28	3.26	—

*A total of 2,691 steer calves were included in this phase of this study.

Table 3. Incidence of water-belly in the winters of 1954-55 and 1955-56 on selected southeastern Montana ranches by range sites.

Site and Site Complexes	No. Ranch Units On Which Site Occurs	Water-belly Number Cases	Number Cattle	Water-belly Percent Incidence
Overflow	1	0	98	0
Thin breaks, clayey and overflow	1	0	16	0
Saline upland and clayey	1	0	110	0
Clayey	11	126	3,469	3.34
Clayey and saline lowland	1	5	144	3.47
Savannah	3	16	398	4.07
Clayey (predominantly) and overflow	2	11	235	4.66
Clayey, savannah and overflow	1	24	345	6.96

water-belly was common. (See Table 3.)

Sites which supported a rather homogeneous cover mostly of grasses or grasses and trees, to the exclusion of palatable shrubs and forbs, showed a higher incidence of water-belly during the study period of two years.

Cropland sites were not surveyed in detail, but it was observed that the incidence of water-belly in cattle on diversified cropland was very low compared to cattle on savannah and clayey sites.

Yearly and Seasonal Incidence of Water-belly

During the two winters of this study, a record was kept of the chronological incidence of water-belly. The data obtained were graphed by semi-monthly periods —1st to 15th and 16th to the last day of month (Figure 2.).

There were 2,350 head of cattle included in this record during the winter of 1954-55 and 3,140 head of cattle during the winter of 1955-56. One hundred thirty-two cases, or a 5.62 percent incidence occurred in the 2,350 cattle, while only 44 cases, or 1.40 percent incidence occurred in the 3,140 cattle in the winter of 1954-55. This difference presents a remarkable contrast between the two years.

There is also a remarkable contrast in the time of occurrence and the seriousness of the water-belly problem during the two winters (Figure 2.). Weather appears to have been a definite influence.

It is well known to the residents, and particularly to stockmen in the study area, that the winter of 1955-56 was much more severe than the winter of 1954-55. United States Weather Bureau records (1956) bear this out. This suggests consideration of two outstanding factors (1) water, and (2) feed, as affected by snow cover.

Colder weather is known to cause reduced intake of water by cattle (Winchester and Morris, 1950). Reduced intake of water has been associated with increased incidence of water-belly by many ranchers. Data obtained through this project is definitely contradictory to such a theory. Less water-belly occurred during the colder of the two winters when cattle supposedly drank less water.

The snow cover had a marked effect on the kind of feed available to cattle during these two winters. During the period November to January of the winter of 1954-55, snowfall was light. Most cattle grazed out on range and even were able to graze "short grasses". There was wide-spread selective grazing on threadleaf sedge by cattle during this winter. Mild weather reduced the normal supplemental feed requirement for this period.

The feed situation was quite different during 1955-56. A general snow fell on the range in the study area during the early part of November. "Heavy feeding was necessary following the cold wave of the 11th (November 1955) and

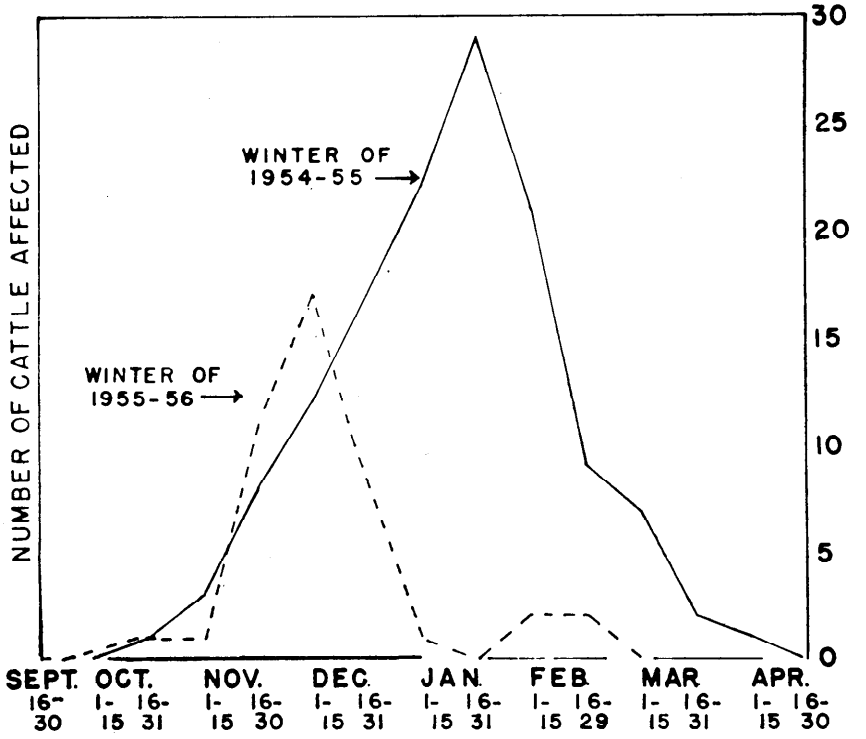

FIGURE 2. Yearly and seasonal incidence of water-belly in cattle on ranches studied in southeastern Montana during the winters of 1954-55 and 1955-56.

was continuous through the 30th". (U. S. Weather Bureau, 1956.) Many of the cattle were moved into ranch headquarters and given a maintenance feeding of supplemental forage. During the rest of this winter there was very little grazing on the shorter range species until about March 1, 1956. Most ranches had an abundant supply of supplemental forage, much of which was alfalfa or mixtures of alfalfa and grass hay, so there was more feeding than normal.

This fortunate combination of weather and resultant management practices furnishes evidence which strongly supports conclusions reached in other parts of this study—that grazing on mature, weathered grass is likely to cause water-belly in cattle. The "short grasses" appear to be more closely associated with the disease than the medium height species.

Water-belly in Relation to Minerals of Forage and Stock Water Samples

Chemical analysis of the samples of mixed range forage taken from the various ranches in this study were analyzed for phosphorus, calcium, magnesium, potassium, protein, and silica. These data are reported on a moisture-free basis.

There was a highly significant negative correlation between the amount of phosphorus, calcium, magnesium, and potassium in the forage and the incidence of water-belly. There was a highly significant positive correlation between the amount of silica in the samples and the incidence of water-belly in the steers. Table 4 shows the coefficients of correlation.

Water used by the cattle contained very little calcium, phosphorus, and silica. The contributions of these minerals to the grazing animals' diets from stock water was very small compared to that furnished by range and other forages. A steer would need to drink 1,000 gallons of water to acquire as much silica in its diet as it would get in one day from 30 pounds of range grass forage. The mineral content of water is not considered to be an important factor in the water-belly problem.

Table 4. The incidence of water-belly in relation to plant minerals: coeficients of correlation.[1]

	Incidence vs. Phosphorus	Incidence vs. Calcium	Incidence vs. Magnesium	Incidence vs. Potassium	Incidence vs. Silica
Linear	—.5546**	—.4899**	—.5657**	—.4769**	.5581**

**Significant at .01 level

[1] Statistical analysis was conducted by Montana State College Statistical Laboratory

The corollary study of mineral content of western wheatgrass, green needlegrass, bluebunch wheatgrass, needle-and-thread, Junegrass, Sandberg bluegrass, blue grama, and threadleaf sedge revealed some new and valuable information.

The trend in the mineral content of these species during the year varied seasonally and in a way which again suggests relationships to the water-belly problem. The silica content of all plants was high during the late fall and winter—the season of high water-belly incidence. The content of potassium, phosphorus, and magnesium particularly, was low during that same season. Calcium followed a somewhat modified path, but was high during the early part of the water-belly season.

The silica was by far the most abundant mineral found in the species sampled. Potassium ranked second to silica, followed by calcium, magnesium, and phosporus. These findings agree with those of Tobiska, *et al.*, (1937), except that in their study, phosphorus exceeded the magnesium. The trend in silica content by growth stages was similar to that found in annual plants in California ranges during the growing season, as reported by Gordon and Sampson (1939).

The November 13 samples were divided and half of each sample was washed to determine the amount of superficial (soil) silica burden. Washing reduced the silica in the samples about one-twentieth. The residue washed from the samples contained 48 percent silica.

Figure 3 shows the mineral content of the seven grasses and one sedge sampled by growth stages for one year.

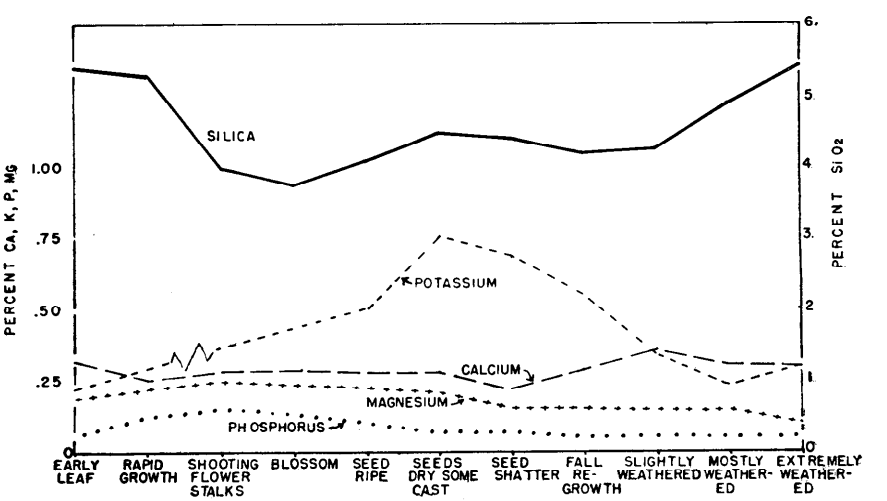

FIGURE 3. Minerals in seven grasses and one sedge, by growth stages for one year: western wheatgrass, bluebunch wheatgrass, blue grama, threadleaf sedge, Junegrass, Sandberg bluegrass, needle-and-thread, and green needlegrass. Samples collected near Ashland, Montana.

Figure 4 shows the mineral content of the two "short grasses", blue grama and threadleaf sedge, for one year (1954-55). The silica content of these two species was extremely high during the late fall and winter season, when there was a high incidence of water-belly in range cattle. The silica content of the important mid-grasses, western wheatgrass, needle-and-thread, and green needlegrass was lower and the content during the winter time was only 4.1 percent as compared to 7.6 percent for the so-called "short grasses."

More recent research work along this line by the Montana Agricultural Experiment Station indicates that range shrubs such as saltbush, winterfat, greasewood, silver sagebrush, and rabbitbrush have a very low content of silica at all times, usually less than one percent.

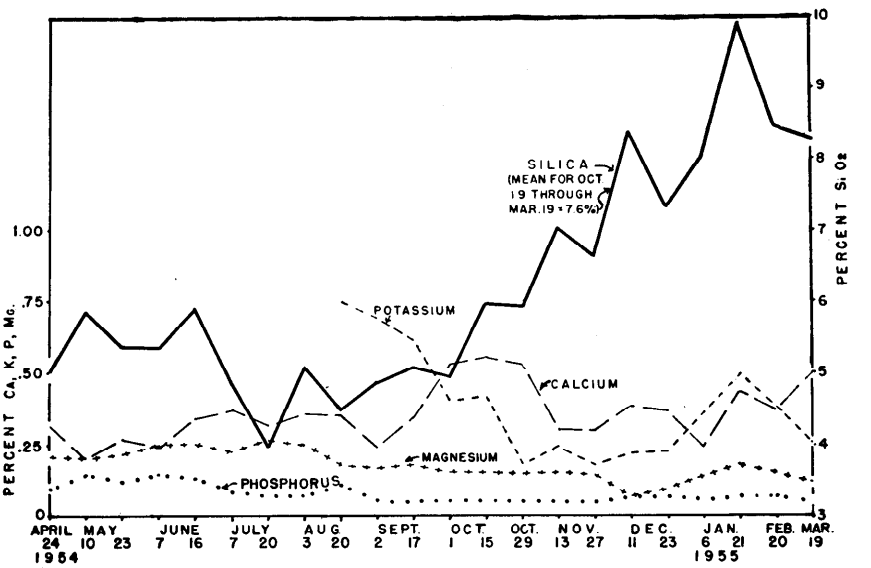

FIGURE 4. Minerals in two "short grasses"—blue grama and threadleaf sedge—for one year, 1954-55. Sampled near Ashland, Montana.

From these results, it appears that the practical cattlemen can avoid some of the losses due to water-belly by removing steers from native grass ranges as they dry up and moving the animals to range containing an abundance of palatable shrubs, legumes or green, immature grasses. Since many range areas, particularly in the Great Plains, have very little shrubby vegetation, planting fall pastures to grasses and legumes may offer some relief. Use of legumes and early cut grass hays to supplement range forage may also help reduce the incidence of this disease among steers on ranches where it is a problem.

Summary

Urolithiasis, or water-belly, is one of the greatest nutritional disease problems of the beef cattle industry.

This exploratory study was conducted for the purpose of developing a better understanding of the rangeland factors which affect water-belly, and to find a means of reducing losses due to water-belly of range steers. The relationships of range vegetational types, range condition and range sites, and the mineral content of range forages and stock water in relation to the seasonal incidence of water-belly were investigated.

Studies were made of twenty-five ranches in the southeastern one-fourth of Montana which lies in the 10 to 14 inch rainfall belt. Most of the area is considered to be within the mixed prairie association of the grassland formation. Comparable ranch units were studied in pairs.

There was less water-belly in steers on range containing palatable shrubs than on range containing only grasses, or grasses and unpalatable shrubs.

On ranches studied there were fewer cases per hundred steers of water-belly on good condition range than on excellent condition range.

Where overflow and saline upland sites were grazed independently of clayey and savannah sites, there was less water-belly.

The study of minerals in range forages and supplemental forages showed a strong positive correlation between silica content and water-belly incidence. The correlation was negative in the case of other minerals studied.

During the two years of this study, the seasonal incidence of water-belly in range cattle varied markedly. The difference in seasonal incidence in the two years and the difference in percentage incidence was attributed to a difference in availability of weathered range forage due to snow cover. It is believed that reduced intake of weathered range grasses, particularly blue grama and threadleaf sedge, because of heavy snow cover, and the consequent increase in the feeding of good quality hay, played a part in reducing the incidence of water-belly during the winter of 1955-56 compared to the previous winter.

In a one-year corollary study of range forage mineral content, seven important range species and one sedge were sampled on one ranch, at two-week intervals May through January and at monthly intervals February through April. All samples were analyzed for moisture protein, calcium, phosphorus, magnesium, potassium, and silica. A distinct annual trend in the amount of silica in these species was discovered. A high silica content of these plants in a weathered condition during the winter coincided with a high incidence of water-belly. Potassium, magnesium, and

phosphorus were higher in the summer and lower in the winter.

It is suggested that cattlemen can prevent some of the losses due to water-belly by making greater use of green fall pastures and legumes, by saving range with palatable shrubs for fall and winter pasture for steer calves, and by feeding legume and early cut hays to steers prior to and during the normal water-belly season.

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