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Locoweed Poisoning in Cattle: An Overview of the Economic Problems Associated with Grazing these Ranges

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LOCOWEED POISONING IN CATTLE: AN OVERVIEW OF THE ECONOMIC PROBLEMS ASSOCIATED WITH GRAZING THESE RANGES

by

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John E. Barnard

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ABSTRACT

Locoweed Poisoning in Cattle: An Overview of the Economic Problems Associated with Grazing these Ranges

by

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Locoweed poisoning, caused by ingestion of certain species of Astragalous and Oxytropis, has had serious economic impacts through a loss of productivity in livestock. This study has attempted to evaluate losses suffered by livestockmen grazing their cattle on areas infested with locoweed species. The results indicate a serious economic impact on these individuals.

Personal interviews were carried out with five cattle ranchers faced with typical locoweed problems. These beef cattle operations were located in Utah, Wyoming, and New Mexico. All of these producers described similar problems and losses due to locoweed poisoning. Information obtained from these interviews was used to estimate a 1978 dollar loss for three ranches, running in common, and located near Park Valley, Utah.

This study found the problem areas to be: (1) reduced weaning weights of calves; (2) increased requirements in the number of replacement heifers; (3) an increase in death loss; (4) reproductive problems (abortions and infertility); and (5) increased costs associated with labor and management problems. The summation of economic losses in each of these problem areas reflected a total estimated loss of $30,689.02 in 1978.

To determine if locoweed poisoning had long-range effects on weight gains, a sample of 20 calves were put on a 139-day feeding experiment. Of these 20 calves, 12 had grazed a locoweed-infested area, while the remaining 8 had no access to the plant. Overall average gain of both groups was found to be nearly identical. This indicates that animals will recover with proper but, sometimes, costly management.

Profitability of spraying locoweed-infested ranges with 2,4-dichlorophenoxy acetic acid (2,4-D) was determined through information supplied by the Wyoming rancher. An internal rate of return of 39.4 percent was found by using this method of locoweed control in this particular instance.

Ranchers interviewed in this study estimated their losses due to locoweed poisoning to be from 30 to 40 percent reduction in profit. Although profit margins were not determined, the estimated loss of $30,689.02 found in this study would be close to their determination. With the rampant increase in operating costs which have occurred in the past decade, producers could not long endure losses of this magnitude. However, it was determined that with proper plant control and management these losses could be substantially reduced.

(58 pages)

CHAPTER I

INTRODUCTION

Locoweed poisoning has been a problem of grazing western ranges since the first introduction of domestic animals to this area. Although the locoweed poisoning effects were recognized at this time, the Astragalus and Oxytropis genera were not isolated as the cause until 1906 (Marsh 1909). Certain species of these genera, which cause the poisoning, tend to be among the most troublesome of toxic plants.

Physical signs of locoweed poisoning are not readily evident when animals first graze locoweeds. An animal may even seem to thrive for a short time after eating the plant. Signs of poisoning can begin to appear after the animal has grazed the plant for three weeks but varies (James et al. 1969c). These signs include dullness, depression, neurological disturbances, emaciation, excitement when disturbed, and a loss of sense of direction (James et al. 1968). With continued grazing these symptoms become more severe and may even result in death.

The consequences of animals grazing locoweed result in a cost to livestock producers due to losses caused from poisoning. These consequences include (James 1972b):

1. Damage to the nervous system from which animals never fully recover. When stressed, these neurological disturbances will again become evident throughout the animal's life.

2. Varying degrees of emaciation with prolonged consumption of locoweed. There is a decrease in feed consumption and eventual recumbency associated with this problem.

3. With continued grazing of locoweed, animals become habitual consumers of it. If animals are removed from access to the plant at an early stage of intoxication, the recovery is rapid. However, if these animals are again introduced to the locoweed, they will readily graze the plant, sometimes even to the exclusion of other plants.

4. Reproductive disturbances also may result from excessive consumption of locoweed. Abortions may be expected to occur in a high percentage of the afflicted animals. Fertility problems and a resulting inability to conceive also are associated with this problem. Malformed, small, and weak offspring are sometimes born to poisoned dams.

5. If animals are allowed to graze the plant for an extended period, death can result.

6. Animals grazing locoweed-infested ranges require special care during and after the grazing season, increasing management costs.

Livestock producers faced with locoweed problems have incurred substantial economic losses due to the consequences of grazing the plant. Little research has been done on the economic aspects of locoweed poisoning. This study is designed as a preliminary investigation of the economic losses resulting from grazing rangelands where locoweeds are a problem.

Objectives

The general objective of this study is to document economic problems associated with grazing cattle on a locoweed-infested range in Northern Utah.

The specific objectives are:

1. Determine the loss resulting from marketing calves which are lighter than normal at weaning.

2. Find the loss incurred from an increased number of replacement heifers to replace severely poisoned cows.

3. Set a value on the average annual death loss due to locoweed poisoning.

4. Calculate the loss due to abortions and infertility in cows grazing on locoweed.

5. Estimate the costs of increased management problems associated with grazing locoweed.

6. Determine the extended effects of locoweed poisoning on weight gain of calves.

7. Calculate the profitability of locoweed control by spraying areas where the plant grows with 2,4-dichlorophenoxy acetic acid (2,4-D).

CHAPTER II

REVIEW OF LITERATURE

Practically all literature on the Astragalus and Oxytropis genera has been concentrated either on the physiological effects on poisoned animals or the taxonomy of the plants themselves. Very little literature was found on the economic aspects of locoweed poisoning or plant control. However, economics of the locoweed problem is directly related to conditions of afflicted animals and knowledge of taxonomic history of the genera.

Locoweed poisoning has been restricted primarily to states west of the Mississippi River. Locoweeds are toxic to all classes of livestock and are considered to be one of the most troublesome groups of poisonous plants on western rangeland. Poisoning effects from these plants have been observed since the introduction of livestock into this area and was first reported before 1873 (James 1972b). Although suspected, the Astragalus and Oxytropis genera were not experimentally incriminated until 1906 by C. D. Marsh (1909).

There are approximately 300 species of Astragalus in North America making this genus one of the largest in the legume family (Kingsbury 1964). Taxonomy of the Astragalus genus is complicated. However, Barnaby (1964) has thoroughly reviewed the distribution and classification of this genus. Astragalus species may be annuals, biennials, or perennials, while Oxytropis species are principally perennial. Both Astragalus and Oxytropis have a taproot and are herbaceous (Barnaby 1964).

Not all species of Astragalus are toxic. There are approximately thirteen species which produce locoweed poisoning when consumed, including A. lentigenosus, A. pubentissimus, O. sericea, and A. mollissimus (Kingsbury 1964). Some of these species are more toxic than others but all will produce the same toxic symptom when consumed in sufficient amounts. These toxic species grow throughout the West and have had a large economic impact on range livestock production (Nielsen 1978a).

Locoweeds are adapted to a wide variety of soil types with coarse soil fragments consistently associated with the occurrence and abundance of loco plants (James et al. 1968). Payne (1957) found that O. sericea grew in a wide range of soil depths. Some locoweeds are edemic to specific soils by unusual requirements for a specific nutrient. Such a requirement may restrict these taxa to an area of only a few acres.

Seeds of some Astragalus may retain their vitality for thirty to forty years and perhaps longer (Barnaby 1964), germinating readily when optimal ecological conditions exist and infestations frequently result. Heaviest infestations seem to occur after wet, warm autumn seasons. Marsh (1909) observed that locoweeds were frequently abundant in high rainfall years but nearly disappeared during dry years. Apparently, factors other than moisture are involved in germination since some species become epidemic only if temperature, as well as moisture, is optimal (James et al. 1968).

Once species of Astragalus and Oxytropis were proven to be the cause of locoweed poisoning, there has been much effort to isolate the toxin. Some of the suspected toxic agents have been barium (Crawford

1908), selenium (Trelease and Beath 1949), and locoine (Fraps and Carlyle 1936). James and Keeler (1971) suggested a relationship between locoism and lathyrism. The research showed many similarities between the teratogenic and abortifacient consequences in locoism and lathyrism but also produced many different signs. Therefore, their data cannot unequivocally incriminate a lathyritic mechanism in the loco effect. The identity of the toxic agent is still unknown.

Loco plants are generally considered unpalatable to domestic livestock (Marsh 1909). However, when range conditions are poor or stress conditions exist, animals will readily graze the plant. Some species, such as A. pubentissimus, continue to remain green when other plants have dried (James 1972b), compounding grazing problems. Mathews (1932) found that the locoweeds do not lose their toxicity on drying.

Once livestock begin to eat loco plant, they become habitual consumers of it (Marsh 1929). After the habitual effect has taken place, animals will often graze locoweed to the exclusion of other more desirable forage. Habituation is not alleviated by moving animals to areas free of locoweeds. When removed from accessibility to the plant, an animal, once poisoned, will graze it again at the first opportunity, even when it has been unavailable for long periods. Personal interview with ranchers indicated animals poisoned in previous years were the first to become poisoned in successive years. Marsh (1929) suggested some animals acquire the habit by observing other livestock grazing locoweed.

When animals first graze the loco plant, they may seem to thrive for a period of time. However, since the toxic material in the loco

plant has a cumulative effect, physical signs of poisoning do not appear until considerable damage has been done to the animal (James et al. 1968). Mathews (1932) indicated poisoning signs in animals fed A. earlei occurred after about sixty days of consumption. James (1972b) reported that an animal might eat the plant for up to three to four weeks before signs of poisoning are observed. This time period can vary considerably depending on species and amount consumed by individual animals, especially under range conditions. For cattle, consumption of about 90 percent of the animal's body weight is required to produce the first visible signs, while consumption of 320 percent of the animal's weight will produce death when fed A. earlei or A. wootonii for eighty to one hundred days (Mathews 1932).

Classical symptoms of locoweed poisoning listed by Marsh (1909) include a slow staggering gate, rough coat, staring look, emaciation, recumbency, a muscular incoordination, and extreme nervousness. Eventual loss of appetite and subsequent emaciation will occur with prolonged consumption of the plant. This could be due to histologic changes in thyroid glands, intestine, liver, pancreas, and brain (Van Kampen and James 1969). Afflicted animals have been reported to have problems consuming water, sheep doing so with a stiff chewing motion (James et al. 1969b). Mathews (1932) found that an accumulation of amniotic fluid in the amniotic sac, known as "water belly," was common. Animals removed from all access to the loco plant will again regain their appetite and recover from outward signs of poisoning, except those associated with the nervous system (James et al. 1969c). Once an animal has ingested toxic levels of

a locoweed, extreme nervousness and erratic behavior may become evident whenever the animal is stressed throughout its life.

Protein, minerals, and other concentrated supplementations have not proven effective in preventing or alleviating toxic effects of locoweeds. Mathews (1932) indicated that cattle fed high concentrate rations along with locoweed actually showed signs of toxification at an earlier time. James and Van Kampen (1974), in a similar experiment, suggested that a high protein and mineral ration fed with A. wootonii reinforced the action of the locoweed toxin. Dietary supplementation also failed to prevent abortions and congenital malformation in sheep fed A. lentiginosus along with supplements (Keeler and James 1971).

Abortions can be caused from locoweed consumption even though physical signs are not evident. Sheep fed locoweed have aborted as early as ten days or as late as the fifty-fifth day of gestation (James 1976). As much as 60 percent of a herd of ewes has been reported to abort due to loco poisoning. Cattle ranchers interviewed reported that their abortion rate was much higher than normal in herds grazing areas where locoweeds abound. Mathews (1932) reported that cattle which aborted due to loco poisoning had a normal gestation when bred again when locoweed was not available.

According to Mathews (1932), sexual desire in the bull and estrus in cows were suppressed about the time toxic symptoms appeared and remained suppressed as long as the animal continued to eat the plant. Van Kampen and James (1971) stated that reproductive disorders in rams and ewes from ingesting A. lentiginosus included cessation of spermatogenesis in the ram and of oogenesis in the ewes. Personal observations and

interviews with cattle ranchers showed that fertility was affected in herds grazed on locoweed-infested areas. The calving seasons tend to last much longer than normal in herds grazing on locoweed during the breeding season, indicating irregular estrus cycles in the cattle.

Small, weak, and sometimes deformed offspring are born to locoweed-poisoned dams. James (1976) observed that the poisoning effects on the fetus parallel that of the dam. The incidence of birth defects associated with locoweed poisoning is difficult to assess because they are quite like other commonly occurring problems, such as contracted tendons in the ankles and carpel joints (James et al. 1969a), but the incidence is considered to be low. The ability of offspring from locoweed-poisoned dams to survive is hampered, due possibly to changes in internal organs (James 1972a). The offspring may recover with proper care but are of less economic value because of poor condition and lighter weights.

Mathews (1932) concluded that the locoweed toxin does not pass into the milk of lactating cows fed locoweed. However, all ranchers interviewed believed that calves could become poisoned from nursing cows grazing locoweed. James and Hartley (1977) determined that the toxin in locoweed is secreted in the milk. In their experiment, calves nursing cows fed A. lentiginosus showed signs of locoweed poisoning although calves had access to toxin only through the milk.

Payne (1957) concluded that O. sericea was a typical "increaser" on range grazed by domestic livestock. As a range area deteriorated in condition because of heavy grazing pressure, the density of this species increased. Blankinship (1903) noted that the existence of viable seeds

in the soil insures that locoweed will be one of the first plants to become re-established after livestock are removed from an overgrazed area.

In discussion of possible control methods, Blankinship (1903) recommended grubbing as a means of control. A four-section area cleared of O. sericea in 1902 showed no new plants in 1903, although the author expected that eventually some new plants would arise from seed stored in the soil. When collecting and grubbing A. earlei and A. wootonii, Mathews (1932) noted that the dust from these plants was very irritating to the eyes and upper respiratory tract of man. He, therefore, recommended that prolonged exposure to the dust from this source should be avoided.

Spraying locoweed-infested areas with 2,4-dichlorophenoxy acetic acid (2,4-D) seems to be the most logical method of control at the present time. An interview with a Wyoming rancher, using this herbicide to control locoweed, indicated an increased carrying capacity of one third after spraying due to a reduction in the loco plants and an increase in desirable forage. The original estimate of the life of this spraying project was three years, but it is now being projected as ten years or more.

Where control of the loco plant is not practiced, prevention of poisoning has been the most realistic method. Preventative measures suggested by Marsh (1916) include: the use of range when poisonous plants are least poisonous or least palatable, provide abundant feed to reduce consumption of poisonous plants, and use care in the management of animals new to the range. James et al. (1968) also warned against

introducing hungry animals into areas infested with poisonous plants and the use of extreme care in grazing animals near watering places because poisonous plants are often abundant near isolated watering locations. The above recommendations are especially applicable to the loco plants as once consumption begins livestock become habitual consumers of the plant, and the initial ingestion should, if possible, be avoided.

At the present time, the only treatment for locoweed poisoning is to remove the animal from infested areas. However, since neurological disturbances result from locoweed poisoning, the afflicted animals are easily disturbed and hard to handle (James et al. 1969b). Attempts to move poisoned animals should be done with care and may prove harmful.

Locoweed has had severe economic impacts on livestock production. Nielsen (1978a) cited the following examples of economic losses to livestock producers due to locoweed. In 1958, over 6,000 sheep were killed on locoweed in the Uintah Basin of Eastern Utah. In 1964, one rancher lost $125,000, another rancher lost $55,000, and a third rancher lost $65,000 worth of sheep to locoweed poisoning. All ranchers interviewed believed their losses due to locoweed poisoning were from 20 to 40 percent of profit.

In summary, it should be noted that the literature dealing with locoweeds typically repeats information appearing in earlier papers; information frequently based on observations or opinions along with experimental data.

CHAPTER III

METHODS OF PROCEDURE

Overview

Information obtained from ranchers in New Mexico, Wyoming, and Utah was used to evaluate the decreased producticity in cattle grazing on locoweed-infested ranges (Nielsen 1978b). All of the ranchers reported similar problems and losses associated with grazing this plant. A combination of information and data from all of these sources was used to estimate economic loss in 1978 for Utah ranchers.

The Study Area

Three cattle operations in Park Valley, Utah, were studied to determine losses in productivity caused from locoweed poisoning. Cattle belonging to the three producers are grazed in common throughout the grazing season. The grazing area is in two portions, being adjacent to each other, and located in a mountain range north of Park Valley. One range area is privately owned by the ranchers, while the other is administered by the United States Forest Service.

The privately owned area is typical of Intermountain summer rangeland. There is not a locoweed problem in this area, but existence of larkspur (Delphinium) species has caused problems. At the present time, the range is under an improvement program through a reduction in stocking rate.

On May 20, 1978, 855 cows were allowed to graze this area. On July 6th, 394 head of cows were removed and driven onto the higher adjoining area administered by the U. S. Forest Service. This area has a serious locoweed problem, specifically Oxytropis sericea nutt. (white pointloco). The cattle grazed this area for sixty-five days. During this period, many animals were to be severely poisoned. Most of these afflicted animals had to be removed from the area before termination of the grazing season. On September 10th, all cattle were driven off this allotment and back onto private land. The entire herd again grazed the private range area until weaning time. One rancher removed his animals on September 29th, while the remainder of the herd was removed by October 15th.

Measurement of Weaning Weights

On October 11th, a random sample of calves was separated from the herd. This sample consisted of twenty-eight head which had grazed the locoweed area and twenty head which had remained on the private range. Each animal was weighed, sex noted, and birth dates estimated by ranchers (Tables 1 and 2).

Gain per day for each animal was found (weight ÷ age in days = gain per day). Average weight, age, and gain per day for both groups were determined. Since age of the calf was the greatest variable, all weights were adjusted to a standard 205-day weaning weight. The equation which accomplished this is (Ensminger 1978):

TABLE 1

ADJUSTED 205-DAY WEANING WEIGHTS FOR CALVES ALLOWED TO GRAZE LOCOWEED
(In Pounds)

Calf Number	Actual Weaning Weight	Age in Days	Adjusted 205-Day Weaning Weight
1	400	218	392
2	330	179	368
3	550	300	398
4	360	210	353
5	315	210	309
6	430	238	380
7	405	210	397
8	425	270	339
9	470	270	374
10	425	270	339
11	430	238	380
12	310	148	402
13	460	270	366
14	285	300	217
15	240	210	236
16	375	210	368
17	295	179	328
18	425	210	416
19	255	179	282
20	385	210	377
21	325	210	319
22	260	179	287
23	285	179	316
24	320	210	314
25	370	210	363
26	325	210	319
27	350	210	343
28	275	179	305
Total	10,080		9,587
Average	360	218.14	342.4

TABLE 2

ADJUSTED 205-DAY WEANING WEIGHTS FOR CALVES NOT ALLOWED TO GRAZE LOCOWEED (In Pounds)

Calf Number	Actual Weaning Weight	Age in Days	Adjusted 205-Day Weaning Weight
1	310	179	345
2	590	300	425
3	300	179	333
4	260	179	288
5	365	210	358
6	330	210	324
7	260	148	333
8	430	210	421
9	315	179	351
10	335	179	373
11	365	210	358
12	320	148	416
13	550	330	368
14	485	330	328
15	335	148	437
16	385	210	378
17	435	210	426
18	290	210	285
19	420	238	371
20	340	210	334
Total	7,420		7,252
Average	371	210.85	362.6

$$\text{Adjusted 205-day weight} = \left(\frac{\text{actual weaning weight} - 70 \text{ lb. birth weight}}{\text{actual weaning age in days}}\right) \times (205 \text{ days}) + 70 \text{ lb. birth weight}$$

where the 70 lb. birth weight is an assumed constant. The average 205-day weaning weight for both groups was then calculated (see Tables 1 and 2). The difference in average weight between the group allowed to graze the plant and the group which did not have the opportunity is considered the loss in weaning weight from locoweed poisoning.

An analysis of variance was used to determine significance in differences between average adjusted weaning weights of the two groups. This was accomplished with the following formulation (Ott 1977):

Null and alternative hypothesis:

H_o: $\mu_1 = \mu_2$

H_a: one population mean differs from the other

where

n_1 = size of sample 1; animals which had an opportunity to graze locoweed

n_2 = size of sample 2; animals which had no opportunity to graze locoweed

n = total sample size

T_1 = total sum of sample 1

T_2 = total sum of sample 2

$G = T_1 + T_2$ sum of all sample measurements

Using the sample measurements, the total sum of squares is, TSS

$$TSS = \sum_i \sum_j y_{ij}^2 - \frac{G^2}{n}$$

The sample totals can be used to compute the sum of squares between samples, SSB

$$SSB = \sum_i \frac{T_i^2}{n_i} - \frac{G^2}{n} .$$

Then, the sum of squares within samples is, SSW

$$SSW = TSS - SSB .$$

The computed F test value is then found with an analysis of variance table (AOV):

TABLE 3
ANALYSIS OF VARIANCE

Source	Sum of Squares	Degrees of Freedom	Mean Square	F-Test
Between samples	TSS	$df_1 = 1$	TSS/df_1	$\frac{TSS/df_1}{SSW/df_2}$ = F-Test
Within samples	SSW	$df_2 = 2$	SSW/df_2	
Totals				

This computed F-value is then compared to a tabulated critical F-value where $\alpha = .05$ (indicating rejection region), $df_1 = 1$, and $df_2 = 46$. Either the null or alternative hypothesis is then accepted through the above computation.

From interviews with the various ranchers, a calf crop of 75 percent was estimated in cows grazing the locoweed-infested area. Number of calves produced by this percentage, times the adjusted average weaning weight for calves allowed to graze the plant, times a price of $70 per cwt gives an estimated return. It is assumed that, without the locoweed problem, these calves would have been weaned at the same average weight as calves not allowed to graze the plant. By using the previous procedure, with the heavier weaning weight, another return was

determined. The difference between these two returns is the estimated cost due to weaning weight loss in calves grazing locoweed.

Increase in Replacement Heifers

From information received through personal interviews with ranchers, a 5 percent increase in the number of replacement heifers was noted. Producers are reluctant to keep heifers in their breeding herds which had previously consumed locoweed. For this reason, the determination of loss, caused from an increase in replacements, will be estimated from heifers which had no opportunity to graze the plant.

The locoweed-infested area had 394 cows grazing it. Using a reduced 75 percent calf crop, number of calves produced was estimated. This analysis was done with no replacements kept from this group. The private range area had 461 cows grazing it. A 90 percent normal calf crop was assumed to estimate the number of calves produced from cows having no access to locoweed. Through combining the two calf crops, approximate total number of calves produced is known. Assuming that one half of these calves are heifers and there is a 5 percent increase in replacements, the extra number of heifers kept can be found. Without locoweed problems, these calves could have been sold. Therefore, loss due to an increase in replacement heifers would be the cost incurred by not marketing these animals. This cost was found by multiplying the increased number of replacements by the average weaning weight of calves not grazing locoweed by $70 per cwt.

Death Loss

Cost resulting from death loss was estimated from personal interviews. Ranchers reported varying amounts of death loss from year to year. For example, Utah ranchers noted that in 1977 the loss from locoweed was three cows and twenty-three calves, while in 1978 they lost only seven calves. Therefore, the average of these two years was used to determine the loss incurred from this problem.

Without locoweed problems, these calves could have been sold at the heavier average weaning weight. Using a $70 per cwt sale price, the three factors were multiplied together to estimate a dollar loss through calves dying.

A long-term (20-year) average for the value of a breeding cow was found. This value times average number of cows dying annually gives the estimated loss in cows.

Combining the cost incurred from calves dying and the value found for mature cows lost gives the estimated cost due to deaths in animals consuming locoweed.

Abortions and Fertility Problems

The ranchers in Utah indicated a 15 percent reduction in calf crop due to locoweed poisoning. Under range grazing conditions, it is difficult to determine which cows had aborted their calves and those which did not conceive. All females were vaccinated for leptospirosis and vibriosis annually so reproductive problems from these sources should not be present. For every open cow, there is one calf lost that could have been sold at weaning age.

Multiplying the number of cows in the locoweed area by the resulting 15 percent reduction in calf crop gives an estimated number of calves lost to reproductive disorders. It is assumed that these calves could have been sold at the heavier weaning weight and a sale price of $70 per cwt. The resulting loss then is found by multiplying these factors.

Management Problems

All of the ranchers interviewed indicated increased costs through extra management problems incurred when grazing locoweed-infested ranges. These include supplemental feeding and care, increase in labor, and decreases in forage utilization. There was no information available from this study to determine the costs of these problems. However, it was noted that if these poisoned animals were sold without using these management practices, an average price discrimination of 2.5 cents per pound resulted. This price discrimination was used to reflect the cost of the management problems.

From data, interviews, and observations, it was estimated that approximately 40 percent of the herd grazing locoweed would show enough physical symptoms of poisoning to be discriminated against. By using a reduced calf crop to 75 percent and multiplying the result by the 40 percent affected, number of calves discriminated against was estimated. These calves would be sold at the lighter average weight of the herd grazing locoweed. Therefore, lighter weaning weight, times number of calves affected, times price discrimination gives the estimated dollar loss.

Summing losses found from each problem area results in an approximate total loss incurred through grazing range where locoweed exists.

Extended Adverse Effects on Weight Gain

A total of twenty calves, twelve suspected of being poisoned from the locoweed toxin and eight which had no access to the plant, were put on a 139-day feeding trial. The experiment began November 23, 1978 and ended April 11, 1979.

On arrival, animals were numbered, identified with an ear tag, and weighed. Blood tests also were taken at this time. Animals were weighed at two-week intervals thereafter until conclusion of the experiment.

At the beginning of the trial all animals were fed free-choice alfalfa hay. On December 8, the ration was altered to include one pound per day per head of a 14 percent protein dairy concentrate mix and eleven pounds per head of alfalfa hay. On December 23, the concentrate was increased to two pounds per head and eleven pounds of hay per head. On January 23, grain was increased to three pounds with the hay ration remaining at eleven pounds. On April 2, the ration was increased to 15.5 pounds of hay with three pounds of grain and remained at this level until conclusion of the experiment on April 11.

At the end of the trial, total gain and gain-per-day for each animal was found. Averages from both groups were compared to determine if poisoned animals suffered long-range adverse affects on weight gains (Tables 3 and 4).

TABLE 4

GAIN IN CALVES ALLOWED TO GRAZE LOCOWEED (In Pounds)

Calf Number	Weight at First Weighing (11/23/78)	Weight at Final Weighing (4/11/79)	Total Gain	Gain/ Day
69	320	522	202	1.45
70	320	467	147	1.06
71	240	413	173	1.24
73	300	481	181	1.30
74	340	544	204	1.47
76	290	492	202	1.45
77	320	457	137	0.99
81	285	445	160	1.15
82	485	711	226	1.63
85	250	410	160	1.15
86	250	426	176	1.27
87	255	415	160	1.15
Average	304.58	481.92	177.33	1.28

TABLE 5

GAIN IN CALVES NOT ALLOWED TO GRAZE LOCOWEED (In Pounds)

Calf Number	Weight at First Weighing (11/23/78)	Weight at Final Weighing (4/11/79)	Total Gain	Gain/ Day
68	295	472	177	1.27
72	305	507	202	1.45
75	280	447	167	1.20
78	315	460	145	1.04
79	285	432	147	1.06
80	285	518	233	1.68
83	360	526	166	1.19
84	360	531	171	1.23
Average	310.63	486.63	176.00	1.27

Locoweed Control

Information obtained from an interview with a Wyoming cattle rancher was used to estimate benefits received from spraying locoweed problem areas with 2,4-D. This rancher noted improvements in his ranch operation after the spraying project was completed. He estimated that, before spraying, an annual loss of $15,000 resulted due to locoweed. Costs of the spraying project also were given.

An internal rate of return was estimated with the following formula (Nielsen 1967):

$$I = R\left[\frac{1-(1+i)^{-n}}{i}\right]$$

where

I = initial cost of spraying

R = expected annual benefit (loss due to locoweed)

n = number of years that benefits will last

i = internal rate of return (the unknown).

The resulting internal rate of return is compared to an assumed normal rate of return on investment of 10 percent to determine profitability of spraying a project such as this.

Utah ranchers estimated their cost of spraying would be 48 percent greater than the Wyoming rancher's was. To relate this higher cost to their situation, another internal rate of return, using the same data with the higher cost, was estimated and compared to a norm of 10 percent.

CHAPTER IV

RESULTS AND DISCUSSION

An attempt was made to estimate the economic losses incurred from grazing cattle on locoweed-infested ranges. It must be noted that the following results were determined from data gathered with very little control and personal interviews with ranchers faced with locoweed poisoning problems. Since this study is intended to be a preliminary investigation to the economic impact of grazing locoweed, estimates were made from the available data and information in order to introduce the economic severity of the problem.

Weight Loss in Calves

Age-of-calf was the greatest variable in determining differences in weight between calves from cows that were grazed on locoweed-infested ranges and those which were not. The calves had the opportunity to graze the same areas as their mothers. Therefore, the following equation was used to set all calves weaning weights at the same 205-day weaning basis (Ensminger 1978):

$$\text{Adjusted 205-day weight} = \left(\frac{\text{actual weaning wt. - birth wt. of 70 lbs.}}{\text{actual weaning age in days}}\right) \times (205 \text{ days}) + \text{birth wt. of 70 lbs.}$$

where the birth weight of 70 pounds is an assumed constant. At weaning, calves on the locoweed-free area averaged 20.2 pounds heavier than those associated with the locoweed-infested area (Tables 1 and 2).

All ranchers interviewed reported reduction in weaning weights much higher than this. A Wyoming rancher estimated his locoweed-poisoned calves were as much as 50 pounds lighter than normal. The Park Valley ranchers indicated the 1978 grazing season produced fewer toxic symptoms than previous years. Therefore, an analysis of variance was used to statistically determine if there was a difference in the mean 205-day adjusted weights of the two groups of calves. The analysis was determined with the following procedure from data in Tables 1 and 2.

Null and alternative hypotheses:

H_o: $\mu_1 = \mu_2$

H_a: one population mean differs from the other

Sample sizes:

$n_1 = 28$; $n_2 = 20$

Total sample size of $n = 48$

Total of the two groups (Tables 1 and 2):

$T_1 = 9,587$

$T_2 = 7,242$

Sum of all sample measurements:

$G = T_1 + T_2 = 16,839$

Total sum of squares for both groups:

$$TSS = \sum_i \sum_j y_{ij}^2 - \frac{G^2}{n}$$

$$TSS = (392)^2 + (368)^2 + \ldots + (334)^2 - \frac{16,839^2}{48}$$

$$TSS = 6,013,619 - 5,907,331.7$$

$$TSS = 106,287.3$$

Population totals can then be used to compute the sum of squares between samples:

$$SSB = \sum_i \frac{T_i^2}{n_i} - \frac{G^2}{n}$$

$$SSB = \frac{9,587^2}{28} + \frac{7,252^2}{20} - \frac{16,839^2}{48}$$

$$SSB = 3,282,520.3 + 2,629,575.2 - 5,907,331.7$$

$$SSB = 4,763.82$$

Then, the sum of squares within samples is:

$$SSW = TSS - SSB$$

$$SSW = 106,287.3 - 4,763.82$$

$$SSW = 101,523.48$$

The computed analysis of variance table (AOV) for these data shows:

TABLE 6

ANALYSIS OF VARIANCE COMPUTATION

Source	SS	df	MS	F
Between samples	4,763.82	1	4,763.82	4,763.82/2,207.03 = 2.15
Within samples	101,523.48	46	2,207.03	
Totals	106,287.30	47		

The tabulated analysis of variance table for these data shows (Ott 1977)

$$F = 4.06 \quad \text{when:} \quad \alpha = .05,\ df_1 = 1, \text{ and } df_2 = 46$$

Since the tabulated value of F = 4.06 exceeds the calculated F = 2.15 value, the null hypothesis of equality of the mean scores for the two groups must be accepted. Therefore, it cannot be conclusively

stated that the 20.2 pound average weight difference between the two groups is significant or due to locoweed poisoning.

It should be noted that these data were taken as a random sample from the entire herd grazing the locoweed-infested area. Since consumption habits of individual animals varies greatly, some animals become more severely poisoned than others and would probably have a lighter weaning weight than calves with a lower consumption of the plant. Also, average weaning weights of calves not grazing the locoweed range were lighter than normal. This could be due in part to the fact that calves from both groups could have been born from dams which had grazed the locoweed area during the previous year, affecting their performance to gain weight. Data obtained coincides with previous literature on the subject. Effects of locoweed poisoning are dependent upon the amount of consumption and varies with individual animals. Therefore, animals which were severely poisoned would be lighter than animals which consumed moderate amounts of locoweed, thereby influencing average weaning weights. Also, age-of-calf was the greatest variable in these data. This is due to the fact that age was estimated by ranchers rather than determined through record keeping.

Although the statistical computation shows no significant difference between the mean of the two groups, a mathematical computation of the dollar value difference is quite significant. Previous literature and interview information indicates weaning weight loss to be one of the primary concerns in locoweed poisoning. Since the intention of this study is to determine an overall economic loss, the calculated 20.2 pound average weight difference will be used.

Economic Loss Due to Lighter Weaned Calves

The adjusted average weaning weight of calves grazing the uninfested area was 362.6 pounds (Table 2) when adjusted to a 205-day standard. Average weights of calves grazing locoweed, on the same 205-day standard, was 20.2 pounds lighter or 342.4 pounds (Table 1).

During the 1978 grazing season, 394 cows utilized the range area where locoweed was present. All ranchers indicated a reduction in percentage calf crop due to locoweed poisoning. A New Mexico rancher reported his calf crop was reduced from 91 percent to 81 percent after invasion of locoweed. Park Valley, Utah ranchers estimated their calf crop to have been reduced by at least 15 percent for cows grazing locoweed. Using a norm calf crop of 90 percent and a reduction to 75 percent for the 394 cows in the locoweed area, there would be a production of 295 calves.

Usually replacement heifers would be deducted from these calves. However, livestock producers are reluctant to keep heifers that had previously consumed locoweed. Therefore, the analysis will be determined as if all 295 of these calves were sold.

The price received for weaned calves in the autumn of 1978 was approximately $70 per cwt ("Commodity Price Report" 1978). By selling these 295 calves at this price, with an average weaning weight of 342.4 pounds, there would be a return of $70,705.60:

$$(295 \text{ calves})(342.416)(\$70/\text{cwt}) = \$70,705.60 .$$

Without locoweed problems, it can be assumed that this reduced number of calves would have been sold at the same weight as calves not

allowed to graze locoweed, or 362.6 pounds average. These 295 calves would then return $74,876.90:

$$(295 \text{ calves})(36.616)(\$70/\text{cwt}) = \$74,876.90 .$$

The difference would approximate the costs of weight losses in calves grazing the locoweed range, or $4,171.30:

$$(\$74,876.90 - \$70,705.60 = \$4,171.30) .$$

Increase in Replacement Heifers

Livestock producers reported that severely poisoned cows had to be sold. This results in a higher number of replacement heifers needed to keep the herd size constant. Cows replaced would be sold at a lighter weight than normal because of poisoning. One rancher indicating that the approximate average weight of these poisoned cows was 770 pounds, whereas their normal weight would approximate 1,000 pounds.

Although poisoned cows and heifers would recover and conceive again, ranchers are reluctant to keep heifers in their herd once they have been poisoned. Since locoweed consumption has a habitual effect, cattle once poisoned will readily graze the plant again at the first opportunity. Ranchers attempt to utilize replacement heifers from herds that have not had access to locoweed.

Economic loss from an increased number of replacement heifers

Ranchers interviewed estimated a 5 percent increase in the number of replacement heifers due to the locoweed problem. The locoweed

infested area had 394 cows grazing in it. With an assumed 75 percent calf crop, this results in 295 calves, of which none would be kept as replacements. The adjoining area, without locoweed problems, had 461 cows grazing it. With an assumed 90 percent calf crop there would be 415 calves produced. All replacements would be taken from this section of the herd. The total number of calves then is 415 plus 295, or 710. It is assumed that 50 percent of these would be heifers. This means that with a 5 percent increase in replacements, 18 calves must be kept that could otherwise be sold. The 18 calves at an average weaning weight of 362.6 pounds, sold at $70 per cwt would give a loss of $4,568.76 to the producers:

$$(18 \text{ calves})(362.616)(\$70/\text{cwt}) = \$4,568.76 \ .$$

It is estimated that 18 poisoned cows will be culled and replaced with heifers. From one of the interviews it was noted that severely poisoned cull cows were sold at an average weight of 770 pounds, 330 pounds less than normal. Therefore, there also is a loss in selling these cull cows amounting to $1,782:

$$(18 \text{ cows})(330 \text{ lbs less})(\$30/\text{cwt}) = \$1,782 \ .$$

The total loss from an increased number of replacement heifers would then amount to $6,350.76:

$$(\$4,568.76;\text{calves} + \$1,782.00;\text{cows}) = \$6,350.76 \ .$$

Death Loss in Cows and Calves

If consumption of locoweed is excessive, death can occur. Mathews (1932) indicated that consumption of Astragalus earlei, equal to 320 percent of the animal's weight, will produce death. The amount of consumption of locoweed is dependent on range condition, environmental factors, and individual consumption habits of animals. Therefore, the number of death losses in a particular herd can vary greatly from year to year.

Varying levels of death loss was found. A New Mexico rancher reported his normal death loss was 1.5 percent but was increased to 5 to 8 percent in herds grazing locoweed. Figures obtained from ranchers in Park Valley, Utah showed that in 1977 their death loss due only to locoweed was three cows and twenty-three calves. These ranchers also indicated that in some previous years their death loss was much higher than this. In 1978, their death loss from this plant was estimated to be only seven calves. The data suggests that consumption of locoweed can vary from year to year. Also, the amount of death loss is dependent on management practices. If calves observed to be severely poisoned are removed from access to the plant immediately, they will not die.

Economic loss due to death loss

Since the amount of death loss varies considerably, an average for two years will be used. The average death loss for 1977 and 1978 then would be 1.5 cows and fifteen calves in the Park Valley area.

The average of fifteen calves could have been sold at an average weaning weight of 362.6 pounds had locoweed not been a factor. Had these calves been sold at $70 per cwt, the resulting loss is $3,807.30:

$$(15 \text{ calves})(363.316)(\$70/\text{cwt}) = \$3,807.30 .$$

Assuming the long-term (twenty-year) average value of breeding cows is $250 per head (Nielsen and Cronin 1977), the 1.5 average death loss of cows would produce an average annual cost of $375.

The total value of death loss incurred from grazing locoweed would be the sum of these, or $4,182.30:

$$(\$3,807.30;\text{calves} + \$375;\text{cows}) = \$4,182.30 .$$

Abortion and Fertility Problems

As with other problems caused from locoweed, the number of abortions plus cows unable to conceive also is related to the amount of consumption of the toxic plant. Under range grazing conditions it is difficult to determine which cows aborted and which did not conceive. Ranchers indicated that there was a reduction in calf crop from 10 to 20 percent in herds where locoweed was available. The reduction in calves due to the extra number of open cows will be used to estimate losses from reproductive problems.

Fertility disorders associated with grazing locoweed have the greatest economic impact. The New Mexico rancher reported that, in 1975, 106 cows known to be poisoned from locoweed produced a 41 percent calf crop. He also reported that, in 1978, forty-two locoed cows produced twenty-six calves for a 62 percent calf crop. The Wyoming

rancher interviewed indicated that, with the locoweed problem, twenty to thirty mature cows could be open; whereas without the locoweed problem, this was reduced to two open cows. The ranchers in Utah estimated at least a 15 percent reduction in their calf crop due to locoweed.

Extended breeding seasons due to effects on fertility also is a problem. The Wyoming rancher had sixty to seventy-five calves born after the normal calving period. Another rancher noted that 75 percent of locoed cows would pass at least one heat period. As can be seen from Tables 1 and 2, the Park Valley ranchers had an abnormally long calving period. Calves were born over a period of 162 days. This results in extra management costs to maintain the breeding herd and the sale of lighter or nonuniform weight calves in the fall.

Economic Loss from Reproductive Problems

Although an exact figure for the reduction in calves could not be obtained, the approximate reduction can be used to estimate the loss from reproductive problems. If the calf crop of the 394 cows grazing locoweed was reduced by 15 percent, there is a resulting loss of fifty-nine calves. These fifty-nine calves could have been sold at an average weaning weight of 362.6 pounds. Using the sale price of $70/cwt, this loss would amount to $14,975.38:

$$(59 \text{ calves})(362.6)(\$70/\text{cwt}) = \$14,975.38 .$$

Management Problems

Animals which have been poisoned on locoweed require extra care to offset the poisoning effects. Ranchers indicated that severely

poisoned cattle were put on heavy supplemental feeds after being removed from access to the plant. The New Mexico rancher noted his extra cost for this procedure was $12.50 per head. All ranchers graze these animals on green feed and/or supplement them for thirty to sixty days to add weight and improve appearance to conform with normal market standards.

Cattle grazing on locoweed-infested ranges must be observed closely. This results in extra labor costs. Under normal conditions this labor time could be used for other enterprises. Also, animals that are observed to be poisoned must be removed from access to the plant if possible. Ranchers in Park Valley noted that every time these cattle were inspected, some would have to be removed from the area. A few animals showed signs of poisoning and were removed only nineteen days after grazing on this area began. This practice shows a loss of forage utilization in the locoweed-infested area and a possible overuse of forage in the adjoining range.

Economic analysis of extra management practices

It was not possible in the preliminary study to determine the actual costs of the above mentioned management practices. However, ranchers did indicate a price discrimination against animals sold while still showing signs of locoweed poisoning. If these extra management practices were not used to offset the poisoning effects, the animals would probably be sold at a lower price. Loss incurred from not using these methods will be used to estimate a cost.

From interviews, the average amount of price discrimination was determined to be 2.5 cents per pound. Data, interviews, and observations indicated that approximately 40 percent of the calves showed the obvious signs of locoweed poisoning. With a 75 percent calf crop, the 394 cows on this allotment would produce 295 calves. Assuming 40 percent of these calves were severely locoed, there would be 118 head sold at a lower price. These 118 head, at the lighter average weaning weight of 342.4 pounds and sold at $.025 per pound less would show a loss of $8,010.08:

$$(118 \text{ calves})(342.4 \text{ lb.})(\$.025/\text{lb.}) = \$1,010.08 \ .$$

Economic Analysis of Total Loss

Using the above-determined figures, the approximate loss due to grazing locoweed in this area during 1978 would be:

weight loss in calves sold	=	$4,171.30
higher number of replacement heifers	=	6,350.76
death loss	=	4,182.30
abortions and fertility problems	=	14,975.38
price discrimination	=	1,010.08
approximate total loss	=	$30,689.82

The ranchers in Park Valley, Utah estimated their loss due to locoweed was in the range of 35 to 40 percent reduction in profit. It was not in the realm of this study to determine the actual operating costs and profit margins of these ranchers. However, the estimated loss of $30,689.82 in 1978 would very likely be close to the ranchers' estimate.

The Wyoming rancher interviewed estimated his annual loss to be $15,000 on a 500-cow ranch. The Park Valley area was comprised of a total herd of 855 cows. A loss of $30,689.82 in this area would closely coincide with the estimate given by the Wyoming producer.

The Extended Effect of Locoweed on Weight Gain

The data in Tables 3 and 4 show average gain for both the locoweed accessible group and the nonaccessible group to be nearly identical for the 139-day feeding trial. This result may seem somewhat surprising but actually coincides with previous literature on the subject. Animals which have been locoed will recover to near normal condition after a period of time with proper management practices.

Calves which grazed locoweed had been removed from access to the plant for eighty-three days before the feeding trial began. Also, some of the calves, known to be poisoned, were fed high concentrate rations by ranchers previous to the study.

Blood tests taken when animals were received showed no remaining signs of poisoning. Physical signs of the poisoning were only slightly noticeable in calves suspected of being locoed. As the feeding experiment progressed, all signs of locoism disappeared in these calves, except when they were disturbed. During weighing trials, some calves would become excited and difficult to handle.

There are other speculations as to the reason for both groups showing nearly the same daily weight gain. Although the calves in the locoweed grazing group were subject to locoweed poisoning, it was not

known if all of these animals had consumed enough of the plant to produce a severe condition.

It can be seen from Tables 3 and 4 that both groups had an average weight that was very light for November. This would indicate nearly all of the calves were born late in the year. Since fertility is affected with locoweed poisoning, some calves in the nonaccessible group may have been born to dams that had been locoed the previous year. It is, therefore, possible that calves from both groups had received internal damage from dams ingesting locoweed. This also may have affected their performance in weight gains.

For the above-mentioned reasons, the feeding trial does not give conclusive evidence that future weight gains are not affected. It does show that, with proper management practices, poisoned animals can recover. For example, calf number 82 (Table 3) was known to be severely locoed. This animal was fed a high concentrate ration by the rancher for some time before the feeding trial began. Therefore, its condition had improved considerably and by the end of the experiment showed the second highest gain.

Methods of Locoweed Control

At this time, the most logical method of locoweed control is to spray with 2,4-D. Livestock producers who have used this form of control noted marked improvements in production. Advantages of spraying these problem areas are listed below:

1. An increase in usable range forage
2. Heavier weaning weights of calves

3. Fewer open cows, thus, a greater calf crop
4. Requirements for fewer replacement heifers
5. A shortened breeding season, thus, fewer late calves
6. A lowered percentage of death loss
7. A reduction in management requirements.

The disadvantages of spraying an area where locoweed exists are:

1. The cost of the spraying project
2. Possible loss ofuse for as much as a grazing season.

The cost of spraying is dependent on the environmental and topographical features of the range to be sprayed. Areas which are inaccessible must be applied by aircraft. Cost of this can vary greatly. The rancher in Wyoming indicated the cost of spraying on his ranch was $5.25 per acre, while the New Mexico rancher's cost was $5 per acre. On the other hand, the ranchers in Utah reported that if their locoweed-infested areas were sprayed, the cost would be approximately $10 per acre.

Cost of nonuse of an area can be quite high. The locoweeds do not lose their toxicity on drying (Mathews 1932). Most ranchers would prefer to graze sprayed areas and sustain the subsequent loss rather than incur a heavier loss from nonuse. An alternative to this would be to spray portions of an area over a period of years and practice nonuse in the area which had been sprayed or coordinate the grazing system to avoid use of the range immediately after spraying.

Benefits from locoweed control

Since the range area in Park Valley, Utah has not been sprayed in recent years, no data were available to determine an accurate return

for spraying this area. However, the Wyoming rancher interviewed had sprayed areas on his ranch where locoweed was a problem. Results from this project show evidence of the advantage of locoweed removal.

On this ranch, 7,000 acres have been sprayed using 2,4-D at two pounds per acre with 1.66 galls of diesel per acre. The cost of this spraying project was $5.25 per acre, or $36,750. It is assumed that nonuse was not practiced and, therefore, will not be used as a cost. The original estimate of the life of the spraying project was three years but has now been projected as ten years or more.

The rancher indicated marked increases in production after the spraying project was completed. These increases are listed below:

1. Before spraying, 250 calves per year were poisoned and had weaning weights 50 pounds lighter than normal. After spraying, weaning weights returned to normal.

2. An increase in calf crop was noted. Before spraying, twenty to 30 mature cows were open every year, whereas, after spraying, this was reduced to two mature cows.

3. Prior to spraying, sixty to seventy-five calves were born after the normal calving period. In 1978, after spraying, this was reduced to sixteen late calves.

4. The number of replacement heifers was reduced from seventy to fifty head per year.

5. Before spraying, fifteen to twenty cows were poisoned severely enough to be removed from access to locoweed. After spraying, no cows had to be removed from these areas.

This rancher determined his annual loss to locoweed was approximately $15,000. Cost of the spraying project was $36,750. Assuming that all costs occur in the same year and that the benefits begin the year after treatment and last for ten years, an internal rate of return on investment can be approximated (Nielsen 1967). The equation used to compute this return is:

$$I = R\left[\frac{1 - (1 + i)^{-n}}{i}\right]$$

where

I = initial cost of spraying

R = expected annual benefit (loss due to locoweed)

n = number of years that benefits will last

i = internal rate of return (the unknown).

Then,

$$\$35,750 = \$15,000\left[\frac{1 - (1 + i)^{-10}}{i}\right]$$

The internal rate of return is then equal to 39.4 percent. Assuming that a reasonable rate of return on investment is generally about 10 percent, the computed return rate of 39.4 percent is quite high. This shows that the spraying project was profitable with a ten-year life.

The Utah ranchers said their cost of spraying would be nearly $10 per acre. Relating the above example to this higher cost would give a total cost of $70,000 to spray the 7,000 acres. If these ranchers saved $15,000 annually for ten years by spraying the same acreage,

their internal rate of return would be 17 percent. This also is a reasonable rate of return. However, indications are that the ranchers in this area are actually incurring greater losses on less acreage than the above figures show. The internal rate of return would likely be greater than 17 percent.

In looking at the Park Valley spraying problem in respect to the length of life of the spraying project, one could afford to spray a 7,000-acre area and still get a 10 percent return on investment if the life of the spray lasted only six years.

Also, when considering the maximum amount which could be invested to spray 7,000 acres, an output of $13 per acre could be invested and still get a 10 percent return on investment with a ten-year spray life.

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

Conclusion

Historically, the locoweed plants have had severe economic impacts on the productivity of livestock in the Western United States. Production is hampered through weight loss, reproductive problems, deaths, and an increase in management costs when animals are allowed to graze locoweed-infested ranges.

The estimated annual loss of $30,689.82 determined for ranchers in Park Valley, Utah shows the severity of the problem. It should be pointed out that this loss figure could vary considerably for each year depending on management practices and environmental conditions. However, indications are that losses found in this study are actually on the low side. Producers in this area noted that 1978 was not an extremely bad year for locoweed poisoning, and in some previous years their losses have been much higher. Due to rapidly expanding costs of production, cow/calf operators cannot long endure losses of this magnitude.

Although locoweed poisoning was shown to cause substantial losses in production, it also was found that the plant can be profitably controlled through spraying. An internal rate of return of 39.4 percent was estimated for one producer who had used this form of control. Therefore, it is determined that with proper management practices, these losses could be substantially reduced.

Recommendations

Since this thesis is a preliminary investigation of the economic problems of grazing cattle on locoweed-infested areas, losses found are only estimates. Largest flaws in this study were lack of control when collecting data and the inability at this time to accurately measure several problems associated with grazing this plant. Because of the many unmeasured variables, results did not lend themselves to efficient use of statistical analysis. Further studies on this subject should be carried out by collecting data through actual measurement in all problem areas and statistical analysis used to prove results. Some recommendations will be made to benefit further investigation into problems associated with locoweed poisoning.

Calves should be identified and marked at birth so each calf and its dam can be identified at all times and actual ages known. When determining a loss in weaning weight in these calves, both groups should be weighed before grazing their respective areas and again at weaning time. This would give a gain over the grazing period rather than from an estimated birth date as this study has done. Unmeasured variables would then be greatly reduced and data could be statistically analyzed to determine actual weight loss in calves grazing on locoweed.

Calf crop percentages should be determined through concise record keeping in both herds grazing locoweed and herds which have not. This would give the actual reduction in number of calves sold due to locoweed poisoning rather than the 15 percent estimate used in this study.

Cattle grazing on locoweed must be closely observed throughout the grazing season to determine actual number of animals which were severely poisoned from the toxin. An actual number of cows culled due to locoweed and the resulting increase in replacement heifers could be found by using this method. The amount of death loss due solely to poisoning from the plant also could be determined through this procedure.

Costs in increased management practices could be found by measuring loss in forage utilization during the grazing season, amount of increased labor time required, and cost of forage and supplementation used to offset poisoning effects and bring these animals up to market standards.

From results of the above procedures, marginal and average costs of producing calves under locoweed grazing conditions could be attained. These costs could then be compared to revenues received to determine the profit margin. After this profit margin is calculated, then it can be compared with a profit margin without the locoweed problem. The difference between these two profit margins could be considered the extra cost of a cow/calf producer operating under locoweed grazing conditions.

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APPENDIX

Personal Interview Information

1. How many cows and calves do you have grazing on the locoweed range area?

   Cows _____
   Calves _____

2. How many do you have grazing on the adjoining range to the south?

   Cows _____
   Calves _____

3. On what dates are they to be removed?

   Forest Service land _____
   Private land _____

4. On what dates were these cattle turned out on these ranges?

   Forest Service land _____
   Private land _____

5. On what date were physical signs of locoweed poisoning first noticed?

   In cows _____
   In calves _____

6. If these affected animals were removed from the locoweed range, on what dates were they removed?

   Date _____
   Number _____

   a. Were they put on the range directly south of the locoweed range?

      Date _____
      Number _____

   b. Were any of the animals affected enough that they were required to be taken back to the ranch vicinity?

      Date _____
      Number _____

7. What type of management practices or special rations do you use to offset the locoweed poisoning?

   a. How long did you use these extra management practices on affected cows and calves?

8. Do you think that calf poisoning is more of a result of nursing poisoned cows or actually consuming the locoweed plant?

9. How many of your cows and calves actually died from locoweed poisoning?

In 1977: cows _____
calves _____

In 1978: cows _____
calves _____

10. How many of your cows do you believe abort directly from locoweed poisoning?

In 1977 _____
In 1978 _____

11. How many of your calves were born small and/or weak due to the poisoning?

In 1977 _____
In 1978 _____

12. How many of your calves were born with physical abnormalities?

In 1977 _____
In 1978 _____

Could you please describe the conditions of these abnormalities?

13. Do cattle buyers use price discrimination against your calves which have been poisoned with locoweed, as compared to your calves which have not been affected?

What is the amount of this price discrimination?

In 1977 _____
In 1978 _____

14. How many extra trips do you make to the top of the mountain because of locoweed problems? (Trips above those that would be made if no locoweed problem existed.)

15. Could your lower (south range) be stocked heavier if there was no locoweed on top?

16. Does locoweed problems affect the value of your ranch if it was put on the open market?

17. Give your opinion of how locoweed poison affects the economics of your ranch operation.

VITA

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