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Economics of Controlling Tall Larkspur

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ECONOMICS OF CONTROLLING TALL LARKSPUR

by

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INTRODUCTION

The production of livestock in Utah is important to the economy of the state. The economic life of many communities throughout the state depends on income from livestock. Cash receipts from range livestock were $62.7 million or 38.8 percent of the total from agriculture in Utah in 1958 (18).

Much land in Utah is used almost exclusively for livestock production. Of the 52.7 million acres in Utah about 78 percent is used for the production of range livestock (15). Sheep obtain approximately 86 percent and cattle 56 percent of their forage needs from range lands (15, p. 28). Although there are alternative uses for some areas, grazing livestock is the only significant economic use for much range land in the state.

A large part of Utah's range land is federally owned. The Bureau of Land Management manages about 48 percent of the total land area in the state, and the United States Forest Service manages approximately 15 percent (15).

Seasonal grazing of livestock on forest land in Utah is important to livestock men. Most ranchers use the forest lands for grazing livestock for summer feed. Permits to graze livestock on the forest land are counted as part of the capital structure of the ranching operation by ranchers.

Forest Service allotments generally include land of high altitudes

which restricts grazing to the summer months. The grazing period is usually from June 1 through September but sometimes extends to early October. Also, in some areas at higher elevations snow remains in shaded areas until late July. Late spring and early fall snows prevent the grazing pattern from varying widely.

By having some land to carry livestock through the winter months and a permit for grazing on the forest in the summer, the rancher can build a larger unit than he could if he had to pasture his livestock year around on private land.

Poisonous Plants on Ranges Curtail Economic Potential

Poisonous plants existing on range land in Utah causes considerable livestock loss each year. Most poisonous plants are widely scattered throughout the state within the environmental situations to which they are suited. Because of this scattered distribution, about the only thing ranchers can do to keep death losses to a minimum is intensify management of the range. Several alternatives are open to ranchers.

First, grazing area may be reduced. Land heavily infested with poisonous plants cannot be counted as acres of available forage. If a plant poisonous to sheep only invades a sheep range, the use of the affected area will be greatly reduced to eliminate as much death loss as possible. Ranchers will avoid grazing livestock on the heavily infested areas during the extreme danger period. By avoiding one area for a period of time, other areas may suffer from over-use.

Second, grazing time may be curtailed. Time permitted on the range may have to be cut because of poisonous plants. If permitted time is

cut, the production of livestock from the given area will drop. Grazing time lost is an economic loss to ranchers. Cattle obtain feed in two ways. They may harvest their own feed by grazing or they may be fed feed harvested by some other means. When grazing time is lost, cattle must obtain a larger proportion of total feed from other more expensive sources. This would change the pattern of ranch operation and would usually increase operating costs.

Third, the number of animals permitted on range may be cut because poisonous plants decrease available desirable forage. When the permit number is cut the permittee suffers an economic loss. He may have to decrease the size of operation or find other feed for animals in excess of his permit. A decrease in size of operation will usually decrease gross returns and an increase in harvested feed will usually increase operating costs.

Poisonous plants growing on range land increase the costs of ranching in several ways. First, animal deaths is the biggest single loss rachers suffer from grazing a range infested with poisonous plants. Some ranchers estimate an annual death loss of 5 percent; others estimate a higher percent. Ranchers know death losses occur on the range but are not certain just how much is attributable to poisonous plants. The cost of producing animals that die must be borne by the reduced marketable product; hence, cost per unit of output increases as deaths increase.

Second, labor costs are higher on ranges infested with poisonous plants. Ranchers try to herd livestock away from heavily infested areas. A range free from poisonous plants requires only normal herding of livestock to keep them to available feed at the time the feed should be

harvested. On cattle ranges, herding keeps cattle scattered over the whole range. Another increased cost is the additional labor required to care for sick animals that have been poisoned.

Third, poisonous plants contribute to uncertainty in ranching. A certain amount of risk and uncertainty exists with any type of operation where the future cannot be predicted accurately. Risk can be calculated and handled in the cost structure of ranching but uncertainty cannot. Ranchers grazing cattle on areas infested with poisonous plants cannot tell when they will suffer extreme losses. In fact, the loss could be so severe, in a given year, that ranchers would be forced out of business. Because of the uncertainty ranchers may maintain a greater liquidity ratio to protect operations against extreme losses. They may also restrict size of or diversify operations to counter uncertainty.

One poisonous plant, tall larkspur, is the subject of this study. The plant grows on high summer ranges and is generally poisonous to cattle only. In some areas tall larkspur poisoning is serious. Ranchers and range managers are concerned with the economics of its control.

The Economics of Controlling Tall Larkspur--The Problem

Can tall larkspur be controlled economically? If so, benefits from control must exceed costs of control.

Before a control project is undertaken, certain factors should be known. Data needed for complete economic analysis of tall larkspur poisoning on cattle ranges would include a) losses sustained by ranchers because of tall larkspur, b) costs of controlling tall larkspur, and c) increase or decrease in ranch income resulting from tall larkspur control.

Though perfect data are not available at this time, a conceptual analysis will help define the overall problem and indicate the direction for future needed research.

Losses

Economic losses suffered by ranchers from tall larkspur poisoning fall into several categories. First, death losses are the most dramatic since carcasses can be seen for sometime after death and represent the greatest economic loss. Death losses include those animals killed by ingesting the weed, and also those calves lost because the mother died. These losses can be measured both in physical and economic terms from records of ranchers and range management agencies and from secondary sources.

Second, animal weight losses from tall larkspur poisoning are economically important. Even though a cow gets well after being poisoned the weight lost while she was sick is real. If the cow goes direct to the feed yard after recovery, it would take more feed to get her back to normal condition. When a cow nursing a calf gets sick from eating larkspur, her flow of milk will decrease. This will cause the calf to be smaller because of insufficient nourishment. Orphaned calves seldom weigh as much as calves with mothers at market time. This loss in calf weight can be estimated from ranchers' experiences.

Third, cows consuming tall larkspur may abort, and bulls may become sterile possibly for short periods but long enough to reduce the calf crop. At present, data are not available to measure this loss. However, research is underway by veterinarians at this station and elsewhere to determine the effect of poisonous plants upon reproduction in cattle.

Fourth, losses are sustained because of untimely grazing of tall larkspur ranges as well as related ranges. Often cattle are held off the tall larkspur ranges in hopes that the plant will become less palatable as it ages. The result is overgrazing lower units. Also, grasses on the tall larkspur range may pass their nutritive peak before being grazed. Determination of these losses are technical problems for which data are not available at present.

Fifth, the presence of tall larkspur on ranges increase the risk and uncertainty of the total ranch operation and losses result. Permit values may be lower on tall larkspur ranges than on larkspur free ranges. Contingency funds with resulting interest costs must be increased to protect an operation against possible extreme animal losses. Data are not available at present to adequately estimate these losses to ranchers.

Costs of control

Avoiding losses from tall larkspur poisoning is crucial if increased income is a goal of ranchers. An animal saved will enhance net income provided the cost of saving the animal does not exceed the economic productivity of the animal. Some methods of controlling tall larkspur are: a) herding, b) fencing, c) replacing cattle with sheep, and d) controlling the plant. Each, if successfully accomplished, could result in avoiding animal losses.

First, herding would require several men full time if animals were to be scattered over a large allotment. If tall larkspur captures more and more of the range over time, herding would not arrest its spread. Also, substantial areas on some ranges would be withdrawn from grazing, and much desirable plant life in association with tall larkspur would go

unused if animals were herded off the poisonous plants. Also, laxity on the part of herders might result in some animal losses. Herder wages and maintenance could be obtained from ranchers or from secondary sources.

Second, fencing would not contain the plant if it spreads to new areas. Also, fences represent a considerable initial cost with maintenance costs added annually. Areas fences would be withdrawn from grazing which would represent another cost for this type of control. Fencing costs are available from secondary sources.

Third, since sheep are not as susceptible to tall larkspur poisoning as cattle, substituting sheep for cattle could alleviate the problem. However, sheep and cattle ranges are often separated by institutional pressures. Also, a cost would be incurred in shifting from an established pattern of ranching to one unfamiliar to ranchers. In the short-run, at least this alternative control measure seems unfeasible. Data on cost of shifting are not now available. Securing them represents a major research project in its own right.

Fourth, controlling the plant would not only avoid animal losses but also enhance the range by replacing tall larkspur with desirable plants. Costs of control would include: a) cost of killing the plant, b) cost of reseeding the treated area where necessary, and c) costs of protecting the treated area until the cover of desirable plants was satisfactory. Some data pertaining to the latter two are available from secondary sources. Costs and methods of killing the plant have not been adequately determined. Mechanical and chemical methods have been suggested. However, the side effects of these methods on the land and associated plants have yet to be determined. These data are important to a complete

economic analysis of tall larkspur control. Research is underway at this and other stations to provide necessary data with reference to chemical control.

Change in ranch net income

Will controlling tall larkspur increase or decrease net ranch income? This question can be answered by using the marginal analysis of economics. If a ranch's marginal (added) returns resulting from control exceed the marginal costs resulting from control, it would pay to control tall larkspur. If marginal returns to this technical improvement do not exceed marginal costs, it would not pay to control it. Losses saved by control plus output enchancement must, therefore, exceed all costs of controlling tall larkspur for economical feasibility.

A hypothetical ranch situation will help emphasize the complexities of an economic analysis of tall larkspur control.

An hypothetical example

Assuming complete data are available, a model solution can be built.

Following are assumptions made to give complete data for the model. The grazing area is a 2,000 acre forest allotment.

One-half of the allotment is infested with tall larkspur. It is scattered so fencing or herding is not feasible.

Grazing permits allow 100 cattle to graze the allotment from June 1 through October 1.

One rancher is the sole operator on the allotment.

Cattle are the only source of income to the rancher.

The owner gets an 85 percent calf crop each year.

Tall larkspur is the only poisonous plant infesting the range.

About 3 percent of the allotted cows die each year from poisoning.

One-third of the orphaned calves die; the remaining two-thirds weigh 200 pounds less at selling time when they come off the range.

Larkspur can be controlled by selective herbicides.

Cost of chemical and application are estimated to be $2.50 per acre applied with an airplane, $2.80 per acre applied with a Jeep truck, and $5.00 per acre applied with a back pack sprayer.

Enough grasses grow among the larkspur so revegetation will not be necessary.

The price for cows is $20 per hundred pounds and cows weigh 1,000 pounds each.

The price for calves is $30 per hundred pounds.

The rancher grazes his cattle year long but the forest allotment is the only place the man has to put his cattle during the summer.

Losses from larkspur poisoning.--During the summer three cows died from larkspur poisoning. Two cows that died had calves nursing them. One calf died from lack of mother's milk. One calf weighed 200 pounds lighter at selling time. Economic losses from death due to larkspur is $600 from cows that died, $120 from the calf that died, and $60 from the orphaned calf, for a total of $780. Also, one cow aborted after getting sick from eating larkspur and one cow was not bred because a bull was sick from eating larkspur. If larkspur did not exist on the range, the rancher would have had two more calves to sell worth $240. Total economic loss from tall larkspur being present on the allotment is $1,020.

Cost of controlling tall larkspur.--About 700 acres can be sprayed with an airplane. The remaining area can be sprayed with a Jeep truck with the exception of about five acres which will have to be sprayed with a sprayer strapped on someone's back. Costs for spraying are $1,750 for airplane spraying, $1,106 for Jeep truck spraying, and $25 for back pack spraying. A total of $2,881 would control tall larkspur on this model range.

Change in net income.--Tall larkspur control is considered a capital improvement that will last for 10 years. By amortizing the cost of controlling larkspur at 5 percent, the rancher's average yearly cost is about $418 over a 10-year period. His yearly gross income increased $1,020. Net income increased $602 per year. To this must be added benefits resulting from less tangible factors such as increases in permit values, greater carrying capacity, and decreased risk. Certainly, if these were the cost-benefit relationships there would be no question about controlling tall larkspur on this range.

Objectives of the Present Study

Data are lacking for a complete economic analysis of tall larkspur control. However, a beginning can be made with data from research completed. The full picture will have to await the completion of research now underway and yet to be commenced.

This study has three objectives: a) to become acquainted with tall larkspur and research related to it; b) to determine measurable losses

from tall larkspur; and c) to suggest possible gross benefits from control.

The present study will be concerned primarily with animal losses resulting from tall larkspur poisoning and possible gross benefits from its control. Data will come from a particular case--the Manti Canyon Cattle Association--with permits to graze the Manti Canyon allotment on the Manti-LaSal National Forest. This allotment is grazed exclusively by cattle owned by members of the association. Results with modification will be applicable to surrounding areas also.

The Manti Canyon Cattlemen's Association

Manti Canyon Cattlemen's Association is an organization of 17 men. Members of the association have permit rights to graze 868 cattle on the Manti Canyon allotment from June 1 through October 5 each year. Permittees do not always fill their permits each year. Some years cattle are not allowed on the allotment until later than June 1, and they are sometimes taken off the range before October 5. This depends on availability of feed.

The total allotment area is divided by fences into three units called lower, middle, and upper. Cattle are put on the lower unit and are moved up as the summer progresses. The gate between the middle and upper unit is opened July 24 and the cattle are driven out of the middle unit by August 5.

The association, with supervision from the Forest Service, manages the allotment. Members of the association take turns riding the range to keep the cattle scattered and put out salt. Dues are assessed to

each member and prorated on the number of cattle his permit allows. The secretary of the association accounts for all the expenses incurred. Each permittee is given a chance to work out some of his expenses by riding the range or other work that is needed to maintain the allotment.

Permittees of the Manti Canyon allotment live in Manti. Typically a ranch organization consists of some private land which is used to grow hay and grain and provide meadow grazing in early spring and late fall. One cutting of hay is harvested from the meadow during the summer. Breeding stock are wintered on the meadow hay. Also, some calves are fattened on the alfalfa hay and grain grown on the irrigated land.

Each rancher has his own cattle. The association runs all cattle in common on the allotment, but each man takes care of his own during the time cattle are not on the allotment. Some members of the association have livestock enterprises other than beef, but for most of the ranchers beef cattle is the main enterprise. Ranchers are concerned with good management on their allotment because their whole ranching operation is built around it and, thus, their livelihood depends upon it.

Methods of Study

The study area considered in detail was the forest allotment for the Manti Canyon Cattlemen's Association in Manti Canyon, Utah. Approximate size of the allotment area was 20,000 acres. Seventeen ranchers have permits to graze 868 cattle from June 1 through October 5. Ranchers of the association eagerly cooperated with researchers on this project.

The grazing allotment was all on forest land and grazed by cattle only. Tall larkspur was the only plant growing on this allotment that

was poisonous to cattle. The upper unit was the only unit infested with tall larkspur.

Complete enumeration of the permittees was made to obtain data. Ranchers were asked to estimate annual death loss from larkspur poisoning. Information on individual ranch organization was obtained while interviewing ranchers. Each rancher gave percent calf crop by years. Officers of the association checked their records and estimated grazing time lost due to the presence of larkspur on the range.

Secondary sources provided data on poison plants. Data obtained included location of infestation, animals each particular plant affected, and the observable symptoms of animals poisoned by the plants. Previous research published and unpublished were sources of data for tall larkspur as a plant as well as research on its control.

Plan of presentation

Data collected are presented and discussed as follows: Next a description of tall larkspur (Delphinium Barbeyi) will be discussed in connection with a review of literature on past research pertaining to poisonous plants. The measurable economic losses and probable gross benefits for the Manti Canyon Cattlemen's Association will be presented in concluding sections.

REVIEW OF LITERATURE

Some plants found on Utah ranges are generally dangerous to sheep only (Table 1). Other plants are poisonous to cattle only (Table 2). Others are poisonous to both sheep and cattle (Table 3). It is believed that 95 percent of the livestock poisoning in the state is caused by plants listed in the tables (17, p. 4). Each plant has its peculiarities concerning growing conditions, dangerous season, type of poison, and effect on animals. Five of the more important poisonous plants found on Utah ranges are larkspur, loco, halogeton, milkweed, and sneezeweed.

Loco (Astragalus spp., Oxtropis spp.) is sometimes called poison vetch. Various varieties of loco grow in all parts of Utah. Some grow in driest deserts, others on foothills, and other on high mountains. Some locos are highly poisonous and others are not. Animals that have eaten loco are easily recognized. They act peculiarly as a result of nervous disorder. The gait is jerky and uncertain because of inability to coorindate muscles. They act as if blind, shying from familiar objects, jumping imaginary hazards, and otherwise exhibiting crazy behavior (17, p. 8).

Halogeton (Hologeton glomeratus) is not a native plant of the state. It has spread rapidly since first discovered in Utah in 1942. The rapid spread of the plant has caused sudden and tremendous losses on ranges previously considered safe. It is an annual desert plant and grows where

Table 1. Selected poisonous plants in Utah generally dangerous to sheep only

Common name	Scientific name	Where it grows	Dangerous season	Effect upon the animal
Death Camas	Zigadenus paniculatus	Foothill and wetter desert lands	Spring, especially very early spring	Vomiting, frothing at the mouth followed by coma
Greasewood	Sarcobatus vermiculatus	Alkali valley bottoms along drainageways not in high mountains	Spring	Kidney lesions
Halogeton	Halogeton glomeratus	West deserts, along roadsides and overgrazed areas	Late fall or winter especially when sheep first get on winter range before moisture has chance to wash out poison	Rapid death
Horsebrush	Tetradymis glabrata and T. canescens	Mostly on west desert range and foothills T. canescens. Sometimes grows at high elevations	When growing rapidly in early spring, April to June	Causes bighead. A disease of the liver. May cause death without bighead.
Lupine	Lupinus spp.	Mountain and foothill land	All summer but especially in midsummer when in fruit	Nervousness or depression
Rubberweed	Actinea Richardsonii	Central and southern Utah. Mostly in dry mountains & foothills	Spring, summer and fall	Vomiting, weakness thin stock
Sneezeweed	Helenium Hoopesii	Mountain summer range,& Central Utah and southward	All summer slightly more toxic later	Profuse vomiting and "spewing sickness"

Source: L.A. Stoddart, A.H. Holmgren, and C.W. Cook, Important Poisonous Plants of Utah. Special Report No. 2, Agricultural Experiment Station, Utah State Agricultural College, Logan, Utah, June 1949, pp. 10-11.

Table 2. Selected poisonous plants in Utah generally dangerous to cattle only

Common name	Scientific name	Where it grows	Dangerous season	Effect upon the animal
Low larkspur	Delphinium Nelsonii	Foothills and sagebrush deserts	Early spring	Trembling, constipation. Usually legs are extended rigidly. Sudden falling, violent struggling.
Tall larkspur	Delphinium Barbeyi	Mountain summer ranges, common under aspen and along streams	All--especially spring	Same as low larkspur
Oak	Quercus Gambelii	Foothills	Early spring especially after a late frost turns leaves black	Emaciation, constipation, weakness
Water hemlock	Cicuta Douglasii	Wet places, meadows, rivers and ditch banks	Roots are always very poisonous. Tops only in early spring	Frothing at mouth, twitching. Violent spasms and sudden death

Source: L. A. Stoddart, A. H. Holmgren, and C. W. Cook, Important Poisonous Plants of Utah, Special Report No. 2, Agricultural Experiment Station, Utah State Agricultural College, Logan, Utah, June 1949, pp. 10-11.

Table 3. Selected poisonous plants in Utah generally dangerous to cattle and sheep

Common name	Scientific name	Where it grows	Dangerous season	Effect on animal
Arrowgrass	Triglochin martima	Wet and generally alkaline meadows and wet bottom lands. Common in meadow hay	All, but especially in dry season and after first fall frost	Difficult breathing Rapid death or recovery
Chokecherry	Prunus virginiana var. melanocarpa	Roadsides and valley bottoms at low elevations and generally in higher mountain ranges	All, but especially in early spring. Often safe in fall	Difficult breathing, uneasiness, stupor, convulsion, usually bloating
Copperweed	Oxytenia acerosa	Eastern Utah, usually along dry washes or alkali flats	All, but generally eaten in late summer or fall	Slow action. Loss of appetite, coma and death without great struggle
Loco	Astragalus spp. Oxytrophis spp.	Everywhere	All, especially spring	Constipation. Rough coat and long mane and tall hair. Incoordination of muscles and peculiar gait, crazed action.
Milkweed	Asclepias spp.	Roadsides, sandy soils, waste places. Not in high mountains	All summer and even occasionally in winter	Severe spasms and violent struggling. Rapid and noisy breathing.
Selenium[a]	Numerous plant species. Chief genera Astragalus Stanleya Mentzelia	Eastern Utah foothills and desert lands. Common on blue shale or clay soils	All year, mostly spring	May be slow involving emaciation and sloughing of hoof and hair. Animals may be more violent. Walk aimlessly and appear blind.

[a]Selinium is a poison element found in certain soils and is taken up by some species of plants.

Source: L. A. Stoddart, A. H. Holmgren, and C. W. Cook, Important Poisonous Plants of Utah, Special Report No. 2, Agricultural Experiment Station, Utah State Agricultural College, Logan, Utah, June 1949, pp. 10-11.

disturbance of soil or vegetation has made a place for it. It is common along roadsides, ditches, sheep bed grounds, and overgrazed ranges, especially on alkali soils (17, p. 12).

Milkweed (Asclepias labriformis) is found on sandy soils with wet subsoils throughout Utah. Several varieties are common on rocky or sandy soils and in waste areas along ditches and stream beds. Milkweeds are common in hot dry climates such as found in southern Utah desert areas. They are among the most important of all poisonous plants, especially those varieties with long whorled leaves (17, p. 13).

Sneezeweed (Helenium Hoopesii) is the most dangerous summer sheep poison in Utah. It occurs on high mountain ranges from central Utah southward. The plant is poisonous throughout its life. It is unpalatable, and sheep graze it in quantity only when other feed is scarce (17, p. 8).

Several varieties of larkspurs are important on Utah ranges. These are discussed in more detail.

Varieties of Larkspur

A range plant handbook prepared by the United States Forest Service indicates that native larkspurs are perennial, while those naturalized from the Old World are annual (5, p. W58). Some 60 native and two naturalized larkspurs occur on western ranges. Larkspurs are widespread with one or more species occurring in every western state. The genus is one of the best known members of the buttercup or crowfoot family (Ranunculaceae). Some species are very poisonous; others rarely cause death loss to cattle.

Tall and low larkspurs are designated by the elevation at which they grow. Tall larkspur grows at higher and low larkspur at the lower elevations. Several species occur in each group. Delphinium species growing on the western ranges are: Delphinium Geyeri, Nelsonii, bicolor, Mengiesii, and pinetorum in the low larkspur group; and Delphinium occidentale, glaucum, and Barbeyi in the tall larkspur group. Of the tall larkspurs, Delphinium Barbeyi is the most important one in Utah.

According to Stoddart, Holmgren, and Cook (17, p. 4), most tall larkspur poisoning in the state is caused by this species. Tall larkspur is generally known by cattlemen throughout the state; however, other plants are sometimes mistaken for it.

Similar plants

Two plants that are commonly mistaken for tall larkspur are wild geranium (Geranium viscosissimum) and western monkshood (Aconitum columbiaum). The mistake in identifying these plants occurs during the early stage of growth. Leaves of wild geraniums closely resemble those of tall larkspur (13, p. 7). The two plants can be distinguished by the stems before flowering. Tall larkspur has a hollow stem. Wild geranium has a solid stem. After flowering, larkspur is easily identified by its flower. No other plant growing in areas where larkspur grows has a flower resembling it.

It is more difficult to distinguish between monkshood and larkspur. The leaves of monkshood resemble those of larkspur although they are more closely attached to the stem. The stem of larkspur is hollow while that

of monkshood is pithy. The root of monkshood is short and bulblike instead of long and woody as in tall larkspur. Monkshood frequently grows in considerable abundance in the midst of clumps of tall larkspur (13, p. 7).

Tall larkspur (Delphinium Barbeyi)

Tall larkspur is a perennial which reaches a height of 3 to 6 feet and looks almost like the cultivated flower, delphinium. Larkspur flowers are usually dark blue to purple; however, occasionally the flowers may be pink or cream colored (Table 4).

Larkspur starts its growth as soon as the snows recede. It grows in dense stands on north slopes and other slopes where snow lays longer. Looking at a patch of larkspur one can see the outline of the heavy snow bank (Figure 1).

Figure 1. Dense stand of larkspur growing on north slope in Hougaard Fork, Manti Canyon, 1959

Table 4. Botanical description of Delphinium Barbeyi

Flowers	Dark blue (occasionally pink or cream colored), on narrow-bracted ascending, sticky - tawny - hairy stalks, borne in rather short, dense, end clusters.
Follicles	3 hairless, often bluish veined, somewhat cylindrical, short-oblong, somewhat joined at base, erect, each tipped with persistent slender stalk and splitting down inside ridge, many seeded.
Leaves	Hairy stalked alternate rounded in outline, 3 to 6 inches broad, palmately parted into usually 5 main divisions; each division mostly broad and variously cleft or lobed.
Stem	1 to several, simple erect, 2 to 7 feet tall, leafy stout, hollow, dark green, hairy throughout but with spreading tawny hairs toward top.
Petals	4 smaller than sepals, in two unequal pairs: upper pair usually yellow tinged with blue, prolonged backward into nectary-bearing spurs and enclosed within sepal spur; lower pair usually blue each with narrow claw and broad, wavy edged blade, yellow haired on inner side.
Stamens	Numerous
Outer flower parts	5 petal-like, irregular, with somewhat sticky yellowish hairs; upper sepal prolonged into a spur as long or usually longer than sepal.
Root	Tap. Deep woody perennial.

Source: U.S. Forest Service, Range Plant Handbook, United States Department of Agriculture, U.S. Government Printing Office, Washington D. C., 1957.

Larkspur grows on the high mountain slopes (Figure 2). It grows taller than other competitive vegetation indicating that it is a good competitor for available plant nutrients. It has a deep root system and usually grows on deep soil. The plant is usually more dense where large snow banks lay. As the snow melts, the root system absorbs the available moisture. This causes the plant to start growing earlier than other plants on the range. The plant is able to get moisture when short rooted plants cannot. This helps account for the plant's late growth. The larkspur plant may be green and still growing when other vegetation is drying up from lack of moisture.

Figure 2. Tall larkspur growing on a west slope in South Fork, Manti Canyon, 1959

Larkspur is poisonous throughout its growing period. It reaches its poisonous peak during early summer. The plant is quite succulent while growing rapidly (Figure 3). At this stage of growth the plant may be eaten more readily by cattle than at other stages. The poisonous properties decrease as the plant matures. However, larkspur plants should be considered dangerous until frost has stopped its growth (5, p. W59).

Figure 3. Dense larkspur, Hougaard Fork, Manti Canyon, 1959

Poison properties of the plant.--The poison properties in larkspur are alkaloids. Alkaloids are organic substances containing nitrogen (7, p. 28).

The following are symptoms of larkspur poisoning: a) staggering, b) falling, c) nausea, d) excessive salivation, e) frequent swallowing, f) quivering of muscles, g) retardation of heart action, and h) paralysis of respiratory center (19, p. 28).

Animals fatally poisoned with larkspur bloat almost immediately after death. Cattle poisoned usually head down hill. Some pressure from bloating can be relieved by turning the animal's head uphill. Sticking to relieve bloat may help, but no sure cure has been developed for larkspur poisoning (2, p. 23).

Research Related to Control of Tall Larkspur

Research has been done on larkspur control. Some of the results have been published and some remain unpublished. Most research has been concerned with the poisonous qualities of the plant, where the plant grows and whether it affects sheep or cattle. Some data have been published on costs of controlling other species of larkspur, but none on controlling Delphinium Barbeyi.

The writer interviewed Binns and James (11) concerning preliminary research on chemical control of tall larkspur. They set out some plots in 1959 on the Manti-LaSal forest and used 2,4-D and 2,4,5-T. The chemical was mixed with a fertilizer that acted as a carrier for the chemical and stimulated the growth of the grass undercover. The fertilizer absorbed the chemical, making it dry and easy to carry to the plots. The mixture

was made into pellet form so it could be spread by hand. Permittees made supervised application on selected plots. These plots are under observation at present. No conclusions have been drawn, though casual observation indicates a high rate of kill of the surface growth from 2,4,5-T. Eugene Cronin (10) was conducting experiments in 1960 on the South Fork of Manti Canyon to see which herbicide would do the best job of killing, the best time of application, and the best rate of application on tall larkspur.

Some studies have been made on the cost of chemicals applied to other undesirable range plants, and some have been made on the cost of revegation of range lands. Data were obtained from the Forest Service and the Bureau of Land Management (BLM) on cost of fencing and other range improvement techniques. Previous research done on cost of revegetaion, fencing, chemical control, and grubbing may or may not be applicable to conditions on Manti Canyon. A bulletin prepared by Agricultural Research Service of the United States Department of Agriculture (19) states that all larkspurs are poisonous but some species seldom cause cattle losses. Two of the most poisonous are Delphinium Barbeyi and D. Nelsonii. Stoddart, Holmgren, and Cook (17) state that most tall larkspur poisoning in Utah is caused by Delphinium Barbeyi. Beath (2) stated that Delphinium Barbeyi is a problem for cattlement who use the mountain area for grazing.

Most research done on larkspur concludes that larkspur will not affect sheep under field conditions. Some work has been done in which forced feeding of larkspur to sheep has poisoned them. Huffman, Morgan and Binns (7) concluded that cattle are often poisoned by larkspur

but sheep can consume large quantities without being poisoned. Marsh, Clawson and Marsh (13) suggest herding sheep closely on larkspur areas to reduce cattle losses from larkspur poisoning. They suggest this as means of reducing plants, and particularly if the rancher owns sheep and cattle. Beath (2) states that records from forest supervisors indicate that under range conditions larkspur is not considered dangerous to sheep. Sampson (16) indicated that studies have been done where sheep have been affected by feeding them large quantities of leaves of Delphinium Barbeyi; but the dosage required was several times larger than that required for cattle.

Little work has been done on cost of controlling larkspur. However, some studies have been made on the cost of grubbing small plots and using selective herbicides. Bohmont (3) cites some work on larkspur eradication by grubbing. The cost in 1939 ranged from $1.65 to $20 per acre. It cost $20 per acre to eradicate larkspur containing approximately 17,500 plants.

Bohmont (3) further indicates that Delphinium Barbeyi is quite difficult to eradicate with growth regulating materials. Using 2 pounds 2,4-D ester at the right time one could expect 90 percent kill on tall larkspur. Hyder (9) did some work with chemicals on sagebrush larkspur. He concludes 2,4-D was consistently more effective than other chemicals tried. He indicates the percentage kill depends on the time of application. Robert H. Haas (12) has done some work on controlling Delphinium occidentale. He indicates by correspondence that low volatile ester of 2,4,5-T applied at the rate of 4.0 pounds provided a plant kill of approximately 80 percent. These results were from treatments applied

in early June of 1959 when tall larkspur was about 16 inches tall and in early bud stage.

Cost of eradicating larkspur has been estimated by Bohmont (3,p.11) from $2.00 to $4.00 per acre for the chemical plus the cost of application. Cost of application varies. Cook in 1959 (4) supplied data on cost of applying chemical to sagebrush. The total cost was $2.81 per acre for applying 2,4-D at 2 pounds per acre with a ground rig with a 30-foot boom on a Jeep truck. When a 4-foot boom with 2½ gallon back pack was used the total cost was $4.65 per acre. Airplane spraying was contracted in 1959 for $2.50 per acre. Two pounds of 2,4-D plus 3 gallons of water was used with the aerial spraying.

Costs of revegetation varies with the type of terrain. Lowery Fork of Manti Canyon was reseeded during 1952. A total of 435 acres was reseeded. Total costs for the reseeding were $11,833.35. Cost breakdown is as follows:

Plowing	$2,626.00
Seeding	424.00
Seed costs	4,058.69
Fencing	2,903.00
Equipment rentals	458.36
Miscellaneous	1,363.30
Total	$11,833.35

The average cost per seeded acre for reseeding Lowery Fork in 1952 was $27.20 (20).

No grazing was permitted on Lowery Fork in 1953. It was grazed for 15 days by 70 cattle during the second year, 1954. The third year 300

AUM's were allowed to be harvested. After three years, the seeding was established well enough for normal use. Final increased carrying capacity was 70 AUM's per year (20).

Forest lease fees were $.60 per AUM on the Manti allotment in 1960. Eight hundred sixty-eight cattle were allowed to graze Lowery Fork for about 2 weeks which would be 434 AUM's. The first year the cost of deferred grazing was $260.40; $239.40 the second year; and $162.00 the third year, or a total of $781.20. Deferred grazing costs will vary from one range to another, depending on how long reseeding takes to get established well enough to stand normal use.

An area reseeded needs protection while the grasses are getting rooted well enough to stand grazing. Usually the least expensive way to protect grasses is to fence cattle out. Total cost for 3.25 miles of fence in Lowery Fork was $2,903. This is an average of $893.23 per mile. Materials used to construct the fence were barbed wire, steel posts, and cedar posts. The biggest single cost of fencing was labor. A total of $1,697 was spent on labor for fencing 3.25 miles, or $522.15 per mile.

There seems to be general agreement that larkspur can be controlled. Whether or not larkspur can be controlled economically is still questionable. Past research has been done on small plots and in different types of terrain. To know the rate of kill, the best time of application, herbicide, and rate of application to use will have to be determined by future research underway at this station. Research that has been done can serve as a guide to determine the economics of controlling larkspur.

ECONOMIC LOSSES FROM TALL LARKSPUR POISONING

Each year considerable economic loss results from tall larkspur poisoning. Ranchers with permits to graze cattle on high mountain ranges expect to lose some animals. Losses are attributed to various causes such as poison plants, sickness, preditory animals, and natural causes. When a large number of cattle die on one allotment during a single year ranchers usually try to find the trouble.

Permitees who graze cattle on Manti Canyon allotment as well as other places have experienced considerable larkspur poisoning. Tall larkspur is abundant on the upper unit of the allotment. It is the major poisonous plant on the allotment that affects cattle. Ranchers are able to recognize the symptoms of tall larkspur poisoning. Also, animals are often found dead in the larkspur patch that they grazed.

The total area of tall larkspur on the allotment in 1960 was estimated at about 343 acres by on-the-spot estimation methods. Patches of larkspur were classified as dense or sparse according to percent ground cover that was larkspur. If 50 percent or more of the ground cover was tall larkspur, the stand was considered dense. Anything under 25 percent was considered sparse. If 26 to 50 percent of the ground was covered by tall larkspur, the stand was classified as sparse to dense. Tall larkspur grows among desirable forage but grows faster and higher than most plants growing in the same areas.

Manti Canyon has eight forks feeding into it from the top (Figure 4).

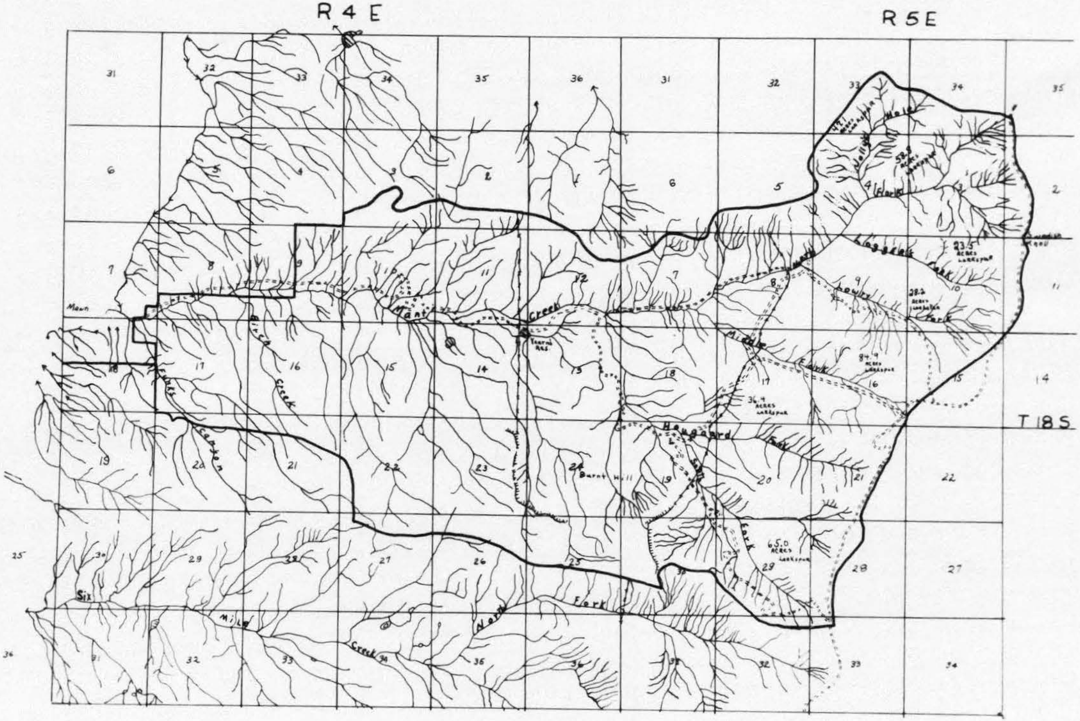

Figure 4. Manti Canyon grazing allotment on Manti-LaSal National Forest, 1960

Each fork is named. Part of Lowery Fork has been reseeded and fenced. The upper unit is broken into nine distinct areas. Middle Fork has more acres of larkspur than any other single area on the upper unit (Table 5). Of the total of 343.5 acres, 133.6 were densely covered with larkspur, and 160 acres were sparse to dense with larkspur.

Tall larkspur was more abundant on the slopes facing north and west. It was also dense in shaded pockets on south slopes and along stream banks. Tall larkspur grows in opening in pines and among pine and aspen trees. About 180 acres of the 343 was in open country and approximately 163 acres was among trees.

Table 5. Acres of larkspur by canyon forks in Manti Canyon, 1960

Forks	Dense	Sparse	Dense to sparse	Total
	Acres	Acres	Acres	Acres
South and Little South	34.5	10.0	20.5	65.0
Hougaard	21.0	7.9	7.5	36.4
Middle	23.3	3.7	57.8	84.8
Lowery	8.4	2.2	.8	11.4
Logger	13.6	4.2	5.7	23.5
Reseeded	8.7	3.9	4.2	16.8
North	15.9	15.4	27.5	58.8
Jolley's	8.2	2.6	36.0	46.8
Total	133.6	49.9	160.0	343.5

Animal Losses from Larkspur Poisoning

Animal losses include death of cows, steers, and bulls and death and weight losses for calves. Other losses such as those from improper management of ranges associated with tall larkspur, abortion, and associated risk and uncertainty must await further research.

Death losses

Death loss comes directly and indirectly from tall larkspur poisoning. The association members incur both kinds of death losses. Cows, steers, and bulls die from eating larkspur and calves die as a result of losing their mothers. These deaths result in the greatest single economic loss suffered by the Manti Cattlemen's Association.

During the period 1956 through 1959 a total of 3,386 adult cattle actually grazed the range (Table 6). The total four-year death loss was 269 adult cattle, or an average annual death loss of 7.9 percent.

A breakdown by class of animals that died from larkspur poisoning on the allotment indicates that 247 cows, 18 steers, and 4 bulls died during the four-year period (Table 7).

The allotment has been generally grazed by breeding stock. A few steers have been put on the range to fill an individual's permit right in years when breeding stock was short. This, of course, accounts for a greater number of cows dying than steers. Steers grazing the allotment were over a year old. Most bulls were 2 years old or over. Some replacement heifers have also been included; however, cows dominated the animal pattern on the allotment in the past.

Table 6. Adult cattle grazing the Manti Canyon allotment and deaths from tall larkspur poisoning, 1956-1959

Year	Cattle on allotment	Death from larkspur poisoning	Percent deaths
	Number	Number	Percent
1956	850	53	8.2
1957	868	58	6.7
1958	818	105	12.8
1959	850	53	6.2
Total	3,386	269	7.9

Table 7. Adult animals that died from larkspur poisoning on the Manti Canyon allotment by class of animal, 1956-1959

Year	Cows	Steers	Bulls	Total
	Number	Number	Number	Number
1956	44	9	0	53
1957	52	5	1	58
1958	100	3	2	105
1959	51	1	1	53
Total	247	18	4	269

Economic losses

Only bulls graded "B" or above are allowed on the forest allotment. Ranchers indicated the average replacement value of a bull to be $525. The association lost 4 bulls from larkspur poisoning. Total value of bulls lost during the 4-year period was $2,100 (Table 8).

Table 8. Number and value of bulls that died from larkspur poisoning on Manti Canyon allotment, 1956-1959

Year	Number died	Price per bull	Total value
1956	0	$ 0	$ 0
1957	1	520	520
1958	2	530	1,060
1959	1	520	520
Total	4	525	$2,100

Ranchers estimated that steers weigh on the average about 800 pounds when they are brought off the range about October 5 (Table 9). Since most animals are sold when they come off the summer range, prices as of October were used to convert pounds of beef to dollars. A total of 14,400 pounds of beef was lost from 18 steers that died from larkspur poisoning from 1956-1959.

Ranchers could give the number of cows that died each year but were unable to distinguish age differences among animals that died. For this reason cows lost were considered to be over 18 months of age. The average weight for cows sold by association members during 1959 was 1,011 pounds. This weight was used to convert cows lost to pounds of beef lost (Table 10).

Table 9. Number and value of steers that died from larkspur poisoning, pounds of beef lost, price of feeder steers for October, 1956-1959

Year	No. steers died	Pounds of beef lost	October price	Total value
1956	9	7,200	$13.00	$ 936
1957	5	4,000	17.45	698
1958	3	2,400	23.38	561
1959	1	800	25.45	195
Total	18	14,400		$2,391

Table 10. Number and value of cows and heifers that died from larkspur poisoning, pounds of beef lost, prices for October, 1956-1959

Year	No. cows died	Pounds of beef lost	October price	Total value
1956	44	44,484	$ 9.90	$ 4,404
1957	52	52,572	13.27	6,976
1958	100	101,100	16.79	16,975
1959	51	51,561	15.70	8,095
Total	247	249,717		$36,450

Weight losses

Weight lost is pounds of beef that could have been produced if no larkspur poisoning had taken place compared to what actually was produced. Only weight lost by calves will be considered. Other animals may eat enough larkspur to make them sick. They may lose weight while sick, but the loss is not generally permanent. The only time weight lost is significant is at the time the animal is sold. It was not determined how much weight was lost by those animals that get sick from eating larkspur and then recover fully.

The four-year death loss was 247 cows. The average calf crop for the association was 85.2 percent for the four-year period (Table 11).

Table 11. Number of cows grazing Manti Canyon allotment and number of calves born, 1956-1959

Year	Cows	Calves	Percent calf crop
	Number	Number	Percent
1956	722	604	83.6
1957	794	657	82.7
1958	803	717	88.5
1959	837	718	85.8
Total	3156	2690	85.2

It was assumed that the percent calf crop would apply to those cows that died. For example, the average calf crop was 85.2 percent and the average number of cows died was 61, so the death of 61 cows left 52 calves motherless.

Permittees estimated one-third of the motherless calves died and the other two-thirds weighed 200 pounds less at the time of sale. Loss from calves was converted into pounds of beef. It was estimated that 400 pounds of beef were lost for each calf that died and 200 pounds of beef were lost for every calf that did not die but lost its mother (Table 12).

Table 12. Number and value of calves without mothers, number that died, pounds of beef lost, prices for October, 1956-1959

Year	No. calves without mothers	No. of calves died	Lbs. of beef-calves lived	Lbs. of beef-calves died	Price per cwt. October	Value of beef lost
1956	37	12	7,400	4,800	$14.85	$ 1,812
1957	43	14	8,600	5,600	18.55	2,634
1958	89	30	17,800	12,000	25.10	6,476
1959	44	15	8,800	6,000	31.35	4,640
Total	213	71	42,600	28,400		$15,561

Of the 213 calves left motherless, 71 calves died. The other 142 weighed 200 pounds lighter at the time of sale. A total of $15,561 were lost from calves for the four years.

Value lost from larkspur poisoning totaled $36,450 from cows, $15,561 from calves, $2,391 from steers, and $2,100 from bulls (Table 13). About

$56,502 were lost from larkspur poisoning during the four-year period. The average yearly loss was $14,126, or $16 per head of permitted cattle.

Table 13. Total value of losses from larkspur poisoning for various classes of livestock, 1956-1959

Year	Cows	Calves	Steers	Bulls	Total
1956	$ 4,404	$ 1,812	$ 936	$ 0	$ 7,152
1957	6,976	2,634	698	525	10,828
1958	16,975	6,476	561	1,060	25,052
1959	8,095	4,640	195	525	13,450
Total	$36,450	$15,561	$2,391	$2,100	$56,502

PROBABLE GROSS BENEFITS FROM TALL LARKSPUR CONTROL

Gross benefits accrue to ranchers in the form of increased income. Income would be increased by having more products to sell if no death losses occurred from poisoning.

Animal Losses Saved

Total economic losses can not be measured completely at this time. Losses other than animal losses occur. For instance, uncertainty increases when grazing larkspur infested ranges since an individual rancher does not know when his losses will be crippling. Because of this, permit value may decrease on ranges where larkspur grows.

During 1958, 818 cattle were grazed on the Manti Canyon allotment (Table 14). Of the 818 cattle, 105 died from larkspur poisoning or a 12.8 percent death loss. This was for the association as a whole. For individual ranchers, the death loss ranged from 3.4 percent for rancher number 7 to 20.7 percent for rancher number 9. The degree of uncertainty leaves the rancher guessing as to what year he may suffer a loss so severe that he would be forced out of the ranching business.

How much is economically feasible to spend on controlling tall larkspur? If death and weight losses could be saved, ranchers with permits to graze Manti Canyon would enjoy about $14,126 additional income each year. They could afford to spend nearly $40 per acre of larkspur on the allotment. Costs for controlling other undesirable range plants is much less than $40 per acre.

Table 14. Cattle grazed, number died from larkspur poisoning, for each rancher and percent death loss on Manti Canyon allotment, 1958

Rancher	Number on range	Number poisoned	Percent
1	67	6	9.0
2	32	4	12.5
3	5	0	0
4[a]	155	29	18.7
5	36	4	11.1
6	42	5	11.9
7	29	1	3.4
8	29	4	13.8
9	29	6	20.7
10	65	4	6.2
11	92	13	14.1
12	67	8	11.9
13	65	6	9.2
14	32	5	15.6
15	36	6	16.7
16	37	4	10.8
17	Non-use	0	0
Total	818	105	12.8

[a]More than one permit.

The big problem now is to find a selective herbicide that will kill larkspur and give desirable vegetation a better chance to grow. Research is being conducted at present by this station and others to determine which herbicide is the best to use, the best rate of application, and the best time to apply it.

Other Losses Saved

The grazing pattern on the Manti Canyon allotment cannot be changed because of elevation. Three units are grazed by 868 cattle at different times. However, the cattle have been held in the middle unit longer while larkspur was at its extreme danger period on the upper unit. Signs of overgrazing are present on the middle unit. Good feed exists on the upper unit and is sometimes wasted by holding cattle off until grasses are headed. As the middle unit becomes more misused, some management practice will have to change. It may be fewer numbers of cattle permitted on the range or lost time on the allotment. If either happens, ranchers will suffer increased production costs per unit of marketable product.

Increased Carrying Capacity

By eradicating tall larkspur on the 343 acres infested with it on the Manti Canyon more area would be available for grazing. Also this would allow better managed grazing. Cattle could be taken from the middle unit a few days earlier, thus giving the middle unit a chance to renovate itself. Eradication of larkspur may not allow any increase in numbers of animals grazed or extend the grazing time of those now permitted but it might prevent a decrease in numbers or time.

SUMMARY AND CONCLUSION

Production of range livestock in Utah is important to the state's economy. A large proportion of Utah's meat is produced on range lands. Much of the range land is federally owned and managed by agencies of the United States government. Alternative uses for range land are limited. One of the more important ways to realize economic benefits from range resources is to graze livestock. Permitees with rights to graze on federal lands count the permits as part of their capital investment in ranching. The range is closely coordinated with privately owned resources. The economic health of many communities depends on this public and private land relationship in livestock production.

Poisonous plants decrease the marketable product causing ranchers to acquire less income. They also decrease the forage by the amount of desirable plants displaced by poisonous plants. Utah range land is infested with several poisonous plants. Some of these plants are poisonous to sheep only, others to cattle only, and others to both sheep and cattle.

Tall larkspur (Delphinium Barbeyi) is the plant with which this study has been primarily concerned. About 868 cattle are grazed on the Manti Canyon Cattlemen's Association forest allotment. Tall larkspur is the most important plant poisonous to cattle growing on the allotment above 7,000 feet elevation. Permittees have suffered death losses from larkspur each year that they have grazed the allotment.

Most severe death losses occurred during 1958. The range is divided into three units by fences. The upper unit is grazed approximately two and one-half months. It is there that cattle deaths occur from eating tall larkspur. Data are lacking for complete economic analysis; however, estimates of death and weight losses were obtained from ranchers.

Average annual economic losses from weight and death amounted to about $14,000 or slightly more than $16 per head of permitted cattle. Total acres of larkspur on the allotment were estimated to be 343. If death and weight loss could be saved, at least $40 per acre of larkspur could be spent each year on control. No cost data were available on controlling Delphinum Barbeyi. However, research on other species of larkspur indicated control costs to be much less than $40 per acre. Research is underway at this and other stations on controlling Delphinium Barbeyi but as yet no conclusions have been drawn. Experts in the field of chemicals have no doubt that it can be killed, but the best herbicide, time of application, rate of application, and cost of kill are still not known.

Other costs should be considered for a complete economic analysis. If revegetation is necessary, this cost should be added to the cost of controlling larkspur. It may be that fencing small isolated areas would be the most economic way to prevent poisoning. Where the plant is scattered over a large area, herding may be a more feasible way to prevent losses from larkspur. Larkspur is scattered over such a big area on Manti Canyon that fencing or herding would not be economically feasible.

Benefits accrue to ranchers other than death and weight loss saved. A greater product could be harvested from the Manti Canyon allotment. This could come in more pounds of beef from the same number of animals weighing more at selling time or more animals could graze the same area. Permit rights might increase in value as larkspur diminished. A larkspur free range would have less risk and uncertainty than a heavily infested range; this would cause less capital to be tied up to tide ranchers over in years of heavy death losses.

Although some of the economic losses were pointed out by this study, more research on cost of controlling larkspur is needed before a complete economic analysis can be made. Research is underway at Utah's Experiment Station and elsewhere to determine the cost of controlling Delphinium Barbeyi. Until conclusions are made on costs of larkspur control, this study can serve to point out losses sustained by ranchers grazing cattle on ranges infested with larkspur. Therefore, the economic analysis of this study will be considered tentative.

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