THE ECONOMIC VALUE OF FORAGE FOR LIVESTOCK
ON PUBLIC AND PRIVATE RANGES IN UTAH

by

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INTRODUCTION

The United States Government controls about 359 million acres of land in the 11 Western States. This vast acreage produces recreation for vacationers, timber for lumbermen, water for city and rural consumption, forage for livestock and wildlife, and minerals for miners. In many cases, the users of these products are competing and are clamoring for a larger share of this land. Consequently, land use is continually changing. Since 1941, the amount of timber cut has tripled, recreation has doubled, watersheds now yield a better quality of water (Clawson, 1957), forage for wildlife has increased, but forage for livestock use has decreased.

The public agencies (especially the U. S. Forest Service and the Bureau of Land Management) that administer this federally controlled land are vitally concerned about being able to effectively and fairly allocate its use. In order that decisions may be made in the light of economic criteria, these agencies are promoting studies in the area of each of the land uses listed above. In cases where society demands other than the greatest economic good, the costs of satisfying the "right" use needs to be determined.

Objectives of the Study

Forage for livestock affects more people directly than any other land use except for sightseeing and recreation (Clawson, 1951). About 17.2 percent of the total feed required for livestock in the 11 Western States is supplied by federally administered lands (Gardner, 1963). Some research has been done regarding the economic value of forage on private
land, but there has been little done in the area of deriving the actual economic value of forage on public range. The purpose of this thesis is to explore that area and provide an essential segment of the information to be used in making public agency decisions.

The objectives of this study are: (1) to determine the economic value of forage per animal unit month\(^1\) on public land in Utah for livestock grazing, and (2) to determine the factors associated with variations in value of forage.

By achieving these objectives, information will be supplied to answer questions dealing with the administration of public lands. Objective (1) will establish forage values while Objective (2) will make possible the prediction of this value outside the immediate study area.

**Review of Grazing History in the West**

When a resource exists in apparently unlimited amounts, it becomes essentially a free good. Supply is so much greater than demand that price becomes zero. Such was the case with the forage on the federal lands of the West in the early 1800's. Few white men had intruded on the West. Instead, this vast land was used only by wildlife and the American Indian.

Livestock was first introduced to the West by the Spaniards via Mexico, Cuba, and Florida (Clawson, 1960). The first cattle in Utah came with the Escalante Exploration Party on their way to Oregon (Walker, 1964). Cattle and horses were allowed to graze free and often ran wild on the ranges (Clawson, 1960).

\(^1\)An Animal Unit Month is the quantity of forage required to maintain a 1000 pound cow for a month.
Until 1870, growth of the livestock industry in the West was relatively slow; but the slaughter of most of the buffalo, subjugation of the Indian, and completion of the first transcontinental railroad set the stage for the rapid growth of the cattle industry in the 1870's (Clawson, 1960). Evidence of the cattle boom can be observed in Utah's cattle census. In 1870, there were 39,180 cattle; in 1875, 174,076; and by 1880, the figure dropped to 95,416. The abundant free forage was an attraction too great to resist, and rich Eastern and European livestock speculators sent many migrant herds, as large as 25,000 head, into the area (Cooley, 1964). By 1878, the vacuum had been filled in Utah and cattle began to be exported (Walker, 1964).

Great fortunes were gained and, in some cases, fortunes lost in the cattle speculating business. A combination of disease, Indians, predators, and changing livestock prices was too much for some livestock companies to withstand (Clawson, 1960). By 1910, many of the large beef cattle ranches had disappeared (Arrington, 1964).

Not long after the cattle boom came millions of sheep. In 1889, there were one million sheep in Utah; by 1899, the number had reached four million. After 1899, sheep numbers began to decline (Arrington, 1964).

During those years, no thought was given to conservation. The explorers and the early pioneers were optimistic about a never ending supply of forage. Typical of their optimism is the statement made before 1870 by General L. P. Bradley: "... I believe that all the flocks and herds in the world could find ample pasturage on these unoccupied plains and the mountain slopes beyond ..." (Stewart, 1924, p. 16). But the supply did run out and the livestock overgrazed the forage to the extent that accelerated deterioration set in. Destructive floods and dust storms
destroyed range soils that had taken nature millions of years to build.

Much of the history of today's livestock industry has evolved from the methods used for federal land disposition. The present day situation and problems have developed from the laws and conservation practices that were established and developed. In order to encourage the pioneers to settle the vast expanse of the North American Continent, the United States passed laws granting land free to anyone willing to take the risk and make the sacrifice of taming the frontier.

Between the years of 1795 and 1820, an attempt was made to sell the land to gain funds to pay off the public debt. Land was sold for prices ranging from $.12 to $2.50 per acre (Stewart, 1924). Land sales were generally unsuccessful, so other land disposition laws were passed.

The Preemption Acts were in effect between 1801 and 1841. Settlers were given the right to occupy 40 to 160 acres for a period of time, at the end of which they were required to pay $1.25 per acre in order to gain title (Stewart, 1924).

In 1862, the Homestead Act was signed by President Abraham Lincoln (Roberts, 1964). This act granted the right of ownership of 160 acres to a pioneer if he would live on and cultivate the land for five years. As an alternative, the land could be purchased for $1.25 per acre when he had lived on it for six months (Stewart, 1924). No one person could claim more than one homestead.

The Timber Culture Act, passed in 1873, granted ownership of land for growing certain amounts of timber. The Desert Land Act of 1877 conveyed 640 acres to an individual if he could find underground water to irrigate the land within three years (Stewart, 1924).
In 1916, the Grazing Homestead Act was passed allowing a rancher to claim 640 acres without cultivation. It was hard for Congress to understand that western land was so unproductive that a single section would feed only a few head of livestock. Several sections were needed to make an economical ranch unit (Stewart, 1912).

These were the main laws for land disposal and were sufficient if the land was productive enough to cultivate. But most of the Western United States was too rough and dry for tilled crops, consequently, its highest use was in the production of forage for livestock; therefore, the disposition laws were inadequate and it was almost impossible for the livestock rancher to obtain ownership of range land.

In 1879, Major John Wesley Powell proposed a system of land classification to make possible the disposition of grazing land that wasn't productive enough to cultivate (Clawson, 1957). This proposal was unacceptable to Congress, but it was said of his idea less than 50 years later: "With nearly a clear field, the application of Powell's wisdom might have meant a far more credible page in the agricultural history of the arid regions." (Stewart, 1924, p. 54).

A rancher had no means by which to obtain ownership of most of the western livestock range, so he did what he could to protect "his" grazing lands. If he could control one or several watering holes in an area, he could exert that same control over grazing (Stewart, 1924).

Ranchers would allow a homesteader to settle on a watering hole and then buy him out. Often he would have his hired hands set up a homestead sometimes taking on fictitious names so that more than one tract could be claimed. After the land was legally established as private property, the hired hand would sign over the ownership papers. Even
though it was against the law to fence free federal range (Stewart, 1924), many ranchers attempted to do so, only to be forced by the law or other ranchers to take them down. Many a range war was fought over a watering hole (Stewart, 1924) or over a barbwire fence (Clawson, 1960). Lives were often the price paid to claim the right to a grazing area.

Any range that the rancher could control or claim took on definite value to him. If he controlled the water holes, the range became useless to anyone else. Consequently, the privately owned land upon which the water hole was located took on the value of the surrounding federal range land to the extent that the rancher was even taxed for that extra value. The range's only watering holes could be sold at a price that included the value of the surrounding federal range (Foss, 1959).

In areas where no control over grazing could be exerted, ranchers would often overgraze their "own" range to make it less attractive to "tramp" herds that might "steal" all the forage and leave a range completely destitute (Stewart, 1924). The attitude of most ranchers was that they might as well graze the forage, because if they didn't, someone else would. They lived by the principle of "first there first served", and often the first there were the only ones served. Because of this attitude the forage on our ranges was rapidly exploited.

The first conservation efforts were not for forage protection, but rather to prevent further exploitation of the timber lands. In 1897, the President was given power to set aside public domain as Forest Reserves (Parkins, 1938). The Forest Reserve Act of 1897 officially gave the Federal Government power to administer grazing (U. S. Department of Interior, Forest Service, 1960). A protective and administra-
tive organization for the Forest Reserves was established in the Department of Interior (Smith, 1930). The Act of 1905 transferred the Forest Reserves to the Department of Agriculture, and fees were charged for the first time on January 1, 1906. The first fees for cattle were $.20 to $.35 per head for the summer and $.05 to $.08 for sheep (Dutton, 1953).

During the years between 1928 and 1931, fees were increased to a price that was slightly lower than the leasing fee charged on privately owned land. An attempt to keep the fee up to date was made by adjusting the 1931 price with the current livestock prices. This method of adjustment is inadequate, and a new appraisal is needed today (Dutton, 1953).

Public domain's free range continued to be overgrazed for 43 years after the first law permitting Presidential declaration of Forest Reserves. By then, the ranchers were clamoring for some kind of controlled grazing. The Taylor Grazing Act of June 28, 1934, gave the authority for setting up the needed Grazing Service. Its purpose was:

To stop injury to the public grazing lands by preventing overgrazing and soil deterioration, to provide for their orderly use, improvement, and development, to stabilize the livestock industry dependent upon the public range, and for other purposes. (U. S. Department of Interior, BLM, 1955, p. 1).

Apparently the Grazing Service was meant to be temporary, because its preamble states: "... that in order to promote the highest use of public lands pending its final disposal ..." (U. S. Department of Interior, BLM, 1955, p. 1). This may have been just a political move to get the Act passed, because no laws were ever enacted to make final disposal of the lands possible. Consequently, the temporary Grazing Service became permanent.
The Department of Interior was given the administrative responsibility of the Grazing Service. The established fees to recover the cost of administration and not to gain revenue (Clawson, 1957). An advisory board, elected from the livestock men, was to be the local governing body (Foss, 1959). The first fee of $.05 per Animal Unit Month (AUM)\(^1\), was decided upon in a mass meeting of ranchers at Salt Lake City in 1936. All agreed this was a fair fee with the exception of the Nevada ranchers who claimed that when they had purchased fee simple range land, the value of the federally administered land was included. Therefore, they had already paid for its use and should not be charged again. This claim was upheld by the Nevada Supreme Court but later repealed by the U.S. Supreme Court (Foss, 1959).

In 1946, the General Land Office and the Grazing Service were amalgamated to form the Bureau of Land Management (BLM) (Clawson, 1951). The following year, fees were changed to a rate of $.08 per AUM. In 1950, the fees were raised to $.12 per AUM, and in 1958, to $.19 per AUM. The 1958 fee was derived by adding the average price of sheep to the average price of cattle for the previous year and dividing by two (Foss, 1959). In 1963, the formula was changed to 150% of the average price of cattle and sheep and the fee became $.30 per AUM.

As each agency (U.S. Forest Service and BLM) was established, ranchers were issued a permit for a certain number of livestock according to rules established. These rules were as follow:

\(^1\)An Animal Unit Month is the quantity of forage required to maintain a 1000 pound cow for a month. Forest Service and BLM Standards call anything from a 6 month old calf to a cow and calf one AUM.
1) Commensurability: The ability of a rancher's fee simple property to supplement grazing on federally controlled range to form a well-balanced, year-round, livestock operation (Clawson, 1950).


3) Maximum and minimum limits on number of permits issued to each rancher. (Applies only to Forest Service range) (Roberts, 1964).

4) Capacity of range according to the quantity and quality of feed (Clawson, 1951).

Permits were at no time to be construed as a right to graze, but rather a personal privilege. Nevertheless, a sales price has accrued to the permits because the grazing fee was less than the value of the forage. Permit values tend to equate the costs of private and public land usage.

The Origin and Present Status of Permit Value

When permits were first established by the Forest Service and the Bureau of Land Management, they had no value. But as soon as a rancher had the claim to a grazing privilege, it took on value because it allowed access to a resource of production. In spite of the fact that the Forest Service reserved the right to decide to whom permits could be transferred, they allowed ranchers the privilege of trading permits when attached to livestock or base property. Transferability of permits has become institutionalized to the extent that "politically and economically, if not legally, range users have established a large measure of right" (Clawson, 1951, p. 295). The transferability has allowed sales value to accumulate for permits (Gardner, 1963a).
It has been argued that the first value that permits acquired was a windfall gain to the rancher owning permits (Roberts, 1963b). This is true to a certain extent, but the argument merits closer consideration. Wherever a rancher had established any claim or control over public grazing land, such as owning all the waterholes in an area or enough private land to force control, the public range had value to him for sale or as a loan collateral. Soon after permits were established, the pseudo value of private land returned to the federal range. In this case, no additional value was created. The sales value of the ranch with permits should have been equal to the sales value of the ranch prior to the establishment of the permit.

On the other hand, there were cases where ranchers had no control over grazing, and therefore, no ability to transfer grazing privileges. They could command no price because any rancher could simply graze the forage that was available. As soon as these ranchers were given permits and grazing control was enforced, they became recipients of a windfall gain in the form of permit sales value.

Few ranchers harvesting forage on public lands today are benefactors of this windfall gain, for most have at some time or another purchased permits from another rancher.

Of all grazing permits on western National Forests, about 40 percent have been held by the same family for more than 30 years; over half for more than 20 years; nearly three-fourths for more than 10 years; and about one-fourth for 10 years or less (U.S. Department of Agriculture, Forest Service, 1953, p. 11).

The value that has accrued to permits since they were first established is nothing more than "Henry George Rent", which has also accrued to all private land.
Each grazing permit is legally attached to private property or "base" land. But all base property does not have the same relationship to the permit. Some base acts as a technical complement to the publicly allocated forage. In order to do so, it must be located so that it falls in the same allotment or is grazed in conjunction with the permit. In this case, some of the permit value often accrues to private land (Roberts, 1963b). Permits and base are so related that when a factor affects the demand for one, the demand for the other is likewise affected.

The other type of base property is the valley pastures and farm land that can be used as a substitute for public grazing. Here the permit will reflect all of the value of the forage, and private land will claim none (Gardner, 1963b). In this case, when the number of permits are reduced, the private land can be used as a substitute, hence, the private land takes on more value. Most of the Forest Service grazing permits in Utah have this type of base property. Ranchers were asked by the enumerator if permits were transferred with base property or with livestock and, in almost all cases, a livestock-permit transfer was indicated. Apparently, there was no transfer of forest permit value to base property.

With the evidence that is available, there should be no question as to the existence of permit value. Yet, there are some who refuse to recognize the existence of this value. The law states that a permit is a "personal privilege" and not a "right" to graze and, therefore, is interpreted to mean it can have no value. But the fact remains, value does exist in permits and is a sizeable investment to the ranch owner. It is the opinion of some who support the view that no permit value exists, that the rancher is to blame, and the loss of investment due
to permit reduction is punishment for creating a value in something that by federal law should have no value.

There is an economic law that states that when something becomes scarce it takes on value, and the more scarce it becomes, the greater is its value. Scarcity is created when demand is greater than supply. There is a physical law, commonly referred to as the "law of gravity", which states that water will run down hill. A man-made law could be passed against either of these, but would have nothing to do with the actuality and effects of either the physical or the economic law. To say that it is a rancher's fault that permits have value is comparable to saying that it is water's fault that it runs down hill. It becomes their fault only because of their existence. Both are subject to natural laws that neither can change.

The question becomes not one of, "does value exist", but, "who recognizes value and who doesn't". Permits have value:

1. to the rancher as an investment and for exchange,
2. to a financial institution as collateral for a loan,
3. to the forage market where value serves as an effective and efficient way of allocating forage among ranchers,
4. for tax purposes; permits are figured at market value when an inheritance tax or a capital gain tax is charged (Williams, 1965).
5. to the Bureau of Reclamation who compensates ranchers for the full value of their loss (including permit value) under the eminent domain process (Verdin, 1965).

No value is recognized:

1. by the Bureau of Land Management and Forest Service,
2. by the State Tax Commission when assessing a property tax; however, when the value of public land has shifted to private land, it is taxed.
The impact of no recognized permit value is very significant to most people who have anything to do with grazing on public range. The effect on the rancher and his ranching operation is probably most important. When permit reductions are made, ranchers are subject to a substantial loss of investment. By 1961, Forest Service reductions resulted in a rancher loss of about $260 million (Gardner, 1963). This loss has caused much rancher antagonism toward the public agencies. Often court trials have resulted causing considerable delay in public agency management action. The lack of legal permit value has hindered the forage market in allowing forage to be allocated in it's most efficient use. (See statistical mean comparison tes, Page 42.) Since financial institutions cannot legally value permits, it hinders them in making loans for the full value of any ranch using public forage. To those outside the ranching situation, it has the effect of making public forage seem much cheaper than private forage. It appears that the only cost to the rancher is the small annual fee that is charged. Marion Clawson (1963), former Director of the BLM called grazing on public lands for such a small fee "petty larceny". In reality, permits do have value and it has the effect of equalizing the costs of public forage with the costs of private forage, therefore, the charge of larceny is an unjust one.

The Recent Trends and Status of the Utah Livestock Industry

The number of cattle in Utah has more than doubled since 1900, increasing from 343,690, to 698,000 by 1962. Since 1924, cash receipts from cattle have increased over 500 percent and have claimed a greater proportion of the total agricultural income (Evans, 1962). The sheep industry has been declining since 1942, to the extent that sheep numbers are lower in Utah today than at any time since 1884 (Thomas, 1950).
A factor indicating the importance of Utah's forage production is the income that range livestock brings to the Utah rancher. Cattle and sheep together brought $62,717,000 in 1963 and $56,016,000 in 1964 (U.S. Department of Agriculture, Statistical Reporting Service, 1964). About 32 percent of the total cash farm income for Utah comes from beef production. The Utah sheep industry ranks eighth in the nation, producing 4.53 percent of the total sheep (Nelson, 1964).

The amount of forage harvested from federally administered land is continually changing. Table 1 and Table 2 indicate the trend of change that has existed for the past 25 years. This trend is expected to continue for the next few years.

Table 1. Change in the number of livestock on Utah's federally controlled ranges

<table>
<thead>
<tr>
<th>Type of livestock</th>
<th>Number on BLM range in 1960</th>
<th>Number on FS range in 1960</th>
<th>Percent change since 1940</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep</td>
<td>1,000,000</td>
<td>400,000</td>
<td>-40%</td>
</tr>
<tr>
<td>Cattle</td>
<td>160,000</td>
<td>200,000</td>
<td>-20%</td>
</tr>
</tbody>
</table>

Table 2. Change in number of AUM's of forage on Utah's federally controlled ranges in Utah between 1951 and 1959a

<table>
<thead>
<tr>
<th>Federal agency</th>
<th>AUM's used in 1951</th>
<th>AUM's used in 1959</th>
<th>Number of AUM's reducedb</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLM</td>
<td>2,597,350</td>
<td>2,337,615</td>
<td>259,735</td>
<td>10%</td>
</tr>
<tr>
<td>FS</td>
<td>552,300</td>
<td>469,455</td>
<td>82,845</td>
<td>15%</td>
</tr>
</tbody>
</table>


bIn many cases FS reductions were in actual use while the BLM reductions were of historical non use (Clawson, 1957).

The number of cattle in Utah is continually increasing, yet the amount of forage supplied by federal lands is continually declining; consequently, private land must carry the extra load. Table 3 outlines the change in private land use since 1925. A larger proportion of private land was being used for pastures in 1959 than in 1925. Sheep ranges have been changed to cattle to help fill the need.

Table 3. Change in use of private lands in Utah between the years 1925 and 1959a

<table>
<thead>
<tr>
<th>Type of land</th>
<th>Acres in 1925</th>
<th>Acres in 1959</th>
<th>Percent increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total in Farms</td>
<td>5,000,724</td>
<td>12,688,518</td>
<td>154%</td>
</tr>
<tr>
<td>Total Cropland</td>
<td>1,563,198</td>
<td>2,007,651</td>
<td>28%</td>
</tr>
<tr>
<td>Total Pastured</td>
<td>3,067,251</td>
<td>10,587,888</td>
<td>245%</td>
</tr>
</tbody>
</table>

Table 4 is an outline of land ownership in Utah. The importance of federally administered range land is readily observed. About 34.3 million acres of the total 36.3 million acres of federal land in Utah is used for livestock forage production. Privately owned grazing land adds 9.1 million acres while state and other lands add 2.8 million, making a total of 46.2 million acres of grazing land in Utah. Forage for livestock is produced on about 87.8 percent of Utah's lands (Reuss, 1951).

Table 4. Land ownership status, Utah, 1961a

<table>
<thead>
<tr>
<th>Agency</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area</td>
<td>54,346,240</td>
</tr>
<tr>
<td>Inland Water</td>
<td>1,649,280</td>
</tr>
<tr>
<td>Total Land Area</td>
<td>52,696,960</td>
</tr>
<tr>
<td>Total Federal Land</td>
<td>36,382,429</td>
</tr>
<tr>
<td>Forest Service</td>
<td>7,913,308</td>
</tr>
<tr>
<td>Bureau of Mines</td>
<td>12,347</td>
</tr>
<tr>
<td>Bureau of Land Management</td>
<td>24,314,289</td>
</tr>
<tr>
<td>Fish and Wildlife Service</td>
<td>89,060</td>
</tr>
<tr>
<td>National Park Service</td>
<td>295,908</td>
</tr>
<tr>
<td>Bureau of Indian Affairs</td>
<td>439</td>
</tr>
<tr>
<td>Bureau of Reclamation</td>
<td>1,851,664</td>
</tr>
<tr>
<td>Department of Defense</td>
<td>1,899,796</td>
</tr>
<tr>
<td>Other Agencies</td>
<td>5,618</td>
</tr>
<tr>
<td>Indian Tribal and Trust Lands</td>
<td>2,370,956</td>
</tr>
<tr>
<td>State Lands</td>
<td>2,985,200</td>
</tr>
<tr>
<td>Private Lands b</td>
<td>10,958,375</td>
</tr>
</tbody>
</table>


bPreliminary estimates
Review of Literature

People with differing viewpoints suggest valuation of forage by various methods. Some of the suggestions are: forage is worth as much as the value of the weight gained by the consuming livestock; it is worth as much as the cheapest alternative feed that will produce the same animal product; forage is worth as much as it contributes to the total ranch income (Nielsen, 1965).

Economic theory was used for private land forage valuation by Johnson and Hardin (1955). The three methods of value determination were defined as follows:

1. **Salvage disposal value** - The value of the forage if leased for pasture.
2. **Acquisition cost** - The cost of purchasing an AUM of feed from the next available source.
3. **Marginal value product** - A measure of the marginal value of the forage in producing livestock products.

The relationship between the three values is illustrated in Figure 1.

For decision making, the relationship between MVP and the two market values is important. As long as MVP is above the acquisition cost, i.e., quantity $OQ_2$ AUM's of forage, more AUM's should be purchased. MVP falls as more AUM's are consumed until it is less than both acquisition price and salvage price, i.e., at quantity $OQ_3$ AUM's. Here the rancher should sell forage until MVP rises above salvage value. If MVP is between acquisition and salvage values, i.e., at quantity $OQ_1$ AUM's, there is no incentive for off-range transfers.
Figure 1. Relationship of acquisition and salvage value to marginal value product of range forage.

To discover the value of forage on publicly administered land the tools of acquisition price and MVP will be used. These values will be studied by examining the law of a free market as it applies to forage on public and private ranges.

In a freely competitive market for grazing services of range lands, both publicly and privately owned, the equilibrium price (for a given quality of service) would be the same for all buyers (users) and equal to the value of the marginal product of the grazing service. (Gardner, 1962, p. 50)

Resource prices serve the function of allocating resources among different uses and different geographic areas. Resources are correctly allocated when they make their maximum contribution to Net National Product. (Leftwich, 1961, p. 323)
It becomes important then, to determine if a freely competitive market exists. Nielsen (1965) points out that the market can be hindered by four different factors: (1) monopoly, (2) monopsony, (3) interference with the price mechanism, (4) non price impediments. By looking at the present marketing situation, it is possible to discover if any of these impediments exist.

Monopoly of federal range does exist, but little monopoly power can be used when the entire forage market is considered. Federal agencies may control most of the grazing in a particular market area; therefore, some influence on the market may be imposed.

Monopsony power may have existed on particular ranges in the past (Upchurch, 1961), but the modern facilities of transportation for livestock to a range area has in most cases made many ranchers potential users.

The public agencies have interfered with the price mechanism by setting their grazing fee below the amount received for forage on railroad, Indian, or private lands (Gardner, 1962). The market, however, has adjusted to this price impediment by creating a permit value that is free to fluctuate with change in economic conditions or policies set by the federal grazing agencies.

The non-price impediments that exist on public range are as follow: (a) Forest Service rules have limited the transferability of permits. If transfer were completely prohibited, there would be no market for forage on federally controlled range (Gardner, 1962). Until 1956, permits were cut by 10 percent when permits were transferred from one rancher to another (Gardner, 1959). Today permits must be transferred with cattle
and/or base property. Ranchers often make the transfer of permits with cattle or land only for the Forest Service records. After the transaction is complete, the cattle or land is often returned to the original owner. The Bureau of Land Management has not placed these restrictions on transfer of permits. (b) Prior use of publicly-owned land for grazing was used to allocate the permits when they were first created, but since that time it has had little effect upon those willing to purchase permits from the original owner. (c) The requirement of commensurability may be a limiting factor if base property must be purchased in order to buy a grazing permit. In Utah, most livestock owners already own private land that will serve as base property; therefore, this requirement has become institutionalized to the extent that it has little effect on the market. (d) The Forest Service has an upper limit and a lower limit on the number of permits that any one rancher may own. Only a few of the largest ranchers would be hindered by this factor. (e) Lack of security in grazing tenure could have an effect on the value of public land forage. Since Forest Service permits have been cut to a greater extent than BLM permits, the effect might be more apparent there. Gardner (1962) pointed out that extensive cuts have not caused a trend of declining permit values; therefore, the effect is probably small. In another study, however, he found that where publicly controlled grazing is secure, ranches with federal range were selling for the same price as ranches without. But where the public grazing was insecure, ranches with federal range were selling for less (Gardner, 1963b).

If restrictions are effective, then a difference in market value will be reflected between the public and the private forage market price.
On the other hand, if the difference between public and private grazing costs has been fully capitalized into permit value, then the non-price impediments have no limiting power on the market (Gardner, 1962; and Neilsen, 1964).

Gardner (1959) studied and compared the costs of grazing on privately owned range versus federally administered range. He discovered that the private leasing fee was larger, but included charges for services not provided by the federal agencies. The extra rancher management expense for public range was estimated and added to the federal fee. The difference between the public grazing fee plus extra expenses and the private leasing fee was capitalized into an estimated permit value. He found a difference between the calculated permit value and the actual permit value and concluded:

If immobilizing productive factors by using non-price rationing criteria reduces their economic value, then a case can be made for misallocation of the factors in the efficiency sense. The inability of the resources to move to their highest economic use impeded economic development by diminishing the product that might have been taken from the resource. (Gardner, 1962, p. 63).

This thesis will use Gardner's basic ideas, but will take a slightly different approach. Total management cost and on site forage value for public range will be compared to similar values on private range. If a significant difference is detected, Gardner's conclusion will be reinforced.

Analytical Procedure

It is hypothesized that public and private forage are produced and sold in the same free market, and the price for each will be similar for comparable ranges. If the hypothesis is true, the MVP of private forage = MC of private forage = MVP of public forage = MC of public
forage. If price impediments exist which hinder the market, this equation will not balance. The following economic models are used in the analysis:

Model one

This model defines the total utilization cost for grazing from the rancher's viewpoint. The total utilization costs are viewed as representing the economic value of the range forage when sold on a competitive market.

For forest range:

\[ Y_1 = F_1 + P_1 C + E_1 \]  \hspace{1cm} (1)

Where:

- \( Y_1 \) = total use costs per AUM for U. S. Forest Service range,
- \( F_1 \) = the Forest Service range grazing fee per AUM,
- \( P_1 \) = the market value per AUM for Forest Service grazing permits,
- \( C \) = the capitalization rate,
- \( E_1 \) = the total non-fee use costs per AUM

For BLM range:

\[ Y_2 = F_2 + P_2 C + E_2 \]  \hspace{1cm} (2)

Where:

- \( Y_2 \) = total use costs per AUM for a Bureau of Land Management range,
- \( F_2, P_2, C, E_2 \) are defined as in formula 1 except for the BLM rather than the Forest Service.

For private range:

\[ Y_3 = F_3 + E_3 \]  \hspace{1cm} (3)
Where:

- \( Y_3 \): total use cost per AUM for grazing on private range,
- \( F_3 \): private range lease fee per AUM,
- \( E_3 \): total non-fee use costs per AUM.

\( F_1 \) and \( F_2 \) are fixed by the public agency, but the \( P's \), \( E's \), and \( F_3's \) are free to fluctuate as market conditions change or as public fees misprice their forage. If the proposition is correct, then \( Y_1 = Y_2 = Y_3 \) and the value of comparable ranges in a certain area can be established by examining either public or private ranges.

The above discussed formulas have partitioned total rancher use costs among resource owners. The \( E's \) are the costs of non-fee services provided by the rancher; \( F_1 \) and \( F_2 \) are society's return from forage harvested from publicly administered land. \( F_3 \) is the private land owners rent. The \( P's \) are actual assets owned by the rancher and are part of the fixed cost of capital investment necessary for using federally controlled range.

Model two

This model is used to estimate value of forage at the site. It is the amount actually paid for forage when no services are provided.

For forest range:

\[
V_1 = F_1 + P_1 c
\]  \hspace{1cm} (4)

Where:

- \( V_1 \): the value per AUM to ranchers of the forage on the Forest Service range site,
- \( F_1 \): the Forest Service grazing fee per AUM,
\( P_1 \) = the market value of Forest Service permits per AUM,
\( C \) = the capitalization rate.

For BLM range

\[ V_2 = F_2 + P_2 C \]  \hspace{1cm} (5)

Where:

\( V_2 \) = the value per AUM to ranchers of the forage at the site on Bureau of Land Management range,
\( F_2 \), \( P_2 \), and \( C \) are defined as in Formula 4 except they are for the BLM rather than Forest Service.

For private range

\[ V_3 = F_3 \]  \hspace{1cm} (6)

Where:

\( V_3 \) = the value per AUM of the forage at the site to ranchers on private range,
\( F_3 \) = the leasing fee per AUM.

The difference between the \( Y \)'s and the \( V \)'s is that the \( E \)'s (the non-fee costs per AUM) have been subtracted from the \( V \)'s. The \( V \)'s then represent the amount which the landlord (public or private) can charge for forage at the site without upsetting the balance between public and private range values.

**Model three**

This model will be used to determine the factors that are associated with use cost variation. The goal is to be able to predict the value of the forage on any range. In order to be useful, this model must explain enough of the variation of the \( Y \)'s in Formulas 1, 2, and 3 to make prediction possible. The formula to be used is:
\[-25-\]

(1)

\[ Y = f (X_i) \]

Where:

\[ Y = \text{total annual cost for forage per AUM for any range,} \]
\[ X_i = \text{the variables that influence } Y \text{ variation (such as death loss, distance to the range, etc.).} \]

**Empirical Procedure**

The data needed to satisfy all the models above were derived from four main sources: (a) Previous research and history, (b) Public agencies, (c) Ranchers, (d) Financial institutions.

All background information was obtained from articles revealing the history of grazing in the West. The Bureau of Land Management and the U. S. Forest Service supplied the physical data needed on each allotment for stratification and analysis of the particular types of range. The ranchers supplies all the cost data used as the P's, E's, and F_3's for Model one and two, and X's for Model three. The financial institutions supplied information on permit values and history and provided explanations for changes in permit value over the years.

Information on range types and the names of private ranch owners were available only as the enumerator entered each area. No preconceived idea as to whom was going to be contacted was formed. BLM, FS, county agents, and other ranchers supplied the names of ranchers that were questioned. All ranges were stratified and sampled according to four different types of distinguishing characteristics. The rangelands were first separated according to type of livestock (cattle or sheep). The next breakdown was made according to who controlled the range: Forest Service, Bureau of Land Management or the rancher. Season of use was broken down into four different seasonal types: winter, summer, spring-fall, and year-round.
The final division was made on the type of range. The three divisions used were valley, mountain, and desert range. The valley category was comprised of pasture, meadow, and river bottom; the mountain classification included all the high ranges used in the summer; and the desert contained foothills and dry desert land.

Each particular range unit or allotment was theoretically isolated for ease of data gathering and analysis. Each allotment was viewed as if it were separate from all other parts of the ranch operation. None of the investments for buildings, machinery, or equipment were included as part of the total grazing costs. It would be erroneous to assume that the computed AUM grazing costs could be totaled for a year to arrive at gross rancher expense. The derived total costs deals only with direct expenses involved in each particular allotment. No costs were included that apply to all types of grazing on a year around basis, such as tax and depreciation on livestock and equipment, etc. No investment for sheep camps, trucks or other equipment was included. Only the variable costs that accumulated while grazing each particular allotment were considered as expenses. The same criteria for costs was used for all types of range so accurate comparisons could be made.

Over 800 observations were made, but because some questionnaires were incomplete, only 635 were used in the analysis. Information was sought for all types of range, but in some cases the number of observations on a particular type of range was too few for dependable analysis. However, enough types had sufficient observations to allow reliable conclusions to be drawn.

Where possible, actual leasing situations on private range were observed; but to insure that an adequate number of observations would
be included in the sample, rancher estimates of leasing costs were also obtained. A statistical mean difference test at the one percent level indicated that both actual and estimated leasing cost questionnaires belonged to the same population. Thus, the ranchers are aware of the leasing market costs in their area. All observations (actual and estimated) were used in the analysis.
DETERMINING FORAGE VALUE

Permit Value

One of the larger costs of grazing on the federally controlled range is the investment that ranchers have in permits. In this section, several different aspects of the permit value are presented to show its importance in the overall ranching picture.

Table 5 outlines the average permit values for the State of Utah. The greatest number of observations were found on BLM winter desert range and on Forest Service summer mountain range, and the average value for cattle permits over the state was $12.08 and $20.15 per AUM, respectively. Sheep permits on BLM winter range sold for $2.35 per Sheep Month,¹ and the Forest Service summer range was $5.23. Figures 2 and 3 outline permit values on a county basis. Value of Forest Service permits for cattle varies from a low of $6.22 per AUM in Juab County to a high of $34.69 in Kane County. BLM cattle permits vary from $5.33 in Carbon County to $19.85 in San Juan.

Financial institution report

The information obtained from the questionnaire that was used for financial institutions throughout the State of Utah revealed the history and trends in permit values. Only 17 of those questioned were able to give the type of information necessary for this study. They had

¹A Sheep Month is the quantity of forage required to maintain a 130-147 lb. ewe for one month.
Table 5. Average permit values for the State of Utah for the various types of range

<table>
<thead>
<tr>
<th>Type of livestock</th>
<th>Controlling federal agency</th>
<th>Season of use</th>
<th>Type of range</th>
<th>Number of observations</th>
<th>Permit value $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>Forest Service Summer</td>
<td>Desert</td>
<td>3</td>
<td>$12.21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bureau Winter</td>
<td>Desert</td>
<td>37</td>
<td>12.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Land Spring-fall</td>
<td>Desert</td>
<td>19</td>
<td>8.52</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Management Summer</td>
<td>Desert</td>
<td>21</td>
<td>10.68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Year-round</td>
<td>Mountain</td>
<td>14</td>
<td>13.51</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>Forest Service Summer</td>
<td>Mountain</td>
<td>48</td>
<td>5.23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bureau Winter</td>
<td>Desert</td>
<td>42</td>
<td>2.35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Land Spring-fall</td>
<td>Desert</td>
<td>4</td>
<td>2.93</td>
<td></td>
</tr>
</tbody>
</table>

Cattle permit values are on an AUM basis and sheep permit values are on a Sheep Month basis. One AUM is equal to five sheep months.
had extensive experience loaning money to ranchers who "own" public grazing permits. Thirteen allowed permit value to be used for collateral toward a loan, and four did not. Collateral value for permits was added to the value of cattle and/or private property to camouflage it for their records.

The change of permit value for the last 20 years was reported by the financial institutions as follows: seven were not familiar enough to comment, five claimed permits had increased in value, and five said there had been little change. When asked about the permit change of value for the last ten years, all except three were able to comment. Three claimed that permit value had increased, and 11 (78.6 percent) claimed permit value had leveled off, with little change in value.

When questioned as to what effect permit reductions, livestock prices, and inflation had on permit value in the last ten years, they reported as recorded in Table 6.

Most of the ten financial institutions that claimed permit reductions had caused permit value to level off agree that while cuts had a depressing value on permits, the reduced supply of forage and higher price for beef pushed permit prices upward, and the overall effect of the two movements caused the value to level off. Another factor causing an upward trend in permit values was that public range, especially Forest Service, had greatly increased in quality during the 20 year period.

Private land values were also studied; fifteen financial institutions claimed that private range value had increased substantially, one said there was no change, and the other did not comment. When asked if the insecurity of public grazing had any effect on the trend of private land prices, ten (62.5 percent) responded that it had pushed prices higher,
Table 6. The effect of permit reductions, livestock prices, and inflation on permit value for the last 10 years in Utah.

<table>
<thead>
<tr>
<th>Cause of permit value change</th>
<th>Financial institutions indicating affect</th>
<th>Effect on permit value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>4</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>increase</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>no comment</td>
</tr>
<tr>
<td>Livestock price</td>
<td>5</td>
<td>little or none</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>increased</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>recently down</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>no comment</td>
</tr>
<tr>
<td>Permit reductions</td>
<td>10</td>
<td>level off</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>down</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>up</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>no comment</td>
</tr>
</tbody>
</table>
six said it had no effect, and one did not comment. Other reasons given as to why private land value had increased are: (1) speculation in areas near larger cities, (2) higher cattle prices and inflation, and (3) private range improvements.

It appeared to most of the financial institution agents questioned that insecurity of grazing tenure has had an effect on permit values on publicly owned range and on the value of privately owned grazing land. Although permit values have not actually decreased, their value increase had been depressed.

Rancher report

The ranchers interviewed were asked to compare the value of public grazing permits and privately owned land 20 years ago to today's value. Although this question was answered only by a relatively small number of the total ranchers interviewed, a trend can be seen.

Table 7 is an outline of the percent increase in value of each type of grazing land. Most of the BLM land is desert or hill land and is comparable to the private desert range. The forest grazing land is similar to the private mountain range. During the 20 years, desert private and desert public ranges increased nearly the same amount. Private mountain range values increased 94 percent more than did the permits of Forest Service range, indicating a rancher preference for privately-leased grazing land over publicly-controlled range. When the 1944 real value is compared to the 1964 real value (adjusted by land value index), the same trend is evident, forest range permits declined in real value, while private mountain range increased.
Table 7. Change in value of privately owned land and grazing permits on federally administered land over the last 20 years (1944-1964).

<table>
<thead>
<tr>
<th>Type of Range</th>
<th>Value 1944</th>
<th>Value 1964</th>
<th>No. obs.</th>
<th>% increase in $ values</th>
<th>% real value change</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLM Permits</td>
<td>4.01</td>
<td>11.61</td>
<td>17</td>
<td>+185</td>
<td>+1</td>
</tr>
<tr>
<td>Private Desert Land</td>
<td>5.12</td>
<td>14.50</td>
<td>36</td>
<td>+183</td>
<td>-1</td>
</tr>
<tr>
<td>Forest Permits</td>
<td>7.30</td>
<td>20.15</td>
<td>8</td>
<td>+176</td>
<td>-3</td>
</tr>
<tr>
<td>Private Mountain Land</td>
<td>4.18</td>
<td>15.46</td>
<td>17</td>
<td>+270</td>
<td>+29</td>
</tr>
<tr>
<td>Private Valley Land</td>
<td>21.41</td>
<td>109.62</td>
<td>32</td>
<td>+512</td>
<td>+73</td>
</tr>
</tbody>
</table>

Total Utilization Cost

In this section, an analysis is presented of the data that fits Formulas 1, 2, and 3 (Page 22). The ranges are stratified into groups that will make them comparable: First, by type of livestock; second, by type of ownership of land; third, by season of use; and fourth, by the particular type of range. Where ranges are comparable on all four of these divisions, the means of their total utilization costs is statistically compared.

Table 8 presents the data for Formulas 1 and 2. The symbols in the rows are defined as follows:

- \( P \) = Average permit value for each particular type of range.
- \( PC \) = Permit value multiplied by the market rate of interest which is 6 percent, thus changing the permit value to an annual cost per AUM in perpetuity.
- \( F+PC \) = On site value.
\( E_a \) = Cost of death loss.

\( E_b \) = Herding expenses while on range. Included both cattle and/or sheep herding where applicable.

\( E_c \) = Livestock water. Includes maintenance of watering holes and water hauling expense.

\( E_d \) = Total distance factor cost. This item includes the cost of moving the livestock to and from the range either by trailing or hauling, and the cost of travel to and from the range while the livestock is there.

\( E_e \) = Miscellaneous operating expenses. These expenses are made up of fence maintenance expense, association fees,\(^1\) salt and supplement feed costs, and other incidentals.

\( \{E\} = \) The total of all \( E \)'s or the total management costs for grazing livestock.

\( Y_1, Y_2 = \) Total utilization costs for Forest Service and Bureau of Land Management forage. The total expense of harvesting one AUM (or Sheep Month) of forage from public range.

Formula 3 for private land requires two tables (Tables 9 and 10) for data presentation. The fees and additional management expense vary with different types of leasing contracts. Six types of leasing agreements were found in Utah. The two most common were selected and used for the entire analysis. The four types discarded were variations of the two selected. In leasing type one, the landlord is given the responsibility

\(^1\text{Ranchers have found that total expense can be lowered by hiring one man to herd during the season, scatter salt for all the livestock and maintain fence, etc. The cost is allocated in the form of association fees.}
Table 8. Costs for grazing on public range in Utah, 1964

<table>
<thead>
<tr>
<th>Type of livestock</th>
<th>Controlling agency</th>
<th>Cattle&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Sheep&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forest Ser. range</td>
<td>Bureau of Land Management range</td>
<td>Forest Ser. range</td>
</tr>
<tr>
<td>Season of use</td>
<td></td>
<td>Summer</td>
<td>Winter</td>
</tr>
<tr>
<td></td>
<td>Mount. Desert</td>
<td>Mount. Desert</td>
<td>Desert</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Summer</td>
<td>Winter</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of observations</td>
<td>192</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>$20.15</td>
<td>$13.51</td>
<td>$10.61</td>
</tr>
<tr>
<td></td>
<td>1.23</td>
<td>.81</td>
<td>.63</td>
</tr>
<tr>
<td></td>
<td>1.80</td>
<td>1.11</td>
<td>.93</td>
</tr>
<tr>
<td></td>
<td>1.09</td>
<td>1.05</td>
<td>1.07</td>
</tr>
<tr>
<td></td>
<td>.27</td>
<td>.10</td>
<td>.24</td>
</tr>
<tr>
<td></td>
<td>.05</td>
<td>.04</td>
<td>.17</td>
</tr>
<tr>
<td></td>
<td>.66</td>
<td>.42</td>
<td>.54</td>
</tr>
<tr>
<td></td>
<td>.42</td>
<td>.34</td>
<td>.30</td>
</tr>
<tr>
<td></td>
<td>2.49</td>
<td>1.95</td>
<td>2.32</td>
</tr>
<tr>
<td></td>
<td>4.29</td>
<td>3.06</td>
<td>3.25</td>
</tr>
</tbody>
</table>

<sup>a</sup>Cattle costs are given on an AUM basis

<sup>b</sup>Sheep costs are given on a Sheep Month basis
of managing the grazing and livestock. His lease fee is higher to cover the extra services provided. In leasing type two, the lessee must manage the forage and livestock. Here the lease fee was less because fewer services were provided by the landlord. Tables 9 and 10 outline the costs of grazing for the two main types of private leasing. The symbols in the rows are defined as follows:

- **F** = Total charge to the lessee for leasing land or forage for grazing.
- **E_a** = Cost of death loss.
- **E_b** = Total herding expense while on range.
- **E_c** = Livestock water, includes maintenance and water hauling expenses.
- **E_d** = Cost of travel to and from range during the grazing season.
- **E_e** = Miscellaneous management expenses that include: fence maintenance costs, any use of a tractor, time spent for irrigation, and other incidental items.
- **E_f** = Cost of salt and supplement feed.
- **E_g** = The cost of moving livestock to and from range by truck or trail, also includes cost of roundup.
- **\{E** = Sum of E's or total management expense.
- **Y_3** = Total utilization expense to a rancher for harvesting an AUM of forage from private land.

In order to facilitate analysis, it was necessary to compare the means of the total cost of grazing for leasing type one and for leasing type two. A mean comparison test indicated that there was no significant difference at the 1 percent level for either cattle or sheep total leasing costs. Statistical analysis for the remainder of model one was completed under
Table 9. Costs of grazing on private range in Utah under leasing type one.

<table>
<thead>
<tr>
<th>Type of livestock</th>
<th>Cattle&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Sheep&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Season of use</td>
<td>Summer</td>
<td>Winter</td>
</tr>
<tr>
<td>Type of range</td>
<td>Valley</td>
<td>Mount.</td>
</tr>
<tr>
<td>No. of observations</td>
<td>54</td>
<td>55</td>
</tr>
<tr>
<td>Fee</td>
<td>$3.89</td>
<td>$3.81</td>
</tr>
<tr>
<td>E&lt;sub&gt;a&lt;/sub&gt;</td>
<td>.47</td>
<td>.64</td>
</tr>
<tr>
<td>E&lt;sub&gt;g&lt;/sub&gt;</td>
<td>.21</td>
<td>.37</td>
</tr>
<tr>
<td>ΣE</td>
<td>.70</td>
<td>1.01</td>
</tr>
<tr>
<td>Y&lt;sub&gt;3&lt;/sub&gt;</td>
<td>4.60</td>
<td>4.83</td>
</tr>
</tbody>
</table>

<sup>a</sup>Cattle costs are given on AUM basis.

<sup>b</sup>Sheep costs are given on a Sheep Month basis.
Table 10. Costs of grazing on private range in Utah under leasing type two.

<table>
<thead>
<tr>
<th>Type of livestock</th>
<th>Cattle&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Sheep&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Season of use</td>
<td>Summer</td>
<td>Winter</td>
</tr>
<tr>
<td>Type of range</td>
<td>Valley</td>
<td>Mount.</td>
</tr>
<tr>
<td>No. of observations</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Fee</td>
<td>$2.96</td>
<td>$2.58</td>
</tr>
<tr>
<td>Ea</td>
<td>.36</td>
<td>.55</td>
</tr>
<tr>
<td>Eb</td>
<td>.38</td>
<td>.21</td>
</tr>
<tr>
<td>Ec</td>
<td>.01</td>
<td>.06</td>
</tr>
<tr>
<td>Ed</td>
<td>.15</td>
<td>.32</td>
</tr>
<tr>
<td>Eg</td>
<td>.71</td>
<td>.14</td>
</tr>
<tr>
<td>Ef</td>
<td>.03</td>
<td>.01</td>
</tr>
<tr>
<td>Eg</td>
<td>.11</td>
<td>.25</td>
</tr>
<tr>
<td>Y&lt;sub&gt;3&lt;/sub&gt;</td>
<td>1.75</td>
<td>1.54</td>
</tr>
<tr>
<td>Y&lt;sub&gt;3&lt;/sub&gt;</td>
<td>4.71</td>
<td>4.12</td>
</tr>
</tbody>
</table>

<sup>a</sup>Cattle costs are given on an AUM basis.

<sup>b</sup>Sheep costs are given on a Sheep Month basis.
the assumption that the Y's of leasing type one and two belong to the same population.

Where enough data was available, mean comparisons were made between the total use cost of similar private and public ranges. The Forest Service administers high summer ranges and the Bureau of Land Management controls lower desert and hill ranges used in the spring, fall, and winter. Consequently, all the comparisons were made between Forest and private ranges and between Bureau of Land Management and private ranges. No comparisons were made between Forest Service and BLM ranges.

The results of the mean comparison tests are presented on Table 11.

Table 11. Private vs. public range comparisons of total use costs per AUM, Utah 1964

<table>
<thead>
<tr>
<th>Range class</th>
<th>Number of observations</th>
<th>Total Average use costs</th>
<th>Statistically significant differences at the 5% level of probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Public</td>
<td>Private</td>
<td>BLM</td>
</tr>
<tr>
<td>Cattle:¹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter desert</td>
<td>37</td>
<td>8</td>
<td>3.25</td>
</tr>
<tr>
<td>Spring-fall desert</td>
<td>19</td>
<td>13</td>
<td>2.80</td>
</tr>
<tr>
<td>Summer mountain</td>
<td>192</td>
<td>68</td>
<td>4.28</td>
</tr>
<tr>
<td>Summer desert</td>
<td>21</td>
<td>7</td>
<td>3.25</td>
</tr>
<tr>
<td>Year-round desert</td>
<td>12</td>
<td>3</td>
<td>4.64</td>
</tr>
<tr>
<td>Sheep:²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summer mountain</td>
<td>48</td>
<td>25</td>
<td>1.31</td>
</tr>
<tr>
<td>Winter desert</td>
<td>42</td>
<td>3</td>
<td>.86</td>
</tr>
</tbody>
</table>

¹Cattle costs are given on an AUM basis.

²Sheep costs are given on a Sheep Month basis.
In all comparisons but one, the difference in average total utilization costs was not significantly different at the 5 percent level; therefore, $Y_1$ could equal $Y_2$ and $Y_2$ could equal $Y_3$. In some cases, the number of observations is small because of lack of leasing of private range; consequently, results in those cases might be questioned. But the evidence points toward the conclusion that a "free market" for livestock forage is operative and has adjusted to the restrictions that have been superimposed upon the public grazing resources for over 30 years.

However, in the case of Forest Service versus private mountain range, further examination is required. The difference is small, but is significant at the 5 percent level. Explanation of this result might be found in the superimposed market restrictions for public range. The same rules apply to both BLM and Forest Service grazing except for minimum and maximum rules that apply only to the Forest Service. Since the sample was taken well within these limits, the effect of this rule would be negligible; but when grazing permit reduction history is examined, a difference is found. Forest Service permit reductions have been larger and more frequent than those of the BLM. Forest Service permit reductions have been cuts in actual use, while the reductions on BLM ranges have, in many cases, merely eliminated historical non-use. The pressure of future reductions is much greater on Forest Service than on BLM because recreation, forestry products, etc., demand more of the mountain land than the desert land. A fear of future permit reductions has apparently had the effect of depressing the market value of Forest Service forage. Evidence presented in the Permit Value section supports this conclusion. If the fear of further reductions were eliminated, the difference between the two would disappear unless other unseen factors play a part in the cause for difference.
On-Site Values

In this section the data for Formulas 4, 5, and 6 will be examined and a statistical mean comparison will be made for the on-site forage values on comparable ranges. The value of the forage at the site represents the actual price that can be charged by the land owner for the forage when no services are provided. The on-site values for public range is adequately presented in Table 8 under the "F + PC" row. For leasing type two, on-site values are presented in Table 10 under the "Fee" row.

The leasing type one fee is the price that the lessee must pay in order for his livestock to harvest the forage under this type of leasing agreement; but this fee includes more than just the value of the forage. The landlord provides additional services. These are services that the lessee provides for the livestock under leasing agreement two. Since actual costs of these services were figured on the same basis for the lessor and the lessee, they should be similar. On-site value for leasing type one was derived by subtracting the cost of the services provided from the fee. These figures are presented in Table 12. The services provided are represented by $S_b$, $S_c$, $S_d$, $S_e$, and $S_f$ and are defined the same as $E_b$ through $E_f$ in Tables 9 and 10.

Where leasing type one and leasing type two were found on the same type of range, a statistical mean comparison test was made for the on-site values. In all cases, no significant difference was found; therefore, the on-site values for the two types of leases were assumed to be in the same population and statistical analysis from this point was carried on with this assumption.
The on-site means were statistically compared for the same ranges that are compared for Y in Table 11. The results are presented in Table 13.

Sheep winter desert range shows a significant difference between BLM and private ranges. Yet on the total utilization cost level, there is no significant difference. The difference that appears between the Y means is reversed to the difference between the V's. The private mean is 2¢ lower than the public at the Y level, while at the V level the private mean is 28¢ higher than the public. By comparing each cost item, it becomes apparent that the ranges are considerably different. In each case where there is a difference in cost, the private forage use costs are cheaper, i.e., death loss is 5¢ less, herding is 5¢ less, total distance cost is 6¢ less, and salt and supplement feed are 10¢ less. Each of these items indicate that the private range is better quality and is closer to the home ranch. Consequently, sheep ranchers are willing and able to pay more rent for the private ranges analyzed here.
Table 12. Costs of the services provided and the on-site value of private leasing type one

<table>
<thead>
<tr>
<th>Type of livestock</th>
<th>Cattle(^a)</th>
<th>Sheep(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Season of use</td>
<td>Summer</td>
<td>Winter</td>
</tr>
<tr>
<td>Type of range</td>
<td>Mount.</td>
<td>Desert</td>
</tr>
<tr>
<td>No. of observations</td>
<td>54</td>
<td>55</td>
</tr>
<tr>
<td>Fee</td>
<td>$3.89</td>
<td>$3.81</td>
</tr>
<tr>
<td>(S_b)</td>
<td>.19</td>
<td>.22</td>
</tr>
<tr>
<td>(S_c)</td>
<td>.04</td>
<td>.03</td>
</tr>
<tr>
<td>(S_d)</td>
<td>.13</td>
<td>.18</td>
</tr>
<tr>
<td>(S_e)</td>
<td>.71</td>
<td>.33</td>
</tr>
<tr>
<td>(S_f)</td>
<td>.02</td>
<td>.04</td>
</tr>
<tr>
<td>(\sqrt{S})</td>
<td>1.09</td>
<td>.80</td>
</tr>
<tr>
<td>(V_3)</td>
<td>2.80</td>
<td>3.01</td>
</tr>
</tbody>
</table>

\(^a\) Cattle costs are given on an AUM basis.

\(^b\) Sheep costs are given on a Sheep Month basis.
Table 13. Private vs. public range comparisons of on-site value per AUM, Utah 1964

<table>
<thead>
<tr>
<th>Range class</th>
<th>Number of observations</th>
<th>Mean annual on-site value</th>
<th>Statistically significant differences at the 5% level of probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Public</td>
<td>Private</td>
<td>FS</td>
</tr>
<tr>
<td><strong>Cattle:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter desert</td>
<td>36</td>
<td>7</td>
<td>1.03</td>
</tr>
<tr>
<td>Spring-fall desert</td>
<td>18</td>
<td>12</td>
<td>.80</td>
</tr>
<tr>
<td>Summer mountain</td>
<td>178</td>
<td>65</td>
<td>1.81</td>
</tr>
<tr>
<td>Summer desert</td>
<td>18</td>
<td>6</td>
<td>.95</td>
</tr>
<tr>
<td>Year-round desert</td>
<td>12</td>
<td>3</td>
<td>1.70</td>
</tr>
<tr>
<td><strong>Sheep:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summer mountain</td>
<td>45</td>
<td>20</td>
<td>.42</td>
</tr>
<tr>
<td>Winter desert</td>
<td>41</td>
<td>3</td>
<td>.21</td>
</tr>
</tbody>
</table>

*Cattle costs are given on an AUM basis.

Sheep summer mountain ranges show a similar relationship to that of sheep winter desert ranges. At the on-site level (V), private forage is more expensive than public, but at the total utilization cost (Y) level, public forage appears more expensive than private. The difference in the total E's is again responsible for variation in on-site costs.

With an understanding of what causes the on-site costs of the private sheep ranges to be significantly different from the comparable public ranges, the other significantly different means are found on the cattle-summer mountain ranges. In model one, the total utilization cost mean comparison test found the same ranges significantly different. Since management expenses have only a small degree of flexibility for changing market situations, and since permit price and private fees will fluctuate, any
factor that would cause total utilization costs to be significantly different would show up at the on-site value level. It is concluded that the same factor that affected the Y's, namely, actual, and expected reduction of grazing permits, has caused the on-site values to differ between Forest Service and private ranges.

Cattle vs. Sheep Forage Markets

A question important to this study is: Does forage for cattle and forage for sheep compete in the same market? To determine if the market price of an AUM of cattle forage and an AUM of sheep forage is similar, several mean comparison tests between cost of cattle forage and sheep forage were made. The results are presented in Table 14. In all cases, the Y's (total utilization cost) were significantly different at the 5 percent level of probability. The V's (on-site value) were only significantly different on Forest Service range, but not on private and BLM range.

The results found at the V (on-site) level can be explained by observing the policies used by each type of range administrator. The Forest Service does not exchange the use of a particular range from sheep to cattle or vice versa on the basis of five sheep for one cow. They make the exchange according to the type and quality of forage available for each type of livestock. Since the rancher cannot exchange five sheep permits for one cow permit, it is not surprising to find the on-site values significantly different. On the other hand, BLM range permits are usually exchanged on a five to one basis. To a certain extent the V's on BLM range are forced to be similar. Only the private range owner can freely change from
Table 14. Total utilization cost (Y) and on-site costs (V) mean comparison between cattle and sheep for all types of range.

<table>
<thead>
<tr>
<th>Total Utilization Cost (Y)</th>
<th>Cattle obser.</th>
<th>Sheep obser.</th>
<th>Cattle mean</th>
<th>Sheep mean</th>
<th>F value</th>
<th>Significant at the 5% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>for BLM ranges</td>
<td>84</td>
<td>42</td>
<td>3.35</td>
<td>4.43</td>
<td>17.45</td>
<td>yes</td>
</tr>
<tr>
<td>for FS ranges</td>
<td>192</td>
<td>48</td>
<td>4.26</td>
<td>6.17</td>
<td>85.71</td>
<td>yes</td>
</tr>
<tr>
<td>for private ranges</td>
<td>189</td>
<td>58</td>
<td>4.60</td>
<td>5.71</td>
<td>20.21</td>
<td>yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>On-site Costs (V)</th>
<th>Cattle obser.</th>
<th>Sheep obser.</th>
<th>Cattle mean</th>
<th>Sheep mean</th>
<th>F value</th>
<th>Significant at the 5% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>for BLM ranges</td>
<td>84</td>
<td>42</td>
<td>1.10</td>
<td>1.04</td>
<td>.54</td>
<td>no</td>
</tr>
<tr>
<td>for FS ranges</td>
<td>192</td>
<td>48</td>
<td>1.79</td>
<td>2.10</td>
<td>12.66</td>
<td>yes</td>
</tr>
<tr>
<td>for private ranges</td>
<td>189</td>
<td>54</td>
<td>3.08</td>
<td>2.85</td>
<td>.88</td>
<td>no</td>
</tr>
</tbody>
</table>

Fee for private leasing type one  

<table>
<thead>
<tr>
<th>Cattle obser.</th>
<th>Sheep obser.</th>
<th>Cattle mean</th>
<th>Sheep mean</th>
<th>F value</th>
<th>Significant at the 5% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>9</td>
<td>3.65</td>
<td>4.50</td>
<td>4.83</td>
<td>yes</td>
</tr>
</tbody>
</table>

\(a\) The sheep values previously given on a Sheep Month basis have been multiplied by five to convert to an AUM basis to make comparison possible.
cattle to sheep or vice versa at any ratio he desires. Since no significant difference is found between the V's on private range, the rancher is probably indifferent as to whether he leases an AUM of forage to one cow or five sheep.

When leasing type one fees are compared between sheep and cattle, a significant difference is found. This occurs because more services are provided by the landlord for the sheep than for the cattle. When forage values at the site are compared, there is no significant difference.

When a rancher is purchasing forage for livestock, he is concerned with what the cost of the forage is to him. In determining this cost, he must look at two different values: First, the fee (for public forage, the fee plus the discounted permit value), and Second, the additional management expenses. The seller of forage must look at the same two values. He cannot raise his lease fee above the point where the total cost of his forage to the purchaser is above the alternative price to the user.

Since the landlord is indifferent as to whether he sells his forage to a sheep rancher or a cattle rancher, he will sell where he can get the greatest return. If the cattle rancher can afford to pay more than the sheep rancher for the same forage or vice versa, the landlord will lease the forage to him. Consequently, both are forced to pay the same price per AUM for forage.

The on-site value reflects the amount actually paid for forage when no additional services are provided. Since the on-site values of forage are not significantly different between cattle and sheep, it can be concluded that the forage for both sell on the same market. The extra management expenses are higher for an AUM of sheep forage than for an AUM of
cattle forage which explains why there was a significant difference in the mean comparison test at the Y level. When the same amount is paid for the forage, the total price is significantly higher for sheep than for cattle.

The Y's reflect the value of the forage to the rancher. Since the Y's for sheep are higher than the Y's for cattle, it might be concluded the forage for sheep has a greater economic value, and therefore, forage should all be shifted to sheep consumption for the greatest contribution to society. If the criterion for economic yield to society is the amount of NNP added, the difference in value might be corrected if the wool subsidy were subtracted. Even with the wool subsidy, it is evident that:

\[
\frac{MVP_s}{P_s} < \frac{MVP_c}{P_c}
\]

Where: \(MVP_s\) = the marginal value product gained from the last unit of forage consumed by sheep,

\(P_s\) = the total price paid for a unit of forage for sheep,

\(MVP_c\) and \(P_c\) = the same as above except for cattle instead of sheep.

The evidence that this phenomena exists is that the sheep industry in Utah is continually growing smaller while the cattle industry is expanding. The difference between costs and returns is smaller for the sheep operator than for the cattleman.

This part of the thesis and the analysis included had the purpose of fulfilling objective number one; namely, to determine the economic value of forage per AUM on public land for livestock grazing. Other

\(^1\) NNP is Net National Product
questions such as: Are fees adequate, and how will a change in fees affect the forage market? were raised. Some information can be given toward answering these questions.

What is the forage value? It has been assumed that the rancher is free to choose how much private forage he will use and, therefore, will consume up to the point where MFC is equal to MVP. The value of private forage is equal to the amount actually paid for it. It has been determined that a "forage market" does exist and the cost of public forage is equal to the cost of private (except in the case of Forest Service). The MVP public forage = MFC public forage = MVP private forage = MFC private forage.¹

The value of an AUM of forage can be estimated by the amount that a rancher will spend to harvest it. The Net National Product is increased by the same amount. This figure can be used to compare the economic value of forage to any other use for multiple use decisions. When range improvement investments are made, the value of the forage added can be determined and used as economic criteria for decision making.

Are fees adequate? In reality, this is not one question but two: Is the public sector paid the market value of the forage? Does the rancher pay in full for the forage? To the first question, the answer is no, but to the second question, the answer is yes. The rancher pays as much for forage on public land as he does for forage on private range, in spite of the fact that the public sector receives only a small part of this value. If the public sector were to glean the full value of the forage,

¹ This assumes that the production equilibrium conditions are such that
\[
\frac{MVP_1}{MFC_1} = \frac{MVP_2}{MFC_2} = \frac{MVP_n}{MFC_n} = 1.0
\]
it could do so only by destroying permit value. If fees were raised to
full value, the rancher would be paying a second time for federal forage.
To expect the rancher to pay double when his margin of profit is already
so small, may cause economic distress to any who depend upon public land
for forage.

The other alternative is to compensate the rancher in full for his
permit before charging the full forage value fee. However, this would
take a large amount of federal funds. If the opportunity cost of the amount
required to fully compensate the rancher for his permits were figured, it
would nullify the added return from the full forage value fee. The public
agency or society's return would be the same as it is at the present.
Several variables contributed to the variation in the total range utilization costs ($Y$). A multiple regression analysis is used to make predicting of $Y$ possible with a minimum number of variables. In the analysis of the previous section, it was concluded that a market was in operation and that $Y_1 = Y_3$ and $Y_2 = Y_3$ for similar ranges; therefore, the total forage value of either type of range (public or private) can be derived by using the type of range from which the data is most readily available.

Some of the variables were discrete and impossible to rank on a gradation basis, so the ranges were stratified in order to make prediction more accurate. Ranges were stratified first on the basis of whether sheep or cattle grazed on the land. Types of vegetation caused some ranges to be classed as cattle ranges and other to be classed as sheep. Since a statistical difference is found between total utilization costs of forage used for cattle and sheep, a different $Y$ must be predicted in each case. Season of use was also stratified on the basis of winter, spring-fall, summer, and year-round grazing. The clearest distinction is made between winter and summer ranges. The summer range is usually the higher mountain land, and the winter range is the lower desert country. Spring-fall range is in the transitional area or the foothills. Season of use has become institutionalized to the extent that it is difficult to transfer one to another even when it might be ecologically proper.

Because of limited observations, only those types of ranges where observations were numerous enough to make analysis reasonably accurate
were used. The X's in the multiple regression for public ranges are as follows:

- \( X_1 \) = Carrying capacity
- \( X_2 \) = Length of grazing period
- \( X_3 \) = Percent of range improved
- \( X_4 \) = Death loss
- \( X_5 \) = Total distance factor costs
- \( X_6 \) = Amount spent on improvement
- \( X_7 \) = Herding during season
- \( X_8 \) = Miscellaneous, includes supplement feed, salt, and incidentals
- \( X_9 \) = Water for livestock
- \( X_{10} \) = Fence maintenance costs
- \( X_{11} \) = Association fees
- \( X_{12} \) = Public fees
- \( X_{13} \) = Discounted permit value

The results of the analysis and the data for the formula used for prediction are shown in Table 15. Only the six statistically significant variables are summarized. The b's were tested for significance, and the results are presented in Table 16. All were found to be significant.

Since private ranges are leased by two different methods, two sets of variables were used, one to fit each type of leasing. For leasing type one, the variables are:

- \( X_{14} \) = Travel expense
- \( X_{15} \) = Livestock water costs
- \( X_{16} \) = Fence expense
- \( X_{17} \) = Irrigation and tractor expense.
Table 15. Multiple regression summary for total use cost on publicly administered range lands

<table>
<thead>
<tr>
<th>Range Class</th>
<th>Coef. of det.</th>
<th>Observations</th>
<th>Death</th>
<th>Distance</th>
<th>Imp. Herding</th>
<th>Value</th>
<th>Misc.</th>
<th>Permit</th>
<th>Exp. disc.</th>
<th>Exp. exp.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y</td>
<td>a</td>
<td></td>
<td></td>
<td>X4</td>
<td>X5</td>
<td>X6</td>
<td>X7</td>
<td>X13</td>
<td>X8</td>
</tr>
<tr>
<td>Cattle:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mount. summer</td>
<td>.7058</td>
<td>.18</td>
<td>192</td>
<td>.68</td>
<td>1.43</td>
<td>-1.24</td>
<td>.67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desert winter</td>
<td>.9207</td>
<td>.44</td>
<td>37</td>
<td>1.11</td>
<td>1.54</td>
<td>1.14</td>
<td>1.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desert summer</td>
<td>.9333</td>
<td>.45</td>
<td>21</td>
<td>1.07</td>
<td>1.65</td>
<td>1.00</td>
<td>.89</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mount. summer</td>
<td>.7990</td>
<td>.59</td>
<td>48</td>
<td>1.03</td>
<td>.99</td>
<td>1.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desert winter</td>
<td>.8988</td>
<td>.2434</td>
<td>42</td>
<td>1.18</td>
<td>.97</td>
<td>1.05</td>
<td>.95</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- $X_1$ = Type of range
- $X_2$ = Land, irrigated or dry
- $X_3$ = Length of grazing period
- $X_4$ = Carrying capacity
- $X_5$ = Percent of range reseeded
- $X_6$ = Animal gain
- $X_7$ = Investment for improvement
- $X_8$ = Death loss costs
- $X_9$ = Cost of moving animals to and from range
- $X_{10}$ = Rate of leasing fee
- For leasing type two, seven more variables had to be added because of the additional lessee expenses.
  - $X_{11}$ = Miscellaneous management expenses
  - $X_{12}$ = Total herding expense while on range
  - $X_{13}$ = Salt and supplement feed
Table 16. Summary of test for significance of b's in the multiple regression analysis for publicly administered range

<table>
<thead>
<tr>
<th>Type of range</th>
<th>b's</th>
<th>Calculated t</th>
<th>Sig. at the .01 level</th>
<th>Partial r</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cattle:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain summer</td>
<td>b₆</td>
<td>292.8</td>
<td>yes</td>
<td>-.49</td>
</tr>
<tr>
<td></td>
<td>b₄</td>
<td>79.3</td>
<td>yes</td>
<td>-0.013</td>
</tr>
<tr>
<td></td>
<td>b₁₃</td>
<td>67.1</td>
<td>yes</td>
<td>.23</td>
</tr>
<tr>
<td></td>
<td>b₅</td>
<td>16.1</td>
<td>yes</td>
<td>.51</td>
</tr>
<tr>
<td>Desert winter</td>
<td>b₈</td>
<td>130.2</td>
<td>yes</td>
<td>.82</td>
</tr>
<tr>
<td></td>
<td>b₅</td>
<td>64.0</td>
<td>yes</td>
<td>.55</td>
</tr>
<tr>
<td></td>
<td>b₁₃</td>
<td>25.4</td>
<td>yes</td>
<td>.63</td>
</tr>
<tr>
<td></td>
<td>b₄</td>
<td>23.2</td>
<td>yes</td>
<td>.25</td>
</tr>
<tr>
<td>Desert winter</td>
<td>b₅</td>
<td>186.3</td>
<td>yes</td>
<td>.66</td>
</tr>
<tr>
<td></td>
<td>b₄</td>
<td>89.3</td>
<td>yes</td>
<td>.41</td>
</tr>
<tr>
<td></td>
<td>b₈</td>
<td>42.9</td>
<td>yes</td>
<td>.41</td>
</tr>
<tr>
<td></td>
<td>b₁₃</td>
<td>16.5</td>
<td>yes</td>
<td>.08</td>
</tr>
<tr>
<td><strong>Sheep:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain summer</td>
<td>b₈</td>
<td>82.0</td>
<td>yes</td>
<td>.55</td>
</tr>
<tr>
<td></td>
<td>b₄</td>
<td>45.7</td>
<td>yes</td>
<td>.52</td>
</tr>
<tr>
<td></td>
<td>b₇</td>
<td>39.1</td>
<td>yes</td>
<td>.49</td>
</tr>
<tr>
<td>Desert summer</td>
<td>b₈</td>
<td>69.5</td>
<td>yes</td>
<td>.65</td>
</tr>
<tr>
<td></td>
<td>b₇</td>
<td>42.4</td>
<td>yes</td>
<td>.70</td>
</tr>
<tr>
<td></td>
<td>b₄</td>
<td>51.4</td>
<td>yes</td>
<td>.60</td>
</tr>
<tr>
<td></td>
<td>b₅</td>
<td>19.1</td>
<td>yes</td>
<td>.38</td>
</tr>
</tbody>
</table>
Table 17 presents the results for the multiple regression analysis on private land. Only the significant variables are included in the table. The b's are tested for significance and results presented in Table 18; all were found to be significant at the 1 percent level.

Table 17. Multiple regression summary for total user costs on leased private range lands. Utah 1964.

<table>
<thead>
<tr>
<th>Range class</th>
<th>Number of obser.</th>
<th>Coef. of det.*</th>
<th>Regression coefficient (b's)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>a</td>
<td>Death costs</td>
</tr>
<tr>
<td>Lease type one:</td>
<td></td>
<td></td>
<td>R²</td>
</tr>
<tr>
<td>Cattle summer valley (Y₃)</td>
<td>54</td>
<td>.88</td>
<td>.8248</td>
</tr>
<tr>
<td>Cattle summer mt. (Y₃')</td>
<td>55</td>
<td>.02</td>
<td>.9375</td>
</tr>
<tr>
<td>Lease type two:</td>
<td></td>
<td></td>
<td>R²</td>
</tr>
<tr>
<td>Sheep spring fall mt. (Y₃'')</td>
<td>16</td>
<td>-.02</td>
<td>.9397</td>
</tr>
<tr>
<td>Sheep summer mt. (Y₃'')</td>
<td>16</td>
<td>.36</td>
<td>.9057</td>
</tr>
</tbody>
</table>

* All significant at the one percent level of predictability.

It should be remembered that in this analysis no cause and effect relationship is intended, but prediction only. The causal factors, however, are evidently closely correlated with the variables included. By using a linear regression formula and the b's given in Tables 15 and 17, it is possible to predict the Y value of an AUM of forage on private or public range.
Table 18. Summary for test for significance of b's in the multiple regression analysis on leased private range lands.

<table>
<thead>
<tr>
<th>Type of range</th>
<th>b's</th>
<th>Calculated t</th>
<th>Sig. at the .01 level</th>
<th>Sample r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leasing type one:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle summer valley</td>
<td>$b_{10}$</td>
<td>86.4</td>
<td>yes</td>
<td>.69</td>
</tr>
<tr>
<td></td>
<td>$b_8$</td>
<td>86.4</td>
<td>yes</td>
<td>.59</td>
</tr>
<tr>
<td></td>
<td>$b_9$</td>
<td>3.26</td>
<td>yes</td>
<td>.30</td>
</tr>
<tr>
<td>Cattle summer mountain</td>
<td>$b_{10}$</td>
<td>687.3</td>
<td>yes</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>$b_8$</td>
<td>250.5</td>
<td>yes</td>
<td>.39</td>
</tr>
<tr>
<td>Leasing type two:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep spring-fall mountain</td>
<td>$b_{10}$</td>
<td>115.9</td>
<td>yes</td>
<td>.77</td>
</tr>
<tr>
<td></td>
<td>$b_{12}$</td>
<td>71.8</td>
<td>yes</td>
<td>.33</td>
</tr>
<tr>
<td></td>
<td>$b_8$</td>
<td>47.9</td>
<td>yes</td>
<td>.39</td>
</tr>
<tr>
<td>Sheep summer</td>
<td>$b_{10}$</td>
<td>109.2</td>
<td>yes</td>
<td>.79</td>
</tr>
<tr>
<td></td>
<td>$b_{12}$</td>
<td>43.3</td>
<td>yes</td>
<td>.23</td>
</tr>
</tbody>
</table>

An important factor in this analysis should be recognized. The Y's and X's were not independently estimated as is required for an accurate multiple regression analysis. With the date readily available, it was impossible to arrive at the X's and Y's independently. Consequently, the calculated b's provide an indication of the relative importance of each type of cost. The importance of each cost category is expressed as a proportion of the total variable cost.
SUMMARY

The objectives of this study are: (1) to determine the economic value of forage for livestock per animal unit month on public and private lands in Utah, and (2) to determine the factors associated with variations in forage values.

Forage value can best be calculated by determining how much a rancher is willing to pay for it. When a competitive market for livestock forage is in operation, the total costs of forage on comparable private or public ranges are equal. If a rancher is free to choose the amount of forage he will use, he will take forage to the point where MVP = MFC (assuming unlimited resources exist). At this point, the value of the forage is equal to the costs.

Forage has two alternative values; namely, sales value and value or return in the form of livestock products. The sales value is the value of the forage at the site, or the price that can be charged for forage. The "return" value is estimated by the variable utilization cost to the rancher which should be equal to the MVP.

To determine if forage sells on a free market, a statistical mean comparison test was made between comparable public and private ranges. These tests were made for both the on-site costs and the total utilization costs. Tests were made between Forest Service and private rangelands, and between BLM and private rangelands.

A prediction formula was derived through a multiple regression analysis. The dependent variable was the range utilization cost, and
the independent variables were those factors that might affect the dependent variable variation.

**Highlights of the Study**

1. Forage on public lands had sales value even before the BLM and Forest Service were established. Since the initiation of publicly administered grazing privileges, permits have had value and have been continuously bought and sold among ranchers. The average value of a Forest Service permit for Utah in 1964 was $20.15 per cow month and $5.23 per sheep month. For BLM winter range the permit value was $2.08 per cow month and $2.35 per sheep month.

2. Most of the financial institutions that were interviewed indicated that the increase in permit value had leveled off in the last ten years because of past and expected permit reductions. They also agreed that private rangeland value has increased because of the uncertainty on public range.

3. Ranchers estimated that private mountain range values had increased by 270 percent while the purchase price of forest permits increased only 176 percent over the last 20 years. Private desert land and BLM permits increased nearly equal amounts during the same period of time.

4. The average utilization cost of forage on Utah ranges was:

<table>
<thead>
<tr>
<th></th>
<th>per cow month</th>
<th>per sheep month</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Forest Service</td>
<td>$4.28</td>
<td>$1.31</td>
</tr>
<tr>
<td>For private mountain</td>
<td>4.79</td>
<td>1.25</td>
</tr>
<tr>
<td>For BLM winter</td>
<td>3.25</td>
<td>.86</td>
</tr>
<tr>
<td>For private winter</td>
<td>3.37</td>
<td>.84</td>
</tr>
<tr>
<td>For private valley pastures</td>
<td>4.62</td>
<td>—</td>
</tr>
</tbody>
</table>
5. The average on-site value of forage on Utah ranges was:

<table>
<thead>
<tr>
<th></th>
<th>per cow month</th>
<th>per sheep month</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Forest Service</td>
<td>$1.81</td>
<td>$.42</td>
</tr>
<tr>
<td>For private mountain</td>
<td>2.96</td>
<td>.60</td>
</tr>
<tr>
<td>For BLM winter</td>
<td>1.03</td>
<td>.21</td>
</tr>
<tr>
<td>For private winter</td>
<td>1.07</td>
<td>.49</td>
</tr>
<tr>
<td>For private valley pastures</td>
<td>2.83</td>
<td></td>
</tr>
</tbody>
</table>

6. The statistical mean comparison test of comparable public and private ranges indicated there were no significant differences either in the on-site values or in the utilization costs; except between Forest Service and private mountain range.

7. The average on-site value of an AUM of cattle forage was statistically compared to the average on-site value of an AUM of sheep forage to determine if cattle and sheep compete in the same market for forage. These differences were not statistically significant which indicates that the two users compete for forage in the same market.

8. The multiple regression analysis indicated that the most important factors that were associated with variation of the total utilization cost were:

   (1) For federal range; death loss, distance costs, permit purchase cost, herding expense, and other miscellaneous expenses.

   (2) For private range; death loss, grazing fee, herding costs, and distance factor costs.
CONCLUSIONS

1. A competitive market for livestock forage is operative and has adjusted to most of the restrictions that have been superimposed upon the public grazing resource.

2. Ranchers pay as much for forage on public range as they do for forage on private range, even though society does not receive full compensation in the form of grazing fees. An attempt by society to capture more value through increased fees will have the effect of making ranchers pay a second time for forage on public range and will cause a loss of wealth in the form of permit value reduction.

3. Since a market for forage does exist, the rancher will feed as much forage as he finds economically feasible, or up to the point where \( MFC = MVP \). Therefore, total utilization cost appropriately reflects the value of the forage.

4. Ranchers prefer forage on private mountain range to that on federal mountain range. Forest Service grazing reductions have decreased rancher demand for permits because they fear loss of wealth invested in grazing permits and range improvements.

5. Forage for cattle and sheep sell on the same market, i.e., on-site values are similar; but it costs more to harvest an AUM of sheep forage than an AUM of cattle forage.
LITERATURE CITED


Stewart, George. 1924. This Public Domain of Ours. Utah Agricultural Experiment Station, Logan, Utah, Circular 49, 55 p.


Virden, Thomas B. 1965. Interview with Land Appraiser, Bureau of Reclamation, Salt Lake City, August 16.


Williams, Blaine D. 1965. Interview with Tax Specialist Internal Revenue Service, Salt Lake City, August 16.
APPENDIX
UTAH FOREST SERVICE, 1963

Date ____________

Allotment ___________________ Cattle _______ Sheep _______

District ______________________ County ______________

Total acreage __________________

Animal units _________ Grazing period: Date on _______ Date off ______

Total AUM __________________

Type of range: Mountain ____ Hill ____ Desert ____ Meadow ______

Type of vegetation: Dry _______ Irrigated ______

Native ____________ Acres or % __________

Reseeded or cleared ____________ Acres or % __________

Improvements Rancher share Forest share

Fence ______________________

Water Development __________

Reseeding ____________________

Roads ______________________

Other ______________________

Grazing privilege

Cuts in last 10 years:

Planned cuts:

Ranchers with cattle on this allotment

1. ______________________

2. ______________________

3. ______________________

4. ______________________
<table>
<thead>
<tr>
<th>Allotment</th>
<th>Cattle</th>
<th>Sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>County</td>
<td></td>
</tr>
</tbody>
</table>

Total acreage: 

<table>
<thead>
<tr>
<th>Type of range:</th>
<th>Mountain</th>
<th>Desert</th>
<th>Meadow</th>
<th>Hill</th>
<th>Other</th>
</tr>
</thead>
</table>

Dry | Irrigated |

Type of vegetation:

<table>
<thead>
<tr>
<th>Native</th>
<th>Acres or %</th>
</tr>
</thead>
</table>

Reseeded or cleared: 

<table>
<thead>
<tr>
<th>Improvements</th>
<th>Ranchers share</th>
<th>BLM share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reseeding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Grazing privilege

Cuts in last 10 years:

Planned cuts:
Ranchers with cattle on this allotment

1. __________________________
2. __________________________
3. __________________________
4. __________________________
### FOREST SERVICE - BLM RANGE

<table>
<thead>
<tr>
<th>No.</th>
<th>Enumerator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>Date 1964</td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
</tr>
</tbody>
</table>

#### District - Unit

<table>
<thead>
<tr>
<th>Allotment</th>
<th>County</th>
</tr>
</thead>
</table>

#### Season of Use

<table>
<thead>
<tr>
<th>Date on</th>
<th>Date off</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Phone</th>
</tr>
</thead>
</table>

#### Number of this rancher's cattle on this range

- Total cows (ewes) on ranch

### RANGE VALUE

#### A. Grazing permit value

- per Au or AUM

1. Includes price of cow (sheep) yes no
   
   If yes, cow (sheep) value

2. Is base property sold with grazing rights yes no
   
   Does it sell for more than the same type of land without public grazing privileges yes no About how much

#### B. Grazing Cuts

1. Past 10 years

2. Future cuts

#### C. Animal Gain

<table>
<thead>
<tr>
<th>Cow (sheep)</th>
<th>much loss</th>
<th>sl. loss</th>
<th>mt. wt.</th>
<th>gn. wt.</th>
<th>excel</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Calf (lamb)</th>
<th>weight off.</th>
<th>Estimate</th>
<th>Actual wt.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Yearling</th>
<th>Estimate</th>
<th>Actual wt.</th>
</tr>
</thead>
</table>
D. Death loss

Cows (sheep)  

Calves (lambs)  

Yearlings  

Cause: 
PUBLIC RANGE OPERATIONAL EXPENSES

A. Investments:
1. Water development _____________ Agency _____________
2. Fence _____________ Agency _____________
3. Roads _____________ Agency _____________
4. Other _____________ Agency _____________

B. Herding:
1. Cattle
   a. During season Days _______ Number of men _______
   b. To and from range Days _______ Number of men _______ Distance ______
   c. Pay per man day _______ per month _______
   d. Herder board ___________
   e. Hay, grain, horse, etc. ___________

2. Sheep
   a. Number of herders ___________
   b. Herder board ___________
   c. Hay, grain, horse, etc. ___________
   d. Amount paid per month ___________

C. Salt:
1. Amount ___________ Cost ___________
2. Days spent scattering salt ___________

D. Drinking water expense:
1. Water development maintenance Days _______ Materials, etc. _______
2. Water haul Days _______ Men _______
   a. Number of trips _______ Distance _______
   b. Truck size: Under 1 ton _______ 1 ton _______ 1½ ton _______ 2-2½ ton _______
   c. Road type: oiled _______ gravel _______ mountain _______
3. Water pumping expense ___________
E. Travel Expense:

1. Haul cattle  yes ___ no ___ Days ___ Men ___
   trucks hired ______ own trucks used ______
   a. Number of trips ______ Distance ______ (round trip)
   b. Truck size: under 1 ton ___ 1 ton ___ 1½ ton ___ 2-2½ ton ___
   c. Road type: oiled ___ graveled ___ mountain ___
   d. Gas $_______ Oil $_______ Other $_______
   e. Hauling contracted
      1. per mile ______
      2. for entire job ______

2. Other trips to the range: days ______ men ______
   a. Number of trips ______ Distance ______
   b. Truck size: under 1 ton ___ 1 ton ___ 1½ ton ___ 2-2½ ton ___
   c. Road type: oiled ___ graveled ___ mountain ___

F. Fence maintenance:

1. No. of man days ______
2. Cost of equipment, etc. $_______

G. Association fees: Amount per AU $_______

H. Supplement feed: yes ___ no ___
   1. What ______
   2. How much ______
   3. Cost ______

I. Other costs or labor:
### PRIVATE RANGE

<table>
<thead>
<tr>
<th>No.</th>
<th>Enumerator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sheep</th>
<th>Date 1964</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>County</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Season of use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Type of range**
- Mt.
- Hill
- Desert
- Field
- Meadow

**Type of forage**
- Native
- Improved
- Irr.
- Dry

### LESSOR

<table>
<thead>
<tr>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

### LESSEE

<table>
<thead>
<tr>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

#### A. Rental fee

<table>
<thead>
<tr>
<th>Actual</th>
<th>Estimate</th>
<th>Lease fee</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **Per cow**
   - Per sheep
   - Per acre

2. **Per pair**
   - Total fee

3. **Yearling**
   - Per lb. gained

#### B. Carrying capacity

<table>
<thead>
<tr>
<th>Acres</th>
<th>Number of cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### C. When grazed:

<table>
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<tr>
<th>J_F_M_A_M_J_J_A_S_O_N_D</th>
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#### D. Animal Gain

1. **Cow (sheep)**
   - mch loss
   - sl. loss
   - mt.wt.
   - gain wt.
   - excel

2. **Calf (lamb)**
   - wt. off
   - Est.
   - Actual

   **Age taken off range**

3. **Yearling**
   - lbs. gained
   - Est.
   - Actual

---

### Death Loss:

1. **Cows (sheep)**
   - Cause:

2. **Calves (lambs)**

3. **Yearlings**
F. Land value:

1. Original value ________________ Date __________________

2. What will it sell for today? _____________________________

Other investment in land or capital

1. Fence: original cost __________ Date __________________

2. Water Development: cost ___________ Date _____________

3. Corrals, etc.: cost ______________ Date _______________

4. Other: cost ______________________ Date _____________
PRIVATE RANGE SERVICE COST

(Lesser Expenses)

A. Property tax for this range

Assessed value

Taxing rate

B. Herding expenses

During season: days

Number of men

Pay per man day

Per month

C. Lessor Salt Expense

How much salt

price (or value)

Days spent scattering salt

Number of men

Cost

D. Drinking water maintenance: Days

Number of men

Materials, etc. $

1. Water Haul Expense: Days

Number of men

a. Number of trips

Distance

b. Truck size: under 1 ton 1 ton 1½ ton 2-2½ ton

c. Road type: oiled gravel ed mountain

2. Water Pumping Expense:

E. Travel Expense: Days

Number of men

1. Number of trips

Distance

2. Truck size: under 1 ton 1 ton 1½ ton 2-2½ ton

3. Road type: oiled gravel ed mountain

F. Fence Maintenance: Number of man days

1. Cost of materials and equipment $

G. Tractor tillage and seeding expense:

Days Cost per day Seed and supplies

H. Irrigation: Number of man days

Cost per day

1. Water assessment
I. Lessor supplement feed expense:
   1. What
   2. How much
   3. Cost

J. Lessor death loss expense:
   Average loss Cost

K. Other expenses:
PRIVATE RANGE EXTRA EXPENSE

(Lessee cost above private fee)

A. Herding Expense:
   Cattle:
   1. To and from range: Days_____ Number of men_____ Distance_____  
      Pay per man day______ or month ________

   Sheep:
   1. Number of herders ___________ pay per month __________  
      Herder board _______________ hay, grain, and horse, etc. ___

B. Lessee salt expense:
   1. How much salt ______ cost ________
   2. Days spent scattering salt ______ number of men ______

C. Travel Expense:
   1. Haul cattle? yes ____ no ____ days ____ men ____
      a. Number of trips ______ distance (round trip)
      b. Truck size: under 1 ton__ 1 ton __ 1½ton__ 2-2½ ton ___
      c. Road type: oiled ______ graveled ______ mountain _____

D. Lessee supplement feed expense:
   1. What ______________
   2. How much ______________
   3. Cost ______________

E. Lessee death loss expense:
   Average loss ____________ Cost ______________

F. Other:
FINANCIAL INSTITUTION ________________________________
Address ________________________________
Name ________________________________

I. Are permits allowed for collateral? Yes ______ No ______
A. How much of the permit sales price is allowed? ________________
B. Have you allowed more in the past? ____________________________

II. What is the sales value of a public grazing permit?
   A. Forest service: Cattle ________________
       Sheep ________________
   B. B.L.M. Cattle ________________
       Sheep ________________

III. What has been the history of a permit sales value?
    1920
    1930
    1940
    1950
    1960
    1964

What are the causes of this change?
A. Grazing cuts:
B. Change in price of beef:
C. Inflation:
IV. Has the cut or fear of cuts had any effect of the value of private grazing land?

V. Are there other causes for the change in value of private land? Speculation or income tax evaders?

VI. Is there private range that is comparable to public that you can give me the price of?