5-1961

Economics of Managing State-Owned Grazing Lands

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ECONOMICS OF MANAGING STATE-OWNED GRAZING LANDS

by

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A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Agricultural Economics

UTAH STATE UNIVERSITY
Logan, Utah

1961

ACKNOWLEDGMENT

Appreciation is expressed to Professor E. M. Morrison, Acting Head of the Department of Agricultural Economics, and to each member of the committee in charge of my graduate program for their helpful suggestions.

I am indeed grateful to Dr. N. K. Roberts, project supervisor, for his sincere interest and helpful suggestions given throughout this study.

Special thanks is given to Frank J. Allen, Director of the State Land Board and members of his staff, who made available records of the Land Board and provided work space for collecting data. Thanks is due Bureau of Land Management District offices in the state who also made information available for this study and to Harold Hiskey who helped gather the data.

Gratitude is expressed to my wife, Jeanne, for typing the preliminary copies and for her helpful suggestions and to others who have helped in any way during this undertaking.

Lowell R. Anderson

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CHAPTER I

INTRODUCTION

Range land is an important resource in Utah's economy. Of 52.7 million acres of land in Utah about 78 percent is used for production of range livestock (14).[1] In 1958, cash receipts of range livestock amounted to 62.7 million dollars, or 38.8 percent of Utah's total agricultural cash receipts (19).

Of total land within its boundary, the state owns 2,723,157 acres, or 5.17 percent (32). The state legislature has designated the Utah State Land Board as the responsible agency for administering this land to provide income for various state institutions.

The people of the state of Utah are required to pay for the operation of common schools and other public institutions. Many of these tax supported institutions are partly financed by interest from permanent school funds. As the cost of operating these institutions is growing each year, it is in the interest of the state that the permanent school funds yield as much revenue as possible. It is important that management of state land be such that the greatest possible revenue from the resource be forthcoming.

The State Land Board (hereafter referred to as the Board) does not have the knowledge that can be developed from research on the income possible from management alternatives. Can state lands be managed differently to increase state revenue? The answer to this problem is important

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[1]Numbers in parenthesis refer to references listed at the end of the thesis in "References."

if the Board is to make decisions which will maximize future returns to the state from state-owned lands.

Revenue received from state land comes from: first, leases both mineral and grazing; second, interest on funds invested from sales of land; and third, oil and other royalties.

This study will be limited to revenue received from grazing. It is realized that other sources of income are important; however, studies now in process will place emphasis on revenue from mineral leases, royalties, and investments.[1] Many problems are involved in receiving revenue from grazing leases. It is difficult to keep all land leased. The central problem of leasing state land is the physical task of providing supervision because of the land being scattered throughout the state in tracts of approximately 640 acres among lands of other ownership. Effective supervision of these scattered lands becomes difficult if not impossible. As a result of ineffective supervision, it is no secret that state lands have not increased or even maintained original productivity. In past years the state has not been able to lease all of its land; yet some unleased land has been used by various livestock men in the state. Because of the lack of personnel and scattered location of the land, it has been impossible for the Board to prosecute livestock men or restrict the use of the land. This results in a loss of income to the state.

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[1]Bureau of Economic and Business Research at the University of Utah is in the process of making an analysis of mineral leases. Under a grant from the Land Board the Utah State Experiment Station will analyze investment possibilities.

In the present situation it is difficult to fix carrying capacity on much of the state land. Land examiners employed by the state have time to appraise and work with trouble leases only. This leaves much state land receiving little or no attention.

Objectives of Study

This study will analyze two alternative management practices in an attempt to partially answer some of the state land management problems. These alternatives will be concerned with comparing revenue from state-owned lands with the present situation. Therefore, the objectives of this study are: First, to determine present grazing use status of state-owned land; second, to determine income alternatives from clustering unimproved state-owned lands within Bureau of Land Management (BLM) District 7; third, to discuss costs and benefits from improving state-owned land clusters within the same district. Also, the development of state land policy will be described.

Sources of Data and Method of Procedure

Background and early developments of Utah land policy and land grants came from secondary data as referenced.

Bureau of Land Management and State Land Board offices were contacted to obtain information on status of state land. BLM districts were used as areas of division. State land was analyzed in relation to grazing units within BLM grazing districts. Data for this part of the study were obtained from BLM district offices throughout the state. Grazing lease records from the Board office were used to determine the amount of state land within each grazing unit.

The most detailed analysis was limited to BLM District 7. The analysis of this district is used to illustrate what may be possible in all 11 BLM districts in the state. The alternative of clustering land within District 7 was determined by land trading ratios. Data used were the number of suggested acres per animal unit month in each unit and the total number of acres in each grazing unit. Information was taken from records in the BLM District 7 office in Price, Utah. The number of state-owned acres within each grazing unit were gathered from the Board office.

Information for objective number three came from results of research on costs and benefits of range improvement practices. The BLM office at Price was able to provide costs of some improvements in District 7.

Review of Literature

No previous studies have been made to determine income to the state from land management alternatives. Several studies have been completed that have considered some phases of administration of state land.

Henry A. Dixon made an investigation of the permanent school funds and procedures of the Board from its beginning through 1935. From the study he made three observations of weaknesses in organization and operation of the Board. First, it was politically controlled; second, it made no provisions on the Board for direct representatives of beneficiaries; and third, the multi-headed system caused confusion and prevented fixing of responsibility (5).

William P. Miller completed a doctoral dissertation in 1949 which explored developments in public school land policies in Utah. This work

gave special attention to effects that Dixon's study had on the financial procedures of the Board (10).

Seth Evans in a master's thesis at the University of Utah analyzed the accounting system used by the Board in its activity of land management and investment of school funds. Various recommendations for improvement in accounts of the grantee institutions were made (6).

Arthur D. Smith of Utah State University recently completed a study entitled "The Status of Federal Land Grants in Utah and Proposals for Their Management." This study was directed to state lands as a resource and departed from importance of revenue to state institutions. Objectives of this study were: First, most effective and desirable ownership of lands; second, means of effecting this ownership; and third, means by which original purposes of the land and the interest of the state might best be served.

Smith concluded that land in state ownership was of such low value that much of it was not well suited to private ownership. Other lands, though sufficiently high in value to justify private ownership, have important public values. As a result he deemed it inadvisable to sell state lands. A new organization was proposed in place of the present Board. The new department would be known as the State Land and Forestry Commission. Activities of the present Board and Forestry and Fire Control Board should be merged into one department. The commission should be composed of á group of individuals representing various governmental and private interests. Smith also saw a need for an exchange of state lands, grouping them in tracts which would offer adequate possibilities for supervision (16).

In addition to the above, studies have been made on a national level indicating the status of all land grants made by the United States for education. None have had direct application to the subject matter of this study.

CHAPTER II

HISTORICAL FRAMEWORK

This chapter briefly outlines the origin of land grants in the United States and more particularly the history of public land grants in Utah. It is included for the purpose of giving a background to problems of state land management. The problems are actually an outgrowth of many years of administration of state land.

Origin of Land Grants in the United States

The Continental Congress in 1780 proposed that states cede their land claims to the national government and thus create a national domain from which future states might be carved. New York in 1781 made the first cession and in following years the other original state relinquished their land claims to the national government.

In order to make distribution of the land, the government adopted a rectangular form of land survey under which a new territory was laid out into townships six miles square. Each township was in turn subdivided into sections one mile square and into quarter sections, and a regular system of numbering for each was begun (Figure 1).

Ohio was admitted as a state in 1802. It was the first state to be carved from the national domain and represented the initial land grant to aid education by the national government. When becoming a state the problem arose as to whether or not federal land lying within the new state

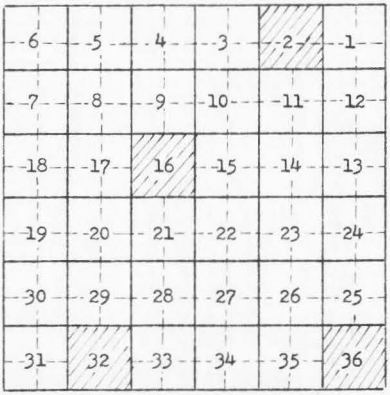


Figure 1. A congressional township showing sections, quarter sections, plan of numbering, and location of sections 2, 16, 32, 36

could be taxed. Congress offered section 16 in each township for schools if the new state would not tax federal land or the purchasers of federal land for a period of five years after the purchase. This policy was followed with each new state except Texas, West Virginia, and Maine. Texas owned its land when admitted to the Union, whereas West Virginia and Maine were created from original states. When California was admitted in 1850 sections 16 and 36 were granted (Figure 2). Between 1850 and 1896 all new states received these two sections; however, with admission of Utah in 1896 sections 2, 16, 32, and 36 were granted for school purposes (3).

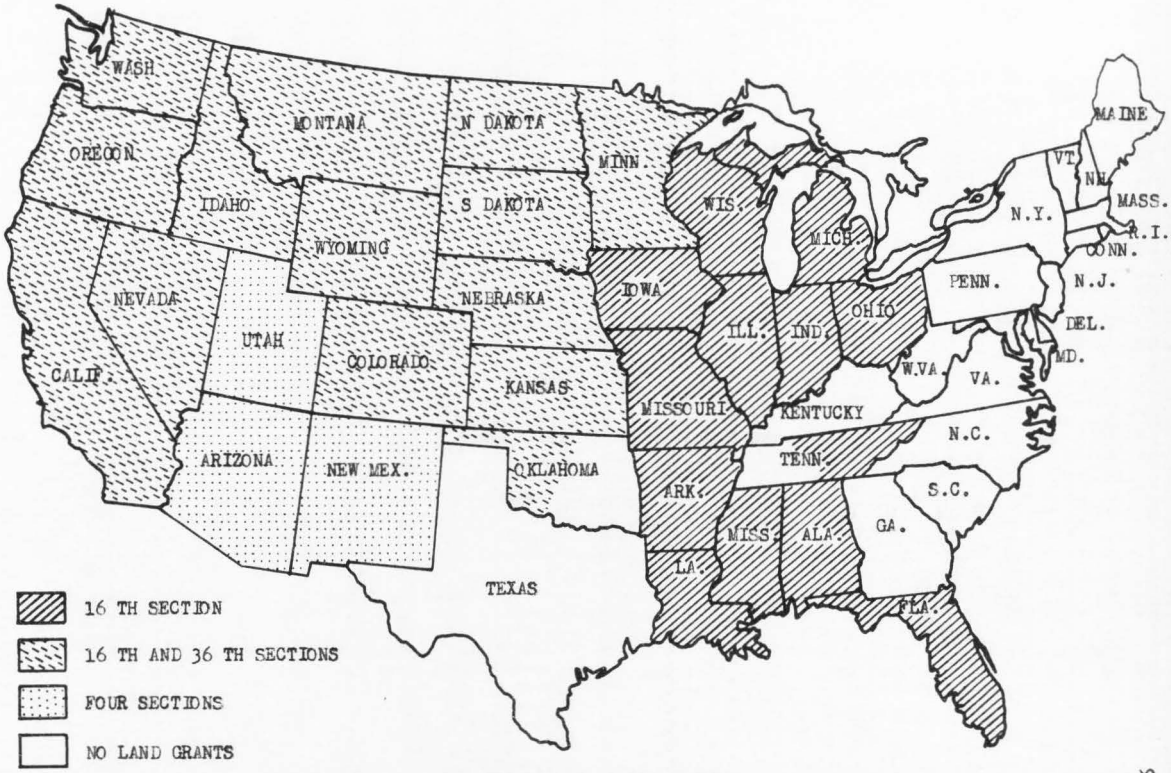


Figure 2. Land grants for common schools

Land Grants to Utah

Four sections in every township in the state were granted for the support of the common schools. Besides the grant to the common schools, other institutions were given specified amounts of land to be chosen by the state. In all, the federal government gave the state of Utah over one-ninth of the land area within its borders, or approximately 7.4 million acres (Table 1).

The federal government gave this grant of land to the state of Utah on the following conditions: First, the proceeds from the sale of these lands were to become a permanent fund; second, only the interest from the land could be spent; third, the interest from the fund was to be spent only for the support of designated state institutions (28, p. 107). Provisions stipulated above were accepted by the state of Utah.

Organization of land agency

To allow for provisions set forth by the federal government the state legislature established the first Land Board in 1896 (37). This Board consisted of the Governor, the Secretary of State, the Attorney General, and two resident citizens of the state. The next year organization of the Board was changed slightly by an act of the state legislature "to consist of the Governor, the Secretary of State, and five resident citizens of the state, who shall be appointed by the Governor, by and with the consent of the Senate." (36, p. 7)

Changes in the Board have been rather frequent since statehood (Table 2). Dixon observed that from the time of statehood until 1935 (a period of forty years) there had been eight reorganizations of the

Table 1. Federal land grants made to Utah under various legislative acts[1]

Purpose of grant	Area granted (acres)	
Agricultural College	200,000	
Normal School	100,000	
School of Mines	100,000	
University	110,000	
Common Schools (sections 2, 16, 32, 36)[2]	5,844,196	
Total educational grants		6,354,196
Deaf and Dumb Asylum	100,000	
Utah State Hospital	100,000	
Institute for Blind	100,000	
Miners' Hospital	100,000	
State Industrial School	100,000	
Total institutional grants		500,000
Public buildings	64,000	
Reservoirs	500,000	
Carey Acts[2]	37,240	
Total other grants		601,240
Grand total		7,455,436

[1]Utah Land Board. Biennial Report of the Land Board, July 1, 1954 to June 30, 1956. Salt Lake City, Utah, p. 21.

[2]Reuss and Blanch (14, p. 47).

Table 2. Organization of the Utah State Land Board from statehood to the present[1]

Period	Composition	Terms of members	Title
1896-1897	Governor, Secretary of State, Attorney General, and two resident citizens	Elected for 4-year terms	State Board of Land Commissioners
1897-1901	Governor, Secretary of State, and five resident citizens	2 years	(same)
1901-1905	Governor and four resident citizens	2 years	(same)
1905-1921	Five resident citizens	2 years	(same)
1921-1925	One commissioner	4 years	State Land Commissioner
1925-1931	Governor, Secretary of State, and Attorney General (Identical to the State Board of Loan Commissioners)	Elected for 4-year terms	State Land Board
1931-1937	Three resident citizens[2]	6 years	(same)
1937-1941	Five resident citizens[3]	5 years	(same)
1941-1957	Three members of the Commission of Finance	6 years	(same)
1957-	Five resident citizens (one representative from each of the five districts)[4]	6 years	(same)

[1]Laws of Utah. (Compiled to 1941 by Smith)

[2]Per diem basis, except for one who was named by the governor to be the executive secretary.

[3]Per diem basis. An executive secretary was employed

[4]Per diem basis. A director was appointed by the Board and employed full time.

Board or an average of a change every five years (5, p. 73). The 1957 legislature created the present Board which is composed of one representative from each of five districts into which the state is divided (Figure 3).

Organization of the present Board taken from Utah Laws reads as follows:

> The State Land Board shall be composed of five members not more than three of whom shall belong to the same political party appointed by the Governor, with the advice and consent of the Senate for a term of six years, except that two of the first Board members appointed shall be designated to serve for only two years, and one of the first board members appointed shall be designated to serve for only four years in order that thereafter the terms shall be staggered, with the terms effective April 1 of the odd numbered years. For the purpose of appointment to the Land Board, the State shall be divided into five districts . . . . The Governor shall make appointments to the Land Board in such a manner that each district will have one resident on the Board. Each member appointed shall receive a per diem remuneration to be determined by the Board of Examiners for each day spent in the performance of official duties, and shall be reimbursed for all necessary expenses incurred while performing such official duties including travel expenses. One member of the Board shall be designated by the Governor as chairman . . . .
>
> Three members of the Board shall constitute a quorum for the transaction of business.
>
> The Land Board, with the approval of the Governor, shall appoint a director for a six-year term or until his successor has been appointed and qualified, who may be removed for cause by the Board after holding a public hearing. The director must be a qualified executive in land management. The director under the supervision of the Land Board shall administer all land laws within the jurisdiction of the Land Board and perform such other duties as may be provided for by law. Unless otherwise provided by law or authorized by the Land Board, he shall not hold any other public office, nor any office in a political party or organization and shall devote his entire time to the service of the State in the discharge of his official duties. The director shall receive as salary a sum of money to be determined by the Land Board. He shall furnish a bond in such amount and kind as shall be determined by the Commission of Finance, which said bond shall not be less than $25,000 and conditioned that he will faithfully perform his duties, safely keep and

Figure 3. Districts for the purpose of appointment to the State Land Board (Source: Utah Laws, 1957)

> account for all funds, securities, documents, and papers entrusted to his care, and upon expiration of his office deliver all funds, securities, documents and records of his office to his successor. (38, p. 342)

Sale of state land

In past years state policy has been to transfer state-owned land to private ownership. Utah has approximately 2.5 million acres, less than half of the original grant (25, p. 74). Smith indicated several methods were employed by the state to sell land. These were designated as public, private, preference, selection, relinquishment, and Carey Acts sales (16, pp. 19-23).

First, for the most part, common school grants were disposed of under the first three of these methods. A land appraisal was made prior to offering the land at public auction. The appraised value was to be the minimum acceptable price. Second, after the land had once been offered at public sale and remained unsold, it could be sold at a private sale. Third, preference sales were made only to persons who were found to be occupying school sections at the time of the land survey. In such instances the occupant was permitted to purchase the land at private sale for not less than $1.25 an acre without its first being offered at public auction. The purchaser must,however, have occupied the land for at least two years and have made application to purchase within six months of the time the survey plans were filed in the county offices.

Fourth, selection procedures apply to the land granted under the "floating grants." These grants were satisfied by selection of lands anywhere within the state except in federal reservations. The Board

was authorized to sell selected lands at private sale without appraisal in 1899. Fifth, relinquishment sales were essentially identical in operation to other selection sales. Many settlers who had filed homestead entries under federal laws found it convenient to relinquish these entries and make application to the state for selection of lands. Securing a title was simpler under state procedures than under federal provisions. Sixth, Carey Acts were several laws known as desert land acts. They provided for obtaining title to arid desert lands subject to their being reclaimed through irrigation.

Acreage limitation to sales

Throughout the period of disposal laws have restricted the amount of land that could be bought by one individual. The law adopted in 1896 specified that not more than 160 acres of land suited to cultivation could be sold to one individual; however, no reference to grazing land was made at that time. The first acreage limitation on grazing came in 1917 when it was specified that 2,560 acres would be the maximum for grazing purposes (16, p. 23). In the last decade there have been very few sales of any number of acres. The Board states this policy as follows:

> For the present, at least, due to the difficulty in investing state funds and to avoid the possibility of any loss in the postwar adjustment and transition, a policy has been established not to sell lands in any quantity. Only small, isolated tracts which are not producing any revenue and which are difficult to administer are now available for sale.(35,p.4)

Leasing state lands

As a means of gaining revenue, the legislature provided that lands which remained unsold could be leased for not less than 2 percent of

their appraised value per year. The first Board reasoned the leasing as follows:

> Instead of having our valuable ranges devasted and destroyed by roving and predatory bands of sheep and cattle from other states and territories, these lands will be leased to our own citizens for their own benefit, who will be interested in protecting same from these annual excursions . . . protected by the watchful eye of the lessee and improved by occupancy, they will rise gradually in value from year to year and prove an increasing source of revenue to the state. (31, p. 23)

Early policies regarding leases were to make them short in the belief that the appraised value of land would rise and thus rentals could be increased. As time passed, longer leasing terms became the rule. The reason for longer leases is explained by the Board:

> We desire to cooperate with all agencies interested in the stabilization of the livestock industry and the preservation of our range resources. Longer term leases are being granted to avoid unnecessary trailing and range depletion. (34, p. 9).

A typical lease at the present time is 10 years. Upon expiration of a lease, the Board does not have to re-lease to the same individual. In case of multiple applications the Board is authorized to receive bids and to accept the highest bid. This procedure is still provided by statute (29, p. 330) although the policy stated in 1942 of giving preference to the previous lessee appears to have been the recent practice (35, p. 4).

Until recently no effort was made to regulate the use of leased state lands. Leases are granted now subject to the following terms and conditions:

> 1. Lessee shall have the right to use the above described property only for the purpose of grazing livestock, and lessor reserves the right to determine the number and kinds

of livestock which may be grazed and to determine the number of days and seasons of the year during which such livestock may be grazed.

2. Lessee shall pay lessor as a rental the sum of _____ cents per acre per year in advance. Lessor reserves the right to adjust the rental at the end of any year during the term thereof, if in lessor's opinion such a change is indicated by range survey, or because of sale or lease of the leased premises.

3. Lessor may sell the above described property, in whole or in part, as it may desire, and lessee shall quit the premises at the end of the calendar year; provided that the lessor shall send notice of sale to lessee. Lessor also reserves the right to terminate this lease in whole or in part should it desire to lease all or part of the above described property for industrial or commercial purposes, and industrial or commercial activity may interfere with grazing uses.

4. Lessor reserves the right to lease said property to third persons for mining or exploration for coal, oil and gas, and all other minerals.

5. This lease is deemed to incorporate by reference all provisions of applicable laws and rules and regulation of the State Land Board, and will be deemed modified whenever such laws and rules and regulations are amended hereafter.

6. Lessee shall not cause waste by improper grazing use or otherwise, and shall comply with good conservation practices to safeguard and improve water and other surface resources, and shall comply with lessor's requirements and requests respecting conservation practices.

7. Lessor reserves the right to cancel this lease when it is determined that lessee's federal or private allotment boundary lines exclude the leased premises.

8. Lessee shall not assign, mortgage, pledge or otherwise dispose of any interest in this lease without consent of the lessor.

9. It is understood this lease is issued only under such title as lessor may have, and that lessor does not warrant its title, and in case of title failure, lessee shall not be entitled to claim any refund of rentals paid to lessor.

10. Should lessee violate any term or condition hereof, lessor reserves the right to cancel this lease by sending

notice to lessee, postage prepaid, at the address shown on lease.

11. This lease shall remain in effect, unless sooner terminated as herein provided for a term of _____ years, beginning _____ 19_____. (32)

CHAPTER III

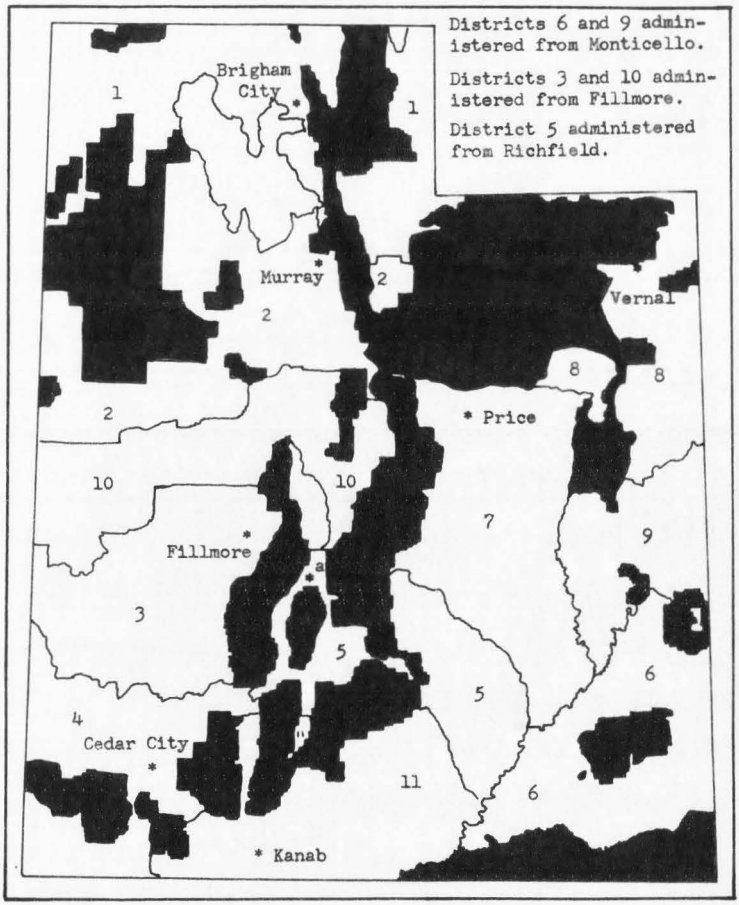
PRESENT STATUS AND INCOME OF STATE LANDS

Report of status and income from state lands are based upon BLM grazing districts as they have been geographically divided under the Taylor Grazing Act of June 28, 1934. The Taylor Grazing Act provided a method whereby injury to the public grazing lands could be stopped by preventing overgrazing and soil deterioration. It further provided for orderly use, improvement, and development. Finally, it intended to stabilize the livestock industry dependent upon the public range (22).

Soon after passage of the grazing act vast areas of western public lands were organized into manageable administrative units. During 1935 and 1936 districts were organized in Utah. State committees of stockmen assisted the Department of Interior in determining the boundaries of grazing districts. Utah was first divided into eight districts. District 9 was created in 1939 out of what was then District 6. In 1944 to aid in better administration of the land, several districts were reorganized and Districts 10 and 11 were added. Boundaries as they exist at the present are illustrated in Figure 4. Due to the fact that most state lands are bordered by BLM range, it is helpful to analyze state land within BLM grazing districts and grazing units.

Land Administered by the Board

It has been construed that state ownership is not secured until at such time as the federal cadastral survey is approved by the Secretary



[a]Richfield

Figure 4. Location of Bureau of Land Management grazing districts and district offices (area in black not included in BLM districts)

of Interior. The survey has been in progress since 1896 and has not been completed at the present time. The state is, therefore, still acquiring land from time to time under the common school grant. Further discussion of this land will be excluded because of the indefinite amount of land to be acquired.

Frequently it has happened in Utah history, that by the time an area was surveyed, some of the school sections lay within some kind of federal withdrawal such as a national forest, Indian reservation, or a national park. In these cases the state can not acquire the school sections within the withdrawal (33). Instead, it retains the right to select equal acreage elsewhere on the public domain. This right is called an indemnity or lieu selection right and becomes a basis on which the state acquires land in sections other than the four designated by the federal government (33). Over the years Utah has accumulated several hundred thousand acres in lieu selection rights which it has not yet exercised.[1]

The Board is now embarking on a program of land selection; however, these lands are not now in state ownership and additional research is in process to aid the Board in their selection. For this reason lieu land will not be considered in this study.

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[1]There are some misunderstandings in status concerning lieu selection rights. The Department of Interior and State Land Board can not agree on the exact number of acres that can be selected. If the interpretation of the Board is accepted, lieu selection will amount to about 2.4 million acres. If the Department of Interior interpretation holds, lieu selection will be cut to around 600,000. (U.S. Statutes at Large, XXVI, Part 1, 796).

It will be remembered that the original grant was about 7.5 million acres. The 1958 Yearbook of Agriculture indicates that Utah was one of the states that sold from one-fourth to one-half of its land (25). Adjustment also must be made for lieu land that has not been selected and land that has not yet been surveyed to which the state will be entitled. Acres in this study are the ones owned by the state at the present time and are used for grazing.

Location of State Land

State-owned lands are widely dispersed throughout the state because common school grant fixed by numbered sections the positions in each township. In the case where lieu selection or land exchange rights have been used, concentrations of land have been effected in some townships. While the land holding is scattered and representative of all school districts, the non-contiguous nature of individual sections greatly adds to complexity of administration.

Quality of State Land

The arid nature of Utah is a major contributing factor to the low productivity of state land. The long period of colonization before Utah became a state (49 years) explains in part the reason for the less fertile land in state holdings. During this early period the irrigable land in the state was taken by settlers either by homestead or preference sale.

Due to the physical characteristics, the state land is principally used for grazing. Climatically, it is mostly arid or semiarid, receiving annual precipitation of 10 to 15 inches (14, p. 7). Much of the land is

in desert valleys, deep canyons, or rugged desert mountains. Soils on much of these lands are thin, poorly developed, and highly alkaline. A very small percentage of the land is suitable for crop production. Also, some areas can not be used for livestock grazing because of the light vegetative cover. The rest of the land produces forage plants that are edible by domestic livestock and wildlife. Grass, shrubs, or native forbs dominate the plant cover. Smith indicates that the three dominant types of vegetation are pinion-juniper, sagebrush, and salt-desert shrub. These types make up as much as two-thirds of the total acreage. No other type makes up as much as 10 percent of the total (16, p. 47).

Grazing Capacity

Grazing capacity is regarded as the maximum animal numbers which can graze each year on a given area of range without causing a downward trend in forage production. Total grazing load upon the land is usually measured in terms of animal unit months (AUM'S) or the number of months that animals on the basis of cow equivalent are upon the land. In describing quality of land it is usually referred to in number of acres per AUM. For example, if a range has been suggested to have 11 acres per AUM, it would be classified as better grazing range than say a range with 19 acres per AUM.

The state does not have the organization of the personnel to make a complete inventory of carrying capacity for all their land. As a result the Board relies heavily on the BLM to furnish carrying capacity estimates for state land within each of the grazing districts. Suggested

average acres per AUM for each of the grazing districts are given in Table 3. These suggested acres are preliminary and may be changed when more recent data become available. Grazing capacity varies from 11.2 acres per AUM in District 1 to 19.6 in District 9.

As a step to better management and greater protection of the range, the state made an addition to conditions of the lease contract in 1957. "Where premises are within a federal allotment, number, kind, and season shall conform to federal regulations for that allotment unless other instructions are issued" (32). This statement reflects the degree to which the Board relies upon grazing capacity estimates of the BLM.

Lease Fee

It appears that the grazing fee for state lands is determined by several different methods. In the case where land is located in such a position that competition for the range among ranchers exists, this influences and raises the rental fee. Formulas have been used in some instances to determine the fee based on capitalization rate and stipulated rate of return on capitalized value. If location or conditions are such that it becomes difficult to lease land, the state will accept the minimum lease rate which is two and one-half cents per acre, or $5.00 per lease, whichever is the greatest.

The average fee in 1959 for state land within the BLM grazing districts in Utah was $.047 per acre (Table 3). In comparison with BLM grazing fees, state fees are higher. The fact that BLM fees are lower than state fees keeps pressure upon the state to maintain lower fees. This difficulty is pointed up in different goals of the two land

Table 3. Status and income from grazing state-owned land within Bureau of Land Management grazing districts

Districts	State leased acres	State unleased acres	Total state acres	Average fee per acre	BLM suggested acres per AUM	State annual proceeds
1	207,825	4,920	212,745	$ .058	12.0	$ 12,156.80
2	199,838	10,000	209,838	.053	13.3	10,522.15
3	252,805	21,300	274,105	.032	12.0	8,012.70
4	174,861	2,560	177,421	.037	15.4	6,465.50
5	177,278	83,650	260,928	.035	18.0	6,192.20
6	148,163	69,160	217,323	.036	26.7	5,373.04
7	320,685	36,360	357,045	.036	18.5	13,131.22
8	205,504	7,567	213,071	.044	12.8	9,106.82
9	211,174	1,960	213,134	.061	29.2	12,942.03
10	161,719	14,920	176,639	.036	15.8	5,834.80
11	171,236	65,990	237,225	.034	19.5	5,871.37
Other[1]	137,302	36,380	173,682	.106	--	14,540.36
Total	2,368,390	354,767	2,723,157	.047		$110,148.99

[1]Represents scattered sections in national forests, military reservations, bird refuge, fish and game preserves.

owners. The federal government is more interested in meeting management costs than earning profit. The state, on the other hand, finds it difficult to manage their land but would like to maximize returns from the land.

Unleased Lands

At the time data were gathered for this study (1959), the state had 354,767 acres of land that were not returning any revenue to the state from grazing. This range land was not leased either because it was waste and unsuitable for any type of grazing, or it could not be grazed because of topography. In some situations the Board has not been able to persuade or force ranchers who are in a position to use the land to pay even the minimum rental, and because of lack of personnel have not been able to charge users with trespass of the range. If even the minimum rental fee of two and one-half cents could be received from this land, it would amount to $8,869.17. Unleased land presents a problem to the Board under present management.

Total Revenue

Total revenue received in 1959 from grazing leases came from 2,084 different lease contracts and 2,368,390 acres. The revenue has been broken down by BLM districts (Table 3). The grand total was $110,148.99 which represented the annual income to the Board received from the grazing of livestock on state-owned land in 1959.

CHAPTER IV

CLUSTERING STATE LANDS

Authorization for exchange of state land for federal land is provided in Section 8 of the Taylor Grazing Act of June 28, 1934, which reads in part:

> The Secretary of the Interior shall accept on behalf of the United States title to any State-owned lands within or without the boundaries of a grazing district, and in exchange therefor issue patent to surveyed grazing district land not otherwise reserved or appropriated or unappropriated and unreserved surveyed public land; and in making such exchange the Secretary is authorized to patent to such State, land either of equal value or of equal acreage.[1] (22, p. 5)

Clustering land in BLM District 7 has been assumed for illustrative purposes. At present state-owned land is scattered throughout the district (Figure 5). For location of District 7 in relation to other districts and as to location in the state, see Figure 4.

Problems of Clustering State Land

Whether clustering state land is an advantage or not will depend upon the point of view. Viewpoints may differ for agencies, people, and goals. From the viewpoint of the Board, whose goal is to obtain maximum income from state holdings, the following problems have to be considered: First, it would be possible with state land blocked to administer and manage it independently of adjoining land owners. Land management would

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[1] Although exchange of equal acreage is provided for in the statutes, the Department of Interior will seldom consider an exchange of equal acreage.

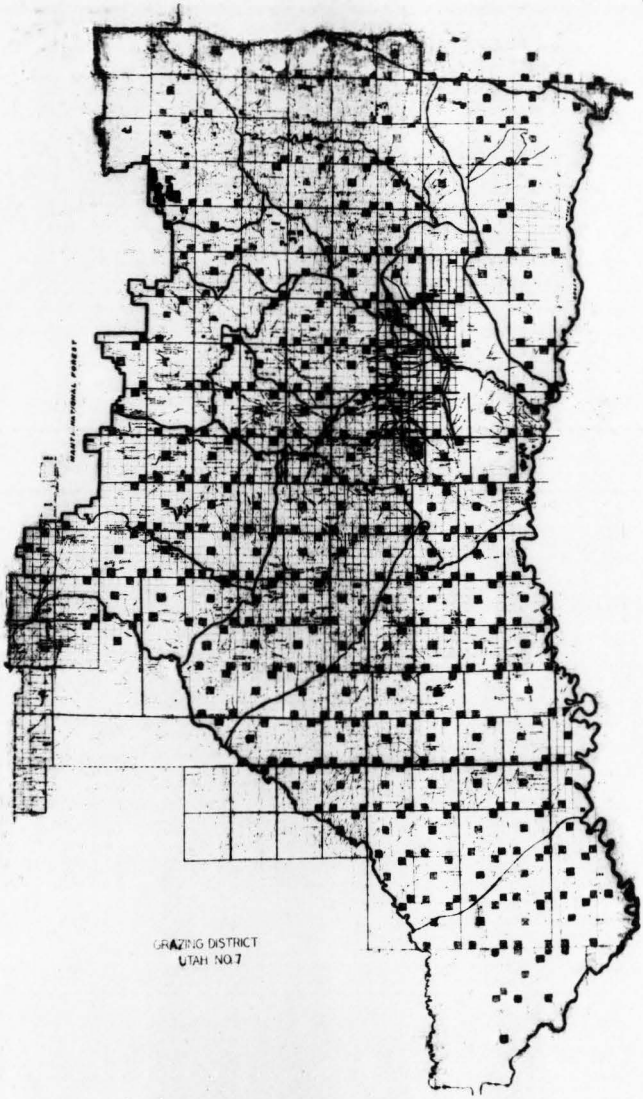

Figure 5. Bureau of Land Management Grazing District 7 showing scattered position of state-owned land

undoubtedly become a more important function of the Board. It should be realized that the cost of bringing about the cluster would be substantial due to additional surveys, appraisals, and classifications. The cost of management would increase with the responsibility of managing the land as it would no longer be closely associated with the BLM.

Second, in some situations grazing rights would have to be reorganized. It is possible with only a physical appraisal as a basis for exchange that economic losses may occur. Ranchers, use state land in some areas as a base for grazing permits with BLM. In the event state lands were clustered, ranchers would lose permits unless some adjustments were made. On the other hand, ranchers would feel more secure due to having a larger unit to lease from one owner. They would be more interested in making improvements that would aid not only their operation but also the state.

Third, the state would be in a better position to lease all of its land. It could suggest that the cluster be used as one or a few units. Ranchers, however, may not be able to operate certain clusters as a unit due to water, location, or some other limiting factor.

Fourth, clustering would reduce the work and money spent on leasing land. At the present time hundreds of accounts have to be kept in order to lease to the many individual ranchers. If the land were organized in clusters, the number of lease contracts would be cut to about three per cluster. This in turn would reduce the number of leases needing approval and supervision. While the administrative costs could be reduced, some management costs would be greater. Additional personnel would be required to provide for adequate management of the clusters.

Fifth, professional help could be used more effectively in clusters. Range managers and other experts could drive direct to the cluster and analyze the operation in one area instead of making stops at numerous scattered sections. Management programs could be planned more effectively where land is in clusters.

Sixth, an economic disadvantage is possible if the state anticipates selling all of its land. The market would be limited to a small number of people in a position to buy an entire blocked operation. Effects of this limitation would depend on the terms of the sale. On the other hand, land sold section by section can expect some competitive bidding which may increase the price. However, ranchers may not be interested in buying sections surrounded by public land which they do not own.

Seventh, state land is not subject to federal legislation, creating or adding to wilderness, Indian reservations, parks, or monuments. It is possible that the state will make some withdrawals on its own. This should be considered. However, state withdrawals will probably not be extensive. After the consolidation of state land, ranchers who lease the land would have more security. It is believed that a state lease is a firmer right than federal permit because as control comes closer to the individual his desires are generally given greater consideration.

Eighth, selecting the best range to be clustered would increase possibilities of range improvement practices. Research on other agricultural lands has indicated that more response can be expected from adding production factors to better land than poorer land.

Method of Clustering

In effecting an exchange of state land for federal land, trading ratios have been developed based on the physical data from the BLM District 7 office at Price, Utah, as well as information from the Board office. Ratios were figured from acres required for one animal unit month (Table 4). For example, Buckhorn grazing unit is considered to be the better unit in District 7. It requires 12.3 acres for an AUM. On the other hand, Under the Ledges, Roost, and Flat Top take 25.1 acres per AUM.[1] Putting this situation in form of a ratio

$$\frac{25.1}{12.3} = 2.04 \qquad [1]$$

means that one acre in Buckhorn is worth 2.04 acres in Under the Ledges, Roost, and Flat Top. Assuming that the quality of randomly scattered state lands in each area equals the BLM lands, then the state would have to give up a fraction more than 2 acres of state land in Under the Ledges, Roost, and Flat Top for 1 acre of BLM land in Buckhorn.

The Board has indicated efforts would be made to exchange for the better land and demand equitable rent for it (33). In this case the state would trade land in Under the Ledge, Roost, Flat Top, Summerville, Nine Mile, and as many acres as necessary in Park Unit for all BLM land in the Buckhorn unit (column 4, Table 4).

The second best land as determined by the BLM is in Salt Wash with 12.4 acres per AUM. The ratio principle is still employed,

$$\frac{20.0}{12.4} = 1.61 \qquad [2]$$

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[1] These units are not separated by Bureau of Land Management in appraisal for acres per AUM.

Table 4. Trading ratios based on Bureau of Land Management suggested grazing capacity, 1960, District 7

Grazing units	(1) Suggested acres per AUM	(2) Buckhorn ratio (Col.1 / 12.3)	(3) Salt Wash ratio (Col.1 / 12.4)	(4) Buckhorn equivalent (Col.6 / Col.2)	(5) Salt Wash equivalent (Col.6 / Col.3)	(6) Total state acres	(7) Total BLM acres
Under the Ledges[1] Roost Flat Top	25.1	2.041	2.024	59,379		121,193	1,088,365
Summerville	23.8	1.935	1.919	14,125		27,331	273,904
Nine Mile	22.9	1.862	1.847	4,564		8,499	85,968
Park	20.0	1.626	1.613	2,106	11,850	22,538	85,969
Cedar Mountain	18.9	1.537	1.524		8,566	13,055	128,284
Range Creek	18.7	1.520	1.508		12,664	19,098	294,940
Muddy Creek	18.4	1.496	1.484		10,235	15,189	179,704
Gordon Creek	15.6	1.268	1.258		14,231	17,902	73,828
Miller Creek	15.3	1.244	1.234		6,061	7,479	56,175
Sinbad	14.5	1.179	1.169		29,763	34,793	321,273
Huntington Creek	13.8	1.122	1.113		9,420	10,485	73,951
Cove and Coal Creek	13.3	1.081	1.073		25,972	27,868	254,967
Salt Wash	12.4	1.008	1.000		23,182	23,182	192,951
Buckhorn	12.3	1.000		8,433		8,433	80,174
Total				88,607	151,944	357,045	3,190,453

[1]Under the Ledges, Roost, and Flat Top are not separated by BLM in appraisal for acres per AUM or or total BLM acres.

One acre of BLM land in Salt Wash is worth 1.61 acres of state land in Park unit. This process was continued for the rest of the grazing units (column 5 Table 4). After completing the computations, the state would have all of the Buckhorn grazing unit plus 151,944 acres in Salt Wash (Figure 5). The BLM would control and manage the remaining acres in the district for the Department of Interior. The state would lose acres in this trade due to acquisition of better land. Upon completion of the exchange the state would own 240,551 acres; whereas, before the exchange the total acres were 357,045 for a loss of 116,494 acres.

Present Return

Returns to the Board from grazing state land in District 7 for 1959 is summarized in Table 5. The total revenue ($13,131.22) is received annually using the present method for determining rental fees. Present revenue includes income from grazing leases within the boundary of BLM District 7.

Clustered Returns

Clustered returns under the present method of establishing lease fees for grazing state land would be determined by multiplying $.032 (average fee for Buckhorn) by the number of acres (88,607) within Buckhorn after the exchange has been effected. This would amount to $2,835.42. Since the state would also own 151,944 acres in Salt Wash in addition to the acres in Buckhorn, these acres would have to be multiplied by the average fee for that grazing unit ($.026) for a total of $3,950.54. The totals from Buckhorn and Salt Wash units would amount to $6,785.96 for a decrease in state revenue of $6,345.26.

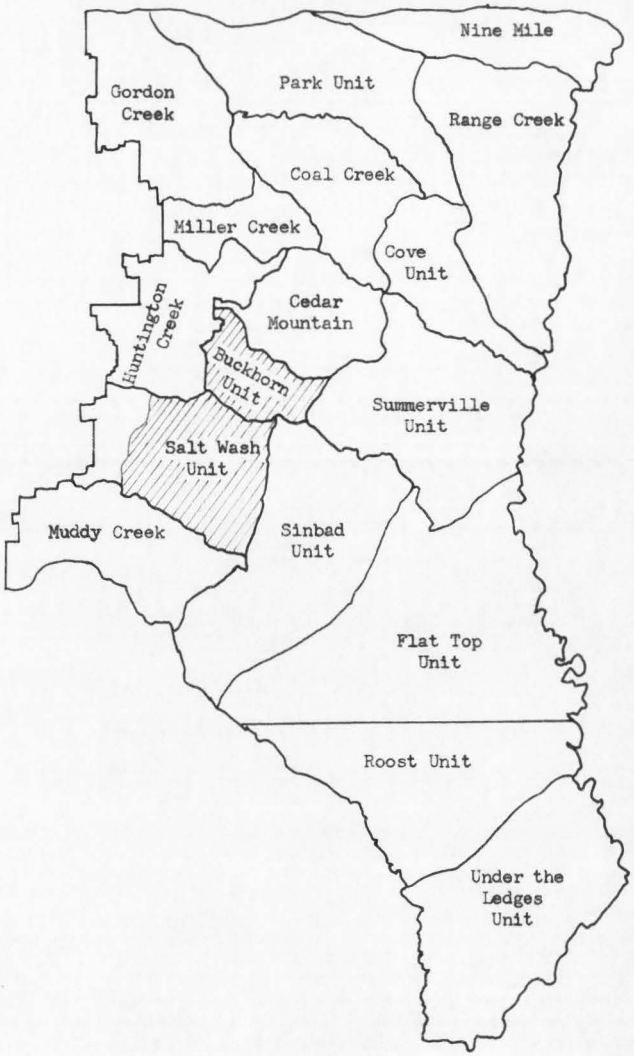

Figure 6. BLM Grazing District 7, showing grazing units; shaded section represents approximate state-owned land after exchange

Table 5. Status and income from state-owned land within grazing units of BLM District 7, 1959

Grazing units	State leased acres	State unleased Acres	Total state acres	Average fee per acre	BLM suggested acres per AUM	State annual proceeds
Buckhorn	8,433		8,433	$ .032	12.3	$ 273.99
Salt Wash	21,182	2,000	23,182	.026	12.4	540.56
Cove and Coal Creek	27,868		27,868	.059	13.3	710.03
Huntington Creek	10,485		10,485	.036	13.8	378.70
Sinbad	29,793	5,000	34,793	.027	14.5	792.83
Miller Creek	7,479		7,479	.041	15.3	308.80
Gordon Creek	17,542	360	17,902	.077	15.6	1,350.54
Muddy Creek	13,269	1,920	15,189	.027	18.4	361.83
Range Creek	17,658	1,440	19,098	.045	18.7	799.51
Cedar Mountain	13,055		13,055	.050	18.9	651.10
Park	22,378	160	22,538	.104	20.0	2,317.77
Nine Mile	8,499		8,499	.036	22.9	309.39
Summerville	27,011	320	27,331	.039	23.8	1,043.56
Flat Top	50,877	6,340	57,217	.025		1,272.97
Roost	22,969	11,660	34,629	.025	25.1	577.22
Under the Ledges	22,187	7,160	29,347	.026		577.51
Totals	320,685	36,360	357.045	.042	17.5	$13,131.22

It was observed that there was little correlation between the physical quality of the range and the amount of rental charged by the state. To illustrate, by physical appraisal Buckhorn is the best grazing unit in the district with 12.3 acres per AUM. Yet the average state rental fee is only $.032 per acre, while Cedar Mountain unit with 20 acres per AUM is leased for $.104 per acre. This lack of relationship was checked and substantiated by means of the regression technique, which is one of the more common methods of statistical analysis used to measure relationship between two variables. The correlation coefficient (r) was computed to determine degree of correlation between acres per AUM and fee charged per acre. It revealed an r value of .05 which indicates a highly insignificant relationship.

This suggests that grazing fees, to be realistic, would have to be revised to take into consideration the forage appraisal and to be consistent with physical classification of the land.

Methods of Establishing Grazing Fees

There are various methods used for establishing grazing fees. These methods vary in uniformity and in point of reference. In Colorado a qualified appraiser sets the rate based on personal inspection and in comparison with land of similar nature. Fees in some states are set strictly by formula and use as point of reference a present income concept. For example, the state of Washington bases its fee upon the landlord's share of production by use of the following formula:

$$\frac{L \times S \times G \times P}{M} = \text{AUM fee} \qquad [3]$$

L = proportion of average stockman's investment assigned to land. (Assumed to be 40 percent; balanced in livestock and improvements.)

S = landlord's fair share of land income (assumed to be 30 percent)

G = average pounds gain in livestock weight for permitted grazing season (to be determined by study and field checks)

P = average past year selling price of livestock per pound (from State Department of Agriculture, Bureau of Agricultural Economics)

M = number of months in permitted grazing season (4)

To indicate the effects of this formula under the proposed clustered situation for District 7, assumptions have been made to agree with the Washington formula. In addition, the average gain in weight of livestock for permitted grazing season was arrived at by using gains reported as a result of obtaining required TDN (11). The gain (120 lbs.) is an average for all cattle using winter TDN requirements for 5 months. The average price of beef cattle and calves in 1959 was $24.22 per hundred weight. Putting this information in the formula

$$\frac{(.30)\ (.40)\ (120)\ (.242)}{5} = \$.696 \text{ per AUM} \qquad [4]$$

for Buckhorn and Salt Wash, with 12.3 and 12.4 acres per AUM, respectively. This would amount to

$$88{,}607 \times \$.057 + 151{,}944 \times \$.056 = \$13{,}559.46 \qquad [5]$$

for an increase over present system of

$$\$13{,}559.46 - \$13{,}131.22 = \$428.24 \qquad [6]$$

One of the main limitations of the above system is the fact that it is determined on a weight gain basis. Gain is not realistic for much land that is used as winter range in Utah. In some cases it is

economical for animals to lose weight in the winter with the idea of gaining back in the spring, summer, and fall. Another disadvantage is that the formula is not designed to indicate grazing capacity.

Many rental values are based on "appropriate" value of AUM's. The Board land examiners have established a method of fee computation which is based on set values for AUM's. The values are as follows:

Winter range	$1.15 per AUM
Summer and fall	$1.25 to $2.25 per AUM
Spring	$2.25 per AUM

Values vary because the winter AUM supports one cow, while the spring, summer, or fall AUM will generally support a cow and calf.

In the proposed clustered situation computations to arrive at a rental fee per AUM for the Buckhorn and Salt Wash grazing units will be necessary. The number of state AUM's in District 7 after the exchange was found by dividing the total acres in Buckhorn by the suggested acres per AUM for the grazing unit.

$$\frac{88,607}{12.3} = 7,204 \text{ AUM's in Buckhorn} \qquad [7]$$

It was essential to complete the same operation for Salt Wash.

$$\frac{151,944}{12.4} = 12,254 \text{ AUM's in Salt Wash} \qquad [8]$$

The AUM's in Buckhorn and Salt Wash were added together to obtain the total AUM's owned by the state if an exchange took place.

$$7,204 + 12,254 = 19,458 \qquad [9]$$

District 7 contains all of the grazing seasons; however, to be

conservative and because most of the area is winter range, $1.15 per AUM was used.

$$19,458 \times \$1.15 = \$22,376.70 \quad \text{Total AUM value} \qquad [10]$$

This amount was capitalized at 5 percent.

$$\frac{\$22,376.70}{.05} = \$447,534.00 \quad \text{Total capitalized value} \qquad [11]$$

To determine the capitalized value per acre it was necessary to divide the annual total capitalized value by the total number of acres.

$$\frac{\$447,534.00}{240,551} = \$1.86 \quad \text{Capitalized value per acre} \qquad [12]$$

Assuming the grazing lease is based on a 3 percent return on the capitalized value per acre

$$\$1.86 \times .03 = \$.056 \text{ rental fee per acre} \qquad [13]$$

In determining annual income to the state from clustered land in District 7 the lease fee was multiplied by the total number of acres.

$$240,551 \times \$.056 = \$13,470.86 \qquad [14]$$

for an increase over present system of

$$\$13,470.86 - \$13,131.22 = \$339.64 \qquad [15]$$

The basic limitation in the above method of determining rental fee is the set value placed on certain grazing season AUM's. Realistic values will differ as to animals and requirements of the animals.

In an attempt to overcome some of the weaknesses of the above methods proposed by others, this thesis develops a method based on physical productivity using an inverse feeding standards technique. It establishes a rental fee that takes into consideration the value

of the AUM in relation to kinds of animals, age of animals, seasons of grazing, and price of alternative feed. The value of an AUM is left flexible based upon the total digestible nutrients (TDN) required by various animal conditions. All of these conditions have been summarized in a formula. The formula for establishing the capitalized value per acre is as follows:

$$X_v = \frac{RMP}{TAC} + \frac{L}{CA} \qquad [16]$$

Where X_v = capitalized value per acre

R = TDN requirements per day

M = days in a month

P = price of a substitute

T = TDN composition of the substitute feed

A = acres per AUM

C = capitalization rate

L = added costs of getting to range feed

A representative fee has been calculated for the proposed clustered state land based on a 3 percent return on the capitalized value. The capitalized value was obtained from the above formula. Explanation of the variables are needed at this point.

(R) The successful year round production of livestock will depend upon the degree of attainment reached in their day-to-day nutrient requirements. Extensive research has been conducted to determine the TDN requirements for various weights in all phases of an animal's life (11, 12). It is assumed, if the range animals are maintaining themselves, that they are obtaining the needed TDN (Table 6).

Table 6. Daily nutrient maintenance requirements of sheep and cattle

Body weight (pounds)	TDN requirements per day (lbs.)	Gain or loss (lbs.)	Probable season
	Ewes - non-lactating and first 15 weeks of gestation		
100	1.3	0.07	Winter
120	1.5	0.07	Winter
140	1.7	0.07	Winter
160	1.9	0.07	Winter
	Ewes - last 6 weeks of gestation		
100	2.0	0.37	Spring
120	2.2	0.37	Spring
140	2.4	0.37	Spring
160	2.5	0.37	Spring
	Ewes - first 8-10 weeks of lactation		
100	2.7	0.08	Spring and
120	2.9	0.08	early
140	3.1	0.08	summer
160	3.2	0.08	
	Ewes - last 12-14 weeks of lactation		
100	2.0	0.07	Late summer
120	2.2	0.07	and
140	2.4	0.07	early fall
160	2.5	0.07	
	Mature pregnant cows		
800	11.0	1.50	Winter
1000	9.0	0.40	Winter
1200	9.0	0.00	Winter
	Cows nursing calves, first 3-4 months postpartum		
900			Spring and
1100	16.8	0.00	early summer
	Normal growth heifers and steers		
400	7.0	1.6	Spring, summer
600	8.5	1.4	and fall
800	9.5	1.2	
1000	10.5	1.0	

Source: National Academy of Science--National Research Council. Nutrient Requirements of Domestic Animals, IV and V. A Report of the Committee on Animal Nutrition. Washington, D.C. 1957.

(M) The number of days in a month could be considered a constant; however, it was left as a variable because of the slight variations from 28 to 31 days in some months.

(P) Livestock either have to graze state land, land of other ownership, or be fed a substitute feed. What would be the expense or the price of a substitute feed for livestock? This variable is used in the formula to help determine the value of an AUM in the belief that the range is worth as much as the cheapest substitute fee. The figure used in the formula is relatively free. It could be the current price of the substitute, last year's average price, or the last 10 years' average price. In the following examples it was assumed that alfalfa, BLM permits, and private rentals are possible substitutes for state range feed. The price used, in the case of alfalfa, was the last 10 years' average price for Utah alfalfa. Rounded to the nearest cent, it amounted to $.01 per pound, or $20.00 per ton.

(T) The percentage of TDN composition is available for all feeds that might be substituted for range forage (12). This variable in the formula makes the adjustment from TDN to quantity of the substitute actually used. Alfalfa TDN composition is estimated at 50.7 percent.

(C) Capitalization rate is a stipulated amount and is usually determined by the rate of interest available from investing in alternatives. This rate may vary depending on the alternatives.

(A) Acres per AUM is a physical appraisal of the range. These differ and will affect the capitalized value per acre. Estimates of (A) were made by BLM range managers.

(L) Added cost of range feed is sometimes substantial aside from the price of the substitute feed. Example of some of the additional costs would be transportation, herding, fencing, and possible additional death losses. This is a more difficult figure to obtain. It was assumed in the computation below to be $.50 per AUM where an AUM is equal to the TDN requirements of 9 pounds per day (7).[1] An example of this method follows:

$$X_v = \frac{(9)(30)(.01)}{(.507)(12.4)(.05)} - \frac{\$.50}{(.05)(12.4)} = \$7.78 \qquad [17]$$

The lease fee was established by the rate of return desired from the capitalized value per acre. The formula is expressed

$$X_l = (X_v)(I) \qquad [18]$$

Where I = rate of return desired

X_v = capitalized value per acre

X_l = lease fee per acre

Substituting in the formula

$$X_l = (\$7.78)(.03) = \$.233 \qquad [19]$$

If this example held, total returns to the state from District 7 compared with present situation would be

$$240,551 \times \$.233 = \$56,048.38 \qquad [20]$$

for an increase of

$$\$56,048.38 - \$13,131.22 = \$42,917.16 \qquad [21]$$

To indicate how capitalized value will vary as factors within the formula change, a series of tables have been prepared. TDN requirements for sheep and cattle have been used. Typical sheep daily TDN requirements

[1] $.50 was indicated by B. D. Gardner in a study in western Colorado.

used were 1.7 (Appendix A, Table 12) and 2.9 (Appendix A, Table 13). For cattle 8 lbs. TDN per day (Appendix A, Table 14), 9 lbs. TDN per day (Appendix A, Table 15), 16.8 lbs. TDN per day (Appendix A, Table 16). Within the tables listed, the capitalization rate varies from .02 to .10 and the acres per AUM changes from 5 to 26.

Lease fees based on capitalized value will vary depending upon the rate of return desired and upon the acres per AUM. To show the effects of a change in the lease fee based on a 5 percent capitalized rate for sheep and cattle with the same TDN requirements as listed above, tables have been constructed (Appendix B, Tables 17-21). The rate of return in these tables changes from .01 to .09. Acres per AUM change from 5 to 26.

One of the problems of the above TDN analysis is that the substitute feed may not be alfalfa, but rather the purchase of BLM grazing permits or leasing private range.

In the event that purchase of permit rights on BLM range is the alternative feed rather than alfalfa, a different method of obtaining the rental fee for clustered land has been developed by present research based on the value of the permit right plus a capitalized grazing fee. To explain further, it was determined that the average selling price of BLM permits sold in the state in 1959 was $43.00 per animal unit for 6 months' grazing season.

This means that ranchers think that the capitalized value of the permit is $43.00 or $7.17 per AUM before the BLM fee is taken into consideration. The fact that the rancher has purchased the permit does not exclude his payment of the annual grazing fee ($.22 per AUM in 1959) charged by the BLM. The grazing fee must first be multiplied by the

season, and capitalized and added to the cost of permit to obtain a complete capitalized value. If 6 months is the typical grazing season, then the annual fee would be $1.32 per AUM; this amount capitalized at 5 percent would be $26.40, the total capitalized value per AUM.

$$\$43.00 + \$26.40 = \$69.40 \qquad [22]$$

This procedure can be formalized as follows:

$$X_v = \frac{S}{A} + \frac{BM}{CA} \qquad [23]$$

Where X_v = capitalized value per acre

S = sales value of permit per animal unit

M = months covered by permit

A = acres per AUM

B = Bureau of Land Management fee

C = capitalization rate

Now to arrive at the capitalized value per acre in Buckhorn and Salt Wash which together have 12.35 acres per AUM, substitute in the formula

$$X_v = \frac{\$43.00}{12.35} + \frac{(\$.22)(6)}{(.05)(12.35)} = \$5.61 \qquad [24]$$

To arrive at a lease fee representing 3 percent return on capitalized value formula [3] can be used.

$$X_1 = (\$5.61)(.03) = \$.168 \qquad [25]$$

The $.168 lease fee arrived by this method is low because of the relatively low grazing fee assessed by the BLM; however, total returns to the state from District 7 under this example would be

$$240,551 \times \$.168 = \$40,412.57 \qquad [26]$$

for an increase in total revenue of

$$\$40,412.57 - \$13,131.22 = \$27,281.35 \qquad [27]$$

If the alternative competing feed is private land, then the state can raise their lease rates to that paid for private range. The average fee for private grazing in Utah was $.45 per acre in 1959 (20). Total returns from District 7 under this situation would be

$$240,551 \times \$.45 = \$108,247.95 \qquad [28]$$

for an increase in total revenue over the present revenue of

$$\$108,247.95 - \$13,131.22 = \$95,116.73 \qquad [29]$$

It should be pointed out at the conclusion of this chapter that, while factors used in each of the formulae are believed to be fairly representative, emphasis should be placed on the methods developed. Further research will undoubtedly change some of the components used in determining the returns to the Board. As factors are refined they can be very easily substituted for those used as examples in this chapter. It is believed that additional study should be made to gain more accuracy in the factors before definite decisions are made on the basis of either of the methods developed.

CHAPTER V

IMPROVEMENT OF CLUSTERED RANGE

After more than a hundred years of concentrated use of the livestock range in Utah, land owners now realize that present resources must be made to last as there are no new frontiers. Misuse of much of the land in the past has decreased present forage production. The traditional way to increase or restore productivity (popular with government and private land owners alike) is conservation; that is, to graze lightly the range at present to allow the plant cover to build up by its own recuperative powers.

In event some parts of the range are so denuded that plants are unable to recover by their own powers, reseedings have been successfully completed where climatic conditions are favorable. Some of the BLM districts have reported successful range reseedings; however, information obtained from the BLM district office at Price indicates that restoration attempts by range reseedings have failed due to arid conditions.

Insofar as physical factors are concerned in District 7, opportunities for improving the productive capacity of state land are for all practical purposes limited to adequate management and selected improvements other than reseeding.

An economic evaluation of range improvements requires analysis of both costs and returns. In a situation where direct range restorations

are possible and successful reseedings have been completed, it is possible to arrive at economic increases by using some basic assumptions. On the other hand, if management improvements are of the nature of fences, roads, or dams, then many problems are encountered, both conceptual and empirical, particularly in evaluating returns. Many benefits are difficult to measure. For example, what are the methods used to determine the economic benefits of a drift fence? To what extent in monetary terms do water development benefits exceed costs and over what period of time? Can an access road increase range production? If so, how can this be measured economically? Another problem arises as to benefits. Do the benefits, if any, accrue only to the land owner and livestock owner, or does society as a whole benefit?

There can be no question as to benefits in a real way from these type of improvements. However, experimental work is insufficient at the present to give firm answers to economic questions.

The cost side has problems as well. The BLM district offices have kept cost records on all improvement projects; however, most improvements were contracted by private people and the contract cost may or may not be close to the actual cost. It is difficult from the records to determine the component parts that make up total cost such as labor, equipment, material. It should be realized that under different circumstances costs will change. No one type of improvement will cost the same in all different locations. As the terrain becomes steeper, rockier, or further from headquarters, costs will increase on all improvements. It appears, however, because range improvements have been made in many different areas

and under various conditions, that costs recorded by the BLM would be indicative of costs that can be expected if improvements are made. Therefore, average costs have been calculated as a guide to the Board (Tables 7-11).

Additional research on methods of measuring range improvements in economic terms is needed. Some authorities have placed conservative estimates of increased carrying capacity resulting from full development of range lands at 30 percent (21). If grazing capacity could be increased by this amount, it could increase total revenue to the state by 30 percent provided fees were adjusted accordingly.

It will be the procedure in the remaining part of the chapter to describe improvements that have proven beneficial. Costs will be reported as they have been taken from the BLM offices. Insofar as possible, costs have come from District 7; however, where improvements have not been completed in recent years, costs of improvements from other districts have been used to indicate and approximate costs.

Types of Improvements

Not all types of improvement programs are applicable to every range. Employing such improvements as are useful are the responsibilities of range managers. To obtain maximum production from range, such improvements as are useful should be applied. Range improvements that have proven to be beneficial to land owners and livestock men alike in District 7 are water development projects, range fences, erosion control measures, access roads, and poison weed control.

Water developments

Perhaps the most important range improvement practice needed on state-owned range is the development of stock watering facilities. Many ranges normally are not supplied with adequate water for the best use of the range. Under a desert situation as found in District 7 there are three kinds of water developments possible--springs, wells, and reservoirs. The purpose of water developments is to equalize grazing on the range. To use the range properly, animals must be within a relatively short distance from water. In the event natural water is not available, water developments are needed if maximum use of the range is to be had.

Springs are the most common type of improvement. Costs of springs will vary depending on the location and type of development.

Wells are the most expensive type of water development and require more care and upkeep, but they are necessary on many ranges where the water table is deep and few springs exist. The most common well is the drilled well. Drillers charge by the foot for this type of work, hence the deeper the well, the greater the cost. Common sources of power to operate wells come from windmills or gasoline engines. Each of these have certain advantages. In general, windmills are satisfactory because winds are common enough to supply the power needed.

Reservoirs, though somewhat limited in adaptability, are of great importance on improved ranges. The disadvantage lies in the fact that reservoirs depend upon surface runoff or seepage and may be empty when most needed as in times of drought or in dry seasons of the year. They are the cheapest to construct and are built not only as a possible source

of water but as part of an erosion control program (Table 7). It is possible that none of the above alternatives are applicable on some parts of the range. If not, studies have indicated that water hauling can be useful in gaining greater use of the range (23, 24).

Table 7. BLM water development projects and costs, 1957-1960

Project	Number taken from record	Total cost	Average cost per development
Spring development	17	$ 27,396.00	$ 1,611.53
Spring maintenance	28	12,032.00	429.71
Well development	2	5,791.00	12.32/ft.
Well maintenance	7	2,084.00	297.71
Reservoir construction	46	9,273.92	201.60
Reservoir maintenance	26	3,843.00	147.81

Benefits from water improvement.-- The advantages of better and more adequate watering facilities are evident. Monetary return from the use of ranges are dependent upon meat production. If animals are required to travel long distances to and from watering places, gains and hence profits suffer. It is reported that in rough country the ideal distance between water should not exceed 1 mile, whereas in level country the distance may be increased to 3 miles and still obtain satisfactory use of forage (21, p. 10). Improper distribution of watering places causes concentration of animals and excessive grazing in the vicinity of existing water. If adequate watering places are available on the range, livestock distribution is more uniform.

Range fences

Fences used on range lands are either boundary or drift fences. A boundary fence may entirely enclose an allotment, while a drift fence is an incompleted stretch which keeps stock from drifting from one area to another. Barb wire fence is the most common type used by the BLM. The advantage of barb wire is that materials can be transported more readily to placed needed with construction costing less than for most other types of fence. Usually not less than four strands of wire are used in construction of range fences. Posts are not over 16 feet apart. Stays, jumpers, or dancers are often placed midway between the posts for additional support. The wire is placed approximately 1 foot apart with the bottom wire about 15 inches from the ground. This provides a fence slightly over 4 feet high (17).

Costs of fencing vary, depending upon the area. In District 7 costs per mile of fence during the last 5 years were available from records for some of the grazing units. Average cost per mile of fence was $922.34. The range was from $1,704.73 in Range Creek to $442.80 in Cove unit (Table 8).

Benefits from range fences.--The most important function of a fence is that of securing proper distribution of stock. In some cases there is marked difference in time forage is ready for grazing in the spring. Since cattle left to themselves will move to higher range before the feed is ready, fences in strategically located places control this movement. Because sheep are on the range under the supervision of a herder at all times, drift fences are not so important as on cattle ranges.

Table 8. Costs of fencing in some grazing units of District 7, 1955-59

Grazing unit	Fence miles	Total cost	Average cost per mile
Salt Wash	36.50	$29,301.69	$ 802.79
Huntington Creek	4.75	3,396.56	715.07
Buckhorn	11.50	7,914.79	688.24
Sinbad	29.00	32,782.75	1,130.44
Cedar Mountain	5.42	8,487.00	1,567.71
Miller Creek	1.75	1,581.49	903.71
Park	.50	258.94	517.88
Coal Creek	3.00	1,698.59	566.19
Summerville	2.50	2,138.36	855.34
Cove	4.00	3,091.22	442.80
Range Creek	.75	1,278.55	1,704.73
Total	99.67	$91,929.94	$ 922.34

Boundary fences between sheep and cattle allotments or between two cattle allotments can be advantageous to the range in that it equalizes grazing.

Soil erosion control

Conservation of soil has received much attention in recent years. Experience in the control of soil erosion on range land has developed a group of tried and proven practices, although much remains to be learned. These practices are all based on the principle of reducing the velocity of runoff. Small washes can be controlled by means of dams. Large gullies require detention structures to retard a greater volume of runoff. In some cases it is feasible to divert swift water from a gully and spread it over adjacent plains to dissipate the sediment load. The forage produced on water spreading areas frequently exceeds the original quantity by several times (21).

Costs of these types of improvements will very greatly as will other developments based upon the extent to which they are used and the conditions under which they are made. Some erosion control projects have been completed in District 7. The costs have been broken down into equipment and labor because of the variation in types of structures. In 1959 a caterpillar tractor with dozer cost an average of $10 per hour, while supervision and labor amounted to $12.00 per day (Table 9).

Benefits from soil erosion control.--Retaining soil in position increases moisture content in the soil and helps to build up and restore forage on the range. Society also benefits because runoff temporarily detained is released at a slower rate and its erosive force is thus reduced.

Table 9. Costs of equipment and labor used in soil erosion control in District 7 for 1958 and 1959

Equipment and labor	Costs
Caterpillar with dozer	$10.00 per hour
Carryall	8.40 per hour
Labor	12.00 per day
Supervision	12.00 per day

Access roads

Construction of range access roads have major advantages: First, they encourage trucking animals rather than trailing; second, they provide a means whereby supplemental feeds may be hauled into distant range areas and stored for use during winter. This makes it possible to use ranges during heavy snow; third, roads greatly aid the range in that camps, equipment, and range materials can be distributed uniformly over the range. The average cost for road maintenance in BLM Districts 1 and 7 during 1955 to 1959 was $19.49 per mile. Average cost of road construction was $108.12 (Table 10).

Table 10. Costs of road construction and maintenance of BLM roads Districts 1 and 7, 1955-1959

Description	Number of miles	Total cost	Average cost per mile
Road construction	46.82	$ 5,062.00	$ 108.12
Road maintenance	442.50	8,624.00	19.49

Poison weed control

Poison plants are nature's sign of a sick range (17). In District 7 halogeton has started an invasion of some of the poorer range land. Studies on poisonous range plants have indicated that they can not be economically eradicated from the whole range under present techniques of control. However, sprays have proven effective in congested areas around springs and along some stock trails. Cost per acre of spraying were gathered from the BLM records (Table 11). Within the range of data costs per acre decrease as the number of acres sprayed increase.

Table 11. Cost incurred by BLM from spraying halogeton in 1958-1959.

Sprayed by plane	Acres	Total cost of spraying	Cost per acre
Halogeton	282	$2,328.00	$8.26
Halogeton	340	1,632.00	4.80
Halogeton	500	2,381.28	4.76
Halogeton	7,685	18,000.00	2.35

Benefits from poison weed control.--Controlling poisonous plants increases the opportunity for desirable plants to grow, increasing the grazable forage and ultimately livestock output. Animal losses saved from poisonous plant control can sometimes be considerable (15). These consist of death and weight losses as well as losses from abortion. Other benefits resulting from poisonous plant control consist of reductions in risk and uncertainty as reflected in the ranches' capital structure, interest costs, depressed permit values, and other more subtle expressions of uncertainty in ranch organization and management.

Possible Increased Revenue from Increased Carrying Capacity

Improvements will ultimately decrease acres required per AUM or increase the finish on a given herd size. If formula 16 page 41 is used to determine the grazing rate on clusters of state land for District 7, it is possible to calculate the amount that the state can increase revenue provided lease fees are adjusted also (Table 12).

For example, if grazing capacity on clustered state land in District 7 was increased from 12 acres per AUM to 11 acres per AUM, it would increase capitalized value $.72 per acre, grazing fee $.02 per acre, and total revenue $5,292.12 per year. The increase in revenue represents the amount of money that could be spent by the state to improve the range without decreasing total revenue below the unimproved situation.

Initiating Improvements

Improvements can be initiated either by ranchers, by the Board, or through a cooperative effort. Ranchers are encouraged by the state to initiate and finance improvements on state lands at present. Under the present situation lessee's investment is protected by statute, and by policy. Section 65-1-40, Utah Code provides that a lessee must be paid the value of his improvements on state land when it is sold (29, p. 327). The Board's policy protects the lessee. Unless the purchaser pays for improvements, a sale is seldom made. The state encourages ranchers to make improvements by allowing either a decrease in rent or giving an assurance that the fee will not be increased until the rancher has recovered his investments over time.

Table 12. Changes in annual revenue to the state associated with an increase in grazing capacity[1]

Acres per AUM	Capitalized value per acre	Change in capitalized value per acre	Lease fee per acre	Change in lease fee per acre	Change in total revenue
14	$ 6.90		$ .207		
13	7.42	$ .52	.223	$ .016	$ 3,848.82
12	8.05	.63	.241	.018	4,329.92
11	8.77	.72	.263	.022	5,292.12
10	9.65	.88	.289	.026	6,254.33
9	10.72	1.07	.322	.033	7,938.18
8	12.06	1.34	.362	.040	9,622.04
7	13.80	1.74	.414	.052	12,508.65
6	16.08	2.28	.482	.068	16,357.47
5	19.30	3.22	.579	.097	23,333.45

[1]Computations above are a result of analysis based on the TDN analysis formula [16] p. 41. Number of acres 240,551.

Assumptions: Capitalization rate 5 percent, 9 lbs. Daily TDN requirements, $.50 added cost of range operation, alfalfa TDN composition 50.7 percent price of alfalfa $.01 per lb. and 3 percent return on capitalized value to establish lease fees.

A second alternative would be for the state to initiate and pay for all range improvements. This would necessitate hiring additional personnel. However, improvement could progress in a more orderly fashion, and the state could adjust lease fees as soon as benefits became apparent.

The third alternative would be a cooperative effort between ranchers and the Board in initiating improvements. This would entail close cooperation and communication between the two for effective management. Contracts signed voluntarily by both parties would have to designate cost and benefit sharing features.

Which of these alternatives would provide the greatest amount of revenue to the state is an area for additional study. Other areas of investigation will have to solve the benefit measurement problem as well as some aspects of the total improvement cost measurement problem.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Upon admission to the Union, Utah along with other states received grants of land from the federal government. Revenues from the grants were to promote education and other public improvements. Utah's grant consisted of sections 2, 16, 32, and 36 in every township upon completion of the federal cadastral survey. The survey has not been completed at the present time so the exact total number of acres resulting from this grant is not known. In addition to the four sections in every township, various public institutions were given a specific number of acres. The estimated total land granted to Utah is 7.4 million acres. After adjustments were made for sale of state land and for land yet entitled to the state, grazing lease records examined in December 1959 revealed 2,723,157 acres in state ownership.

At present state lands are in scattered sections throughout the state. Much of this land is low in productivity. The main use is livestock grazing. The agency responsible for the management of state land is the Utah State Land Board, composed of one representative from each of five districts into which the state has been divided. Under present administration revenue is received from leases both mineral and grazing, interest on funds invested from sales of land, and oil and other royalties.

The purpose of this study was to suggest possible alternatives to the Board on management of their grazing land. The present system was

compared to two alternatives; namely, clustering lands in their present state of improvements, and clustering lands and improving them. This analysis was based on Bureau of Land Management grazing districts.

District 7 was chosen for more detailed analysis. Clustering was established by using trading ratios based on the physical acres per AUM suggested by the BLM and exchanging BLM acres for state acres. The proposed exchange clustered all of the state land within Buckhorn and Salt Wash grazing units within District 7 for a solid block of 240,551 acres. Under present fees, total revenue would be decreased by $6,345.26 after the cluster has been completed.

It was observed and verified by regression technique that there was little correlation between the physical quality measure used for the range and the amount of rental charged by the state. To arrive at a more equitable method of establishing fees several systems were suggested to indicate the effects they would have on total revenue for state land within the boundaries of BLM District 7. First, a formula used by the state of Washington was applied to the proposed clustered land in District 7. It revealed an increase over present revenue of $428.24.

Second, calculations based on fixed values for AUM's for state land were applied to the proposed clustered situation and resulted in an increase of $339.64.

Third, in an attempt to overcome some of the weaknesses of the previous methods, a formula was developed in this research using an inverse feeding standard technique. It establishes a rental fee that takes into consideration the value of the AUM in relation to kind of animal, age of animals, seasons of grazing, and price of alternative

feed. These conditions were summarized in formula [16] and when alfalfa was considered the substitute feed revealed an increase of $56,048.36. Other alternatives considered the purchase of BLM permits and leasing of private range as the substitute feed. Formula [23] was developed to indicate rate of rental to charge for state land when BLM permit purchases were the alternative to grazing state land. In this situation increase in total revenue was $27,281.35. In the event the alternative competing feed is leasing private land, then the state could raise their lease rates to that paid for private range ($.45). This action resulted in an increase in total revenue over the present revenue of $95,116.73.

Reseeding of range land in District 7 has not been successful due to the arid climate. Improvement of the range is by selected improvements such as water facilities, roads, soil conservation controls, and weed control. Costs for these improvements were taken from BLM records. Benefits resulting from improvements were discussed in a general framework. Insufficient research limited economic analysis; however, based upon the assumption that grazing capacity increased, it was determined that certain amounts could be spent on improvements without decreasing gross returns below pre-improvement levels (Table 12).

Under the proposed clustered situation the state would have less trouble in keeping the land leased and in collecting payments; also, the state would have more freedom in managing the land if it were clustered. The BLM would be in a better position and would be able to manage their land more effectively by having the state land consolidated. The blocking of state land would provide greater security to the livestock

business; ranchers would be more interested in range improvements if given proper incentives.

The two alternatives discussed within this study are only two of the many that the Board has to consider for increasing annual returns from state-owned lands. The adoption of the alternatives proposed would give some assurance that the remaining state lands would be managed in such a way as to make a greater contribution to the welfare of the entire state and would be a means of increasing revenue to the grantee institutions.

Conclusions

Clustering state-owned land is one method of increasing returns to the Board, provided grazing fees are revised to reflect productivity of the range. Present state lease fees do not indicate a relationship to physical productivity suggested by Bureau of Land Management in District 7. Under the present fee system, clustering would be inadvisable as revenue would decrease. In the event a fee setting system is established which is based on productivity, clustering would increase returns to the Board. Income from state-owned land could be increased as the land is now located, providing the fee was changed to indicate value of productivity. State lease fees are at present higher than are fees charged by the Bureau of Land Management; however, they are considerably lower than private lease fees. This fact would make it difficult to change fees while the land is scattered. The difficulty would be reduced after clustering has been completed.

Lessees under clustered condition would be reduced as well as the

number of state-owned acres. As the exchange of land, based on value for value, is completed with the state obtaining the better land, the state will lose title to a greater amount of less productive land. This would give the Board less land to manage, but would increase effective control of the remaining land.

Some areas in which additional research is needed before final action is taken are: First, the state land fee setting system; second, changes in management cost as a result of clustering; third, benefits accruing from range improvements; fourth, costs of some kinds of improvements and their benefits; fifth, political implications of changes in Board policy; and sixth, economic feasibility of complete state-owned land sale and investment of funds as an alternative to increase state revenue.

Work on some of the above aspects are now in progress. Extension of this study to include all state-owned land in Utah is now well underway.

REFERENCES

(1) Caton, D. D., and Beringer, Christoph. Cost and benefits of reseeding range lands in southern Idaho. Idaho Agricultural Experiment Station, Bulletin 326, May 1960.

(2) Clawson, Marion, and Held, Burnell. The federal lands: Their use and management. Baltimore: The John Hopkins Press, 1957.

(3) Cubberley, Ellwood P. Public education in the United States. Boston: Houghton Mifflin Co., 1934.

(4) Department of Natural Resources. Regulations concerning permit range lands, state of Washington. Olympia, Washington, 1959.

(5) Dixon, Henry A. The administration of state department school funds. Los Angeles: University of Southern California Press, 1936.

(6) Evans, Seth Parker. An analysis of the accounting system employed by the Utah State Land Office. (M.S. Thesis. Dept. of Economics) University of Utah, 1959.

(7) Gardner, B. D. The pricing of livestock forage on federal range lands. Economic Research in the Use and Development of Range Resources. Report No. 2, 1959.

(8) Letter from Board of Land Commissioners Office, Boise, Idaho. April 14, 1960.

(9) Letter from Board of Land Commissioners Office, Denver, Colorado. March 21, 1960.

(10) Miller, William P. Developments in public school land policies in Utah, 1935-1948. (Ph.D. Thesis. Dept. of Economics) Stanford University, 1949.

(11) National Academy of Sciences--National Research Council. Nutrient requirements of domestic animals. IV. Nutrient requirements of beef cattle. A report of the Committee on Animal Nutrition. National Academy of Sciences--National Research Council, Washington, D.C. 1957.

(12) National Academy of Sciences--National Research Council. Nutrient requirements of domestic animals. V. Nutrient requirements of sheep. Rev. 1957. A report of the Committee on Animal Nutrition. Washington, D.C. 1957.

(13) Peters, William S. and Johnson, Maxine C. Public lands in Montana, their history and current significance. Missoula, Mont.: Montana State University, April 1959.

(14) Reuss, Lawrence A., and Blanch, George T. Utah's land resources. Utah Agricultural Experiment Station Special Report No. 4, Logan, Utah, 1951.

(15) Richman, LaVar M. Economics of controlling tall larkspur. (M.S. Thesis. Dept. of Agricultural Economics) Utah State University, Logan, Utah, 1961.

(16) Smith, Arthur Dwight. The status of federal land grant lands in Utah and proposals for their management. (Ph.D. Thesis. Dept. of Agricultural Economics) University of Michigan, 1957.

(17) Stoddart, Laurence A., and Smith, Arthur D. Range management. 2nd ed. New York: McGraw-Hill Book Co., Inc., 1955.

(18) Talbert, Nelda. Our public lands. Twenty-five years under TGA. Bureau of Land Management 9(2): 7-15. October 1959.

(19) U.S. Agricultural Marketing Service. The farm income situation. U.S. Dept. of Agriculture. Sept. 1959.

(20) U.S. Agricultural Research Service. Ranch organization and related data, desert-operated sheep ranches, Utah, 1959. (Unpublished)

(21) U.S. Bureau of Land Management. Rebuilding the federal range. Wash. D.C.: U.S. Govt. Printing Office, 1951.

(22) U.S. Bureau of Land Management. The Taylor Grazing Act of June 28, 1934, with amendments to Sept. 1, 1955. Washington, D.C.: Govt. Printing Office, 1956.

(23) U.S. Department of Agriculture. Hauling water for range cattle. Leaflet No. 419, Washington D.C.: Govt. Printing Office. Sept. 1957.

(24) U.S. Department of Agriculture. Hauling water for sheep on western ranges. Leaflet No. 423. Washington, D.C.: Govt. Printing Office. Jan. 1958.

(25) U.S. Department of Agriculture. Land. The Yearbook of Agriculture. Washington, D.C.: U.S. Govt. Printing Office, 1958.

(26) U.S. Department of Agriculture. State legislation for better land use. A special report by an Interbureau Committee of the U.S. Dept. of Agriculture. Washington, D.C.: Govt. Printing Office, 1941.

(27) U.S. Department of the Interior. The federal range code for grazing Districts. Washington, D.C.: Govt. Printing Office. January 1956.

(28) U.S. Statutes at Large. Public Laws, Vol. XXVIII.

(29) Utah, Code (annotated) 7: 327-330.

(30) Utah Land Board. Biennial Report of the Land Board July 1, 1954 to June 30, 1956. Salt Lake City, Utah. 1956.

(31) Utah Land Board. First Annual Report. 1896.

(32) Utah Land Board. Grazing Lease Records. January 1960.

(33) Utah Land Board. Landletter. 1(2):2.

(34) Utah Land Board. Twenty-Second Biennial Report. 1940.

(35) Utah Land Board. Twenty-Third Biennial Report. 1942.

(36) Utah Land Commissioners. Second Annual Report. Salt Lake City, Utah, 1897.

(37) Utah, Laws. 1896.

(38) Utah, Laws. 1957.

(39) Utah State Agricultural College. Recommendations for range reseeding in Utah. Extension Bull. #212. Logan, Utah.

APPENDIX A

APPENDIX A

Capitalized Range Values per Acre, per Ewe and per Acre Based on Daily TDN Requirements

Tables included in this Appendix have been calculated on the basis of formula [16], p. 41. Assumptions used to complete the calculations are given under each of the tables.

$$X_v = \frac{RMP}{TAC} + \frac{L}{CA}$$

Where

X_v = Capitalized value per acre where an AUM is assumed to equal 9 lbs. daily TDN

R = TDN requirements per day

M = Days in a month

P = Price of a substitute

T = TDN composition of the substitute feed

A = Acres per AUM

C = Capitalization rate

L = Added costs of getting to range feed

An animal-unit-month (AUM) is a common unit used to express range productivity. It is the forage required to support a mother cow, or the equivalent in other classes of animals. Five sheep commonly equal one AUM.

Table 13. Capitalized range values per acre per ewe based on 1.7 lbs. daily TDN requirements[1]

Acres per AUM	Capitalization rate								
	.02	.03	.04	.05	.06	.07	.08	.09	.10
5	$9.11	6.08	4.55	3.64	3.04	2.60	2.27	2.03	1.82
6	7.59	5.06	3.79	3.04	2.53	2.17	1.89	1.69	1.52
7	6.50	4.34	3.25	2.60	2.17	1.86	1.62	1.45	1.30
8	5.70	3.79	2.85	2.27	1.89	1.63	1.42	1.26	1.13
9	5.06	3.38	2.53	2.03	1.69	1.45	1.26	1.13	1.01
10	4.56	3.03	2.28	1.82	1.51	1.30	1.14	1.01	.91
11	4.14	2.76	2.07	1.66	1.38	1.19	1.03	.92	.83
12	3.79	2.53	1.89	1.53	1.26	1.09	.94	.84	.76
13	3.50	2.34	1.75	1.41	1.17	1.01	.87	.78	.70
14	3.25	2.16	1.62	1.30	1.08	.93	.81	.72	.65
15	3.03	2.03	1.51	1.21	1.01	.87	.75	.68	.60
16	2.84	1.90	1.42	1.14	.95	.82	.71	.63	.57
17	2.68	1.78	1.34	1.07	.89	.77	.67	.59	.53
18	2.53	1.68	1.26	1.01	.84	.72	.63	.56	.50
19	2.40	1.59	1.20	.96	.79	.69	.60	.53	.48
20	2.27	1.52	1.13	.92	.76	.65	.56	.51	.46
21	2.16	1.45	1.08	.87	.72	.62	.54	.58	.43
22	2.07	1.38	1.03	.82	.69	.59	.51	.46	.41
23	1.98	1.32	.99	.79	.66	.56	.49	.44	.39
24	1.90	1.27	.95	.76	.63	.54	.47	.42	.38
25	1.82	1.25	.91	.72	.62	.52	.45	.42	.36
26	1.75	1.17	.87	.70	.58	.50	.43	.39	.35

[1]Capitalized value per acre is obtained by multiplying figures in table by 5.

Assumptions: Ewes, wintering replacement lambs - body wt. 80 - 120 lbs.

Daily TDN requirements - 1.7

TDN composition of alfalfa - 50.7 percent

Price of alfalfa - $20.00 per ton, or $.01 per lb.

Added cost of getting to the range - $.50 per AUM

Capitalization rate varies from .02 to .10

Acres per AUM - varies from 5 to 26

Table 14. Capitalized range values per acre per ewe based on 2.9 lbs. daily TDN requirements[1]

Acres per AUM	Capitalization rate								
	.02	.03	.04	.05	.06	.07	.08	.09	.10
5	$15.56	10.37	7.78	6.22	5.18	4.44	3.89	3.45	3.11
6	12.97	8.64	6.48	5.19	4.32	3.71	3.24	2.88	2.60
7	11.12	7.41	5.56	4.44	3.70	3.17	2.78	2.47	2.22
8	9.72	6.48	4.86	3.89	3.24	2.77	2.43	2.16	1.95
9	8.64	5.77	4.32	3.45	2.88	2.47	2.16	1.92	1.73
10	7.78	5.18	3.89	3.12	2.59	2.22	1.94	1.72	1.56
11	7.07	4.72	3.53	2.83	2.36	2.02	1.76	1.57	1.41
12	6.48	4.33	3.24	2.59	2.16	1.85	1.62	1.44	1.30
13	5.98	3.88	2.99	2.39	1.94	1.69	1.49	1.29	1.20
14	5.56	3.71	2.78	2.22	1.85	1.59	1.39	1.23	1.11
15	5.19	3.45	2.59	2.08	1.72	1.48	1.29	1.15	1.04
16	4.86	3.24	2.43	1.93	1.62	1.39	1.21	1.08	.97
17	4.58	3.05	2.29	1.83	1.52	1.31	1.14	1.02	.92
18	4.33	2.88	2.16	1.73	1.44	1.23	1.08	.96	.87
19	4.10	2.73	2.05	1.64	1.36	1.17	1.02	.91	.82
20	3.89	2.59	1.94	1.56	1.29	1.12	.97	.86	.78
21	3.71	2.47	1.85	1.48	1.23	1.06	.92	.82	.74
22	3.54	2.36	1.77	1.41	1.18	1.01	.88	.79	.71
23	3.38	2.26	1.69	1.35	1.13	.97	.84	.75	.68
24	3.24	2.16	1.62	1.30	1.08	.92	.81	.72	.65
25	3.11	2.08	1.55	1.24	1.04	.89	.77	.69	.62
26	3.00	1.99	1.50	1.20	.99	.85	.75	.66	.60

[1]Capitalized value per acre is obtained by multiplying figures in the table by 5.

Assumptions: Ewes - first 8 to 10 weeks of lactation - 120 lbs. body wt.

Daily TDN requirements - 2.9 lbs.

TDN composition of alfalfa - 50.7 percent

Price of alfalfa - $20.00 per ton, or $.01 per lb.

Added cost of getting to the range - $.50 per AUM

Capitalization rate varies from .02 to .10

Acres per AUM - varies from 5 to 26

Table 15. Capitalized range values per acre based on 8 lbs. daily TDN requirements

Acres per AUM	Capitalization rate								
	.02	.03	.04	.05	.06	.07	.08	.09	.10
5	$42.34	28.22	21.17	16.93	14.11	11.91	10.46	9.56	8.41
6	35.28	23.52	17.64	14.11	11.76	10.08	8.72	7.96	7.01
7	30.24	20.16	15.12	12.10	10.08	8.64	7.47	6.83	6.01
8	26.46	17.64	13.23	10.58	8.82	7.68	6.53	5.98	5.26
9	23.52	15.68	11.76	9.41	7.84	6.82	5.81	5.31	4.67
10	21.17	14.11	10.58	8.47	7.06	6.15	5.23	4.77	4.21
11	19.24	12.83	9.62	7.70	6.42	5.58	4.75	4.35	3.83
12	17.64	11.76	8.82	7.06	5.88	5.11	4.36	3.98	3.50
13	16.28	10.86	8.14	6.51	5.43	4.72	4.02	3.67	3.24
14	15.12	10.08	7.56	6.05	5.04	4.39	3.73	3.41	3.00
15	14.11	9.41	7.06	5.64	4.70	4.09	3.48	3.19	2.81
16	13.23	8.82	6.62	5.29	4.41	3.84	3.27	2.98	2.63
17	12.45	8.30	6.23	4.98	4.15	3.61	3.05	2.81	2.48
18	11.76	7.84	5.88	4.70	3.92	3.40	2.90	2.65	2.33
19	11.14	7.43	5.57	4.46	3.71	3.23	2.75	2.51	2.22
20	10.58	7.06	5.29	4.23	3.53	3.07	2.62	2.39	2.10
21	10.08	6.72	5.04	4.03	3.36	2.93	2.49	2.28	2.00
22	9.62	6.41	4.81	3.85	3.21	2.80	2.38	2.17	1.91
23	9.20	6.14	4.60	3.68	3.07	2.67	2.28	2.08	1.83
24	8.82	5.88	4.41	3.53	2.94	2.56	2.18	1.99	1.75
25	8.47	5.64	4.23	3.39	2.84	2.45	2.09	1.91	1.68
26	8.14	5.43	4.07	3.26	2.71	2.37	2.01	1.84	1.62

Assumptions: Wintering weanling calves or wintering yearling cattle - body wt. - 600 lbs.

Daily TDN requirements - 8 lbs.

TDN composition of alfalfa - 50.7 percent

Price of alfalfa $20.00 per ton, or $.01 per lb.

Added cost of getting to the range - $.50 per AUM

Capitalization rate varies from .02 to .10

Acres per AUM - varies from 5 to 26

Table 16. Capitalized range values per acre based on 9 lbs. daily TDN requirements

Acres per AUM	Capitalization rate								
	.02	.03	.04	.05	.06	.07	.08	.09	.10
5	$48.25	32.17	24.13	19.30	16.08	13.78	12.06	10.71	9.65
6	40.21	26.81	20.11	16.08	13.40	11.49	10.05	8.93	8.04
7	34.47	22.98	17.23	13.80	11.49	9.85	8.61	7.66	6.90
8	30.15	20.11	15.08	12.06	10.06	8.62	7.54	6.71	6.03
9	26.81	17.87	13.40	10.72	8.93	7.66	6.70	5.95	5.36
10	24.13	16.09	12.06	9.55	8.05	6.90	6.03	5.36	4.77
11	21.94	14.62	10.96	8.77	7.31	6.27	5.48	4.88	4.38
12	20.11	13.40	10.05	8.05	6.70	5.74	5.02	4.47	4.02
13	18.56	12.37	9.28	7.42	6.18	5.30	4.64	4.12	3.71
14	17.23	11.49	8.62	6.90	5.75	4.92	4.31	3.83	3.45
15	16.08	10.72	8.04	6.43	5.36	4.59	4.02	3.57	3.21
16	15.08	10.05	7.54	6.04	5.03	4.30	3.77	3.35	3.02
17	14.19	9.46	7.09	5.68	4.73	4.05	3.54	3.15	2.84
18	13.40	8.93	6.71	5.36	4.46	3.83	3.35	2.98	2.68
19	12.69	8.46	6.34	5.08	4.23	3.62	3.17	2.82	2.54
20	12.06	8.05	6.04	4.83	4.03	3.44	3.02	2.68	2.41
21	11.49	7.66	5.74	4.59	3.83	3.28	2.87	2.56	2.29
22	10.96	7.31	5.48	4.39	3.66	3.14	2.74	2.44	2.19
23	10.49	7.00	5.25	4.20	3.50	3.00	2.62	2.33	2.10
24	10.05	6.71	5.03	4.02	3.35	2.87	2.51	2.24	2.01
25	9.65	6.45	4.82	3.86	3.21	2.75	2.41	2.15	1.93
26	9.28	6.19	4.64	3.72	3.09	2.66	2.32	2.07	1.86

Assumptions: Wintering pregnant cows (mature) 1000 to 1200 lbs. body weight.

Daily TDN requirements - 9 lbs.

TDN composition of alfalfa - 50.7 percent

Price of alfalfa $20.00 per ton, or $.01 per lb.

Added cost of getting to the range - $.50 per AUM

Capitalization rate varies from .02 to .10

Acres per AUM - varies from 5 to 26

Table 17. Capitalized range values per acre based on 16.8 lbs. daily TDN requirements

Acres per AUM	Capitalization rate								
	.02	.03	.04	.05	.06	.07	.08	.09	.10
5	$90.05	60.04	45.03	36.02	30.02	25.73	22.51	20.01	18.01
6	75.05	50.03	37.52	30.02	25.01	21.44	18.76	16.68	15.01
7	64.32	42.89	32.16	25.73	21.44	18.38	16.08	14.30	12.86
8	56.29	37.52	28.14	22.51	18.76	16.08	14.07	12.51	11.25
9	50.03	33.36	25.01	20.01	16.68	14.30	12.50	11.12	10.00
10	45.03	30.03	22.51	18.01	15.01	12.86	11.25	10.00	9.00
11	40.95	27.29	20.47	16.37	13.64	11.70	10.23	9.10	8.18
12	37.52	25.01	18.76	15.01	12.50	10.72	9.38	8.33	7.50
13	34.63	23.10	17.31	13.85	11.55	9.89	8.65	7.70	6.92
14	32.16	21.44	16.08	12.86	10.72	9.19	8.04	7.15	6.43
15	30.02	20.01	15.01	12.01	10.00	8.58	7.50	6.65	6.00
16	28.14	18.76	14.07	11.26	9.38	8.04	7.04	6.25	5.63
17	26.49	17.66	13.24	10.60	8.83	7.56	6.62	5.89	5.30
18	25.01	16.68	12.50	10.01	8.34	7.15	6.25	5.56	5.00
19	23.70	15.80	11.85	9.48	7.90	6.77	5.92	5.26	4.74
20	22.51	15.01	11.25	9.01	7.50	6.43	5.63	5.00	4.50
21	21.44	14.30	10.72	8.58	7.15	6.12	5.36	4.77	4.29
22	20.47	13.64	10.23	8.19	6.82	5.84	5.11	4.55	4.09
23	19.58	13.06	9.79	7.83	6.53	5.59	4.89	4.35	3.91
24	18.76	12.51	9.38	7.50	6.25	5.36	4.69	4.17	3.75
25	18.01	12.00	9.00	7.21	6.00	5.15	4.50	4.00	3.60
26	17.32	11.54	8.66	6.93	5.77	4.92	4.33	3.85	3.46

Assumptions: Cows nursing calves, first 3-4 months portpartum, or fattening yearling cattle - body weight 900 - 1100 lbs.

Daily TDN requirements - 16.8 lbs.

TDN composition of alfalfa - 50.7 percent

Price of alfalfa $20.00 per ton, or $.01 per lb.

Added cost of getting to the range - $.50 per AUM

Capitalization rate varies from .02 to .10

Acres per AUM - varies from 5 to 26

APPENDIX B

APPENDIX B

Lease Fees Based on 5 Percent Capitalized Value

Tables included in this Appendix have been calculated on the basis of formula [18] page 44.

$$X_l = (X_v)(I)$$

Where

X_l = lease fee per acre where an AUM is assumed to equal 9 lbs. daily TDN

X_v = capitalized value per acre where an AUM is assumed to equal 9 lbs. daily TDN

I = rate of return desired on capitalized value

Table 18. Lease fees based on 5 percent capitalized value per acre per ewe (1.7 lbs. daily TDN requirements)

Acres per AUM	Return on capitalized value								
	.01	.02	.03	.04	.05	.06	.07	.08	.09
5	$ .036	.073	.109	.146	.182	.218	.255	.291	.328
6	.030	.061	.091	.122	.152	.181	.213	.243	.274
7	.026	.052	.078	.104	.130	.156	.182	.208	.234
8	.023	.045	.068	.098	.113	.136	.159	.182	.204
9	.020	.041	.061	.081	.101	.122	.142	.162	.183
10	.018	.036	.055	.073	.091	.109	.127	.146	.164
11	.017	.033	.050	.066	.083	.099	.116	.133	.149
12	.015	.031	.046	.061	.076	.092	.107	.122	.138
13	.014	.028	.042	.056	.070	.085	.099	.113	.127
14	.013	.026	.039	.052	.065	.078	.091	.104	.117
15	.012	.024	.036	.048	.060	.073	.085	.097	.109
16	.011	.023	.034	.046	.057	.068	.080	.091	.103
17	.011	.021	.032	.043	.053	.064	.075	.086	.096
18	.010	.020	.030	.040	.050	.061	.071	.081	.091
19	.010	.019	.029	.238	.048	.058	.067	.077	.086
20	.009	.018	.028	.037	.046	.055	.064	.074	.083
21	.009	.017	.026	.035	.043	.052	.061	.070	.078
22	.008	.016	.025	.033	.041	.049	.057	.066	.074
23	.008	.016	.024	.032	.039	.047	.055	.063	.071
24	.008	.015	.023	.030	.038	.046	.053	.061	.068
25	.007	.014	.022	.029	.036	.043	.050	.058	.065
26	.007	.014	.021	.028	.035	.042	.049	.056	.063

Based on assumptions in Table 13.

Table 19. Lease fees based on 5 percent capitalized value per acre per ewe (2.9 lbs. daily TDN requirements)

Acres per AUM	Return on capitalized value								
	.01	.02	.03	.04	.05	.06	.07	.08	.09
5	$ .062	.124	.187	.249	.311	.373	.435	.498	.560
6	.052	.104	.156	.208	.259	.311	.363	.415	.467
7	.044	.089	.133	.178	.222	.266	.311	.355	.400
8	.039	.078	.117	.156	.194	.233	.272	.311	.350
9	.034	.069	.103	.138	.172	.207	.241	.276	.310
10	.031	.062	.094	.125	.156	.187	.218	.250	.281
11	.028	.057	.085	.113	.141	.170	.198	.226	.255
12	.026	.052	.078	.104	.129	.155	.181	.207	.233
13	.024	.048	.072	.096	.119	.143	.167	.191	.215
14	.022	.044	.067	.089	.111	.133	.155	.178	.200
15	.021	.042	.062	.083	.104	.125	.146	.166	.178
16	.019	.039	.058	.077	.096	.116	.135	.154	.174
17	.018	.037	.055	.073	.091	.110	.128	.146	.165
18	.017	.035	.052	.069	.086	.104	.121	.138	.156
19	.016	.033	.049	.066	.082	.098	.115	.131	.148
20	.016	.031	.047	.062	.078	.094	.109	.125	.140
21	.015	.030	.044	.059	.074	.089	.104	.118	.133
22	.014	.028	.042	.056	.070	.085	.099	.113	.127
23	.013	.027	.040	.054	.068	.081	.094	.108	.121
24	.013	.026	.039	.052	.065	.078	.091	.104	.117
25	.012	.025	.037	.050	.062	.074	.087	.099	.112
26	.012	.024	.036	.048	.060	.072	.084	.096	.108

Based on assumptions in Table 14.

Table 20. Lease fees based on 5 percent capitalized value per acre (8 lbs. daily TDN requirements)

Acres per AUM	Return on capitalized value								
	.01	.02	.03	.04	.05	.06	.07	.08	.09
5	$ .169	.339	.508	.677	.847	1.016	1.189	1.354	1.523
6	.141	.282	.423	.564	.706	.847	.988	1.129	1.270
7	.121	.242	.363	.484	.605	.726	.847	.968	1.089
8	.106	.211	.317	.423	.529	.635	.741	.846	.952
9	.094	.188	.282	.376	.471	.565	.659	.753	.847
10	.085	.169	.254	.339	.424	.508	.593	.677	.762
11	.077	.154	.231	.308	.385	.462	.539	.616	.693
12	.071	.141	.211	.282	.353	.424	.494	.565	.635
13	.065	.130	.195	.280	.326	.391	.456	.521	.586
14	.061	.121	.181	.242	.303	.363	.423	.484	.544
15	.056	.113	.169	.226	.282	.338	.395	.451	.508
16	.053	.106	.159	.212	.265	.317	.370	.423	.476
17	.050	.099	.149	.199	.250	.299	.349	.398	.448
18	.047	.094	.141	.188	.236	.282	.329	.376	.423
19	.045	.089	.133	.178	.223	.268	.312	.357	.401
20	.042	.085	.127	.170	.212	.254	.296	.338	.381
21	.040	.081	.120	.161	.202	.242	.282	.322	.363
22	.038	.077	.116	.154	.193	.231	.269	.308	.346
23	.037	.074	.110	.147	.184	.221	.258	.294	.331
24	.035	.071	.106	.141	.177	.212	.247	.282	.318
25	.034	.068	.102	.136	.170	.203	.237	.271	.305
26	.033	.065	.098	.130	.163	.196	.228	.261	.293

Based on assumptions in Table 15.

Table 21. Lease fees based on 5 percent capitalized value per acre (9 lbs. daily TDN requirements)

Acres per AUM	Return on capitalized value								
	.01	.02	.03	.04	.05	.06	.07	.08	.09
5	$ .193	.386	.579	.772	.965	1.158	1.351	1.544	1.737
6	.161	.322	.482	.643	.804	.965	1.126	1.286	1.447
7	.138	.276	.414	.552	.690	.828	.966	1.104	1.242
8	.121	.241	.362	.482	.603	.724	.844	.965	1.085
9	.107	.214	.322	.429	.536	.643	.750	.858	.965
10	.095	.191	.287	.382	.477	.573	.668	.764	.859
11	.088	.175	.263	.351	.438	.526	.614	.702	.789
12	.081	.161	.242	.322	.402	.483	.563	.644	.724
13	.074	.148	.223	.297	.371	.445	.519	.594	.668
14	.069	.138	.207	.276	.345	.414	.483	.552	.621
15	.064	.129	.193	.257	.321	.386	.450	.514	.579
16	.060	.121	.181	.242	.302	.362	.423	.483	.544
17	.057	.114	.170	.227	.284	.341	.398	.454	.511
18	.054	.107	.161	.214	.268	.322	.375	.428	.482
19	.051	.102	.152	.203	.254	.305	.356	.406	.457
20	.048	.097	.145	.193	.241	.289	.338	.386	.435
21	.046	.092	.138	.184	.229	.275	.321	.367	.413
22	.044	.088	.132	.176	.219	.263	.307	.349	.395
23	.042	.084	.126	.168	.210	.252	.294	.336	.378
24	.040	.080	.121	.161	.201	.241	.281	.322	.362
25	.039	.077	.116	.154	.193	.232	.270	.309	.347
26	.037	.074	.112	.149	.186	.223	.260	.298	.335

Based on assumptions in Table 16.

Table 22. Lease fees based on 5 percent capitalized value per acre (16.8 lbs. daily TDN requirements)

Acres per AUM	Return on capitalized value								
	.01	.02	.03	.04	.05	.06	.07	.08	.09
5	$ .360	.720	1.081	1.440	1.801	2.161	2.161	2.882	3.242
6	.300	.600	.901	1.201	1.501	1.801	2.101	2.402	2.702
7	.257	.515	.772	1.029	1.286	1.544	1.801	2.058	2.316
8	.225	.450	.675	.900	1.125	1.351	1.576	1.801	2.026
9	.200	.400	.600	.800	1.000	1.200	1.400	1.601	1.801
10	.180	.360	.540	.720	.900	1.081	1.261	1.441	1.601
11	.164	.327	.491	.655	.818	.982	1.146	1.310	1.473
12	.150	.300	.450	.600	.750	.901	1.051	1.201	1.351
13	.138	.278	.415	.554	.692	.831	.970	1.108	1.246
14	.129	.257	.386	.514	.643	.772	.900	1.029	1.157
15	.120	.240	.360	.480	.600	.721	.841	.961	1.081
16	.113	.225	.338	.450	.563	.676	.788	.901	1.013
17	.106	.212	.318	.424	.530	.636	.742	.848	.954
18	.100	.200	.300	.400	.500	.600	.701	.801	.901
19	.895	.190	.284	.379	.474	.569	.664	.758	.853
20	.090	.180	.270	.360	.450	.541	.631	.721	.811
21	.086	.172	.257	.343	.429	.515	.601	.686	.772
22	.082	.164	.246	.328	.409	.491	.573	.655	.737
23	.078	.157	.235	.313	.391	.470	.548	.626	.705
24	.075	.150	.225	.300	.375	.450	.525	.600	.675
25	.072	.144	.216	.288	.360	.433	.505	.577	.649
26	.069	.139	.208	.277	.346	.416	.485	.554	.624

Based on assumptions in Table 17.