1954

Economics of western range resource use

John Alfred Hopkin
Iowa State College

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ECONOMICS OF WESTERN RANGE RESOURCE USE

by

John Alfred Hopkin

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of The Requirements for the Degree of DOCTOR OF PHILOSOPHY

Major Subject: Agricultural Economics

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

Head of Major Department

Signature was redacted for privacy.

Dean of Graduate College

Iowa State College

1954
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It has been recorded that Bertrand Russell initiated a game involving the conjugation of irregular verbs in a manner depicting man's curious propensity for self-righteousness: "I am firm; you are obstinate; he is a pig-headed fool . . ." (93, p. 1). The American version of this game has reached a state of high development in the area of range resource use and development. Editorial writers for Harpers Magazine, the American Cattle Producer, and the National Woolgrower, members of the House and Senate investigating committees, representatives of the federal land administrative agencies, spokesmen for sportsmen's organizations, et al., show varying skills in the art of the game.

That the conflict is economic in its origin is revealed by a close inspection of the issues that are debated. These issues focus on the decisions involving the rate and manner of resource development, the intensity of resource use, and the allocation of the resources toward the alternative products of multiple-use. These are the kinds of problems for which the science of economics has been developed - problems involving the allocation of scarce resources among competing ends. It is somewhat surprising that in the vast
amount of literature that has accumulated relative to western range resource use and development, economic analysis of the problems are conspicuous by the rareness with which they occur.

This study originated as an outgrowth of the author's experience in trying to orient a range economics research problem into the existing supply of range research methods. Procedures for integrating economic theory into range research methods were lacking. The need for a logical theoretical framework for such research became evident. This study is an attempt to adapt the logic and theorems of the maximizing criteria to provide this needed framework where the quantity to be maximized is the net social product from the resources in question.

Maximizing net social product is an ex ante concept, whether by private firms or public agencies. It is intended, in the chapters ahead, that this framework can be formulated with sufficient precision to furnish criteria that will: 1. Assist private firms and public agencies in making decisions that will result in a greater net social product than would otherwise obtain - ex post; and 2. Provide a framework for making future research more useful for decision making. If this objective has been achieved considerable credit is due to the efforts of two groups of scientists. The largest contribution comes from the great minds that
designed, forged, and refined the tools that comprise the science of economics. The second is a smaller and more contemporary group - those who have pioneered with the economic problems of the Western Range Area, with its extreme physiographic and climatological variation, and its unique institutional setting.

It is a pleasure to express my sincere appreciation to all who have helped in the preparation of the manuscript: To Dr. E. O. Heady for inspiration and guidance in graduate study and for his continued encouragement and suggestions in writing this dissertation; To Dr. John A. Nordin and Dr. Howard H. Hines for the stimulus of their criticisms of an early draft, and for editorial suggestions; To staff members in the Department of Forestry and the Department of History and Government who gave valuable criticisms and suggestions which improved the last two chapters; To Bonita G. Hopkin who gave of her time, interest, and energy throughout the entire program of graduate study, typing the early drafts, and assisting with the editing and proofreading are among the tasks that can be identified and for which appreciation can be specifically expressed.
CHAPTER I

WHAT AND WHERE ARE THE WESTERN RANGE RESOURCES

A. The Western Range

Western range resources are even more difficult to define than the western range itself. Most writers on the subject have not attempted to define "range", but have been content to describe it (39, p. 7). For the most part, those who have described the range consider it as an extensive and uncultivated area that can, in the main,

. . . ., be restored and maintained only through control of grazing. It consists almost exclusively of lands which, because of relatively meager precipitation, or other adverse climatic conditions, or rough topography, or the lack of water for irrigation, cannot successfully be used for any other form of agriculture. (255, p. 1)

Range land may be characterized by the necessity of harvesting the forage product by grazing livestock.

The boundary line separating the western range from land to the east is somewhat arbitrary and controversial. The boundary line used herein will be that used by the Forest Service in its 1936 study, The Western Range, and is shown in Figure 2. It calculated the aggregate range area to be 728 million acres, or 76 per cent of the total
975 million acres of the area west of its boundary (255, p. 3). The region is particularly characterized by heterogeneity of vegetative type, physiography, climate, land-tenure pattern, and kind of ranch organization.

Stoddart and Smith have divided the western range into nine separate regions of vegetation: "(a) tall grass, (b) short grass, (c) desert grass, (d) bunch grass, . . . (e) northern or intermountain shrub, (f) southern desert shrub, (g) chaparral, (h) pinon-juniper, and (i) coniferous forest" (208, pp. 66-68). These major vegetative types are shown in Figure 1.

Determined largely by climatic conditions and vegetative types, the timing of grazing may be year-long, winter, summer, or spring-fall, and spring-fall-winter. Figure 2 shows the Forest Service classification of the western range by season of grazing. Imposed on the Forest Service map is a regional classification used by Clawson in an attempt to get greater homogeneity as a basis for describing the western range. He describes each region as follows:

The Northern Great Plains, as here defined, includes, roughly, 200 million acres. . . . It is predominantly rolling plains area, with a few intruding mountains. The elevation mostly ranges from 1,500 to 6,000 feet . . . . Precipitation

---

1By permission from Western range livestock industry, by Marion Clawson. Copyright 1950. McGraw-Hill Book Company, Inc.
Figure 1. Major vegetative types in the Western Range Area (by permission from Range Management by Stoddart and Smith, copyright 1943, McGraw-Hill Book Company, Inc. (208))
Figure 2. Seasonal use of forage, Western Range Area (the regional subdivisions have been imposed on a map prepared by the U. S. Department of Agriculture (255))
varies mostly from 12 to 20 inches and is pre-
dominantly summer . . . . The plant cover is
chiefly short grass; . . . . The land is nearly
all privately owned, though much by non-residents.
Most of the range livestock are beef cattle.
Animals must be fed in the winter, though the
light snowfall enables them to graze at times
during that season.

The Southern Great Plains . . . includes
roughly 150 million acres . . . even more uniform
in topography than the Northern. The elevation
ranges mostly from 1,000 to 6,000 feet. The plant
cover is chiefly short grass, with some desert
grass . . . . Practically all the land is now in
private ownership. Almost no feeding is practiced
in the Southern Plains, except a little cottonseed
cake to weak cows and calves in wintertime . . .

The Southwest . . . includes 150 million acres.
Nearly one-third of this area is "desert"; that
is, it supports so little vegetation and has so
little livestock water as to be virtually unusable
for grazing. It includes a wide variety of vegeta-
tion types, reflecting a considerable variation
in topography, elevation and precipitation. The
area is relatively hot and dry, with much of its
annual precipitation coming in torrential thunder-
showers. A large portion of the area is in Federal
ownership-national forests, Indian reservations and
grazing districts . . . . Beef cattle predominate,
although many sheep are found . . . . Many of the
livestock operators are Indians, with traditionally
small herds and flocks.

The Intermountain Area . . . is a very large
area (350 million acres) with a large irreducible
heterogeneity. It includes the whole Rocky Moun-
tain system and to the summit of the Sierra-Cascade
system. In between lies an extremely varied
topography, with sharp variations in precipitation
and forage type within short distances . . . . The
proportion of valley, foothill and mountain area
varies in different parts, but their intermixture
is common throughout. A great deal of the land is
Federally owned . . . . This is the great range
sheep area, though beef cattle are highly important.
Except in the northern part, and where early lambs
are produced, sheep graze through the winter as well,
on the great semi-desert winter ranges, where snow provides most of the water for their use. Beef cattle must be fed through the winter, usually for a three- to four-month season.

The Northwest . . . includes 40 million acres in those parts of Oregon and Washington lying west of the Cascade Summit . . . on small areas of natural grassland and on cutover forest lands unsuitable for general farming.

California . . . includes roughly 60 million acres . . . the relatively low coastal mountains, the Great Valley and its foothills, and the western slope of the Sierra. Precipitation comes almost wholly in the late fall, winter, and spring . . . . Seasonally, then, this area is the reverse of most other western range areas . . . . Many thousand cattle are purchased each fall, usually from surrounding range states where the best grazing season has just ended, and placed on the foothill ranges, to be sold as good grass fats in the spring. Sheep production is mostly seasonally reversed also. Old ewes, unfit for longer use on rough range areas, are purchased in adjoining states and bred for early lambing . . . . Over 70 per cent of the lambs go to market in April. (39, pp. 27-31)

Probably one of the most distinguishing characteristics of the Western Range is its complicated patterns of land ownership that currently exist - a heritage of over 150 years of a developing federal land policy, and of about 75 years of man's trying to adjust and alter that land policy to the terrain and climate of the western range.
B. Irrigated and Dryland Farming

Intermingled throughout the entire Western Range Area are important smaller areas of irrigated farming. In some cases these irrigated valleys have provided stability to the surrounding area by furnishing an emergency feed base when needed, and by providing a market for feeder livestock. In other cases, the degree of integration between the range livestock and irrigated sectors may be negligible, as in the case of the south-central Arizona irrigation region where truck gardening and cotton are the main enterprises.

There are, within the Western Range Area, three important dryland wheat farming regions: the hard winter-wheat region, centered in western Kansas and eastern Colorado; the spring-wheat region of North Dakota and northern Montana; and the Palouse region of the northwest. In the two Great Plains Regions dry farming is somewhat intermingled with the range-livestock industry.

C. Western Industry

The mining industry actually preceded livestock raising in many regions of the west. In several localities it has remained and expanded. Closely connected to the
mineral resources have grown up several resource-based industries, such as the copper industries of Montana, the steel industries of Utah and Colorado, and the oil industries of Wyoming, Oklahoma, Texas and California. The industrial expansion of the nation, under the impetus of World War II, located many heavy industries on the western periphery in the areas served by hydroelectric power furnished by the Grande Coulee, Bonneville, and Hoover Dams.

At the present time the ratio of industry to agriculture, whether in terms of physical products produced, number of persons employed, or derived income, is lower for the Western Range Area than for the remainder of the United States (262). In the past, a large portion of the mineral-based industry in the West was in the production of those products the demand for which has been characterized by a slow rate of growth (193, p. 709), such as silver, iron, and copper. Notable exceptions to this have been gold and petroleum. Very recent years have unveiled the possibility of a large expansion in the manufacturing of light metals, such as aluminum, titanium, and others - products for which there is a rapidly growing demand (270, pp. 63-95).

While there are many acres of so-called forests in the Western Range Area, the lumbering activity has been somewhat limited except in the northwest (39, p. 78). However,
some forest enterprises are scattered throughout many of the communities of the Intermountain and California regions and some in the Southwest, although on a much smaller scale than in the Northwest. The necessity for roads into forest areas before lumbering can be carried on has made the influence of the forest industries favorable to other resource uses, such as the livestock industry, fishing, hunting and recreation.

From the standpoint of transportation, the Western Range Region is strategically located between the central market terminals of the Midwest and the fast-growing population centers on the West Coast. Both rail and truck transportation facilities are quite adequate for east-west traffic. North-south commercial travel in this region, however, is difficult. Some who have tried commercial travel north or south have humorously opined that north-south transportation has advanced very little since the Old Chisholm Trail.

D. Population and Population Trends

Aside from the cities of Denver, El Paso, Salt Lake City, and Spokane, the extreme West Coast, and, more recently, the areas surrounding Phoenix and Sacramento, the
Western Range Area is extremely sparsely populated, relative to the other regions of the United States. Close examination of the census statistics on population trends for the 17 western states indicates such a lack of homogeneity that it is doubtful if any inference on the supply and demand for labor would be generally applicable for all of the area. The extreme west coast states have shown an unusual growth in population, as have Arizona and Nevada. Wyoming, Utah, Texas and Colorado have shown a percentage growth slightly higher than the national average. Kansas, Montana, Nebraska, the Dakotas, and Oklahoma have had either very small increases or, in some cases, population decreases during the past two decades. (see Table 1)

Some localities in the region are characterized by a high birth rate, low death rate, and a high degree of population immobility, as is true of Utah, Texas, and Wyoming. Arizona and New Mexico have even higher birth rates and population immobility and have very high death rates. For Washington, Oregon, California, and Nevada, the birth rates and death rates are higher than the national average, but these states have had a high positive net migration, primarily for purposes of retirement or for industrial employment. Other states of the region have lower-than-average birth rates as well as death rates, and have experienced
Table 1

Changes in Population in the Seventeen Western States

<table>
<thead>
<tr>
<th>State</th>
<th>Population 1950</th>
<th>Per cent of change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1930-1940</td>
<td>1940-1950</td>
</tr>
<tr>
<td>California</td>
<td>10,490,070</td>
<td>21.7</td>
</tr>
<tr>
<td>Arizona</td>
<td>745,259</td>
<td>14.6</td>
</tr>
<tr>
<td>Nevada</td>
<td>158,283</td>
<td>21.1</td>
</tr>
<tr>
<td>Oregon</td>
<td>1,512,100</td>
<td>14.2</td>
</tr>
<tr>
<td>Washington</td>
<td>2,363,289</td>
<td>11.1</td>
</tr>
<tr>
<td>New Mexico</td>
<td>677,152</td>
<td>25.6</td>
</tr>
<tr>
<td>Utah</td>
<td>686,797</td>
<td>8.4</td>
</tr>
<tr>
<td>Texas</td>
<td>7,677,832</td>
<td>10.1</td>
</tr>
<tr>
<td>Colorado</td>
<td>1,318,048</td>
<td>8.4</td>
</tr>
<tr>
<td>Wyoming</td>
<td>288,800</td>
<td>11.2</td>
</tr>
<tr>
<td>Idaho</td>
<td>585,092</td>
<td>17.9</td>
</tr>
<tr>
<td>Kansas</td>
<td>1,894,390</td>
<td>-4.3</td>
</tr>
<tr>
<td>Montana</td>
<td>587,337</td>
<td>-4.1</td>
</tr>
<tr>
<td>South Dakota</td>
<td>650,029</td>
<td>-7.2</td>
</tr>
<tr>
<td>Nebraska</td>
<td>1,318,079</td>
<td>-4.5</td>
</tr>
<tr>
<td>North Dakota</td>
<td>617,965</td>
<td>-5.7</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>2,223,650</td>
<td>-2.5</td>
</tr>
</tbody>
</table>

^Source: Bureau of Census (262).

a substantial out-migration in the last two decades (263, pp. 109-110).

E. Technology and Production Trends

In agriculture, the West has not experienced the same technological revolution that has characterized agricultural production of the midwest and other areas. There has
been no hybridization of range grasses, for instance, that can compare with hybrid corn. Since moisture is the limiting factor of plant growth on the non-irrigated lands of the West, there likely will not be the same physical production response to fertilizers comparable to those now being obtained in the Southeast.

In the farming areas, generally, and in the grain producing areas in particular, the technological changes have been labor-saving (i.e., they have substituted capital for labor - tractor, beet-harvester, cotton-picker, etc.) rather than product-increasing. The out-migration from the grain producing areas of the upper Missouri Basin area, Kansas, and Oklahoma can be looked on as a favorable adjustment to the changing economic environment (30, pp. 714-715).

The range-livestock industry has experienced considerably less change than have the farming areas, generally. There is little opportunity for mechanization in ranching, other than in the crop harvesting processes - which are usually a minor part of the total ranch activities. Investment in range improvements have been limited by lack of information, capital, and by institutional barriers.

If, as has been pointed out, the economy of the Western Interior is largely dependent upon demands that have the attribute of relatively slow growth (193, p. 712); and if
technical innovations of the product-increasing variety have shown little promise, then, it is likely that this area will find itself supplying a smaller proportion of the nation's goods. Assuming this to be true, one cannot infer that a lower standing of living, relative to the rest of the United States, is in store for the inhabitants of this area, since some of the states in this area have shown a remarkable degree of mobility. In appraising the outlook for the future one should not discount the growing importance of petroleum and light metals, or the increasing demands for outdoor recreation and scenery. At best, any attempt at long-range forecast is beset with the uncertainties of unforeseen technological and social change.

F. Need for Considering All of the Resources

It needs to be emphasized at the outset that we are interested not only in an economic analysis of western range lands but of all resources that have alternative uses. Labor and capital usually are not fixed in location and thus have an opportunity for alternative allocation. From this standpoint one might reason that economic analysis of labor and capital is more meaningful than economic analysis of land. This would certainly be true for those desert
areas where there is no alternative use for land other than for winter grazing of sheep. As our present bundles of resources come to us from out of the past, it is not always possible to separate the capital and labor from the land, or to distinguish the results of management from the influence of institutional environment. Such attempts would have little economic meaning for the future. Our approach will be to take the resources that are available for use and consider their alternative combinations of uses to see which combination promises to be the most rewarding.

There have emerged from out of the past a greater number of institutional forces influencing the uses of land than is true of the other factors. Particularly is this true of the western range area with its very complex pattern of property arrangement. This does not mean that there are no institutional restrictions on the use of labor and capital, however.

Some of the present system of land tenure in the West is largely the result of historical accident - it simply grew up that way. In the next chapter we will review, very briefly, the historical development of the federal land policy and the growth of the western range-livestock industry. This should help us to understand the present situation, and explain, in part at least, why the present
conditions exist. We will then take up the weightier task of defining the nature of our economic problem.
CHAPTER II
HISTORICAL BACKGROUND

A. Land Policy Development

The land policy of the Federal government was dichotomous at its inception. The new Confederacy was in a severe financial position, and the only apparent source of revenue was the sale of the public domain. Hamilton, the brilliant young Secretary of the Treasury, proposed such a sale at a price that would bring substantial revenue - the financial consideration of the land policy. The agrarian concept, attributed to Jefferson, and, indeed, led by him at this early period, was that land should be given outright to the settler, or, at most, sold at a very nominal fee. This was the colonization consideration of the land policy.

1. Land disposal

At a time when the form of government itself was not definite, and when that government was without alternative means of raising revenue, Jefferson, himself, became one of the leading figures in the program of disposing of public lands by sale to land companies. The problem of defense against Indians at the frontier confronted the Congress;
and there was a real risk that the new territories might ally themselves with either Spain, to the south, or England, to the north. The need for revenue seemed the most critical issue. Even in the beginning "Congress was not free to devise a land policy in a quiet, philosophical manner" (90, p. 53), but gave way to temporary political and economic expediency.

Dissatisfaction with the speculation, fraud and lack of settlement under the land companies, led the new Republic to revise its land laws in favor of the settler. Sales of 160- and 640-acre tracts at a minimum of $2.00 an acre were permitted, with credit terms up to five years. Eventually, the minimum tract was lowered to 80 acres and the minimum price to $1.25 per acre, and the credit terms were eliminated. The tempo of land sales increased substantially, reaching a peak of over 20 million acres sold in 1836 (90, p. 103).

In appraising the policy of land disposal for revenue one notable historian has said:

When the government most needed revenue, lands did not sell; when revenues could be raised otherwise, land brought in considerable cash. In the fitful years preceding the panic of 1837, the surplus in the treasury, over which Congress wrangled interminably, was due, in no small part, to receipts from land. Thus more clearly than before proving that as a regular source of income, the receipts from the sale of public land are about as bad as possible. (90, p. 6)
Gradually the Jeffersonian agrarian concept took over the public land policy from the "revenue" concept. To its advocates it was the settler who was important, and that land policy which served him best was best for the Republic.

The pre-emption rights that were incorporated into the land laws during the "thirties" and "forties" permitted the early "squatter", the Daniel Boone type of pioneer who forged ahead of the frontier, to buy the land he had cleared and settled, once the frontier caught up to him and the land was surveyed. This gave him protection from the land speculator who previously had pushed him off the land he thought was his own. The Pre-emption Act did not nullify the earlier concept of land sale, but it did provide early precedent for occupying and using public land without authority, not as a trespass, but as a right (38, p. 66). It was also the forerunner of the Homestead Act, embodying the long-felt need for limiting the amount of land to one farm unit per person.

The Homestead Act of 1862 culminated over 30 years of political effort on the part of the public land states to get free land for the home builder. The act required five years of residence on the land, specified certain minimum improvements that had to be in evidence, and limited the amount of land to 160 acres per family.
East of the hundredth meridian the Homestead Act of 1862 was probably the most successful public land law passed by the Federal government. The inadequacy of the act as a land policy, in the more arid and mountainous regions, soon became apparent. In his annual report for 1875, Mr. Williamson, the Commissioner of the General Land Office, stated:

... it may be safely affirmed that, except in the immediate valleys of the mountain streams, where by dint of individual effort water may be diverted for irrigation purposes, title to the public lands cannot be honestly acquired under the homestead laws. (264, p. 7)

In 1877 Congress passed the Desert Land Law which permitted the settler up to 640 acres, or any part thereof that he had brought under irrigation, with only three years required for patent. This limit was cut down to 320 acres in 1890. Hibbard summarized the effect of the public land laws pertaining to individual settlers of this period as follows:

The first real breakdown of the Homestead Act was in its attempt to cross the plains. For this task it was ill adapted. It may be objected that it broke down in its application to the forest regions. In a sense it did, but not with respect to the welfare of settlers. On the plains the Homestead Act was a failure from the standpoint of both individual and nation. To the credit of Congress be it said that this failure was recognized early and the Desert Land Act of 1877 passed as a modification. This act was a poor solution of the difficulties, and subject to much abuse. The act of 1891, covering many features of the
land situation, improved the method of disposing of the desert land, yet fell woefully short of the ideal . . . . Fraud was invited and the challenge accepted. Land presumably intended for farms was acquired under this act for grazing. (90, pp. 454-455)

A commission to study public land problems was appointed in 1879. They recommended that for all purposes of sale public lands be classified as either arable, irrigable, pasturage, timber and mineral, and, for the pasturage lands, proposed sale in units up to 2,560 acres.

There are several reasons why Congress did not look with enthusiasm on this recommendation which, if followed, might have resulted in a vastly different land pattern than has emerged. In the first place, the grants in large tracts to individual companies for purposes of internal improvement, particularly to the railroad companies from 1860-1871, had caused political backfire. Second, this policy was in contrast to the most acceptable political slogan of the time - "free land to the homesteader". Third, since it was felt that all that was needed on most of the land was water, irrigation development appeared to be the key to the solution. Also, the early monetary problems created by a surplus in the federal treasury, over which Congress had wrangled so bitterly before the Civil War, had left their impressions. Many were opposed to land sales in any quantity. Finally, the public attitude toward the new cattle industry that
was "mushrooming" in the west was one of suspicion and disapproval.

The Carey Act of 1894 was the first real attempt at collective irrigation development on a large scale; it provided that such development be done by the states. Federal land was to be turned over to the states, which, in turn, were to see that the land was irrigated, settled, and cultivated. Not more than 160 acres were to be sold to one person. By 1909 only 288,553 acres of Carey Act land had been irrigated (90, p. 437).

Agitation for irrigation development by the federal government was increasing during the last quarter of the nineteenth century. By 1900 the political platforms of both parties favored reclamation of arid lands. When Theodore Roosevelt, in his first annual message to Congress, called for irrigation development by the national government, it took until June, 1902, to pass the Reclamation Act, representing a new departure in federal land policies. The federal government was in the business of providing water for irrigating land.

Although the original act provided that the "reclamation fund" should consist of money received from the sale of land, and that the settler should repay the cost of construction of the project in annual payments not to exceed 10 years (266, p. 4), both of these restrictions have long
since been altered. For purposes of this study the Reclamation Act is important in three respects: first, it called for the classification and withdrawal of lands that might be suited to irrigation development; second, it re-emphasized the idea that arid lands might one day be irrigable; and finally, it made the likelihood of their being disposed in large units for grazing homesteads extremely low. It represents today the last hope to a prospective settler, a lucrative prospect to a local chamber of commerce, and a plum to the politician.

2. Land reservations

As early as 1817 Congress delegated to the President the authority to withdraw lands from entry for special purposes such as wagon roads, military posts, etc. (169, p. 294). With the reservation of the Warm Springs of Arkansas in 1832, a new principle of federal land policy was introduced wherein "ground possessing extraordinary natural values was kept from becoming private property on the theory that a wider public good would be served by retaining title in the government" (165, p. 45). The reservation of the area now known as Yellowstone National Park was made by a special act of Congress in 1872.

Until after the Civil War forests, for the most part, were the stuff pioneers chopped, burned, and pushed into
one corner to provide land for cultivation. They passed up
the plains of Illinois and Iowa to move north or south into
wooded land. Right after the Civil War the great lumber
companies moved into Michigan, Wisconsin and Minnesota, and
soon found their way to the great northwest. Most of the
areas now labeled "the cut-over areas" marks the routes they
followed during this period. In 1881 the first forestry
work officially began as a separate office under the Commis­
sioner of Agriculture. This finally became a bureau in the
Department of Agriculture in 1897. A year later Gifford
Pinchot, without doubt the most colorful and controversial
character associated with the public lands, was made chief
of the bureau (90, p. 530).

The actual establishment of the forest reserves was a
most intriguing political maneuver. A very omnibus land
bill, later called The Act of 1891, had passed both houses
of Congress in slightly different forms. It called for the
abolition of both the Pre-emption Act and the Timber Culture
Act, along with other minor changes. It was while this
bill was in conference that section 24 (now known as the
Forest Reserve Act) was added as a "rider". The section
provided the president with authority to set apart and re­
serve "from time to time" public lands as forest reserves.
The measure passed with very brief discussion and not a
single objection (38, pp. 105-106). From the congressional
furor that arose when President Harrison actually set aside over 13 million acres, and more especially when President Cleveland followed with nearly 26 million acres of public domain as forest reserves, one must conclude that several congressmen were not completely aware of the implications of what they were voting for in the closing hours of the 1891 session of Congress.

At first, Congress provided no funds for the administration of these forest lands, leaving them under the jurisdiction of the General Land Office of the Department of Interior, which, although it had provided rules and regulations for the use of the reserves, had no personnel to do the job. President McKinley's new administration in 1897 provided for the administration of the withdrawn reserves by the General Land Office of the Department of the Interior. Provision was made for a settler whose claim, or a land owner whose patent, fell within the boundaries of a forest reserve to exchange such lands for another tract of vacant land open to settlement, if he so desired.

The turn of the century witnesses a new awakening consciousness to many types of land frauds that had been going on under the Desert Land Law, the Timber and Stone Act, and even the Homestead Act. In 1902 there was an expose of fraud in high places with regard to this homestead exchange provision. One United States senator was
indexed and several employees of the General Land Office were dismissed, including the commissioner (165, pp. 43-44). President Roosevelt appointed a commission to study the effectiveness of existing land laws, and to study the use, condition, disposal and settlement of the public lands. The commission was composed of Pinchot, Newell (Head of the Reclamation Service) and Richards (Commissioner of the General Land Office) (165, p. 45). One of the immediate results of the investigations and recommendations of the commission was that the right to exchange lands in forest reserves for land outside was repealed. Other less direct results were to have a greater effect on things to come. Administration of the forest reserves were transferred from the General Land Office of the Department of Interior to the Forest Service of the Department of Agriculture, headed by Pinchot, in 1905. The Commission's recommendations that the Timber and Stone Act be repealed, that the commutation privilege of the Homestead Act not be permitted until after three years of residence, and that the Desert Land Law be reduced to 160 acres, drew strong opposition from many sections of the west on the grounds that to do so would be to halt the development of the western regions.

A law was passed in 1906 permitting homestead entries on land within the forest reserves that was classified as agricultural. That the Forest Service failed to so classify
much land that was requested served only to further agitate
many elements of the West (165, p. 6), which were already
opposed to the vigorous crusading policies of Pinchot. The
heavy expansion of withdrawals from entry for forest re­
serves and a 66-million-acre withdrawal of public land on
the basis that it might contain workable deposits of coal
caused further anxiety.

One other important by-product of Pinchot's early in­
vestigations into the activities of the General Land Office
and the land frauds was his conviction "that the Department
of the Interior and the Land Office were corrupt, politically
motivated, and incapable of trust in resource administration"
(38, p. 109). This was to cause him later to become em­
broiled with Secretary of Interior Ballinger and others in
such bitter debate that President Taft dismissed him in
1910. Relationships between the Departments of Agriculture
and Interior were frequently bad for many years.

Gradually western interests began to align themselves
and take the offensive. In 1907 the administration started
out to get a substantial increase in the Forest Service bud­
get, and ended up losing the funds received from the sale of
products from the forests. At the same time the president
was deprived of his "power to create forest reserves in the
states of Oregon, Washington, Idaho, Montana, Colorado and
Wyoming" (165, p. 98). The bill had to wait on the
President's desk long enough to permit him to sign an order creating some 16 million additional acres of forest reserve. He then signed the act into law prohibiting himself from making such withdrawals, to the continued infuriation of the West.

President Taft and his administration were more conservative than Roosevelt and Pinchot, each of whom felt it his duty "to do everything the law will let him do for the public good, and not merely what the law directs or compels him to do" (168, p. 117). The former were successful in getting the Withdrawal Act passed in 1910, to the disappointment of the "state's rights" faction who opposed it, and to the disappointment of the Pinchot-led conservationists, who felt that such powers were inherent in the office of the President, and that such a law would weaken, not strengthen, their position. The passage of the Withdrawal Act produced an anomalous situation the public land states. "While it gave the much desired congressional sanction of the withdrawal principle, it made no provision for the use of the lands withdrawn" (165, p. 118). The need for leasing provisions to handle such lands as the mineral reserves and water and power site reserves became evident with Congressional sanction of the Withdrawal Act. It took 10 years of weary debate, including a filibuster by Senator LaFollette, and the heavy demands for natural resources of a world war,
to bring about passage of the first leasing bills for non-metallic mineral lands and water-power sites. Thus, another precedent was set, but it was long in coming. Undoubtedly the development of the "Campbell system" of dry-farming, and the enthusiasm that it generated, caused many to feel that there were agricultural potentialities in most of the arid lands - a "wait and see" attitude prevailed.

In the meantime the range-livestock industry was in a dilemma. On the one hand it was pushed back more and more by each new homestead settlement, and thus it tended to favor withdrawal from entry. Yet it needed some kind of control of the public range that was rapidly deteriorating under the policy of "first come-first served". In order to understand the full meaning of this conflict the following summary of the history of the range-livestock industry has been attempted.

B. Development of the Western Range-Livestock Industry

The western range-livestock industry first originated to meet the needs of the immigrant along the Oregon Trail. It grew as the intensity and number of western routes grew. In 1859 Horace Greeley wrote along the way that
Several old mountaineers have large herds of cattle which they are rapidly increasing by a lucrative traffic with the emigrants, who are compelled to exchange their tired, gaunt oxen and steers for fresh ones on almost any terms. (67, p. 72)

As the gold strikes in the mountain areas attracted fortune seekers, cattle started moving up from Texas in small numbers to supply the fast growing mining towns of Colorado, Montana, and Wyoming. Writes one historian,

Here was a market for the Montana stock grower, who soon found that taking gold dust from the miners in exchange for beef was almost as profitable and far more certain than getting it from the placers. (160, p. 21)

Many who came to dig gold stayed to raise cattle on the free range. The new army posts that sprang up all over the West created many new markets for beef. A demand was rapidly created for stock cattle. The first big herd of Texas longhorns came over the Bozeman Trail from Dallas to the Gallatin Valley in 1866 (160, p. 21). The way was provided for expansion when the railroads came into Wyoming in 1867.

Ignoring reports of the historians, geographers, and the Land Office Commissioner that this Great American Desert was "an impediment to the prosperity of the new communities west of it, in not yielding that sustenance required for increasing population" (265, p. 138), the stock business began in dead seriousness, and the "Texas invasion" of the lands northward was underway. This became one of the most
romantic and legendary epochs of a romantic era - longhorns born in Texas, growing up while enroute, eluding both the Indian and the bandit along the way, finally were fattened on the ranges to the north, and "rode the rails" to Omaha or Chicago. Many of the mountain valleys soon began to carry their own breeding herds, thus creating a thriving market for breeding stock. Things looked good to the stock­man. Wrote Bill Nye, noted humorist and editor for the Laramie Boomerang,

Three years ago a guileless tenderfoot came into Wyoming leading a single steer and carrying a branding iron; now he is the opulent possessor of six hundred head of fine cattle - the ostensible progeny of that one steer. (160, p. 86)

In competition with the continuing "drives" of cattle from Texas, higher quality but less hardy cattle were shipped in by rail from the farms of Iowa and Illinois. The risks were rapidly getting greater, but so were cattle prices. The center of speculation moved from the open range to Wall Street and then to London. Land and cattle companies multiplied. The fever spread to Scotland. Writes John Clay,

The ranching pot was boiling over in Edinburg . . . , drawing rooms buzzed with the stories of this last of bonanzas; staid old gentlemen who scarcely knew the difference between a steer and a heifer, discussed it over their port and nuts. (41, pp. 34-36)
Sheep first came into the range area in much the same way as cattle, breaking off from immigrant trains when feed got scarce. Sheep were a well-integrated part of the agriculture of the Mormon settlements. Their expansion was most rapid in the Pacific states, however, and in the South, where the Spanish and Indian agriculture included bands of sheep. Between 1865 and 1885 was the period of the great drives of breeding herds of sheep from the Pacific coast states to the mountain and plains areas (294, p. 258). This brought a new and more intensive type of competition for the free range. The Public Land Commission study of 1879 indicated that the ranges were becoming over-stocked.

Not only were the ranges of Colorado crowded with cattle, but the increase in the numbers of sheep had developed a condition where the cattleman must fight for his range or get out of the state. (160, p. 92).

Most of them chose to fight, and range wars resulted.

The competition from sheep, the need for close cooperation between cattlemen whose herds ranged together on the free range, the threat of the cattle rustler, and the increasing pressure of more cattle coming onto the range, caused the stockmen to band together legally into associations as early as 1871 (160, p. 119). Soon each territory had its own state association and these became affiliated quite closely into national associations. These associations became very influential forces in the operating
legal processes for some areas.

The fact that all the land was free to everyone made it hard for one man to say that a certain range was his, or to prevent further overgrazing by newcomers. Frequently a stockman announced his claims to certain ranges by publishing such claims in the nearest newspaper. However, there were only two ways of making such a claim stick (160, p. 184): Either he must band together with surrounding stockmen and "discourage" newcomers or, he must gain control of the water. The latter was more permanent, and sometimes no harder. The Homestead Law, the Desert Land Law, the Timber and Stone Law and others were all used by the stockman, his cowboys, and sometimes hired stooges, to file on claims that were soon commuted. These were located successively along the water-beds. Private and state land (school sections, railroad land, etc.) began to command a premium if strategically located.

In areas where the association was strong enough to prevent the small operator from starting, or the granger from edging out on the range, the cry of "cattle king" went up. In areas where the association was weak, threats to newcomers were disregarded. Neither the sheepherder nor the homesteader were inclined to back down against what they called this "arrogant monopoly seeking to exclude men from free pastures without the shadow of a claim" (160, p. 188).
The invention of barbed wire in 1874 permitted the extension of fences beyond the heavy timbered country out onto the plains.

Fencing spread so rapidly that the whole range industry was in danger of being strangled to death in a web of its own making . . . . A Texas governor was forced to ask the state legislature to free the county seat of Jones County, which was completely circumscribed by a fence. (160, p. 191)

This illegal fencing first brought vigorous protest from the pioneer looking for land on which to homestead. It soon brought vigorous protest from the Commissioner of the General Land Office. Illegal enclosures were a problem for the Commissioner until about 1908 (165, p. 86).

As early as 1884 the National Cattle Grower's Association began considering the possibility of urging Congress to enact laws that would permit leasing. However some factions felt there was no need of leasing what could be used free of charge. Livestock numbers increased greatly during the early eighties. In 1885 there began a series of dry years, climaxd by a severe winter in 1887 that brought about the destruction or liquidation of many herds. "The catastrophe that struck the cattle growing industry in 1886-1887 demonstrated that the open range method of utilization could no longer be employed" (160, p. 215). The number of cattle on the ranges were cut back; more pressure was placed on
owing hayland and putting up hay. The number of cattle in Wyoming, for instance, decreased from nine million head in 1886 to less than three million head in 1895, but the number of sheep increased markedly during this period.

C. The Slow Process of Adjustment

As the forest reserves became withdrawn from entry, new adjustments were required in the range-livestock industry. The Forest Service enforced a practice of limited grazing wherever they could. The policy of paying for a grazing permit under regulated conditions was slow to be accepted, but the cattle growers soon were lined up behind the Forest Service since it gave them a degree of control over that portion of the range. Sheep were looked upon as despoilers of the range and forest, and were excluded from many forest ranges; consequently, the Wool Growers opposed the Forest Service from the beginning. The cattlemen found it to their advantage to back the "conservation" forces in limiting the wholesale application of the Homestead Law, and the repeal of the Desert Land Law. This brought further condemnation from the grangers, and placed the cattlemen in the very awkward and inconsistent position of opposing the
"state's rights" elements of the west, which were joined by the sheepmen (165, pp. 72-89).

President Roosevelt came out in 1905 favoring control of grazing on the public domain. The same year the National Livestock Association went on record as favoring essentially the same thing. After this 1905 meeting, however, the Wool Growers pulled out of the Association. They were opposed to grazing control. Congress looked on any leasing bill as one that favored the "cattle baron" against "the poor man looking for a home".

The Kinkaid Act of 1904 provided that homesteaders who had proved up on 160 acres could extend their acreage to 640. This experiment was restricted to northwestern Nebraska. Its extension to other states was delayed by the sudden rise of dry farming, and the liberalizing of the homestead law to 320 acres. The last of the great homestead acts was the Stock-Grazing Homestead Act of 1916, which provided for homesteads of 640 acres of grazing land. Under the impact of high cattle prices resulting from war demands, many new homesteaders were temporarily in the "small ranch" business, thus crowding back, even further, the established cattleman. Most of the grazing homesteads were destined not to endure, as such. Writes Webb:
It has been reported that a species of lizard which evolved on the Great Plains lived for thirty years in a western Texas corner stone. No one has asserted that he enjoyed his existence; yet his life must have been a round of pleasure as compared with that of the grazing homesteader in the arid region had the latter complied with the law. (291, p. 24)

Congress had passed leasing bills on small segments of mineral and power-site lands in 1920, and it seemed the time had finally come for leasing the grazing land. However, the jurisdictional feuds arose again to stop this possibility. Meanwhile the question of grazing fee increases on forest lands came before Congress. By 1928 there had been a substantial increase in the grazing fee in exchange for a five-year lease. However, the Forest Service had lost the support of the cattlemen who now supported the "state's righters" (165, pp. 197-199).

Early in his administration President Hoover recommended that the public lands be turned over to the states. Extensive commission investigation, preceding the writing of the proposed legislation, revealed that even the West could see little merit in transferring the remaining lands to the states if the federal government withheld the mineral rights. It also appeared that this was a necessary condition of transfer as far as Congress was concerned. The "state's rights" argument against grazing control no longer was a real barrier to leasing.
The success of the Mizpah-Pumpkin Creek Grazing District experiment in Montana, which was initiated cooperatively between the Department of the Interior and the state of Montana, received widespread attention by the close of the Hoover administration. The Taylor Grazing Act, providing for leasing of the public domain for grazing purposes, was finally passed in 1934, but not without considerable debate and the devastating dust storms that occurred in May of that year. One senator called these storms "... the most impressive lobbyist that have ever come to this Capital" (165, p. 220). The act provided that the Secretary of Interior should create grazing districts in those areas valuable chiefly for grazing. The Secretary was directed to cooperate with local associations of stockmen in the problems of administering the districts. Grazing fees were to be distributed with 25 per cent going to the Department for range maintenance and improvement, 50 per cent to the individual states, and 25 per cent to the Treasury. All land within the district was to be withdrawn for classification, but if classified as agricultural it was to be reopened for homestead filing in units up to 320 acres. Certain small isolated tracts could be sold at public auction, and provision was made for the leasing of other isolated tracts to private individuals. Other details of this important act will be discussed in Chapter VII.
Subsequent legislation and presidential orders have further increased the national forests, Wild Life Refuges, and Indian Reservations. About 11 million acres of land were purchased by the federal government from destitute farmers and small ranchers during the depression under the Agricultural Adjustment Act, the Emergency Relief Act of 1935, and the Bankhead-Jones Farm Tenant Act of 1937. Some of this land was turned over to the wild life refuges, national forest, etc., while about seven million acres were placed under the administration of the Soil Conservation Service. In the middle and late thirties there was a recurrence of the jurisdictional feud between the Departments of Interior and Agriculture as to which agency was to safeguard the conservation of the nation's natural resources. The controversy seems to persist in many circles. John D. Black, in describing the closing days of the 80th Congress said, "It was possible . . . to compromise on the nature and content of the actions to be taken by government on behalf of Agriculture; but not on what agencies were to take the actions" (14, p. 2). The Hoover Commission's suggestions on re-organization "have ever since provided the stuff for bitter and closely guarded negotiations between Agriculture and Interior that smack somewhat of the high level negotiations at PanMonJong" (99, p. 11).
In 1946 the American National Livestock Association, in cooperation with the National Wool Growers Association, called for a legislative program that would permit the "present users" of land which was used primarily for grazing purposes to buy the land under terms of ten per cent down, the balance to be paid in 30 years, with interest at 1-1/2 per cent. The oil and mineral rights were to be maintained by the federal government. Grazing land administered by the Forest Service was to be transferred to the Taylor Grazing administration (2, p. 7).

The Forest Service, with the aid of the conservationists, particularly the Izaac Walton League (107), and several editorials and feature articles in popular magazines (51 and 52), had soon arrayed such a public resentment against the "monopolistic cattle barons" that no legislative action was taken, even during the Republican 80th Congress.

The Robertson Amendment of 1947 amended section 14 of the Taylor Grazing Act, increasing from 760 acres to 1,520 acres the maximum size of the isolated tracts that could be declared eligible for sale at public auction. Except in areas of new irrigation development on public land the Robertson Amendment and the Small Tract Law of 1938 (permitting small tracts of five acres) have virtually replaced the original homestead law (165, p. 291).
A graphic presentation of the chronological disposition and reservation of the public domain in the United States is presented in Figure 3. This chart does not attempt to isolate the forces leading to land disposition; it merely shows the impact of all forces at a particular time. Table 2 shows the total disposition of public domain under each category as it had occurred up to June, 1949. The 1862 Homestead Act, the Enlarged Homestead Act, and the Stock-Raising Homestead Act are included together under homesteads. There are some estimates and residuals due to the incompleteness of early statistics; particularly is this true of "public sales and other disposals" (48, p. 5). As shown in Table 2 over four hundred million acres of the original public domain never passed into private ownership. To this has been added more than 48 million acres of land that once passed into private ownership but has since re-entered the federal land roll. A breakdown of the federal lands by administering agency and land origin is listed in Table 3. In the fullest sense, the Indian lands are not public lands, but belong to the individuals and tribes of the Indian race and are held in trust by the federal government.
ORIGINAL LAND ENTRIES, 1800-1950


ACRES (MILLIONS)

YEARS

1800, 1810, 1820, 1830, 1840, 1850, 1860, 1870, 1880, 1890, 1900, 1910, 1920, 1930, 1940, 1950

*Bureau of Agricultural Economics Neg. 29225 has been modified slightly. Data for 1944-1950 taken from Bureau of Land Management Report (232 p 130).

Figure 3. Original land entries by years, 1800 to 1950
Table 2
Disposition of Public-Domain Land in the
Continental United States^a

<table>
<thead>
<tr>
<th>Item</th>
<th>Area acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granted or sold to homesteaders</td>
<td>285,384,633</td>
</tr>
<tr>
<td>Granted to railroad corporations</td>
<td>91,624,685</td>
</tr>
<tr>
<td>Granted to veterans as military bounties</td>
<td>61,000,000</td>
</tr>
<tr>
<td>Confirmed as private land claims</td>
<td>34,604,828</td>
</tr>
<tr>
<td>Sold under Timber and Stone Laws</td>
<td>13,857,306</td>
</tr>
<tr>
<td>Granted or sold under Timber Culture Laws</td>
<td>10,866,888</td>
</tr>
<tr>
<td>Sold under Desert Land Laws</td>
<td>10,002,277</td>
</tr>
<tr>
<td>Granted to states</td>
<td>223,839,534</td>
</tr>
<tr>
<td>State reservations</td>
<td>8,200,000</td>
</tr>
<tr>
<td>Public sales and other disposals</td>
<td>295,432,166</td>
</tr>
<tr>
<td><strong>Total disposals</strong></td>
<td><strong>1,034,812,317</strong></td>
</tr>
<tr>
<td><strong>Present public domain</strong></td>
<td><strong>407,455,203</strong></td>
</tr>
<tr>
<td><strong>Area of original public domain</strong></td>
<td><strong>1,422,267,520</strong></td>
</tr>
</tbody>
</table>

^aU.S.D.A. Circular 909 (48, p. 5).
Table 3
Area of Public Domain and Acquired Land, by Administering Agencies, 1950a

<table>
<thead>
<tr>
<th>Agency</th>
<th>Public domain (acres)</th>
<th>Acquired land (acres)</th>
<th>Total (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bureau of Land Management</td>
<td>178,843,674</td>
<td>249,809</td>
<td>179,093,483</td>
</tr>
<tr>
<td>Forest Service</td>
<td>138,999,592</td>
<td>21,582,584</td>
<td>160,582,167</td>
</tr>
<tr>
<td>Bureau of Indian Affairs</td>
<td>55,608,363</td>
<td>1,671,366</td>
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<td>166,083</td>
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<td>istration</td>
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<td>Tennessee Valley Authority</td>
<td>1,308</td>
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<td>Other Agenciesb</td>
<td>70,211</td>
<td>1,082,150</td>
<td>1,152,361</td>
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<td><strong>Total</strong></td>
<td>407,455,203</td>
<td>48,176,970</td>
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aU.S.D.A. Circular 909 (48, p. 4).

bIncludes War Assets Administration, Farm Credit Administration, Atomic Energy Commission, Federal Security Administration, Bonneville Power Administration, Bureau of Mines, Veteran's Administration, and the Departments of Justice, Commerce, State, and Treasury.
D. Influences of the Historical Development on Present Land Ownership Patterns

The preceding review of the historical development of land policies and of the range-livestock industry emphasizes the inadequacies of those policies, particularly as settlement reached the western range area. Agrarian fundamentalism found its clearest expression in the Homestead Law. The assumption of homogeneity of land implied in the 160-acre homestead principal became ridiculous west of the 100th meridian. Under irrigation probably less than 160 acres might have been sufficient, in many cases, to provide full employment for the farm family, while non-irrigated range land in the same area might have required over 5,000 acres to provide the same opportunity.

Without challenging the concept involved in this policy, its political inflexibility, in the absence of land classification, prevented the necessary adjustment to the new physical environment of the west. The causes of the political inflexibility are revealed in their historical development and may be summarized:

1. The politician developed an unfavorable attitude to land sales. In the first place land sales were an unsatisfactory source of revenue, since the flow of income
was inversely correlated with the need, and the surplus aroused bitter conflict with and between "state's righters". Second, extensive land sales had been tried in that early period when government machinery was inadequate, both with respect to power and administrative "know-how", to prevent extensive fraud and exploitation of the settler.

2. Politicians had developed an inherent fear of bigness in land disposal. Almost without exception large land grants had unfavorable political repercussions.

2. Antagonism toward the early western range-livestock industry developed soon after the industry was established. To the homesteader and his political backers the stockmen were regarded as "monopolists" and "cattle barions"; the conservationists and their political backers sometimes attacked them as "desecrators of the public resources".

4. The range-livestock industry was at first looked upon as a forerunner of the permanent homesteader and as such was tolerated just as it had always been tolerated in other areas. As early as 1875, the inadequacy of the homestead laws and the permanence of the range-livestock industry was recognized by many. The 320-acre and 640-acre amendments to the homestead law were not nearly a sufficient correction, in most instances.
5. Many people expected that latent irrigation development and new dryland farming techniques would emerge to make the 160-acre homestead satisfactory.

6. The "state's righters", backed by prospective settlers, were opposed to the expansion of the federal government into the business of permanent landlord with managerial powers. This problem still remains unresolved, although it is gradually diminishing.

7. Jurisdictional feuds, partly the result of overzealous individuals and partly the natural consequences of a growing bureaucracy, delayed the setting up of administrative machinery for controlling public domain use long after most of the politicians and users were ready for action.

Thus, following the first recognized inadequacy of the homestead law, nearly 60 years were required before any management control was placed over the public domain, and this occurred during the greatest period of land settlement the United States has ever known. In the meantime many homesteaders had settled on inadequate units, eventually to give them up. Many never proved up on their claims; others proved up on them and then were forced to sell; others merely moved away, renting their land, holding on to the title with the faint hope that oil might one day be found. Still others struggled against odds until the great
depression at which time a large number of small farms joined the tax-delinquent rolls and were later sold by the counties.

Needless to say, a very complex land ownership pattern has developed in most parts of the Western Range Area. Figure 4 shows the detail of land ownership for selected counties in Montana and Colorado, showing the extreme complexity that still exists in many regions.
A. A part of Park County, Colorado
B. A part of Golden County, Montana

Figure 4. Examples of land ownership patterns in the Western Range Area (taken from Senate Document No. 199 (255, p. 239))
CHAPTER III
DEFINITION OF THE PROBLEM

A. How Defined

Economic problems are definable only in relation to ends or goals. Robbins (179, p. 18) defined economics as the science of allocating scarce resources among competing ends or wants in such a way that the satisfaction of those wants would be maximized. The science of economics specifies the necessary conditions for maximizing a given end or objective under specified situations. An economic problem exists if the maximizing conditions have not been obtained and the problem can be defined in terms of the deviation from the theoretical optimum (78, p. 9).

Resource users and consumers also express economic problems in terms of deviations from some expected maximum situation. It is when people feel that their goals or wants are not being fully met (relative to some norm) that they express concern. The expression of doubt, confusion, and conflict (53, pp. 487-512) over the allocation of scarce resources is evidence that an economic problem exists.
Most of the debates and differences of opinion in the area of range resource use focus on the decisions involving the rate and manner of resource improvement, the intensity of use of the resources, and the allocation of the resources among the alternative products of multiple use. One need read in this field only cursorily to become aware of the excessive amount of confusion, conflict, and differences of opinion that exist. Even among the "experts" or "specialists" there are substantial differences as to the nature and extent of the problems, and differences as to their solution.

To those who are interested in this field the problem of objectivity needs to be faced. I mean by objectivity the capacity of individuals, working separately, but with the same goals, assumptions, hypothesis, and available facts, to arrive at the same conclusions as to the solution of the problem.

Few things are so evident as the lack of objectivity in the research dealing with western range and public land resources. Competent and honest men have come out with vastly diverging recommendations. (102, p. 22)

The Bureau of Land Management has estimated (37, p. 18), for instance, that carrying capacity of the grazing districts can be increased 30 per cent by long-term improvements such as reseeding, water spreading, etc. A Forest Service official is not so optimistic and feels that for most of the area perhaps the only hope for conservation of the resource
"lies in light grazing use or temporary non-use . . . .

Many of these cattle allotments will be closed to grazing use, as the only safe alternative" (190, p. 48, 52). "Where Mr. Saunderson feels that range deterioration is widespread, Dr. Vass finds no such indications for Wyoming" (97, p. 997). Dr. Aven Nelson, reporting on a comparative study of the Red Desert area to determine if it had been injured in the time intervening since 1896 (when he first studied the vegetation of the area) concluded that "there had been no deterioration traceable to grazing" (222, p. 7).

Dr. A. F. Vass, after making a study of cattle production on Wyoming's mountain valley ranches, writes

Many of the ranges which have been reported to have been ruined by overgrazing have later been found to be back to normal following a season of favorable rainfall . . . . The forage plants growing on our western ranges are the result of thousands of years of elimination and adaptation, having been grazed by animal life for long periods, and are not easily improved upon or destroyed by man within a few years' time . . . .

The value of Wyoming's unappropriated lands for grazing purposes is many times the value of the waters arising thereon, and any attempt to prevent the best use of these lands for grazing purposes in order to experiment in runoff and silt accumulation might well come under the heading "destructive conservation", as the loss of forage would be many times any saving that might result from silt control . . . . (279, p. 31)

However, Saunderson (189, pp. 480-482) calculates the value of upland water resources to be as high as 30 dollars per
 Representative Barrett, in commenting on Secretary Anderson's reply to the report of the house sub-committee on public lands, stated that he found honest differences of opinion on the condition of the range, that many experienced stockmen who had observed the range year after year for half a century believed the range to be on an upgrade, and that experts from state universities testified that, in their judgment, the range was not deteriorating (10, pp. 17-18).

The following are suggested as the more important reasons for the differences in conclusions and recommendations of honest men in the field:

1. Conflicting objectives or ends in the use and administration of the resources. Preserving the concept of the family farm, a more equal income distribution, maximization of profits of individual firms, attaining an ecological forage climax, prevention of soil movement, and others appear to have been elevated, at times, to the position of ultimate ends. There is need of a clear-cut expression of more ultimate ends, thus recognizing other objectives as only intermediate ends which may be competitive or complementary with other intermediate ends. Research workers can avoid some apparent lack of objectivity by carefully stating their intermediate ends (profit maximization, ecological climax, etc.) in relationship to the
expressed ultimate ends (such as maximum welfare of a region, nation, or group of nations).

2. The influence of differing ideologies and of personal and professional biases. While it is probably true that the most impelling forces in research are the ideologies (194) and convictions of the researcher, high professional integrity and the rigor and skill of the scientific method must be employed to insure that these forces are not carried over into the findings.

The late Professor L. A. Salter, Jr. wrote:

Social scientists have not looked into the entire process of science to see where it has made the greatest advance. They have not generally noted the source and solution of the problems in means-consequence relations, the importance of problem formulation, the interpretation of hypothesis as tentative models of solution, the functional correspondence of ideas and operations, the suggestive role of generalizations, and the critical characteristic of experimental testing as that of producing a process of interaction among the elements of the problem. (181, p. 66)

3. Failure to include all of the resources under consideration. Even in economic studies the mistake has frequently been made of considering only the land resources without regard to the labor, capital, and management resources. This is partly an outgrowth of the forces mentioned in 2 above.
4. The effect of the multiple-use of resources branching into different disciplines. Although this is frequently inter-related with the first two reasons, it is felt by the author to warrant separate listing. Individuals are sometimes working in different tributaries, figuratively, and trying to map the same stream.

5. The extreme heterogeneity of the physical resources. Erroneous inductions have been made implying that what has been found to be true in the Great Plains applies with equal validity in the intermountain area, for instance. It is the natural consequence of improper definition of the "universe" in particular research problems.

6. Improper and inadequate accounting techniques in measuring costs and benefits. Where prevailing accounting techniques (and institutional setting) impute marginal costs to individuals and society proportionally different than the marginal revenues accrue, dissimilar accounting techniques might lead to honest differences of opinion. Adjustments in the accounting techniques and institutions usually will require less sacrifice in terms of ultimate ends than would be lost by the abandonment of the marginal analysis approach.

In addition to the above, a final suggestion is of a more general application and is more fundamental in nature.
Should the above suggestions be fully met, including strict adherence to the rules of the scientific method - problem formulation, statement of hypothesis, testing of hypothesis, and generalizations - objectivity still might not obtain if each researcher were using different (either incomplete, inaccurate, or non-applicable) theoretical models of solution.¹

A central thesis of this study will be that confusions, conflicts and doubts have been accentuated by the failure on the part of many research workers in the area of range resources to use an adequate theoretical economic framework as "the logic underlying the theoretical solution" (82, p. 837).

By a framework for economic analysis, will be meant a body of logical economic theory showing the functional

¹While Salter states that the hypothesis becomes a model of solution to the problem, he is not specific as to the origin or orientation of the "model of solution", except that it be related to the means-consequence relations. His critique involves an appraisal of the procedures used in land economic research and does not ask the equally important, and even more fundamental, question of whether that research was oriented in a framework of economic logic. The two questions are not the same, and both need to be answered in appraising economic research.
relationships at given levels on the means-end continuum. It must be formulated on specific assumptions using deductive logic. Its primary functions are in making the objectives more specific, in defining the limits of the problem, and in constructing the theoretical models of solution to the problem. Hypotheses relevant to the stated problem are formulated on the basis of the theoretical model. The theoretical model, then, guides the empirical investigation by specifying which "facts" are necessary to test the hypotheses and by determining the statistical procedures to be used in 1. collecting, and analyzing the data, and 2. testing the hypotheses, so as to predict what will happen or what can be made to happen better within the stated problematic situation.

B. The Problem

It is proposed that the central economic problem relative to range resource use is the allocation of all scarce resources available to the western range area, among the competing wants of all individuals and/or groups of individuals concerned, in such a manner as to maximize the
satisfaction of those wants over that period of time for which those individuals or groups are planning.¹

The phrase "all scarce resources available to the western range area" will include: 1. the land resources, as inventoried in the previous chapters, 2. all labor resources available for use in the area, including the skills, lack of skills, etc., and 3. all capital and management resources available for use in the area. This is a partial equilibrium analysis, since prices outside the area are assumed given. However, resources, other than land, need to be considered reasonably mobile between the area and outside areas.

The ultimate goal considered in this study is to "maximize human satisfactions". It will be assumed that this goal is obtained when "total net social product" has been maximized - social product being an aggregate of the "goods" and "services" desired by the individuals of the social group in question weighted according to the choice

¹The term "economic horizon" (212) will be used to represent the period of planning. It refers to that period in the future that is meaningful, or is considered in making present decisions.
indicators of society.¹ This social group must necessarily be defined separately for each segment of the problem. For instance, if a particular consideration involves flood control on the Columbia River, only those individuals noticeably affected by flood in the Columbia River need be included; whereas, if one were considering alternative proposals affecting recreation on federal lands, only those individuals who would be in position to visit the national forests during that period of time under question need be considered in evaluating the gross social product. (Under the present policy of making heavy investment of public funds, the costs may be distributed quite generally

¹The problem of choice between alternatives is basic to the principles of economics. A choice indicator "is the criterion, measuring stick, or index by which alternatives are selected". Unless a choice indicator is present there is no basis for a preference between alternative situations. Heady wrote that

All problems in economics involve choice indicators or choice ratios. The choice indicator, as a yardstick by which selection between alternatives is made, indicates the relative value or weight which is attached to one as compared to another alternative. (78, p. 8)

For most allocation problems the appropriate choice indicator will be the ratio of the discounted prices. Where possible, attempts should be made to express extra-market values (31, pp. 85-86) in monetary terms. This will not always be possible, however, and it will be necessary or desirable, at times, to resort to other procedures for determining the preferences of society.
throughout the economy in the form of higher taxes.) It is not denied that the impact of a flood in the Columbia Basin might ultimately exert some pressure on the price of jute in Pakistan, or that a policy of encouraging recreation on national forests might affect the demand for tickets to the Metropolitan Opera. What is claimed is that as a first approximation these repercussions must, of necessity, be ignored. A problem must ultimately be made definable at some point by sacrificing generality. This will present no serious bias, since these effects are negligible in most instances.

If the goal of maximizing net social product over time be accepted, the criteria by which alternative resource allocations be measured should be those of economic efficiency. Some alternative criteria (such as maximizing number of family farms, minimizing variation from equal income distribution, prevention of soil movement, etc.) will be considered for purposes of making comparisons with the solution obtained under efficiency criteria.

The basic logic and theorems of the efficiency criteria have been in the process of construction and refinement for nearly two centuries. These will be drawn upon freely, and modified where needed to formulate a framework for economic analysis of range resource use.
C. Some Limitations of the Study

Because this is a partial analysis, it might be claimed by some that implications of certain allocation problems have been omitted. This will undoubtedly be true. It is intended that the most important implications will be included. This study, as an attempt to adapt existing economic theories to provide an analytical framework, is not an empirical study. Secondary data will be used, wherever possible, to indicate some of the implications of the theoretical models, and to support some of the hypotheses, although it needs to be emphasized that no hypotheses will be tested in a statistical sense. This must await many years of empirical study, as well as deductive refinement.

The brief review of the historical development of our federal land policy, and of the range-livestock industry, indicates the force of the institutional restrictions in which the area is encased. There has been a tendency, in past research, to consider the institutions as fixed, and thus the research findings have tended to perpetuate the institutions. Another approach would be to consider the institutions as variables. A realistic way of doing this is to omit the institution entirely in working out the solution to the problem. After the maximizing solutions
have been determined as best they can be, then one can inquire as to the institutional changes needed to bring about the new allocation; or, what amounts to the same thing, the economist can point out precisely what the present institutional arrangement costs (through inefficiency) as compared with some alternative arrangement.

It may be justifiably claimed that each problem that is raised (and the entire gamut of the economic problems of range resource use) is left just as we get to the root of it, or before. This is primarily the limitation of time and space, and not the limitation of the proposed framework. The solutions to most of the problems can be found only through long and painstaking research, including experimentation. The primary objective of the study is to present the framework for economic analysis, and to indicate some of the implications for research, management, and policy.
CHAPTER IV
FOUNDATIONS FOR THE ECONOMIC FRAMEWORK - THE
MARGINAL CONDITIONS

We have stated that our ultimate objective or goal in the use of the resources in question is to maximize net social product. In this chapter we will want to lay out the necessary conditions for obtaining our objective, and then see how well the assumptions underlying these conditions are met in reality. We will attempt to examine, briefly, the process of planning and decision making under dynamics.

A. Economic Statics

Economic statics is not concerned with time - events are not dated (92, p. 115) for all dates are the same. It is an obvious simplification from reality, but it is a convenient one, since it permits us to state quite precisely the conditions under which our objective may be fully obtained. The necessary marginal conditions for maximum welfare under economic statics are as follows (92, p. 86):
1. The marginal technical rate of substitution between any and all pairs of factors of production for all producing firms must be the same as the inverse of the price ratio of the factors.

2. The marginal rate of transformation between any factor and any product must be equal, for all firms, to the inverse of the price ratio\(^1\) of the factor to the product.

3. The marginal technical rate of transformation between any two products must be equal, for all firms, to the inverse of the price ratio\(^1\).

4. The marginal rate of substitution between any two products must be the same for all individuals who consume both, and must be equal to the inverse of the price ratios\(^1\) (173, p. 35).

5. The producing firms must be of optimum scale, and operating at least-cost combination\(^2\). There must be no adjustments in the scale of firms possible which would result in either a lower cost of production for the same amount of product, or an increase in product from the same amount of factors.

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\(^1\)At the present the ratios of the prices of factors and products will be used as the choice indicators. If, later on, we deal with goods having no market price other choice indicators will be considered (see footnote page 58).

\(^2\)The least-cost combination implies condition one and two, although conditions one and two do not necessarily imply condition five.
The second-order conditions for maximum welfare are that consumers have a diminishing marginal rate of substitution between each pair of commodities (indifference curves are convex to the origin); that there is a diminishing marginal rate of transformation between any factor and any product, or between any two products (transformation curves are concave to the origin); and that factors substitute for one another at a diminishing rate (substitution curves are convex to the origin) (92, pp. 78-88). Another set of conditions, called the total conditions (173, p. 37), requires that it be impossible to increase welfare by producing a new product or using a new factor not otherwise considered. Finally, "there must be a positive surplus, so that it does not pay to shut down production altogether" (92, p. 87).

We will assume the second-order conditions to hold, with very few exceptions, one of which we will consider. Although we will assume the total conditions to hold in this study, one of the primary functions of technological research is to discover and/or develop new factors of production and new products. As to whether the total conditions hold in a given situation is a question of fact that will need to be investigated at the time. The same can be said with regard to there being a positive surplus.
B. Economic Dynamics

Economic dynamics is where time is considered as a variable. Production and consumption are planned not only for the present but for many periods into the future. Under the Hicksian (92, pp. 191-212) conditions of "subjective certainty", where individuals and firms have single-valued expectations, each factor of production and each product in each time interval can be considered as a separate factor or product and can be substituted for (transformed into) other factors or products in other time intervals. The necessary conditions for maximizing welfare still apply, with the one exception that the discounted prices are used instead of actual prices in determining the price ratios. The new criterion to be maximized is that of the capitalized value of the stream of net social products. That decision (allocation over time) is to be preferred whose present capitalized value of the expected stream of net social products is the greatest.

The several "units" of time (the Hicksian week (92, p. 122)) that comprise the planning period of the decision maker will be called "planning intervals" (31, p. 32). The "planning period" will refer to the total length of time that is considered by the decision maker in making the
decision. Both the planning interval and the planning period are variables and thus need to be determined in the maximizing process. The "decision maker" refers to individuals, or groups of individuals, who make the decisions of production and/or consumption that are to be carried out, whether the resources (products) in question are private or public.

In reality, only a limited number of expectations are single-valued. Lange (130, pp. 29-34) suggests that expectations be considered as "a probability distribution of possible values", out of which some particular value may appear to the entrepreneur or consumer as the most probable price - this may be the mode, for instance. He considers the "practical range" of the probability distribution as the measure of the degree of uncertainty. (The "practical range" of the probability distribution of possible outcomes is obtained subjectively by each individual by disregarding the extreme values of both tails of the probability distribution. These values are disregarded because the individual feels that the probability of these extreme values is too small to bother about.) Lange's solution does not require that decision makers "visualize an exact probability distribution" of possible prices but only "that each person forms some idea about the most probable value and the
practical range" (49, p. 30). In this limited sense there undoubtedly are many expectations that are formulated as probability distributions, although it obviously does not describe those cases where individuals are completely ignorant of the outcome possibilities (141). In general decision makers react unfavorably to uncertainty so that sellers consider a price which is expected with greater uncertainty to be equivalent to a lower most probable price with greater certainty. The reverse reaction would be true for buyers.

Tintner (216) distinguished between "subjective risk", where the probability distribution of possible outcomes are known, and "subjective uncertainty", where there exists known or anticipated \textit{a priori} probabilities to specific forms of the probability distribution. Under the former situation individuals react not only to the dispersion as measured by the range, coefficient of variation, or standard deviation, but also to the skewness and kurtosis, as measured by the third and fourth moments. This he called the "risk preference functional" which is determinate for each individual. The alternative with the higher risk preference functional has the higher degree of subjective risk to the individual. Solution of Tintner's second model resorts to an "uncertainty discount functional", where the
individual behaves in a definite way if faced with alternative sets of utilities with definite probabilities (213). The applicability of this model is subject to serious limitations, therefore, because the measurement of utility poses difficult conceptual problems.

The reaction of the decision makers to uncertainty is illustrated in Figures 5 and 6 in terms of indifference curves (130, p. 31). The Y axis indicates the most probable price, and the X axis indicates the uncertainty (either the "practical range" as suggested by Lange, the "risk preferential function" of Tintner, or some other measure such as the coefficient of variation). From the indifference curves, showing the reaction of sellers to uncertainty, it can be seen that sellers would be indifferent between a certain price OC and a most probable price OA expected with a degree of uncertainty OB; while buyers would be indifferent between paying a definite price OC and a most probable price OA expected with the degree of uncertainty OB. Thus, the effective (130, p. 33) expected prices for the goods to be sold at future dates decrease, and the effective prices of goods and/or factors of production to be bought at future dates increase, as the degree of subjective risk, or uncertainty, increases. The decision makers find that, beyond a certain date, the effective expected marginal costs are greater than the effective expected price of the product,
Figure 5. Indifference curves of sellers

Figure 6. Indifference curves of buyers
and the effective expected prices of the factors of production become greater than the effective expected marginal productivities of the factors. Similarly, consumers find that the effective expected prices of goods they plan to buy are higher than the effective expected marginal "utility". The planning period becomes determinate with the introduction of uncertainty and individual time preference. This planning period we have called the economic horizon.\(^1\)

C. The Economic Horizon for Individuals and Groups

In the remaining part of this chapter it is intended that we explore further the influence of uncertainty, time preference, and interest rate on the economic horizon. In each case we will want to see what can be said about the differences of the impact of these three variables on the economic horizon of individuals and the economic horizon of groups of individuals. The information obtained from such an inquiry will be useful later on in appraising alternative systems of range resource control and allocation.

\(^1\)See footnote p. 57.
1. **Risk and uncertainty**

Following the suggestion of Knight (123), we will distinguish between risk and uncertainty since each should be treated differently in making maximizing decisions, even though it is claimed by some that individuals react in about the same way to both (31, p. 111). "Risk" refers to the situation where the empirical probabilities of outcome can be established either by a priori knowledge of the characteristics of the eventuality or by reliable statistical sample. "Risk is insurable in an actuarial sense; uncertainty is not" (78, p. 440). Pure risk should enter into the decision making process by affecting the cost schedule and thus should exert little influence on the economic horizon. Risk costs to individuals should differ from risk costs to groups of individuals only to the extent that grouping permits uncertainties to be converted to risks. This may be very important with respect to uncertainties of nature (insect pests, fire, hail storm, flash floods, etc.) since it may permit hedging, pooling, or spreading arrangements that were not possible for the individual.

"Uncertainty" refers to situations where the probability of an outcome cannot be empirically determined, and is therefore of a subjective nature. Decision makers may allow for uncertainty in the planning process by discounting, as
previously noted. This may be impossible, if the most probable outcomes cannot be estimated, or it may be inadequate if the possibility of an intolerably unfavorable outcome exists (111, pp. 14-28). Discounting under this latter situation would be inadequate to prevent, say, bankruptcy, if the most unfavorable outcome were to be actually realized. On the other hand, heavy discounting would result in a "risk premium" (loss of foregone opportunities) that is not warranted if the most unfavorable situation was not to occur. Uncertainty may be allowed for, also, by flexible planning. According to Hart

The key to the uncertainty problem lies in two characteristics of business planning: (a) the fact that between the present and any future calendar date . . . additional information is expected, so that estimates for each date improve as the date approaches; (b) the fact that many decisions relating to the output or capital outfit can be postponed (sometimes costlessly, sometimes at some cost in efficiency) until more information has come in. Flexibility . . . is worth incurring costs for, because it avoids wastage of information accruing between the date of planning and the date for which plans are made. (75, p. 422)

A necessary part of flexibility in resource management is the ability to alter the allocation and production process with a minimum of delay and resource loss as additional information becomes available. On this point it seems reasonable to conclude that there would be less delay and restriction associated with allocation shifts on the part of individuals than would be true for groups of individuals.
Finally, we need to consider the impact of the more important uncertainties - changes of technology, changes of consumer demand, and changes of social institutions - on individuals versus groups. Groups, whether a large corporation like General Motors, a corporate community, a business or professional association, or a bureau of the federal government, can exert considerable influence on the stability of institutions above and beyond the total of the individual efforts of the members of that group. Unless the group is able to diminish the impact of uncertain consumer demand by spreading the effect through increasing the alternatives, there appears little to be gained by grouping to meet this contingency. An example of this would be where DuPont Corporation might put ten new fibers on the market not knowing which the public might take, but feeling less uncertainty about public acceptance of some of their products than one individual who has invented and manufactured but one new fiber. Changes of technology may present less uncertainty to groups than to individuals particularly if the "vested interests" of the group can exert a degree of control over technological change.

2. Time preference

Time preference is the psychological reaction of an individual to the differences in his wants (as he is
presently aware of them and as he can anticipate them) and his expectation for the provision of those wants (59, pp. 62-98). While it is meaningful to talk about differences in the uncertainty faced by a group and that faced by individuals, this distinction is no longer meaningful with regard to time preference. There is no time preference of groups apart from the time preference of the individuals that make up that group. The distinction that must now be made is whether or not individuals decide (or vote) differently when making decisions concerning their own individual (and family) time-distribution pattern than when they are "voting" for the time-distribution pattern for the group. What individuals decide concerning their own individual time-distribution pattern we will call "individual time preference". The results of individuals "voting" for the time-distribution pattern for groups we will call "group time preference".

Individual and group time preferences are affected by many different forces, some of which are economic, sociological, technological, cultural, and religious. All those forces influencing propensity to consume and liquidity preference, as outlined by Keynes (121, pp. 91-95), must be considered. As a general rule, individual time preference is altered in favor of the present relative to the future by an increase in uncertainty, including the prospect
of not living to enjoy the future goods. It will tend to be altered in favor of the future relative to the present as 1. the degree of future control of the resource increases for the individual, either by altering the institutional environment or by development of new technology that decreases the possibility of resource loss (deterioration, leakages, etc.) over time; and 2. the level of individual income becomes higher (both ex post and ex ante).

Individual time preferences vary greatly from one person to another. One person may give little or no consideration to future needs. (In rare instances this may be the case with an entire group of individuals, also, such as the Hopi Indians, for instance.) On the other hand, some individuals have been known to ignore present needs to the point of malnutrition or even starvation while hoarding for the future. Either extreme is the exception, however, and usually is regarded as being pathological. As a general rule, individual time preference will favor the present, relative to the future, to a greater extent than will group time preference for two important reasons. First, uncertainties are less for groups than for individuals. Particularly is the uncertainty of not living to enjoy the future goods diminished for corporate bodies whose continuance is not dependent on the continued life of individual members of the group. Second, the human quality of appraising
individual living standards relative to those about them ("keeping up with the Joneses") rather than in an absolute sense causes an individual to decide his own time-distribution pattern differently depending on whether or not the time-distribution pattern of the group around him is to be affected in the same manner as his own.

3. Rate of interest

There has been considerable controversy over the part played by the interest rate in allocating resources over time. Hicks concludes that: "Interest is too weak for it to have much influence on the near future; risk is too strong to enable interest to have much influence on the far future" (92, p. 226).

The effect of interest on the time-distribution pattern for individuals and groups can be shown best by stating the effects of a rise in the rate of interest. First, the planned stream of output will be tilted downward, i.e., output near the present will increase and output in the more distant future will be diminished. Second, the planned stream of inputs will be tilted upwards, i.e., fewer long-run inputs will be planned for the near future in favor of more short-run inputs at later periods. Finally, it is doubtful if anyone can predict consumer reaction to changes in the rate of interest. Although the existence of interest
may be "neither a necessary nor a sufficient condition for bringing the planning period to an end" (31, p. 99) under unusually elastic expectations of production response, still it is influential in altering the planning period in most cases.

The rate of interest to use in the planning and decision making process for resource allocation should be determined by the alternative earning rate of the marginal unit of available capital. For federal agencies this rate would be the current market rate for long-term federal securities. The market rates are relevant for individuals only in those limited cases where sufficient capital can be secured through the market to meet the demands of alternative investments. For most entrepreneurs the internal earning rate (opportunity cost) of capital will be the effective interest rate. It is observable that the market rates of interest are higher, as a general rule, for individuals than for groups of individuals. First, there is a tendency toward less uncertainty in the production process for groups than for individuals. Second, as a general rule, loans to groups tend to be much larger than loans to individuals, thus permitting lower administrative costs. Because of the nature of the contract there may be less risk of default or fraud from groups than from individuals.
4. **Total effects on the economic horizon**

The influence of the interacting forces of uncertainty, time preference, and the interest rate on the economic horizon of individuals and groups can be summarized by saying that, in general, the economic horizon for groups will be greater than for individuals. This will tend to become even more so as the aggregate of individuals that make up the group becomes larger and as the group becomes more legally identified. The largest group we will consider will be the consumers of the nation. This group we will call "society".

There is no reason to suppose that the economic horizon (either for individuals or groups) will not change as the problem changes. There is greater uncertainty inherent in planning for certain courses of action (cloud-seeding or fertilizing dryland wheat) than for others (vaccinating range calves for black-leg or buying a new combine).

If there is a significant difference in the economic horizon of groups, generally, and that of individuals, this may exert influences on the manner in which resources are used. It may help to identify and explain conflicts in resource allocation.
D. Conflicts in Economic Horizons under Dual Control of Resources

As was pointed out in earlier chapters, resources used in private production in the Western Range Area might not be completely under the control of the entrepreneur; they may be partly controlled by a public agency. This is especially true of land resources, but it is true, also, of labor and capital, to a certain extent, since the public agency may exercise control over the manner and extent to which labor and capital can be combined with the public land in private production.

The entrepreneurial objective of the private operator is to maximize his discounted stream of expected net revenues. With respect to the public land resources, over which he has varying degrees of control, the private operator's objective is to plan to use the public land during the period over which he has future control of it so as to maximize the discounted stream of expected net revenues from all of his resources (over his entire planning period).

It has been expressed by some (224, p. 130) that the primary objective of the public resource administrator is that of guaranteeing permanence of resource, per se. (There have been basic inconsistencies among various administrative
agencies in this regard, concerning mineral deposits, on the one hand, and forest and grazing, on the other hand.) In the economics of agricultural production, fluctuations in the level of maintenance of the production plant rationally occur because of: 1. enterprise combinations over time (rotations), with some crops building up the level of soil fertility and quality of the soil, followed by other crops that lower both the level of fertility and quality; (2) variations in the relative value of products caused by economic fluctuations; and 3. variations in climatic conditions. The optimum solution to the intertemporal allocation problem, for either the private operator or public administrator, would be the maintenance of resources at a constant level if and only if 1. the expected rate of flow of surpluses was so geared that there would be no gradual increase or decrease in the level of resources over time, and 2. the expected rate of flow of surpluses was constant with respect to time.

We will discuss the application and implications of the first condition in a later chapter under the heading of resource conservation. For reasons mentioned above, we claim that the second condition is unrealistic in most instances.

If the length of period over which the private operator has future control of the range resource is of such short duration that the decisions made by the private operator
conflict with the objectives of society, maximum net social product will not be obtained. As the uncertainty of future use of a resource increases for the private operator, the shorter becomes his economic horizon with respect to the resource in question; this tends to bring his economic decisions concerning the use of that resource more into conflict with the objectives of society. Two general types of solution are available when this kind of conflict arises. The first would be to increase the length of the period of the private operator's control of the resource. The ultimate degree of this solution would be private ownership, which has obtained on slightly more than 50 per cent of the western range lands, and two-thirds of the range feeds (118, p. 137).

The second type of solution to this conflict is to decrease the degree of the private operator's control of the resource so that he does not make decisions concerning the intensity or period of resource use, i.e., invest a greater degree of control in a public agency. This, in general, has been the procedure adopted for the public lands. Many of the personal problems of conflict with public lands committed to private production center in the general area of tenancy and leasing systems. Ideally, a leasing system should result in 1. the most efficient organization of the producing firms relative to its producing the goods that
consumers want, and 2. an equitable division of the products among the owners of the various resources employed in production, based on the marginal productivities of the resources which each control (79).

The conflicts arising out of the dual control of the resources will tend to influence most of the allocation problems that arise in this study, and will be considered at several points in later chapters.

E. Application of the Marginal Conditions

Given the stated objective of maximizing net social product, the criteria for obtaining this objective are the necessary marginal conditions adapted to dynamics. In the subsequent chapters we want to investigate the application of these marginal conditions to the economic problems of range resource use. We suggest that these economic problems fall under four main headings: 1. optimum factor combination and use, 2. optimum scale of firms, 3. optimum product combination, and 4. the pricing of factors and products. This latter set of problems arises out of the environment in which some of the factors and products are rationed and their respective prices are administered.
We will assume that marginal condition four holds, i.e., that consumers will equate their preferences to the prices of the products. However, this condition will have to be considered, with slight modifications, for those goods that have not been evaluated in monetary terms. The influences of uncertainty and institutional forces are present to a high degree in all range resource problems. Rather than devoting a separate section to the analysis of institutions and another to the analysis of uncertainty, these influences will be considered in their relation to each of the above four classes of problems.
CHAPTER V
OPTIMUM FACTOR RELATIONSHIPS

Marginal conditions one and two\(^1\) define the optimum factor (resource) combination and allocation for a given size of firm producing a given set of products. In this chapter we will want to determine in more detail what it is that these two conditions specify with respect to the factor relationships for western range resource use. It needs to be emphasized that all of the marginal conditions hold for any degree of aggregation for which welfare is to be maximized, whether it be the firm, the household, the firm-household, the community, the Western Range Area, or the Nation. Empirically the problem becomes more difficult at some levels of aggregation than at others, but the fundamentals of the problem are the same.

A. Optimum Factor Relationships - with Simplifying Assumptions

To begin with, let us insert the simplifying assumptions of perfect competition with out attention focused at

\(^1\)See page 62.
the level of aggregation of an owner-operated firm—a rancher operating on range land whose primary product is forage for domestic livestock. Even under these restrictive assumptions it becomes obvious that more is involved than getting a maximum product from the range land. The factors of production—viz., land, labor, capital, and management, which we will label $X_k$, $X_a$, $X_c$, and $X_m$, respectively—substitute for one another in the production process, but it is necessary that all four be present before production can occur. All four factors are scarce in an economic sense, and, without exception, the marginal rate at which one factor substitutes for another ultimately diminishes making the determination of the optimum combination of factors an economic problem. Our model specifies that the factors be so allocated that

$$\frac{\text{MVP}_k}{P_k} = \frac{\text{MVP}_m}{P_m} = \frac{\text{MVP}_c}{P_c} = \frac{\text{MVP}_a}{P_a} = 1$$

where $P$ represents the price of the factor represented by the subscript, and MVP represents the marginal value product of the factor. The marginal value product is obtained by
multiply the marginal physical product by the price of the product.¹

Let us further assume the amount of land and management given, and focus on the problem of determining the best technological methods of improving the forage product of the range to see if our simple equation (I) will throw any light on the solution. Additional labor and capital may be combined with the present land and management to produce range improvement by any one of the following methods.

1. Range reseeding. Both artificial and natural re-seeding are being practiced. Artificial reseeding is being done with and without removal of undesirable plants and with and without seed bed preparation (171). Natural re-seeding is being done through rotational and deferred grazing with and without mechanical disturbance of existing plant cover (8). Imported insect enemies may be used, in some cases, to destroy existing undesirable plant species.

2. Removal of sagebrush (and other brush-type vegetation) by burning (139), by mechanical and by chemical methods (18).

¹This is true only under conditions of pure competition (29, p. 6), which may not always be the case; e.g., with lumber and certain other timber produces there are some firms that are large enough to affect the price of factors in an area, and they may be able to exert considerable influence on the price of the product.
3. Development and distribution of stock water to encourage better distribution of livestock on the range (230).

4. Upland water diversion and irrigation (172).

5. Addition of corals, loading chutes, etc., to facilitate handling of livestock.


7. Predatory animal control.


Our theoretical model directs that maximum net product will result when available labor and capital have been invested in each of the above alternatives up to the point where the net marginal return from each alternative is the same and is equal to zero. However, range forage is not an end in itself but is only one method of increasing the livestock feed. There are several alternative methods of obtaining more feed, such as meadow renovation and fertilization, purchase of protein supplement, land leveling, seeding, and irrigation development to bring new land under cultivation, etc. This places a restriction on the above solution to the effect that the net marginal returns from range improvement should not be less than the net marginal returns from alternative sources of comparable feed.
Neither is increased livestock feed an end in itself but only a means to higher net returns from the ranching enterprise. There are clearly many alternative means to higher ranch incomes other than increased feed. Investment in more labor at breeding and calving time; investment in research and breeding stock to eliminate dwarfism, or to improve the efficiency of the breeding herd; investment in new haying machinery in order to reduce the peak-labor demand; and any other alternative means must be considered. The maximizing equilibrium for the firm occurs when the net returns for the marginal units of labor and capital are equal to each other, and are the same for every possible alternative use. This condition would have to hold when we drop the assumption of fixed land resources, since investment in land is another alternative use for capital - another means of obtaining increased livestock and higher ranch incomes.

As the level of aggregation moves to the interfirm level, our conditions still hold. Optimum allocation of capital between ranches would occur only when the net returns from a dollar spent on range improvement on one ranch were just equal to the net returns from a dollar spent to improve the range of other ranches. (It has previously been specified that this is equal to the net returns from
other alternative uses of capital on each ranch.) The same kind of equilibrium conditions must hold between ranching, generally, and alternative agriculture, such as irrigation development, dryland farming, or timber production, and between agriculture and non-agricultural industries in the area, or even between areas. Needless to say, these marginal conditions should hold within each segment of each industry, and within each industry and geographic area, as well as between them. Reder (173, pp. 39-46) has shown that under conditions of perfect competition the conditions of maximum welfare will obtain.¹

B. Optimum Factor Relationships - with

Realistic Assumptions

In reality, perfect competition is seldom obtained for several important reasons. Some of the factors come in rather large and fixed units, especially in those geographic areas where interfirm exchange of resources and custom services are relatively unimportant. Land, of course, is immobile and is not divisible into infinitesimally small

¹Certain limitations of this statement will be discussed in Chapter XII.
units. Labor will normally be hired by the month or by the job. Management, in the short-run, tends to be fixed in total supply, but frequently may not be used to capacity. The forms of capital may vary, and the size of the units will be different for each form of capital. These facts do not nullify the application of our conditions, however. The marginal units of land can be identified as the smallest (or the most desirable) unit of land that is available to be added. Our units become a bit "lumpy" and, instead of having continuous marginal functions, we have functions that may be discontinuous at certain points.

It is equilibrium in the planning process (ex ante) in which we are primarily interested. The conditions of equation (I) will still hold, with two important modifications. First, since production is for the future, marginal physical products and product prices are not known but are expected. The relevant ratio is the ratio of the discounted expected marginal value product to the discounted expected price of the factor. Where the resources are to be committed in the present time interval, the discount rate for factor prices would be zero and current factor prices would be used. The second modification is the result of limited resources. The ratio of the discounted expected marginal value product to the discounted expected factor price should be equal to 1.0 (net marginal returns equal to zero) only if
the supply of the variable resources is sufficient to obtain that point for every possible alternative; otherwise this ratio would be greater than 1.0 but would be equal for every resource and for every possible alternative.

C. Application of the Conditions for Optimum Factor Relationships - Range Improvement as an Example

In the remaining part of this chapter we will consider some of the implications of optimum resource allocation in the institutional environment of the Western Range Area. We will take the economic problem of range improvement as an example and attempt to see what is required in order for the marginal conditions to be obtained. (Again, we will want to keep in mind the restriction that the net marginal returns from range improvement should be equal to the net marginal returns from any alternative employment of the limited resources.) This might indicate certain institutional and/or policy adjustments that are desirable from the standpoint of efficient resource combination and use.
1. **Equilibrium under dual resource control**

Completely owner-operated livestock ranches are more nearly the exception than the rule in the Western Range Area. Land is rented from private absentee owners and from state and federal agencies. Focusing again at the level of the firm (remembering the general equilibrium conditions that are imposed at the interfirm level) let us consider the economic problems involved in improving range resources under dual control.

Inputs with leased land may be classified as (a) factor-saving for the landlord, (b) factor-saving for the tenant, (c) product-increasing for the tenant, and (d) product-increasing for the landlord. This classification is meaningful in determining the equilibrium of inputs under leasing since the cost of the inputs may be borne by the landlord, by the tenant, or by both.

a. **Leasing federal lands.**

(1) **If landlord makes the improvement.** Under the usual type of grazing lease of federal lands the landlord (the federal government) legally is free to invest in range improvement at any time. Except for the lack of knowledge and for the institutional lags of altering the codes for administering agencies, it seems
reasonable to expect that equilibrium investments of type (a) should be rationally obtained. These would be the kind of range improvements that would save labor and capital for the federal government. The administering agencies tend to be sufficiently flexible to take advantage of any developments of this kind, except in cases that involve reorganization of the agencies that result in the curbing (or elimination) of some services of the agency.

Investment in type (d) improvements could be those that result in an increase in the grazing fee to the government. There is another important type of range improvements that may be regarded as product-increasing for the landlord, if we regard the government as an agent of society. This would be those investments that result in an increase in the value of some product other than grazing, such as reduced downstream flooding, siltation, etc. Investment in conservation that increased forage product at some future time beyond the economic horizon of the tenant must be regarded as type (d). Discussion of the economic problems involved in determining an equilibrium investment in type (d) improvements must be delayed for a later chapter.

Before the landlord could rationally make investments of type (b) (factor-saving for the tenant) and type (c) (product-increasing for the tenant) it would be necessary to have an increase in the grazing fee. Historically, the
public landlord has not been very successful in raising the grazing fees in order to make the needed type (b) and (c) improvements. The public-land agencies, likewise, have found it difficult to obtain funds from Congress for improvement of the public range lands. Regarding the federal budgetary process as the source of funds for range improvement, one public land administrator wrote¹:

The whole budget procedure is especially bad as applied to the administration of federal lands. Federal land administration is essentially a business enterprise. . . . The predominant psychology in the Congress, as in the country at large, is that an appropriation to a federal bureau is money lost and gone forever - maybe necessary on political or humanitarian grounds, but surely not soundly invested. This concept and the facts of land administration do not jibe well . . . a federal administrator . . . cannot appraise possible incomes or other gains from a given line of action, and put against that the costs, in order to decide which line of action is best or most profitable. He may go through such a process, but then he has to sell it to a long line of reviewers, anyone of whom may alter his conclusions but none of whom may take the responsibility for failure in case the program subsequently goes wrong. (38, pp. 222-223)

Appropriations are generally on an annual or, at best, a biennial basis, and are generally not known until July 1, or after. By this time any work in range resource development should be at its peak. A long range program of resource investment on the part of the landlord is not very hopeful under the present setup. Recent national administrations have suggested that the federal budget be split

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and that the investment budget be considered separate from the operations budget. Although the opposition party (first the Republicans and then the Democrats) denounced the suggestion as a political maneuver for making false claims about the budget, it has much to commend it from the standpoint of public resource investment and administration.

(2) If tenant makes the improvement. There is no reason to assume that the tenant will chose to make types (a) and (d) improvements, except as these may be supplementary or complimentary with types (b) and (c) improvements. Society has recognized an interest in soil conservation, flood control, and erosion control in private lands, and public programs have been initiated to compensate farmers and ranchers for making certain improvements and for following certain practices that are designed to increase returns to society. Those practices having particular application to the range area are the so-called Class "B" group (practices primarily for improvement and protection of established vegetative cover) (259, p. 5). The federal government shares in the cost of these practices "up to a maximum of 50 per cent of the average cost", to the extent of available program funds. Only under very limited circumstances, however, can private operators be compensated for making these same improvements on public land. If the
agricultural conservation payments are sound for private lands there seems little reason why they should not be extended to public lands.

Another form of compensation to ranchers for making range improvements might be through the procedures for computing federal income tax returns. This occurs whenever the rancher is permitted to compute annual depreciation on his investments in range improvements at a rate faster than the improvements are actually depreciating. This form of compensation is very prevalent in industry, as well as agriculture. The recent recommendation of the President to the Congress that farmers be permitted to write off conservation investments in four years will increase the extent of this form of compensation substantially. During periods of high livestock prices, when income tax rates are highly progressive, a substantial amount of the cost of range improvements might be returned to the rancher in the form of lower taxes.

However, before the tenant would be willing to make types (b) and (c) investments on rented land the returns to him from so doing must promise greater returns than for any other alternative use of his scarce resources. This would require that he have secure tenure expectations extending sufficiently into the future so that the capitalized value
of discounted expected marginal returns from making the range improvement would be greater than the discounted expected marginal returns from alternative uses of those resources.

(3) **The influence of uncertain expectations on public land range improvement by the rancher.** The uncertainty of expectations inherent in the present system of grazing tenure on public land is of several kinds and varies some from one agency to another. There may be uncertainty regarding the number of animal units\(^1\) that can be grazed on a particular public range and the time that the livestock may go on, or must be taken off, the public range. In those instances where the spring range is leased from one public agency (Bureau of Land Management) and the summer range is leased from another (Forest Service), a crisis may arise if the livestock are ordered off one range before being permitted on the other. There is uncertainty, in some cases, about possible cuts in the permit upon transfer of the base property to someone else. There is uncertainty with respect to continuing tenure beyond the term of the contract. The

\(^1\)An animal unit is the equivalent of one mature beef cow or five mature sheep. An animal unit month (AUM) is the equivalent of one animal unit grazed for one month. This definition, which is standard in traditional range and ranch economics, assumes a constant rate of product substitution in the use of factors. This is considered further in Chapter XI.
possibility for continued use of, or compensation for, range improvements on the public land may be uncertain.

Part of this uncertainty arises out of the physical environment where weather is highly variable and where society has expressed interests in other uses of the land. Part of the uncertainty arises out of institutional setting, which, in a democracy, should be amenable to the desires of the majority of the people.

It has been pointed out by some public agencies (190, pp. 107-108) that historically there are many cases where the grazing privilege has continued in the same family for over 30 years. This, of course, is not the issue. It is expected security of the future (ex ante) and not historical security of the past (ex post) that the ranch manager considers in making his decisions. It must be granted, however, that expectations may be influenced by (but not wholly determined by) historical pattern. There are equally interesting instances of how unexpected curtailment of the grazing privilege has forced ranchers out of the livestock business (174).

The disequilibrium of investment of type (b) and (c) inputs may be illustrated in Figure 7, where RN is the stream of discounted expected returns under normal conditions of market and technological uncertainties. Under these
Figure 7. The effect of uncertainty on discounting over time
conditions the entrepreneur's economic horizon is TN and he would equate the discounted marginal revenues and discounted marginal costs over the time TN. Where additional uncertainties due to uncertain tenure expectations are present, the stream of discounted expected return might be represented by RM. The corresponding economic horizon, for decisions involving the public land, would be equal to TM. This tends to establish the equilibrium investment in range improvement on public land at a lower level than for owned land.

Kelso (118, p. 145) suggests that tenure expectations on public land be made more secure to the tenant either by 1. perpetual contracts, freely transferable by the tenant, purchasable by the government agency at a negotiated price, or 2. term-of-year contracts which provide that there be compensation for the investments that are unexhausted at the time of contract termination. We would like to point out that the latter suggestion may be improved by two amendments. First, the contract should be renewed (or extension denied) at a specified period (say three to five years) before the termination of the contract, thus having the effect of extending the contract indefinitely into the future, but still providing successive points for its termination. In farming areas where the tenant has the
possibility of "mining" the soil, this suggestion might give rise to serious soil erosion problems during those final years when the tenant knew he would not be permitted to renew the lease. In the case of the grazing lease on public land, however, the tenant does not have control over the intensity or timing of use. It is only the continuance of the grazing privilege that is in question. One precedent for this type of adjustment may be found in the regulations pertaining to grazing leases under the Bureau of Land Management (42, p. 244). Here the lessee may request, under certain circumstances, that the lease be extended for a period of 10 years from a particular date, regardless of when that date falls with reference to the termination date of the lease.

The second suggestion is that, where possible, compensation for unused investments should be made not at their cost-less-depreciation value, but at the capitalized value of their remaining discounted stream of marginal net\(^1\) products. These amendments would increase the security of expectations of the tenant and encourage his decision to invest in range improvement on public land to the same extent that he would invest in range improvement on private land.

\(^1\)Net in the sense that any cost, other than investment cost (such as upkeep, for instance), should be deducted.
b. Leasing private lands. A large amount of grazing land in the Great Plains Area is leased from private individuals - largely from absentee owners. Less than one-third of the land is owned by the operator (137, p. 217). Not too much is known of the status of the leases on these lands outside the grazing districts. Frequently the absentee ownership is on relatively small acreages (160 to 640 acres) that were parcelled out to private ownership under some modification of the Homestead Act. Ownership has been retained against the increasing pressures of high land values in the expectation of future irrigation development and/or the possibility that oil might be discovered on the property at some future time. In most cases the absentee owner is far removed from the land, psychologically as well as geographically.

Because of the rationale under which most absentee landlords hold their lands it seems likely that inputs of type (a) (factor-saving to the landlord) and type (d) (product-increasing to the landlord) would tend to be unimportant unless certain inputs tended to decrease the tax base. Responsibility for initiating action leading to changes in the leasing contract, favoring more secure tenure and range improvement, must rest almost wholly with the operator. It is a personal observation that more initiative has been
exerted in this direction by groups acting through a grazing association or district than by individuals acting alone. Since the usual type of lease is a cash lease, all that need be required is to lengthen the terms of the contract and provide that the lessee be compensated for the unused portion of the improvements as previously specified. To the extent that the probability of higher property taxes was increased because of the improvement, the landlord would have to be compensated by higher rental fees. Tenant-landlord relationships in this area have received little attention from agricultural economists as compared to the attention devoted to the problems of leasing in other areas. The amount of leased private land is decreasing, however, as some absentee owners finally decide to sell title to the land. Greater information is needed in order to adequately delineate the problem.

2. Interfirm transfers and optimum factor relationships

Another condition necessary for obtaining optimum investment of factors in the production process is that there should be no interfirm transfer of revenues disproportionate from the interfirm transfer of costs for the private producers. Since the operator considers only those costs and revenues that apply to him, if the above condition does
not hold he will make decisions that may conflict with the basic goals of the group. The existence of this conflict is quite common. The terms "on-site" and "off-site" benefits and costs - quite familiar terms in the jargon of those connected in any way with natural resource use and development - refer to these interfirm transfers which are the outgrowth of property. One possible solution can be found through property arrangement such as the Iowa Conservancy District (42, p. 1505), the grazing district or association (44), and the small watershed concept of flood control (242); all of which are designed to pool the land resources (and certain labor, capital and management resources) so that the land area is sufficiently large that most of the benefits become "on-site" benefits, as far as the decision making body is concerned. Another solution might be a more effective application of the principle of compensation by improving the device of subsidy (159) and by perfecting the legal instruments for recovering damages (31, p. 189).

3. Determining the input relationships

In this discussion we have not gone into the detailed technological problems involved in range improvement. To do so would take us far into the physical aspects of the problem which, although a very necessary part of the problem,
is not the one to which we are most directly concerned in this study. The basic technology for working out the physical phenomenon comes from the relatively new applied science of range management. The logic of the maximizing principles are not a part of the theories and principles of range management, but come, rather, from the science of economics. From the general outline of the principles and practices of the science of range management (209 and 182), it is clear that what is involved is not a science of management as that word is generally understood. Management infers the making of decisions concerning the use of means (resources) in such a way that specified ends will be maximized in terms of some choice criteria. Clearly what is involved in the science is a range technology - the principles and practices of determining the technological processes of the range resources as they were, as they are, and as they may become under alternative uses. But the choice criteria are not inherent in the resources themselves, nor within the individual scientist who studies the relationship; rather they come from the preferences of all the individuals who use the products from the resources.

Inputs in range improvement may be technical compliments of each other, or they may substitute for one another. The usual relationship is that inputs substitute for one another at a diminishing rate. Those inputs that are
technical complements of each other should be considered as one input, e.g., if mechanical removal of sagebrush from the range must be followed by artificial reseeding of desired species of grasses in order to obtain an increase in the productivity of the range, then these two inputs should really be considered as one input. The necessary marginal conditions for optimum factor relationships assumes that the input relationships are known. In order to meet these conditions it is important that the physical relationships of the different methods of range improvement be determined, and that the production functions of inputs in these several forms be quantified. The agricultural economist and the range technician may very well combine their bodies of knowledge and techniques to determine the functional relationships between the different forms of inputs, and between inputs and outputs. Heady and Olson make the following suggestion:

Animal husbandmen, agronomists, and production economists might well work cooperatively were the several structural relationships (which simultaneously are necessary for establishing optimum combination of farm resources) to be estimated. While many of the phenomena are of physical nature, models (basic logic) which are helpful in experimental design can also be drawn from production economics. Studies based on models of this nature would generally represent a departure from conventional experimental designs. (86, p. 70)
Marginal condition five states that one of the necessary conditions for maximum net social product is that the producing firms be of optimum scale, i.e., there must be no adjustments in the scale of firms possible which would result in either a lower cost of production for the same amount of product or an increase in product from the same amount of resources. In this chapter we desire to review this condition and point out some of its implications with respect to range resource use. We will consider the optimum scale of private firms only (ranches, logging companies, etc.) and not that of public agencies (Forest Service, etc.). The same principles and logic that apply to set the bounds of optimum scale for private firms apply equally to public agencies and government; the technology and choice criteria may be different. However, to consider this broader question takes us further into the discipline of political science than time and space will permit. It is a study in itself. We can only suggest that the basic logic of economies of scale might be a very useful tool in determining the norms for political science (12).
A. Family Farms and Efficiency

In Chapter II it was stated that probably the most consistent concept that tended to emerge in our federal land policy was that of the family-size farm. It is still the basis for many agricultural programs today. Some advocates of the family-size farm appear to value it as an end in itself, which it obviously is not. Others feel that the family-sized farm is our best safeguard against political and social upheaval, or that it is a means of guaranteeing equity of income. Still others favor the family-size farm claiming that it, alone, will give "good land use".

As has been pointed out by Heady (84, p. 354), the inference that agriculture is the last safeguard of freedom, morals, and democracy, does not seem justified by current or historical observation.¹ He opposes the claim that economic efficiency is not a paramount issue in farm size policy.

Historic precedent, agrarian principles, and "other ends" are cited as standing at a level with or above economic efficiency. But economic efficiency is involved regardless of the end or basis taken for prescribing optimal conditions.

¹As an antidote for an "overdose of agricultural fundamentalism" one might read Mencken's essay on "The Husbandman" (147, pp. 43-60), or the very interesting recent work by McConnell (144).
of production. It involves choice between all competing ends, irrespective of their nature, where limited resources and services are concerned. On the one hand: does a policy of farm size limitation represent the most efficient means of attaining goals such as social stability, church membership or an equitable distribution of income? While alternative objectives of farm size may be complementary over a range, they certainly become competitive at other levels. Income redistribution may come at the expense of production, and vice versa. (84, p. 355)

Saunderson defines the lower limits of the family-size ranch in terms of a size that will provide a minimum

... net income for family use of three thousand dollars annually ... and this means, under normal prices and costs, a ranch operation of three hundred head of cattle or two thousand ewes.

(He apparently feels that it is the number of head of livestock, and not the net family income, that should vary as the price level varies.) He sets the upper limit of the family-size ranch "at the point necessary to get full advantage of ranch economy and management". He goes on to state:

In the general western picture these family-type ranches are probably exceeded in acreage and in production by the larger ranches, in ownership other than that of the family living on and operating the ranch. Here the important distinction is that these larger ranches are essentially investments and are so regarded and operated even though the management may be that of a resident and noncorporate owner. (190, pp. 144-145)

He does not appear to be aware of the contradiction of maintaining, on the one hand, that the family-size ranch is
"at the point necessary to get full advantage of ranch economy and management", and, on the other hand, of pleading for action that will prevent investment capital from flowing into ranch units larger than this (190, p. 147). As to whether or not the large-scale corporate ranches are existing by mining the soil, as is sometimes claimed (190, p. 146), is a matter for further study. There are some reasons to suppose that the famous King Ranch of Southern Texas, the Wyoming Hereford Ranch of Southeastern Wyoming, and many others that could be named, keep both range and meadow land in a relatively high state of productivity.

B. Optimum Scale in Terms of Efficiency

It is proposed that the criterion by which we define optimum scale be that of economic efficiency. Should there be a conflict between the size of ranch as specified by this criterion and that desired under other social objectives (equal income distribution, for instance) then society must choose between the two. In order to make a choice, they must have some idea about the costs of the inefficiencies of operating the smaller ranches. They should consider alternative means for obtaining more equal income distribution (provided this is one of their goals) that might be
more effective and/or less wasteful than by limiting the size of ranches below that which gives most efficient use of resources.

1. Returns to scale defined

In the early production and distribution theories of the classical economists, the "residual claimant" method of computing the return to a factor was used. "Rent" and "profit" were the center of attention. Separate determination of the share of product to each factor followed the work of the marginal productivity theorists, who frequently assumed that the value of the product would be exhausted by such a process. Wicksteed appears to have been the first to pose this question explicitly, but it was left to Flux, in his review of Wicksteed, to connect his argument with Euler's theorem (206, pp. 320-329). Economies of scale can be defined in terms of Euler's theorem. Given a function \( Y = f(X_c, X_a) \) constant returns to scale exist if \( \lambda Y = f(\lambda X_c, \lambda X_a) \), where \( \lambda \) is any constant; which means that the production function is a linear homogeneous function. It can be shown that the partial derivatives \( \frac{\partial Y}{\partial X_c} \) and \( \frac{\partial Y}{\partial X_a} \) are functions of the ratio of \( X_c \) to \( X_a \) only, \( (1, p. 317) \) and that

\[
x_c \frac{\partial Y}{\partial X_c} + x_a \frac{\partial Y}{\partial X_a} = Y \quad (II)
\]
If \( \lambda y < f(\lambda x_c, \lambda x_a) \) decreasing returns to scale are specified and conversely for increasing returns to scale.

Under conditions of a linear homogeneous production function, the optimum size of the producing firm becomes indeterminant; ranch size becomes a matter of complete indifference, as far as costs are concerned. The assumptions of linear homogeneous relationships are not explicit and need to be stated. First, it assumes that all factors are infinitely divisible; second, it assumes that knowledge and/or skill is absolute (i.e., there must be no gain in knowledge or skill through specialization); and, finally, it assumes that there are no institutional barriers or technological bottlenecks to continued expansion. To the extent that each of these assumptions are met, constant returns to scale may reasonably be expected to exist.

The question of whether or not variable cost curves were due to the "law of proportions of factors" or "economies of scale" has been debated at length in the literature by Carver, Knight, Davenport, and others. Chamberlin concluded that:

The two are closely interwoven, and the explanation . . . involves their synthesis, rather than their separation . . . . The role of the entrepreneur is not to discover the most efficient proportions and then to reproduce these continuously until the most efficient size is secured. (29, p. 133)
The real answer lies in the kinds of technological changes that have to take place in the particular industry involved. The units of change for the factors must be those units that can actually be made. One hires one man to herd one band of sheep, or one hires two men to herd two bands of sheep, and not 1.267 men to herd 1.276 bands of sheep. Some of these indivisibilities tend to hold in the long-run as well as in the short-run. In most cases, to change the "scale" of things involves, also, altering the organizational setup. The important consideration is what happens to costs of production as these kinds of changes occur.

2. **Long-run and short-run economies of scale**

We will distinguish between a short-run and long-run cost curves in the traditional manner established by Viner. The short-run cost curve refers to a cost structure and time period in which some factors are fixed in quantity and form. The important forces giving rise to reduced short-run costs obviously grow out of proportionality relationships. "The term long-run refers to the cost possibilities which face a producing unit over a period of time of such duration that no factors need be considered fixed" (78, p. 364). The long-run cost curve - the envelope curve - is defined by the locus of tangents to successive short-run cost curves.
The short-run adjustments, involving changes in the form and proportionality of variable factors relative to fixed factors, should be guided by the criteria discussed in the previous chapter. The opportunities for scale adjustments in a given situation may be many and varied, or they may be limited. With a fixed amount of owned and leased land and a permit for a specified number of livestock on the summer range of the public land, a rancher operating a small, sub-economic unit is faced with the problem of increasing his scale of operations. His opportunities for intensifying are limited to the amount of increase productivity he can bring about on his land by the application of range and meadow improvement techniques. The subsequent improved carrying capacity of his own land will not permit an increase in the number of livestock he can operate unless he can substitute some of this increased capacity for summer grazing, which is presently limited by his grazing permit.

C. Tenure Structure and Economies of Scale

The manner in which increased uncertainties affect the economic horizon of individuals was discussed in Chapter IV. The amount of resources that a manager is willing to commit for future production (as well as the length of time
for which he is willing to commit them) is affected by the degree of uncertainty of expectations. The added uncertainties prevailing in many grazing leases would tend to lower the level of resource commitment, resulting in smaller ranches than would rationally obtain under ideal tenure arrangements. This would agree in principle, with Kalecki (116, pp. 95-103), who claims that an eventual rise in the long-run cost curve is attributable to the principle of increasing risk.

This may be considerably more than offset by the pricing of the factors, under leasing.¹ If the public land forage, which is rationed to selected ranchers, is obtained at a price which is only a fraction of the cost of owning the land, an economic advantage may accrue to the holder of the grazing permit making it possible for him to extend his private land holdings to a point beyond what would otherwise be optimum. The hypothesis is here proposed that the tenure structure and administration policy of public grazing lands retards proper adjustments to scale in western livestock ranching 1. by decreasing the time span of the economic horizon of the rancher, 2. by pricing the forage at what may amount to a subsidy and 3. by penalizing attempts at

¹A more detailed discussion of the pricing problem is presented in Chapter VIII.
interfirm adjustments of grazing permits. To test this hypothesis there is need to detect unused and inefficiently used resources, and to correlate their presence with various forms of tenure structure. Such a study might lead to further recommendations for the improvement of tenure structure and resource allocation.

D. Methods of Determining Economies of Scale

1. Residual claimant method

Early methods of studying economies of scale in agriculture followed essentially the "residual claimant" method used by the earlier classicists for computing the return to one of the factors; labor income imputed as a return for labor was the usual measure. Variations in the labor incomes of different farms in a locality were compared, by means of tabular analysis, with the number of acres of land in the farm (289). Increasing returns to scale were inferred from these studies. Applying the same analytical technique, many such studies confirmed the original findings for periods of favorable prices, but indicated decreasing returns during periods of unfavorable prices. The real difficulty with the "residual method", as applied, is
that returns are imputed to all the factors except one at an "average" or "market" rate and not at the "marginal productivity rate" for the factors. The residual thus tends to accumulate the differences between the market rate and productivity rate of the other factors and impute this residual to the one factor.

In studying the factors associated with successful ranch management Vass and Pearson computed the residual return to capital expressed in per cent. The relationship between rate of return on investment and scale, as measured by number of cattle units or sheep units, was determined by means of linear regression and correlation analysis. For the Wyoming mountain valley cattle ranches they stated:

That the size of the ranch is an influential factor is emphasized by the correlation between the number of cattle units on the ranch and the rate of return on investment .... The gross correlation coefficient .... suggests that the rate of return is increased by approximately one per cent with each additional 346 head of cattle units. (279, p. 81)

Although the regression analysis, being linear, indicated continuous increasing returns to scale, the authors were quick to point out that such was not the case.

The increase in the size of the ranch by a hundred head, however, has a much greater influence on the rate of return on the smaller ranches than on the larger ones ... as far as these data are concerned this situation is true until the average size of the ranch is between 500 and 1,000 head. (279, p. 82)
In their study of range sheep production on the Red Desert Area they found it "to be a general opinion that the small wool grower can operate more efficiently than the large outfits" (280, p. 55). That they were aware of the weakness of imputing a residual to one factor is indicated by their stating that "if labor income had been used as a measure the results would have been more marked in favor of the larger operator" (280, p. 55). Even so, their analysis did not completely confirm the "general opinion" noted above, but indicated that the best returns were made on those ranches where the number of breeding ewes ranged from 4,000 to 9,000.

Variations of the "residual claimant" method still predominate the economic studies of ranching that are being done. In 1952 Tompkin found that "the high income group was made up mainly of larger ranches" (218, p. 26).

2. Determining scale relationship from the production function

Another method of investigating economies of scale in livestock ranching is first to estimate the aggregate production function for the industry and then to determine the degree of homogeneity of the function. Like the previous method, the production function is subject to several empirical difficulties. Because of the lack of homogeneity
of products, the dependent variable must be in terms of income (usually net income). This possibly is but one of the variables that go to make up the planning objectives of the rancher (and his family). Other important objectives may be the education of the children, leisure and travel for the family, community service, etc. To the extent that this is true, total net income might not reflect the degree to which the rancher has attained his objectives. Second, managers possess varying degrees of managerial ability which, so far, have not been measurable. Third, there are differences in the effectiveness of the physical resources between ranchers, although they may be described by the same units, i.e., 1,000 dollars of capital on one ranch may be much more effective in obtaining net income than 1,000 dollars on another ranch, not because of any differences in scale but because of the form in which the capital is applied. All three of the above would tend to confound the true scale relationship.

Attempts to minimize the confounding by stratification have certain limitations. Since no method has been devised for measuring management, this important variable cannot be accounted for in the equation. To account for differences in the effectiveness of the other variables (when the differences can be detected and measured) by stratification might soon exhaust a population or make the sample
unwieldy. In the attempts to apply this technique to agriculture, this weakness is usually acknowledged in the description, ignored in the analysis, and compensated for by a value judgment in the conclusions (82) which seems to be all that can be done at the present time.

In using regression analysis, the researcher should use care in the selection of the form of the equation to be determined (103). Regardless of the degree of curvilinearity of the functional relationship of the data to be analyzed, a linear formula must show a linear function. The researcher can be guided by economic logic and familiarity with the phenomena in question in selecting the form of the equation. Furthermore, he may actually try several different equations and test them for goodness of fit.

The usual type of function assumed for studying marginal productivities of the resources, and economies of scale, is of the Cobb-Douglas type (214), designated by the equation

\[ Y = aL^bM^cC^d \]  

(III)

This function is linear in the logarithms and can be expressed as

\[ \log Y = \log a + b \log L + c \log M + d \log C \]  

(IV)
If natural logarithms are used the equation yields the elasticities of each of the resources (on the average for all farms) directly as the exponents. The sum of the exponents would equal 1.000 if there were constant returns to scale for this industry under the circumstances being studied. A procedure for testing the hypothesis that a given production function is a linear homogeneous function has been outlined by Tintner (215, p. 92).

So far as this author has been able to determine this technique has not been applied to any economic analysis of livestock ranching in the Western Range Area. In a study of cattle ranching in the Eastern Kalahari, Union of South Africa, Toit fitted the data obtained for cattle ranches for 1951 and 1952 to a Cobb-Douglas type of function, using land (L), labor (M), and capital (C) as the inputs, and gross income (Y) as the dependent variable. He obtained production function \( \log Y = 0.73030 + 0.145013 \log L + 0.225454 \log M + 0.569795 \log C \), which gives a total elasticity of 0.940262.

Tintner's method for testing whether a linear homogeneous production function exists was used. The F values obtained indicates that the functions did not differ significantly from one. The implications of this finding are very important because it indicates that, on the average, no economies of scale or diseconomies of too large a scale exists for this particular group of ranchers under the 1950-1952 conditions. (217, p. 164)
3. **Synthesized scale models**

A third method is to synthesize the short-run cost data for several ranches, each of a different size. It is based directly upon input-output information obtained by the physical sciences - range management, agricultural engineering, etc. - through production response studies. This procedure was applied to an analysis of potato production by Fellows (57). The basic resource organization and production practices used by the outstanding potato producers were "used as guides to determine the necessary features of an entire business" (57, pp. 39-40). He felt that little could be gained at the present time by attempting to determine the least-cost combination point by simultaneous equations, and hence resorted to the "less refined and more time consuming" method of budgeting the influence of several alternative setups with physical relationships based upon his "standards of performance" (57, pp. 41-42). To the extent that linear relationships are assumed in the "standards of performance", the method of "linear programming" developed at the Cowles Commission (124) may be a more general and more precise analytical tool, although it does require the use of higher algebra. The synthetic or budget method has not been applied to scale analysis of livestock ranching, although Quenemoen (172) did use a somewhat similar procedure in
studying the economic aspects of water spreader developments on ranches in Montana.

E. Trends in Ranch Size

It seems reasonable to assume that the long-time trend in size of ranches is in the direction of more efficient units. This could be thrown out of order, temporarily, by abnormalities existing in the economy, either within or outside of the range-livestock industry. In the days of the great cattle boom of the early eighties there were many large cattle companies organized with British and Scotch capital, such as the Swan Company of Wyoming and Nebraska that owned in the neighborhood of 600,000 acres of land running from Ogallala, Nebraska, west to Laramie, Wyoming, and from the Union Pacific Railroad, north to the Platte River. It claimed to have nearly 125,000 head of cattle (160, pp. 99-102). Others were organized with American capital, such as the famous XIT Ranch of Northwestern Texas, which ran upwards of 150,000 head of cattle on over three million acres of land (72). Many of these large companies went into the hands of receivers in the immediate years following the range calamity of 1886-1887. Some remained intact until well into the twentieth century. The advent
of the Taylor Grazing Act had some impact on these extremely large ranches that were dependent on the open range. A few large ranches still remain, and appear to be on secure financial footing today.

At the other extreme are those who settled on 320 to 640 acres, and, from that base, operated a homestead stock-ranch. Many of these began between 1900-1925. Some dropped out immediately, and others continued into the great depression before joining the ranks of the tax delinquent. Some have survived, but under the pressure of rising livestock prices, and high land values, there has been a tendency for the small units to be combined.

The extremely small units (less than 50 head of cattle) and the very large units (over about 600 head of cattle) were eliminated from their definition of the "family-operated cattle ranch", but Hockmuth and Goodsell found that "total private land in the family-operated cattle ranches rose from an average of 1,200 acres in the 1931-34 period, to more than 1,700 acres during the war and post war period" (98, p. 5). Other studies of earlier periods seem to confirm this trend in the averages (152). There has been no detailed study of the trends in the scale of livestock ranches in the western range area since the advent of the Taylor Grazing Act, although there has been no dearth of opinions expressed on it. For the most part, these opinions
indicate a tendency for the very small units to be absorbed by more efficient units and for the number of extremely large units gradually to decrease (39, pp. 220-223).

The distribution of sheep and cattle ranches by size groups can be shown from census data for the years in which the census is taken. The 1940 census\(^1\) was used by Hockmuth and Goodsell to show the frequency distribution for the Intermountain Region.

Calculations . . . show that (sheep) ranches in the Intermountain region with less than 500 sheep constitute 38 per cent of all ranches with sheep and four per cent of the sheep numbers. Similarly, ranches with 500 to 3,099 sheep make up 45 per cent of all ranches and contain 41 per cent of all stock sheep. Ranches with more than 3,100 sheep per ranch comprise 17 per cent of the total ranches in the region and have 55 per cent of the total stock sheep. (95, p. 7)

The distribution of cattle ranches for the same region showed\(^2\) that about two per cent of the ranches had 1,000 head of cattle or more, five per cent had between 500 and 1,000 head, 10 per cent had between 250 and 500 head, 22 per cent had between 100 and 250 head, and 60 per cent had

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\(^1\)Census data for 1940 lent themselves to this type of analysis better than did subsequent census data. Preliminary comparisons of the data available for the 1945 and 1950 census reports indicate that the ratios were not substantially different from those obtained using 1940 data.

\(^2\)These percentages were derived from Table 1, page 4 of Hockmuth and Goodsell (98, p. 4).
less than 100 head. It is generally agreed that these smaller units are inefficient. It was Saunderson's opinion that:

In numbers, though not in production, the family-sized ranches are exceeded by the small ranches and stock farms of subeconomical size. Any ranch that operates less than one hundred head of cattle or less than a full range band of sheep may be classed as subeconomical. (190, p. 145)

Even with cattle prices as favorable as during 1951 and 1952 Tompkin concluded:

Many ranches in the area are too small to constitute an economic unit. Only favorable feed prices for the crop products they sell to large neighboring ranches can keep these small spreads going properly. Off farm employment would also help but the opportunities are limited in the area. (218, p. 43)

It appears likely that there are very substantial economies of scale at the lower limits. The small rancher has little opportunity to diversify or to substitute home products for family income. Because of his location with respect to the community, there is usually very little opportunity for outside employment on a part-time basis, either for the rancher or for members of his family. His only hope for full employment, and a higher level of family income, is to increase the number of his livestock. New land and/or increased grazing permits are his most important method of achieving this, although improved range productivity may help some. Thus, the meaningful adjustments that can
be made in increasing the size of ranches are those that involve interfirm adjustments - the small ranches combining into larger ranches or the large ranches scaling down, thus adding to the small ranches. The extent to which either of these is advisable depends on the real economies of scale that exist in the industry (22, p. 124).

F. Reasons for Economies of Scale in Livestock Ranching

Most economies of scale that have accrued to agriculture in recent years have been due to mechanization where power units and machine combinations of high capacities could be substituted for labor and fixed costs could be spread over a large acreage (78, p. 369). In the livestock ranching industry, mechanization, for the most part, has been applied only to hay harvesting. The jeep and small truck have replaced the saddle horse for some jobs in working the cattle on certain terrain. Likewise, the small tractor has become standard fence-fixing equipment on some ranges where terrain permits it. Fencing of the range into convenient pastures is an important way in which capital is being substituted for labor, particularly in the Great Plains Regions and on those ranches where public land grazing permits are not
important. On those sheep ranches that use the high mountain ranges of the national forests in the summer, with the sheep migrating to the desert ranges in the winter, the advantages of scale due to substituting high-fixed-cost capital for labor is quite negligible.

The optimum number of sheep that constitutes a "summer band" is usually about 1200-1500 head (16, pp. 977-994). One or two men will accompany the herd, depending on the terrain, the number of summer bands that are located in a given mountain area, and other factors. As the number of summer bands per firm increase, the labor and management involved in supplying and supervising them increases, but probably at a decreasing rate up to some point. There are obvious economies of scale involved in spreading the necessary overhead costs over more units of product. These may soon be offset by the need for duplicating overhead service, or by the difficulties of communication and supervision (33).

The importance of terrain and natural barriers of expansion are very real in providing the bottlenecks that set the upper limits of scale to ranching, particularly in the mountain areas. A study of the origin and physical characteristics of those large-scale ranches that have survived for some time reveals that "the land included in the ranch constituted a good, if not a superior, operating unit, because of certain natural features of the lands in question"
and that, for the most part, the land was acquired, originally, in large blocks at a rather low cost.

Because of the extreme seasonality of the jobs that must be done on a ranch, the opportunity for increased efficiency through specialization is usually quite limited. At one season of the year irrigation structures and range development receive the attention of the cowboys. They next must be "hay-hands"; and when the hay is harvested, the round-up begins. After the cattle are settled on the winter range or winter feed ground, and those to be sold have gone to market, the winter feeding program gets under way. During the calving season full time is devoted to seeing that neither cow nor calf is lost due to lack of care. In the meantime, the fences are repaired and extended whenever it is possible to do so. A "top cow-hand" is a specialist in many things.

It appears reasonable that there is some advantage to be offered to large ranches in terms of buying and selling efficiency, but little is really known about the degree or extent of this. Selling the steers or lambs at the ranch is usually associated with larger ranches whose quality product has attracted interested buyers from the winter feeding areas. Where the ranch is large enough to justify its own auction at the ranch, a distinct advantage may accrue through the years. The presence of the livestock speculator...
and the community auctions are attempts to provide this service to all ranchers. The extent to which better prices have been obtained by the rancher through sales at the ranch or the auction, rather than through the central market, is still an unresolved issue (205). Several of the larger ranches operate their own ranch store thus permitting wholesale buying, both to the ranch itself and to the families who live at the ranch headquarters. This may actually be more important in attracting and holding good workers than in reducing operating costs directly.

G. Nature of Economies of Scale in Livestock Ranching

Although time was quick to show the inadequacy of the homestead laws (even the 640-acre version) when settlement reached the Western Range Area, we still do not know very much, empirically, about scale relationships of livestock ranches (or, for that matter, about economies of scale in agriculture, generally).

It appears quite reasonable that the important economies of scale occur at points below that which offer approximately full employment to the operator during the winter months. Sheep ranches operating under conditions
where the pastures are unfenced, whose number of sheep are less than one summer band (1,200 to 1,500), are obviously subecononomic if they cannot combine with other small operators to make one cooperative summer band. From the previous discussion, one perhaps could hypothesize that there are approximately constant returns to scale over a long range, and that the limitations of management and labor (39, pp. 222-223) and/or physical limitations of terrain provide the important bottlenecks that set the upper limits to economies of scale.

The fact that there continue to exist in the same region, for relatively long periods of time, ranches of vastly different sizes does not, in itself, prove the hypothesis of constant returns to scale since it is possible to explain this phenomenon without this hypothesis. Small ranches may continue to operate at a loss simply because the bookkeeping and accounting techniques used by the rancher never reveal the fact. Collapse of the business is prevented only because of the joint accounting of firm and household, which permits the family to work at less than opportunity cost simply because they are unaware of what is happening. This may help to explain not only why the so-called subecononomic unit continues to exist but why the smaller unit may actually be less likely to go into the hands of receivers or to cut back on production in
times of depression. Differences in the financial arrangements of firms may be more meaningful than economies of scale in explaining why some firms continue to exist and others do not.

Of course, not all operators are engaged in ranching for the purpose of maximizing profits, and some may be willing to accept lower returns from operating their own ranch than they could obtain elsewhere. The tradition and "color of the old west" provides additional prestige to being a "rancher". Holding on to "the old homestead" has almost become an end in itself with some families. Although the opportunity for gainful employment for the family may be somewhat limited on the small ranch, it may still be much better than it would be if the operator were to sell out and move to the city.

A constant upward trend in the average size of livestock ranches in the western area, on the other hand, is not inconsistent with the hypothesis that there are constant returns to scale over a long range, above a certain minimum size. The gradual elimination of some of the very small, subeconmic units would result in this upward trend of averages.
H. Economies of Scale in Other Western Range Industries

The business of dude-ranching is a growing industry in the west. Very little is known, empirically, about the nature of its cost structure. Although most dude ranches also run some livestock (usually cattle) an important source of revenue is from vacationers who spend a few days, or even a season, actually living at the ranch. Obviously, the product sold is more nearly a differentiated product in the Chamberlinian (29) sense than it is a purely competitive product. In rare cases where unusual scenic value is characteristic of a given ranch, the situation is more nearly monopolistic among selected clientele. Thus, the most profitable scale cannot be determined from an analysis of the cost structure alone, since advertising and other selling costs are important in raising the price of the product. In most cases, relatively high fixed costs are involved in performing the personal services required. It seems reasonable, on an a priori basis, that substantial economies of scale exist. The procedures outlined earlier for studying economies of scale of livestock ranching can be applied directly to the study of economies of scale, not only for dude ranching, but for the different segments of
the lumbering or mining businesses, or other industries using western range resources.

I. Income Distribution Criterion and Optimum Scale

Having considered optimum scale from the standpoint of economic efficiency, let us turn briefly to consider any conflicts that may arise between this solution and the solution obtained from an income distribution criterion. The degree of conflict obviously will depend on the true nature of the economies of scale for the respective industries involved.

It appears likely, from what information is now available, that these two criteria conflict at the upper limit of scale, and may conflict at the lower limit of scale depending on the point at which constant returns to scale are approached. There are many ranches (estimated variously from 40 to 80 per cent by number, depending on the region) that, from the standpoint of production efficiency, are obviously too small. Some of these ranches do not provide the minimum socially acceptable standards of living for the ranch family. The Joint Congressional Committee on the underemployment of rural families (246) indicated that
there was what they called "underemployment" existing in several areas of the United States, including parts of the Western Range Area. It appears to the author that the Committee described as "underemployed" those individuals receiving less than a socially acceptable standard of living. Ranches could be below optimum scale in terms of our marginal conditions and still provide a standard of living to the farm family that was not less than the socially acceptable minimum.

The real conflict between these two criteria arises from the kinds of recommendations for scale adjustments that would be made based on each. From the standpoint of resource efficiency, as long as ranches were operating in an area of increasing returns to scale, fewer and larger ranches would be recommended. On the basis of a more equitable income distribution it might be preferable to reduce the size of the larger ranches in order to increase the size of those units that are now smaller than the minimum required to provide an acceptable standard of living.

In reality, there are two kinds of problems involved here - that of poverty in agriculture, and that of efficient use of agricultural resources. Although they are closely linked together, they can be solved by the same policies and programs only under the very unusual circumstances
that provide a stable and expanding economy in non-agricultural sectors of our society.

The usual recommendation of agricultural economists is that both of these problems finally be resolved outside of agriculture; i.e., that they be solved in the city. In outlining proposed long-run adjustments for ranching in the Northern Great Plains Kelso suggested that ranchers should:

Reduce the number of farm and ranch units in the northern Great Plains ranching area because not all of the units now there are large enough to . . . permit the family to earn a decent income. In a report on the northern Great Plains issued by the Bureau of Agricultural Economics in 1941, it was estimated the number of farm and ranch units in the ranching area of that region should be reduced by 20 per cent. (119, p. 3)

Based on the assumption that productive employment can always be found outside agriculture, the solution is to move people out of agriculture and into industry. As a long-run goal or objective for policy, this is economically sound; although it may be far from sufficient as a long-run policy, by itself. As a permanent solution, it is not yet known whether the American people are yet ready for 1. the amount of government activity necessary to guarantee full employment, or 2. the amount of regimentation and coercion
necessary to get masses of people to move from agriculture. Yet, if our recommended solution to the problem lies in that direction, and if we are not willing to accept the conditions required for the solution, a dilemma exists (163, pp. 160-162), since our growing welfare psychology does not permit a continuing of the sub-social standards accompanying the depth of poverty that exists on many of these sub-economic units. Thus, our action programs so far have been of the form that would perpetuate the conditions, giving rise to inefficient use of resources, with very little being done to correct the causes.

Many of the small, subeconomic units, and this is especially true of the Southwest, are heavily dependent on public land - particularly forest land. As will be shown in greater detail in the next chapter, the policies for distributing grazing permits demonstrates a definite bias on the part of the Forest Service in favor of perpetuating the very small units by their preference classification. In describing conditions in New Mexico, which are typical of the Southwest, Holmes states:

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1The stand taken by the leaders of both political parties regarding the Employment Act indicates that full employment may now be a goal of relatively high order, as far as the industrial sector of the economy is concerned. The problems of unemployment and poverty in agriculture in the serious problem areas are largely still to be solved.
From the data . . . one may find that submarginal users hold over 80 per cent of the permits (for national forest grazing) but graze only a small fraction of the animal units. Sixty per cent of the cattle and horses grazed on forest ranges are allocated to the permits of only 11 per cent of the permittees.

The social-economic question of what to do with and for the large body of small permittees will probably continue to plague the Service for some time. The permit system has given such users a leasehold on poverty, for they have considerable security of tenure under the grazing rules; and poverty and depression have not sufficed to drive the village Spanish-Americans and other small operators from the areas in and near the forests. Perhaps loss in their "rights" and a resultant increase in their difficulties would drive them from the land they so gravely overburden, but such a solution smacks too much of nineteenth century economic brutality to win approval now.

The problem is far too complex and deeply rooted for the Service to solve. The solution involves questions of social acculturation, education, job opportunities, and fiscal policy; and these must wait upon public and legislative recognition. (100, pp. 9-10)

Should the policy makers be successful in establishing a long-run policy of moving people out of agriculture, it would be necessary to change the federal range code, particularly as it pertained to the distribution of grazing privileges. Even then, it would be doubtful if the frontline personnel of the Forest Service and Bureau of Land Management - those who deal directly with the users - would have much recourse but to provide for the continued use by these small subecononomic users until such time as the
short-run poverty problem is solved in a more satisfactory
and permanent manner. The points here presented do not
argue in favor of solving the rural poverty problem by ad-
justing the scale of firms downward until an equal size of
ranch has been obtained by everyone. To the contrary, we
would argue that any satisfactory long-run solution to the
problem of resource efficiency lies in the direction of
transferring human resources out of agriculture. As was
mentioned in the first chapter, several states in the Western
Range Area are characterized by a high degree of population
mobility. In other states, however, population mobility
is more limited and resource inefficiency results in aggra-
vated local conditions of poverty - this is especially true
of the Southwest. In these localities, the transfer of
human resources out of agriculture must be preceded by the
adoption of public programs of education, economic stabili-
ization, and social acculturation of the so-called "second-
class" citizens.¹ Because of the dilemma of our present

¹One very important question pertaining to economies
of scale is the optimum speed with which adjustments
should be made. There might be important social and tech-
nological reasons why these adjustments should not take
place at too rapid a rate. The optimum rate for adjustment
would depend partly on the degree of social and professional
change involved in the process.
social thinking, however, this long-run adjustment may be "too long" in coming, and we probably will be unwilling to endure the hardships, in the short-run, and will continue to apply expedient palliatives that work against the long-run optimum scale adjustment.
CHAPTER VII
AGENCIES OF COLLECTIVE CONTROL

Whether one's approach to the study of the Western Range Resources is *ex post* or *ex ante* the role of the federal lands in the economy of the area bulks large. The part played by a particular tract of land in the economic picture of the area surrounding it depends only partly on the physical attributes that make up the land - its physiography, climate, etc., which influence its physical product; it also depends on the public agency that administers the use of the land.

In this chapter we desire to describe the basic policy framework for each of the important public land agencies and to indicate ways in which those policies are carried out. We will then consider some of the group-tenure devices that have been developed to cope with the tenure problems of the range-resource area.

A. The Forest Service and the Bureau of Land Management

About 51 per cent of the livestock in the 11 western states were grazed for an average of 4.4 months on federal
land in 1949 (48, p. 26). Of this amount, 24 per cent was on land administered by the Forest Service and 59 per cent was under the Bureau of Land Management. For the most part, the Forest Service land is located chiefly on higher elevations, either mountains or plateaus, with heavy snowfall and a relatively short growing season limited usually to the summer months. About 80 million acres of the national forest land are classified as usable for grazing (48, p. 6), of which over 90 per cent was actually used for that purpose in 1949. There is not general agreement as to the amount of land in national forests that produces little or no commercial timber. The Forest Service reports indicate about 50 million acres of noncommercial forests and 36 million acres that are nonforested (260, pp. 87-89).

Except for the revested Oregon and California railroad grant lands (called "O and C" lands) the Bureau of Land Management administers land located largely in the arid and semiarid plains and interspersed mountains and valleys. The vegetation varies from heavy timberland to desert shrubs. Grazing, although usually seasonal, may extend through all seasons. Considerable forest products and mineral products are sold by the Bureau.

Together, these two agencies manage more than four-fifths of the public land in the western range region. In
many areas their land is contiguous with the boundary line being completely arbitrary as far as physiographic features are concerned. The policies of the two agencies on such matters as livestock numbers per section, timing of the grazing season, grazing fees, range improvements, recreation, security of tenure and distribution of grazing permits, and many other issues, are of special importance when ranchers deal with both agencies at the same time on land that is very similar.

The basic regulations for each are laid down in the Federal Code (43). From this have emerged numerous policy statements and manuals, the most famous being The Use Book (269) for the Forest Service. In 1949 the Bureau\(^1\) published the Federal Range Code for Grazing Districts (228). Recent policy statements have clarified some of the policies of these two agencies and have indicated some of the changes that are taking place within the agencies. Perhaps the most useful procedure at this point is to compare these two agencies on several of the more important issues.

The 110 national forests of the Western Range Area average about 1,250,000 acres each and have been subdivided into

\(^1\)To avoid monotonous repetition, the Bureau of Land Management will be designated by the "Bureau" and the Forest Service will be identified by the "Service" in this section.
a total of 600 ranger districts. The Service "has spent about 150,000 dollars to 175,000 dollars and employed about 50 persons per million acres of land administered" (39, p. 112). The Bureau, on the other hand, has 58 grazing districts that cover 158 million acres averaging about 2,500,000 acres per district. The remainder of the Bureau land is outside of grazing districts of which over 18 million acres are leased directly to private grazing (232). In recent years, it has spent about 33,000 dollars and employed about six persons per million acres of land administered (39, pp. 111-112).

1. **Distribution of the grazing privilege**

On page one of *The Use Book* one finds the first statement of the Service's policy toward grazing.

There is no law which gives an individual or corporation the right to graze stock upon national forest lands. The establishment of private rights in national forest lands would defeat the social purposes to which they have been dedicated. The grazing of such lands may be allowed by the Secretary of Agriculture only as a personal privilege. (269, p. 1)

The grazing privileges are distributed according to a system of preferences that have been devised to contribute "to the stability of the livestock industry", to make the forage resources of greatest value, to "prevent monopoly", and to bring about an "equitable distribution of privileges"
(269, p. 25). To do this, the forester may establish protective, exemption, and maximum limits which form the core of the Service's distribution policy.

The protective limit is the number of stock for which the permits of Class A owners . . . will be exempt from reduction in the renewal, except when sufficient reductions for range, forest, or watershed protection cannot be made on preferences in excess of the protective limit.

The exemption limit is the number of stock below which the preference of no owner of dependent commensurate range property used primarily for the production of livestock will be reduced for purposes of distribution.

The maximum limit is the number of stock above which an increase in preference to any person, firm, or corporation may be refused. (269, p. 20)

On the basis of these limits, preferences are established for applications. "Class A preferences" are those who own and reside on "improved ranch property which is depend-ent upon the national forest" (269, p. 25) but who do not own more than the established exemption limit number of stock. "Class B preferences" are the prior users of the forest range who do not own improved ranch property, and persons owning such property but who own too many livestock for Class A preferences. "Class C preferences" are those who do not regularly use the forest range and who do not own improved ranch property.

Until very recently redistribution of grazing privileges were made through transfer adjustments - adjustments in the
number of the livestock included in the permit when property was transferred from one person to another. Recent legislation (252, p. 3) prohibits transfer cuts as such. The rules and regulations governing the conditions under which 1. transfers of grazing privileges and 2. adjustment in livestock permit numbers shall be made, in the light of this new legislation, have not yet been made public.

The Federal Range Code under which the Bureau operates, provides for preferences in the granting of grazing privileges to

... those applicants within or near a district who are landowners engaged in the livestock business, bona fide occupants or settlers, or owners of water or water rights, as may be necessary to permit the proper use of lands, water, or water rights owned, occupied, or leased by them. (228, p. 1)

whereas the Service bases its grazing privileges primarily on livestock, the Bureau uses a property base.

The "base property" refers to privately owned or controlled land, or water, used for the support of the livestock for which a grazing privilege is sought.

For the purpose of determining the proper use of the base properties of all applicants and their relative dependence on the Federal range, land and water conditions and other factors affecting livestock operations in the area will be considered and determined according to customary use and best practices for good range management. Base properties will be classified as land or water and further in the following manner:

Class 1. Land dependent by use or full-time prior
water. Class 2. Land dependent by location, or full time water . . . .

Land dependent by use means forage land which is of such character that the conduct of an economic livestock operation requires the use of the Federal range in connection with it and which, in the five-year period immediately preceding June 28, 1934 (referred to in this part as the priority period), was used as a part of an established permanent, and continuing livestock operation for any two consecutive years or for any three years in connection with substantially the same part of the public domain . . . .

Land dependent by location means forage land which is so situated and of such character that it can properly be used as a base for an economic livestock operation utilizing the forage resources of the Federal range.

Full time water means water which is suitable for consumption by livestock and available, accessible and adequate for a certain number of livestock during those months in the year for which the range is classified as suitable for use . . . .

Prior water is water which, during all or a substantial part of the five-year period immediately preceding June 28, 1934 . . . . was used to service certain public range within the service area of the water for a livestock operation that was established, permanent and continuing and which, during the period of such use, normally involved the grazing of livestock on the same areas of public land for a certain period or periods of each year . . . . (228, pp. 2-6)

Before an applicant is qualified for consideration he must 1. be a citizen of the United States or have filed a declaration to become a citizen, or 2. be a group, association, or corporation which is authorized to conduct business under the laws of the state in which the grazing privileges sought are to be exercised, provided also that
the controlling interest is vested in individuals who would be qualified under 1, above.

The first priority of preference is for free use permits for "not to exceed the number of livestock kept for domestic purposes to those who reside near enough to the public land to graze such livestock in the immediate neighborhood of the residence". The regular licenses and permits would then be issued in the following order:

(1) To applicants owning or controlling land in Class 1, . . . permits to the extent of the dependency by use of such land; to applicants owning or controlling water in Class 1, . . . permits to the extent of the priority of such water.

(2) To applicants owning or controlling land or water in Class 2 . . . .

(3) To other applicants, licenses or permits for the number of livestock for which range is available and which can be properly grazed without detriment to the operations on the range of applicants owning or controlling base properties in Class 1 and Class 2. (228, p. 7)

If there should still be any surplus of forage the range manager can issue written permits to anyone provided "such use will not be detrimental to the Federal range" and that it "will not adversely affect other licenses or permittees" (228, p. 8). It should be emphasized that dependency, when used by the Service, is something quite different than when used by the Bureau. In the latter case, it more nearly describes priority than dependency.
In contrast to the Service, the Bureau makes "no reductions in grazing privileges . . . when permits or leases are transferred from one party to another". Reductions are not made for purposes of redistribution.

A permittee or lessee may retain his right to grazing use of the public land so long as:

(1) He retains ownership or control of the property upon which his grazing preference was based.

(2) He conforms to all of the terms of his permit or lease and the provisions of the Federal Range Code for grazing districts.

(3) He continues to make substantial use of his base property in conjunction with substantial use of the grazing privilege permitted on the public land.

(4) The area of public land he is authorized to use is not diminished by withdrawal, appropriation, selection, or otherwise made available for a use higher than grazing. (229, p. 2)

Two important differences between the policies of the Service and those of the Bureau are evident. First, the average size of firms are smaller under the Service. The Bureau has issued licenses, or permits, for about 50 per cent more livestock than the Service, while the latter has about 25 per cent more grazing users than the former (39, p. 114). Second, individual operators have been able to achieve a larger degree of "property" in Bureau land than in the national forests. That is, there has been greater insecurity of tenure connection with permits from the
Service than from the Bureau, particularly for the larger ranch units, which tend to have rather insecure tenure on land administered by the Service. The rules provided in the Service regulations were designed, in part, to give added security to small stockmen. It now seems that, in some respects, these rules were too effective to suit the Service. J. E. Holmes points out that

Over the years the practice developed of considering a grazing permit as being attached to or becoming a part of the land. Thus, if a man purchased the land he automatically purchased the range rights with it . . . . This custom was to present certain very real philosophical difficulties. This meant that private individuals and corporations were acquiring certain PROPERTY RIGHTS upon the national forests. This was very definitely contrary to the entire philosophy of Pinchot and T. R. Roosevelt . . . . (100, p. 82)

The Service has ruled that in all sales or transfers of either land or livestock all permits revert back to it. The practice of making transfer adjustments has emphasized this ruling which has been upheld by the courts (100, p. 24). Still the rule itself has not accomplished what was intended of it. In appraising this rule McGowan wrote:

In the first place, it would be impossible to buy or sell property unless the purchaser was assured of a "range right", and the Forest Service was compelled to transfer the permit to the purchaser as a matter of form, though they claim that as a matter of right they need not do so. But it has had the effect of introducing a degree of instability in the industry . . . . For all practical purposes, these permits are property rights, attached to land just as a water right is, even though the courts and the Forest Service do not consider them as such. (145, p. 83)
2. **Pricing of the forage products**

Except for the free-use permits mentioned above, both the Service and the Bureau charge grazing fees for permits on a per-head basis for all animals six months of age or older. No grazing fee is charged for livestock under six months of age. In both cases, the fee is determined by the administrator and not by bidding among the prospective users.

The Forester is authorized to determine the fair compensation to be charged for the grazing of livestock on the national forest, upon the basis of the following factors: (1) A proper use of the grazing resource to best serve the public interest. (2) Reasonable consideration of the value of the forage to the livestock industry. (3) Effect of the rates upon the livestock producers. (269, p. 46)

The policy followed by the Service for some time is to charge fees, in a given year, that bear the same ratio to the 1931 basic range appraisal rate as the average prices received for beef and lamb the preceding year bear to the corresponding average prices received during the period 1920 to 1932 for sheep and 1921 to 1930 for cattle. For example, the average 1931 basic range appraisal rate was 14.5 cents per head per month, and the average price received for beef cattle (other than calves) for the period

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1The important economic issues associated with factor and product pricing will be discussed at length in the following chapter.
1921-1930 was 6.62 cents per pound. If, in 1953, the average price received for beef cattle in the 11 western states was 15.0 cents per pound, the 1954 fee should be 32.9 cents per head per month.

The Bureau charges a separate fee for grazing and for range improvement. Provision has been made for the fees to vary between districts. In actual practice, the grazing fee has been six cents and the improvement fee has been two cents per AUM per month since 1947 (228, pp. 13-14). Five sheep or goats are considered equal to one cow, or horse, by both agencies.¹

3. Range improvements

Within the limits of available funds, which must be appropriated by Congress, the Service constructs and maintains range improvements. Thus far such funds have been very limited. Before a permittee can legally perform or construct any range improvement on the national forest, he must obtain a special permit.

Generally speaking, improvements essential to proper range management will be constructed by the permittees concerned under free permits allowing the builders to obtain the resulting

¹This practice assumes that one class of livestock replaces another at a constant rate ignoring any supplementary relationship that exists between the classes. See Section C-1 of Chapter XI for further discussion of the economic implications of this assumption.
benefits without the fee being correspondingly increased because of the increased value of the range on account of the improvement for a 10-year period, and thereafter vesting title in the government . . . . To be justified it must be clearly shown that the plan will secure better range and forest management and that in the long-run the action proposed will result in increasing rather than diminishing the total receipts from grazing fees . . . .

With the consent of a permittee who has constructed or maintained, or who may hereafter construct or maintain, range improvements which are necessary to the efficient utilization and management of national forest range, the Forester may make an adjustment of the grazing fees for a period of years sufficient to recompense the permittee for the value of such improvements. (268, pp. 69-70)

The period over which fees may be adjusted in order to recompense the permittee will usually be from one to five years and is not to exceed 15 years.

Increased grazing capacity resulting from protection adjustments will be recognized as belonging to the allotment or unit on which the adjustment was made. Distribution will be made among the users of the allotment or unit on an equitable basis, provided a longer period than ten years is not involved. After a ten-year period, distribution will be reconsidered, taking into consideration existing conditions. (268, p. 4)

In 1951 the regulations were changed to allow the permittee to retain possession of improvements as long as he

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1 This would apparently be true only if the improvement had been made at the beginning of the 10-year accounting period which ends in 1955. This point is not clear in the policy statements.
holds the grazing permits, except where the project was built cooperatively with the government. Congress has recently directed (252, p. 2) that if a permittee who has made structural range improvement should be deprived of the use of the range through no fault of his own he is to be compensated for the appraised value of the improvements. Compensation is not to exceed the amortized value of the improvements based on replacement cost. The new law provides for payment "by a subsequent permittee to his predecessor of the value of improvements constructed by such predecessor". The Service has the power to act as agent for any cooperative group of users who desire to make range improvements subject to essentially the same limitations that individual permittees use. In actual practice, group investment perhaps has resulted in more range improvement than has resulted from individual investment on forest land.

For Bureau land, section four of The Taylor Grazing Act provides that the permittees may construct "fences, wells, reservoirs, and other improvements necessary to the care and management of the permitted livestock" (233, p. 4) after written permission has been obtained.

The Act also specifies that, before a new permittee can use improvements constructed by a former permittee, the applicant must pay to the prior user the value of such
improvements. The value of the improvements are to be determined "under rules and regulations of the Secretary of the Interior. The decisions of the Secretary in such cases is to be final and conclusive" (233, p. 4). The old permittee may actually go on the public land and remove certain kinds of improvements, upon approval of the administering agency, if not compensated by the new lessee. The compensation cannot exceed three times the annual rental of land that the original lessee has lost (43, p. 244).

A lessee on Bureau land is subject to having the land reclassified and taken from him at any time.

Lands embraced in a grazing lease are subject to classification . . . and disposition under the provisions of section 7 and 14 of the Act of June 28, 1934 . . .; provided; that before any application for such classification and disposition is allowed, evidence is furnished that the applicant has agreed to compensate the lessee for any grazing improvements placed on the lands under the authority of the lease, and, in addition, for increased cost in the lessee's grazing operation during the unexpired term of the lease. In any event, the amount allowed because of such increased operating costs shall not exceed an amount equal to three times the annual rental of the lands removed from his leasehold. (166, p. 8)

4. Advisory boards

The use of advisory boards - selected representatives of the local users - has been followed to varying degrees by both the Service and the Bureau. In most cases the
advisory boards for the Service have been less influential than those of the Bureau (39, p. 114). The Service regulations provide that

Whenever a national livestock association appoints an advisory board or committee representing users of the national forests in all of the different states, it will be recognized by the forester and consulted annually regarding matters which concern the use of national-forest range . . .

Whenever a state livestock association appoints an advisory board it may be recognized by the regional forester and consulted in regard to general matters within an entire state . . .

In the administration of national forests, good results have been secured through cooperation with associations representing the users of small grazing divisions who have a community of interests. (269, pp. 78-79)

Certain requirements and procedures are specified in the regulations which, when met, make an advisory board to a local livestock organization eligible to be heard by the Service. The extent to which their recommendations will be used is then left to the administrative officer concerned. Any proposal for substantial modification of grazing policy

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1 Senate Bill S.2548 passed March 4, 1954, authorizes the Secretary of Agriculture to establish multiple-use advisory councils for any lands under his jurisdiction (252, p. 4). The councils may make recommendations with respect to any question of policy affecting the multiple-use of such lands. They are not to supersede or perform any of the functions of the advisory boards, however. It is still too early to tell what influence this bill will have on the influence of the advisory boards and councils of the Service.
should be "reviewed with local advisory boards before adoption" (268, p. 5).

One point of contention of long standing between the Service and the stockmen was that a stockman who felt he had been unjustly dealt with by a decision of a Service official could appeal that decision only to higher offices within the Service, up to and including the Secretary of Agriculture. To meet this situation Service regulations provided for the creation of grazing boards to hear complaints against the administrative decisions of forest officials. A member of the Service was to be appointed chairman of the board, with two or four members being selected by the users. Rulings of the grazing board could be used by a Service administrator in rendering a decision, although he was not bound by them. The grazing boards achieved a somewhat higher status than the advisory boards.

At the request and continued agitation of the stockmen's associations, the recent land bill, S.2548, provides for the following (252, pp. 3-4):

1. Informal appeals to a three-man board consisting of a Department of Agriculture employee (not from the Forest Service) designated by the Secretary, a second member designated by the appellant, and a third member appointed by the other two. 2. Formal review de novo, at which a record would be made for anyone dissatisfied with the result of the informal review. 3. Further appeal to the United States district court based on the record made in the formal review.
For the Bureau, Section 18 of the Taylor Grazing Act provides that each grazing district shall have its own advisory board. The regional administrator is to assign the number (from five to twelve) to be elected and the Secretary is to appoint one representative of the wildlife interests. The regional administrator must see to it that the election process provides that the free-use permittees "will be entitled to one representative, who shall be a free-use . . . permittee" (228, p. 27). The functions and duties of the advisory boards for the Bureau are

... that they will advise and make recommendations on: the grazing capacity of the Federal range in the grazing districts; all applications for grazing privileges except their own; the qualifications, classification, and requirements of base property; the transfer and relinquishment of base property qualifications; cancellation of grazing permits; range line agreements; variance in range improvement fees; requirements for unit or allotment fences; proper rules of fair range practices; allotments of range; seasonal use of the range; cooperative agreements or application for the construction or maintenance of range improvements; work plans for range improvements and conservation programs; and reservations of grazing capacity for wild game animals. (229, p. 3)

Because these advisory boards 1. have been created by law, 2. are elected by their members, for the most part, 3. have a broad representation of users, and 4. have considerable latitude in the kinds of problems they handle for their members and for the Bureau, they are highly regarded
by the stockmen in the area. They are only advisory, however, and their decisions may be overruled by the responsible administrative official. Provision is made whereby a user may appeal the decision of an administrative official. Ultimate appeal to the courts is provided.

5. **Uses other than grazing**

At the boundaries where the lands administered by the Bureau and Service come together there are sizeable areas that are very similar. As one moves away from the boundary line, however, differences in the land become emphasized. One might reasonably expect that, in total, the policies of the two agencies with respect to uses other than grazing would be different in emphasis.

The national forests were originally reserved to provide federal supervision of products other than forage, primarily. In fact, the use of grazing is not included in the original purposes of the withdrawal act.

In line with the objective of the greatest good to the greatest number in the long run, the Forest Service applies two basic principles in the management of national forest resources.

One is the principle of sustained yield . . .

The other basic principle is called multiple use. A given unit of forest land may at the same time produce timber, forage for livestock, and big game range. Most of the land may be an important watershed. There may be choice recreation
spots; there may be mineral deposits or water-power sites; there may be outstanding scenic values . . . multiple use management looks to the coordinated development and use of all the resources and values of the land. (268, p. 1)

In order to carry out a program of multiple-use, the administrative and supervisory personnel need to be competent in many distinct disciplines. It has been the tradition of the Service that its personnel do not lack in confidence. A very high *esprit de corps* has been maintained distinct from other federal agencies. It is one of the few agencies outside the military forces that has its own uniform, for instance. The following statement of a forest official is typical of the characteristics the Service has come to expect in its personnel:

The U. S. Forest Service must be able to accurately evaluate or appraise the relative worth to the public of the several resources which the land areas offer. I do not necessarily mean an appraisal in dollars. Spiritual and aesthetic values represented by wildland scenery, trees, water and wild life are just as tangible as the things we reduce to timber receipts and grazing fees, but we cannot safely measure them by the same standards. Never-the-less, the wildlands manager must have sufficient keenness of perception to accurately gauge all of these things, and not upon the basis of current conditions, but upon the probabilities of all time public needs. And out of this comes the dictum that each public wildland area shall be managed for that use or combination of uses which promises to yield the greatest permanent benefits to the greatest number of people. (201, p. 833)
Maintaining a high degree of confidence in the correctness of decisions that demand such super-human powers of perception is undoubtedly one of the things that has led the opposition to charges that "multiple user has become a shibboleth" and that "multiple use attempts to conceal the lack of management and mismanagement that have resulted from a failure to designate the one most valuable use and manage them primarily for that use" (190, p. 105).

The Department of Interior has traditionally held to the functionalized administrative organization for the management of natural resources with each agency administering a special use. The supervision and discipline are by functions in this case, as compared with the area administration of the Service. With the organization of the Bureau of Land Management in 1947 the trend has been toward closer coordination of the uses, resulting more in a multiple-use approach. In 1952 the Bureau collected nearly 65 million dollars from users of which about 51 million dollars was from mineral leases and permits, about 2 million was from grazing permits and leases, over 1.1 million was from sale of timber, and nearly .7 million was from sale of land (231, pp. 92-93).

In comparing the important public land management agencies in New Mexico, Holmes stated:
The National Forest Service occupies a political position somewhat different from that of the state land office and the U. S. Bureau of Land Management. The state office may be likened to the spearhead of a pressure group, while the Forest Service, to its occasional discomfort, frequently serves as a battleground for a number of conflicting interests. The Land Bureau tends to react more like the state land commissioner's office. It is closely tied to and tends, at the lower levels particularly, to identify its interests with those of the group being served and regulated . . . . There are, however, significant differences between the state offices and the Bureau. Game interests are generally better protected by the federal agency, also, the Bureau attempts to balance equitably the interests of the commercial and the several classes of non-commercial users. (100, pp. 8, 17)

The problem of multiple-use will be discussed in greater detail in Chapter XI at which time we will consider the nature of the alternative uses and subject them to economic analysis using our maximizing criteria.

6. Pricing and distribution of timber cutting privileges

The majority of timber sales from land administered by the Bureau are "small, unadvertised sales for the benefit of local people" (272, p. 35). Sales from the public domain must be advertised when the value of the sale exceeds 1,000 dollars. In 1952 there were 1,901 free-use permits with an average value of timber of 126 dollars per permit (231, p. 63). During the same year the average value of timber sold was 1,828 dollars per sale (231, p. 65). This does
not include the sales from the Oregon and California and Coos Bay lands where the bulk of the timber sales originate. Most of the sales from these lands are large sales and are advertised and open for bidding. There appears to be no established preferences in disposing of timber cutting permits.

On the national forests, timber sales in excess of 2,000 dollars must be advertised and sold at competitive bidding (253). The Sustained Yield Unit Act of 1944 authorizes cooperative management of federally owned and private forest lands. "One such cooperative sustained-yield unit has been established by the Forest Service" (272, p. 35). In 1946 the Service made a 100-year agreement with the Simpson Logging Company providing for unified management of 270,000 acres of federal and private woodland in the northwest. The Simpson Logging Company agreed to follow the logging practices and silvicultural recommendations of the Service; in exchange, they are to have the privilege of cutting timber on the national forest without bidding. The value of the timber is to be determined by Forest Service appraisal (68).

There is an inconsistency in the Service's policy of distributing products with respect to forage, on the one hand, and timber, on the other. We noted the definite bias in its policy of distributing grazing privileges in favor of
the small operators. The following official statement indicates the opposite bias in distributing timber cutting privileges.

Small mill operators seldom own their own timber, but purchase logs or stumpage from hand to mouth. Few of them use good forest cutting practices. Because of these factors, and the ease with which the business may be entered by persons of limited financial and business qualifications, small mills are a continuous threat to the growing stock in any locality. . . . New information from field surveys emphasizes how much of our timber supply problem lies with the small holdings. (256, pp. 28, 32)

The Service has associated bigness in the use of grazing resources with "monopoly" and with the destruction of our national natural heritage" (243, p. 163). In the use of timber resources, however, it holds that bigness is necessary to protect the resource from the "destructive forces of cutthroat competition" that characterizes the competitive activity of small firms. It seems doubtful if the nature of economies of scale of the two industries warrants this difference in policies.

B. The Soil Conservation Service¹

Most of the federally owned land in the western range area that is administered by the Soil Conservation Service

¹As of November 2, 1953, "The management of publicly owned lands administered under Title III of the Bankhead-Jones Farm Tenant Act" (258, p. 2) was transferred from the Soil Conservation Service to the Forest Service. The policies
(about 6 million acres)² is administered under authority of Title III of the Bankhead-Jones Farm Tenant Act of 1937, which provided special authority for a program of federal purchase and development of land that was considered sub-marginal for cultivation. Land acquired in connection with the land-use adjustment programs of the National Industrial Recovery Act of 1933 and the Emergency Relief Act of 1935 were transferred, finally, to the Soil Conservation Service. This land is located in "land utilization projects" predominantly in the Great Plains Region.

The Soil Conservation Service apparently offers considerable local autonomy in the establishment of the basic issues of pricing of the lease or permit and the standards for distributing the grazing privilege.

In order to provide any semblance of management or security of tenure in some cases requires the control of all of the land in one organization, preferably an organization of local users of the land. These organizations can either be outlined in this section are those that were developed and followed by the Soil Conservation Service. Up to the time of the final writing of this study no new statements relevant to management of these lands has been forthcoming from either the Department of Agriculture or the Forest Service.

²Estimated from Table 17 of Davidson (48, p. 72).
grazing associations, cooperative state grazing districts or soil conservation districts. More than 70 per cent of the land under the jurisdiction of the Soil Conservation Service is leased for management to such local organizations. (273, p. 3)

The distribution of grazing privileges is made according to a preference system which is developed separately for each project, which, in addition to the "standard citizenship requirement" is based primarily on the following standards (273, pp. 4-5): 1. The minimum size of unit believed necessary to provide an adequate living. This is the size up to which special efforts are made to build all operators. 2. The maximum limit or the size above which the project will not help an operator build by allocating to him additional preferences. 3. The location of applicant's home, or his commensurate property in relation to the project in order to qualify for use privileges. 4. Base period and prior use. The necessary standards for each area are developed in consultation with local leaders and groups, and in consideration of local conditions and the Soil Conservation policies.

Although a "preference" entitles the holder to special considerations over other applicants it does not convey any legal rights to the use of the land. "A preference, once
established, runs on year after year unless voluntarily re­
linquished" (273, p. 4).

Policies with respect to range improvement appear to be quite flexible. By nature of its primary function the Soil Conservation Service would be expected to more actively participate in such things as tree planting, range reseed­
ing, etc. As of December 31, 1951, it had completed 903,700 acres of range reseeding, 13,182 miles of fences, had planted 45,815 trees, and had developed 4,953 separate stock water sources (273, p. 2) on all of their projects in the United States since 1937.

The prices of their products are also flexible. The grazing fees are "geared to the prices received by the stockmen", but are influenced by some estimate of the "value of the privilege, customary charges in the area, and chang­
ing economic conditions" (273, p. 5). There are products other than range forage. The woodland products are gener­
ally sold on the stump to the "highest qualified bidder".
(It is apparently a question of judgment as to which bidders are "qualified".)

The intensively developed recreational areas are operated by concessionaires who obtain their contract by a bidding procedure. Charges con­
sistent with customary rates are made of the users of the recreational facilities by the concession­
aires, of which a bid percentage is paid the government. (273, p. 4)
C. Bureau of Indian Affairs

The Bureau of Indian Affairs administered roughly 44 million acres of pasture and range land in 1950 (48, p. 10). Although this land is usually included in the statistics of federal land, it is really owned by the several Indian tribes (remainders of the old Indian nations) and is held in trust by the United States.

The primary objective of the Bureau is, supposedly, to help the Indians improve their basic standards of living so they can assume the role of "first class" citizens. The part played by the Indian lands in this process is neither clear nor consistent. On most reservations there is a land surplus under present use by the Indians which is made available to non-Indians. Although more than 4,000 statutes and treaties affecting federal supervision of Indians and their lands have been recorded, there is still considerable latitude in policies under which those lands are leased.

Grazing lands in excess of the immediate needs of the Indians are contracted by lease for small acreages and by grazing permits for larger acreages. By law the maximum period by either type of contract is five years. Leases are generally on an acre basis by the tract and permits on a permitted number of livestock at a cash rate per head. Permits are for year long or seasonal use. All contracts contain provisions to protect the land from excessive grazing. Permits particularly contain stipulations for additional
measures to provide for land protection, maintenance of stock water facilities, etc. Development of stock water facilities is encouraged. To this end, assistance is rendered in locating, designing, and under some conditions in the actual construction. (227, p. 2)

With the current increase in Indian population, which is more than matched by a resurgence of their spirit, a time may be approaching when they may want to use their own lands directly. The Bureau is beginning to initiate a planned program of withdrawal of federal supervision (227, p. 1). Except where otherwise stated, we consider the leases of Indian lands to be more nearly as private land leases.

D. Other Federal Agencies

In addition to the previously mentioned agencies, the Bureau of Reclamation has about 10 million acres in the Western Range Area that have been acquired or withdrawn from entry as being susceptible to irrigation in connection with contemplated irrigation developments. Of this, about 2.0 million have been turned over to the National Park Service Administration to operate; some 5.8 million acres are managed under cooperative agreement with other federal agencies, chiefly the Bureau of Land Management and the Fish and Wildlife Service. The "Forest Service provides forest
and watershed management of timber and range land at reclamation reservoirs within national forest boundaries" (48, p. 8).

The Fish and Wildlife Service controls nearly two million acres in the Western Range Area and nearly 14 million acres are under the jurisdiction of the military forces.¹ There is some overlapping of these two agencies, however. Use for grazing of domestic livestock is incidental to their primary use in both of these cases.

The Bureau of Reclamation is influential in the West to a proportion much greater than the proportion of land under its jurisdiction. As originally established the funds available for construction of irrigation projects were quite limited, but both of these limitations have long since been removed. Large sums of money have been proposed for the construction of multiple-purpose dams in the West. These projects have impacts on the economy of the western range region and the entire economy of the nation, the importance of which is hotly debated. Some of the important economic issues of water resource development will be discussed in Chapter IX.

¹Derived from Table 17 of Davidson (48, pp. 72-77).
E. State-owned Land

There are approximately 50 million acres\(^1\) of land in the Western Range Area that is owned by the states that are not reserved for state parks, institutions, game reserves, etc. This land is administered by the several state land commissions, which are either elected or appointed. Very little attention has been given by research workers to the use and status of these lands. Holmes found that for New Mexico, which has far more state-owned land than any other state, the level of management was quite low, and that the "political orientation of the land office toward the livestock industry" (100, p. 6) was evident.

In general, state-owned lands are of higher productive capacity than are federal lands. From what little information is available on these state lands, it appears that the ownership pattern is very scattered and that the units are too small for any kind of intensive management. Most state land commissioners lack the authority to acquire parcels of land either by purchase or barter in order to organize

\(^1\)There are 53,727,000 acres in the 17 western states, and 43,788,669 acres in the 11 western states (48, pp. 95-96). Data for the Western Range Area have not been tabulated separately.
operating units that would permit more effective supervision. Most of their land is leased to individual livestock operators and these leased lands become a part of the operator's "base" property in determining commensurability for other public land. Those tracts of land that are not leased to private individuals are leased to some grazing association or district. The fees are different by states. The states also differ in their policies of range improvement.

F. Grazing Associations and Districts

The first attempts at group tenure in the West were the early mining districts where miners banded together to form an "extra-legal" association through which they enabled themselves to trespass upon the public domain without fear of being molested by a fellow trespasser. Of these mining districts, McGowan wrote:

Though the mining districts were in existence for little more than a quarter of a century, they served a tremendous need in their time, and left no small heritage to the future . . . .

They definitely established the principle that the prior appropriator of public owned land and water shall have prior rights to use the property without regard to location.

. . . they also established the principle that he who attempts to claim a right to use the
public domain or the water on it must constantly use it; otherwise, it will be subject to appro-
priation by others.

... They gave us our present law of western water rights. (146, p. 63)

The Rock Springs Grazing Association - a stock company operating in Southwestern Wyoming - was organized over 40 years ago and is no doubt the oldest grazing association still in existence. Its purpose is not dissimilar to the early informal livestock associations - that of securing continued control over the range lands that its members use. By obtaining control of the railroad-grant lands in the Rock Springs Area, the Association obtained control of approximately two million acres of winter sheep range in the Red Desert of Southern Wyoming. The federal land used by the Association is leased from the Bureau. "Each share in the corporation is rated as commensurate for 1,696 animal units" (138, p. 44), which is quite different than the usual procedure of basing grazing permits on feed and water directly.

The Mizpah-Pumpkin Creek Grazing Association, as mentioned earlier, was formed on somewhat of an experimental basis in 1928 as an unincorporated group. Out of it came the Montana Grass Conservation Act which provided special state legislation for the incorporation of grazing associations. It empowered grazing associations
... to acquire forage producing land by purchase, lease, or otherwise from private owners or from State, county, or Federal agencies; to control and manage range use by means of preferences, permits, and allotments; to acquire or construct fences, water facilities, and other range improvements; to specify the breed, quality, and number of male animals turned into common grazing areas; to fix the amount of grazing fees and assessments on range users, and hire range riders and other employees; to purchase or market livestock, livestock products, equipment and supplies; to undertake reseeding and other range improvement practices; as well as to conduct other fiscal and management practices necessary for the general purposes of grazing-district operation. (138, p. 6)

In some states, particularly Nebraska and North Dakota (282, pp. 19-20), the soil conservation districts exercise management control over range lands. In this case, the grazing district, since it is the soil conservation district, becomes a legal subdivision of the state, and all owners or land users within the district are members and must participate. Like the Montana grazing district, these soil conservation districts can be formed only after formal hearings and a "referendum of all occupiers" (138, p. 7). In other cases the powers of the grazing association are limited to the general powers of corporations, the most important being those pertaining to trespass. In most of the western states where grazing associations are important, the cooperative or corporative association prevails (64).

Group tenure appears to be most successful in those areas where there is a complex pattern of land ownership
of county, state, federal, and absentee private ownership. The association may achieve control of considerable blocks of land by purchase, private land lease, public land lease, or memorandum of understanding and thereby achieve a greater degree of security of tenure expectations and greater efficiency of operation than could be obtained individually. By broadening the land area over which particular decisions relative to range use and improvements are made the off-site benefits and costs are diminished so that the full consequences of a particular decision accrue more nearly to those making the decision. The overhead costs of large equipment necessary for some types of range improvement can be met by the association that could not be met by any individual. Loomer and Johnson concluded from their study of group tenure in the Northern Great Plains that

Group tenure also offers the benefits of lower rentals and grazing fees. State and county lands are generally leased at lower rates and better terms to groups than to individuals because the tenure group assures land owners of greater stability of income and better land use. Group enterprise has the advantage of increased bargaining power.

From the viewpoint of the land-managing agency, the advantages of group tenure are of three general kinds: educational, advisory, and administrative. (138, p. 45)

Where the public land in an area is in large blocks, constituting a large part of the area, the advantages of the
grazing association diminishes. Control by a public agency, acting on the recommendations of the advisory group of the association representing the users, appears to be more effective (138, p. 46), especially where the advisory group is given an influential position. Where uses other than grazing become very important, such as on most areas of the national forest, control by the grazing association (or any other group representing a single use) seems neither likely nor judicious. The advisory boards have not been very influential in most cases of this kind because the advisory boards represent only one group - the livestock producers.¹

As to whether or not a reconstruction of the advisory board to provide a balance of power between the different users of the resource would add to the usefulness of the board is debatable. To the extent that the recommendations of the board become the decisions of the agency, the focal point of political pressure would undoubtedly shift from the agency to the advisory board. However, from the standpoint of education and public relations, this reconstruction of the advisory board may be very helpful. Local competitive users could participate in the administrative process in an advisory capacity and might tend to settle their own

¹See footnote p. 155.
problems among themselves in a manner most acceptable under the local circumstances.
CHAPTER VIII
PRICING OF THE FACTORS

One of the assumptions underlying the necessary marginal conditions for maximum welfare is that the factors and products are priced so that the market is cleared of all factors and products that are offered at that price and that no demand at that price goes unsatisfied. Previous mention has been made of the important role played by the pricing mechanism in allocating the factors of production, but we also pointed out that in the area of public land resources some of the factors are allocated in a milieu of rationing and price fixing. In this chapter we desire to examine the extent to which the above assumption holds and to discuss some of the implications arising out of the present pricing system for rationed factors and products.

A. Price of Land

1. Malpricing of forage

Evaluation of range land is difficult because of the degree to which variable climatic forces affect the yield of forage. It is further complicated by the lack of seasonal
homogeneity of the forage so that the value of forage for one season depends, to a large extent, on the availability and cost of forage for the other seasons. If one has access to spring, summer, and fall range at a very nominal fee, the land furnishing the winter forage can absorb all the surplus from the others. Vass shows that

... 12 animal unit months of feed on Wyoming ranges varied from 60 cents on Taylor Grazing District land to $5.29 on privately owned lands during 1940. ... We find one rancher paying three to eight times as much per cattle unit for his forage as his neighbor, due to this tax and investment free policy of the Federal Government. ... This complicated land ownership pattern in the state is a more important factor in influencing profits and losses in ranching than all management factors combined. (276, pp. 534-535)

In 1949 the grazing fee per animal unit month was eight cents for the Bureau of Land Management, 49.0 cents for the Forest Service, 39.3 cents for the other federal agencies (48, p. 38). The cost for forage on privately owned land is very difficult to determine. If the land is rented from private individuals, the cost is, of course, the contractual rent paid for the use of the land. But the market for renting isolated tracts of privately owned land in the western range region is very imperfect, making the "sales value" or "income value" methods (155, pp. 194-198) of determining land costs of doubtful value. If the land is owner-operated it becomes equally difficult to determine
its value and annual cost, other than taxes. Generally speaking the land has no alternative uses other than grazing and return to a particular tract of land may be dependent on joint use of other parcels of land.

The market rate of interest may not be the gauge by which the operator determines whether or not to invest in private range or ranch land. Objectives other than high financial return may attract, and hold, investment capital in ranching in some areas. It was the flow of capital from non-agricultural sources - from doctors, successful businessmen, etc. - into the ranching business, both for purposes of investment and recreation, that led Holmes to conclude: "All of the land, whether held by user or non-user, carries a burden of capital which has been found as difficult to support as Sinbad found the Old Man of the Sea" (100, p. 34).

The high progressive personal income tax rates might increase the pressure of outside capital in ranches that offer scenic and recreational services irrespective of the possibility of economic return.

a. Need for adjustment in pricing policies. Because of differences in location, topography, and productivity of the land under different administrative agents (and differences in the degree of control of the land resource that accompanies the permits and/or leases from the different
agencies), some price differences should be expected. However, it is doubtful if the above price differences really express any differences in the quality or quantity of what is being purchased in an AUM of grazing. Price differences as great as those shown above lead to increased pressure on public land administrators by private operators for grazing permits, over-capitalization of private lands giving control of surrounding public lands, and distortion of resource allocation away from optimum.

Loomer and Johnson point out some of the ramifications of this maladjustment in forage pricing from their study of group tenure.

The difficulty that some districts have met because of the practice of different public agencies charging different fees for grazing lands under their control and supervision causes some concern. For instance, a grazing district may pay 8 cents per animal-unit month to one agency, and 18 cents per unit to another agency for land of approximately the same quality. Consequently, an individual member who operates largely on the cheaper land must pay the district a weighted average fee that is actually somewhat greater than the 8-cent fee that would be charged if he dealt directly with the agency. It is reported that in some districts this situation has become so acute that there is danger of dissolution of the district for this reason. (138, p. 49)

In his study previously alluded to, Holmes (100, pp. 11-12) points out that ranch lands giving access to public land grazing permits have a high capitalized value that does not seem to associate with lands that are adjacent to privately
leased land. He concludes that this is due to the extremely high degree of security of tenure expectations associated with the leased public lands that is not associated with the leased private lands. Pingrey (170, pp. 17-18) agrees with this, in part. It appears to this author that the inference emphasizes the wrong forces. Some security of tenure expectations is a necessary condition, but not a sufficient condition for such a capitalization process. Another necessary condition, and one which seems more important, is that the rent or grazing fee be considerably below its marginal value product. This distinction becomes very important if one is looking for recommendations for corrective action. It is suggested that adjustment of the grazing fees and not a lessening of the security of tenure expectation is the proper solution in this case.

The important arguments against pricing forage according to the marginal value of its product are of two kinds. First, determining the value of the marginal product is not feasible for all situations. Even if a value of marginal product schedule could be quantified for each situation, political acceptance of such a pricing mechanism seems unlikely, since our factor markets frequently are not so much in terms of value of marginal product as in terms of value of average product for each quality or grade of a particular resource. This tends to be true of labor, capital, transportation,
machinery, and most of the things ranchers buy. Pricing according to value of marginal product would require the consideration of a great many variables with a vast number of relationships among the variables. It would require prices to fluctuate considerably with seasonal supply and demand and with changes in the elasticity of expectations. Highly fluctuating prices may actually make planning of purchases by producers and consumers difficult, and since the virtue of the marginal principle is that it aids rationality, nothing is gained by "pushing it to the point where it makes rational choice difficult" (47, p. 205). Many industries and agencies resort to the practice of using routines and formulas that make factor prices relatively stable in the short-run (7, pp. 258-259).

Nevertheless, if factors are to be allocated rationally by prices there should not be 1. an undesirable quantity of unused factors (available for use at that price) for which there would be a demand at a lower price, or 2. a substantial unsatisfied demand at that price. As to what constituted an "undesirable" quantity of unused factors would depend on the degree of instability and uncertainty inherent in a given situation. It appears evident, from the previous discussion, that a "substantial unsatisfied demand" exists for forage from government lands at the present time.
The second argument against pricing the cost of the forage according to the marginal value of its product is that it would alter the established pattern of land costs in a range region. Whenever land is made the basis for disseminating any social benefits or subsidies over time, the expected future benefits are siphoned off by the land owners contemporary with the initiation of the subsidies. In many cases, the present land owners have paid quite dearly for the lands or livestock that gave them access to the federal grazing permits at a low cost. To raise this fee now would require a double payment. If this argument be granted weight, it could be used to justify the continuance of almost any program (government or otherwise) once it got started, regardless of the soundness of the program. The argument may be nullified by the use of the compensation principle.¹

b. Determining the price of forage. The important essential variables giving rise to the price of a grazing fee are: 1. quantity and quality of forage production and the production coefficient rate at which grass is transformed into meat (these roughly can be expressed as carrying capacity in standard terms of animal unit months of

¹This will be discussed further in Chapter XI.
feed	extsuperscript{1}; 2. price of the livestock products; and 3. cost of resources, other than forage, associated with animal production. It may not be easy to reduce all of these to a formula that can be applied generally to determine the price of the grazing fee. Clawson (34) preferred the ranch budget as the basis of land evaluation, capitalizing the expected profit into land values, provided this did not result in making the cost of the forage higher than the next cheapest alternative source of feed. He would use market rates of interest for determining sales and lease values of range land. As discussed previously, market rate may be less meaningful to the operator than an "opportunity cost" rate. The use of individual ranch budgets by the land administrators may be much more difficult, politically, than a less refined analytical device that could be found acceptable. What apparently is needed is a formula that can be somewhat standardized for specified administrative areas, and which will allow the important variables to influence the grazing fee.

(1) A suggested formula for determining range land values. After several years of studying ranch organization and investments Vass (274) used the following formula

\footnote{Some of the limitations of the animal unit month of feed (AUM) are discussed in Chapter XI.}
to determine the "long-time" investment in range land per animal unit:

\[ I = 66 - \frac{36 (cc - 60)}{100} \]  

(V)

where \( I \) is the investment in land per animal unit that the "average" rancher can afford to have invested in land the carrying capacity (cc) of which is 60 acres per animal unit for 12 months of feed. The \( \frac{36}{100} \) represents his estimate of the capitalized value of the discounted stream of surpluses associated with a unit change in carrying capacity. As the amount of land required to carry one animal unit increases, the total worth of that land becomes less, ceteris paribus, because of less efficient utilization of the forage, higher operating costs, lower calf crop, etc. Vass does not show how this incremental value was determined, but the formula considers it as a linear function of carrying capacity.

In working with Vass, the author devised the following formula for determining investment in range land per animal unit.

\[ I = ABe - r (cc - d) \]  

(VI)

where \( A \) is the "average" investment in land that is associated with the standard carrying capacity \( d \); \( B \) is the price
of livestock products sold during the period in question (usually this will be the previous year) expressed as a percent of the price received during the selected base period; e is the constant base of natural logarithms, 2.718; r is the estimate of the natural logarithmic functional relationship between changes in land values and changes in carrying capacity. Vass has estimated the variables of the formula to be

\[ I = 66e - 0.007 \times (cc - 60) \]  

(VII)

for "average long-run" investment.¹

It is suggested that formula (VI) provides a logically sound basis for determining grazing land values, since it 1. considers the quantity and quality of range forage (cc), 2. permits a nonlinear estimate of the value of marginal product per AUM associated with each unit change in cc, and 3. considers the relative price of livestock prices. In connection with the latter consideration, the procedure used by the Forest Service (discussed in the previous chapter) ignores changes in the cost of resources other than forage that a rancher has to pay. It assumes that the ratio of changes in costs to changes in prices received is a

¹From unpublished data in the files of the Department of Agricultural Economics, University of Wyoming.
constant. Where deviations from this become significant adjustments could be incorporated into the formula by the use of appropriate indices. There is need to work out the \( A, r, \) and \( d \) variables of the equation for areas that are essentially different in their ranch organization. The \( A \) and \( d \) variables could be obtained from reliable ranch and range surveys, and \( r \) could be estimated by means of budget analysis. The \( c_c \) would be obtained separately for each range site by range technicians.

(2) Determining grazing fees. In those cases where land is to be sold for grazing purposes, the suggested formula may be helpful in determining the sale price. This could be used equally well for private or public grazing land. However, it does not, by itself, determine the grazing fee, although it does provide an evaluation on which to base the grazing fee. Using land values determined by his formula, Vass computed feed cost per animal unit by figuring interest (at 5.0 per cent) and taxes (at 1.25 per cent) on the land values. He claims that the values he arrived at were based on private ownership where the operator had "complete control and management" and could plan for the future "without interference". He considers the public domain lands to be worth less than this to the ranchers. Based on the opinions of the ranchers, he placed the value of forage from public lands at about one-third to one-half the value of
that from deeded land. For a particular tract of land with a carrying capacity of 30, the capitalized value per animal unit (per 30 acres) would be 76.80. The animal unit fee (based on 6.25 per cent of this) would be 4.80 dollars per year or .40 dollar per AUM (274).

It is not necessary to determine values of public lands to determine the grazing fees. They can be computed directly from estimates of the total value of the product produced. Campbell and Wood (26) reported on a system used by the Canadian government where the fee was determined by

\[ F = \frac{1}{10} \left( \frac{250P}{cc} \right), \]

where \( P \) is the price of beef in Calgary for the last six months of the previous year. The fraction \( 1/10 \) was the share of the value of the forage that was to be retained by the government. In this case, \( F \) is the grazing fee per acre. If \( 250P \) is to represent the actual contribution to total product of the forage during the summer months, it leaves very little product to be attributed to the other resources used through the year, since most ranches do not produce more than 290 to 320 pounds of beef per year per animal unit. The formula makes no adjustments for differences in the total value of the forage caused by differences in carrying capacity, which seems a weakness when applied to areas having different carrying capacities.

The share of the forage to be retained by the government (1/10 in this case) would have to be determined on the
basis of the objectives of the pricing policy. If the policy objective were to price the forage from the public land according to costs of forage from comparable private lands (as is here proposed), then the original problem of determining the relationship between land values and carrying capacity needs to be faced. We then must agree on an acceptable rate of interest. We have thus gained very little from the latter formula.

The pricing of the grazing fee or lease must consider the demand for and supply of range resource products. The impact of technology on forage productivity will increase the specialization of land use and productive capacity of land that is level and otherwise suitable for renovation. It probably will lower the demand for grazing on other lands.

2. Property taxation and federal payments in lieu of taxes

A vital part of the problem of pricing the factors (products) sold from the federal lands has its roots in inter-governmental fiscal relationships of the federal, state, county and local governments. Both the federal real estate and federal activities are very unevenly distributed among the thousands of units of local government, particularly in the so-called "public lands" states of the west. The Senate Committee on public lands reported in 1947 that the valuation
of federally owned lands as estimated for assessment purposes expressed as a per cent of total assessed valuation of private real estate being taxed, varied "from less than one per cent in 5 states to 76 per cent in the State of Nevada . . ." (157, pp. 4-5). The recent report of the Council of State Governments to the Commission on Organization of the Executive Branch of the Government presented the problem this way:

How can the National Government carry on its operations and hold property without imposing special burdens upon taxpayers of communities where the operations or properties are disproportionately large? (251, p. 114)

There are two different problem situations. The first arises from the large land holdings of the federal government that leave very little property tax base in a given county or district; the second arises from a concentrated governmental activity, like the construction of a reclamation project, that throws extremely heavy demand on the local units of government for schools, etc., without providing any increase in the tax base. The attitude of many officials of local and state governments are expressed by the following statement:

History has shown that the cost of state and county government increases to the private landowner as the area of public land increases. This is partly due to the fact that Government employees often live on government owned land, in Government owned buildings, use Government
owned cars, etc., while the cost of education of their children, expense of law enforcement on Government lands and many other costs of local government must be borne primarily by property owners. (249, p. 174)

We will consider only the first problem situation above, since it is directly connected to the over-all pricing problem. Involved, directly, are the considerations of obtaining greater justice among taxpayers, questions of determining the basis for justice and of determining when justice has been best met. The literature on this subject, as well as the proposed legislation (some of which has been passed), would indicate a definite consciousness of social injustice to many local communities because of a lack of property tax base. However, we will concern ourselves, primarily, with those policies and practices that tend to interfere with economic efficiency in the use of resources as specified by our maximizing criteria.

Although much of the federal land has never been on local and state tax rolls, there have been substantial federal acquisitions of land that was once taxable. The communities, including the local governments, schools, and roads, were patterned after the communities further to the east under the expectation that the land would be entered on and settled by private, tax-paying citizens. Where, as the result of government reservation and acquisition, or
by failure of the land to be settled under the inadequate land laws, much of the land is not on the tax rolls, the cost of private ownership, in terms of property taxes, is high. Where the ownership of land gives access to public land at a very low fee, compensation tends to be made. Where this is not the case, the cost is definitely a handicap (275).

To partially alleviate this situation Congress has approved a policy of having the administering agency pay to the states a specified per cent of total receipts in lieu of taxes (239). In most states these payments are considerably below what would be received from taxes if the land was in private ownership. The National Education Association's Committee on Tax Education and School Finance has estimated that if the federal land in Fremont County, Wyoming, for instance, were to be evaluated according to comparable land in the county and assessed at the average of assessment of private land in the county, the federal government would pay the county $570,553 dollars annually. The county actually received, in lieu of taxes, $22,469 dollars for the fiscal year ending June 30, 1948 (157, pp. 135-137).

The Federal Real Estate Board, after careful study of the problems involved in federal payments to state and local
governments because of federal real estate, offered the following general principles:\(^1\):

The underlying objective in developing these principles is to bring about substantial equity between the local and federal taxpayer. The cost of national functions and programs should not impose an undue burden on local taxpayers through federal-tax exemption; neither should the federal taxpayer be required to support unjustified subsidies to the localities containing federal lands. . . . In order to achieve this objective, it is believed the following principles should govern:

1. Each class of real estate, according to the general character of its use, should be considered separately . . . . No blanket formula could possibly bring about the desired balance between the local and federal interest.

2. The amount of the federal contribution should take into consideration the extent of the actual tax loss, the benefits to the local community from federal ownership, and the effect of federal ownership on requirements for services to state and local governments . . . .

3. Where the determination of the tax loss and other factors with respect to each taxing district concerned is difficult or impossible, and where the real estate in question is revenue producing, contributions on a receipts-sharing basis is a practicable alternative . . . .

4. Federal contributions ought not to be made to specified local jurisdictions in such a way as to encourage perpetuation of undesirable or unnecessary units of government or to impede reforms in the organization and functioning of local governments . . . . (241, pp. 12-13)

\(^1\)Quoted also by the National Education Association (165, pp. 149-150).
Although the above four considerations are based on the objective of achieving equity among taxpayers, they apply with equal validity if economic efficiency in resource utilization is our objective. Following the suggestion of the Board's first principle, we will consider the resources administered by each of the important management agencies separately.

a. Federal payments for resources administered by the Bureau of Land Management. Since the Bureau was established it has provided four distinct sources of revenue to states and counties: The Mineral Leasing Act receipts, receipts from the sale of land, O and C and Coos Bay land receipts in Oregon, and Taylor Grazing Act receipts from grazing lands.

The mineral leasing acts of 1920 and 1927 specify that 37-1/2 per cent of the royalties, bonuses and rentals obtained from leasing land bearing oil, gas, coal, potash, phosphate and sodium, be paid to the states, and that 52 per cent be paid into the reclamation fund. The states may use their portion for roads and for public educational institutions in the state. For the fiscal year ending June 30, 1948, 9,496,300 dollars was returned to the 11 western states from the mineral leasing fund. This was about one-third of the total amount to these states from all public
land funds from all sources (157, p. 148). All but about 600,000 dollars was returned to four states, with Wyoming getting 3,386,398 dollars.

The trend in political philosophy for many years seemed to be toward considering the mineral resources of the nation as the general property of the republic to be distributed among all states, regardless of the state in which it was located. This trend has certainly been reversed by the present administration with respect to the "tidelands" oil off the coast of California, Texas, and Louisiana. As far as the author can determine, the issues involved in the distribution of the mineral lease funds of the Bureau are essentially the same as those involved in the current "tidelands" oil dispute.

Five per cent of the funds received from the sale of public lands are returned to the states. In the last three decades this has become a mere token, and, without exception, has been "credited to the permanent school funds of the states" (157, p. 158).

Section 10 of the Taylor Grazing Act as amended in 1947 requires that the federal government pay to the states from

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1For a brief summary of the history and review of the issues involved see Appendix A of the National Education Association report (157, pp. 186-192).
which the receipts originate 50 per cent of the revenues from leases of lands outside the grazing districts. For lands within grazing districts the breakdown of the fee is quite different. At the insistence of the range users, and their official Washington representatives, the Bureau held that the grazing fee should be determined solely by cost of administration. Since products other than forage were also administered by the Bureau, then only a pro-rata share of the administration cost should be considered in determining the fee. The Bureau of Agricultural Economics was asked to assist in determining the proper division of the costs for administration and for improvement of public lands between the grazing and other uses. Their study indicated that "70 per cent of all costs of administration and 89 per cent of all costs of improvements" (244, p. 17) should have been chargeable to the livestockmen for 1944 and 1945.

The Act, as amended in 1947, requires the Secretary to consider the importance of public benefits when determining the amount of fees on grazing district land. As was mentioned in the preceding chapter, the grazing fee for districts is six cents per AUM, and the range improvement fee is two cents per AUM. Only 12-1/2 per cent of the grazing fee is returned to the counties in lieu of taxes. The total amount returned to the states from district fees and from outside leases was only 251,841 dollars, for all the 11 western
states for fiscal year ending June 30, 1948 (157, p. 148). This is considerably below what would have been returned to the states had this property been taxed equally with comparable private property. For the state of Wyoming, for instance, the actual amount returned from Taylor Grazing lands was 66,349 dollars for fiscal year 1948. The National Education Association Committee estimates that taxes from these lands, had they been assessed according to comparable private property in the state, would amount to 753,776 dollars.

The solution to this problem may be that which is used on the reconveyed Coos Bay Wagon Road lands, where full tax-equivalent payments are made (up to 75 per cent of the receipts). This, however, is on land where the timber income is relatively high. The Taylor Grazing lands are not only low in productivity, but the grazing fees are exceptionally low. Three alternative, mutually exclusive, solutions are proposed.

The first solution would be to raise the grazing fee to make it as nearly comparable to its average value product as possible (according to the pricing formula and procedure previously discussed), and then return to the counties full tax equivalent payments to be used at the discretion of the county commissioners. The rate of assessment of public land should tend to be equal to that of comparable private land.
As to whether or not these would be the same in any one year would depend on whether or not some predetermined set sum in lieu of taxes was used or whether the actual taxing process for private lands was used also on federal lands. At the present time this latter procedure is not legally possible. It would require an amendment by Congress plus enabling acts in 14 of the 17 western states (238, pp. 1-23) before this could be done. This procedure would have the affect of materially increasing the grazing and leasing fees. At the same time it would reduce the tax load on private property, and/or substantially increase the value of the local government and community service. Previously it was noted that very high property taxes and low grazing fees both tend toward miscallocation of resources.

The second solution would be to make the adjustment at the county level by switching from a land base for property taxes to an animal unit base, as far as ranches and range lands are concerned. Ranchers with the same number of animal units would pay the same amount of property taxes even though one operated on privately owned land and the other operated on federal land. Administratively, this procedure appears to be more difficult than the former suggestion. Unless some adjustment upward in the grazing fee is made, however, the cost of forage from public land would still be considerably below investment opportunity costs of
owning the land and the malpricing might not be entirely corrected until some grazing fee adjustment was made.

A third alternative solution might be to completely alter the taxing policy from a property base to an income base. This could be standardized on a state basis, for administrative efficiency, with funds being reallocated to counties, school districts, and communities. Under this system, the ranchers who have access to range lands at subsidized rates would, as a consequence, pay more taxes. This method would have apparent disadvantage as far as county and local units of government are concerned. The tax revenue would not be stable over time, nor would it be predictable. This difficulty could be overcome if the government units concerned would be willing and able to carry a reserve contingency or resort to deficit financing when needed. There are important questions of incentives to production when taxes are marginal to production, and other vital fiscal policies that we can neither explore or appraise because of the limits of time and space.

b. Federal payments from resources administered by the Forest Service. The present laws require the Service to return to the individual states 25 per cent of the receipts originating therein. These are to be distributed to counties within which the national forests are located to be used for roads and schools. Ten per cent of the receipts are to be
spent directly by the Service on roads and trails in the national forests where the receipts originated. After a detailed study of the funds returned to counties in lieu of taxes, the Congressional Committee on Public Lands reported, in 1947:

Thirty-nine years of experience with such a system of contributions, the oldest of its kind yet devised by the Congress, makes it possible, from the testimony offered at the hearing, to catalog the following facts and conclusions.

1. Federal contributions to county government are uncertain because the Federal Government is not under duty to create any revenue in which local governments can share . . . .

3. It is obvious that there is no relation between size of the annual payments and the value of the national forest premises . . . .

5. The present act limits the expenditures of contributed funds to public schools and public roads . . . . These contributions should be released for general county budget purposes, thus performing the greatest possible service from year to year.

7. . . . The Forest Service is proceeding, without congressional or budgetary review, to trade cutting-rights to national-forest timber for deeds to private lands, thereby increasing the national-forest acreage. . . . The counties are thereby deprived of the revenue which this Federal timber would produce if sold for cash. Furthermore, the acquired lands pass from local tax rolls, thus striking a further blow at the tax base of local government. (247, pp. 8-9)

The committee pointed out that the success of the Service's present cooperative program of encouraging perpetual forestry on private lands would not be successful unless
stable tax rates could be obtained for the areas concerned. "Such stable tax rates could not exist without equally stable Federal contributions." They recommended a continuation of the conservation program of the Service, but proposed that the public lands be assessable and taxable at the same rates as private property.

The Department of Agriculture has indicated a willingness to go along with this proposal, in effect, and have proposed annual payments to counties based on a given per cent (suggested at three-fourths of one per cent) of the fair value of the forest lands. This is comparable to the average tax rate of real estate for the nation for the years 1942 to 1945 (248, p. 3), although the general trend over time indicates a rate above one per cent may be more realistic (241, p. 50). The Department assumed a fair value of about 5.00 dollars per acre as a preliminary approximation (248, p. 4) and estimated, in 1948, that the new plan would increase payment to the counties of the nation by two million dollars per year over the next 10 years. This would not be true for the West, however, where, for fiscal year 1948, the Service returned some 6.2 million dollars (if the 10 per cent expended on forest roads and trails are included). This amounted to about one per cent of the estimated fair value of the lands computed at 5.00 dollars per acre.
In total, the Forest Service pricing and refund policies seem reasonably adequate. They attempt to price their grazing fee at what it is worth to the user, and to return, in money and service, 35 per cent of the revenue to the counties. In individual cases, however, linking the payments to revenue rather than to inventory value has not provided a satisfactory source of revenue to local governments. We, therefore, endorse the change in revenue distribution proposed by the Department of Agriculture.

Under the present Forest Service policy there will be very few cases in which the grazing fee will provide the cost of administration plus the proposed return to the local communities which means that the federal taxpayer will bear part of the cost. This appears warranted on the assumption that there is a "substantial public interest - local, regional, and national - in the national forests in terms of timber conservation, flood control, watershed protection and recreation" (157, p. 153).

c. **Taxing policies for Indian lands.** Lands held in trust for the Indians and administered by the Bureau of Indian Affairs return no revenue to the government, and none is returned to the local units of government in which these lands are situated. The needs of the Indian wards are, supposedly, furnished by the federal government and no burden should thus devolve to the local governments. The
situation is complicated by an increasing tendency for Indian children to attend public schools, instead of the Indian schools; and by non-Indians operating Indian lands, living on tax-exempt Indian lands, and requiring local governmental services. The Hoover commission recommended:
1. That the Indians be integrated into the rest of the population; 2. That pending complete integration, the administration of Indian social problems be progressively transferred to state governments; 3. That a comprehensive program have as its objection: (a) The transfer of all tribal property to Indian owned corporations. (b) Termination of tax exemption for Indian lands (167, p. 159). These recommendations are, of course, for long-run adjustments. As a temporary expediency the following conditions may be warranted: 1. Providing for in-lieu payments on leases of lands to non-Indians, and 2. "providing more adequate tuition payments for Indian children attending public schools" (167, p. 160).

B. Pricing of Capital

1. The credit situation

The availability and cost of agricultural credit to the western range industry has come a long way since the
1880's when credit was easily available at 30 per cent or higher on the rancher's book count of livestock during the cattle booms, but could not be renewed when cattle prices dropped (39, p. 281). Although the cost of the capital became considerably reduced as the industry became more stabilized, the industry experienced two periods of very painful adjustments due to the lack of adequate credit during periods of severely falling prices - 1920-1921 and 1930-1932.

The Federal Land Bank was created in 1916, but it could not make loans exceeding 25,000 dollars until 1933. In 1933 the Farm Credit Administration was created consisting of: 1. The Federal Land Bank to provide long-term credit through the National Farm Loan Associations; 2. The Production Credit Corporation to extend short-term credit for agricultural production through the local production credit associations; 3. The Bank for Cooperatives to extend credit for cooperative marketing and purchasing organizations; and 4. The Intermediate Credit Banks to rediscount paper of certain credit agencies loaning directly to agriculture.

2. **The credit needs of the range-livestock industry**

The credit needs of the range-livestock industry are revealed by three characteristics that are quite peculiar to the industry. Frist, due to the high variability of
weather and prices, there is a correspondingly high variability of income from ranching. Second, the capacity of the land to produce income depends directly on the availability of livestock to harvest the forage. Finally, the capacity of the ranch unit to produce net income may depend directly on the continued use of the public lands that are currently a part of the unit.

Speaking of the impacts of the variability of ranch income on credit needs Clawson stated:¹

These violent and long-continued swings in ranch income raise serious credit problems for the range-livestock industry. First of all, there is the problem of sound appraisal... at the best, both rancher and appraiser are likely to be swayed by the income of recent years even when they try to consider a long-run average...

Accurate appraisal on a truly long-term basis is the first step, closely associated with it is the amount of the loan which can safely be made. The maximum safe loan is obviously that which can safely be carried with the long-term average income. This limit should not be reached under better than average income conditions, or even under average conditions, for then it leaves no margin for periods of low income...

The timing of loan advances and repayments is also highly important. In the first year or two or three of a low-income period, any deficits in operating expenses, interest, and principal payments can probably be paid out of accumulated reserves, at least for many ranchers. If incomes

remain at low levels for a longer period, it will be necessary to extend further credit. Operating deficits may be incurred, and the value of the collateral will be shrinking. These are not enticing prospects to hold out to the ordinary creditor in asking further advances! . . . No credit agency, subject to having its own funds withdrawn by depositors, would be able to follow such a policy. Yet, unless this is done, the credit agency is not providing the range industry with the kind of credit it needs. (39, pp. 278-279)

To be of greatest service to the industry, credit agencies must not only encourage a high degree of debt liquidation in time of high ranch incomes but probably must have the legal power to insist on it. They also must have the financial ability and legal authority to permit the continued extension of credit at times when no principal or interest payments are forthcoming from the ranchers. In their economic study of the Cannonball River area of North Dakota, Helfinstine and Schaffner concluded there was a definite need for increased agricultural credit. "There is particular need for intermediate credit for production (investment) that would not need to be repaid until increased returns are realized" (87, p. 31).

3. **Credit facilities available**

The credit facilities available to the Western Range Area are essentially those that are available to the rest of the economy. The interest rate charged by banks varied
in 1952 from a low of 5.2 per cent for California to a high of 8.2 per cent for Texas, compared to 6.5 per cent for the United States average, according to unpublished figures compiled by the Production Economics Branch of the Agricultural Research Service. The above percentages were the lowest and highest rates, respectively, for all states in the union. This is somewhat typical of the capital market in the west. Contract interest rates on farm mortgages recorded during March, 1953, showed the Mountain and Pacific states to be higher than the national average, with the Great Plains states generally lower (267, p. 2).

The Federal Land Bank provides loans that cannot exceed 65 per cent of the normal value of the land - normal value being based on the appraisal value in the period 1909-1914, except for special commodities for which normal demand has changed materially since the base period. Interest is generally at 4.0 per cent, and the usual length of the loan is 34.5 years. In periods of low prices they have found it necessary to postpone payments. At the present time their policy seems to be that "foreclosure will not be made as long as it appears probably that the rancher can and will pay interest and principal in the long run" (39, p. 285).

In appraising the production credit associations Murray concluded:
Three noteworthy features of the production credit associations are interest rate competition, available credit in time of emergency, and development of a cooperative credit system. Interest rate competition has been effective in many communities even though the loan volume has not been large. (154, p. 293)

The associations have been much more important in the South and West than in other agricultural areas. They have been particularly successful in the West where the bulk of their loans have been livestock loans (154, p. 291). In many instances the associations are able to meet the needs of the range-livestock industry for flexible payments, as far as intermediate and short-term production credit for livestock are concerned.

The Farmer's Home Administration provides very little capital to the western range-livestock industry. It is well suited to meeting the need for flexible payments and it provides considerable supervision and operational planning assistance to the rancher, but it is severely restricted in the type of loan and the size of unit on which loans can be made.

A need for close coordination between long-run and short-run credit by a single loaning agency grows out of the fact that the land (the loaning base for long-term loans) has no capacity to produce income unless livestock (the loaning base for short-term loans) are present. A long-term loan that otherwise was satisfactory to both the
loaning agency and the rancher could be placed in jeopardy for both if foreclosure on the livestock were made necessary by failure to meet the obligations of a short-term chattel mortgage on the livestock. Better coordination between the Production Credit Corporation and the Federal Loan Board is needed in providing for the integration of long-term and short-term credit.

4. Security of tenure and credit restrictions

The Farm Credit Administration and other loaning agencies have long been recommending that ranchers be granted greater legal rights in their grazing permits. The present situation results in the credit needs, (particularly short-term and intermediate credit needs, which frequently are in proportion to the scale of operation) being out of proportion to the loaning base, as determined by the amount of owned land. If the grazing permits are not saleable or transferable by the rancher, they cannot provide collateral for a loan. This, of course, restricts the availability of capital. The fact that a rancher has access to investment free land does materially affect his credit needs, however.

With the recent increase in ranch loans by insurance companies, many of the companies are giving considerable weight to the existence of grazing permits by emphasizing
the capacity of the ranch to produce income rather than the value of the mortgaged property. It is difficult to appraise the success of the insurance companies in meeting the credit needs of the range-livestock industry, since they have not yet faced a severe financial setback of very long duration. They stress long-time loans and give little consideration to the short-term credit needs in time of financial stress.

A very interesting clause in the Code of Federal Regulations pertaining to grazing leases of the Bureau of Land Management provides a significant deviation from the above policy. It states:

a. A lease may be pledged as security for a loan of $500 or more from a lending agency when the loan is made for the purpose of furthering the lessee's livestock operations. Before the loan is made the lending agency may ascertain from the signing officer the status of the grazing lease and other pertinent information concerning the lease.

b. Upon request of the borrower lessee, where such extension will be in accordance with applicable law and not contrary to the public interest, the lease may be extended for a period of 10 years from the date of loan subject to such terms and conditions as are then provided by the regulations. (43, p. 244)

As it now stands this clause applies only to leased lands under the Bureau of Land Management. Study should be undertaken to see if the policies of this clause should not be extended to grazing permits of the Bureau and Forest Service.
The federal government recently has undertaken a program of financial aid to livestock producers in drought-stricken areas of the United States, administered by the Farmer's Home Administration. A part of this assistance is in the form of emergency credit extended to qualified operators. It emphasizes the need for, and the lack of, this kind of credit, as well as the degree of political activity of this group. It also seems to indicate the direction we are going in our attempts to meet the contingencies arising out of the high weather and price uncertainty that characterizes the Western Range Area. The tendency appears to be to make the conditions necessary to justify emergency assistance less and less stringent. To the extent that this is true, a temporary ad hoc program substitutes for a long-run policy for meeting these problems. Perhaps we need to determine the efficacy of such a substitution.

C. Pricing of Labor

Because of the extreme heterogeneity of population concentration and mobility, as discussed in Chapter I, it is doubtful if any inference on the pricing of labor would be applicable for all localities in the Western Range Area. The composite farm wage rate per hour as of July, 1953, as
computed by the Bureau of Agricultural Economics, showed hourly wages varying from 1.07 dollars for Washington to 0.57 dollar for New Mexico. With the exceptions of New Mexico and Texas, the composite farm wage rate was higher for the 17 western states than for the national average (226, p. 10).

These data omit the variation within states, however. Estimates made from the U. S. census of Agriculture, 1949, compiled cooperatively by the Bureau of Agricultural Economics and Iowa State Experiment Station show some interesting comparisons between type of farming regions in the Western Area. The residual income of all farm labor per worker (in dollars) varied from a low of 612 dollars for the Northern Rocky Mountain cut-over area of Northwestern Washington to a high of 3,978 dollars for the irrigated specialty crops area of Southern Arizona. For most of the range-livestock producing areas the estimated residual returns per worker varied between 1,600 dollars to 2,200 dollars. Of interest, also, in this comparison, is the dollar value of inputs other than labor\(^1\) for the several type-of-farming areas. There is practically no difference

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\(^1\)This was determined by computing interest on capital invested. Interest on land, buildings and machinery was computed at 5.0 per cent of the census value; interest on livestock was computed at 7.0 per cent.
in the capital inputs per worker between Northwestern Washing­
ton and the irrigated area of Southern Arizona. The entire range-livestock region is characterized by high capital inputs per worker, relative to the other type of farming areas.

If one uses the residual income of all farm labor per worker as an estimate of the average productivity per worker, one is impressed by the lack of consistent association between labor productivity on farms and index of wages. The irrigated specialty crop areas of the Southwest, for which a high residual income per worker was estimated, tend to hire migrant seasonal farm labor at prices lower than the average farm wages for the area.

Because of the general sparse population and occasional community isolation, the price and availability of labor in a given locality is severely affected by such economic activity as the construction of a large multiple-purpose dam, the erection of a steel mill, or a new oil strike such as occurred in the Williston Basin. In other areas where the opportunity for work off the farm or ranch is extremely limited, wage rates are relatively low.

There appears to be a difference in the price of labor on large and on small ranches. The prestige of working for a large ranch apparently is quite important to some cowboys
and sheepherders who are willing to work on large ranches at somewhat less than they could make by alternative employment. Regarding the labor relations on the large ranches, Clawson wrote:

The relations between management and hired labor on the large-scale ranches had and have much resemblance to feudalism. The manager ran the ranch in a manner not unlike that of the old feudal lord. Hired cowboys and other men were free to leave, of course, but while they were on the ranch their actions were generally controlled in a manner not customary on smaller establishments. . . . Management of hired labor under ranching conditions was one of the most difficult problems of management. Large-scale ranches were often successful in proportion to their ability to get efficient performance of their hired labor. Ownership and management of this type of enterprise appeal to certain types of men, and it seems probable that many large-scale ranchers have been willing to follow this type of life for much lower financial rewards than they might have obtained elsewhere. (39, p. 223)

As mentioned in the preceding chapter, there are sections in the Western Range Area where the returns per worker are extremely low. This is particularly true of the Southwest in the Indian and Spanish-American settlements. A high degree of labor mobility has prevented this problem from becoming severe in some localities to the north and east. If labor is sufficiently mobile, and sufficiently informed, the marginal productivity of labor should tend to be the same in all areas. This obviously is not the case. It is doubtful if a high degree of mobility is desirable until better
education, social acculturation, and financial assistance for migration can be affected for these very backward areas. In the meantime a sociological and (we would add) humanitarian problem exists in addition to the problem of inefficient resource use.
CHAPTER IX
OPTIMUM PRODUCT COMBINATIONS

A. General Application

Continuing with the marginal conditions necessary for maximum welfare, we will now examine, in some detail, the condition which specified that the marginal rate of transformation between any two products must be equal, for all firms, to the inverse of the ratio of society's preference for the two products. This condition will have important economic meaning in all production processes except those where joint products are always produced in fixed proportions. Absolute joint products rarely exist in agriculture.

The one important case where joint products are produced in the Western Range Area is on land that has no alternative domestic use other than for sheep grazing. In this case mutton and wool are produced jointly in fairly fixed proportions, in the short-run. Over a period of years, however, the sheep industry does respond, through breeding and selection, to produce more and better mutton and less wool (or vice versa) in response to substantial shifts in the price ratio. Where joint products are important the two products should be considered as one single
product for economic analysis. Thus, the important economic problem in the use of labor and capital for producing mutton and wool in the above case arises from the fact that these factors have alternative uses for producing other products in other areas.

We will discuss the application of this marginal condition under three main subgroupings. First, in this chapter we will explore its application to the problem of determining the type of agriculture at two important marginal areas: 1. In those areas tentatively delineated as being marginal for dryland cropping, and 2. in those areas where prospective irrigation development may extend into the present range area. Second, in the next chapter we will consider a product produced at different time intervals as separate products and discuss the problem of optimum intertemporal combination of products. Finally, we will consider the problem of obtaining an optimum combination of products in those situations conventionally characterized as "multiple-use".

B. Dryland Farming and/or Range Lands

Although the Mormon pioneers, as early as 1849, were successful in raising some crops without irrigation in
areas of limited rainfall, dry farming was made popular by H. W. Campbell around 1900 (165, p. 144). As was pointed out in Chapter II, under the impetus of the Campbell system of dry farming and a long series of years of higher-than-average annual precipitation much of the Northern and Central Great Plains were settled under the enlarged homestead acts. Dry farming was also extended to the foothills on the periphery of the intermountain valleys. Intermingled with the dryland farms were livestock ranches. Frequently both dry farming and livestock ranching were and are practiced by the same operator.

The gradual (and, at particular times, not so gradual) abandonment of homesteads began very early because of the growing burden of high property taxes and low and uncertain production from severely inadequate parcels of land. It was especially noticeable during the agricultural price recession following World War I. Kumlien et al. wrote of these years:

A perusal of precipitation data for South Dakota by years 1890-1935 and compared with population changes for that same period will show a definite ebb and flow of population into and out of the state as rainfall was sufficient or below normal. (126, p. 3)

The severe drought covering the period 1930-1936 combined with the depression burdened most counties, in the Great Plains particularly, with tax-delinquent and
abandoned farms, stranded families, and mass unemployment (125). The unusual continuing winds climaxed the series of events with the "dust-bowl" (21), right after the "New Deal Administration" of F. D. Roosevelt got underway.

1. **Zoning as a permanent solution**

The literature in the professional agricultural and economic journals of this period indicate the direction that most groups turned to find answers to these problems. There was immediate emergency relief in the form of grants, loans, etc. (202 and 197), but a more permanent solution was sought through the Resettlement Administration. Under the leadership of Wehrwein and others from the University of Wisconsin the idea of rural zoning became a popular recommendation (296). Wehrwein defined zoning as "a positive control over land use, listing in each zone what the private owner may or may not do with his land and fixing a penalty for the violation of the ordinance" (292, p. 119). As used in Wisconsin, it applied largely to the cut-over area, and was used to keep people from settling on relatively unproductive lands or isolated tracts and becoming a burden to the social institutions. As applied in the Great Plains, zoning was used to prevent land owners from breaking their land out of sod. Considerable interest and discussion centered on the problem of defining the geographic boundaries
of land use. There were attempts by some to define boundary lines, based primarily on precipitation and soil qualities (203), that would permanently divide the tillable land from the untillable land. A series of land-use studies were undertaken at most agricultural colleges (176). In a few Great Plains states some counties were successful in passing zoning ordinances preventing the extension of dry farming (286).

The assumptions pertaining to the physical relationship between the two enterprises implied in the zoning proposal is of the general nature pictured in Figure 8 which shows the relationship to be perfectly competitive on each side of the zoning boundary. On one side of the boundary the relationship is shown by the line DA, while the line BC represents the physical relationship on the other side of the boundary. At any assumed price line, the slope of which is between that of BC and DA (PP' for instance), the optimum solution would be to grow all wheat on one side of the zoning boundary and have only livestock grazing on the other side.

Economic recovery, a series of years with high annual precipitation, and World War II combined to remove (at least temporarily) the serious conditions of the problem before it was solved. Land that was on the county tax-
Figure 8. Constant marginal rates of product substitution between grass and wheat
delinquent rolls moved into private ownership either to be seeded into grass or to be plowed up again. In Montana, Wyoming, and Colorado, particularly, thousands of acres have been broken out of virgin sod or sagebrush and planted to wheat. Based largely on earlier studies of technology and "normal costs" and "long-time average yield capacity", warnings of impending dangers have been sounded. "We are going to have a recurrence of the pains of readjustment in Western dryland agriculture" (190, pp. 19-21).

There is talk, again, of rural zoning ordinances and of a reallocation of some of the land presently used for wheat production. In the summer of 1953 the wheat farmers voted by an overwhelming majority to accept acreage allotments for wheat production. This procedure tends to cut wheat acreage about the same proportion in all areas rather than to remove it entirely from lands with comparatively high alternative uses. Research is getting under way in the Western Range Region to study the economic problems of marginal shifts between range and dryland cropping (175, p. 31).

2. *Alternatives to zoning*

There are several important changes, both in price and technology, that have occurred since the early thirties.
New mechanization of dryland wheat farming has made possible economies of scale. New varieties of wheat have been developed that reduce some of the hazards due to disease, and the minimum moisture requirements for production have been lowered.

One procedure being followed on thousands of acres of former grass and sagebrush land in Wyoming warrants mention (and further study). During very recent years some ranchers have been leasing their sagebrush land that is level enough to be tillable to a contractor. The contractor agrees to pay the landowner a small portion of the wheat crop each year for about four years, whereupon the contractor is to reseed the land to grass and return it to the rancher. It is too early to know how successful this program will be or how far it can be extended, but it is evidence of another important change. "It may no longer be true that huge losses will be incurred in shifting land back from crop to livestock production" (175, p. 32).

There undoubtedly is still a need for identifying the factors which determine the economic feasibility of shifts between dryland cropping and range. There is need, also, for developing short-cut methods, or even rules-of-thumb, that ranchers can use in making better decisions concerning such shifts. It is the opinion of this writer that the economic return from research resources devoted to further
diminishing the cost of shifting back from cropping to grass will be high. This will call for the development and selection of new varieties of grass and new revegetative techniques that will increase the probability of securing a good stand of grass during adverse moisture conditions. It is entirely possible that with such a development the practice of plowing up much of the range might become a standard recommendation. The cost of renovating the sod and sagebrush land could be offset by the production of some cultivated crop for a few years (practicing summer fallow), followed by reseeding to grasses. From what we now know of the productivity of reseeded ranges, and of crop rotations (85), the total productivity will be increased by such a rotation.

When it becomes possible to shift back to grass with a reasonably high degree of assurance of obtaining a good grass stand, the physical relationship between the two enterprises will be of the general nature illustrated in Figure 9, which suggests that an increasing marginal rate of substitution exists throughout the entire range of substitution. It also suggests that a degree of complementarity exists at the two extremes. With this kind of physical relationship the optimum combination would be where not less than OC of wheat and not less than OE of beef were
Figure 9. Increasing marginal rates of product substitution between grass and wheat.
produced. At price ratio $PP'$ the optimum quantities would be $OD$ and $OF$, respectively. During prolonged periods of low rainfall, such as occurred during the thirties, the relationship would revert back to that represented by line $BC$ in Figure 8, where beef production would be specified.

It was the land for which rural zoning (designed to prevent the land being cropped) was proposed during the thirties that produced a substantial part of the wheat that went into the breadbaskets of the world during the last fourteen years. It is doubtful if the labor and capital that was used in this area during this period could have been used so profitably in any other area. In a society of rapidly changing tastes and technology, what is needed, it would seem, is greater mobility of resources between enterprises, not less. This is particularly true of agriculture in areas where precipitation is characterized by a high coefficient of variability sequence (coefs$^1$). High mobility of human resources into and out of the Great Plains Area according to the rainfall may place a strain on the social institutions and adversely affect certain cultural and spiritual values greater than we are willing to accept. If this is the case, rural zoning for certain areas might be justified.

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$^1$See Section C-3 of Chapter X for an explanation of the meaning and origin of this term.
It seems quite feasible, on the basis of a very preliminary examination of the situation, that a program designed to materially increase the size of the smaller agricultural units may go far in reducing the necessity for a recurrence of the mass migrations that occurred during the thirties. Larger units would permit the accumulation of capital during periods of high precipitation to be used as a contingency reserve in periods of low rainfall. This would permit the family to continue its normal process of educational and cultural and spiritual development in times of adverse precipitation while at the same time curbing the intensity of its agricultural enterprises so as to correspond to the rainfall. This solution assumes that a satisfactory procedure can be devised for increasing the size of the small ranching and dry farming units. As pointed out earlier, this calls for a satisfactory solution to the problem of recurrent unemployment in the industrial sectors of the economy. The success of the above mentioned solution would depend, largely, on 1. whether or not it was physically possible to shift from dry farming to grass during periods of low rainfall, and 2. whether or not individuals would have the knowledge and capacity to prevent a soil loss due to wind erosion greater than society was desirous of incurring. The fact that we currently tend to appraise these assumptions and conditions in the negative
should not deter us from further research designed to make them feasible.

C. Irrigation Development and Integration

Nearly 90 per cent of the acreage that is presently under irrigation has been developed by private enterprise (190, p. 162); some of the projects have had a rather unfavorable record. Today, after considerable financial reorganization, most of the private irrigation systems appear to be on a rather sound footing. It is generally agreed, at the present time, that the important irrigation developments that occur in the future will need to be done by the federal government. Currently this responsibility is vested largely in the Bureau of Reclamation although the Department of Agriculture and the Army Engineers play important roles in some areas such as in the Missouri and Columbia Basin.

In 1950 the Bureau of Reclamation administered nearly 10 million acres of public land, much of which was held as being susceptible to irrigation (48, p. 8). Some of this land is to be brought under irrigation by development projects for which money has been appropriated. Other portions of the land are being withheld subject to investigation; it
Is doubtful if it will be economically feasible to bring much of this land under irrigation in the foreseeable future. At the present time the most promising prospects for extending irrigation are on lands that are now in private production either as dry cropland or range land. Several products are proposed that would furnish supplemental irrigation water for land that is now being irrigated under private development.

There is little question that the federal program of water resource development will play an influential part in determining the future economic development of the West. Present proposals call for a federal expenditure of approximately 11.25 billion dollars in the Missouri Basin alone on water resource development. Of this amount, about 29 per cent is proposed for irrigation, and 28 per cent for other agricultural measures, 23 per cent for flood control, 15 per cent for hydro-electric power, two per cent for navigation, and three per cent for other purposes, including river bank erosion control, municipal water supply, recreation, etc. (149, pp. 91-92). In addition to this, vast sums are being spent in the other river basins of the West, and in the interior basin drainages.

A thorough economic analysis and appraisal of water resource use and development would be a study in itself too
vast to include in this treatise. It is the subject of several separate studies by individual research workers and by federal commissions (191). Some of the important economic aspects will be discussed, however, and where our present framework of analysis suggests economic criteria with which to appraise certain policies and proposals some suggestions for increased economic efficiency will be made. This will be very briefly presented under two main headings. The first will be a brief critique of the over-all policies and procedures for water resource development in the West. Then, from the standpoint of the firm, we will discuss the problem of integrating irrigated cropland into a range and/or dryland farming operation.

1. Economic analysis of water resource development

As the water resource use and development policy emerged in the United States, the army engineers were given primary responsibility for flood control, and for the upkeep and supervision of the permanent structures in the rivers and harbors that were used in transportation. The Department of Commerce was given supervision of transportation, primarily through the Office of Transportation and the Inland Waterways Corporation. The construction of the dams for power and irrigation was assigned to the Bureau of
Reclamation in the Department of the Interior, while the supervision of the disposal and use of the power was placed, for the most part, under the Federal Power Commission. The Department of Agriculture was given responsibility for most of the agricultural resources and programs. The programs of resource development emerged separately within several of the above agencies, with little coordination between the two. It was not until the close of World War II that the agencies effectively got together to form interagency river basin committees. At that time it was evident that the patience of the people, and of their elected representatives, was running out and that if some kind of coordinated program was not forthcoming by the existing agencies, an imposed coordination in the form of valley authorities was highly possible. A joint program trying to combine the separate plans into one coordinated program for a given area has been going on since that time.

In 1946 the Federal Inter-Agency River Basin Committee appointed a Subcommittee on Benefits and Costs for the purpose of formulating mutually acceptable principles and procedures for economic analysis of water resource projects (210, p. III). It was about this same time that the Hoover Commission came out with its recommendations for reorganization of the executive branch of the federal government. The
Commission report was quite critical of the lack of coordination that existed in the areas of resource development and suggested a merger of several of the functions into one agency. The Commission pointed out certain shortcomings in accounting procedure and the lack of a central agency to determine priority of water use when conflicts over use arose (235).

a. **The President's Water Policy Commission.** The President's Water Policy Commission report was released in 1950 the first volume dealing directly with the outline of a water policy (272). The report seems to carry the idea that all persons are better off after a dam is built than before since it will increase demand for products. One gets the impression from reading the report that irrigation, *per se*, is good because it gets people to cooperate. No method of determining a restriction on the costs and investment for irrigation was given. The fact that increased agricultural production could be obtained from alternative methods, such as drainage, use of fertilizer, new seed varieties, etc., was not considered. The Commission apparently holds that a sufficient condition for undertaking a project is that total benefits exceed total costs.

b. **The Subcommittee on Benefits and Costs.** The Federal Inter-agency Subcommittee on Benefits and Costs submitted
its recommendations of proposed practices for economic analysis of river basin projects in 1950 in a report that has since come to be known as "The Green Book". This report made several noteworthy proposals for economic analysis, which, if followed, would substantially alter the present evaluation procedures. The Committee held that (210, p. 5):

1. Any service performed by a project would have value only to the extent that a need or demand for that service is expected; 2. The criterion of maximizing net benefits is fundamental in the justification of projects; 3. A project, or any segment thereof, must be the most economic method of achieving the particular purpose for which the project is considered; and 4. The order of undertaking economically justifiable projects should be on the basis of their relative efficiency in the use of resources. They rightly claimed that costs of goods and services should be based on opportunity cost and that no benefits should be credited higher than the cheapest alternative of supplying those services (210, pp. 9-10). Except for projects undertaken during the depression, they would assume a relatively high employment of resources. The scale of a given project should be at that point where marginal revenue equals marginal cost (210, pp. 11-12). They felt that because of uncertainties of changing tastes and technology the economic life of the project should be less than the physical life;
an upper limit on the economic life of 100 years was suggested (210, pp. 24-25). They recommended that estimates of benefits and costs accruing at varying times be made comparable by adjustment to a uniform time basis through the use of interest rates. The interest rate on long-term government bonds was suggested in calculating the annual cost of initial federal investment (currently at about 2.5 per cent); while for calculating the annual costs of private investments and for discounting deferred payments, a minimum rate of 4.0 per cent was recommended (210, pp. 21-24). They recommended that wherever possible projects should be evaluated in monetary terms and where certain intangible benefits necessitate qualitative considerations, a minimum qualitative value should be given (210, pp. 26-27).

c. The Missouri Basin Survey Commission. The Missouri Basin Survey Commission report of 1953 clearly illustrates that very few of the recommendations of the Subcommittee on Benefits and Costs had as yet been adopted by the several agencies. Hearings before the Commission indicated a strong belief that the resource program then in progress lacked the coordination and balance essential to "genuine multiple-purpose planning and even threatens at times to make improvident use of the regions limited supply of water" (149, p. 3). To bring about the needed coordination, the creation of a
Missouri Basin Commission to direct and coordinate the activities of all federal agencies relating to resource development was recommended.

In its economic appraisal of current and proposed programs in the Missouri Basin, the Survey Commission found substantial differences in financial and accounting practices. It reported a disputed cost allocation of near 500 million dollars on main stem dams between the Corps of Engineers and the Bureau of Reclamation arising out of differences in allocating costs, whether reimbursably to irrigation and power or nonreimbursable to flood control and navigation. The practice followed by the Bureau of transferring 30 per cent of the cost of the power plant from power, which pays interest on investment, to irrigation, which pays no interest on investment, has economic and policy implications which the Survey Commission felt were not intended by the Congress. It estimated that the practice of not charging interest on investment during construction would cost approximately 400 million dollars for the proposed construction.

d. Cost-benefit analysis. The purpose of the cost-benefit analysis is to determine whether or not a particular project, or any of the segments of that project, is economically feasible or justifiable. Two conditions have been claimed as the necessary conditions for economic
justification: 1. benefits must exceed costs; and 2. benefits must not be computed to be higher than the cheapest alternative source of the services in question. However, either singly, or together, these conditions are not sufficient. The sufficient condition for economic justification is that this particular project as proposed provides maximum net benefits. This condition implies that the net benefits from this project, as proposed, provides greater net benefits than 1. any other scale or combination of uses possible for this same project, 2. any possible combination of uses on another project in another location, or 3. any other combination of like expenditure for any purpose in any area.\(^1\) It is suggested that both the necessary and sufficient conditions be included in the cost-benefit analysis, and that the proposals of the Inter-agency Subcommittee on

\(^1\)For example, Ulrich (221) has shown that a program of resource development and use in the Piedmont of Virginia could bring into productive use over one million acres at an estimated cost of about 159 million dollars, through clearing, fertilizer and lime, terracing and other water control measures; while it is currently being planning to spend about 850 million dollars to bring the same number of acres under irrigation in the Columbia Valley. This comparison is valid if the secondary costs and benefits, both monetary and non-monetary are 1. relatively insignificant and can be ignored, or 2. comparable between areas.
Benefit® smd Costs be followed in evaluating benefits and costs (210, pp. 15-38).

e. **Cost allocation.** Cost allocation for multiple-purpose projects is important because 1. the costs allocated to flood control and navigation are not reimbursable, and 2. the rates at which power and water are made available to the users are strongly influenced by the proportion of the costs that is allocated to each. There is, of necessity, a degree of arbitrariness in the allocation of costs on a multiple-purpose project. The separable costs-remaining benefits method proposed by the Inter-Agency Subcommittee appears to be reasonable and not too difficult to compute. The method breaks down into seven steps as follows: 1. The total benefits attributable to each use or purpose are determined. 2. The cheapest alternative cost of supplying this same service is determined. 3. The lesser of these two figures is used to represent the value of the benefits. 4. The separable cost for each purpose is calculated. This is "the difference between the cost of the multiple-purpose project and the cost of the project with the purpose removed" (210, p. 54). 5. The separable cost (step 4) is subtracted from the limited benefits (step 3) for each purpose to obtain the remaining benefits. 6. The joint costs (total costs of the multiple-purpose project less the total
of all separable costs) are distributed among the purposes proportional to their remaining benefits. 7. The separable cost (step 4) is added to allocated joint costs (step 6) to obtain the total cost allocation to each purpose.

f. Repayable costs and the Basin Account Plan. The practice of having power repay some of the reimbursable costs for irrigation has been followed since 1906. The present policy is illustrated by the testimony of the Director of Power Utilization, Bureau of Reclamation before the Senate Subcommittee of the Committee on Irrigation and Reclamation.

The parts of the project that were built and are to be used solely for irrigation purposes were charged to irrigation; the same thing was done in the case of power. The multipurpose features then were allocated between them, after which determination was made of how much the irrigators could properly repay. The amount which it was not thought the irrigators could pay was considered as necessary to be repaid from power. (250, p. 61)

The present Missouri Basin Account Plan of the Bureau of Reclamation is an exaggerated case of this practice. It calls for the pooling of costs and revenues of those reimbursable portions of the program that are to be included in the account. The Basin Account in 1951 is shown in Table 4.

The Missouri Basin Survey Commission said of the Basin Account Plan:
Table 4
Reimbursable Cost Allocations and Scheduled Repayments

<table>
<thead>
<tr>
<th></th>
<th>Allocation (dollars)</th>
<th>Scheduled repayments (dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>2,577,113,000</td>
<td>905,367,400</td>
</tr>
<tr>
<td>Power</td>
<td>687,038,000</td>
<td>2,333,550,400</td>
</tr>
<tr>
<td>Municipal water</td>
<td>19,695,000</td>
<td>49,235,200</td>
</tr>
<tr>
<td>Fish and wild life</td>
<td>660,000</td>
<td>- - -</td>
</tr>
<tr>
<td>Recreation</td>
<td>647,000</td>
<td>- - -</td>
</tr>
<tr>
<td>Reserve (power system)</td>
<td>59,330,000</td>
<td>59,330,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,347,483,000</strong></td>
<td><strong>3,347,483,000</strong></td>
</tr>
</tbody>
</table>

Source: Report of the Regional Director, Region 7, Lower Platte River Basin, Bureau of Reclamation, Denver, Colorado, September, 1951. (234)

Under the law no interest is charged on the cost of irrigation but power rates are to be set high enough to retire the power investment with interest at 3.0 per cent in 50 years. The Bureau, however, credits the interest component from power to irrigation to offset the cost of irrigation. This has the effect of making both irrigation and power interest free in that the government does not recover interest on the investment in power. The account is nonexistent in the sense that the funds are held and expended for purposes of constructing future projects. Rather it is a concept under which the Federal Government gets back the same number of dollars that it had put into the reimbursable features. (149, pp. 107-108)

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1The effect on the users is quite different than this, however.
The present policy of assigning repayable costs is nothing more than an income subsidy, or transfer payment, from the power users and the general public to the irrigators. While income transfers may very well be justified and desirable on the basis of a more equitable income distribution, it is doubtful if this is the most efficient method of accomplishing this purpose. The present method leads to two important types of biases. First, as previously mentioned, there is a tendency to shift reimbursable costs from power, on which interest is charged, to irrigation, on which interest is not charged. This practice places a bias in the project analysis in favor of the project. Second, there is an apparent tendency to make liberal assumptions concerning the benefits from irrigation, knowing that a considerable portion of the reimbursable costs chargeable against those benefits will be repayable by power. This would further bias the analysis in favor of the irrigation portion of the project. It is suggested that reimbursable costs correspond with repayable costs, and that income transfers, where desirable, be specifically identified as such.

An indication of the direction in which the present irrigation policy may be leading is revealed by the findings of the Missouri Basin Survey Commission.
According to data supplied, water cannot be brought to any land not now irrigated for less than $100 per acre. For the first three-fourths of a million acres of new irrigation, the cost would range up to about $400 per acre. For the next three-fourths of a million acres, the cost would range from $400 to nearly $700 per acre. For the next one-third million acres, the cost would range from $700 to nearly $2,500 per acre. For a few very small projects, with unfavorable benefit-cost ratios, the cost would run as high as $4,000-$4,500 per acre. While the higher-cost-per-acre projects are not being advanced by the Bureau for construction, they are authorized and under preliminary study. Consequently, they need to be taken into consideration. (149, p. 102)

One line of reasoning, with respect to having power re-pay part of irrigation's reimbursable costs, goes this way. There are substantial secondary benefits derived from irrigation development, such as the secondary and tertiary processing of agricultural products, the new businesses that service the new agricultural community - the dentist, the doctor, etc. (The validity of these assumptions depends a great deal on the opportunity for alternative employment of resources at the time. In times of war mobilization, or inflation, the net secondary benefits may actually be negative. In times of less than full employment of resources, or of pending depression, opportunity cost of some of the resources might be near zero (61)). Since these secondary benefits occur from irrigation and cannot be recaptured by irrigation, the next best way to
recapture them is by charging higher rates for power and using this money to repay the reimbursable costs of irrigation. This assumes, of course, that the users of the power are the ones who enjoy the secondary benefits from irrigation, which is highly unlikely.

If it has been determined that those who receive the secondary benefits from irrigation should not repay a portion of the costs because 1. they cannot be sufficiently identified (as is reasoned in the case of benefits from navigation and flood control), or 2. it is socially desirable that the group be subsidized, then these secondary benefits should not be considered in computing reimbursable costs. We suggest that some of these secondary benefits from irrigation, as well as many of the benefits from flood control and navigation (if they can be estimated as benefits at all) can be determined as accruing to a definite group or geographic area and, therefore, can be recaptured by taxes, fees, or assessments.

The policy of subsidizing irrigation has other implications in resource development that result in inefficiency. Since irrigation was subsidized, there has been a strong desire to spread the benefits resulting from the expenditure of public funds over as large a number of farm families as possible (158). The legal size limit for a project
settlement farm has been 160 acres, except for a very few special cases where Congress has permitted a larger size limit. On most settlement projects the actual farm size is considerably below this, in some cases as low as 40 acres (190, p. 159). Most economic studies that have been made of settlement projects indicate that 1. most of the settlers are severely handicapped by their small, inefficient units, and by a low rate of capital accumulation (219); and 2. there is a strong tendency for the farms eventually to combine into larger, more efficient units (101).

Western soils are almost universally low in organic matter and nitrogen, and some form of livestock operation is essential to successful farm operation under irrigation on most projects. In the upper basins where the growing season is relatively short, even 160 acres may be insufficient to permit the new settler to improve his yields through rotation and livestock operation (278). A policy of establishing farm size on the basis of efficient operation by the farm family would permit a higher repayment capacity for the irrigation sector of the project, and would result in a greater net product return to society, since fewer human and capital resources would be utilized in producing a given amount of agricultural products.
g. Repayment history of irrigation projects. The repayment history of federal irrigation development projects is not favorable (114). Even with the present 50 year repayment period, it is doubtful if very many of them will pay out. The policy of not charging interest does not encourage repayment. Probably an even greater deterrent to repayment, however, is the present joint-liability clause in the contracts that makes it impossible for a settler to obtain clear title to his land and water until after all obligations by all buyers have been met. Should one settler pay off his own obligations he is still liable for the delinquency of others. In the early beginning of irrigation development by the Bureau, the money used in construction was taken from a reclamation fund sustained by sale of western land. As the construction was paid off the fund was again built up. Under these conditions the West claimed that it was using its own money and therefore should not pay interest. However, because of a poor repayment history of irrigation projects, and because of an expanded program of development on the part of the Bureau, the fund has been supplemented by Congressional appropriations. The joint-liability clause appears to be a carry-over from the early experiences of private irrigation development.

Greater economic efficiency in resource development and an
Improved repayment policy would result if 1. interest were charged on all resource investment, whether for irrigation or power, and 2. the joint-liability clause were eliminated.

h. **Cost-sharing.** The concept of sharing the costs of water resource development between federal and state government, local districts, and individuals is receiving increased attention (25). There is an increased feeling that a substantial gap exists "between individual development and large-scale federal development . . . in present-day irrigation policy and programs" (105, p. 147). The small watersheds development program, which is designed to fill this gap, embodies the cost-sharing principle. It grows out of the fact that some of the benefits, but not all of them, accrue to the individual on whose land the investment is made. Other benefits accrue to the surrounding lands, while some benefits are spread over such a vast area that their final destiny cannot be identified (211). On-site-off-site classification of benefits and costs is largely an outgrowth of the institution of property. The small-watershed program attempts to get at the solution of the problem through property arrangement (242). The program is now in an experimental stage of development, but it is anticipated that the small watershed district will pay a portion of the costs, these costs to be apportioned to the individuals within the district according to procedures
acceptable to the district. The proportion of the costs that is to be paid by the district varies from 25 to 37 per cent of the costs for those projects that have been tenta­tively proposed (240, pp. 627-642). It is still too early to appraise this program, since the "ground-rules" of policy have not yet emerged. The concepts on which it is based are at least in the right direction.

2. Integration of irrigation into range and dryland farming operation

The opportunity for further expansion of irrigation for most ranchers and farmers in the Western Range Area is limited almost entirely to those areas that can be serviced from government reclamation projects or those where under­ground water can be used. The latter is limited by the cost of drilling and lifting and by the salinity or alka­linity of some underground water supplies. The possibility of a greater use of underground water channels has received little consideration. In fact, the use of underground water for irrigation is a rather recent development in the United States. Under present laws and practices, there is con­siderable uncertainty attached to an individual firm's investing in equipment to capture and use underground water. Research into the nature, the use, and institutional
controls of underground water is undoubtedly one of the most critical items in the field of water resource use and development, at the present time.

Whether the source of irrigation water be from underground or from a federal multiple-purpose dam, the rancher will be faced with the problem of deciding whether or not to invest in irrigation. His decision should be based primarily on whether the sum of his discounted expected stream of net profits is increased or decreased by the irrigation. The economic affects of irrigation will be 1. changes in the level of income resulting from increased physical output, increased capital investment, and increased operating costs, and 2. a more stabilized physical production over time.

a. Changes in the level of income. The Bureau of Reclamation has estimated that the costs of land development alone (based on 1949 prices) would average about 65 dollars per acre. (There would be a great deal of variation between farms, however.) Increased machinery, building, livestock, and irrigation-structure investment would be over and above this amount. Considerably more man labor is required under irrigation, although this need not increase costs if there exists a surplus of family labor that has no alternative employment. Greater management skill will be required under irrigation since 1. a new farm
organization designed to utilize the new products and/or by-products must be affected, and 2. the management decision under irrigation farming includes the timing, amount, and method of water application so as to obtain the most economically desired yields and maintain favorable soil structure and texture.

The increase in physical product that can be expected with irrigation development will vary from one area to another depending on soil and climate, and will vary between firms depending on the kinds of crops selected. The value of the increased product should be determined by the effective market prices, except where the increased product helps to eliminate some seasonal forage bottleneck, and thus permits a more efficient use of other resources. This emphasizes the importance of considering the entire firm in the analysis. Under static assumptions, the addition of irrigation to the firm would be recommended if and only if the added net profit were greater from the added irrigation than from any other alternative resource use.

b. **Income stability through irrigation.** It is under dynamic conditions with a high degree of variation in precipitation fluctuating about a point that is critical for crop production that irrigation development receives its most enthusiastic support in the arid west (106, pp. 721-722), as a stabilizer of western agriculture. As to whether
or not the addition of irrigated acres to an individual ranch will increase income stability depends on the circumstances of the individual case and on how one measures stability. In terms of variability, as measured by the variance, net income may be made less stable by the shifting of land from range to irrigated cropland for several reasons. First, since the physical product that is added through irrigation is many times larger than the physical product lost by removing land from range grass, variation can be over a much greater range of values. Second, although the irrigated crops are less susceptible to loss due to drought than was the grass, they are more susceptible to other hazards, particularly hail and frost to which several areas of the west are especially subjected (261, p. 730), and to certain diseases and pests that are not common to range land. Finally, the addition of irrigation adds high fixed costs of interest, taxes, overhead, and maintenance that will be reduced very little, during periods of low income. In relative terms, however, it is reasonable that income variation usually will be reduced.

For cases involving shifts from dryland to irrigated farming it is quite clearly established that converting some of the land to irrigation tends to reduce income variation, although it may be less definitely established that the
average expected annual net profits will be increased. In their study of dryland and irrigation farming on the Cannonball River of North Dakota, Helfinstine and Schaffner (87) estimated that labor earnings could be increased from 1,773 dollars to 2,298 dollars (1949 prices) on a 1120-acre cattle ranch, with dry farming emphasizing wheat production, by converting 45 acres of dryland to irrigation. This does not include the added costs of the water delivered to the ranch, such as costs for construction, overhead, and maintenance of the dam and canals. Using the budget technique, they estimated that the coefficient of variation of labor earnings would have been reduced from 159 per cent to 112 per cent, over the period 1930-1949, by the addition of irrigation.

A more meaningful approach to the problem of instability, arising out of weather uncertainty, is to attempt to minimize the chance of a critical loss (a loss that may result in the discontinuance of the firm) in any one year. Both the logic of enterprise relationships and familiarity with the actual physical conditions confirms the general belief that irrigation can stabilize the agriculture of the arid West in this sense. Theoretically, as the number of enterprises are increased, the chance of a low income from all of them at the same time is decreased "if the returns for different enterprises do not have a high positive
correlation" (77, p. 487). From the standpoint of yield variability, there may be very little positive correlation between the range grass and irrigated crops in some areas. The price variability might approach 1.00, however, if both the grass and the irrigated crops are marketed through the same livestock. It would be less than 1.00 if the irrigated crop products are marketed directly. It may be very low for those crops that come under high government support, particularly if livestock prices are not supported.

By 1888 it was realized that irrigated land could add stability to the ranching operation in the Northern Great Plains and Intermountain areas by providing a winter feed base and thus preventing critical losses during periods of low rainfall and severe winters. Since that time ranches have developed around the irrigated meadows that provided the winter feed. There still remain some areas where the present water supply is inadequate to provide winter feed for the livestock from the surrounding range lands during severe winters and where the water supply is unstable. In these areas supplementary water supply from federally developed reclamation projects may be of considerable value in adding stability to the industry. In view of the present anticipated high cost of most of this development, one needs to ask whether or not some more economic alternatives
(such as a subsidized program of storing concentrates, or some form of income insurance) may not be determined, and if the gain in stability is sufficient to warrant the cost. A further discussion of variability due to weather uncertainty follows in the next chapter.

c. Acreage limitations for irrigation development.

Earlier in this chapter it was pointed out that the law specifies that the maximum number of acres of land to which irrigation water from a Reclamation project is to be supplied to one man shall be 160 acres. This limitation is an outgrowth of the family farm concept and the idea that the benefits of subsidized irrigation development should be spread out as much as possible. As the areas to be irrigated changes from the public domain lands to lands that are privately owned, lands are usually held in tracts larger than 160 acres before the project develops. Frequently many sections are held by one man, although only relatively small portions of it usually will be irrigable. Under the present law, owners may select 160 acres to be designated as "non-excess lands"; the remainder will be classed as "excess lands". Should the owner refuse to sell the excess lands at prices, terms, and conditions that are agreeable to the Secretary of the Interior, he becomes ineligible to receive water on his lands. The Missouri Basin Survey Commission found that
A combination of administrative rulings and State law has made it possible to use this provision to force the breakup of larger land holdings. An administrative procedure has been adopted by the Bureau of Reclamation of refusing to deliver water to any lands, excess or non-excess, until the owner has agreed to dispose of the excess. In some States all irrigable lands, whether excess or non-excess, may be included within the irrigation districts which make the repayments to the Government for the project works, and may be assessed for the benefit resulting from making the water available to the land by the project works and ditches, whether or not the water is actually applied to the lands or can legally be so applied. In such situations the water is denied to the excess lands, yet the lands are assessed as if they were irrigated, an assessment which the owner can seldom afford to pay, with the result that he is compelled to sell his excess lands. (149, p. 204)

Administrative rulings permit a private owner to transfer excess lands to his wife and children (even minor children) to the point where each has 160 acres. There does not seem to be any inherent reason why this is the most efficient way in which to solve the above problem. If, as this ruling assumes, the 160 acre limitation is not sound, the law should be altered and made flexible enough to fit each local situation. Subsidization of larger units could be avoided by specifying that all costs reimbursable by irrigation, be repayable by the users - including interest charges. If the distribution of the irrigated lands among the users is to be economically sound, 1. acreage limitation, if desirable, should consider economies of scale of
operation for the kind of agricultural production that is expected to develop, and 2. consideration must be given to the uses of the range and dry farming lands that are expected to be used jointly with the irrigated lands.

d. The extent of integration. Huffman (105, pp. 130-132) lists several different situations wherein range and irrigated lands may be integrated. 1. The irrigation farmer with grazing land as a part of the operating unit, whether owned, leased, or permit grazing; 2. The rancher who has an irrigated feed base; 3. The stabilizing influence that a body of irrigated land might have on the stability of the feed supply through the market. This may work in reverse in some areas where dryland grain farming ships feed grain to the irrigated farms for their winter feeding program. (Unless coordinated in some manner, this may actually increase the variance of total feed supplies, as previously noted.) 4. The exchange of livestock between irrigated and dryland areas; 5. The exchange of farm and ranch labor; 6. The planned coordination within an area brought about by distributing the irrigation water over a larger area by irrigating a small part of many units. This last method would have to be limited to new areas or it would require "a drastic program of public land purchase and a reorganization of the pattern of resource use" (105, p. 133).
From their study of irrigated and dryland farming integration in the North Platte Valley, one of the older projects in the West, Greenshields and Voelker (69) found a surprisingly small amount of integration. In 1946 some three per cent of the farms had dry cropland lying outside the project area, five per cent had pastureland outside the area, and 15 per cent were hiring the use of dryland pasture outside the project for summer grazing. About 40 per cent of the irrigation farmers were carrying on livestock feeding operation, although they did not necessarily purchase their feeders from the surrounding ranch area.

However, on the Buford-Trenton Project in North Dakota, Voelker found that 53 per cent of the operators had from 160 to 1,100 acres of dry farmland, and some had range lands up to four sections (283, p. 23). A study of the Huntley project in Montana, made in 1946 (288), revealed that over four-fifths of the farmers contacted had accomplished some type of integration; two-thirds were grazing some livestock on adjoining rangelands; and one-half produced some dryland crops. Three-fourths of the range land was within five miles of the irrigated land with which it was used, although some was over 20 miles away. Ward and Kelso, concluded from this study:

Maximum stabilizing effects of integration would require a flexible program that would permit livestock fattening on the irrigation project
when feed is plentiful, and a shift to wintering of breeding stock during severe drouths in the dry lands.

Individual operators who have both an irrigated field base and range land could carry feed reserves, but large reserves from an irrigated project would require some form of organization to provide an ever-normal granary and haystack. (288, p. 36)

The above samples of conclusions from studies that have been made indicate that blanket endorsements of irrigation as a stabilizer for the West make certain assumptions about the homogeneity of conditions that may not be warranted. While there are undoubtedly many acres of the West that will qualify as being economically justifiable, the economic investigation and appraisal must be made for each individual situation, both in terms of benefits-cost analysis, and in terms of stability.
CHAPTER X

OPTIMUM PRODUCT COMBINATIONS - INTERTEMPORAL RELATIONSHIPS

In this chapter we will be concerned with a particular aspect of the application of marginal condition three which specifies that one product is to be substituted for another in the production process to a point where the marginal rate of technical substitution is equal to the ratio of the discounted prices. This condition will be applied to the problem of determining the optimum rate of product (resource) use over time. A product in two different time intervals will be considered as two different products.

A. Economics of Resource Conservation

This problem is not unique to the Western Range Area, but is characteristic of the use of all economic resources. It is a problem of determining the optimum rate of resource (product) use over time and has come to be known as conservation (31, pp. 48-61). Obviously this problem is concerned not only with the rate of land use but with all of the resources of production (78, p. 765).
1. **Defining conservation**

We do not desire to review the many definitions and controversies that have developed with respect to conservation. The central problem of conservation is that of determining how scarce resources should be allocated between competing time intervals over time. For a particular resource in question, conservation must be defined in such a way that an optimum or "most desirable" level of conservation can be obtained. Ciriacy-Wantrup defines conservation and the optimum state of conservation as follows:

Conservation is concerned with the **when** of use. . . .

We may then quantitatively define "conservation" as changes in the time distribution of use rates of individual resources in which the aggregate weighted change in use rates is greater than zero. Correspondingly, we have depletion if the aggregate weighted change is less than zero. . . . In the interest of shortness, we will call a given time distribution of use rates a "state of conservation". . . .

As a consequence of this terminology, it may be noted that a change in the state of conservation may mean either conservation or depletion.

. . . We may formulate the optimum state of conservation (as an **ex ante** concept) as that time distribution of use rates that maximizes the present value of the flow of expected net revenues. (47, pp. 51-77)

This definition has certain conceptual advantages, such as removing the term "conservation" from the many "value"
phrases that have tended to grow up with it. Conceptually, it is not difficult to see what is meant and the task of determining the state of conservation for a given firm or group may not be too difficult. It also has certain disadvantages. The base from which conservation or depletion is measured is the status quo for individuals or groups. This is not defined by the definition; nor need it be determined in order to measure deviations from it. Thus, it is impossible to compare the state of conservation for one individual or group with that of other individuals or groups. This may present a handicap in determining functional relationships between hypothetical causal forces and in obtaining of a specified level of conservation.

It seems more meaningful to the author to define conservation separately for each basic kind of resource depending on the physical nature of the resource in question and the objectives of society with reference to the particular resource. The definition, however, should be such that the optimum level of conservation corresponds to that specified by Ciriacy-Wantrup above. This optimum level of conservation has been included in our necessary conditions for maximum welfare.
2. Classification of resources

The solution to the problem of optimum rate of resource use over time will depend somewhat on the resource. Depending on the nature of the intertemporal relationships of its product (services), a resource can be divided into two broad "pure" categories - stock and flow (78, pp. 768-770). A stock resource is one which is not renewable. Thus coal, oil, minerals, and certain aspects of the soil are, for all practical purposes, of this nature. A stock resource permits considerable latitude of substitution between time periods either by storing the resource in situ until used, by capturing it immediately for use as desired, or by storing the product derived from the resource until consumption is desired (31, pp. 35-37).

A flow resource is one the services of which are renewable at regular intervals. Examples include rainfall, winds, stream flow, scenery, etc. These can be broken down further on the basis of their response to human action. First, they can be purposely subdivided depending on whether or not the resources (or their products) can be stored for future use. Once they can be stored, the problem of their use becomes the same as that of stock resources. If they cannot be stored, only one alternative use-rate is reasonable (provided they are used independently of other scarce
resources) and that is to use them as fast as they become available. Second, flow resources can be grouped according to whether or not their flow can be significantly changed by human action. There are those which cannot be changed by human action, such as sunshine. The optimum use-rate for these resources (products) will depend partly on whether or not they can be stored. For those resources whose flow can be affected by human action, such as plant and animal life, and for a considerable part of soil fertility, determining the optimum rate of use over time becomes quite complex. The rate of flow need not be, and probably never will be, constant.

3. A critical zone

Determining the optimum flow may be altered by the fact that there may exist a "critical zone" - "a more-or-less clearly defined range of rates below which a decrease in flow cannot be reversed economically under presently foreseeable conditions" (47, p. 39). Irreversibility may be technological as well as economic. For example, we are presently finding it very difficult to reverse the use-rate (rate of destruction) of the whooping crane. If the present limited stock of whooping cranes should perish, reversibility would be technologically impossible.
The following conditions must exist for a critical zone to be meaningful for planning purposes. First, the resource (product) must furnish satisfactions that are valued no lower than the cost of avoiding the critical zone. Second, there must be no substitute resource (product) that can be obtained at a cost less than the cost of avoiding the critical zone. Where a meaningful critical zone exists, it will serve as a constraint to the solution of the allocation problem.

4. When a conservation problem exists

The economic problem of conservation exists only when the good is scarce relative to the anticipated demand. No conservation problem existed for uranium until its use in supplying nuclear fission energy was discovered. Soils with fertility depth of ten feet located on land where only sheet erosion takes place, present no problem of conservation at the present time. By the same token, when uses for a resource cease to exist, the economic problem of conserving that resource ceases to exist. For instance, early in the second half of the nineteenth century there was great concern about the prospects of a shortage of hard woods suitable for making wheels for wagons and buggies. (Caissons also were mentioned to give it a "flavor of national security".) On the basis of the then existing technology,
a severe shortage of transportation was forecast for the middle of the twentieth century. There is no longer need of hardwood for this purpose.

When suitable substitutes have been developed which can be supplied at a cost lower than the cost of maintaining a resource for future use, the need for conserving that resource is lessened, or perhaps eliminated, depending on the nature of the supply of the substitute. Discovery of efficient techniques of extracting petroleum from oil shales would lessen the need for conserving oil deposits. Development of lighter, more pliable, and stronger metals for home building lessens the future need for lumber. The need for conserving uranium could vanish with the discovery of a means of harnessing solar energy. Hence, the optimum level of conservation must be determined by the current generation in light of known or reasonably anticipated technology, and in harmony with its own rate of discounting the future.

5. Intertemporal input relationships

Some resources and practices are complementary with productivity over time, others are competitive. This basic relationship, which seems fundamental, has received very little consideration in the literature and research of conservation. For instance, many claim that the application
of nitrogenous fertilizers is an act of conservation (and as such farmers qualify for PMA payments by applying such fertilizer). To the extent that the nitrogenous fertilizer has been removed from a given "stock" of nitrogenous substances and combines with limited phosphorous, potassium and other scarce elements in the soil to produce a higher yield this year, this process may be highly competitive with production in later years. To the extent that the application of fertilizer stimulates a more desirable biological growth in the soil and increases the rate of future "flow" of soil fertility, the practice is complementary with future production. What previously has been said about obtaining optimum factor relationships is applicable for conservation resources and need not be repeated.¹

B. Interseasonal Combination of Forage

A special facet of the intertemporal allocation problem for range resources is that of providing livestock feed for every season of the year. One of the primary economic problems of the private operator is to get control of the right

¹For a rigorous discussion of the criteria for determining efficiency in the use of soil conservation resources see Heady. (81)
amount of feed at the proper seasons at a price that will permit a profit, not, necessarily, on that season's production, but on the entire livestock-production cycle. Generally, these feeds are not seasonally homogenous, causing forage bottlenecks with attendant increased economic pressure on seasonally scarce ranges (22, p. 122). Early spring is the usual critical period of supplying feed on most northern ranges. In the South, the fall ranges tend to be the most critical. A seasonal bottleneck of feed actually may prevent optimum use of other resources, even of feeds during other times of the year, with a corresponding loss in net product to the rancher as well as to society. It causes 1. the private operators to bring increased pressure on public land administrators for an increase in grazing permits, 2. severe bidding up of the price of private land having crucial feeds or water supplies, and 3. ranchers to utilize their seasonally short range more intensely, sometimes to the point of overgrazing. This leads to a shift in forage species toward annual forbs and weeds which are generally more perishable and less nutritious than the perennial grasses. Thus the difficulty is only aggravated (39, p. 144).

To the extent that the problem is one of seasonally imbalanced combinations that have grown out of the haphazard, piece-meal development of policy and institutions, the
solution lies in carefully inventorying seasonal forage potential and providing for some redistribution among the ranchers. A rancher with a surplus of spring-fall range relative to summer range might exchange land (or grazing permits) with another rancher who has an excess of summer range, relative to spring-fall range. Outside the very imperfect arena of the land market there has been little or no opportunity for making such an adjustment within the industry; and the land market arena does not include the public lands, since grazing permits cannot be sold or bartered by the lessee. The former Forest Service policy of making transfer cuts when the grazing permits were transferred has tended to discourage such an adjustment (156). To the extent that the use pattern established during a few years preceding the original allocation became a fixed pattern to be extended without adjustment, the possibility for seasonal imbalance was increased. Recent legislation prohibiting transfer cuts should make the adjustment process more attractive to ranchers. Adjustment usually involves at least four parties, however: there must be two (or more) ranchers who desire to make an adjustment; the Forest Service, which may control the summer grazing; and the Bureau of Land Management, which may control the grazing on any or all of the four seasons. Administratively and ideologically the parties are a long way apart at many points.
In contemplating analysis of this problem just prior to World War II, Vass stated:

Unfortunately the Taylor Act has not completely solved the major land problems. In fact, up to the present time, the Grazing Act has tended to freeze the pattern of utilization as it existed during the period 1929-1934. Since it was during this period that the most serious abuses of the range were rampant, it seems hardly desirable to give "stabilization" to an unwise, patchquilt pattern of ownership and use . . . . Little has been done to eliminate uneconomic trailing of livestock or to consolidate the public and private lands used by ranchers into economic, contiguous units. Furthermore, little has been done to eliminate the absurd differences in regulations, fees, and other charges required by the action agencies administering public range, or to insure that ranchers include within their holdings (and the lands subject to their use) adequate amounts of the different types of land, i.e., summer grazing, winter grazing, hay lands, etc. These are the problems of the range. These difficulties cannot be solved simply by freezing the economy of the West in terms of a bad base period. (89, pp. 2-3).

After studying the economics of cattle ranching in northern Wyoming for 1951 and 1952 Tompkin concluded:

The most pressing need seems to be substitution of winter feed for summer feed to reduce the labor and machinery investment somewhat. Some cropland could be converted to irrigated pasture. Many ranchers limit the herd size to the amount of dryland range available, and sell surplus feed. (218, p. 43)

Property adjustment to permit a better seasonal balance of forage will undoubtedly help to relieve the forage bottle-neck, but other measures are needed. Research designed to increase carrying capacity by discovering improved species
and varieties of forage and better cultural practices should be augmented and focused directly on those seasonal ranges that are now acute. From experiments conducted at the Northern Great Plains Field Station at Mandan, North Dakota, Sarvis concluded:

Cultivated pastures are of most value for spring use, before the native ones are ready or fit for grazing. . . . Because of this fact they are of exceptional value for lambing and calving. The new grass improves the condition of the stock, stimulates the milk flow. . . . In contrast to native pastures, cultivated ones can readily be restored if the stands are weakened or destroyed by overgrazing or other causes. Cultivated pastures can be utilized to a higher degree than native ones without the same danger of overgrazing. (186, p. 87)

Technological and economic research should be directed toward making the seasonally surplus ranges more seasonally homogeneous and toward determining the marginal rate of seasonal substitution between ranges. A special application of this would be to make the haymeadow a more efficient producer of pasturable forage during the critical season.

The possibility of making supplemental feeds more economical needs continued study. The coordination between the need for seasonal forage adjustment and new irrigation development in the area should not be overlooked (119, p. 6); although this could work either for or against seasonal forage balance, depending on the degree of seasonal substitutability of the present existing haymeadows and the
forage produced on the irrigated land. From his study of range cattle production in North Dakota, Johnson (112, p. 44) recommended that there be an increase in the production of high protein roughages by raising more alfalfa hay and by earlier cutting of grass hay to reduce the need for purchased high protein concentrates. He lauded the trend toward fencing off seasonal ranges as being a method used to decrease the uncertainty of forage in a given season.

C. Optimum Intertemporal Product Combination - Intensity of Grazing

Determining the optimum intensity of grazing a particular range is a problem of determining the optimum intertemporal combination of products derived from the forage and comes directly within the scope of our problem as an application of the maximizing conditions. We will begin the analysis of this problem under the unrealistic assumption that climatic conditions are the same each year for a particular area in question and direct our attention toward determining the level of intensity of grazing on a private range that will maximize expected net revenues to the operator. Later these assumptions will be relaxed as we
direct our attention to the more general problem of determining the intensity of grazing that will maximize net social product over time.

1. **Theoretical solution under simplifying assumptions**

The following theoretical solution is proposed. Select time interval $T_2$ sufficiently projected into the future to reflect the full effect of varying levels of intensity of grazing. Time interval $T_1$ will cover that interval of time from the present up to the beginning of $T_2$. In terms of the economic horizon, the planning period is now made up of two planning intervals, $T_1$ and $T_2$.

We desire to determine the intensity of grazing (rate of forage use) in time interval $T_1$ that will maximize discounted net revenues over both intervals ($T_1 + T_2$). The first model is in terms of pounds of animal product per

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1The concept involved in this assumption is not new in the discipline of range management. In fact, it forms the core of the science. Such terms as "proper" grazing, or "proper" range management, as the term is used in the field, involves the concept of time. The planning interval exactly the same as is here assumed in $T_1$ is explicit in determining the "forage acre" (208, pp. 229-230), which is one of the determinants of range capacity or carrying capacity.
On the X axis is placed the pounds of animal product per acre in \( T_1 \); the maximum number of pounds of animal product obtainable per acre in \( T_2 \) for each given level of intensity of use in \( T_1 \) is plotted on the Y axis (Figure 10). The model assumes that a marginal rate of transformation of product between time intervals exists and is determinable. A suggested intertemporal transformation function is outlined by the curve DKGE. OE is the maximum amount of product that can possibly be produced in \( T_1 \); OD is the maximum amount of product that can be produced in \( T_2 \) when there is no grazing in \( T_1 \). The maximum amount of animal product that can possibly be produced in \( T_2 \) is HK and occurs when OH animal product is produced in \( T_1 \). The model suggests that up to the point OH the intertemporal functional relationship between \( T_1 \) and \( T_2 \) is complementary, which seems very reasonable for many range sites for at least two important reasons. First, in the absence of any grazing in \( T_1 \), plant species would tend to be altered in favor of the climax species which, frequently, means lower carrying capacity for \( T_2 \); second, as the intensity of grazing in \( T_1 \)

\[ ^1 \]The basic functional relationship of this model is the iso-resource curve (19, pp. 669-712) which assumes all resources constant. Thus, labor and capital, as well as land, must be assumed constant. If we remember that with each acre in question there is a given amount of all resources, except livestock which we are varying, the convenient acre notation should not be misleading.
Figure 10. Intertemporal opportunity curve
is reduced, the forage residue left on the ground increases and so does the risk of loss due to range or forest fire. This tends to reduce forage production in T₂. Sarvis claimed that

The accumulation of old growth sometimes creates an undesirable condition on ranges. A year or two of heavy growth may lead to uneven grazing and to a fire hazard. In some parts of the region this has occurred with favorable seasons. ... Too much old grass in the native vegetation sometimes leads to reduced gains of cattle as they do not consume as much of it as they do of new grass which is more nutritious. (186, p. 43)

Beyond some particular point (OH), however, a further increase in animal product in T₁ is at the expense of sacrificing some animal product in T₂. The competitive range is indicated by that portion of the transformation function in the range KGE. The economic question becomes one of determining how much product in T₁ should be given up (starting from point E) in order to obtain a greater product in T₂; or, (starting at point K) how much product should be sacrificed in T₂ in order to obtain a greater product in T₁. The choice criterion in this case is not difficult, conceptually. It is the ratio of the discounted expected market prices of animal product in the two time intervals and is represented by the slope of the iso-resource line AB. Marginal condition three¹ specifies the optimum level

¹See Chapter IV for statement of marginal conditions.
of intensity of grazing as being at point $G$ on the transformation function, where $OF$ of animal product is produced in $T_1$, which will permit $FG$ animal product in $T_2$.

a. **Range condition and choice indicators.** In actual experimentation and practice it is very difficult to consider the pounds of animal product produced in $T_1$ as the independent variable. Decisions are made on the basis of the range forage (and supplementary feed), and only indirectly are decisions made as to the pounds of livestock product to produce. The variable most used by the range management profession in determining intensity of grazing is range condition, which is defined as the state of health or productivity of both soil and forage of a given range in terms of what it could or should be under normal climate and best practicable management (200). Not only does the effective use of range condition, so defined, depend on the quantitative judgment of the range technician as to what constitutes normal condition, but also as to what constitutes health and productivity. These, of course, are susceptible to qualitative judgment by a skilled technician in the same sense that a physician can make judgments about a state of health of an individual as compared to some norm.

Judgment pertaining to the "best practical management" is of a more serious order. "Best practicable management" must be defined as that manner of resource use that
maximizes the goals or objectives that are relevant; therefore, it cannot be defined in the absence of choice indicators. There are no relevant choice indicators inherent in ecology; to imply otherwise is to assume that higher ecological trend toward the climax vegetative species is an end per se. This, of course, is not correct. To the extent that the climax vegetation is a natural pasture (56), and the grazing value of the vegetative cover is directly correlated with the stage of plant succession (183), the decision based on quantitative ecology yields results that do not conflict with the objectives of maximizing net forage product over time.¹ The choice indicators, in a democracy, come from the preferences of the individuals that make up society and need not (and frequently do not) parallel ecological trend. The "best practicable management" under our model (Figure 10) is where OF of animal product is produced in T₁.

This is not to argue that the concept of range condition is not meaningful in an ecological frame of reference.

¹Maximizing net forage product over time is only a means to the end of maximizing welfare. Under the simplified assumption that forage is the only important product from the resources in question, it is a meaningful end-in-view. Where other products conflict with forage, the solution must be altered. This problem will be discussed in the following chapter.
It probably is the most useful concept in the discipline of range management, since it determines the direction of ecological trend and thus is the basis for predicting forage production capacity on a given site under different practices. It will take all of the skill and ingenuity of the plant ecologists and plant physiologists to determine the intertemporal physical relationships (63). However, decisions concerning resource use are determined by equating the physical relationships with the economic choice indicators. That this problem is complex makes it none-the-less real. It is another example of where the physical scientist and the economist must work together closely, both in concept and method.

b. Determining the physical intertemporal relationship. It is suggested that the percent of forage grazed in $T_1$ be selected as the independent variable in the analysis of this problem. This is functionally related to pounds of animal product produced in $T_1$ and is closely related to range condition. Figures 11 and 12 show the functional relationship between the per cent of forage grazed in $T_1$ (again $T_1$ being of sufficient duration that the full effect of the effects of various intensities of use are reflected in the forage product in $T_2$) and the pounds of animal product in $T_1$ and $T_2$, respectively. The physical relationships expressed in Figures 11 and 12 can be easily transformed into the physical
Figure 11. Relationship between grazing in $T_1$ and total product in $T_1$.

Figure 12. Relationship between grazing in $T_1$ and total product in $T_2$.

Figure 13. Relationship between grazing in $T_1$ and total product in both time intervals.
transformation function of the analytical economic model (Curve DKGE of Figure 10). It is obvious that the physical relationship between per cent of forage grazed in $T_1$ and product in $T_1$ becomes irrational beyond that point where a maximum product is obtained in $T_1$. (With reference to the transformation function it becomes undefined and will not be considered.) The relevant choice indicator is the ratio of the discounted expected prices of animal product (line AB), and the solution is the same as before.

c. Physical relationships insufficient basis for decision. Some individuals or groups prescribe use-rates of range resources that maximize total product in $T_2$ regardless of the sacrifice in $T_1$. (What they apparently have in mind could be represented by Figure 12.) Basing management decision strictly on range condition and using forage production not as a product but only as one of the bases for range condition classification tends to lead in this direction (55, p. 113). A more acceptable physical framework would result from considering the amount of animal product in both time periods ($T_1 + T_2$), as is done in Figure 13, where the physical relationships of Figures 11 and 12 have been combined. The maximum total animal product occurs at a point somewhere between the maximum for $T_1$ and the maximum for $T_2$, depending on the degree of competitiveness of products in the two time intervals. The objective of maximizing
total physical product over both time intervals assumes that society has no preference between a pound of beef or wool at the present and at some time in the future, say ten years from now. The usual behavior in the market refutes this assumption. Maximizing decisions concerning the intertemporal use of resources cannot be made on the basis of the physical relationships alone but must consider the intertemporal preferences of society.

d. Forage as a flow resource. There are those who seem to consider range forage strictly as a flow resource.

Ranching rests upon the utilization of native grass. Native grass is a "fixed resource". This means that there must be full economic utilization of this grass by cattle or sheep at all times, regardless of present or prospective prices and market situations... Adjust the rate of stocking on each individual ranch to a moderate rate... This rate of stocking is always proper, regardless of price and of prospective market conditions. (119, pp. 1 and 3)

The physical relationships pictured here must be as shown in Figure 14, where there is no range of competitive relationship between products in the two time intervals. The price ratios could vary all the way from AB (where animal products have essentially zero value in \( T_1 \)) to A'B' (where animal products have essentially zero value in \( T_2 \)) and the optimum level of intensity of use in \( T_1 \) is not altered from OE. In the short-run, however, the assumption that range forage is a flow resource is not unrealistic for most range sites.
Figure 14. Optimum intertemporal use of forage when considered as a flow resource.
Since mechanical harvesting is generally impractical and frequently impossible, it is not feasible to cure and store the forage from one growing season through another. It must be harvested annually by livestock and there is a rather narrow range of variation in the amount of forage that an animal can economically harvest in a given time interval.

The conditions under which this assumption is true in the long-run, however, seem very limited. To the extent that forage can be substituted from one year to another through increased (decreased) soil productivity, increased (decreased) vigor and productivity of forage plants, trends in plan succession, etc., the flow must be considered as a stock resource. For stock and storable flow resources (or resources that are a composite of stock and flow), the relevant economic model for determining optimum allocation between time intervals involves the logic implied in Figure 10 and presented in the preceding discussion.

2. Application of solution under realistic weather conditions

In the previous discussion the optimum level of intensity of grazing under assumptions of identically repeating annual climatic conditions was expressed in terms of per cent of forage consumed in $T_1$. The purpose of this becomes apparent when this unrealistic assumption is dropped and the
problem is considered under conditions of climatic variation and weather uncertainty. The impact of weather uncertainty is peculiarly severe in the livestock ranching business because of the importance of annual precipitation to annual forage production (36), and the manner in which the forage is harvested. "Variation in range forage production resulting from variation in precipitation is one of the more important range management problems viewed from the ranch organization and income aspect" (96, p. 65). In the seven states of the Northern Great Plains, the correlation between forage condition of the range, as reported by ranchers and others for the crop and livestock reporting service of the Department of Agriculture, and the precipitation of the current and preceding year was .85 for the years 1923-1941 (35, p. 4). The ranchers were asked to report "range condition" as a per cent of normal for their area, normal being subjective in each rancher's mind. What was actually reported was more nearly an index of forage productivity in the economic sense than it was range condition in the ecological sense. For purposes of evaluating, an index of 49 or below indicated conditions as very bad; "50-59, bad; 60-69, poor; 70-79, fair; 80-89, good; 90-99 very good" (35, p. 2); 100 and over indicated excellent and unusual range.

What can be said about an optimum level of grazing intensity under conditions of varying forage productivity
such as that shown for Wyoming in Figure 15. If the ultimate objective of the planning agency was that of permanence of the resource per se, it might recommend a constant level of intensity (constant rate of stocking) geared to consume a given proportion (say 70 per cent) of the forage produced in years of lowest expected rainfall (1934). Since the forage productivity in that year was rated as being about 64 per cent, only 44.8 per cent of the "normal" forage would be consumed (this is represented by line AB of Figure 15). This obviously would provide a considerable excess of forage in all years other than when minimum rainfall occurred. Some writers claim that this is the kind of policy followed by the Forest Service (73 and 28). The writings of the Forest Service seem to add weight to this interpretation.

The outstanding fact is that dry years and the accompanying reductions of forage production and grazing capacity occur with such frequency that good range management requires stocking the range on a basis sufficiently conservative to avoid severe drought losses or forced sales. . . .

Where the fluctuations and advertisements of climate are not too great to permit range use, probably the outstanding prerequisite of management is the necessity for conservative grazing. Stocking the range at a point sufficiently below average forage production to provide adequate feed for the livestock in all but the most severe drought years is almost axiomatic in management to minimize drought losses, assure stable livestock production, and maintain the range resources. (255, pp. 141, 150)
Figure 15. Estimated range condition for Wyoming, 1923-1941

*Taken from Figure 28, Clawson (35).*
Another alternative, one that some ranchers attempt to follow, is to stock the range at a constant rate from one year to the next, but to gear the rate to the "average" expected rainfall. If, for instance, we take the average index of range productivity from Figure 15 of 84 to represent the expected average situation, then the rancher would stock the range at a level that would consume a constant proportion (say 70 per cent) of this, or 59 per cent (line CD in Figure 15). This would tend to overutilize the range forage in periods of low rainfall (1934) and underutilize it in periods of high rainfall. There would be less wastage of forage under this procedure than under the former (line AB) but it would not prevent overutilization in periods of low precipitation.

The possibility of storing the surplus forage in the form of hay or increased flesh on a given number of animals is limited. The only other alternative solution would be to vary the livestock numbers according to the range productivity. This is the same kind of solution concluded from our consideration of the problem under statics where we determined the per cent of forage that should be grazed. Assume, for the moment, that we desired to measure the effect of a particular level of intensity of grazing in T₁ on forage productivity in T₂ for a particular range site. For example, set the level of intensity of grazing in T₁ such that 70
per cent of the forage is consumed during the grazing season. An index of the fluctuation would be indicated by line EF of Figure 15 which represents 70 per cent of the index of forage productivity. This would require, of course, that more livestock be grazed one year than another. This would be repeated for different levels of intensity of grazing and should continue for a sufficient number of years to permit the range scientist and the economist, cooperatively, to estimate the ultimate economic effects of that particular level of grazing intensity. Thus, the logic and analytical framework of our original model (Figure 10) still applies.

a. Implications for range research. There is need to quantify the functional relationships proposed in the model for substantially different range sites. The amount and physical condition of animal product produced under varying intensities of grazing on controlled experiments must be measured and appraised. The market value of the animal product must be correlated with per cent of forage consumed. At the same time, careful study must be made of the ecological changes of the range over time in order to predict future carrying capacity under each level of grazing intensity. Experimental work of this nature is now being conducted on the prairie short-grass and mid-grass ranges of eastern Wyoming, essentially designed to furnish information needed for the theoretical solution (9). The problem is more acute,
and considerably more complex, on the mountain ranges to the West of the Great Plains (97, p. 998). Experiments involving varying levels of grazing intensity on mountain ranges are underway on national forest range land in Northern Wyoming, conducted by the University of Wyoming Agricultural Experiment Station staff (128). This study was designed and is being conducted in such a manner as to furnish usable data for determining the optimum level of stocking for range sites similar to that one. The same thing must be done for many range sites. To increase the objectivity of the studies, as well as the acceptibility of the results, such studies should be conducted cooperatively between the interested agencies.

Reliable results from this kind of experiments are very slow to emerge. In the meantime, however, the logic of the maximizing principles and an awareness that there is such a thing as an intertemporal transformation function can be very useful guides for thinking when formulating plans and making decisions concerning the rate of stocking the ranges, whether private or public.

Some of the interesting and complex problems that arise in trying to determine the optimum level of grazing are:
1. To what extent does surplus, unharvested forage result in an increase (or decrease) of forage product over time?
2. To what extent does it result in an increase or decrease
in other products (hydrological products, timber, erosion control, etc.) over time? 3. To what extent does this unused forage increase the probability of loss due to fire? 4. To what extent can inputs for range improvement (reseeding, etc.) in T₂ rejuvenate a depleted range and thus substitute for reducing the level of intensity of grazing in T₁ in producing forage in T₂? This is a very meaningful question for those range sites with a relatively low critical point. This question may be posed in a slightly different context as: 5. What is the effect of short-run (annual) overgrazing caused by entrepreneurial inflexibility? The answers to all of these questions are a part of the inter-temporal transformation function, the relevant part of which our physical experiments should be designed to estimate.

Experiments designed to show the intensity of grazing that will 1. produce the greatest gains per steer, irrespective of the gains per unit of other resources (land, labor, capital) (188) or 2. result in a "favorable" trend of forage species toward a climax vegetation are of dubious value in helping ranchers and land-management agencies decide on the optimum rate of resource use.

b. Criticism of an important experiment. One very important grazing study that has been going on at the Mandan station has been referred to previously. Perhaps the most important single objective of the study, begun in 1915 and
still in process, was to determine the level of intensity of grazing that would prove most efficient. Sarvis stated:

... the most efficient system of grazing is one that will insure sufficient forage during the entire season to produce the greatest total gain, with the least number of cattle on the minimum unit of land, without permanent injury to the native vegetation. (186, p. 66)

The adequacy of this definition may be challenged. In the first place, the forage need be supplied for the "entire season" (whatever that is defined to be) only when so doing results in greater long-time net profit than any other length of time. If society paid a premium for livestock marketed at a date earlier than the usual marketings, some ranchers might contribute more to net social product by harvesting the grass early through intensive grazing than by more conservative grazing designed to extend the forage throughout the entire season.

Second, "to produce the greatest total gain" must be expressed in terms of something. In the analysis the author pleads for maximum gain per steer which, of course, is not correct since steers are a variable resource and are subject to the allocation principles. "The greatest total gain, with the least number of cattle on the minimum unit of land" amounts to no criterion since it is impossible that maximum gain will be obtained when cattle numbers and acres of land are a minimum. Thus one needs to have a priority for
possible compromises. The extent to which an acre of land would substitute for one steer in producing "the greatest total gain" seems to have been ignored in the objectives of the study. To place total gain per steer as a criterion that society desires to maximize ignores both the law of diminishing returns in the production process and the concept of time preference of individuals.

Finally, the definition states that the most efficient grazing system must accomplish its other objectives "without permanent injury to the native vegetation". If this statement means that full consideration be given to the future productivity of the range (T₂ of Figure 10), it can be accepted. If "permanent injury to the native vegetation" refers to injuries that cannot be repaired or compensated for at any cost, this rarely occurs. Permanence of the native vegetation is not an end in itself but only a means to the end of maximum net social product. Alternative means to this end could involve, possibly, an intensity of grazing that resulted in injury to the native vegetation (in times of extreme stress, such as war) followed by grazing deferment, or by reseeding (with or without cultivation), in order to rebuild the range. All of these alternatives need to be investigated and their economic implications over time anticipated.
The data from these experiments could be made more useful than they have been if full consideration to the quality of beef produced and the market prices at the time the beef were removed from the experimental pasture were considered in assessing the value of the returns. If the rate of stocking the pastures were geared to leave a specified percent of the forage standing, the effect of many of the disturbing variables such as rainfall, etc., would be less confounded.

3. **The private firm and flexible levels of resource use**

We have noted that the optimum level of intensity of grazing must be a ratio (per cent of forage grazed) and will vary according to forage productivity which, in turn, varies according to climatic fluctuations. It remains to be seen whether or not such an optimum level is of any use to the rancher who operates on a fixed amount of land with a fixed number of grazing permits (i.e., grazing permits seldom shift upward, although they do shift downward) and limited labor and capital.

Many range management specialists object to any suggestion of varying the number of livestock on the range in response to favorable forage conditions, because they feel that more or less chronic overstocking would result. Granting that much of the past variation in livestock numbers has not been well conceived, this is not proof that a well-planned program of expansion
and contraction would not be economically sound and acceptable to the industry, and maintain range productivity capacity. (39, p. 160)

a. **Different patterns of weather variation.** Perhaps the key to the problem of fluctuations of forage production lies in the nature of the fluctuations in precipitation. It is general knowledge that in the Western Range Area there is high variability of precipitation (131). This is especially important if this fluctuation is about a point that is critical for a particular agricultural use. The usual measurements of variability, such as standard or average deviation, or coefficient of variation, do not reveal the most vital issues of this problem since they ignore the sequence of these "good" and "bad" years.

Clawson and Hockmuth (40, pp. 16-18) have devised a measure of the variation sequence which they call "coefvs" (coefficient of variability sequence) where the tendency for cumulative surpluses or cumulative deficits from the long-time average precipitation is considered. The absolute (without regard to signs) sum of the cumulative surpluses and deficits is divided, first, by the number of years, and, then, by the average deviation. It chiefly represents the tendency for years of high precipitation to "bunch" and for low years to do likewise. The measure has certain weaknesses which the authors (40, p. 16) point out; but the coefvs appears to indicate the pattern of variability.
sequence, although it does not give consideration to any critical point that may exist. Figure 16 shows the pattern of the coefvs for the Western Range Area, which, in general, seems to divide into three broad zones (39, pp. 41-43). The Southern one-third of the region, plus an area in Wyoming and Nebraska, has a tendency to alternate with wet and dry years. The Central Region has only a moderate tendency toward "bunchiness" of the wet or dry years. In the Northern one-third, there is a definite tendency for the years of low precipitation to be grouped in sequence followed by a sequence of high years.

b. **Adjustment to weather variation.**

(1) **Areas of low coefvs.** The kind of adjustment that a rancher should make to meet the conditions of a fluctuating forage supply would depend, somewhat, on the sequence of the variation - the coefvs. Let us consider first those areas of low coefvs where a year of above-average precipitation tends to follow a year of low precipitation. The usual recommendation, in this case, is conservative stocking and carrying an excess of feed on hand. It may be necessary to have an emergency supply of feed on hand to meet the hazards of death loss due to extremely severe and long storms. Beyond that, however, it appears questionable whether this procedure is adequate to meet the problems arising out of extreme weather
Figure 16. Zones of magnitude of coefficients for average annual precipitation in 17 western states 1900-1939 (by permission of The Western Range Livestock Industry by Marion Clawson copyright 1950 McGraw Hill Book Company, Inc.)
variation that characterize the West. Even if it were adequate, it may not be the most economical way of meeting the problem. Flexibility is the prime requisite for meeting this situation, where summer as well as winter feed is highly variable. This would mean that cattle ranches should perhaps be designed to sell long yearling steers, as a usual pattern, in areas where good animal growth is obtained. If an excess of forage is available for winter, the yearling steers could be kept over until spring. If, in the spring, the outlook for forage and price was very favorable, they could be kept until fall and sold as grass fat slaughter beef; or, should either the price or forage outlook appear unfavorable in the spring, they could be sold at that time as stockers. On the other hand, it might be necessary to cut down on the herd as a result of a drought. By selling, in addition to the long yearlings, the heifer and steer calves as well, the rancher could cut down on his winter herd substantially without affecting his breeding herd.

This would mean that the annual "flow" of revenues would fluctuate highly which would require certain social and institutional adjustments. In the first place, there is a limit to the deviation from "normal" flow of income to the household that can be tolerated. A family can cut down materially on its expenditures for a given period in expectation of higher income for family expenditures later
on, but such expenditures cannot be maintained at zero very long. Second, there are many cash operating expenses that are "fixed", such as property taxes and interest, or that are current operating expenses, such as fuel, feed purchases, etc., that must be paid for currently, i.e., they are not geared to a highly variable flow of revenues. To the extent that these two requirements cannot be met with existing credit machinery, a need for revised credit facilities for this area is indicated.

A second type of adjustment that needs to be made is in the accounting period for federal income tax determination. The present annual base for calculating federal income taxes, plus the progressive tax rates, discriminates substantially against the operator who adjusts his livestock sales to better utilize a variable forage supply. Using a longer base, say five or more years, would help to correct this maladjustment.

A third type of adjustment is necessary when the forage variation occurs on public land which is under the direct jurisdiction of a public administrator. Not only must it be made possible for a permittee to increase his livestock numbers in years of favorable forage supply (and decrease them in years of short forage supply), but the fees should be adjusted to make it economically feasible to alter the makeup of the herd. The pricing policy followed by most
federal agencies of charging a full animal unit fee for all
cattle six months of age or over, and of not counting cattle
under six months of age, discriminates in favor of the cow-
calf organization. One cow and a five-month-old calf can
be grazed for the same fee as a seven-month-old calf. This
tends to distort management practices away from what would
otherwise be optimum. Vass and Pearson (279, p. 53) esti-
mated the animal unit feed ratio for the several ages and
classes of cattle to be: cows, 1.00; two-year-old heifers,
.80; two-year-old steers, .85; yearling heifers, .61;
yearling steers, .64; bulls, 1.25; and three-year-old steers,
1.06. On the basis of these figures, a calf could be esti-
mated at about .25 to .30 animal unit for the summer grazing
period. This procedure would not penalize the operator who
wanted to build greater flexibility into his operations by
planning normally to sell yearling steers. There is no
apparent basis for discrimination in favor of those who
sell calves.

A fourth type of adjustment would be the extension of
a practice that is already quite prevalent in some areas of
California, particularly. Livestock are purchased from
outside the area and shipped in annually to consume the
seasonally surplus forage. The amount of livestock pur-
chased could be geared to the expectation of forage. An
excess of forage in a region could be marketed in this manner provided the forage excess did not exist at the same time in all the surrounding regions.

The problem of allocating the forage on public range, during extremely favorable years, that is in excess of the needs of the regular permittees, poses a "knotty" administrative difficulty. The regular permittee may not desire to expand his livestock numbers temporarily in order to utilize the excess feed; yet, he objects to having the excess forage allotted to a new permittee on the grounds that the new permittee may ultimately establish the required priority for a higher preference rating. A somewhat parallel situation exists in some states where non-riparian water rights prevail with respect to the allocation of excess water. The concept of flood-water right has been developed. A flood-water right permits the holder to a share of the water during those seasons when the flow of water is in excess of the legal requirements of those who hold priority rights. This concept may be worthy of consideration with respect to excess forage on the public lands in very favorable years in order to obtain a more efficient utilization of resources over time.

(2) Areas of high coefv.s. Now let us consider those areas of high coefv.s. Here the philosophy of a
constant-level conservative rate of forage utilization is not only wasteful, but may, in fact, be very risky; since it will be difficult to determine the long-run average.

When precipitation averages 25 per cent above the long-term average for ten or more years, then most people are likely to accept the higher figure as being normal. This was true in much of the northern Plains in the early years after 1900. Farm sizes, local government, and many other aspects of economic and social life were based upon an assumption of greater average rainfall than actually occurred. (39, p. 43).

Ranchers show a lag in adjusting to these "cycles" of ups and downs in weather, but they do shift. They shifted downward during the drouths of the thirties and have shifted back during the succession of wet years of the forties and into the fifties. It would have been uneconomic for them not to have increased livestock numbers at a time when rainfall was above average and prices were very favorable. "Had livestock numbers remained constant through these years, ranchers would have missed the best opportunity of a lifetime to accumulate savings" (39, p. 44).

In a study previously referred to, Tompkin found that

The amount of grazing land per animal unit decreased from 35.6 (acres) in 1951 to 27.6 in 1952. The explanation lies in an increase of livestock on ranches in the latter year. Statistical tests for capacity and stocking rate indicated close association between labor income and per cent of capacity at which the rancher stocked. . . . A study of lower income farms generally reveals below-capacity stocking rates. (218, pp. 18 and 44)
The difficulty involved in recognizing the turning points in the weather pattern makes it necessary that the rancher operate with a high degree of flexibility if he is to 1. avoid economic loss of forage during the first year or so of the increased precipitation phase, 2. prevent critical over-grazing, or 3. prevent forced sale of the breeding herd, when the drouth phase begins. The institutional adjustments suggested for the previous case (low coefv s) apply here with even more force.

(3) Forecasting precipitation and forage production. Most of the serious management problems arising from the fluctuating forage supply would be eliminated if the future pattern of fluctuation were known. Information that is currently available indicates a high correlation between annual precipitation and forage production. Experiments at Dubois, Idaho showed almost the same correlation when precipitation from October 1 to June 30 was used instead of annual precipitation (45). The influence on forage production of precipitation during a particular period varies between regions, however. Clawson (35, pp. 4-5) reports from the analysis of range condition and precipitation for the years 1923-1941 that, for the seven states of the Northern Great Plains, the correlation between precipitation during the current year and range condition was .67, varying
from .52 for Colorado to .71 for South Dakota.¹ When precipitation received during the preceding year was added, the correlation exceeded .80 for every state with an average of .86 for the seven states. For the Southwest, the current year's precipitation appeared to be relatively more important than precipitation during the preceding year. This situation was even more pronounced for the three coastal states and Idaho. For New Mexico, precipitation during the preceding year showed a higher correlation than did precipitation during the current year.

Although many variables have been omitted from this analysis, such as seasonal distribution, length of growing season, etc., the results are strikingly suggestive that, for some parts of the West, at least, it may be possible to predict forage productivity of a summer range area from the precipitation accumulation during the preceding 18 to 20 months. This prediction of forage productivity obviously could be improved if it were possible to forecast precipitation.

For the areas of low coefvs, probability theory may provide the proper logic for making forecasts. If the occurrence of a day of drought were random with respect to

¹These statistics have not been corrected for number of observations.
a constant probability, the frequency of drouth would vary as an exponential function of the duration of the drouth and no pattern or cycle would be established. Blumenstock (17) reports that distributions approximating such exponential curves were observed. For areas of high coefs, probability theory would be of little use in predicting since precipitation in one year appears to be not independent of precipitation in the year preceding it. For these areas one must establish a weather pattern if prediction is to be useful.

The use of dendrochronology as a tool to construct historic patterns of precipitation has been used since Douglas developed the technique of tree ring analysis (192). Weakly states that

The correlation coefficient indicates a very significant degree of relationship between annual rainfall and tree growth in the western part of Nebraska. This is still more true if the correlation is based on rainfall from October 1 to September 30 rather than for the calendar year. (290, p. 818)

He concluded that the tree rings did not indicate any regular recurrence of certain weather conditions with a definite periodicity, but that they did show an alternation of wet and dry periods extending over several years. According to his interpretation of the tree rings there have been six drouths in that area during the last 400 years of over 10 year's duration. Twice the drouths have extended over 20 years.
Although tree-ring analysis indicates that climate is not changing substantially, it apparently provides little basis for predicting weather pattern. For areas of high coefvs, weather pattern of the preceding year may be the "best" estimate for the coming year. This would work for most years except those occurring at the turning points. This, again, emphasizes the importance of operational flexibility.

Although there is little basis for predicting the future pattern of precipitation, the job of predicting forage production is not so hopeless since several preceding (known) events affect future forage production on a given range. Greater study is needed to determine more accurately the relationship between past precipitation, frost, etc., and future forage production. Should the rainmakers prove to be successful in affecting the distribution and/or amount of precipitation, this would be another variable that could be partially controlled and future forage production could be predicted with greater precision.

D. The Intensity of Resource Use and Maximum Welfare

Thus far in our discussion of intensity of grazing we have emphasized entrepreneurial profits. We are still
interested in maximizing net social product of which entrepreneurial profit is only a part. If entrepreneurial profits to ranchers have increased as a result of their producing more livestock products than would otherwise have been produced, it appears, at first, that surely net social product has increased, also. This requires closer scrutiny.

At the risk of repetition, let us state that the rancher's solution to the problem of determining the best rate of grazing the range is to stock each range at a rate (during his expected period of control of that particular range) that will maximize his discounted stream of expected profits from all of his resources (over his economic horizon). This solution would maximize the net social product from the resources in question only if the rancher's tenure expectation on this range and his economic horizon were comparable, and if his economic horizon did not conflict with that of society.\(^1\) The importance of secure tenure expectations is again emphasized.

\(^1\)The two need not be of the same dimension; e.g., assuming there are long-time weather cycles, if the rancher's decisions in the use of a particular range under his control resulted in a maximum total net social product over one complete weather cycle, it also would be likely to maximize total net social product over a longer period, say five complete weather cycles, as a first approximation.
Another point of conflict may arise when products (uses) other than those considered by the rancher are affected by his decision to alter the intensity of grazing. This may be the case when timber, recreation, or watershed protection are important products from the resources. These other products may be very important and still not be affected by an increase in intensity of grazing during favorable years; on the other hand, they may be seriously affected by intensive grazing. It is only when they are adversely affected by an increase in grazing that our previous solution will not hold. The following chapter will be devoted specifically to this problem.
CHAPTER XI
OPTIMUM PRODUCT RELATIONSHIPS CONTINUED —
MULTIPLE-USE

A. Application of the Marginal Condition

The multiple-use of resources is not new. Agricultural economists have been dealing for some time with the economic problem of selecting a most profitable crop or combination of crops from among the possible crop sequences (80). Out of this experience has come the logic and method of determining the optimum enterprise (product) combination. The economic principles of optimum enterprise combination apply with equal validity to range resources as to any other kinds of resources. The necessary condition pertaining specifically to enterprise (product) combination states that an optimum combination of products has been obtained when all possible products have been substituted for one another in the production process to where the gain from the last unit of the increased product just offsets the loss of the last unit of the decreased product. For those products that are exchanged in the market, this can be stated specifically in terms of market prices as
\[ \frac{\Delta X_2}{\Delta X_1} = -\frac{P_1}{P_2} \]  

(VIII)

where \( X_1 \) and \( X_2 \) are separate products and \( P_1 \) and \( P_2 \) are the prices of those respective products.

The iso-product relationships can be defined as either competitive, supplementary, or complementary depending on the marginal rate at which one product is technically substituted for another (78, p. 234). If

\[ \frac{\Delta X_1}{\Delta X_2} \text{ or } \frac{\Delta X_2}{\Delta X_1} \geq 0 \]  

(IX)

an increase in one product is accompanied by an increase in the other product and the relationship is complementary. If

\[ \frac{\Delta X_1}{\Delta X_2} \text{ or } \frac{\Delta X_2}{\Delta X_1} = 0 \]  

(X)

output of one product can be increased without changing the output of the other product and the relationship is supplementary. If

\[ \frac{\Delta X_1}{\Delta X_2} \text{ or } \frac{\Delta X_2}{\Delta X_1} < 0 \]  

(XI)

output of one product can be increased only at the expense of decreasing output of the other product and the two
products are thus competitive. It can be seen at once that the optimum combination as specified by Equation (VIII) can be obtained only in the competitive range of enterprise relationship - in Equation (XI). This obvious point is emphasized only because so much of the research, so many of the recommendations of specialists, and so many of the arguments of pressure groups tend to ignore this basic relationship when dealing with range resource allocation.

There are two difficulties that are confronted in trying to apply this condition to Western Range Resources. The first is the presence of administered prices for some resources. This problem is serious only insofar as the administered prices deviate seriously from market prices of comparable resources. We have already discussed this problem at length and made certain recommendations. The second difficulty is that of finding a suitable medium through which to express a ratio of preference between products when some of the products traditionally have not been subject to evaluation in monetary terms.

B. The General Equation for Solution

The important multiple-uses of Western Range Resources are usually grouped as follows: livestock, wildlife, timber,
recreation, and hydrological products - both the quantity and timing of useful water yield and the prevention of flooding and sedimentation are included in this last category. The problem is one of combining these uses on a given range site in such a manner that the total net product will be maximized. The following is suggested as a general solution. If we designate the above-named uses as \( X_2, X_3, X_4, X_5 \) and \( X_6 \) respectively, and total resource inputs as \( I \), then the transformation function defining the iso-product contours is given by,

\[
F(I, X_2, X_3, X_4, X_5, X_6) = 0 \quad (XII)
\]

The problem of defining the units of measurement for each of the uses (products) must not be ignored. This will be discussed at greater length later in this chapter. At the present time we must be content to assume that the units have been defined and are measurable and that the discounted prices have been estimated.

For a given level of resource inputs the optimum resource allocation would occur when

\[
\frac{\frac{\partial F_2}{\partial X_2}}{\frac{\partial F_3}{\partial X_3}} = \frac{P_2}{P_3} \quad (XIII)
\]

\(^1P_i\) is used to denote the partial derivative of the transformation function with respect to \( X_i \); \( P_i = \) price of \( X_i \); \( i = (2, 3, 4, 5, 6) \).
For a given range site the resource inputs usually are not given, however. Land, of course, is fixed, but capital and labor are variable both as to quantity and form. Investment may be in several forms of range improvement, as noted in Chapter V, or it may be in the form of roads, trails, tree seedlings, erosion control, etc. Each form of capital and labor investment is subject to the law of variable proportions when applied to a given land area under a given management, and thus an optimum level of capital and labor input (optimum factor combination) can be determined for a given range site. Although the above model does not provide for a solution to the factor combination and the product combination simultaneously, the problems must be worked out jointly. A separate product allocation solution will be needed for each of several factor combinations until the optimum optimorum situation has been obtained as nearly as is feasible.
The above general solution assumes that the transformation function is either known or can be determined for a given range site. In most instances, this is a very complex function owing to the interrelationships of complementarity, supplementarity, and competitiveness that exist between the several alternative uses. This limitation alone makes the general equation solution of dubious value as an analytical device.

C. Approximation by a Series of Partial Solutions

A more useful approach to the problem of optimum resource-use combination may be through a series of successive partial solutions. We will consider two alternative products (uses) at a time, starting with a restricted case. When an optimum combination of these two products has been obtained, that combination will be treated as a single product and another product will then be considered for combination with it. This process will be repeated until as many products have been considered together as seems warranted. An optimum combination of two products legitimately can be considered as one product for purposes of this phase of the analysis if 1. the two products being combined are (a) highly competitive (very close substitutes)
or (b) technical compliments, and 2. if the enterprise relationships with the other products are substantially the same for the two products being considered. We will need to examine, as closely as possible, the extent to which this is true in each case. Additional adjustments likely will be necessary to reflect the true interrelationships of all products.

1. **Optimum combination of domestic grazing**

Even in the absence of wildlife, all grazing lands are subject to alternative products since alternative domestic livestock may be used. Essentially sheep and goats utilize the same forage resources and are strictly competitive (direct technical substitutes) in the use of range forage. Aside from the Edwards Plateau of Texas, and some of the small bands operated by the Indians in the Southwest, goats are unimportant in the Western Range Area. This combination can be considered as one product that we will call sheep. Cattle and sheep are the important alternatives for domestic grazing for which an optimum combination will be determined.

There are some areas that, from the standpoint of quantity of livestock products which can be produced in a given time, are better adapted to one class of livestock than to another. For most ranges, however, either class of livestock
(or both classes) can utilize the same range. The marginal rate of technical substitution of one enterprise (sheep) for another (cattle) may be at a decreasing, constant, or increasing rate (represented respectively by Curve A, B and C of Figure 17), depending on the type of range. In the earlier days of struggle for control of the range the belief predominated that sheep and cattle could not use the same range. While still a territory, Idaho enacted a law prohibiting the grazing of sheep on range previously occupied by cattle. A case arising under this law was taken to the Supreme Court to test it for violation of the fourteenth amendment, and, although the law was passed by the territory, regulating the use on federal land, the law was upheld (88, pp. 480-481). This kind of thinking still prevails with many ranchers and grazing associations, and most public grazing land is considered as being either sheep range or cattle range, but not both. Very seldom is it switched from one to the other. This would be the proper solution to the problem only if a decreasing or constant marginal rate of technical substitution existed between sheep and cattle (curves A or B of Figure 17).

A much more reasonable assumption is that an increasing marginal rate of technical substitution exists. On a given range site there are many different forage species. They include annual weeds and forbs, perennial shrubs that are
Figure 17. Hypothetical iso-resource curve - cattle and sheep
more palatable and nutritious to sheep than to cattle, and
the coarse grasses that are preferred by the cattle. This
relationship is represented by Curve C in Figure 17, where
for all price ratios varying between \( P_1P' \) and \( P_2P' \) some
combination of both sheep and cattle would be optimum. For
price line \( P_3P' \) a combination of 4,000 head of cattle and
10,000 head of sheep is specified.

The above model assumes equal resource inputs not only
of range land but of labor and capital, which may not hold
in some instances. Range sheep require closer supervision
than do range cattle. Unless they are under the direct
watch of the shepherder they must be placed within a sheep-
tight fence. This might alter the solution specified above
when the additional costs are considered. There are some
important economies of scale in the production of sheep and
cattle that must not be overlooked.

To encourage adjustment to an optimum combination of
domestic grazing, greater information needs to be known about
the use adaptability of the range. This would call for a
wider application of the detailed range survey. Once the
enterprise relationship has been estimated for a given range
area, this information needs to be made available to the
ranchers using that area. Before the adjustment could be
made on public grazing land, the procedures of adjustment
would have to be worked out by the administering agencies.
At present those agencies consider five sheep to be equivalent to one cow. In those rare instances where adjustments of this kind are made, the rate of substitution is constant at five sheep to one cow.

Let us consider the procedure for adjustment on a given public range where only cattle have been permitted previously. Assume that the enterprise relationship between sheep and cattle on this range, as estimated from detailed range surveys, is shown by curve C of Figure 17. The assumed price ratio between sheep and cattle is represented by the line $P_sP_j$ and the optimum combination is represented by point K. According to curve C, by removing 1,000 head of cattle from the range 10,000 head of sheep can be added and still leave the range in the same condition as when grazed only by cattle. The ranchers using this range should be allowed to exchange permits by obtaining permit for 10 sheep for each cattle unit permit relinquished, up to the point where the 1,000 head of cattle have been removed and 10,000 head of sheep have been added. If adjustments were to be allowed only on the five to one ratio normally used by the public agencies, no adjustment would occur because the price ratio is 6.25 to 1.00 (see line $P_oP'_o$, which is parallel to $P_sP_j$).

Conceptually and analytically no serious problems are encountered in determining an optimum combination of these two products. Because the production periods are both
relatively short, the rate of discount will be unimportant and the relevant expected prices can be used directly with no appreciable influence on the analysis. The units of measurement can be number of head of each which combines the products of each into one single entity for which comparable prices can be obtained.

2. Livestock versus wildlife

Having determined the optimum combination of sheep and cattle, let us now consider this combination as one product, which we will call livestock, and consider the relationship between it and wildlife on the same range. The forms of wildlife that are important for our study are deer and elk (only rarely are moose numerous enough to be considered)\(^1\) in the mountain areas, and antelope in the prairie and semi-desert areas. In those areas where deer and elk are found together, greater study is needed to determine the "best" combinations of these, using the same logic as outlined in the previous section. Since the forage preferences of the two are somewhat different (199 and 195), supplementary relationships undoubtedly exist; also the preferences of sportsmen for one species or another may change as the...

\(^1\)By wildlife, here, we are referring to big game. Other forms of wildlife are very important for other forms of recreation or furs. There are also rodents and predators.
relative numbers of each are altered. It is thus important that attention be devoted to determining the proportion that each species should represent of the total game in a given area.

There are more deer on most ranges today than ever before (148). In some areas they have reached the starvation stage and serious conflicts with other uses have arisen. Most studies of these conflicts have been done by one special interest or another. Only rarely have the opposing groups been brought together to study the problem jointly (225). Little attention has been devoted to the problem of determining the real physical relationship between game and livestock. The physical transformation is not known; however, most decisions and arguments that are made by interested parties seem to take one of two extreme points of view: 1. that the relationship is perfectly competitive, or 2. that a supplementary relationship exists over the entire range.

It is suggested that the enterprise relationship between livestock and game might be shown in the general framework of Figure 18. This model suggests that a supplementary relationship exists at the lower level of domestic grazing. The maximum number of game that can be carried on a given range area without supplementary winter feeding is represented in Figure 18 by the distance OC. That number will not consume all the grass during the summer, but it will
Figure 18. Hypothetical iso-resource curve - livestock and wildlife
keep most of the forbs, herbaceous shrubs, and other browse-
type vegetation grazed down fairly well. This will permit
the quantity of livestock without materially affecting the
condition of either the game or the range. If supplementary
winter feeding of game is practiced, the can be lengthened,
at which time undoubtedly would be diminished some, de-
pending on the type of range and the prevalent species of
game.

At the other extreme is the maximum number of livestock
that can be grazed (OG of Figure 18). This would be the
optimum rate of stocking over time as discussed in the pre-
vious chapter. The model suggests that when livestock
are grazed, there can be OH game on the same range. The
amount of shrubs and underbrush would likely increase if
the quantity of game were diminished much below OH. This
would tend to decrease the amount of forage preferable to
livestock, and the maximum number of domestic animals that
could be grazed would ultimately decrease.

Clearly the relationship between these two enterprises
will differ between range sites and will be altered some-
what as the species composition of livestock and game varies.
Further, the degree of competitiveness between the two
enterprises can be materially affected by the timing of
the "harvesting" of the product, in each case. When the
game are harvested while the livestock are still on the
same range (as is sometimes done) a definite conflict arises.

Let us assume, for the moment, that individual preferences for the products from livestock and game can be expressed through the market in terms of prices. The price ratio would show the aggregate relative preference for one product or the other. For the price ratio represented by the iso-revenue line $P_1P_1'$ the optimum combination would be $OE$ livestock and $OA$ game. If there should be a stronger preference for game relative to livestock, as illustrated by the price line $P_2P_2'$, then $OB$ wildlife would be optimum and the domestic livestock should be reduced to $OD$. In all cases, a rational decision would require domestic grazing equal to or greater than $OJ$, and wildlife equal to or greater than $OH$.

a. Appraising the preferences for game. We have tentatively assumed that the preferences for game could be expressed in terms of prices. This assumption may not be justified since game are not sold in the market in the conventional manner. Rather, a permit entitling the holder to hunt, kill, and retain possession of one of each game species is sold to individuals at a nominal fee. The procedure for distributing the permits differs among states and within states, depending on the game species. In most instances
some degree of rationing is used that supposedly gives each
citizen of a particular state who desires a permit an equal
chance of receiving one. Out-of-state applicants are dis­
criminated against by having a more limited number of
licenses at considerably higher prices.

It is generally accepted that the cost of the license
does not reflect the preference of individuals for game.
However, there have been some attempts to really measure the
total expenditure for hunting in an area by asking each
hunter what he spent on his hunting trip, and how much he
had invested in hunting equipment. A very close check can
be obtained since all legal hunters are registered when their
licenses are purchased, and they are usually checked when
going on and off an area open to hunting. The total amount
spent for hunting and the total number of each species
killed provides an estimate, in monetary terms, of the pre­
ference for game which would be meaningful in those instances
where the total number of permits issued is sufficient to
meet the demand. Under conditions of severe rationing, this
procedure would be less useful, since rationing, generally,
prevents the market price from reflecting the economic value
of a commodity.

There are undoubtedly a great many people who obtain
satisfaction (and value) not from hunting to kill - either
for food or for sport - but from hunting to observe or to
photograph. They would hold that the aesthetic values of wildlife, including game animals, are "largely intangible and purely personal" (15, p. 278). It is difficult to know whether such satisfactions would be increased or decreased by increasing wildlife numbers. One obviously obtains greater satisfaction from watching a rare bird than from observing a sparrow. As deer in the pasture became a commonplace, the satisfaction obtained from observing them, and from reporting such observations, is diminished.

The problem of scarcity and value was of particular concern to the classical economists and was resolved, for the most part, by the marginal theory of value. Cournot cites the case where an individual, possessing the only available copies of "des Memoires de l'ancienne Academie des Sciences" (44, p. 6) increased his total revenue from their sale by destroying many copies, thus raising the marginal value of the last available unit, and thereby raising the price. One might argue that the total satisfactions (utility) obtained by all individuals would surely have been greater had all copies of the book been sold. This need not be so, however, if the satisfaction obtained from possessing one of the remaining copies is derived from the fact that so few copies were available. Comparison between the two situations (before and after) is complicated by the fact that the "goods" concerned are quite different. The single
cow in the Bronx Zoo possibly has aroused more comment and been the source of more satisfactions than any other single animal in this country. She is certainly a different commodity than a cow in a dairy herd in upstate New York.

There is no way to measure the gain in satisfactions to those who seek after rare species, because they are rare, associated with a decrease in the number of that species. It is equally as difficult to measure the gains in satisfaction to the increasing number of people that come in contact with wildlife as the number of wildlife is increased. Black suggests that "any possible measures of the aesthetic . . . values of wildlife will have to be psychological, and probably relative to other objects or uses of time or money" (15, p. 279).

Any attempt to determine the amount of money spent for game should include the money spent by everyone in the pursuit of game, whether to kill, observe, or listen. This figure is not the same thing as total satisfactions\(^1\), but it is our best estimate of the economic value of game. Wallace introduces his report on a study of the economic

\(^1\)Marginal utility theory recognizes the presence of consumer surplus (142, pp. 124-133) as being the difference between what was paid for a unit of a commodity and the maximum amount that would be paid for that unit.
aspects of wildlife resources of the State of Washington by stating:

So long as free individuals are assumed to be the best judge of their own needs and wishes . . . the relative importance of various goods and services to society can be measured only by the relative expenditures which the members of society are willing to make in order to obtain them. Thus, it should be clear that expenditures which members of society make in the pursuit of wildlife as compared with expenditures made for other goods or resources represent the only clear basis for comparing the contribution of each to society's happiness and welfare. (287, pp. 1-2)

In the above study, a random sample of sportsmen were questioned about expenditures. Only Washington residents who purchased a hunting or fishing license were included in the sample. The questions covered all expenditures incurred in the pursuit of fish and game including investments in clothing, boots, fishing and hunting equipment, dogs, cameras, etc. The figures undoubtedly overestimate the annual expenditure for game since many of the purchases are made only once in a lifetime. It assumes that the annual expenditure for all equipment that will endure for many years just offsets the annual depreciation of all such equipment in the universe being studied - an assumption that is highly unrealistic and unnecessary. A more realistic accounting technique would be to determine annual expenses, including an estimate of annual depreciation on capital goods used for the pursuit of game.
The study does point out the possibility of obtaining a measure of the economic importance of game, and thus provides an estimate of the price. For instance, the per-capita expenditure for big game hunting in Washington for 1950 was reported to be 88.00 dollars (287, p. 15). This could be alternatively reported in terms of expenditure per big game license.

b. The difficulty of integrated decisions regarding domestic and wild animals. As stated earlier the ranchers and the federal government own most of the range land and determine the number, kind, and location of the livestock. The states, however, own the game and make final decisions on the location, timing and amount of harvest, etc., under the influence of the local sportsmen's organizations. "An additional hazard of control lies in the fact that forage consuming game animals do not know, nor do they care, who owns the land upon which they graze" (223, p. 733).

Assume a particular range, represented by Figure 18, on which there was OA game and OE livestock (which was optimum for relative preferences as expressed in the price ratio \( P_1 P'_1 \)). If, however, research showed a new price ratio \( P_2 P'_2 \) the state wildlife department would then initiate a program to increase wildlife to OB in order to increase total welfare. Ultimately the ranchers (and the federal land administrators) would need to reduce livestock numbers. It is
possible, under these circumstances, for the ranchers to be dispossessed, in essence, of certain "property rights" and substantial income.

c. Compensation for losses. Suits against state governments for damages done by game have not been successful, as a rule, in obtaining recompense to the rancher for loss of range forage to game. The average annual payment for damage claims paid to private operators by the Wyoming Game and Fish Commission for the ten-year period 1943-1952 was 10,950.45 dollars, which is quite negligible when one realizes that nearly 140,000 dollars was spent for winter feeding of elk for the year 1951-1952 (299, pp. 18-19). It is evident that if no one is to be made obviously worse off by the change than he was before the change was made, it will be necessary to compensate the ranchers for the loss.

One method of compensation that can be applied with a minimum of administration is through the hunting license. All that is required is that the license fee be increased to the sportsman to cover the cost of compensation to the rancher. A coupon attached to the hunting license could be detached by the sportsman when the kill was made. The coupon would be signed by the sportsman and delivered to the rancher on whose property the game was killed. The rancher then would submit all such coupons to the appropriate state official for compensation. The method assumes that
the loss to ranchers is proportional to the number of game killed, which seems reasonable for most areas. However, it does not cover the situation where game damage a given range but migrate to a new locality by hunting season. A more direct form of compensation would be needed in this case if the rancher is to be made no worse off than previously.

This procedure has been followed in very recent years in Wyoming with the antelope hunt. Both ranchers and sportsmen have reacted favorably to it. Many private lands that previously were closed to hunters have been made available to them. During the 1953 hunting season, landowners in the antelope hunting area of Northeastern Wyoming began the practice of charging hunters an additional 10.00 dollars per antelope killed on their land. No figures are available as to the effect this action had, or will have, on the number of antelope harvested. Further study is needed to determine the extent to which the amount of compensation should be shifted in order to more accurately compensate for the damage. The method should be equally as applicable to other game species where private lands are involved to an important degree.

Another form of compensation that is being used at an increasing rate is that of direct payment by the sportsmen to the ranchers for services rendered in connection with
hunting. Many ranchers are finding that the presence of increased numbers of game provides a remunerative market for those services that have come to be associated with dude-ranching - rustic living accommodations, horses, guide services, pack services, etc. (71). In this case, the economic analysis of the rancher is similar to that of selecting the optimum combination of sheep and cattle with the exception that the important decisions about the number of game in an area are made by state officials.

3. Forage versus timber production

Having determined our best estimate of the optimum combination of livestock and game on a given range area, let us again broaden the scope of our analysis. We will now consider this optimum combination of animals as one product and try to determine the optimum combination of animals and timber. Since all of these animals are forage consuming we will represent changes in their numbers by changes in AUM's of forage. Except where otherwise specified, we will assume the forage is harvested at a rate not higher than that which is intertemporally optimum according to the criteria outlined in the preceding chapter.

There are very few empirical data to show the physical relationships between these two products. Decisions relative to resource allocation between the two are constantly
being made, however, most of which imply a competitive relationship. Based on the logic of production economics, and a limited knowledge of range management and silviculture, it is proposed that the relationship between livestock and timber production can be represented by Figure 19. The model implies a complimentary relationship at the lower level of livestock production. This can be explained by

1. an increase in timber fire hazard when the grasses are not grazed off before drying, 
2. increased competition for tree seedlings from forbs and shrubs when no grazing occurs, and
3. a better control of certain tree diseases obtained through control of underbrush.

The model further implies an increasing rate of product substitution (the curve is concave from the origin). The maximum amount of animal grazing, as specified by the criteria for optimum intertemporal rate of grazing (Figure 10), is OA. A rate of animal grazing higher than OA would compete heavily for new tree seedlings and would ultimately reduce timber production. A rate higher than OA could not be continued indefinitely, however, since it also would reduce the amount of forage produced. The nature of the above relationship would differ from one range site to another depending on the climate and soil, the species of the trees, and the kind of livestock. Stocking at a rate beyond that which was determined to be intertemporally
Figure 19. Hypothetical iso-resource curve - forage and timber
optimum for forage production would compete more seriously with timber production in the case of game than with cattle.

There is need for physical experiments on substantially different range sites designed to determine the effect on timber production of varying intensities of animal grazing. The range of variation of intensity of grazing should be broad enough to identify points $M_x$ and $M_f$, and to approximate the slope of the line connecting those two points (188). The projects would have to be of sufficient duration to indicate any effect on timber stand (tree growth) as well as the effect on tree seedling development. Experiments designed to eliminate the confounding of external forces, such as moisture variation, may be costly, but experiments conducted on a single given range site will be helpful. In commenting on the results of an experiment conducted by the School of Forestry, University of Idaho, on cut-over white pine timber land in Northern Idaho, Jeffers stated:

Indications to date are that controlled sheep grazing, gauged by the capacity of the forage, is not harmful to white pine reproduction, and has little effect on other species, may help in the control of blister rust, and is a direct aid in the reduction of fire hazard. . . . Grazing of cut-over forest vegetation at a comparatively early stage plays a major role in the rate of successful development. (109, p. 629)
a. **Units of measurement for forage.** There are numerous measures of output for both forage and timber; it is doubtful if any single measure can be found that will be best for all measurement problems. One must always relate the methods of measurement to the specific problem at hand and select the method on the basis of 1. the precision of measurement that is needed, 2. the costs of the methods of measurement (relative to one another and/or to measurement precision), 3. the funds available for the study, and 4. the professional competence of personnel making the study.

The usual measurement for forage productivity is the AUM which has several limitations as currently used. It combines the concepts of "proper use", animal nutritional requirements, and forage quantity and quality, all of which may be confounded by different rates of substitution of one species for another in supplying the animal requirements. This measurement does not mean the same to all individuals, however, even in physical terms. Questions relative to 1. the amount of animal gain or loss, 2. differences in food requirements for maintenance of body weight and for gain by seasons, 3. the effect of supplementary feed need to be answered before the AUM can become an acceptable standard of measuring forage productivity. These are obstacles that can be surmounted, in part, by definition and
by further experimentation. For most purposes of analysis, it will be more useful to define AUM in such a way that it measures a given amount of nutrition, leaving the problem of interpretation as a function to be performed separately in the light of specific objectives.¹

b. Units of measurement for timber. In one respect, the measurement of timber output is less difficult than measuring forage productivity. It is harvested directly by man into products that are readily measurable. The fact that there are many different kinds of timber products makes the problem more complex but no more profound. Each kind of product can be converted either to equivalent value or equivalent volume. However, it is seldom meaningful to measure the annual productivity of timber on a given site

¹The problem of range forage measurement for economic analysis is generally recognized by research workers. Studies are currently being conducted by the Western Range Regional Economics Research Committee designed to improve the tools of economic measurement of range output. The specific objectives of the study are:

(1) To appraise present measures of range productivity in terms of their usefulness for economic research, (2) To establish definitions and criteria for measures of range productivity which have accurate economic significance, and (3) To test empirically the adaptability for economic research . . . those measures of range productivity currently in use, and others which may appear useful. (175, p. 37)
by the annual harvest. "The fact that trees are both factory and product" (301, p. 171) makes it difficult to determine the annual production on a given site. As a tree approaches maturity the annual growth diminishes. In a mature virgin forest the annual growth, as measured by inventory change plus timber harvest, may actually be negative.

For our purposes in this discussion we will consider timber growth in terms of annual productivity determined by adding any inventory change in timber stock to the annual harvest. The unit of measurement can vary from one site to another depending on the important types of timber products removed. Where saw lumber is the primary product, board feet of lumber may be the appropriate measure. Where veneer logs, mining timbers, cooperage bolts, pulpwood, etc. all come from a given site, cubic feet of timber (in stumpage) will be a more convenient unit of measurement. (In Figure 19 we are using the latter measurement.)

c. Price determination for forage. The problem of price determination for livestock and game, as discussed in a previous section of this chapter, is of equal importance in evaluating the forage. If we assume that the several species of animals have been substituted for one another to the point where the marginal rate of substitution between any two species is equal to the inverse of their price
ratios, then the value of an AUM of forage will be approximately the same for each species. We can then simplify the problem slightly by evaluating an AUM when used by one species - cattle, for instance. If the above assumption cannot be made, then a separate evaluation must be made for each species and an average value (weighted by the relative numbers of animal units of each species) determined. Even when only one species (cattle) is involved, the problem is complicated by the fact that the AUM of forage may be worth more to one rancher than another, depending on the rate of transformation of grass to livestock product and the relative scarcity of forage at that particular season.

Most of the land areas in the West where both timber and forage production are important are federal lands. As noted in Chapter VIII, the privilege of grazing livestock on these lands is rationed and the grazing fee is not competitive. Several different ranchers usually graze their livestock together on the same range. Under these conditions it is impossible to obtain a grazing fee (value of an AUM of forage) that would represent the value of marginal product to all users. An approximation of the "average" value product is about the best that can be hoped for. If the suggestions on forage pricing, as previously outlined, were to be followed, this price could be used to represent the market value of an AUM of forage.
d. **Price determination for timber.** The need for using the discounted expected prices instead of present prices is obvious when considering decisions involving the future use of timber since the production process is usually from about 50 to 150 years. Beyond a certain stage of growth, trees may be valued in terms of 1. present yield of timber, if harvested, multiplied by current prices, or 2. future timber yield multiplied by expected future prices discounted to the present time. That the discounting of future prices is necessary when evaluating future yield can be shown by comparing the two alternatives above. If the possibility exists of harvesting the timber now and investing the proceeds in securities whose value at the end of some specified future period will be greater than the value of the timber would have been at the end of that period had it been permitted to grow, the first alternative would rationally be selected.

(1) **The discount rate.** There has not been general agreement in the forestry profession as to whether or not interest should be charged at all, or, if it is to be charged, what the effective rate of interest should be. Fisher (58, p. 278) has suggested that an effective interest rate, including risk, should be equal to the pure rate of interest divided by one minus the chance of loss. In the case of federal forests, the cost of long-time
government securities could be used to represent the pure rate of interest. This should be corrected by an estimate of the risk arising from fires, disease, windstorm, etc. The Tillamook burn in Oregon in 1933, the loss from chestnut blight, the New England hurricane of 1938, and unusual dendrotonus damage in overmature coniferous stands are all extremes in timber losses (70, p. 5), but they remind us that timber stands are not secure. Some of these risks decrease in importance as the stand matures since the timber can be harvested after damage without serious loss of timber. This is particularly true of disease. Sufficient experience and data are usually available for a given region to permit an estimate of the risk of loss of timber associated with not harvesting it in any given year.

For privately owned timber, the rate of interest for discounting would be determined by the internal opportunity cost of capital (adjusted for differences in the relative risk situation between alternatives). That is to say, if a private operator has the opportunity of harvesting the timber and investing the funds in his business so as to return 12 per cent per annum, the future price of the timber should be discounted at 12 per cent. There are additional risks involved for the private operator beyond the risks for public forests. There is danger of trespass and of not getting the labor at the right time in order to hit a favorable market,
etc. Although a federal agency may have sufficient acres of timber that it can spread the risk of product loss, this is not possible for many private timberland owners.

If we consider 2.5 per cent as representative of the cost of long-term capital to the federal government and assume the probability of timber loss to be one-tenth, then, using Fisher's formula, the discount rate would be

\[
\frac{2.5}{1.00 - .10} = 2.78 \text{ per cent.} \quad (XVII)
\]

(2) Determining future prices. The fact that at any given time (whether present or future) substantially different prices are obtained for the different kinds of timber products does not seriously complicate the problem of price determination since weighted average prices can be used. Nor is the analysis seriously hampered by the differences in the time span required for the production of the several products. This difference can be accounted for by discounting future prices. The serious problem is that of forecasting prices into the future for each of the several products. In some cases, the product in question will not be available for market for upwards of 50 years. This is a problem of estimating the future supply and demand
schedules for the timber products and relating these to the particular geographic area in question.

(a) **Supply of timber products.** In discussing the supply schedule for timber, Marquis (140, pp. 27-37) makes a distinction between "virgin timber", the value of which is derived from the value of its products, and "produced timber" whose value is the result of measurable cost. He holds that the stumpage value of the first is product-price determined, while the stumpage value of the second is product-price determining. Zivnuska opposes this distinction and points out that:

> The cost element in the determination of market price is essentially the seller's anticipations of future prices. . . . Thus in the theoretical determination of the market price of stumpage the influence of cost of production on the position and shape of the supply curve is the same for timber of a particular quality whether it is virgin or second-growth. (301, p. 168)

It is evident from his further argument that Zivnuska is talking about a planning period that is short relative to the production period of forest trees.

Marshall emphasized that "the longer the period, the more important will be the influence of cost of production on value" (142, p. 349) since it will affect supply. For most planning decisions Zivnuska is correct. However, long-run planning by an agency such as the Forest Service can materially affect the future supply by present (and
future) decisions. All forces that affect the future supply of a commodity will affect the market price.

Forecasting the supply of timber for a particular time in the future is complicated by the fact that although there is a very slow change in the amount of annual timber growth over a long period of time, there are pronounced short-period variations in the amount that is harvested. The most likely expected supply of harvested timber for any one of a large number of future years will usually correspond to the annual timber growth. If a supply much greater than the annual growth were harvested over a period of years, both the inventory supply and annual growth would soon diminish. If a supply much less than the annual growth were harvested, the inventory supply would increase for a while, but the annual growth would soon diminish as the timber stand became more mature. The "sustained yield" concept is reasonable as a concept for planning long-range supply, although it may be less reasonable as a policy or program of action, except in isolated instances where the stability of the community itself warrants the cost.

(b) Demand for timber products. By far the most important raw timber products nationally are sawlogs, veneer logs and pulpwood (112, p. 382), although other products may be more important, locally. The demand for timber products is associated directly with the demand for building
construction and the demand for paper. The latter varies somewhat with general business fluctuations. "Building cycles are cyclical fluctuations in the volume of private residential, industrial, and commercial construction, alteration and repair" (300, p. 70). Both short cycles "about the same length as business cycles", and long cycles, of 15 to 20 years duration, have been reported. Knowledge of historical cyclical fluctuations may be helpful in forecasting demand in the near future, but would be of doubtful help in predicting demand for the distant future. Of greater concern are the changes in consumer tastes relative to timber products versus substitute products and changes in technology that affect the supply of wood substitutes.

There has been a general downward trend in the relative consumption of lumber since 1890. During this same time lumber prices have increased three times more than have other building costs (108). The upward price trend for softwoods appears to have been greater, generally, than the trend for hardwoods (204, pp. 19-24). Nearly three-fourths of the present stock of softwoods are in the Western Area (256, p. 50), although most of the growth occurs in the Southeast.

Data prepared by the Forest Service for the President's Materials Policy Commission (271) provides greater detail into the nature of the future demand for timber products. It reports that consumption is declining for cooperage,
hewn ties, fuel wood, and piling. According to Forest Service estimates, the requirements for timber products for 1975 will be 14.7 billion cubic feet (in terms of forest drain) as compared to present consumption of 12.1 billion cubic feet. Use of domestic pulpwood is estimated to increase from 1.7 to 2.9 billion cubic feet, while the need for veneer logs and bolts is estimated to increase from 0.5 to 0.8 billion cubic feet. Other uses are estimated to decrease from 2.3 to 2.0 billion cubic feet (271, p. 36).

The above estimates are in terms of "potential lumber requirements", which apparently ignore relative prices. The term has been defined as

... the quantity of timber products that might be used by consumers afforded reasonable latitude in choice of readily available materials, including timber products, in a national economy functioning at a high level of income and output. (257, p. 1)

Rettie (178, p. 241) distinguishes between estimates of requirements and forecasts of consumption, since the latter will be influenced by deficiencies in supplies. It appears to this writer that "potential requirements", as used in these studies, is a subjective value judgment, although Rettie implies otherwise. Vaux and Zinuska maintain that if the estimate of potential requirements is to be economically significant, the "adequacy" of the supply most be logically defined.
When the rate of production is in such a state of balance with the rate of consumption that the average costs of production equal the average selling price and the marginal costs of production equal the marginal selling price, supplies may be described as "adequate" since there is no economic incentive either to increase or decrease production. (281, p. 321)

There are indications from the changes in lumber consumption that have occurred somewhat simultaneously with a drop in lumber prices relative to other building material that a rather high cross-elasticity of demand exists between lumber and other building material (108, pp. 648-649), indicating there are close substitutes for many lumber products. There is reason to suppose that the substitutional relationships shift considerably with the level of personal incomes (4). Very little research has been devoted to determining this important relationship.

Any model for making long-range forecasts of demand for timber must be dynamic. It must include forecasts of technology that will 1. influence costs of producing timber products, 2. bring about new chemical uses of wood for fuel, fiber, food, etc., and 3. develop additional and improved substitutes for wood at continuing lower prices. It must anticipate changing tastes that will arise from urbanization and/or relative geographic decentralization. A shortage of timber products in any intermediate period will seriously affect both the rate of technological developments
of wood substitutes and changes in tastes (281, p. 325). The present forest production goals and over-all program for achieving those goals seem to have overlooked this latter point. That the introduction of the above variables into the forecast analysis increases the technical difficulties does not alter the fact that forecasts which ignore the above factors may lead to erroneous conclusions.

e. **Estimating optimum forage-timber combination.** If the task of quantifying the necessary variables of our analytical model with a sufficient degree of confidence to warrant a course of action is such a formidable task that the model is worthless, it must then be admitted that we have no basis for making any decisions that affect this combination. Obviously such decisions have been made both by public land administrators and by private operators. That a controversy exists as to the accuracy of those decisions is equally obvious. The fact that a decision is made implies that the one making the decision has formulated some expectation of the physical relationships involved, as well as some expectation of prices. It is unfortunate that so little research in the past has been devoted toward a more precise quantification of the physical relationships involved. For most types of range sites, such research is still in the future. However, the use of the information
now available, used in the logical framework of the suggested model, is a basis from which to start.

4. Private production versus public recreation

There has been an upsurge in the expressed demands of the American people for outdoor recreation. Expenditures for recreation had been increasing rather substantially prior to the great depression. Weinberger (293) shows that the majority of these expenditures were for goods that tended to keep people at home in passive recreational pursuits. With economic recovery in the late thirties, the demand for outdoor recreational facilities was increased. Travel restrictions, overtime pay, and rationing caused by World War II essentially eliminated this demand until toward the close of the war. Since that time, the increase in the number of visits to the national and state parks, national monuments, and national forests has been phenomenal. There were about 95 million visits to national forests and about 35 million visits to parks and monuments in 1951 (37, p. 18), and the number is steadily increasing. This increased demand for wildland recreation is due, primarily, to the following: 1. The shortened work week that has left the family free for a weekend together, 2. Paid vacations, 3. Greatly improved transportation facilities, 4. A generally improved standard of living among the working class,
5. An increase of interarea consciousness by most people following the war, and 6. An increasing population.

The kind of recreation we are particularly concerned about in this section will be "those outdoor activities of a leisure-time nature which are diversionary in character and afford physical, intellectual, and inspirational experience" (27, p. 827). Obviously, the amount of resources available for recreation is limited and many of these resources are capable of alternative uses. There are two different kinds of economic problems that arise in the use of these resources. First, on those natural resources that have little use other than recreation (the Teton Mountains, Grand Canyon, Old Faithful Geyser, etc.) there is the problem of determining 1. the optimum combination of recreational services, and 2. the optimum level of intensity of use of those resources. Second, on most of the lands there is the question of determining the optimum combination between recreation, on the one hand, and private production, on the other.

a. Optimum recreational facilities. Outdoor recreation may be of several forms varying a great deal according to the locality, the proximity to large centers of population, the season, etc. Picnicking, hiking, overnight camping, boating, fishing, and hunting are the more usual forms of recreation that are sought for on these western
range lands. Of much less importance, from the standpoint of numbers participating, are the pack-trail journeys into wilderness areas and the vacationing in summer cottages in the mountains. Skiing is rapidly becoming a major winter sport in most mountain areas.

Among the above recreational needs there are certain conflicts. As more and better roads make the more remote areas available to the masses for picnicking, boating, etc., those areas tend to become less valuable for camping, hiking, or photography. By definition, only a very few people can enjoy a wilderness area at one time. As one natural-area enthusiast said, "crowds never can share the real essence of a wilderness. Crowds can boast only of having been where someone, once, found real value" (285, p. 181). Careful planning of the development and use of recreational facilities will be required to minimize these conflicts. This calls for an inventory of available resources and a study of the future recreational wants of society.

The greatest need likely will be for more picnic areas, camp grounds, and summer homes, calling for more roads, trails, and service areas. The use of aircraft and landing fields instead of expensive road development needs serious consideration (27, p. 828). Development of the jeep and helicopter have materially altered the demand for wildland recreation and are changing the concept of wilderness areas
for many people. As these changes and developments occur and even more people are attracted to these lands, the costs of development, upkeep, and policing will become progressively higher. Under the present policy of making this form of recreation essentially free to the users, considerably increased federal appropriations will be needed. DeVoto (50) estimates that 500 million dollars additional annual appropriation will be required to bring our national parks into position where they can adequately serve the present needs. Overcrowded campgrounds and recreational areas soon lose their attractiveness. The same principles of resource conservation apply with respect to the intensity of human use as apply to other uses.

(1) Pricing and distribution of public recreation. Traditionally, recreational facilities of the public lands have been provided essentially without charge, the idea being that such facilities should be available to everyone. Actually, this is impossible. The present policy may be regarded as one of subsidizing the recreation of the upper middle-class in the financial register, since 1. the very wealthy will usually seek more exclusive facilities offering more elaborate catering service, and 2. those who do not have paid vacations of two weeks or more and who do not have a reliable automobile can visit very few of these public lands.
Recreation is a product of these resources just as is timber or forage. Charges are made for building sites; can they not be made, also, for other facilities? In this way the cost of development and upkeep of the recreational facilities can be passed on to the ones that actually receive the benefits. This policy may be equally as desirable for national parks as for the forests. In the case of the former, the token fee that is now charged could be materially increased, thus increasing needed revenue. Higher fees might tend to discourage those who were inclined to be indifferent between outdoor recreation and other goods, thus freeing these overcrowded facilities for use by those whose preference for outdoor recreation, relative to other goods, is higher.

The argument that wildland recreation is a "social product" like education or national defense (94), that is made equally available for the benefit of all breaks down on the point of reality. Whereas society has financially, morally, and legally undertaken to provide education and protection to every citizen, it has not yet underwritten a policy of providing each family with a car and a paid vacation to some of our large natural areas. This is to argue neither for nor against such a policy but only to point out that it does not now exist and does not appear likely in the near future. This being the case, one may question the consistency
and desirability of taxing everyone, including the lower income group, in order to provide subsidized recreation for those who are financially more fortunate.

(2) **Public recreation and wilderness areas.**

Another ramification of the expansion of outdoor recreational facilities in the national parks and forests is that there will undoubtedly be a gradual encroachment on the wilderness areas. Leopold first defined a wilderness as an area large enough to absorb a two-week pack trip without crossing one's own trail or coming in contact with man (133). He later had to modify this definition and would undoubtedly have to modify it again today. It is highly unlikely that Leopold's definition would have been sufficient for Daniel Boone. Wagar infers that the auto, the airplane, reclamation dams, and highways are bad because they have destroyed the opportunity for isolation from human activity that is needed to keep one moral and honest.

If Jefferson, Whitman and Leopold were right in believing that this nation will remain moral only if uncrowded and if exposed to nature we may need to limit our population. Webb recently worded the belief held by many that democracy flourishes best at the frontier. Demagogues tell us that we cannot turn back to the "good old" uncrowded days when men were honest. (285, p. 181)

In the minds of many people who seek solitude and rest in removed areas today, Leopold's conditions are not necessary. Being removed from other people is always relative and
cannot be defined in static terms. There can be no inter-generational comparisons.

The argument that helicopters should be prohibited from entering wilderness areas, since they represent the capacity of man to advance and exploit, could be applied as well to the horse and pack train, packaged foods, matches, and an endless list of goods and services that make a journey into a wilderness area less onerous and dangerous. These are all products of man's ingenuity to exploit. Few, if any, would insist that wilderness areas be reserved only for those who would clothe themselves in skins and equip themselves with a stone ax. There undoubtedly will continue to be a very vocal demand for wilderness areas; some form of rationing, either through prices or by administrative decree, will be necessary in order to preserve some wilderness areas for scientific as well as aesthetic uses.

b. Determining optimum combination of private production and recreation. It is assumed that the nearly 14 million acres under the administration of the National Park Service (48, p. 4) will continue to be devoted primarily to outdoor recreation of some kind. This land, therefore, is not included in the present discussion. Following the pattern established earlier, we will consider the optimum combination of the products combined thus far as one single commodity and investigate the addition of one more product -
recreation. We are handicapped to begin with, however, since there is obviously a different relationship between game animals and recreation than there is between recreation and tree harvesting. We will, therefore, assume that there is no conflict between wildlife, generally, and recreation and thus omit this one complication from our present analysis. This assumption seems reasonable for nearly all real cases. Thus, we desire to determine the optimum combination of private production (livestock grazing, timber harvesting, etc.) and public recreation. We will be concerned, primarily, with public recreation on public lands. Although some private lands are capable of furnishing public recreation, except on those ranches where dude ranching is practiced, only limited recreation is found. Even on the dude ranches, the actual scenery, pack trips, and excursions are usually on public land.

The present relationship between private production and public recreation might be represented by Curve A, of Figure 20, which implies a substantial range of supplementarity. In the absence of capital improvement, there is a significant area of competitive relationship. However, this can be largely eliminated by: 1. Careful planning of the recreational facilities, such as enclosed picnic areas, campgrounds, play grounds, hiking trails, drinking water, etc.; 2. Construction of cattle guards at fence boundaries;
Figure 20. Hypothetical iso-resource curve - private production and public recreation
3. Consideration of recreational needs when locating facilities for stock watering and salting; 4. Careful policing of camp fires, stock rustling, etc., and increased fire fighting capacity, and 5. Development of wider and better roads to more safely handle recreation traffic simultaneously with trucks hauling timber products. The cost for the above improvements and facilities need not be borne by the taxpayers but by the users of the resource. Increasing grazing fees and charging for recreational facilities would furnish the funds necessary to defray the above expenses.

Obviously, Curve A and Curve B represent the same quantity of inputs of land, but additional labor, capital, and management have been added in the particular forms suggested above in the case of Curve B. Since this process involves the addition of variable amounts of labor, capital, and management to a fixed quantity of land, it is subject to the law of variable proportions. A point exists beyond which it would not pay to go in reducing the range of competition.

As the demand for recreation increases, grazing meadows will undoubtedly be turned into camp grounds and picnic areas. This will necessitate some adjustments in livestock numbers. Timber cutting may need to be restricted, or even prohibited, along some of the more scenic routes. For a relatively few, a conflict exists with respect to wilderness areas. To the user of timber and forage products, the
non-use of timber and forage from millions of acres of wilderness areas is a waste. On the other hand, there are the few nature enthusiasts that are trying to escape from all evidences of the existence of civilized man whose excursion into the wildlands may be rendered ineffective by the sight of a car, a cow, or a comfort station. Most natural area enthusiasts, however, would more nearly agree with Jeffers:

But scenery of exceptional charm and widespread appeal, the sweep of tree-covered hills, the rugged slope of mountain ridges above the timberline, the still solitude of dense timber, sheep grazing contentedly in a mountain meadow, . . . all of these are peculiarly the resources of the wildlands of the forests. (109, p. 631)

Although the above conflicts can be materially reduced, it is doubtful if they can ever be entirely eliminated. If Curve B of Figure 20 represents the situation after the suggested investments have been made, a small area of competitive relationship would still exist. Since the resources in question are administered by federal agencies, the allocation will be made by administrative decision. There is need for an economic frame of reference to furnish administrative guidelines in the allocation of these scarce resources between public recreation and private production. The economic model of Figure 20 is suggested as this frame of reference. It would require that the allocation point be somewhere in the competitive range of enterprise.
combination according to society's relative preferences for the two different kinds of commodities.

c. Limitations of the model. We must recognize that this model is more conceptual and didactic than analytical since each of the so-called commodities are rather complex bundles of commodities themselves, which makes the problem of determining a single unit of measurement of each somewhat complex. From the data necessary for previous analysis, one could express the value of timber and forage products (private production) in terms of dollars. There is no difficulty here.

A more difficult problem is to find a single unit of measurement for recreation. How many human hours of outdoor picnics are equal in value to one overnight camping trip for one family? The present data available for analysis do not tell us this. This question could be answered precisely only if one knew the indifference curves of all individuals concerned and could aggregate them into a community indifference curve (11). The most nearly comparable set of data would be a knowledge of the amount of other goods individuals are willing to forego (the amount of money they are willing to spend) in order to obtain each particular type of recreation. This could, of course, be aggregated for all types of recreation and for all individuals. Although it generally would be impractical, and frequently impossible,
to obtain this schedule of information from the entire universe in question, reliable information could be obtained from a statistical sample. If both commodities are expressed in terms of dollars, the price ratio is, of course, one, and the point of tangency of the price line and the iso-product curve is the optimum combination since it maximizes the total value, to society, of the goods and services in question, in monetary terms.

At the present time no machinery is set up for sampling the users of wildlands recreation to determine the monetary values associated with different levels of such use. In the absence of this information the logic of the model could be followed in making decisions relevant to recreation and private production. Attention should be devoted, first of all, to extending the supplementary relationship as far as is consistent with the law of variable proportions. For adjustments within the competitive range calling for a decrease of one use and an increase of another, the public administrator must use his best estimate of the preferences of the group to which he is ultimately responsible. For reasons that will be outlined in the following chapter, it is suggested that an extension of the public opinion poll may be useful for this purpose. This would imply, however, that those being polled are informed as to what is involved in the shift from one combination to another.
5. **Hydrological products**

A very important product of the Western Range Area is water which is essential to the continued welfare of millions of people. Since this water has several alternative uses, some of which are competitive one with another, considerable controversy exists as to the allocation of the water and the management of the watershed. The more important of these uses are: direct human consumption, irrigation, navigation, power generation, recreation, and, in a negative sense, erosion and flooding.

In this section we will be concerned primarily with the kinds of decisions that can be made regarding the use of resources on the upland watersheds, and the effect of those decisions on the pattern of water flow. Our objective is to discover the criterion by which one determines the optimum pattern of range resource use when consideration is given to watershed management as well as to the other uses we have considered thus far.

a. **Optimum allocation of water resources.** A watershed policy designed to serve only one of the above uses would run counter to the needs of the other uses. From the standpoint of erosion and flood control, the watershed should be so managed as to minimize stream flow, while for power and navigation, a large constant stream flow is most desirable.
For irrigation purposes, on the other hand, a maximum quantity of water available for distribution during the growing season is preferred. Water for direct human consumption requires only that there be an ample continuous flow of potable water. Where sufficient annual flow of water in a particular river drainage basis is more than sufficient to meet all of the demands, conflicts in water use can be overcome by building large multiple-purpose storage dams. However, an allocation problem exists since 1. the annual flow, in some cases, may be insufficient to meet all the needs, and 2. water storage becomes progressively more costly as more and bigger dams are built in a particular river drainage basin.

Ideally, a pattern of stream flow that was constant after the irrigation water had been removed would be desired. However, the kind of watershed management that provides a more constant stream-flow tends to reduce water yield as well as diminish other resource uses. Conversely, watershed management designed to maximize total water yield increases the risk of downstream floods and watershed erosion. Society appears to have decided that where maximum water runoff conflicts with flood prevention, decision should be made in favor of flood prevention. In effect, this places a restriction on the solution, the restriction being that no
decision shall be made, intentionally, that will increase water runoff to proportions approaching flood danger.

An extremely high value obviously is placed on that amount of water necessary to serve the basic human needs; but as these basic needs are furnished, the marginal value of successive amounts of water for direct human consumption decreases and is soon lower than the marginal value of water for alternative uses. The water allocation problem, then, is one of allocating all water among all of its alternative uses, subject to the flood-control restriction noted above. Water for livestock, irrigation, navigation and power, etc., can be evaluated in monetary terms based on its marginal value product. Soil erosion results in 1. reduced soil productivity, and 2. silt deposits in water reservoirs, and thus a value can be placed on successive increments of soil erosion prevention. In the same manner, flood control can be evaluated, except for the social cost of human suffering, loss of human life, and community disturbance. (Society has placed such a high value on these that the other considerations are relatively valueless - hence the restriction).

The optimum allocation of water would be where the net marginal return from each alternative use was the same (again subject to the restriction). The water-allocation problem cannot be considered separately from the problem of water resource development discussed in the previous chapter.
b. **Influences of upland vegetation on water.** In general, the equation for water runoff \( W \) may be stated as

\[
W = P - (I + T + E + X) + S
\]  

(XVIII)

where \( P \) is the total precipitation, \( I \) is the amount of interception, \( T \) is the amount of transpiration, \( E \) is the amount of evaporation, \( X \) is the amount of deep seepage that passes out of the drainage basin through the rock strata, and \( S \) is the change in soil-moisture storage between the beginning and end of a particular period in question.

Most of the earlier writers were of the opinion that forests increased precipitation (302). More recent research indicates that this influence may be negligible, particularly with respect to cyclonic precipitation. Forests do tend to raise the effective ground level and increase the friction of the wind and thus may increase orographic precipitation by about one per cent (122, p. 98). For our purposes, we will ignore this influence and consider precipitation as given.

The amount of rainfall that is intercepted by vegetation before it reaches the ground, and is thus lost, is "a function of the storage capacity of the surface of the vegetation, the evaporation rate during precipitation, and the amount of precipitation per shower" (122, p. 114). The amount of interception is influenced by the vegetative species (151).
and the density and age of the vegetation, as well as the length and intensity of the storm (66). Up to 0.1 inches of precipitation per shower may be lost due to interception.

In the normal physiological processes of plant life, moisture is lost through transpiration. There is a high correlation between transpiration loss and leaf area (122, p. 217), but this varies between species. There is a greater seasonal variation in transpiration loss for deciduous trees than for conifers. It is believed that the rate of transpiration increases for trees as the stand matures.

Evaporation of soil moisture is affected by atmospheric pressure, "wind, solar radiation, temperature, saturation deficit of the atmosphere contiguous to the evaporating surface, and wetness of the evaporating surface" (122, p. 128). Vegetative cover, generally, and forests in particular, reduce solar radiation and soil temperature variation (110). Forests are effective in reducing wind velocity (62). The litter and organic matter that make up the forest floor tend to increase the rate of moisture infiltration (180) and to reduce evaporation from the mineral soil.

Surface runoff is the most rapid way in which precipitation reaches the stream flow. An excess of surface runoff results in floods. Water may also infiltrate and contribute to subsurface flow. Kittredge stated:
The influence of forest in reducing floods is usually large where the floods result from surface runoff in storms of high intensity exceeding the infiltration capacity of denuded soil. It may be negligible in those major storms in which the rainfall exceeds the total storage capacity of the drainage basin. (122, p. 271)

Soil erosion, due to water, increases more than proportionally with surface runoff. Vegetative cover that
1. Absorbs the kinetic energy of wind and falling moisture (132), 2. Increases infiltration, and 3. Decreases the speed of wind and water movement decreases erosion (54). Debris and sediment carried by floods probably cause more damage than the volume of water, in most instances (122, p. 271).
As a general rule, forests tend to: 1. Even out the extremes of stream flow by increasing underground flow and decreasing runoff, 2. Reduce total stream flow, and 3. Reduce the debris and sediment carried by stream flow.

c. Hydrological products versus other uses. Most of the arguments over the use of western range resources for watershed protection have focused on the total value of water yield as compared to the total value for other uses. Considerable effort has been devoted to the problem of determining the total value of the water yield (153). This is useful only insofar as it enables land managers to estimate the marginal returns from water yield associated with: 1. Different allocation combinations, and 2. Different levels of capital, labor, and management inputs.
The relative importance of each of the several hydrological products differs substantially from one river drainage basin to another according to: 1. The total supply of water relative to the needs for each purpose, 2. The relative danger of flooding, and 3. The tendency for erosion and sedimentation that characterizes a given watershed. In the arid Southwest, for instance, has a rapidly growing demand for water for direct human consumption, irrigation, and power. There is little concern about floods, although sedimentation of storage dams may become progressively more expensive. In the Missouri Basin, on the other hand, navigation and flood control are important hydrological products; water for direct human consumption is a less critical issue. The marginal value of a given change in water yield will differ according to the uses to which the water is to be put, and this will vary from one drainage basin to another.

Were it possible to quantify a schedule of marginal values of water it would be of little use in arriving at an optimum management of watersheds until the physical relationships between water yield and other uses were determined. There is need to discover the relationship between increases (decreases) in timber cutting and changes in stream flow (changes in stream flow includes changes in quantity, quality, and seasonal distribution of stream flow). The relationship between changes in the intensity of livestock
grazing and stream flow is equally important. Because of the influence of slope, soil type, soil structure, and climate on these physical relationships, they must be evaluated for each type of range site.

(1) **Influence of grazing on water runoff.** It is doubtful if a significant influence on quantity and seasonal distribution of stream flow will be exerted by variations in the intensity of grazing if the upper limit of intensity is determined by one or the other of the following (whichever is lower): 1. That which is determined to be intertemporally optimum when grazing is considered by itself, or 2. That which is optimum when considered in combination with timber. This variation in grazing might affect the quality of stream flow, however. On sites with steep slope and unstable granitic soil, trampling by livestock tends to increase erosion, particularly where ground cover becomes less than about 70 per cent (161), even though rainfall is not excessive. It is generally reported that the area of the West contributing 80 per cent of the water runoff yields but 20 per cent of the sediment, and conversely (37, p. 17).

The influence of grazing intensity on soil erosion will be different for various levels of labor and capital investment in erosion control structures and practices. Soil erosion control can be at various degrees of intensity and becomes progressively more costly. We have many vague and
conflicting opinions as to the level of erosion control that is economically optimum for a given site. Certain capital and labor investments have proved successful in reducing erosion. The expected level of resource investment in erosion control should be considered when trying to determine the optimum combination of livestock grazing and hydrological products from a given site.

(2) Influence of timber harvest on water runoff. In addition to the influence of physiographic and climatological forces, the relationship between timber harvest and water runoff depends on the manner in which the timber is harvested. The cutting of timber reduces interception and transpiration and increases evaporation (297). Under some conditions optimum silviculture, per se, may indicate that an area should be clear cut. Where this is the case there may be a conflict between optimum silviculture and optimum watershed management. The extent of this conflict would depend on the primary objective of watershed management for the area. If total water yield was more important than flood control and the prevention of sedimentation, there might be little conflict between the two criteria.

For other situations, an accepted silvicultural method of increasing saw timber and pole production of dense young lodgepole pine stands is through mechanical thinning. Goddell concludes from his study of the effect of this
thinning process on water yield in Colorado and Wyoming:

On experimental plots it was found that the thinning of dense young lodgepole pine stands increased net precipitation while not increasing soil-moisture losses. . . . Accelerated erosion has not resulted from the thinning operation, and it appears that the quality of stream flow would not suffer from similar thinnings where the climate and vegetation are such that the erosion hazard is low. (259, p. 378)

For this type of situation at least, timber harvests not in excess of that which is intertemporally optimum (from the standpoint of timber alone) will increase total stream flow without materially affecting the distribution or quality of stream flow.

Some believe that water yield may be increased 25 to 50 per cent without damage to the watershed by controlling the type and density of vegetation (37, p. 19). Watershed management to increase intentionally the quantity, distribution, and quality of water is in its infancy. Models for determining the optimum watershed management decisions should be dynamic and involve the following considerations. First, the marginal value of increments of water must be evaluated separately for each major drainage basin area and frequently for separate sub-divisions of that basin area. Second, the physical relationships involved must be determined separately for each range site. Third, decisions regarding the intensity of resource uses other than watershed protection must be made in the light of expected investments in erosion
control and water resource development. Finally, it is suggested that as a starting point simplified areas be selected for study. Areas where erosion is not a serious problem would be preferred at the outset. Care should be taken to select those areas where only one nonhydrological product (such as grazing) is involved and where the value of the hydrological products are distributed over a small and known area (a small watershed area of the interior basin would be suitable). Emphasis should be placed on determining changes in primary income in a given area or community associated with marginal shifts in resource use that affect the value of grazing (or timber) and water yield.

1A very interesting study has just been completed by Lammi (127) in which the primary money income from range watersheds in Davis County, Utah was appraised for three different levels of inputs of labor, capital, and management. Only the "Synopsis of Dissertation" of this study is available at the time of this writing. The Dissertation will shortly be placed on file in the Library of the University of California, however. This study is certainly a step forward, conceptually, since it focuses on equating marginal returns to marginal costs in resource inputs and land use changes.
D. Further Suggestions for Future Research

The preceding suggested framework for determining the optimum combination of multiple-use resources assumes that all firms, both private and public, are operating at some point on the transformation function. Earlier discussion pointed out that such was frequently not the case. Private firms, because of insecure tenure expectations, capital limitations, high operating costs arising out of apparent improper scale adjustments, inflexibility in seasonal forage adjustment, etc., may be operating at points well within what might otherwise be their transformation line (surface). Suggestions have been made for improving research and institutional adjustments designed to alleviate these restrictions.

In the management of public resources one is soon impressed with the fact that by applying the technology that is currently known more of every product can be produced with the resources now available. One forester of high repute estimated that 100 million acres of commercial forest land could produce all the forest requirements of the United States if those lands "were well managed after they had attained full productivity" (60, p. 213). Mitchell in writing of the Pacific Northwest concluded:
If good practical management is applied to wildlife the forests will not suffer, and if the same kind of management is applied to the forests, wildlife will have a good habitat for a long time to come. (150, p. 30)

A substantial amount of the present conflict concerning the allocation of these public multiple-use resources could be resolved by moving out to the transformation line (surface) in the production process, thus increasing the products of each alternative simultaneously from the same amount of resources. Research designed to improve this situation should include, in addition to experiments and study directed toward solving the technological questions: 1. Research designed to improve the techniques of extending new knowledge to the resource users, and 2. Study directed toward determining the institutional restrictions to adjustment.

For each of the previous allocation problems we have suggested that two kinds of information are needed: first, the physical transformation functions, showing the physical relationships of the several alternative resource uses; second, the relative preferences of society for the products derived from the alternative uses. At present, there appears to be significantly different estimates of the physical relationships for given situations.

We would make the following suggestions for improving, and/or making more acceptable to the users, research dealing with the use of range resources. First, the interested
parties (including "action agencies" and pressure groups) might participate in the general planning of the research. Further, the interested research agencies should coordinate, or even integrate, their research efforts. These two suggestions might go a long way toward making the solutions based on the research findings politically acceptable. Since the actual conduct of the research problem will be done by research agencies and personnel who will also direct the planning of the research, there should be little danger that additional bias should be injected into the research findings by the above processes.

Finally, there should be a synthesis of available information and research efforts to solve the problems in a site complex (6), because the functional relationships are substantially influenced by the natural environment - slope, soil texture and structure, plant and animal species, rainfall, etc. Thus, separate inferences should be made for sites that are significantly different.
CHAPTER XII
ECONOMIC WELFARE AND POLITICAL DECISIONS

Economics has been concerned with human welfare and public policy since its beginning. For the most part, the assumption that perfect competition represented the optimal situation has been either explicit or implicit in the economic literature since Adam Smith. However, both Marshall and Wicksell objected to what they considered to be "a prevalent notion that perfect competition leads to the maximum of satisfaction" (184, p. 206). The latter, particularly, attempted to prove that, when the distribution of income was undesirable, exchange under perfect competition would not lead to an optimal situation (295, pp. 80-83). H. B. Clark claimed that the payment of factors according to their marginal productivity was "morally justifiable" and that it was a "natural law" since it "assigns to every one what he has specifically produced" (32, p. v).

A large portion of the literature of traditional economics has assigned to the price mechanism of the free market the role of directing the allocation of scarce resources; that is, the economic problems of determining the kind and quantity of goods and services that should be produced, and
how they should be produced, was to be solved by the independent decisions of the producers and consumers in a free and perfect market.

A. Limitations of the Price System

We have indicated, however, some allocation problems for which the price system was not being used. If the price system rewards required to achieve the effect desired by society results in a severe redistribution of income, it may be an unacceptable procedure. Dahl and Lindblom cite as an example:

Despite a sentimental attachment to his property, an old settler whose homestead blocks the right of way for a new highway can presumably be induced to move if he is promised half the wealth of the world, or more, but he is less likely to be offered riches than to be moderately paid and then evicted through the hierarchical powers of the government. (47, p. 387)

Where all of the costs and/or benefits do not accrue to the individual or firm through the price system, society has been inclined to modify the use of market prices in the allocation problem. This is perhaps one of the greatest limitations of the price system in the area of natural resource use and development. A host of collective controls have been invented to meet these contingencies. Many of the goods and services people buy come in very large quantities
or have such high fixed costs that they can be available to very few people except through the process of collective action and control. In addition to police protection, national defense, education, etc., that, supposedly, are made available to every citizen, one could mention national park upkeep, flood control, development of irrigation and power dams, etc. In the light of these and other limitations of the price system, even the so-called laissez-faire economists have not been content to relegate all choice and allocation problems to the price system alone but have reserved some choices to be made collectively through the process of voting or have delegated the decision to specific leaders or groups. There is a broad area of disagreement among individuals of all professions and geographic areas as to the kinds of choices that should be delegated and those that should be made strictly by individual decisions operating through the price system.

B. Welfare Economics

Welfare economics is the branch of economics that deals with the study of the limits of the policy recommendations of economists qua economists. Welfare economics is normative in the same sense that medicine is normative. The
explicit norm, in this case, is that the welfare of the community in question is to be a maximum under the given inventory of resources and given technology. Given the norm, however, determination of the preferred policy is held to be a scientific enterprise.

Based on the assumption that utility could be quantified and given a diminishing utility function for each individual, the "old" welfare economics of Pigou, et al., led to the prescription of an equal distribution of wealth (134). The "new" welfare economics that has developed beginning with Pareto (162) claims that it is neither possible nor necessary to measure utility in order to maximize it. Based on the indifference curve analysis, rather than the utility function, it is possible to have prescription without the necessity of interpersonal measurement of utility. Thus, starting from any given situation, one could ask whether or not total satisfactions could be made greater. By means of the welfare vector, one would prescribe a change if and only if the indifference index of at least one person could be increased while no one's indifference index was decreased. If the alternative policy in question resulted in anyone's being made worse off than before (if anyone's indifference index was decreased) one could not prescribe the change. Under this procedure there is no single unique solution, but rather there are an infinite number of solutions along the
"contract curve" each one being unique for a given distribution of wealth (resources). Bergson (13) and Lange (129) spelled out in mathematical notation the equilibrium conditions of an ordinal social welfare function for situations where tastes (preferences) were given and where technology and resource distribution were static. Reder (173) stated these conditions explicitly and expanded them to include a non-static economic system. These conditions form the core of our marginal conditions that we have considered throughout this treatise.

The primary weakness of the welfare vector concept is that there are a limited number of cases to which it can be applied with precision, for, as we noted earlier, most of the policy problems confronting the Western Range Area that involve gains to some group are attended by losses to other groups. Hicks (91) and Kaldor (115) proposed that a change be recommended if those who stood to gain from the change could compensate those who stood to lose, so that, with compensation, both individuals or groups could be better off than before. They would not require that the compensation be made, however, since they were concerned at that point only with the efficiency of the economic institutions in making use of productive resources. (As to whether or not compensation would be made, according to them, would depend on whether or not it was desirable from the standpoint of
income distribution.) Scitovsky (196) showed where the
Hicks-Kaldor criteria could lead to an inconsistency. This
situation would, of course, be avoided if compensation were
considered inseparable from the change. This, again, would
limit the application of welfare economics to those instances
where 1. no one was made obviously worse off than before the
change, or 2. where the losers could be compensated.

Little (135) outlines several reasons why the ideal or
optimum solution will seldom, if ever, be obtained. For a
number of reasons, an individual may not always be consis-
tent in his choices. The influence of uncertainty, savings,
job preferences, indivisibility of products, etc., limit
the application of maximizing conditions at the limits. He
suggests that "a zone of reasonableness" be applied to the
policy recommendations and gives the following as the
criteria for a change. First, the distribution of income
must not be worsened. This, he would hold, is a value judg-
ment that the economist can properly make. Second, the
losers must be unable to bribe the gainers to refrain from
making the change.

C. From Individual Preference to Social Choice

We have seen that it is only under very limited condi-
tions that the precise conclusions of the social welfare
function had any direct application in reality even where individual preferences are assumed constant. Arrow tried to determine if there could be a "process or rule" which would produce a consistent ordering of alternative social actions "as a function of the tastes of the individuals". He imposes five somewhat arbitrary conditions, each one of which, in his judgment, appear desirable; he then shows that, excluding the possibility of interpersonal comparison of utility,

... the only methods of passing from individual tastes to social preferences which will be satisfactory, and which will be defined for a wide range of sets of individual orderings are either imposed or dictatorial. (5, p. 59)

The application of Arrow's analysis to welfare economics and the social welfare function has been challenged by Little, who points out that what Arrow really is discussing is a decision-making process. This is a significant distinction, since

... as many value orderings as there are individuals may coexist. On the other hand, between two alternatives there may exist only one effective decision. ... Whether in this sphere, Arrow's conditions of correspondence are sufficiently acceptable as minimum conditions for a satisfactory democratic decision-making procedure for it to be said that he has proved that consistent decisions cannot be reached via such procedures must be left an open question. (136, pp. 430, 432)
1. Voting as a means of determining preferences

Some of the limitations of the application of the price system for making rational social choice has been pointed out. An alternative method of expressing individual preferences in a democracy is through the voting mechanism. The "paradox of voting" has been illustrated to show that voting may result in conclusions that are inconsistent.

Let A, B, and C be the three alternatives, and 1, 2, and 3 the three individuals. Suppose individual 1 prefers A to B and B to C (and therefore A to C), individual 2 prefers B to C and C to A (and therefore B to A), and individual 3 prefers C to A and A to B (and therefore C to B). Then a majority prefer A to B, and a majority prefer B to C. We may therefore say that the community prefers A to B and B to C. If the community is to be regarded as behaving rationally we are forced to say that A is preferred to C. But in fact a majority of the community prefer C to A. (5, p. 3)

Thus, it is claimed, majority rule by voting fails to satisfy the "conditions of rationality".

The real heart of the difficulty here, as has been shown by Dahl and Lindblom, is that no clearly defined "community" preference exists since the majority voted against each of the three alternatives as being the most desirable of the three. It is obvious that this situation rarely occurs in reality or democracies would be much more unstable than they are.
One reason that it is not an important and common difficulty is that the paradox leaves out an implied value that does influence choices. Why do these three people wish to determine their policy by majority rule in the first place? It must be that the majority process itself has some value for these people. But if that is so, then an additional set of alternatives has to be added: namely, that 1, or 2, or 3, or all of them prefer some agreement (and maintenance of the majority rule process) to no agreement. In a word, what are the consequences of not coming to an agreement? If these people regard the consequences of disagreement as adverse - and if they did not they would not have employed majority rule in the first place - it would be quite rational for them to compromise. (47, p. 423)

The entire argument of Arrow assumes that individuals know precisely what their schedule of preferences are. He has ruled out the process of bluffing, of influencing and persuading. The evolutionary process of discussion and participation as a procedure by which people discover the alternatives and formulate their preferences has been omitted. Voting is a process by which the qualified citizens of a community express their first preference between the alternatives. This requires that 1. the alternatives be discovered and nominated for consideration, 2. the alternatives be screened and partially tested in order to rule out those that appear, obviously, to be not acceptable as alternatives, and 3. a procedure be devised for selecting one alternative from among the admissible set of alternatives, the results of which will be binding on the community. Our society has apparently been more successful in meeting the last
requirement than it has in meeting the first two. Even with political candidates, there seems to be no apriori reason why present procedures of nominating and screening, whether it be for the local school board, or for the President of the United States, provide that the final selection be made from among the most desirable alternatives.

Even so, voting at the polls is a procedure whereby the preferences of individuals can be expressed provided the appropriate alternatives can be defined, and provided, further, that the alternative courses of action are specifically identified with the alternatives for voting. The latter condition is usually met in the case of local bond elections for a municipality or school district. (Although the first condition may be acceptably met, it would seem that here, again, is one of the weaknesses of the voting mechanism as we now use it.)

Only rarely are the alternatives of state and national issues clearly defined and associated with the voting alternatives in a two-party system. Both political parties tend to be in favor of prosperity, national defense, social security, "free enterprise and the American way of life", "conservation and wise use" of our natural resources, etc. Seldom do the voters have the opportunity to express their preferences on clear-cut alternatives of a policy along party lines. Because of the complex organization of our
society, with its politically activated professional and commodity pressure groups, the political party that is successful in obtaining and maintaining office must appeal to the majority of most of the important groups. Thus, the party platforms tend to be pluralistic and non-committal with a broad area of agreement between the platforms of the two major parties. The differences between parties may not be as great as differences within party groups (and these latter differences may be more important in shaping policy issues).

As presently used in America, it is doubtful if a political party can go into office with a mandate from the people concerning important policy issues and when once in office it is doubtful if there exists sufficient party discipline to carry out a mandate. This is particularly true of a party that has long been out of power, since chairmanship of the important committees goes to the senior members of the majority party. As a rule, these senior members are out of touch with the new party leadership that has carried the party to victory. This places a handicap on the President, both as Chief Executive and as leader of the party, in carrying out any new policy (89). One suggestion that is periodically proposed is that the chairmanship of the committees should not go to the senior majority member but that the "most capable" party member be elected. This would
strengthen the role of the party in policy formation and tend to improve the voting mechanism as a means for determining the preferences of the people.

2. **Delegation of choice**

For those decision problems that do not lend themselves to solution through the price system or through the voting mechanism, the problem of choice must be delegated to selected leadership. In reality, many of the important decisions concerning the allocation of western range resources are made by delegated representatives. This method of choice is not without objection. It places the decision with persons who are not choosing for themselves, whereas for both market choice and voting individuals do choose for themselves; at the same time, it does not provide a "criteria of choice on behalf of others" (47, p. 426). While the process of delegation was at first envisioned as one where the delegators (the voters) had direct contact and final control of the decision makers (since they would be the elected representatives), many of our allocation and policy decisions are made by persons who are not elected by the voters. The growing and varied (and, for the most part, quite highly trained) bureaucracy is becoming more and more important in the decision making process. This is particularly true of natural resource management in the "public lands" states
for several reasons. The complexity of the kinds of deci-
sions that have to be made demands the use of specialists in
many fields. The need for, and advantages of, labor and
knowledge specialization becomes obvious when the magnitude
of the services and decisions are concerned. The mere pro-
cess of executing the decisions once the policy is formulated
requires a formidable task force.

The objectives and basic policies of the federal
bureaucracy are theoretically amenable to the electorate
through the mechanism of the Congress and the President since
they actually establish the basic legislation and appro-
priate the budget. However, with respect to regional legis-
lation (and most of the legislation affecting the use and
distribution of western range resources is regional legis-
lation) the majority of the voters may be either unaware or
indifferent to the issues. And, as pointed out previously,
those who are affected and concerned may be unable to express
any preference through the voting mechanism. In this re-
gard, the pressure groups serve as a mechanism through which
specialized groups may make their preferences (and strength)
known at several stages in the governmental process. They
may bring pressure before elections in getting candidates
and platforms favorable to their ends, and they may work for
the defeat of candidates not favorable to their ends. They
may be the source of "grass-roots" policy ideas, and they may lobby for legislation favorable to their group (220, pp. 511-535).

Although legislation may originate with the individual congressman, or within congressional committees, or it may originate within the leadership of the pressure groups, frequently it originates fairly well down the line in the bureaucracy and is written up by the specialists in the bureaus (38, pp. 348-349). Regardless of where the legislation originates, the administrative bureaus are called on to review, adjust, and make recommendations for approval or disapproval. Of course it is Congress and the President who finally approve or disapprove the legislation. Occasionally Congress spells out the objectives and policies (and even the practices) of an act in great detail, but this is the exception. Control of the bureaus by Congress has been more effective in the past by controlling appropriations than by enacting detailed policy legislation as both the Forest Service and Bureau of Land Management have come to know. For most legislation affecting western range resources there are few congressmen outside the Committee on Interior and Insular Affairs in the Senate, the Committee on Public Lands in the House, and the committees dealing with irrigation and reclamation who are familiar or much concerned with the issues.
As a general rule, Congress establishes little more than the broadest kind of policy, leaving it to the bureau chiefs and division heads to formulate the primary objectives and policies in an atmosphere of coercion from the pressure groups. In fact, this is perhaps the most fruitful area of operation for the pressure groups since the administrative officials formulate as well as execute the policies. The influence of the pressure groups may or may not be counterbalancing (220, pp. 213-320). In fact, one of the most active pressure groups influencing Congress may be the bureaucracy itself lobbying under the guise of being the representative of the interests of all the people, generally, and of the politically inactivated groups in particular. There are some advantages as well as disadvantages of having the bureaucracy so influential in policy formation. Because of their special training and career interest, the personnel of the bureaucracy are usually more familiar with the problem and in a better position to objectively appraise the legislation than most others. They can appraise the legislation from the standpoint of administration and execution as well as from the standpoint of objectives.

On the other hand, individuals within the bureaucracy tend to take on the attitude of their bureau. It is difficult to distinguish information service and reporting from propaganda purposefully designed to advance the bureau at
the expense of other bureaus or groups. To the extent that
the bureau is not amenable to the will of the people (either
through the elected representatives or through the pressure
groups), there is the danger that the objectives and pre-
ferences of the bureau may be substituted for the prefer-
ences of the people. The following testimony before the
Barrett Committee indicates that a particular government
bureau did not receive its objectives from the preferences
of an important pressure group in the area. State!an offi-
cial representative of the stockmen:

We have in our Forest Service many admin-
istrators who have had no experience, . . . and
whose technical education has turned to dogma. . . .

The Forest Service is a child of congress,
grown up without parental discipline or instruction,
an arrogant, bigoted, tyrannical offspring, the
same as any offspring reared in the same manner,
void of respect of law and customs of our country.
(243, p. 162)

There are some weaknesses and limitations that are
"inherent tendencies in the sense that they are produced
both by the circumstances that call forth bureaucracy and
by the characteristic form it takes" (47, p. 247). Most of
the complaints of the livestockmen who deal directly with
the public land agency center on three issues: the exces-
sive "red tape", the impersonal handling of individual cases,
and an objection to "being governed by men instead of by
law" (207). Detailed specifications of the rules and
regulations prescribing the conduct of decision making (red tape) are the laymen's best safeguard against being "governed by men instead of by law". Yet that is the very reason why there can be little personal consideration to individual situations. There must be a compromise of these issues for they are inherent in the situation which makes the bureaucracy necessary.

3. **Coordination and planning**

"Planning" has become a strongly negative emotive word in some political circles. To some (76) it has come to be associated with government control of all economic activities. As used here, planning is a process or procedure for coordinating the several activities of the government so as better to achieve the objectives of the citizens. In a society such as ours, where the activities of government service are varied, and often competitive one with another, no one seriously suggests we proceed without planning. The real question is whether this planning process shall be admitted and identified or whether it be carried out on an "extra-legal", **ad hoc** basis.

a. **Central planning agency.** It is the recommendation of most individuals and groups who study the problems of obtaining coordinated national policies of resource use that a planning and coordinating group or council be placed at
the disposal of the highest administrative officer concerned. The Commission on Reorganization of the Executive Branch of the Government concluded:

Coordination is a presidential responsibility. If the machinery for reviewing resource development programs is elsewhere than on the President's staff it will fail in its purpose. If located in one department it could not successfully coordinate the programs of other agencies.

Natural resource programs and public works, as a whole, must be assessed in terms of the general impact on the domestic economy, fiscal program, and other major government-wide concerns. These coordinating functions are a part of the President's executive responsibility and must be exercised by the President with the assistance of an appropriate staff. That involves a view of the over-all picture of governmental programs and appropriate allocation of emphasis and resources. The President's Office requires some technical staff to help him evaluate the implications of technical recommendations. (237, pp. 75-76)

The success of any central planning and coordinating council or agency in a democracy depends on several things in addition to the competency of its personnel. 1. It must have a broad base of public acceptance, as well as the support of the office of the top leadership. 2. It must provide coordinated plans for immediate concrete action. This requires that the recommended courses of action bear on the immediate problems at hand. We would require that the policies be economically sound, as well as socially and politically feasible. 3. If the planning agency is to do an acceptable job, it should not be called on to produce
Immediate solutions to complex problems without time to consider the long-run implications of the solutions.¹ There must be a systematic and deliberate projection of future objectives and alternatives. This would call for the best technological and economic advice available concerning various alternative courses of action. This would be long-range planning of broad objectives, not specific courses of action.

The special services of our most competent research staffs should be available to the planning council to provide much of the basic data needed for coordination and direction. The "front-line" administrative and action agencies should also be used in the planning process since many of the problems are felt most keenly by those who have direct contact with the issues. But it is too much to expect that the composite of the programs of the operating agencies should add up to a coordinated plan of action.

b. Coordinating the natural resource administrative agencies. Numerous references have been made to the fact that each of the several governmental agencies frequently have substantially different policies and procedures relative to the use and development of the resources under their

¹The history of the Bureau of Agricultural Economics provides a most revealing case history in this respect. For an outline and appraisal of the events see Parks (163).
control. We have discussed some of the adverse effects of the lack of a unified program. There are still many areas (geographical and ideological) where the agencies are not coordinated. Among the agencies concerned with administering the public land resources, there has been a notable absence of coordination until recent years. In those cases where coordination exists, it is still on a highly informal and extemporaneous basis. The joint interdepartmental committees seem to be the direction we are going at the present time. The Federal Inter-Agency River Basin Committee, acting under the threat of having a coordinating authority imposed on the functions of the several agencies, has been able to bring the several agencies together on a plan, although it is highly debatable if the plan is "coordinated" in the full meaning of the term.

The Hoover Commission Report emphasized the lack of coordination between the Forest Service, the Bureau of Land Management, and the Soil Conservation Service in their management of "adjacent and intermingled" federal lands (236, p. 24). They found grazing lands, timber lands, mineral lands, and recreation lands all administered by each of the three groups.

c. Reorganization of the departments. One procedure that frequently has been suggested is to reorganize the departments in such a way that the functions to be
coordinated would be combined under one administrative head.

The Hoover Commission study reported that:

"Our three task forces on Agriculture, Natural Resources, and Public Works all urgently recommend the consolidation of these agencies. It has been urged for many years by the students of government. The Commission agrees with this recommendation. (236, p. 26)

The Commission proposed that the major land agencies be grouped in the Department of Agriculture. However, a minority report of the Commission (237, pp. 58-70) proposed the establishment of a new Department of Natural Resources composed of the Fish and Wildlife Service, the Geological Survey, The Bureau of Mines, the National Park Service, the Oil and Gas Division, the Water Development Service, and the Forest and Range Service. The Water Developmental Service would combine the Bureau of Reclamation, the river development functions of the Corps of Engineers, the power marketing functions of the Bonneville and Southwestern Power Administration and of the Division of Power of the Department of Interior, certain river development functions now administered by the Federal Power Commission, and certain functions of the Department of State relating to international boundary lines. The Forest and Range Service would include all functions of the Forest Service, the functions of the Bureau of Land Management, and the research functions of the Department of Agriculture relating to forest insects and diseases."
The author is inclined to favor the proposal of the minority report on the grounds that it would provide for closer geographic and functional coordination. However, the Commission Report may have a greater chance of one day being accepted. Either one would be a distinct improvement over the present from the standpoint of providing a more coordinated program of resource use and development.

The difficulty encountered in coordinating the important federal land management agencies may be indicated by the history of the recent Uniform Federal Grazing Land Act, sponsored by the Stockman's Grazing Committee. The Act applied to lands within the federal grazing districts, national forests, and Title III lands, within the boundaries of the fourteen western states (245, p. 1). Many modifications of the original bill were incorporated into a new bill, S. 2548. The latter, however, pertains only to public lands administered by the Department of Agriculture (254, p. 1).

D. Toward Economizing Through Political Decisions

The maximizing solutions to the several allocation problems that have been posed in this study have been the function of two kinds of relationships. The first was the physical relationships: 1. The marginal rates of
substitution of one factor of production for another; 2. The
production function or input-output function; and 3. The
marginal rate at which one product substitutes for another
in the production process. Much of the discussion of the
preceding chapters was directed toward ways of improving
our knowledge of this kind of information. In this area
the method of science and the word of the scientist is al­
most sacrosanct. There is an increasing tendency on the
part of the layman, the politician and the bureaucrat to
rely unquestionably on the recommendations of the physical
scientist as to what constitutes the "best" allocation of
resources. It has been shown that the physical production
relationships by themselves, although necessary for making
a maximizing decision, are not sufficient.

The second kind of information that is necessary per­
tains to the preferences of the people. One of the limita­
tions of making economizing decisions through government is
the difficulty of communication. Information concerning
the alternatives, under given situations, must be communi­
cated to the citizenry. And then, given the available alter­
natives, and the relative scarcity of resources, the citizens
need to inform those who make the decisions as to their
relative preferences. It should be emphasized that the
decision-making body (the bureaucracy, in most of the cases
we are dealing with) can rely on the price system as a
guide to the preferences of individuals for some allocation problems. The price system will be reasonably accurate when: 1. The products to be allocated, even when rationed, are of sufficient supply that the bulk of the demand, at the specified price, can be supplied; 2. The important costs and returns to individuals and firms can be evaluated in monetary terms; and 3. The contemplated change is relatively small. This latter point is based on the supposition that radical allocation change probably will affect the distribution of income sufficiently that the decision must be considered from that standpoint, also.

1. The preference survey

Direct voting has been suggested as a method of making decisions in some cases. The prerequisites for resolving issues directly through voting indicate that it holds limited promise as a tool for communicating the preferences of individuals to the decision-making body. A supplement to the voting and price mechanisms is the preference survey,

1 The product in question need not be sold in the market. However, the users must be able to express their preferences for the product in terms of the amount of other products (money) they would be willing to sacrifice in order to obtain additional units of the first. The preference survey, below, might provide a mechanism for doing this, in some cases.
where the alternatives are explained in detail to a selected\(^1\) sample of individuals and their relative preferences are recorded. From the relative preferences of the sample, inferences are made concerning the preferences of the population.

Bowen (20) has constructed a model for "measuring collective choice" through "voting". This model was later used by Brown for determining community preference for public land ownership. He states:

Our questions could be answered by placing alternatives before the voters on election day. This assumes that the complex issues could be simplified and that the voters could be educated and interested in the problem. (24, p. 293)

A failure to meet these assumptions is among the important reasons why the traditional election day voting cannot be used in this case and why we must depend on some form of scientific sampling of public preferences among alternatives.

The nature of the questions to be asked, the individuals and/or groups that should be considered as the population, and the method of aggregating the preferences would depend on the nature of the allocation problem in question. In the preceding chapter we discussed the use of this technique as a method of determining the preferences of a community

\(^1\)Because of the limits of space we will neither develop the technique nor discuss the statistical problems of sampling that are involved in this procedure.
for game. Where the individual preferences for a specified quantity of a particular good or service are expressed in terms of what each one would be willing to give up in order to achieve it, there is more information contained in the results than where a mere statement of preferences of alternative courses of action are obtained. Care must be taken to insure that the individuals being sampled can think and respond in the terms of the questions being asked, however. This would require that professional statistical services be available for the use of administering bureaus and legislative bodies in sampling community preferences. These services would be used alongside the services of the other social and physical scientists in arriving at decisions on allocation problems.

The preceding discussion assumes that it will be possible to establish a statistical sampling bureau that can achieve at least the same high degree of competence and objectivity that has characterized the research agencies and institutions. It could be a separate agency, such as the Bureau of Standards, or it could be a part of the Bureau of Census. The idea of sampling public opinions and community preference is not new, of course. It is being used, to a certain extent, all the time. What is needed is a single, competent statistical service group established at
the national level geared to meet the legislative and administrative needs for estimates of the relative preferences of the people.

2. **Some implications of the extensive use of preference sampling**

It seems to the author to be a reasonable requirement that the economic horizon and the planning objectives of the bureaucracy do not differ substantially from those of the society it represents. This may appear at once to be obvious, yet it is perhaps a most subtle and difficult condition to obtain; it is the core of democratic political philosophy (74, pp. 257-268). If a more precise measure of the preferences of society were available both the bureaucracy and the elected representatives (Congress and the President) could better determine the extent to which the policies and practices of the bureaus should be altered to more nearly meet the preferences of society.

The present practice followed by public land agencies of using rancher advisory boards might be influenced some by the above suggested procedure of determining public preferences. The need for the advisory boards as a means of obtaining the "grass roots" opinions of the various segments of the economy would be diminished. On the other hand, the advisory boards could become better informed concerning the
preferences of the group they represent and could speak with greater certainty. It would seem advisable, under these circumstances, to revise the advisory boards, as previously suggested, to include representatives of all important users of the resources in question\(^1\), and to give the advisory boards a greater influence in determining the policies and practices governing the use of the resource.

If a method is devised for direct sampling of community preference, it appears, at first, that the activity and influence of the pressure group would be decreased. The need, on the part of the administration, for the services of the pressure groups might be almost eliminated. Should the preference sampling procedure become effective, the efforts of the pressure groups likely would be redirected toward influencing the desires and influences of the citizens. This is precisely what is being done in those cases where the individual preferences are expressed directly at the voting booth (political campaigning) or in the market place (advertising). Actually, the activities of the pressure groups directed toward the citizenry would be a form of advertising - describing the alternatives of the public.

\(^1\)As noted in Chapter VII, the Forest Service has recently revised its advisory boards to include representatives of the important users. As yet, the extent of the influence of the new advisory boards is unknown.
allocation problem in such terms as to make one alternative more desirable than the other. The activities of the pressure group might ultimately be diminished.

3. The role of economic models in the economizing process

The precise solutions to the allocation problems specified by our marginal conditions are meaningful when experience and/or scientific research is sufficiently developed to establish fiducial limits on the expected functional relationships and expected preference ratios. We have mentioned some important allocation problems where it is possible to apply the economic models outlined in this study.

For a number of the problems, scientific research has been inadequate, or it has not been designed to furnish the information needed for precise solution. Sometimes experience is lacking for a particular alternative or experience may be available only over such a broad range of circumstances that verification of response is impossible. Under these situations the optimum solution to a given problem becomes merely a construct - a theoretically synthesized norm. There are obvious and significant uncertainties associated with it. It is important only in an ex ante sense, since no testable ex post conditions exist. Where this situation prevails, the theoretical model becomes particularly useful. First, it specifies the information
needed for an ideal solution; and second, it prescribes the statistical procedures to be used in collecting and evaluating the information\(^1\). The implications of the several economic models for future research have been noted. A precise solution to these problems must await the research findings.

However, there are some problems for which little information is now known, where decision and action cannot be delayed until research findings are forthcoming. In this case, no basis for action exists aside from the logic of the theoretical economic models. Under conditions of uncertainty, however, there are several reasons why one might want to proceed with caution making only relatively small adjustments from the existing allocation position.\(^2\)

\(^1\)This was outlined with greater detail and precision in Chapter III, Sections A and B.

\(^2\)Even under conditions of uncertainty large changes may be preferable if it becomes clear that small changes will not correct a highly undesirable situation within a desired time span. If, for instance, when it became obvious to nearly everyone that the Homestead Act was failing miserably as a land policy west of the 100th meridian, Congress had been willing to take the risk of drastically changing the acreage so as to provide an economic unit for each settler, many of the resulting adjustment pains could have been avoided. Instead Congress was content to make small changes in the policy that proved far inadequate to correct the difficulty.
Because the amount of change is small, hypothetical estimates of physical response will not be seriously wrong. If it becomes evident that the adjustment is in the wrong direction, the fact that the adjustment has been small usually permits a reversal of the procedure. In addition, most of us form our preferences by testing and comparing. Where large incremental adjustments are made the result may be vastly different from the present reality (47, p. 82-83). As the preferred direction of change becomes confirmed by successive experiences (in reality these are experiments), as scientific knowledge about the physical production responses under given situations becomes greater, and as the people become more confident about their preferences, larger changes from the present resource-use-pattern can rationally be made.
CHAPTER XIII
SUMMARY

The central economic problem relative to range resource use is the allocation of all scarce resources available to the Western Range Area so as to obtain a maximum of the goods and services desired by all individuals and groups concerned. The resources to be considered are: 1. All land resources west of the eastern boundary (placed near the 100th meridian), including climate as well as physiographic features; 2. All labor resources available to the area, including the skills, productivity, and mobility of the workers; and 3. All capital and management resources available to the area.

Most of the debates and differences among and between resource users and consumers concerning range resource use focus on the rate and manner of resource improvement, the intensity of resource use, and the allocation of the resources among the competing products of multiple-use. Considerable confusion, conflict, and differences of opinion exist concerning the optimum solution of these problems. An important cause of the differences of opinions and lack of objectivity among workers in the field, as well as resource users and administrators, is the failure to use an adequate
theoretical economic framework as the logic underlying the analysis.

The primary purpose of this study was to develop a logical framework for economic analysis of western range resource use. The basic deductive theorems (the maximizing conditions) of the framework were taken from general equilibrium theory and welfare economics. These were adapted to dynamics by the use of the concept of the "economic horizon". Because of differences in the effect of uncertainty, time preference, and rate of interest, the economic horizon tends to be shorter for individuals than for groups of individuals.

The application of the marginal conditions to the allocation problems of western range resource use was investigated in the physical and institutional environment in which the resources exist. The institutional environment, however, was not considered fixed, it being theoretically amenable to the desires of the citizens. The marginal conditions hold for any degree of aggregation for which "welfare" is to be maximized, whether it be the firm, the household, the community, the Western Range Area, or the Nation. The assumptions underlying the theoretical models were enumerated, their limitations to specific situations were pointed out, and the policy and research implications of the maximizing solutions were discussed.
In general, the economic problems of range resource use fall under four main types of theoretical solutions: 1. Optimum factor combination and use; 2. Optimum scale of firms; 3. Optimum product combination; and 4. The pricing of factors and products. The latter set of problems arises out of the environment in which some of the factors and products are rationed and their respective prices are administered.

The marginal conditions governing the optimum combination of factors of production specify that factors be so allocated that the ratio of the discounted expected marginal value of product to the discounted expected price of the factor be equal for every resource. This ratio should also be equal for every possible alternative use for each factor. (In absolute equilibrium this ratio would be 1.00.) The physical input relationships needed for making maximizing solutions come from the science of range management. However, the logic of the maximizing principles is not a part of the theories and principles of that science, but come from the science of economics.

To illustrate the implications of optimum resource allocation in the institutional environment of the West, the economic problem of range improvement was selected as an example. In the range-livestock industry dual resource control is the predominant situation and the most important
landlord is the federal government. Inputs combined with leased land may be classified as: (a) Factor-saving to the landlord; (b) Factor-saving to the tenant; (c) Product-increasing to the tenant; (d) Product-increasing to the landlord. Before the government (landlord) would rationally invest in range improvement to where marginal returns equal marginal costs for the investment, it must be able to increase the grazing fee to compensate for types (b) and (c) improvements. Before the tenant would rationally invest in range improvement he must: 1. Receive compensation for types (a) and (d) improvements; and 2. Have increased security of tenure expectations for types (b) and (c). Several suggestions for accomplishing these objectives were explored.

Optimum scale of firms occurs when it is impossible to increase or decrease the size of firms and thus obtain a lower cost of production for the same products or increase the amount of products from the same resources. Three alternative methods for determining economies of scale were explored - the residual claimant, the production function, and the synthesized scale model methods. There is strong evidence that substantial scale maladjustment occurs with the smaller firms. However, very little is yet known about the true nature of economies of scale of the range-livestock industry.

The extent of conflict between resource efficiency and income distribution criteria for determining optimum scale
adjustment depends on the real nature of the economies of scale. There obviously are conflicts in the kind of recommendations one makes based on each criteria. Where poverty in agriculture exists, the recommendation that people be moved out of agriculture is not sufficient, per se, but must be preceded by public programs of education, economic stabilization, and social acculturation.

An important assumption underlying the necessary marginal conditions for maximum welfare is that the factors and products are priced so that the market is cleared of all factors and products that are offered at that price and that no demand at that price goes unsatisfied. This assumption was found to be invalid for several instances of federally owned forage resulting in pressures tending toward mal-allocation. A general procedure was presented for evaluating the forage in terms of: 1. The quantity and quality of forage and the production coefficient rate at which grass was transformed into animal products; 2. The price of livestock products; and 3. The cost of resources other than forage associated with range-livestock production. An integral part of the problem of pricing federally owned resources (factors?) (products) has its roots in intergovernmental fiscal relations of the federal, state, county, and local government because: 1. The large land holdings of the federal government leave a small property tax base in many counties; and
2. The concentrated government activity frequently throws extremely heavy demand on the local units of government for schools, etc. The procedure for solving this difficulty was considered separately for different administrative agencies.

The marginal conditions specifying an optimum combination of enterprises (products) were explored for three different types of allocation problems. The first was that of determining the type of agricultural production for a given situation. Two important types of farming that become marginal with range-livestock production were considered. A theoretical framework for determining optimum marginal adjustment between range land and dryland cropping in areas of weather uncertainty was presented. Another economic problem facing some firms is the integration of irrigation into range and dryland farming operations. The solution to this problem depends on: 1. The changes in the level of income resulting from increased physical output, capital investment, and operating costs; and 2. The changes in the stability of physical production over time. The existing economic criteria for determining the feasibility of irrigation development was appraised.

The second type of product combination to which the marginal conditions were applied was that of determining the optimum rate of product (resource) use over time. This is
the general problem of conservation. A special facet of the intertemporal allocation problem for range resources is that of providing a seasonally balanced forage supply. This problem arises out of inflexibility due to: 1. The lack of seasonal homogeneity of range forages; and 2. Institutional restrictions that discourage interfirm adjustments. The solution lies in decreasing this inflexibility. A theoretical model for determining optimum intensity of grazing over time was developed and adapted to conditions of weather uncertainty. The maximizing solution called for flexible levels of livestock grazing. The pattern of livestock grazing over time would depend on the coefficient of variability of the weather pattern.

The third type of product combination pertained to the optimum combination of the products of multiple-use resources, viz., livestock, wildlife, timber, recreation, and hydrological products. The general solution to this problem was approached through a series of partial solutions. First, the optimum combination of domestic grazing (sheep and cattle) was determined for a hypothetical range. This combination was then treated as a single enterprise (product) and the optimum combination of livestock and wildlife was considered. Following the previous procedure, all animal grazing was considered as forage production and the optimum combination of forage and timber was outlined. The fourth
partial solution was that of private production versus public recreation. Important, in this connection, was the selection of the optimum combination of the different forms of outdoor public recreation. Finally, the relation between the other uses and hydrological products (both water yield and flood and erosion control) was explored.

In each case the solution was a function of the physical marginal rates of product substitution between the two alternatives in question for a specific range site and the relative preferences of society for the products being considered. The general nature of several physical transformation functions was suggested, and procedures for estimating others were outlined.

The relative preferences of society for alternative products is usually expressed in terms of market prices. Not all products are allocated through the market mechanism, however. In some cases individuals express their preferences for alternatives by voting. Many of the allocation decisions pertaining to range resource use have been delegated to elected and/or appointed representatives. The complex and interrelated allocation decisions that are made by the several different elected and appointed representatives (Congress, the President, and the bureaucracy) can be improved by the use of: 1. A central planning and coordinating board; and 2. A professional sampling staff to estimate the
preferences of individuals relative to alternatives by means of statistical sampling.

Where the information needed for a decision is known the theoretical models lead directly to the maximizing solution. Where the information is not known, the models direct the search for the needed facts. In the meantime they furnish the only logical basis for decision making in the absence of information.


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Private Versus Public Land in the Public Interest

In the discussion of the impact of the economic horizon on decision making in Chapter IV, mention was made of conflicts arising out of the situation where production was carried out under dual control of resources - specifically, conflicts arising from private production using public resources. These conflicts arose when the economic horizon and/or the objectives of the entrepreneur differed substantially from those of society. There are two alternative directions that the solution to these conflicts can take. First, the decisions that the private operator makes relative to the use of public resources can be reduced. The implications of this solution are discussed at several points throughout the main body of this study. The second alternative direction is to increase the length of period and/or the extent of the private operator's control of the resource. These are questions of degree to which there is no clear-cut universal answer.

Consider, briefly, the second alternative from the standpoint of economic efficiency. Adjustments designed to increase the rancher's control over the forage on public land would decrease the uncertainty of tenure expectations.
and thus increase economic efficiency of the private firm. However, since there may be important products other than forage for livestock from the resources in question, these products must also be considered. A controversy between the range livestock industry and the Forest Service centers on this point, as illustrated by the Uniform Federal Grazing Land Act (245) sponsored by the Stockmen's Grazing Committee in 1953.

The center of storm raised against the Act as originally presented, was directed against those sections designed to increase the security of tenure of the permittees. As originally proposed, the Act provided that the holders of established grazing privileges be given "first preference" status for the continued use of existing allotments so long as the allottees used their privileges "beneficially to the public interest", and maintained their base property "in accordance with the customary practices of the grazing privilege holders of such localities" (245, p. 4). If and when increased grazing capacity became available on an allotment it was to be awarded to the existing allottee.

The original bill provided for the transfer of grazing privileges by the permittee "as they stand at the time" without charge or penalty. The Forest Service objected strenuously to this on the grounds that: 1. It made of the permit a "right" and would result in the permittee's
acquiring a degree of "equity" or "property-claim" in the national real estate; and 2. It would prevent the Service from carrying out its responsibility for multiple-use management of the national forests. That the first would be true seems rather certain; the second would be unlikely. The Forest Service would retain the same degree of control over the timing and number of livestock grazed as it would have in the absence of this section of the Act. Only the security of tenure or right to use whatever forage is to be used is in question (100, pp. 24-25). The Act provides that: 1. The permittee must manage his own base properties according to certain prescribed conditions and follow the regulations of the Forest Service in his use of the public land; and 2. The power of the Secretary "to limit or discontinue the grazing use . . . for purposes of preventing injury . . . from grazing" or to change the land use from grazing to "any other authorized use" shall not be diminished. Thus, there seems little justification for any fears that the increased security of tenure to the stockmen would interfere with the multiple-use objectives of the Forest Service. Nevertheless, this controversial section of the bill was deleted from the final draft of the bill that was passed.

The ultimate degree of increased control of the resources is private ownership. This is the traditional
solution to this problem in the American capitalistic society as far as agricultural land is concerned. That it is not a perfect solution, by itself, is evidenced by society's providing Soil Conservation Service assistance and Production and Marketing Administration payments to private operators in an attempt to alter their time-preference pattern and/or to assist them to achieve an intertemporal use-rate not in conflict with the objectives of society.

Kelso makes this point:

But it is significant that practically no voices are raised urging public ownership of pasture and crop lands to protect them from abuses by private firms or to enhance investment in their increased productivity. . . .

The social costs of resource deterioration are not so acute on western privately owned grazing lands as they are on the far more productive, more valuable, privately owned pasture and crop lands in the humid areas to the east. (64, p. 142)

He points out this paradox. It is the grazing lands east of the 100th meridian, in the Great Plains, that are in the most serious condition; yet, it is the grazing lands west of the 100th meridian that are being held in public ownership in order to prevent their destruction by private owners.

The primary objection to private ownership of these lands arises from the fact that many of the lands have several uses, some of which do not adapt to decisions made by private operators (recreation, wildlife, hydrological products, etc.). To establish resource control in private
ownership in fee-simple title may make it very inconvenient or costly for the public to maintain control over these other products which the private operator is not primarily interested in. It is evident that the demand for most of these alternative uses is increasing as our population increases in numbers and mobility, as our production efficiency permits greater leisure, and as this leisure becomes more evenly distributed among the members of society.

However, there are many acres of the public lands that have little alternative use other than grazing, whose only claim to recreation and scenery is their "magnificent distances", and where rainfall and water runoff is negligible. In cases of this kind, where livestock grazing is essentially the only product, it would seem to be in the interest of economic efficiency to increase the security of tenure expectations to the maximum, which would be private ownership.

Another reason sometimes voiced against private ownership of the remaining public range land is its low productivity (177). However, this objection does not seem valid to the author. Grazing is an economic activity on this land, the privilege for which the private operator rationally pays a fee. This economic return can be expressed in terms of interest on investment and real estate taxes paid to local governments as precisely as in terms
of grazing fees paid to administrative bureaus and can be
done perhaps at a saving to society. The amount paid to
the local governments by the federal agencies, for compen-
sation in lieu of taxes, is only a portion of the fees
collected. The cost of the local government is the same
regardless of the tenure pattern in question. All that is
required is that land be taxed at a rate consistent with its
productivity, relative to other land. There has been a
significant improvement, in the past three decades, in the
machinery by which property taxes are assessed - both the
technical skill of land classification and the administra-
tive machinery of assessment have been improved (209, pp.
63-73).

There are two important obstacles to the sale of public
land - even land that has little alternative use other than
for grazing. First, because of the uncertainties as to
what the future use and yield of the land might be, the
public is prone to continue the "wait and see" attitude.
The fact that the disposal action cannot be easily reversed
justifiably delays the decision. The second obstacle is
that of the sale price. As discussed in Chapter VIII, most
ranches that now use public lands have had the economic
advantage provided by the public land capitalized into the
purchase price of the ranch. J. E. Holmes described the
issues quite clearly:
Here is a dilemma. If the government sell the lands at the rates proposed by the (livestock) associations, it confirms a capital value out of which the government has obtained no significant return; if the lands are sold on the open market, the current users will suffer the loss of their forage and be under compulsion to buy again what many have already once largely paid for. The ranch economy could not stand the strain of the second alternative; and the press and public may not soon be able to digest the significance of the first. The cry of "land grab" would be almost inevitable. (100, pp. 31-32)

These are rather formidable obstacles to getting the land in private ownership. The general trend appears to be in the opposite direction.

In looking ahead toward long-run adjustments, it appears likely that uses higher than grazing may ultimately be desired on many acres of land now being used primarily for grazing. When the higher use comes land will shift out of grazing whether it is public or private land. One of the problems is to make the change with the least individual and social strain, which requires some flexibility of action. Still we cannot hold all our resources in reserve waiting for a future time to arrive. We must commit them to use under conditions that provide for their efficient use in the present and yet provide the flexibility needed for future adjustment. The optimum solution will be a compromise on these two somewhat conflicting issues.