Irrigation Possibilities

in the

Fort Rock Area

Emery Castle and Carroll Dwyer

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Agricultural Experiment Station, Oregon State College and the Soil Conservation Service, U. S. Department of Agriculture, Cooperating.

Foreword

Your Agricultural Experiment Station at Oregon State College has been called upon several times to evaluate the agricultural potential of various areas of the state. These studies usually are made when something new in the area affects its economic development.

This is the case for the Fort Rock-Christmas Lake Valleys in Oregon. The coming of electricity to the area and the known existence of ground water have interested a number of people in the possibilities of an agricultural economy based upon irrigation through ground-water development.

Farmers and ranchers of the area, through their local Soil Conservation District, requested a soils survey of the area. This request was made jointly to Oregon State College and to the Soil Conservation Service. It soon became apparent, however, that an economic study was needed to supplement the soils survey. This research report is the result of the joint undertaking.

It is believed the information will be useful not only to prospective settlers who may consider entering the area but also to those in the area who may wish to adjust their farm operations.

F. E. Price

Dean and Director.

Irrigation Possibilities in the Fort Rock Area

EMERY CASTLE AND CARROLL DWYER*

Summary

Ground water exists at depths of 25 to 100 feet in the Fort Rock-Christmas Lake Valleys. There is sufficient water to irrigate approximately 30,000 acres, although over 100,000 acres are suitable for irrigation.

But the growing season is short, averaging about 74 days. Killing frosts may occur any month. The opportunities for many different types of farming are limited. Livestock production and feed for livestock appear to offer the greatest promise. Feed for livestock may be fed on the farm or sold as a cash crop.

Costs of land, land development, irrigation facilities, machinery, and livestock are substantial in relation to income potential. These costs may vary from about $180 to over $250 per acre, depending on the size and type of farm organization.

Substituting improved irrigated pastures for range will not pay unless pasture yields exceed 8-animal-unit months of grazing per acre.

An operator considering purchase and development of an irrigated farm should have enough money so he can withstand crop failures, particularly during development years.

The smallest farm size which will provide an adequate return to operator, labor, and management is 160 acres. This size unit will require yields of alfalfa of 4 tons per acre or must carry considerably more than 100 head of beef cows, if it is to return a fair interest on investment and provide a level of living adequate for most farm families.

An opportunity exists for livestock producers with access to public rangeland to use irrigation to improve and stabilize their feed supply.

Economic development of the area will be associated with some risk and uncertainty. Not only are crop yields uncertain (due to frost hazards), but some characteristics of the water supply are not known. The exact location of water, and the type of water-bearing strata, may vary.

The Problem . . .

A large acreage of land in the Fort Rock-Christmas Lake Valleys has ground water 25 to 100 feet below the soil surface. Numerous individuals are interested in the area's possible development with irrigation. The Fort Rock-Silver Lake Soil Conservation District requested that Oregon State

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College and the Soil Conservation Service study the area's physical characteristics, its adaptability to irrigation, suitable types of farming, and the yields and net returns required to justify development. Recently the area has been supplied with electricity which is available for pumping.

The Fort Rock-Christmas Lake Valleys are high desert intermountain valleys with an average elevation of about 4,350 feet. They are located in the northern part of Lake County, Oregon. The closest major towns are Bend, about 85 miles to the north, and Lakeview, about 90 miles to the south. The two valleys cover approximately 282,000 acres.

The first settlement occurred about 1875. Little development took place until after the turn of the century. Between 1900 and 1930 a large part of the area was cleared of sagebrush and planted to dryland crops, but is now largely abandoned. The discovery of a supply of underground water and the availability of electricity offer another type of agriculture for the area. This study investigates the economic possibilities of irrigation.

Physical Characteristics . . .

Ground Water

The U. S. Geological Survey completed an investigation of the ground water basin underlying the Fort Rock-Christmas Lake-Silver Lake Valleys in 1952.[1] Basic data indicate the following:

An underground lake lies under the Fort Rock-Christmas Lake-Silver Lake Valleys. The water has an outlet near the vicinity of Hole-in-the-Ground, northwest of Fort Rock. The water table lies in a saucer shape, from 25 to 100 feet below the valley floor.

The average yearly recharge is roughly estimated at 125,000 acre-feet. The average annual water used by present plant cover approximates 50,000 acre-feet. Underground drainage from the basin is estimated at approximately 75,000 acre-feet per year. About 500 acres were being irrigated at the time of the survey.

The total amount of ground water available for irrigation would be equivalent to that now pumped, plus that saved from the present plant use, plus that lost through the underground outlet. Thus, the total amount of water that could be used yearly for irrigation would be somewhere between 75,000 and 125,000 acre-feet.

Considering the probable amount that could be saved from present plant use, the estimated safe annual yield would approximate 80,000 acre-feet. Assuming the average annual irrigation requirement as 2.5 acre-feet per irrigated acre, about 32,000 acres would be the acreage that could be irrigated.

The geological survey suggests that irrigation development should not be concentrated in any particular area, but scattered over the entire valley plain to equalize water use and avoid a water shortage that might follow concentrated pumping.

Soils

Kenneth Irons and Rudy Mayko of the Soil Conservation Service, U. S. Department of Agriculture, completed

[1] R. C. Newcomb. *"Basic Ground Water Dota in Loke County, Oregon."* U. S. Department of the Interior. Geological Survey. Mimeographed.

a general soils investigation of the Fort Rock-Christmas Lake Valleys in 1955. Alkalinity and salinity determinations and mechanical analyses were made by the Department of Soils of Oregon State College. The Riverside, California laboratory of the Soil Conservation Service analyzed additional samples.

The map (figure 1), based on the general soils investigation, shows the suitability for irrigation of the dominant soils. This map can serve as a general guide for locating soils that are most favorable for irrigation development. A detailed soil survey will be required to delineate accurately the various kinds of soil in enough detail for irrigation planning.

The characteristics of the map areas are:

Area 1. Soils generally suited to irrigation. Dominant soils are deep or moderately deep, with sandy loam, loam, or silt loam texture, and good drainage potentials for removing or preventing an accumulation of toxic salts. These areas also include some soils which are not suitable for irrigation.

Area 2. Soils generally not well suited to irrigation. Dominant soils are either silty with moderate amounts of toxic salts and with poor drainage potential, or sandy with low water-holding capacity, excessive drainage, and liability to wind erosion. Some soils within this area may be suitable for irrigation.

Area 3. Soils not suited for irrigation. There are three dominant soils: (1) shallow, sandy, or loamy soils with irregular topography, (2) soils with low water-intake rates, poor drainage potentials, and strongly alkaline conditions, and (3) active sand dunes. Within this area there may be some small bodies of soils suitable for irrigation.

The acreage included within each of the groups shown on the map is as follows: Area 1, 116,100 acres; Area 2, 91,320 acres; Area 3, 74,580 acres. On the basis of soil characteristics, it appears that more than 100,000 acres are suitable for irrigation development.

Data contained in the report *Basic Ground Water Data in Lake County, Oregon* indicate about 32,000 acres can be safely irrigated. More acres appear suited for irrigation development than there is water to irrigate them.

Weather Characteristics

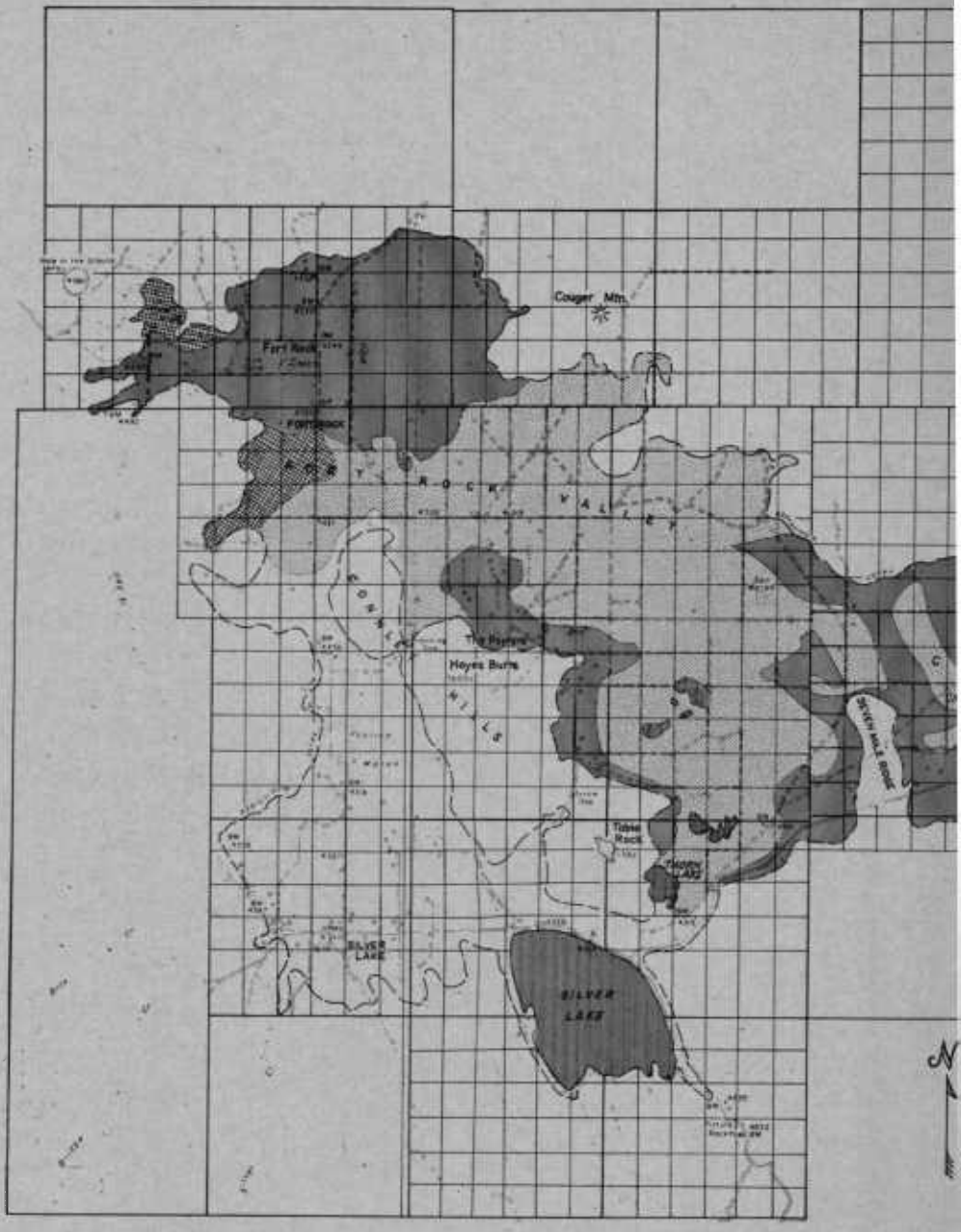
Precipitation. Precipitation in the Fort Rock area averages about 9 inches per year (table 1). Without irrigation, rainfall is not enough for successfully raising most cultivated crops. Some individuals who have been in the area for a long period have summer fallowed to conserve moisture. Even with this practice, their choice of crops is limited.

Table 1. Average Precipitation by Months for Silver Lake and Fremont.*

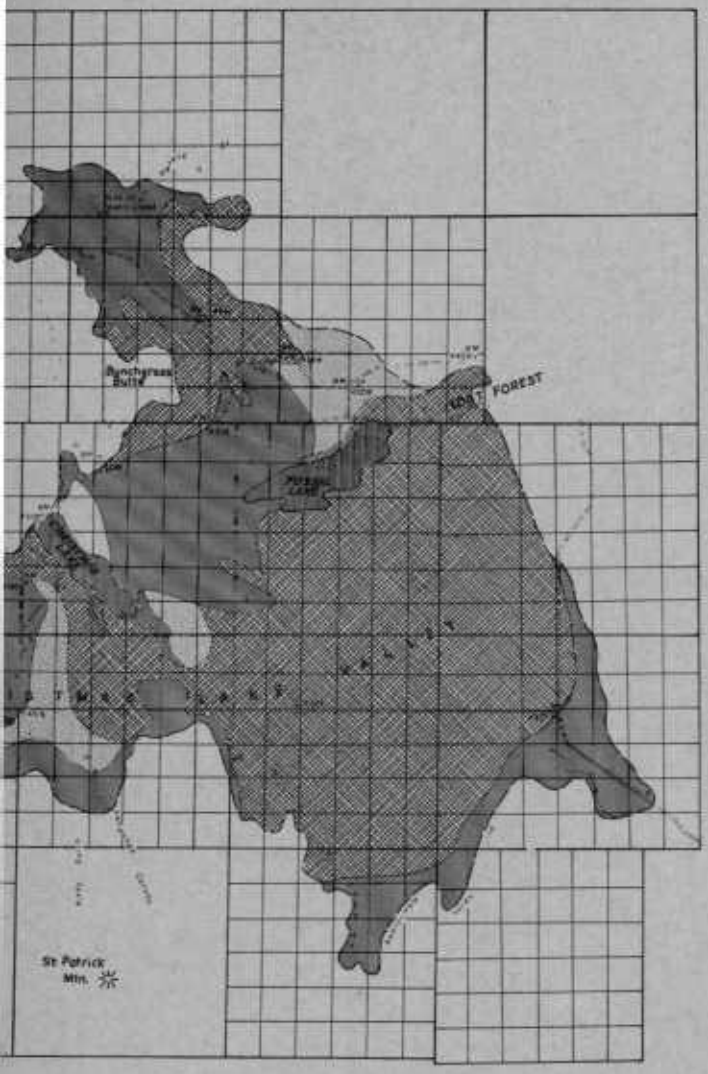
Station	Years of record	J	F	M	A	M	J	J	A	S	O	N	D	Yearly average
Fremont	21	1.03	.96	.53	.70	.72	.83	.52	.33	.63	.56	1.09	1.08	8.98
Silver Lake..	36†	1.03	1.15	.89	.75	1.15	.90	.55	.32	.61	.77	.89	1.13	10.14

* Climatic Summary of the United States, Sections 1-33, 1930, Western Oregon.
† Some years incomplete.

Figure 1. Generalized Soi



ınd Irrigability Map



AREA 1.

Soils suitable for irrigation.

AREA 2.

Soils generally not suitable for irrigation.

AREA 3.

Soils not suitable for irrigation.

0 2 4
SCALE IN MILES

Growing Season. Table 2 indicates the extreme variability of the growing season in the area. Although the average growing season of 74 days is a relatively short time suitable for crops, the average tends to hide the extreme frost danger. Figure 2 indicates it would be hazardous to produce any crop that would be seriously frost-damaged. For 5 of 22 years' available records, the growing season was 50 days or less. This means it is impossible to plant a crop with any reasonable assurance the frost-free date has passed. Table 2 indicates the last killing frost in the spring varied from as late as July 26 to as early as May 28. The first killing frost in autumn varied from August 14 to October 10. This is illustrated by figures 3 and 4. It is impossible, therefore, to know in advance the length of growing season or during what period of summer the longest frost-free period will occur.

In interpreting the above figures, remember that the period is from 1896 to 1924 with some missing years. There is also a question of just what constitutes a killing frost.

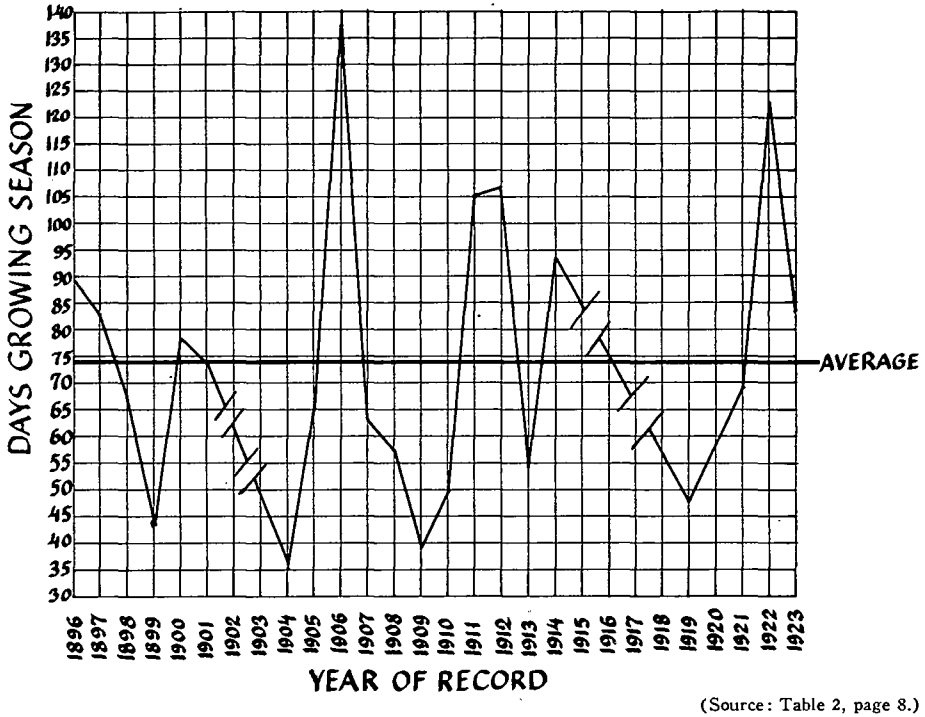
As used in this report, "killing frost" and "growing season" are taken directly from publications of the U. S. Weather Bureau. The Weather Bureau has defined a frost as killing when the

Table 2. Silver Lake, Lake County—Elevation 4,476.[1]

Year	Date of last killing frost in spring	Date of first killing frost in autumn	Length of growing season
1896	June 10	September 8	90
1897	June 9	September 1	84
1898	June 28	September 4	68
1899	July 1	August 14	44
1900	July 1	September 18	79
1901	June 26	September 8	74
1902	June 17	.....	....
1903	June 3	.....	....
1904	July 17	August 20	34
1905	June 29	September 3	66
1906	May 25	October 10	138
1907	June 24	August 27	64
1908	June 27	August 24	58
1909	July 18	August 26	39
1910	June 24	August 13	50
1911	June 4	September 18	106
1912	May 30	September 14	107
1913	July 17	September 9	54
1914	June 7	September 9	94
1916	.....	October 2	....
1919	July 26	September 12	48
1920	June 24	August 25	62
1921	June 4	September 12	70
1922	May 28	September 28	123
1923	June 25	September 17	84
1924	Freezing temperatures every month		

[1] Climatic Summary of the United States, Sections 1-33, 1930, Western Oregon.

Figure 2. Length of Growing Season



(Source: Table 2, page 8.)

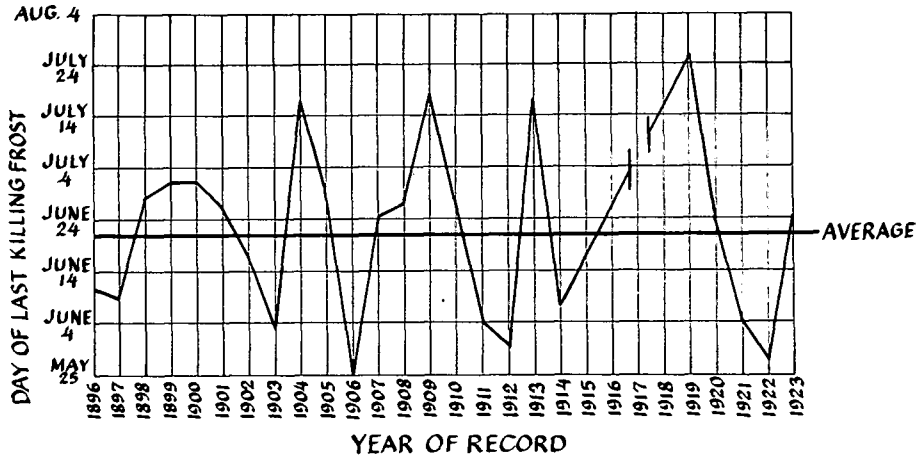
local observer reports that the major crops of an area have been killed. Growing season is defined as the longest period of time that occurs between killing frosts each year. A "killing frost" does not necessarily mean that all plants are killed. Some of the hardier crops such as alfalfa and grasses may survive, although growth is retarded.

Silver Lake has a slightly higher elevation than the Fort Rock and Christ-

Table 3. Temperature at The Poplars, Fort Rock Valley, 1947-53.

Year	Last spring minimum			First fall minimum			Average number of days between last spring and first fall minimum		
	24° or below	28° or below	32° or below	32° or below	28° or below	24° or below	24° or below	28° or below	32° or below
1947	May 14	June 25	June 30	July 4	Sept. 10	Sept. 10	119	77	4
1948	May 15	May 15	June 22	July 2	Sept. 5	Sept. 5	113	113	10
1949	June 30	June 30	June 30	July 17	Aug. 8	Sept. 12	74	39	17
1950	May 28	June 3	June 27	July 12	Aug. 6	Sept. 21	116	64	15
1951	May 2	June 8	June 25	Aug. 12	Aug. 24	Aug. 24	114	77	48
1952	May 5	June 13	June 30	July 17	Aug. 27	Sept. 13	131	75	17
1953	May 25	June 24	June 25	July 21	Sept. 17	Sept. 17	115	85	26
						Average	112	76	20

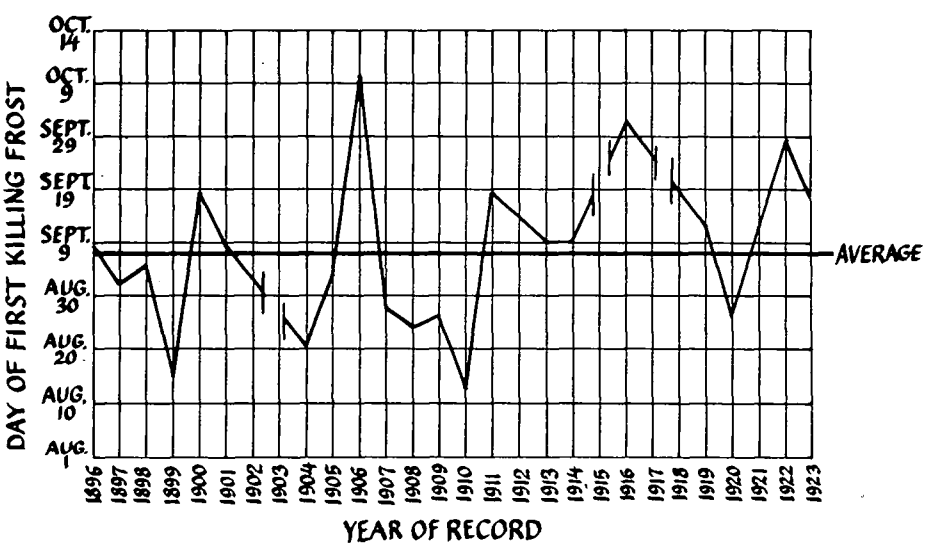
Figure 3. Date of Last Killing Frost



(Source: Table 2, page 8.)

mas Lake Valleys, but the data are the best available. Data presented in table 3 are more precise, although they cover a shorter period. But the conclusions drawn would be approximately the same as those mentioned above. If 28° is selected as the critical temperature, the average growing season is 76 days. Using these temperatures, the critical date in the spring varied from May 15

Figure 4. Date of First Killing Frost



(Source: Table 2, page 8.)

to June 30. In the autumn it varied from August 6 to September 17. On the basis of available data on soils, ground water, and other physical characteristics, it appears that the short and variable growing season is the most serious limiting factor to a successful agricultural economy in the area.

Economic Considerations . . .

Land Ownership

Land ownership in the Fort Rock-Christmas Lake Valleys is constantly changing. Figure 5 indicates ownership as of March 13, 1951. There is both public and private land in the area. Most of the irrigable soils are in private hands. State-owned land is of minor importance, but a considerable amount of land is owned by the Federal Government. Since 1951 some changes in land ownership have occurred.[2]

Land held by the Federal Government is under administration of the Bureau of Land Management, and falls into two categories. One is Bankhead-Jones land that was acquired from private individuals during the 1930's. Note in figure 5 that these lands are concentrated north and west of Fort Rock. BLM cannot make these lands available for public settlement. It is possible, however, to exchange land for Bankhead-Jones lands if certain requirements are met.[3]

The other category held by BLM is desert land (Federal Rangelands). In considering both figures 1 and 5, note the small quantity of land suitable for irrigation that is eligible for entry under the Desert Land Act. This land, some distance from a main highway, is rather isolated, although secondary roads lead to it.

More than half the lands suitable for irrigation are now owned by private individuals. Of the public land suitable for irrigation, individuals may claim the desert land by filing under provisions of the Desert Land Act.[4]

Farm and Ranch Organizations

A mail questionnaire was sent to nearly all farmers and ranchers in the area. Over half of those contacted responded with completed questionnaires. The purpose of the survey was to obtain information about the kind of farm organizations existing in the area. The material reported in this section is taken from the questionnaire.

Most farmers in the area raise beef cattle and most of those replying to the questionnaire indicated interest in irrigation as a means of increasing feed production. A limited number were interested in irrigation as a possible means of producing a cash crop.

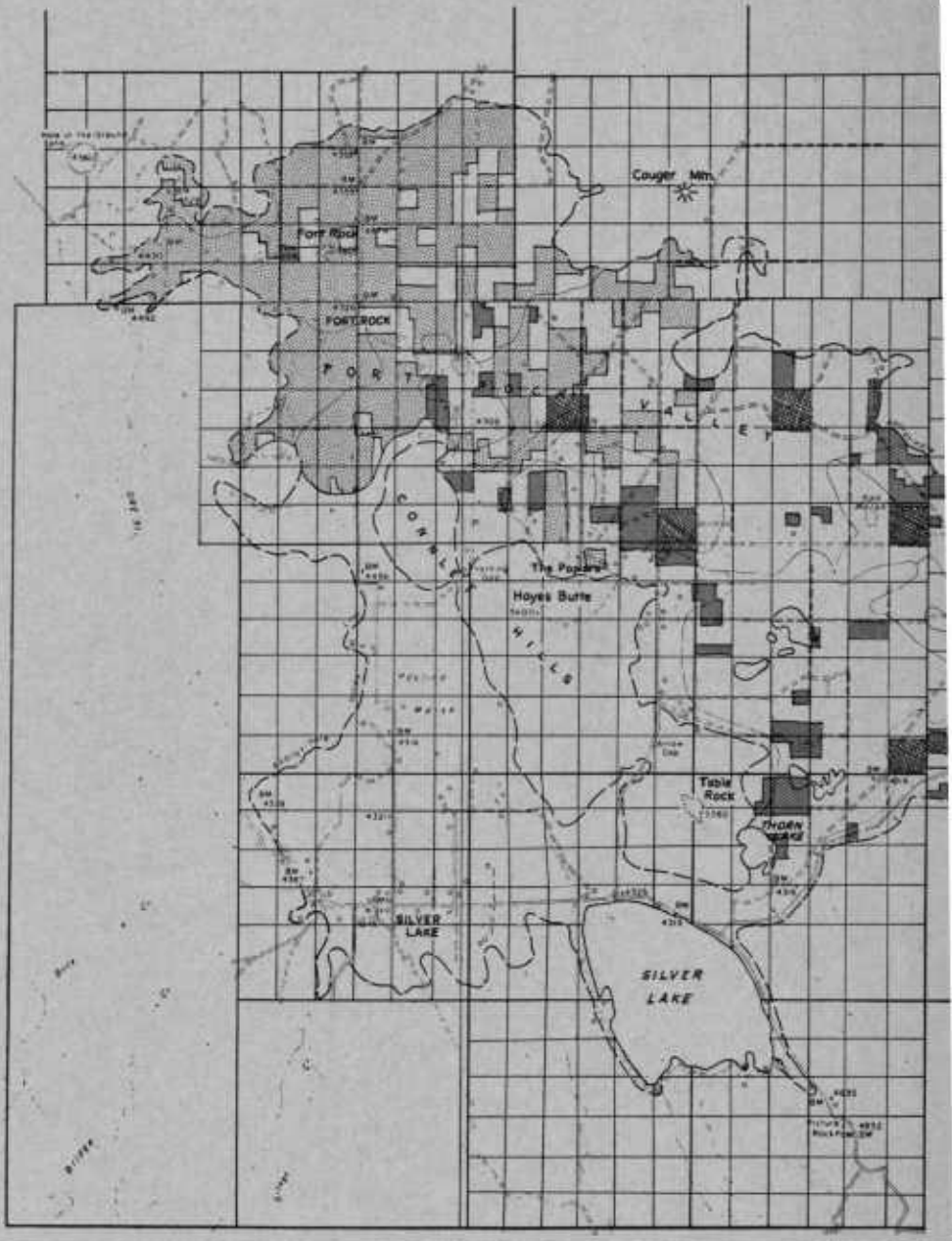
The size of farms and ranches varies considerably. Some ranchers operate as much as 20,000 acres, including owned, rented, and leased land. Others operate as little as 80 acres. The principal product is cattle with a few sheep and chickens being kept by some operators. The number of cattle varies—from over 300 head in some instances to a very small number in others. Most cat-

[2] Since 1951 approximately 4,960 acres have been patented and 2,000 acres have been acquired. About 2,680 acres have been applied for or have been allowed. This has resulted in 5,640 acres having been removed from public ownership since 1951. Most of this change has occurred in the northwest part of the area.

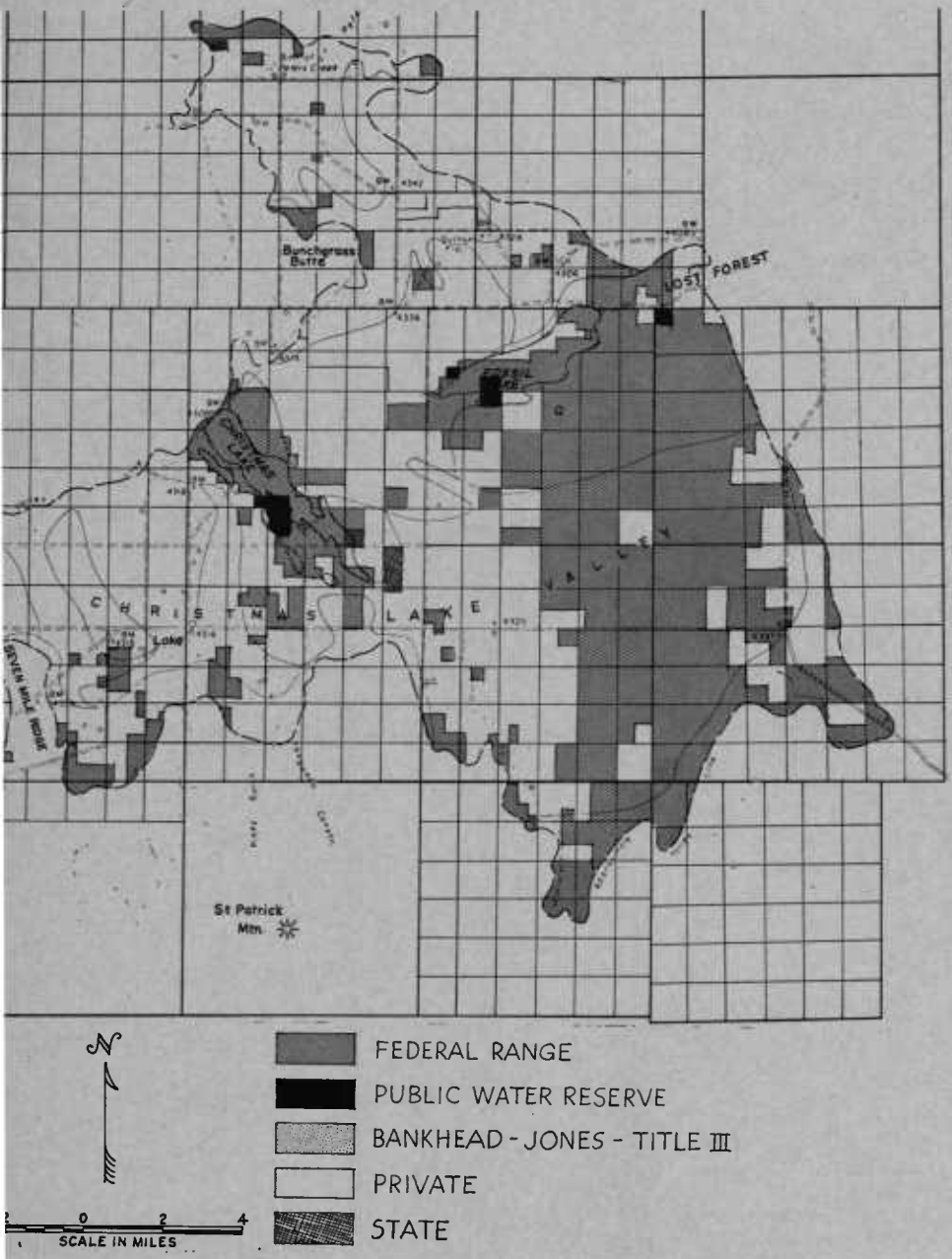
[3] For additional information, see Circular 1408a, Part 146, Title 43—Exchanges of Privately-owned Lands Under Taylor Grazing Act. General Land Office, Department of the Interior.

[4] For details, see Circular 1843, Part 232, Title 43—Desert Land Entries. Bureau of Land Management, U. S. Department of the Interior.

Figure 5. Land O



ıership as of 1951



tle are sold as long yearlings. Some ranchers sell their cattle locally while others truck to Bend, Prineville, Lakeview, and Klamath Falls. Only a small number sell at more distant points. Rye hay is the major winter feed. Livestock production at present is limited by a shortage of both winter feed and summer pasture.

Most farmers and ranchers responding to the questionnaire indicated they would grow additional feed if they decided to irrigate. Alfalfa was mentioned most frequently as the crop they would choose. Most of those who planned to irrigate alfalfa would use it either to raise livestock to a higher finish or to increase the size of their herd. Only a few planned to produce crops for a cash market. Of these, some indicated an interest in grass and clover seed production. Others intended to produce alfalfa hay for sale.

Markets

Nearest trading centers are at Bend or Lakeview, each an average distance of 90 miles. The area is served by main highways and is comparable to many other central Oregon areas as far as truck transportation is concerned. Local demand may provide a market for a portion of the hay and grain produced. Transporting products for sale or farm use imposes a cost of operation which must be considered.

Farm Budget Analysis . . .

Comparison of Farm Organizations

A number of farm budgets were constructed and compared. The purpose of this analysis is to compare four types of farm organizations as well as to supply a basis for estimating possible incomes. Prices, costs, and yields were obtained that would represent what the average operator might realize if he were to develop the water resources of the area. If yield, price, and cost relationships are approximately correct, comparisons among the organizations will be valid.

Spring, 1955 price and cost relationships were used. It is believed these price and cost relationships are more realistic than any long-time average or other normal-price relationship that could be devised. No satisfactory method of forecasting prices and costs has yet been developed.

Yields used are averages of other intermountain regions under irrigation. Many such areas have a more favorable growing season than the Fort Rock area. However, there are some yield records from operators in the Fort Rock area which justify using the intermountain average yields. The average alfalfa yield for Lake County according to the 1950 Census of Agriculture was 2.1 tons per acre.

The use of budgets in comparing farm organizations in the Fort Rock area does not imply that the yields, costs, and returns would apply to any existing or potential farm unit. Neither does it imply that the yields are average for the area. Instead, the budgets indicate what might be expected under the assumed conditions.

The budget analysis has been divided into two parts. The first part compares the different farm organizations and the second discusses the effect of varying yields on the income of one type of organization.

A description of each farm organization follows:

Organization I—*Cow-yearling.* 320 acres owned, none irrigated, tillable, and can be used for rye hay. Public rangeland is available and cow-yearling livestock enterprise is the chief source of income. The number of cows kept each year is approximately 100.

Organization II — *Irrigated cash crop.* Alfalfa as a cash crop is the chief source of income. Barley is grown in a rotation with alfalfa. No livestock.

Organization III — *Cow-yearling —irrigated alfalfa hay.* Similar to Organization I. An acreage is irrigated to provide feed for livestock. Irrigation stabilizes and improves the quality of winter feed. Again 100 cows are kept, and the higher-quality winter feed results in yearlings in better condition at selling time than for Organization I. Public rangeland is assumed available.

Organization IV — *Irrigated pastures.* These pastures are used in place of public rangeland. It is assumed calves will be fed concentrates and sold as baby beef, to provide a greater volume of production. In addition to irrigated pastures, a considerable acreage of alfalfa and barley is irrigated to provide feed. In this organization 100 cows are kept. It has a larger volume of business than either I or III. Public rangeland is assumed not available.

The land use of the various organizations is given in table 4. Note that Organization II has 160 acres and I, III, and IV have 320. It is assumed summer fallow will be used for rye hay production.

Yields and production of crops and livestock are given in appendix table 1, page 21. These yields are averages based on what has been achieved in other similar areas. Current prices, adjusted for seasonal variation, are used in appendix table 2, page 21.

The investment required for the various organizations, shown in table 5 below, appears substantial. But it is known that irrigation development in the area requires a considerable amount of money. Note that Organization II has lower capital requirements than Organization I. The capital, however, is in a different form. For Organization II, capital is mainly in the form of irrigation equipment while for Organization I the main investment is for livestock. In the latter case, cattle would be raised on the farm while irrigation equipment, well drilling, and land leveling require capital outlays. All investment figures must be interpreted in this light.

Table 4. Land Use.

	Alfalfa	Barley	Rye hay	Summer fallow	Irrigated pasture	Other	Total
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Org. I	0	0	155	155	0	10	320
Org. II	120	30	0	0	0	10	160
Org. III	50	15	100	100	0	55	320
Org. IV	70	35	42.5	42.5	120	10	320

Table 5. Investment Requirements.

	Real estate	Irrigation[1] equipment	Livestock	Feed and supplies	Machinery	Total
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Org. I	11,200	0	21,985	2,000	9,470	44,655
Org. II	5,100	17,745	0	1,000	9,870	33,715
Org. III	11,200	11,200	22,585	2,000	10,370	57,355
Org. IV	13,200	29,715	25,625	3,000	11,550	83,090

[1] Includes costs of well, pump, motor, wiring and switches, sprinkler irrigation system, and clearing and minor leveling of land.

Water requirements for various crops are presented in appendix table 3, page 21. Power requirements and power costs were calculated from these data. For a detailed explanation of the procedure used, see Oregon Agricultural Experiment Station Bulletin 548.[5]

The budgets in table 6 indicate important facts. Crop yields must be greater than those used in the budgets if a farmer is to receive adequate returns for labor and management. Organization I clearly indicates that this size and type of enterprise, where public range and purchased feed must be relied upon, is not profitable with current prices and costs. This operation fails to pay interest on investment and to leave any return for living expenses or for capital accumulation. Most successful operators with similar organizations in the area have a larger acreage and more cows.

Budget III, while showing some return for operator's labor and management, does not provide a large amount for family living after interest on investment has been paid. When figuring the return for labor and management, remember that an interest charge has been deducted on the money invested. This return can, of course, be used for family living or for savings. However, it is a cost that must be met if the money is borrowed. If the capital is owned it represents an "opportunity cost." It might be looked upon as what the money would return if used in another way.

Budget IV clearly indicates that the use of irrigated pasture in place of range will not pay under assumed pasture yields. Under other price-cost situations, or with higher pasture yields, however, the situation might be different. With the prices used, irrigated pastures must yield more than 8 animal units per month per acre for the grazing season to be profitable.

The budgets indicate that the capital necessary for acquiring, developing, and stocking a new farm is large. They also show that necessary out-of-pocket costs must be paid, and these may be the costs which could mean financial ruin in case of adverse prices, weather, or other conditions.

It is interesting to compare Organizations I and III. The addition of irrigation to a dry-land cattle organization clearly increases income. This indicates that when irrigation can be integrated into a cattle organization, it may be a profitable undertaking if public range-

[5] Power costs used were based on a rate schedule supplied to the authors by the manager of the company located at Lapine, Oregon, that will supply the area with electricity.

land is available. All public rangeland, however, is already under allotment. A newcomer must rely on a reallocation of existing permits. The amount that could be obtained in this way is difficult to determine. An individual coming into the area who wished to have livestock would be handicapped in view of the returns to Organization IV. He probably would do better to consider a cash crop type of organization as shown in Organization II. The yields and size of farm needed for success with this type of organization are shown in the next section. Many crops were not considered either because long-time yield records were not available, or because of the relatively short growing season.

Effect of Yield on Income

Alfalfa yields of 3 tons per acre were used in the farm organization budgets in the previous section since that is an average yield in other intermountain areas. It is possible, however, that yields greater than this may be obtained by following different management practices. An attempt has been made in this section to relate incomes to different yields.

Organization II has been selected for this purpose. An increase in alfalfa hay yields beyond 3 tons per acre would not result in a proportionate increase in costs. This is because certain fixed costs (depreciation, taxes, and insurance paid) remain constant regardless of yield. Variable costs, however, do increase as yields increase. Harvesting and fertilizer costs are examples. By deducting these fixed and variable costs plus an interest charge on the investment from the total farm income, the farmer's return for labor and management can be determined. It is here that

Table 6. Farm-organization Budget Summaries.

	Farm Organization I	II	III	IV
	Dollars	*Dollars*	*Dollars*	*Dollars*
Farm receipts				
Crop sales	.....	10,001	866	360
Livestock sales	7,032	.....	9,208	12,351
Total receipts	7,032	10,001	10,074	12,711
Farm expenses				
Crop expenses	712	3,600	1,520	4,280
Livestock expenses	127	.....	129	122
Feed	3,380	.....	221	821
Hired labor	276	863	678	1,479
Taxes and misc.	437	337	573	831
Power costs	.....	1,154	509	1,839
Depreciation				
Machinery and equipment	947	1,076	1,127	1,366
Irrigation system	.....	596	371	996
Total expenses	5,879	7,626	5,128	11,734
Net farm income	1,153	2,375	4,946	977
5% interest on real estate	560	255	560	660
7% interest on other investment	2,342	2,003	3,230	4,892
Operator's return for management and labor	−1,749	117	1,156	−4,575

Table 7. Operator's Return for Labor and Management.

Yield per acre	160 acres	320 acres
Tons	*Dollars*	*Dollars*
1	-3,861	-7,722
2	-1,877	-3,754
3	117	234
4	2,191	4,383
5	4,230	8,460
6	6,266	12,532

the farm family must provide for its living expenses and savings. Table 7 and figure 6 indicate the relationship between yield and the farmer's return for labor and management. Note from table 7 that the same general relationship holds for both 160 and 320 acres. Perhaps it is even more important to obtain "break-even" yields for 320 acres than it is for 160, since an unsatisfactory yield results in larger total losses on the 320-acre farm.[6]

Figure 6 indicates that approximately 3 tons per acre of alfalfa are necessary to cover costs of production. Four tons per acre will return approximately $2,500 annually for the farmer's labor and management. The chart can be used in another way. An individual can select a return for labor and management from the side of the chart, say $6,000. Then read downward to the line at the bottom of the chart and find that nearly 6 tons per acre are necessary on a 160-acre farm to yield a return of this amount of money.

Another chart, figure 7, has been prepared to bring out these same relationships in a slightly different fashion. Note there are two cost lines on the graph—total farm costs and fixed costs. Fixed costs are an important part of the total cost of production. It requires a yield of about 1½ tons per acre to cover these costs. On the average, about 1½ tons are needed to cover the variable costs, too. This means that 3 tons per acre are needed to "break even." An additional 1½ tons, or a total of about 4½ tons per acre, would be needed to return a level of living that would be satisfactory to most farm families.

The previous discussion brings out the importance of obtaining high yields to cover certain production costs. Greater production can also be obtained by increasing acreage. This is illustrated in table 7. Similar relationships would also hold if the size of Organizations I, III, and IV were increased. Detailed budgeting for the larger organizations was not done, however, because too much money would be needed. It is also believed the organizations presented give good indication of the smallest size necessary to cover costs of operation and provide a return for family living.

[6] It is assumed in this example that there would he no cost savings hy going from 160 to 320 acres. This probahly is not strictly accurate although it is prohahle that no great savings would he made.

Risk in the Area

No type of farming anywhere is without risk. On a new irrigation project, such as in the Fort Rock area, long-time yield records are not available. The new farmer can only estimate average yields in planning his budget over the long pull.

In addition, the variable growing season is such that yields will vary greatly from one year to the next. With a 160-acre irrigated farm, 3 tons per acre has been calculated to be the "break-even" point. With yields below this point, the farmer may experience difficulty if his capital is limited and his financial reserves inadequate. To be sure, some fixed costs such as depreciation can be postponed temporarily, but they cannot be avoided for a long period. Variable costs of operation such as power charges must be met if the farmer is to produce.

There is another type of uncertainty that the new farmer must face. Although it is known ground water exists in the area, the exact depth and location of the water-bearing strata or the quality of the water for particular farms is not known. Drilling new wells near established wells can reduce but not eliminate the risk.

The cost of a well will depend on the type of water-bearing strata as well as its depth. If considerable sand is encountered, additional cost will be necessary to establish a reliable well. No allowance was made for these possible

Figure 6. Effect of Yield on Income

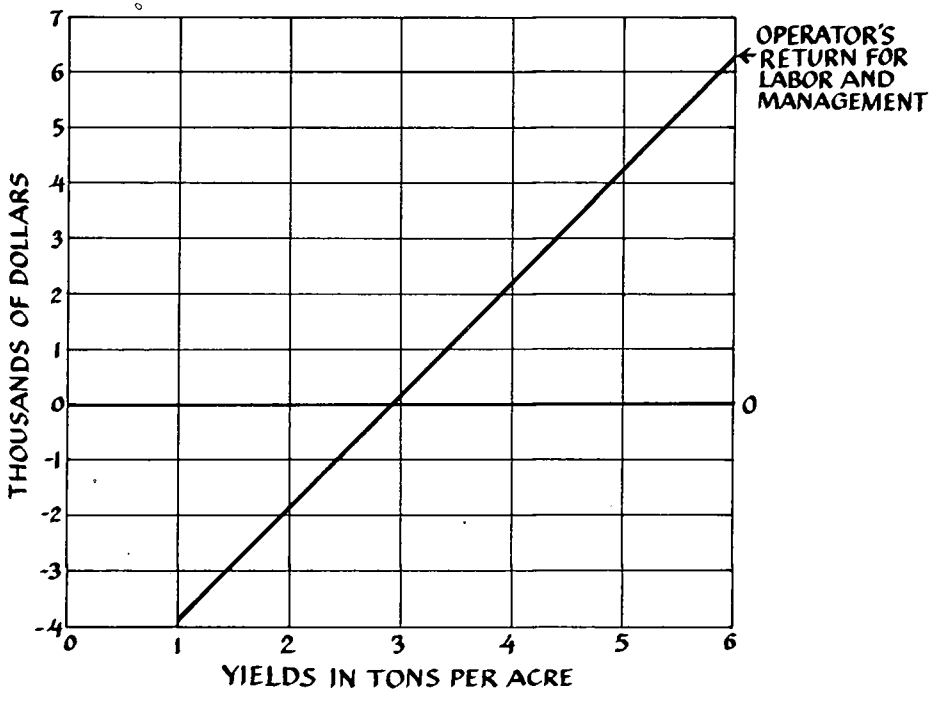
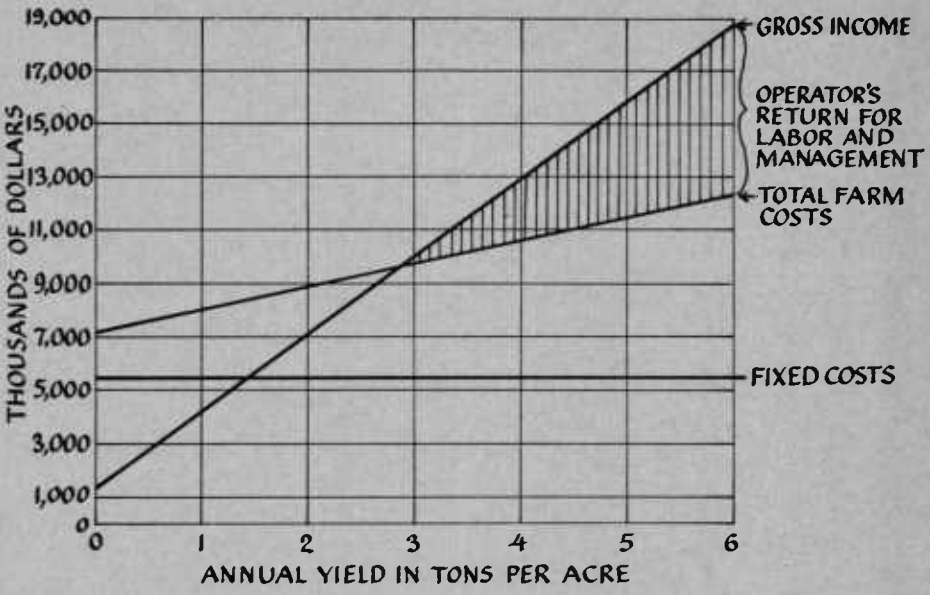


Figure 7. Yields Needed to Meet Costs of Operation



additional costs since information was not available to estimate their possible magnitude. The returns shown, therefore, do not reflect this risk and uncertainty associated with farming and ranching in the area. Irrigation may, however, reduce risk if introduced into the cattle organization and used to stabilize and increase the feed supply.

Appendix . . .

Appendix Table 1. Yields and Production.[1]

Enterprise	Yield per acre	Calf crop	Selling weight
	Unit	*Per cent*	*Pounds*
Alfalfa	3 tons		
Barley	45 bushels		
Irrigated pasture	6-animal-unit months		
Rye hay (summer fallow)	1.5 tons		
Cow-yearling (Org. I)		70	700
Cow-yearling (Org. III)		75	800
Cow-baby beef (Org. IV)		85	819

[1] Yields were determined on the basis of typical yields in irrigated areas of the intermountain region as reported in Crop Production Practices: Labor, power and materials by operation: Mountain and Pacific States. Bureau of Agricultural Economics, U. S. Department of Agriculture. Calf crop and cattle production data were obtained on the basis of conferences with Extension personnel and others familiar with range and livestock feeding conditions.

Appendix Table 2. Prices of Crop and Livestock Products.

Item	Unit	Price
		Dollars
Baled alfalfa	ton	24
Barley	ton	42
819-lb. calves	cwt	21
700-lb. yearlings	cwt	16
800-lb. yearlings	cwt	18
Cull cows	cwt	13
Bulls	cwt	12

Appendix Table 3. Water Requirements.[1]

Crop	Water requirement in acre-feet
Alfalfa	2′ 4″
Barley	2′ 0″
Irrigated pastures	3′ 0″

[1] Procedure and data used are presented in: *Water Requirements in Irrigated Areas from Climatological and Irrigation Data.* Harry F. Blaney and Wayne D. Criddle. Soil Conservation Service. U.S.D.A. SCS-TP-96. Revised February, 1952. A field irrigation and pump efficiency of 50 was assumed on the basis of soils survey data of the area and University of Arizona Agricultural Experiment Station Bulletin 246, *The Cost of Pumping Irrigation Water, Pinal County,* 1951. Rex D. Rehnberg.

Appendix Table 4. Production and Disposal of Livestock.[1]

Kind of animal and product	Number	Sales per head	Total sales	Price per 100 lbs.	Value
	Unit	*Pounds*	*Pounds*	*Dollars*	*Dollars*
Organization I					
Yearlings	41	700	28,700	16	4,592
Cows	16	1,000	16,000	13	2,080
Bulls	2	1,500	3,000	12	360
Total					7,032
Organization III					
Yearlings	47	800	37,600	18	6,768
Cows	16	1,000	16,000	13	2,080
Bulls	2	1,500	3,000	12	360
Total					9,208
Organization IV					
Calves	57	819	46,740	21	9,807
Cows	16	1,050	16,800	13	2,184
Bulls	2	1,500	3,000	12	360
Total					12,351

[1] Horses bought and sold are not shown separately. An annual depreciation charge is shown in the expense and receipt summary.

Appendix Table 5. Production and Disposal of Crops.[1]

Crop	Acres	Yield	Production	Quantity fed	Quantity sold	Price	Value
			Tons	*Tons*	*Tons*	*Dollars*	*Dollars*
Organization I							
Rye hay	155	1.5 tons	232.5	232.5	0	0	0
Organization II							
Barley	30	45 bu.	32.4	0	32.4	42	1,361
Alfalfa	120	3 tons	360	0	360	24	8,640
Total							10,001
Organization III							
Alfalfa	50	3 tons	150	140	10	24	240
Barley	15	45 bu.	16.1	1.2	14.9	42	626
Rye hay	100	1.5 tons	150	150	0	0	0
Total							866
Organization IV							
Barley	35	45 bu.	36.7	36.1	0	0	0
Alfalfa	70	3 tons	210	195	15	24	360
Irrigated pasture[2]	120	0	0	0	0	0	0
Rye hay	42.5	1.5 tons	42.5	42.5	0	0	0
Other hay[2]	0	0	64	64	0	0	0
Total							360

[1] The following sources of information were used in developing feed requirements: (1) Progress Report on the Economics of Conservation Farming in the Pacific Northwest Area: Volume V, Prices, Input Requirements, and Other Basic Data for Farm Budget Analysis. Walter W. Pawson et. al. Bureau of Agricultural Economics, U.S.D.A. Washington Agricultural Experiment Station; Oregon Agricultural Experiment Station with Idaho Agricultural Experiment Station cooperating. (2) James Oldfield, Department of Animal Husbandry, Oregon Agricultural Experiment Station. Organization Costs and Returns on Cattle Ranches in the Inter-Mountain Region 1930-52. Bureau of Agricultural Economics, U.S.D.A.

[2] Other hay was taken from the irrigated pasture.

Appendix Table 6. Labor Requirements for Various Organizations.[1]

	Operator	Hired	Total
	Hours	*Hours*	*Hours*
Organization I	1,739	221	1,960
Organization II	995	691	1,686
Organization III	1,712	542	2,254
Organization IV	1,809	1,283	3,092

[1] Cost of hired labor $1.25 per hour.