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Productivity of Cropland in Cache County, Utah

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PRODUCTIVITY OF CROPLAND IN CACHE COUNTY, UTAH

by

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INTRODUCTION

NEED FOR LAND CLASSIFICATION

In order for land to best serve the present and future generations it should be put into the use for which it is best adapted. To determine the proper use of land, the factors which influence its use, such as soil, climate, and location, should be studied. Then the land should be classified as to its most economic use, based on these factors.

In Cache County there is much work to be done toward a classification of the land. An ideal study; not limited by time nor expense; would include a complete study of all the factors associated with land-use. From this study an economic classification of the land in the county could be made.

This present study was very limited as to time and expense. Its scope included only a study of those factors, principally soil and irrigation water, associated with the productivity of cropland. Productivity was defined to be the power of the land to produce crops.

OBJECTIVES OF THE STUDY

The objectives of this study were: (1) to develop a method for determining productivity, adaptable to the cropland in Cache County, Utah, and (2) to collect the necessary data and classify the cropland in Cache County according to productivity.

DESCRIPTION OF THE AREA

Physical Characteristics

Cache County is located in the northern part of Utah. (Figure 1) The approximate area of the county is 752,000 acres. About half of the county is mountainous, and the other half is a broad valley. Essentially all of the cropland in the county is in the valley.

The valley was once covered by Lake Bonneville, during which time hundreds of feet of sediment were deposited over what is now the valley floor. Its topography is fairly level with a few hills, several lake terraces and deltas, and numerous alluvial fans. The average elevation of the valley is 4,400 feet above sea level, while the mountains rise to a height of almost 10,000 feet.

Cache County is in the semi-arid belt with an annual average precipitation of approximately sixteen inches in the valley. The precipitation is greater at the higher elevations. The rainfall is quite uniform throughout the valley. Snowfall varies from a few inches to two feet or more in the valley, but is much greater in the mountains and is the source of irrigation water. The valley is protected from severe storms and is very seldom subjected to damage from hail.

The annual mean temperature of the valley is approximately 48° F with a range of from about -20° F to 100° F. The average date of the first killing frost is October 8 and of the last frost May 10. The average growing season is 150 days.

The native vegetation of the valley floor consisted of a heavy growth of grass. Along the streams were found cottonwood, birch, willow, and boxelder. The foothills supported a moderate growth of gray sage and grass. The mountains were largely treeless with small groves of pine, juniper, maple, quaking aspen, and scrub oak.

CACHE COUNTY—UTAH

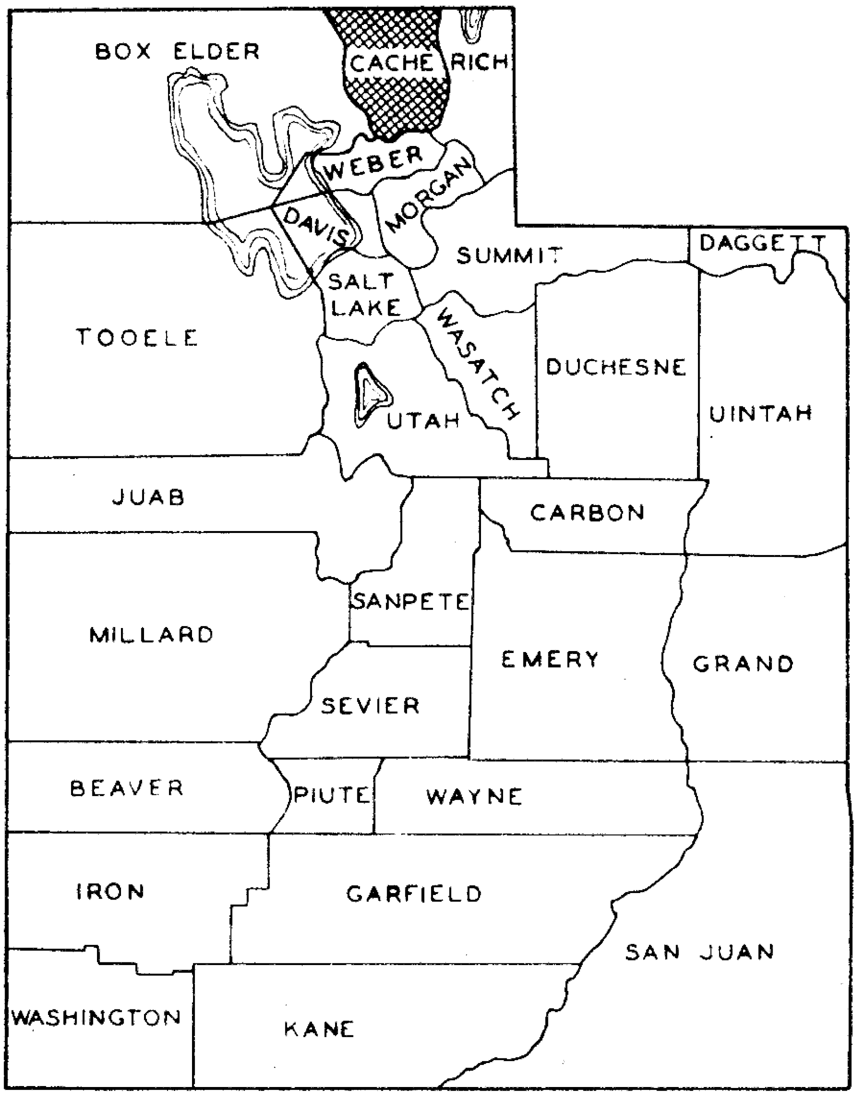

Figure 1

Agricultural Development

The first permanent settlement was established, in what is now Cache County, by the Mormons in 1856. In 1870 the population of the county was 8,229, in 1910 it was 23,062 (7), in 1920 it was 26,992, and in 1930 it was 27,429. In 1940 the total population was 29,797, of which 9,276 were living on farms. (11)

According to the Census of Agriculture there were 2,227 farms in Cache County in 1944 of an average size of 174 acres. This acreage included all land in farms, whether under cultivation or not. There were only about 78 acres of cultivated land per farm. The total farm valuation in 1944 was almost 33 million dollars or an average of $14,615 per farm. (12)

The land in farms which is not under cultivation consists of the wet lands on the valley floor and the mountain ranges. The wet lands are used for summer pasture for dairy cattle and winter pasture for range cattle. The range lands are used for summer pasture for range cattle and sheep.

In 1944 there were approximately 174,000 acres of cropland in Cache County, of which about 60 percent was irrigated. The remainder of the cropland was dry farmed because irrigation water was not available or because application of irrigation water to the land was impractical.

The principal crop raised on dry farms is winter wheat, although there is a sizable acreage of alfalfa hay, some barley, and some alfalfa seed raised. On the irrigated cropland a variety of crops can be grown. Table 1 shows the acreage, yield, and value of the various crops grown in Cache County in 1944. In terms of acres in crops, alfalfa hay is by far the most important crop in the county. Next in importance are two of the small grains, wheat and barley. The most intensive crops,

Table 1.- Acres, yield, and value of crops harvested in Cache County, Utah, 1944*

Crop	Acres	Percentage of total acreage	Yield per acre	Value
Grains				
Oats	2,040	1.5	55.0 bu.	$ 71,855
Barley	22,017	16.0	48.0 "	950,649
Rye	21	0.0	36.2 "	836
Wheat, winter	35,998	26.1	24.3 "	1,136,638
Wheat, spring	8,845	6.4	30.8 "	355,098
Mixed grains	423	0.3	49.6	20,997
Total grains	69,344	50.3		$2,536,073
Forage Crops				
Alfalfa hay	49,266	35.7	2.4 tons	2,112,480
Clover & timothy	806	0.6	2.0 "	27,472
Small grains for hay	467	0.3	1.5 "	9,506
Other tame hay	299	0.2	1.2 "	4,615
Wild hay	3,423	2.5	1.1 "	44,964
Corn for silage	1,626	1.2	– "	30,929
Soy beans	51	0.1	2.2 "	1,650
Total forage crops	55,938	37.6		$2,231,616
Miscellaneous crops				
Alfalfa seed	2,958	2.1	0.86 bu.	57,038
Clover seed	93	0.1	2.6 "	4,356
Potatoes	1,254	0.9	174.5 "	306,382
Sugar beets	4,880	3.5	11.8 tons	586,765
Small fruits	111	0.2	1058 qts.	49,413
Tree fruits & grapes	333	0.2	108.8 bu.	78,025
Vegetables for sale	2,657	1.9	–	304,195
Others, including gardens	306	0.2	–	120,773
Total miscellaneous crops	12,592	9.1		$1,506,947
Total all crops	137,874	100.0		$6,274,636

* U. S. Census of Agriculture Vol. 1, part 31. Utah and Nevada. 1945.

of which potatoes, sugar beets, and peas are the most important, account for less than 10 percent of the total acres in crops, but make up almost 25 percent of the total value of crops. Almost two-thirds of crops harvested, by value, were used on the farm for feed and seed.

The sale of dairy products is the most important source of agricultural income in the county. In 1944, the sale of dairy products accounted for almost half of the value of all livestock and livestock products sold and exceeded the total value of crop sales. (Table 2)

Table 2. Value of farm products sold and used by farm household, Cache County, Utah, 1944*

Products	Value	Percentage of total
Fruits	$ 68,920	0.7
Vegetables	304,195	3.3
Other crops	2,342,257	25.0
Total crops sold	2,715,372	29.0
Dairy products	2,756,529	29.4
Poultry and poultry products	1,436,464	15.3
Other livestock and livestock products	1,962,644	21.0
Total livestock and livestock products sold	6,155,637	65.7
Farm products used by farm household	497,168	5.3
Total products sold and used	$9,368,177	100.0

*U. S. Census of Agriculture, Vol. 1, part 31. Utah and Nevada. 1945.

Ownership

A large part of Cache Valley was settled before the Homestead Act was passed. However, when the area was surveyed after the passage of the act, these settlers were given first right to the land they occupied. Most of the settlers had taken up much less than 160 acres, so they shared in the quarter section granted by the Homestead Act. Most of the range land in the southern end of the county was taken up under the Stock Raising Homestead Act. Most of the mountain area to the east was made a national forest in 1905.

In connection with a land-use planning project made under the direction of the Utah Planning Board, a study of ownership of land in Cache County was made in 1939. The land in the county was divided into four areas based upon ownership. (Figure 2) The area on the west includes essentially all of the cropland in the county. The other three areas are used principally for grazing.

About 92 percent of the cropland in Cache County is privately owned. Most of this land is operated by the owner, so there is very little tenancy in the county.

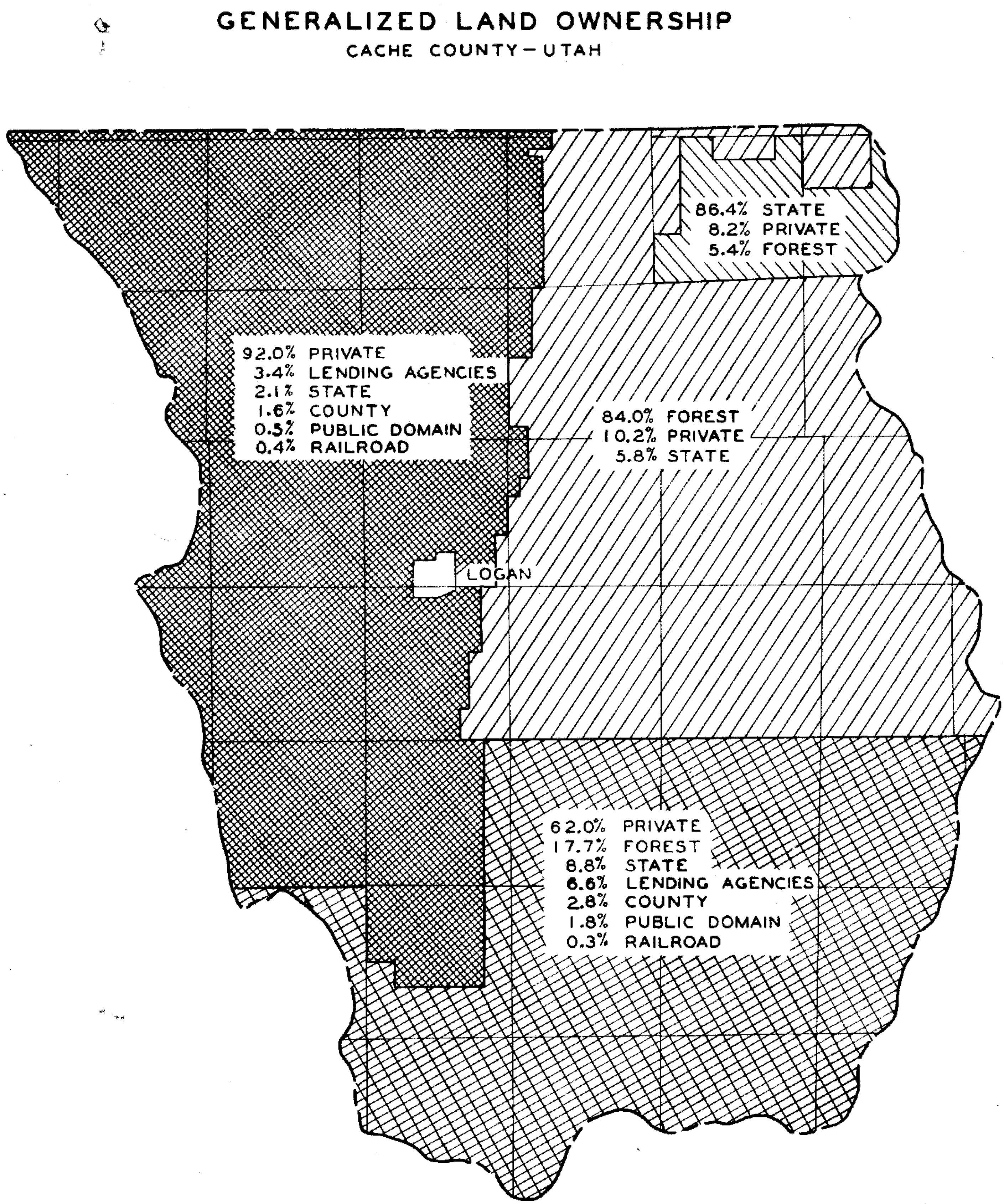

Figure 2

Drawn by B. L. Embry

METHOD OF PROCEDURE

BACKGROUND

So far as is known there has been no land-classification study made with objectives identical to the objectives of this study. Therefore, it was necessary to develop a method of determining productivity before the cropland in Cache County could be classified according to its productivity.

There are several factors that influence the productivity of land, the most important of which are: soil properties, climate, management practices, and irrigation water supply. Studies have been made of the relationship of some of these factors to productivity, and methods have been developed for rating them according to productivity. Some of these methods were helpful in developing the method of procedure used in this study.

A method of rating soil types according to productivity has been used by the Soil Survey Division of the Bureau of Plant Industry, Soils, and Agricultural Engineering. In this method each soil type is given a rating for each crop, based upon the inherent capacity of soil to produce the crops without use of amendments. A second rating is also given for each soil type based upon actual yields obtained under current practices. These ratings are given as a percentage based upon the standard yields. The standard yield (100 percent) for each crop represents approximately the average yield obtained, without such amendments as fertilizers and lime, on the best soil of the region in which the crop is principally grown. In addition to the above ratings for crop, general productivity grades from 1 to 10 are assigned to each soil type. These are based upon the average of the crop-productivity indices weighted according to the relative importance of the individual crops grown on each soil type. (1)

R. Earl Storie of the California Agricultural Experiment Station has developed a method of rating the productivity of soil.

> This method of soil rating, known as the Storie Index, is based on soil characteristics that govern the land's potential utilization and productive capacity. It is independent of other physical or economic factors that might determine the desirability of growing certain plants in a given location.
>
> Percentage values are assigned to the characteristics of the soil itself, including the soil profile (factor A); the texture of the surface soil (factor B); the slope (factor C); and conditions of the soil exclusive of profile, surface texture and slope--for example, drainage, alkali content, nutrient level, erosion, and microrelief (factor X). The most favorable or ideal conditions with respect to each are rated at 100 percent. The percentage values or ratings for the four factors are then multiplied, the result being the Storie Index rating of the soil. (10)

The Soils Department, Utah State Agricultural College, developed a chart on land classification to be used in their soil survey classes. This chart lists six classes of land based upon several land characteristics which affect productivity. These characteristics are: texture of surface soil; texture of subsoil; stoneness; depth to strata of gravel, sand or cobble; depth to solid rock or any impervious horizon; depth to semi-hardpan; depth to lime carbonate concentration zone; alkali--total salts and black alkali; drainage--present and anticipated; topography; erosion; and position. The lands in which these characteristics are most nearly ideal are classified as Class I. Lands with undesirable characteristics are placed in a lower class. (14)

The methodology for an economic classification of the land in Utah was worked out by George T. Blanch, Department of Agricultural Economics, Utah State Agricultural College, and Clyde E. Stewart, Bureau of

Agricultural Economics in 1936. This method included factors other than those affecting productivity as a basis for classification. Some of the procedure that was followed, however, could be applied to a classification based upon productivity only. The system of classification which was planned for the state included eleven classes of land use ranging from waste land to urban development. The irrigated land was further analyzed and sub-areas were set up, in which the factors, soil, water conditions, market location, community location, precipitation, and growing season were nearly homogeneous. These factors were weighted according to their relative importance and a class rating for each was established. Each of the sub-areas was rated by evaluating the combination of factors found in the area. These areas were then grouped into four present-use categories based, in general, upon their rating. These groups were designated as: Class A--which represents areas where major adjustments in land and water relationships are probably not necessary; Class B--which represents areas where major adjustments in land and water relationships are desirable; Class C--which represents areas where major adjustments appear necessary; and Class D--which represents possible development areas. (3)

A method for classifying land according to its productivity was used by the Bureau of Agricultural Economics in a study of the geographic differences in production of agricultural land in the Northern Great Plains. The objectives of the Northern Great Plains study were somewhat similar to the objectives of this study of the productivity of the cropland in Cache County. However, the unit of classification was an entire county, so very little of the methodology could be used for a classification of smaller geographic areas. (15)

GENERAL PROCEDURE

In order to classify the cropland in Cache County according to its productivity, the cropland was broken down into sub-areas. These sub-areas were outlined so that within each sub-area the factors affecting productivity were relatively homogeneous. Crop yields were obtained for each sub-area and a crop yield index for the sub-area was calculated. The sub-areas were then grouped and classified on the basis of these indices.

In using this method the following assumptions were made:

Productivity of land is a result of soil properties, climate, management practices, and irrigation water. Within Cache County, climatic conditions appear to be relatively uniform and data were not available to measure variations, so for this study climate was assumed to be constant. Management practices such as quality of seed used, time of operation, and fertilization, may vary among farms; but there is relatively little difference between areas in the county. The sub-areas were large enough that variation among farms within the sub-areas were eliminated. Therefore, the management factor was assumed to be constant. This left only two variables as influencing productivity, soil properties and irrigation water. These were used as the bases for delineating the sub-areas.

In this study, cropland was defined to include all land regularly used for crops. It includes rotation pasture, cultivated fallow land, land from which wild hay is harvested, and other land ordinarily used for crops but temporarily idle. It does not include permanent pasture or range land. Irrigated cropland includes all land upon which water is applied by the operator, regardless of the method of application.

It does not include land that receives water by natural flooding or seepage.

A separate classification was made for irrigated and for dry cropland.

MAPPING OF CROPLAND

The first step in the classification of the cropland was to locate the areas within the county that are irrigated and dry farmed.

In 1939, as part of a general land-use planning project, the agricultural land in Cache County was mapped under the direction of a County Agricultural Planning Committee. The purposes were to show the present use of land and to form a basis for recommended land-use adjustments. In each community, the committee met with farmer leaders and from the farmers' general knowledge, with the aid of a soils map, topographic maps, and aerial photographs, local land-use areas were mapped and possible areas of adjustment were indicated. When this work was completed, two land-use maps on a scale of one inch to the mile were made. One map showed the present use of land and the other the recommended use of land in the county. (13)

The first map, showing the present use of land in Cache County (Figure 3), was used as a basis for the location of the cropland for this study. A field trip was made throughout the county and boundaries of land use, as shown on the 1939 map, were checked as closely as possible from observation. Aerial photographs made by the Agricultural Adjustment Agency in 1942 were also checked against the map.

In general the map was quite accurate and only a few minor adjustments in the location of cropland were made. These changes were principally a result of the extension of dry farm areas since 1939.

The detail of the map was not sufficient to show all of the variations in land use. For example, within the area shown as dry farm there are many spots where the land is too rough or too rocky to cultivate. There are small areas on the valley floor completely surrounded by cropland, but too wet to cultivate. These areas are in permanent pasture but because of their small extent, they are shown on the map as cropland. Several fields within an irrigated area are so located that it is impossible to apply water, or the water supply is such that all the land cannot be irrigated. These small areas are dry farmed but are shown as irrigated cropland.

In general, the extent of an area in different land use had to amount to a hundred acres or more before it was shown on the land-use map.

After the land-use map was checked and modified, a transparent overlay was made from it showing the location of the areas of irrigated cropland. Another overlay was made of the areas of dry cropland.

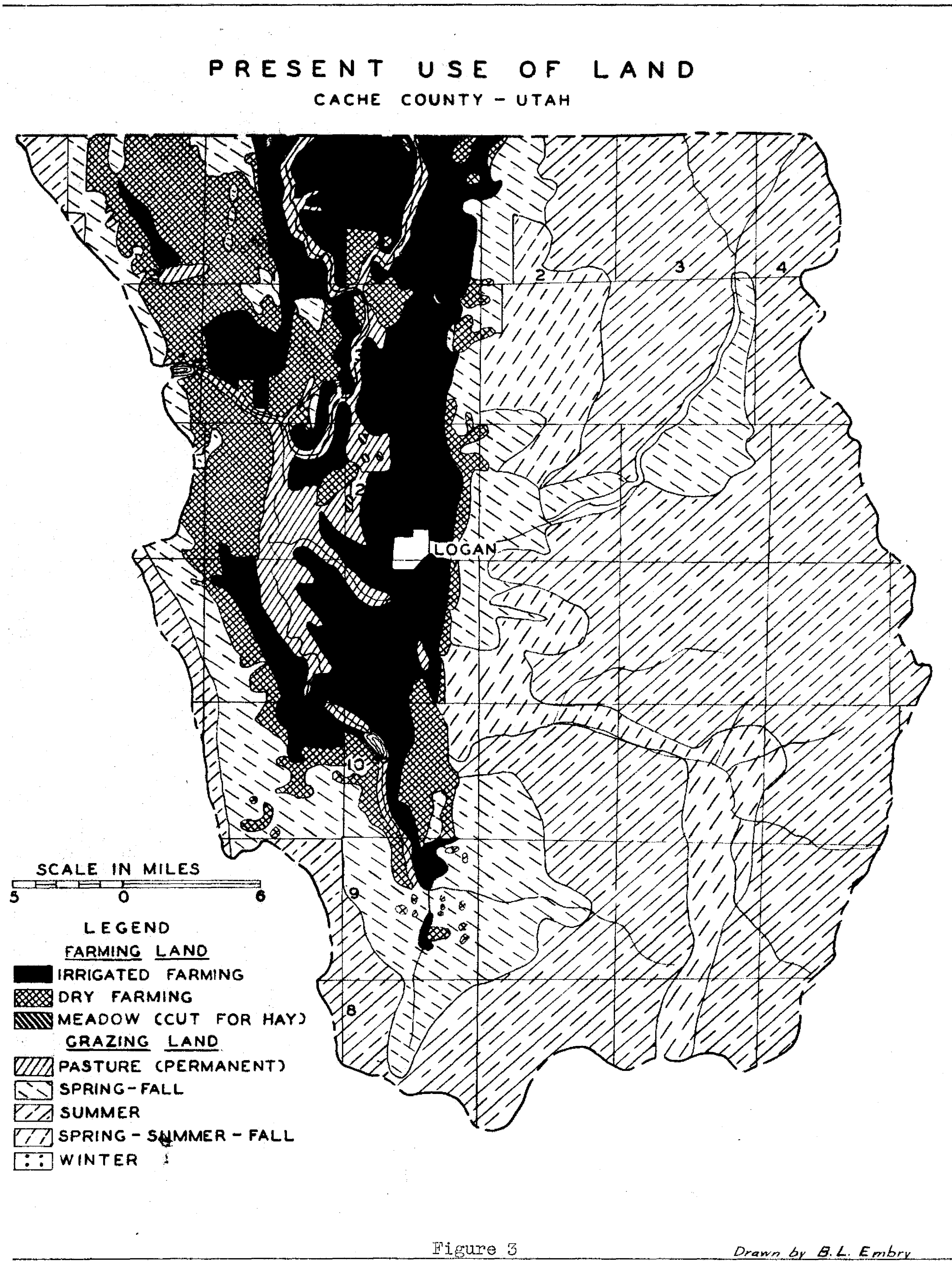
PRESENT USE OF LAND
CACHE COUNTY - UTAH
LOGAN
SCALE IN MILES
5
0
6
LEGEND
FARMING LAND
IRRIGATED FARMING
DRY FARMING
MEADOW (CUT FOR HAY)
GRAZING LAND
PASTURE (PERMANENT)
SPRING-FALL
SUMMER
SPRING - SUMMER - FALL
WINTER
Drawn by B.L. Embry

Figure 3

OUTLINING OF SUB-AREAS

Soil Properties

The first factor influencing the productivity of cropland that was evaluated in this study was the soil.

In 1913 the soils of Cache Valley were surveyed by the Bureau of Soils, U. S. D. A. The technique of soil survey has progressed greatly since that time, methods and accuracy have improved, and much of the soils data compiled in the 1913 report is in need of revision. A small area around Newton has been recently surveyed by the Soils Department of the Utah Agricultural Experiment Station and around Logan some soil surveying has been done by students taking a soil survey class at Utah State Agricultural College. Other than the above, there are no data on the soils in Cache County. Therefore, the data from the 1913 soils map and report, modified by what little current information was available, were used in this study.

The soils of the valley are of two kinds, lake-laid and alluvial deposits. The lake-laid deposits were made at two widely different times and under different conditions. The later deposit is the most important deposit in the valley because it covers 90 percent of the area and is in essentially the same surface shape when it was laid down. The alluvial deposits consist of old and recent alluvial fans, and recent riverand creek alluvium. The parent rock material of the soils in the valley is mainly limestone, with some quartzite and sandstone.

The 1913 soil survey report listed 13 soil series and 39 soil types in the Cache Valley area. These soils were mapped and a description of each is given in the survey report. Since an evaluation of these soils had to be made to determine their relative productivity rating, a brief description of the soils series as taken from the 1913 report follows:

> The Richmond and Blackrock series are residual in origin and embrace three types. The soils of these series occupy an elevated position, are sometimes badly dissected and rough in topography, and are mainly suited to grazing.
>
> The Avon series occurs only along the east and south parts of the valley. It comprises badly eroded heavy soils suited to grazing only, except in a few small areas. Four types of soil occur in the Avon series.
>
> Soils of the Sterling series lie on the Provo terrace, 100 to 400 hundred feet above the valley floor. They are well drained and suitable for fruit and truck growing and general farming.
>
> The Hyrum series has a location similar to the Sterling series and is a good soil for the production of the crops mentioned.
>
> The Mendon series of soils occurs mainly along the west side of the valley. The soils of this series are for the most part well drained and productive, ranking high as grain and alfalfa soils. The series includes eroded old narrow lake terraces, and alluvial foot slopes.
>
> The Millville series occupies a similar position to that of the Mendon series, principally along the east side of the valley. It is a good fruit soil.
>
> The Trenton series of soils occurs on the valley floor and is the most extensive series of soils in the area. Members of this series at Lewiston and along Bear River rank among the best in the area for sugar beets, alfalfa, potatoes, bush and vine fruits, and of grain and alfalfa. Considerable alkali exists in places and caution is necessary in irrigation.
>
> The Salt Lake series occurs along the east and south-central parts of the valley. In most places the soils of this series need drainage and alkali is found in low, flat areas. When drained, the soils rank high for the production of sugar beets, potatoes, alfalfa, corn, small grains, and late truck crops.
>
> The Logan soils are moderately well to poorly drained. They consist of recent alluvial deposits occupying present river and creek flood plains or lower minor terraces.

> The Cache series is represented by one type only, the Cache clay. It is located in the low, flat parts of the valley floor, runs high in alkali, and except for an occasional alkali weed is devoid of vegetation.
>
> The Preston fine sand is a very inextensive but productive soil.
>
> The Rough stony land for the most part occurs on the mountain slopes above the agricultural soils. It is used for pastures. (7)

Each soil series, as analyzed in the 1913 survey report, was reviewed and an evaluation was made of the characteristics of profile that are known to be related to productivity, such as texture of subsoil, depth to rock or hardpan, and lime concentration. The Storie soil-rating chart and the soil classification chart developed by the Utah Agricultural Experiment Station were helpful in making this evaluation. The evaluation of each soil series was expressed as a percentage rating. This rating considered an ideal soil profile as 100 percent.

The surface texture of each soil type was evaluated as to its relation to productivity and this evaluation was given as a percentage rating. This rating was based on an ideal texture as 100 percent.

The ratings of these two soil properties, profile and texture, were multiplied together and a percentage rating for each soil type in Cache County was determined. (Table 3)

After a rating was determined for each soil type, the evaluation of these soils was reviewed by Professor LeMoyne Wilson of the Soils Department, Utah State Agricultural College. He concurred with the rating of the soil types as far as available information made it possible to evaluate the soils in Cache County.

Table 3.- Percentage rating of the profile and the surface texture of each soil type in Cache County, Utah

Soil type	Symbol	RATING		Rating of soil type
		Profile	Texture	
		percent	percent	percent
Avon silt loam	As	80	100	80
Avon gravelly silt loam	Ag	80	75	60
Avon gravelly silty clay loam	A	80	70	56
Avon silty clay loam	Ac	80	90	72
Hyrum loam	H	90	100	90
Hyrum gravelly loam	Hl	90	80	72
Hyrum gravelly fine sandy loam	Hg	90	80	72
Hyrum silt loam	Hs	90	100	90
Sterling loam	So	90	100	90
Sterling gravelly course sandy loam	Sgs	90	60	54
Sterling gravelly sandy loam	Sg	90	65	58
Sterling fine sandy loam	Sl	90	100	90
Millville loam	M	95	100	95
Millville gravelly loam	Ma	95	80	76
Millville silty clay loam	Ms	95	90	86
Richmond silty clay loam	Rs	75	90	68
Richmond gravelly loam	Rl	75	75	56
Cache clay	Cc	75	50	38
Preston fine sand	Pfs	80	65	52
Trenton loam	Tl	80	100	80
Trenton fine sandy loam	Ts	80	100	80
Trenton clay loam	T	80	85	68
Trenton silty clay loam	Ty	80	90	72
Trenton clay	Tc	80	50	40
Salt Lake loam	S	75	100	75
Salt Lake silt loam	Ss	75	100	75
Salt Lake silty clay loam	Sc	75	90	68
Logan fine sand	Lf	80	65	52
Logan loam	Ll	80	100	80
Logan gravelly fine sandy loam	Lg	80	75	60
Logan silt loam	Ls	80	100	80
Logan clay	Lc	80	50	40
Blackrock gravelly loam	Bl	60	60	36
Mendon loam	Ml	85	100	85
Mendon gravelly loam	Mg	85	80	68
Mendon fine sandy loam	Mf	85	100	85
Mendon silt clay loam	Mc	85	90	76
Mendon clay loam	Mo	85	85	72

Other soil properties which influence the productivity of soils are: topography, drainage, alkalinity, fertility, and erosion. Natural fertility of soil is associated with the soil profile and texture and was indirectly evaluated for the soils in Cache County when these two soil properties were rated. The present level of fertility is a result of management practices which were assumed constant for this study.

Erosion is a local condition with the degree varying from field to field and even within the same field. There was little difference observed and there was no information available on the degree of erosion between various areas in the county only as influenced by topography.

There is a definite variation in the soil properties, topography, drainage, and alkalinity in different areas throughout the county. In order to determine the productivity of the land, an evaluation was made of these soil properties.

The topography, drainage, and alkalinity were shown on the 1913 soils map. Some improvement in the drainage has been made since that time, especially in the Lewiston area. During the field trip, which was made as a part of this study, obvious drainage and alkali conditions were checked against the 1913 soils map and adjustments made where necessary.

After all the available information on soils was collected, a transparent overlay was made with the areas of irrigated land divided and sub-divided on the basis of differences in the soil properties. A similar overlay was made for the dry cropland.

Irrigation Water Supply

The second factor influencing the productivity of the irrigated cropland that was evaluated in this study was the irrigation water supply.

In 1945 a detailed study was made of the irrigation companies in Utah by the Irrigation Department, Utah Agricultural Experiment Station. In this study the irrigation companies in Cache County were classified according to the adequacy of the supply of irrigation water as follows:

Class I: The amount of water supplied by these companies is usually adequate; a shortage of 20 percent in any one year is allowable.

Class II: There is a moderate need for supplemental water supply for these companies; a shortage of 40 percent for any one year is allowable.

Class III: There is a pronounced need for supplemental water supply in areas served by companies in this class; some of these areas have high water rights only.

In order to convert this classification of the irrigation companies into a percentage rating for use in this study, a percentage was attached to each class. Class I equaled 100 percent; Class II, 80 percent; and Class III, 60 percent. These percentage ratings were arbitrary, based partly on the 20 percent difference in the allowable shortage in Class I and Class II. The rating of each irrigation company is shown in Table 4.

Some small areas, particularly in the southern part of the county, receive their irrigation water from sources owned by individuals. The water supply in these areas was not classified in the report on irrigation companies. A rating for these individual sources of water supply was estimated from information received from farmers in the areas concerned.

Table 4.- Rating of irrigation companies in Cache County, Utah

Company	Source of water	Acres irrigated	Class of water supply	Percentage rating
Logan, Hyde Park & Smithfield	Logan River	5060	2	80
Logan & Northern	" "	3700	1	100
Hyde Park	" "	1250	1	100
Logan Northfield	" "	1200	1	100
Logan Northwest Field	" "	3000	1	100
Logan Southwest Field	" "	880	1	100
Benson	" "	1000	1	100
Providence, Logan	" "	1000	1	100
Logan Island	" "	600	1	100
Southwest Field	" "	1800	1	100
Richland Acres	" "	2880	2	80
Providence, Blacksmith Fork	Blacksmith Fork River	1000	1	100
Millville, Blacksmith Fork	" "	735	1	100
Nibley, Blacksmith Fork	" "	2800	2	80
Hyrum, Blacksmith Fork	" "	2400	1	100
College	" "	1000	1	100
Spring Creek Irrigation	Blacksmith Fork River & Spring Creek	1600	1	100
Hyrum	Little Bear River	2400	1	100
Hyrum-Mendon	" "	2860	1	100
Wellsville Pump	" "	1440	1	100
Wellsville East Field	" "	6000	1	100
Cub River	Cub River	29000	1	100
West Cache	Bear River	17200	1	100
Bensen, Bear Lake	" "	750	1	100
Paradise	East Fork	2340	2	80
Webster	High Creek	500	3	60
Coveville	" "	800	2	80
Mountain Home	" "	600	2	80
Richmond	Cherry Creek	6000	3	60
Smithfield	Summit Creek	2900	2	80
North Bench	" "	1550	2	80
Newton	Newton, Clarkston Creek	2500	1	100
Clarkston	" "	796	2	80
Spring Creek Water	Spring Creek	900	1	100
Wellsville City & Northfield	Springs	1060	1	100
Mendon North & South	" "	1026	2	80
Logan Cow Pasture	Springs, Sewer	2500	1	100

The areas in Cache County receiving the best water supply obtain their water from Bear River, Cub River, or Hyrum Reservoir. Those receiving water from Logan River, Blacksmith Fork River, and Newton Reservoir have a good water right except during later summer in dry years. Lands receiving water from small canyon streams, springs or wells are in need of additional water during the summer.

In connection with the 1939 project on land-use planning, a map was made showing the land irrigated by each irrigation company in Cache County. From this map a transparent overlay was made for this study sub-dividing the irrigated cropland according to the companies supplying irrigation water.

Sub-areas

The next step in the classification of the cropland in Cache County after all available information on the factors affecting productivity had been collected, was to outline sub-areas or irrigated and dry cropland. The sub-areas were delineated so as to be relatively homogenerous as to factors known to be associated with productivity.

To outline the sub-areas the transparent overlay of the irrigated cropland was superimposed upon the overlay showing the variations in soil properties and the overlay of the areas irrigated by each irrigation company. This made it possible to see soil and water supply at the same time. Boundaries were drawn to include areas in which these variables were essentially the same. These areas were reviewed and those which had similar ratings for each of the soil properties and the irrigation water supply were combined. Non-contiguous areas in which which these factors were similar were included as one sub-area. This resulted in a total of 35 sub-areas of irrigated cropland.

The same procedure was followed for the dry cropland, except that the sub-areas were based only upon soil properties. There were 20 sub-areas of dry cropland.

As soon as the sub-areas were set up a field trip was made throughout the county to collect information from farmers on (1) the location of the boundaries of the sub-areas, and (2) the yield and relative importance of crops grown in each sub-area. The information requested was for the entire sub-area and not for an individual farm. Therefore, a selected sample of farmer leaders was taken rather than a random sample, so that the information would be obtained from men who knew the areas best and who had good judgment.

The farmer leaders from whom the information was obtained included: leading farmers in each community, members of the Land-Use Planning Committees, supervisors of the Veterans' Administration on-the-farm training program, field men for the sugar beet company, field men for the pea canning company, representatives of the Hyrum and Newton irrigation projects, and appraisors for the Federal Land Bank.

These men were asked if the boundaries of the sub-areas were approximately correct and, if not, what corrections should be made. In general the farmers thought the boundaries as originally outlined were as they should be; however, in some areas changes were suggested. As a result of the combined suggestions of these men, some boundaries were shifted and some small sub-areas combined with other sub-areas. These final adjustments reduced to 28 the sub-areas of irrigated cropland and to the sub-areas of dry cropland as shown in figure 4.

Each of the physical factors, which entered into the setting up of sub-areas, had been given a percentage rating, with the ideal condition rated as 100 percent. For each sub-area the ratings of these factors were multiplied together and a rating for the sub-area was determined. (Tables 5 and 6)

Table 5.- Percentage rating of sub-areas of irrigated cropland, based on soil properties and irrigation water supply.
(Ideal condition = 100)

Sub-area	Major soil type	RATING OF SOIL PROPERTIES Pro-file	Texture	Drain-age	Alka-linity	Topo-graphy	Rating of water supply	Sub-area rating
	%	%	%	%	%	%	%	%
1	Hl	90	80	100	100	95	60	41
2	Tl	80	100	100	100	100	60	48
3	Hl,Ma	92	80	100	100	100	60	44
4	H,Mf	88	100	100	100	100	60	53
5	Ts	80	100	95	95	100	100	72
6	Ts	80	100	100	100	100	100	80
7	Ty	80	90	60	60	100	100	26
8	Tc	80	50	100	100	100	100	40
9	Ml,Mo	85	92	100	100	100	80	63
10	Ss,Mo	80	92	95	100	100	60	42
11	Mc	85	90	100	100	100	60	46
12	Ml	85	100	100	100	95	80	65
13	Tc	80	50	60	90	100	100	22
14	Sg	90	65	100	100	100	80	47
15	S	75	100	100	100	100	100	75
16	Ts	80	100	80	100	100	100	64
17	Ma	95	80	100	100	95	80	58
18	M	95	100	80	100	100	100	76
19	Hg	90	80	100	100	100	100	72
20	Sg	90	65	80	100	100	100	47
21	Ms	95	90	100	100	100	100	86
22	Ss	75	100	80	100	100	100	60
23	Ts	80	100	70	70	100	100	39
24	Ml	85	100	100	100	95	80	65
25	Ml,Tl	82	100	100	100	100	100	82
26	So	90	100	100	100	100	80	72
27	H	90	100	80	100	100	80	58
28	Ac,Ll	80	95	90	100	95	60	39

In this system of rating each factor was weighted according to the degree of departure from the ideal. Thus, no sub-area could have a rating higher than the rating of the factor which limited most/of its productivity. For example, in irrigated sub-area 7 (Table 5) the water supply and topography were ideal and the soil profile and the texture of the surface soil were very good. However, because of the poor drainage conditions and the high alkali concentration, this sub-area was rated very low. In irrigated sub-area 2 (Table 5) the texture, drainage, alkalinity, and topography were ideal and the profile was good; however, the lack of irrigation water caused this sub-area to be rated low.

Table 6. Percentage rating of sub-areas of dry cropland, based on soil properties

(Ideal condition = 100)

Sub-area	Major soil type	Rating of soil properties					Sub-area rating
		Profile	Texture	Drainage	Alkalinity	Topography	
		%	%	%	%	%	%
1	Tc	80	50	100	100	100	40
2	Hl	90	80	100	100	95	68
3	As	80	100	100	100	95	76
4	So,M	92	100	100	100	97	90
5	Ac	80	90	100	100	95	68
6	H	90	100	100	100	95	86
7	Ma	95	80	100	100	95	72
8	Sl,Ml	88	100	100	100	95	84
9	Ty	80	90	100	100	100	72
10	Tc	80	50	70	70	100	20
11	Hg	90	80	100	100	95	68
12	Mf	85	100	100	100	95	81
13	Mo	85	85	100	100	95	69

PRODUCTIVITY CLASSIFICATION OF SUB-AREAS

Crop Yields

The next step after the sub-areas were set up was to obtain data on the yield of the major crops for each sub-area.

In order to tie actual yield data to the sub-areas, yields for individual farms had to be obtained and these farms located as to sub-area. The first step in accomplishing this was to locate each sub-area as to range, township, and section. For each sub-area was listed each quarter section that fell essentially within the sub-area. By obtaining the names of owners of land in each quarter section from the ownership maps in the county recorder's office, a list of owners of land in each sub-area was compiled.

As is general throughout Utah, many of the farmers in Cache County own land in several different areas. Crop yields were obtainable from secondary sources by farm and not by separate plots of land. Therefore, in order to restrict the yield data to each sub-area, those farmers who had more than about 10 percent of their land in more than one sub-area were eliminated. Thus, all the farmers in each sub-area were not listed but a large enough sample was obtained to give a satisfactory average.

Yield data for sugar beets and wheat were obtained from the county office of the Production and Marketing Administration. This office maintains a seven-year moving average yield of sugar beets for each grower in the county for use in the sugar beet subsidy program. It also keeps a ten-year moving average yield of wheat for each farmer in the county who carries crop insurance.

For each farmer listed in the sub-areas who raised sugar beets or carried crop insurance was obtained a seven-year average sugar beet yield and a ten-year average wheat yield from the P. M. A. records. These yield data were compiled and average yields of sugar beets and wheat were determined for each irrigated sub-area. An average yield of wheat was calculated for each sub-area of dry cropland.

Yield data for other crops that could be tied down to sub-area were not obtainable from secondary sources. A productivity classification of the cropland based only upon sugar beets and wheat was not satisfactory since there were only about 8 percent and 18 percent, respectively, of the irrigated cropland in sugar beets and wheat. Therefore, the crop yield data from the P. M. A. were supplemented by obtaining estimates of average yields of the major crops for each sub-area from farmer leaders.

The farmers were requested to estimate the average yield for a normal year for the major crops grown in each sub-area. They were also asked to estimate the relative importance of each crop as a percentage of total acres in crops.

After estimates had been obtained, they were averaged for each sub-area and an average yield and a relative weight for each crop in each sub-area were calculated. These estimated yields were used as the basis for the calculation of a crop yield index for each sub-area.

Crop Yield Index

In calculating a crop yield index for each sub-area three decisions had to be made: (1) the crops to be used in the index; (2) the standard yield to be used as a basis for calculating individual crop indices; and (3) the method of weighting to give relative importance to each crop.

In selecting the crops to be used in the crop yield index, three factors were considered: (1) the relative importance of the crop in the county; (2) the distribution of the crop throughout the county; and (3) the availability of a standard yield for comparison.

As shown in Table 1, ten crops with more than 1000 acres each were grown in Cache County in 1944. These included: alfalfa hay, winter wheat, spring wheat, barley, sugar beets, wild hay, vegetables (of which peas are the most important), oats, corn silage, and potatoes. Of these crops three were unsatisfactory for use in the index. Wild hay was raised in only three or four sub-areas and a standard yield was not available for peas and corn silage.

Alfalfa hay, spring wheat, and barley were grown in every irrigated sub-area in the county. Oats were grown in all but one, sugar beets in all but five, and potatoes in more than half of the sub-areas. These six crops were used as the basis for the crop yield index for the irrigated sub-areas. These crops included one forage, three grain, and two row crops.

Winter wheat was the principal crop grown in every sub-area of dry cropland and was used as a basis for the crop yield index for the dry sub-areas. Some alfalfa hay and barley were grown in a few sub-areas, but standard yields for dry farm alfalfa and barley were not available for recent years.

The standard yield used as a base for the individual crop indices was the average yield of each crop in Cache County. This was calculated from the acreage and production figures given in the census reports. An average of the 1940 and 1945 census was taken. (Table 7)

Table 7. Average yields of crops used as standards for calculating crop yield indices of sub-areas of cropland, Cache County, Utah

Census year	Irrigated Crops						Dry Farm Crops
	Alfalfa	Sugar beets	Spring wheat	Barley	Oats	Potatoes	Winter wheat
	tons	tons	bu.	bu.	bu.	bu.	bu.
1945*	2.4	11.8	30.9	48.0	55.0	174.5	24.3
1940*	2.3	13.9	29.0	46.6	50.5	165.1	17.8
Average	2.4	12.8	30.0	46.3	52.8	169.8	21.0

*U. S. Census of Agriculture Vol.1, part 31. Utah and Nevada. 1945.

The latter census does not differentiate between the crops grown on irrigated and dry cropland. Therefore, the standard yield for alfalfa hay includes the relatively small amount grown on dry farms. Nearly all of the spring wheat and barley were grown on irrigated cropland; however, the amount that was grown on dry cropland was included in the standard yield for irrigated cropland. The reverse situation was true for winter wheat.

Because of the inclusion of yields from dry cropland, the standard yield for alfalfa hay, spring wheat, and barley was slightly lower than the actual yield on irrigated cropland. This difference was largely immaterial in determining a relative classification of the sub-areas, sowas disregarded in using these standard yields in calculating the crop yield index for each sub-area.

The method of weighting each crop used in calculating the crop yield index for each sub-area was the relative importance of each crop as a percentage of total acres in crops. This was determined by averaging the estimates obtained from farmers of the percent of total acres in each crop for each sub-area.

After the average yield and relative importance of each crop in each sub-area were determined, individual crop indices and a crop yield index were calculated for each sub-area. For each sub-area of irrigated cropland the average yield of each crop was divided by the standard yield for that crop. This gave an individual index for each crop. This crop index was multiplied by the weight for that crop. The products of this calculation for each crop were added to give the crop yield index for the sub-area. The indices for the individual crops and for the sub-areas of irrigated cropland are shown in Table 8, (See Appendix, Table 1 for calculation of crop yield indices for irrigated sub-area). The average index for the irrigated sub-areas was 128 with a range from 82 to 168.

Since the crop yield index for sub-areas of dry cropland was based on wheat yields, the individual index for wheat was also the index for the sub-area. (Table 9) The average index for sub-areas of dry cropland was 113 with a range from 34 to 137.

Most of the sub-area indices are more than 100. This indicates that estimated crop yields tended to be higher than the standard. There are two probable reasons for this situation. First, while farmers know quite well how many tons of sugar beets their land produced, they can only make a rough estimate of their production of alfalfa hay and they tend to make that high. Alfalfa hay has a greater weight than the other crops, so a high index for this crop greatly influenced the crop yield index for the sub-area. The second reason for higher estimated yields than standard yields, as mentioned previously

Table 8.- Crop yield indicies for sub-areas of irrigated cropland.

Sub-area	Alfalfa hay	Sugar beets	Spring wheat	Barley	Oats	Potatoes	Total
1	96	–	133	119	133	–	121
2	113	137	124	104	57	–	116
3	125	–	129	132	123	–	128
4	150	64	115	109	98	–	132
5	154	98	144	120	113	168	139
6	196	145	154	141	130	186	168
7	104	76	57	76	83	79	82
8	150	104	111	115	88	197	124
9	121	90	118	124	54	172	121
10	138	–	111	127	110	–	130
11	163	109	117	134	121	–	144
12	179	130	154	144	161	157	158
13	113	88	107	104	88	–	109
14	117	90	97	97	114	–	103
15	175	127	140	131	123	186	151
16	142	86	92	107	102	102	116
17	117	117	115	108	80	144	113
18	167	110	141	119	105	164	142
19	154	119	142	130	128	147	142
20	108	90	120	116	114	98	110
21	179	109	141	130	122	124	151
22	146	97	128	124	101	163	134
23	142	107	112	86	73	–	115
24	146	109	138	103	95	–	127
25	179	120	164	134	123	–	153
26	138	94	100	108	95	–	122
27	154	–	132	111	99	–	134
28	112	–	90	65	–	–	102

was that the standard yield of alfalfa hay, spring wheat, and barley is slightly lower than the actual yield on irrigated cropland because of the inclusion of yields from dry cropland in the standard. These high crop yield indices had no effect on the classification of the sub-areas because the classification was based upon the relative and not the absolute level of the index for each sub-area.

Table 9. Crop yield indices for sub-areas of dry cropland

Sub-area	Crop	Standard yield	Number of estimate	Average yield in sub-area	Sub-area crop yield index
1	Winter wheat	21.0 bu.	4	22.5	107
2	" "	" "	11	23.3	111
3	" "	" "	8	25.0	119
4	" "	" "	6	26.0	124
5	" "	" "	10	26.5	126
6	" "	" "	8	25.6	122
7	" "	" "	10	17.7	84
8	" "	" "	7	25.0	119
9	" "	" "	3	20.0	95
10	" "	" "	9	19.8	94
11	" "	" "	4	21.2	101
12	" "	" "	9	27.8	132
13	" "	" "	6	28.7	137

Classification

On the basis of the crop yield index calculated for each sub-area, the irrigated cropland and the dry cropland were each grouped into four classes. The number of classes and the limits set for each class were arbitrary. For the irrigated cropland, sub-areas with a crop yield index of more than 149 were placed in Class I; those with an index between 130 and 149 inclusive were placed in Class II; those with an index between 110 and 129 inclusive were placed in Class III; and those with an index below 110 were placed in Class IV. (Table 10)

Table 10.- Productivity classification of the sub-areas of irrigated cropland in Cache County, Utah.

Sub-areas	Acres	Crop yield index	Class *
1	2560	121	III
2	1886	116	III
3	1752	128	III
4	2493	132	II
5	14394	139	II
6	13474	168	I
7	2425	82	IV
8	1145	124	III
9	3571	121	III
10	1482	130	II
11	4716	144	II
12	2021	158	I
13	11857	109	IV
14	2021	103	IV
15	2021	151	I
16	2627	116	III
17	2762	113	III
18	6804	142	II
19	2627	142	II
20	1482	110	III
21	2156	151	I
22	5120	134	II
23	3301	115	III
24	4851	127	III
25	3975	153	I
26	1347	122	III
27	2964	134	II
28	1145	102	IV

* Class I over 149
Class II 130-149
Class III 110-129
Class IV below 110

For the dry cropland, Class I included sub-areas with an index above 129; Class II included those with an index between 115 and 129, inclusive; Class III included those with an index between 100 and 114, inclusive; and Class IV included those with an index below 100. (Table 11)

The average crop yield index, the acreage, and the number of sub-areas in each productivity class of irrigated cropland are shown in Table 12. The same information is shown for dry cropland in Table 13.

Table 11. Productivity classification of the sub-areas of dry cropland in Cache County, Utah

Sub-areas	Acres	Crop yield index	Class
1	943	107	III
2	5,053	111	III
3	3,099	119	II
4	3,234	124	II
5	3,099	126	II
6	6,400	122	II
7	3,840	84	IV
8	10,712	119	II
9	1,886	95	IV
10	12,059	94	IV
11	1,415	101	III
12	3,840	132	I
13	23,848	137	I

Class I Over 129
Class II 115 -129
Class III 100 -114
Class IV Under 100

The largest acreage of irrigated cropland was in Class II and included eight sub-areas. The least acreage was in Class IV with four sub-areas included. Class I of dry cropland contained the largest acreage with only two sub-areas included. Class III of dry cropland contained the smallest acreage and included three sub-areas.

Table 12. Average crop yield index, acreage, and number of sub-areas in each productivity class of irrigated cropland

Productivity class	Number of sub-areas	Acreage	Average crop yield index
I	5	33,647	156
II	8	40,600	137
III	11	27,284	119
IV	4	17,448	99
Total Irrigated Cropland	28	108,979	128

This classification shows only the relative productivity of the cropland in Cache County. It does not imply that Class I land is as good as the best land in the state or that Class IV land is the poorest land in the state. Class I land should be the most profitable because it is the most productive, but Class IV land is not necessarily submarginal.

The areas of the different classes of irrigated and dry cropland in Cache County are shown in figure 5.

Table 13. Average crop yield index, acreage, and number of sub-areas in each productivity class of dry cropland

Productivity class	Number of sub-areas	Acreage	Average crop yield index
I	2	27,688	134
II	5	26,544	122
III	3	7,411	106
IV	3	17,785	91
Total dry cropland	13	79,428	113

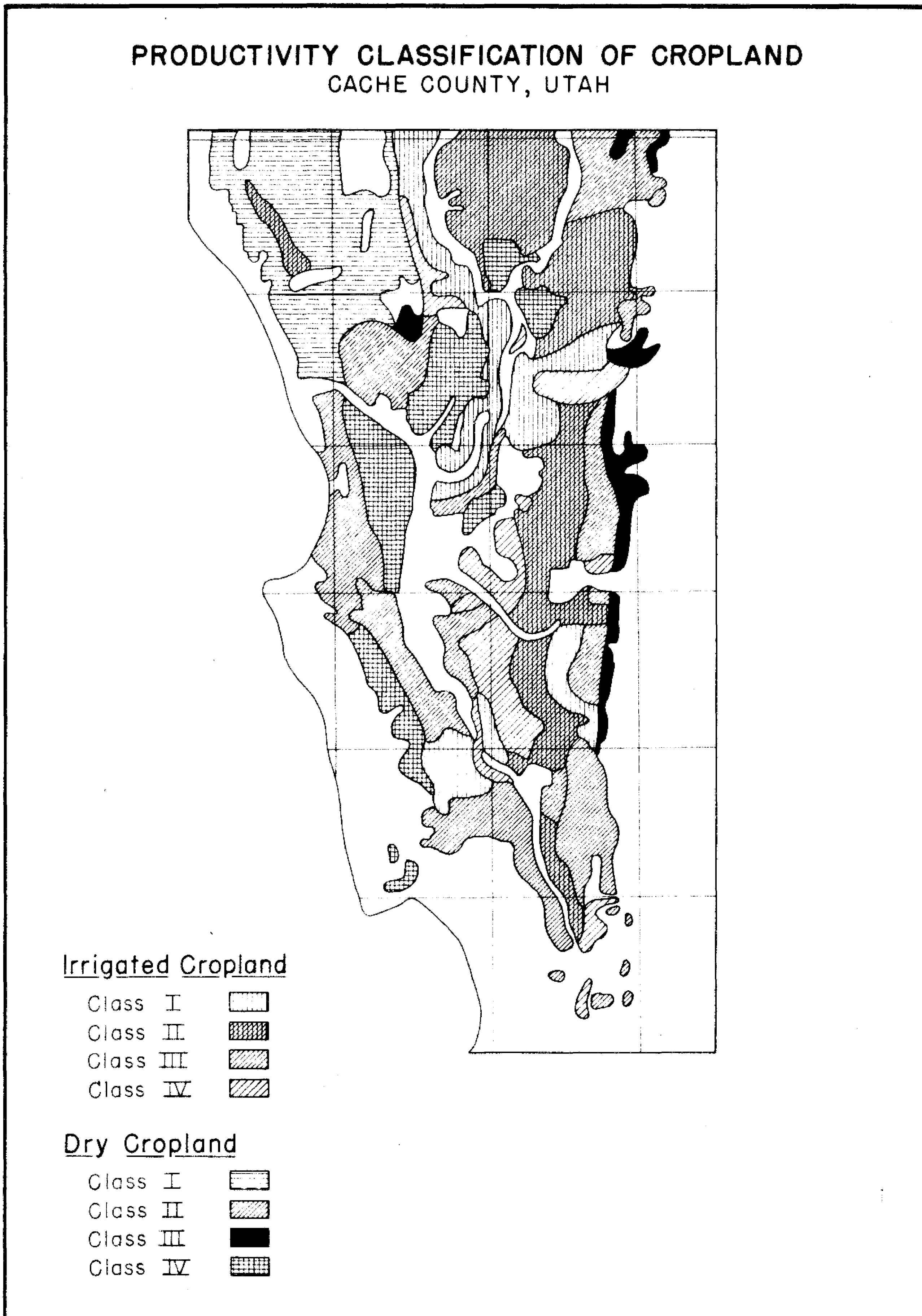
PRODUCTIVITY CLASSIFICATION OF CROPLAND
CACHE COUNTY, UTAH
Irrigated Cropland
Class I
Class II
Class III
Class IV
Dry Cropland
Class I
Class II
Class III
Class IV

Figure 5

VERIFICATION OF PRODUCTIVITY CLASSIFICATION

Relationship to Physical Factors

Most of the Class IV cropland on the valley floor has a clay soil and natural drainage is poor. Seepage from the higher lands as a result of irrigation makes this drainage problem more acute. The Class IV cropland around Smithfield has a combination of a gravelly soil and a shortage of water to give it a low productivity. In the Avon area the water supply is so short that this cropland is only in Class IV.

Most of the irrigated cropland north of Richmond is in Class III as a result of a shortage of irrigation water. The Clarkston and Newton area are also short of water but recent irrigation development in the Newton area should improve the productivity of this cropland. Some of the bench land in Cache County has a coarse texture, and when this condition is combined with a poor water supply, a low productivity results.

The most productive, or Class I, irrigated cropland is located along the West Cache Canal between Cornish and Benson, west and north of Smithfield, south west of Providence and around Wellsville.

The Class I dry cropland is located around Clarkston. The Class IV cropland includes the poorly drained lands on the valley floor and the gravelly bench land south west of Mendon.

As a check on the validity of the productivity classification based upon the crop yield index of each sub-area, the coefficient of correlation between the ratings of physical factors and the crop yield indices of the sub-areas was calculated. The coefficient of correlation for the irrigated cropland was almost .75 which indicates a fairly high relationship for this type of study. (See Appendix Table 2 for calculations.)

The coefficient of determination indicates that about 56 percent of the variation in the crop yield indices of the irrigated sub-areas was accounted for by the variables which entered into the rating of physical factors of the sub-areas. This is fairly good considering three facts: (1) Some of the factors that influence productivity, such as climate and management practices, were assumed to be constant. (2) Some of the data used as the bases for rating the sub-areas, especially that on soils, were inaccurate and not up to date. (3) The crop yield index for each sub-area was based upon estimated rather than upon actual crop yields.

The standard error of estimate, as calculated for the sub-areas of irrigated cropland, indicates that if the physical rating of an area were known the crop yield index could be estimated within less than 13 points at least 67 percent of the time. (See Appendix Table 3 for calculations)

These relationships for the sub-areas of irrigated cropland are shown graphically in figure 6.

The coefficient of correlation as calculated for the sub-areas of dry cropland, was .35. (See Appendix Table 4 for calculations) This means that there was very little relationship between the ratings of physical factors and the crop yield indices, with only 12 percent of the variation in yields accounted for by soil. This appears to indicate that while the rating of dry sub-areas was based only upon soil properties, the productivity was influenced greatly by other factors, most important of which was probably moisture.

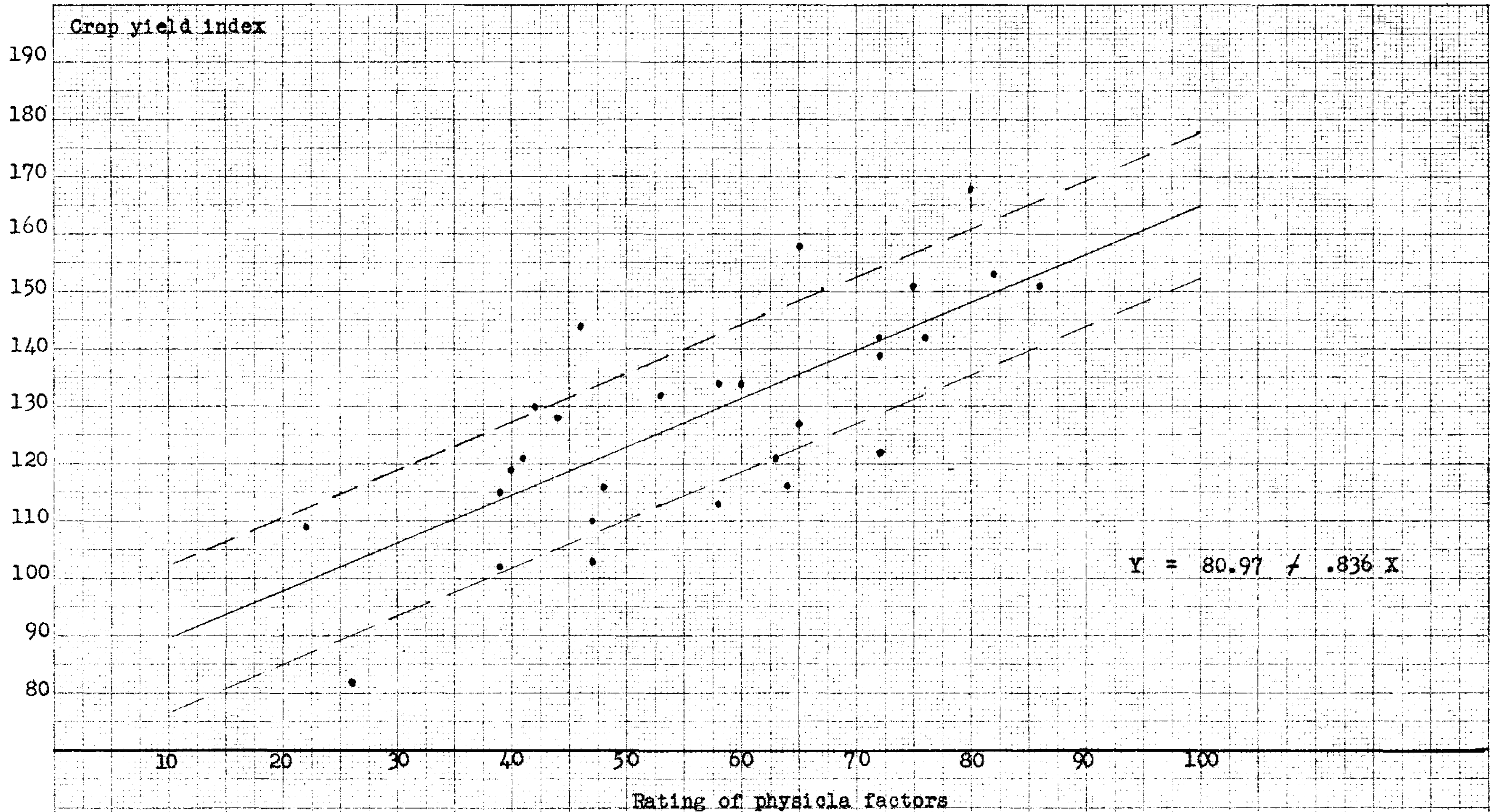

Figure 6.- Scatter diagram and regression line of ratings of physical factors and crop yield indicies of sub-areas of irrigated cropland.

Delineation of sub-areas based upon soil properties provided a satisfactory basis for obtaining crop yields, but if the moisture available could have been evaluated for each sub-area, the rating of these sub-areas would probably have been greatly different. The classification of the dry cropland as to productivity was still valid because it was based upon crop yields from sub-areas which were homogeneous as to soil properties and variations in moisture available were probably not within a sub-area but over a larger area.

Since the coefficient of correlation showed such a small relationship between the ratings of physical factors and the crop yield indices of sub-areas of dry cropland, the statistical analysis was not carried further.

Relationship to Actual Yields of Sugar Beets and Wheat

To verify the classification of the cropland based on estimated crop yields, the yield data for sugar beets and wheat, obtained from the P. M. A., were summarized for each productivity class of irrigated cropland. (Table 14) There was a direct relationship between the productivity classes, based on estimated crop yields, and average actual yields of both sugar beets and wheat.

The difference in the yield of sugar beets on the different classes of irrigated cropland was not highly significant. This does not indicate that the difference in the productivity of the cropland in these classes was not significant. Some of the factors associated with productivity have a different effect on the yield of some crops than on the yield of others. Land which may have too high a water table to give a high yield of alfalfa, for example, may produce a good crop of grain.

Table 14. Actual yields of sugar beets and wheat as averaged from P. M. A. data for classes of irrigated cropland

Productivity class	Sugar Beets		Wheat	
	Number* of farms	7 yr. av. yield	Number* of farms	10 yr. av. yield
I	76	12.7	83	37.8
II	85	12.4	141	33.5
III	62	12.3	114	28.4
IV	26	11.9	80	27.1
Total	249	12.5	409	31.9

*Number of farms for which average yields were obtained from the P. M. A.

Some areas of irrigated cropland have a low productivity because of the lack of water. Where sugar beets are grown in these areas the available water is applied to sugar beets at the expense of other crops. Thus, the yield of sugar beets may be high, but the yields of other crops are low. Only an average of 8 percent of the irrigated cropland was in sugar beets, so this crop had little weight in the crop yield indices.

The actual wheat yields as obtained from the P. M. A. were averaged for each productivity class of dry cropland. (Table 15) This also indicates a direct relationship between the productivity classes based on estimated crop yields and the actual yields of wheat.

Table 15. Actual yield of wheat as averaged from P. M. A. data for classes of dry cropland

Productivity class	Wheat: Number* of farms	Wheat: 10 yr. av. yield
I	60	26.6
II	120	22.2
III	39	20.5
IV	66	18.9
Total	285	22.1

*Number of farms for which average yields were obtained from the P. M. A.

Relationship to Land Use

The more intensive crops are usually associated with the more productive lands. This relationship holds true generally for the productivity classes of irrigated cropland in Cache County. (Table 16) Of Class I cropland there was 21 percent of the acreage in row crops, 45 percent in grains, and 34 percent in forage. For Class IV there was only 5 percent in row crops, 54 percent in grain, and 41 percent in forage.

Table 16. Percentage of total acres in major crops in each productivity class of irrigated cropland

Productivity class	Acres	Forage	Grains			Row crops	
		Alfalfa hay	Spring wheat	Barley	Oats	Sugar beets	Potatoes
		%	%	%	%	%	%
I	23,647	34	17	26	2	15	6
II	40,600	47	15	26	4	6	2
III	27,284	40	26	22	4	7	1
IV	17,448	41	25	26	3	4	1
Total Irrigated Cropland	108,979	41	21	25	3	8	2

SUMMARY

The objectives of this study were: (1) to develop a method for determining productivity, adaptable to the cropland in Cache County, Utah, and (2) to collect the necessary data and classify the cropland in Cache County according to productivity.

As the first step in determining the productivity of the cropland, the areas of irrigated and dry cropland in the county were located on a large scale map. Then information on the physical factors affecting the productivity of cropland was obtained. Of these factors climate and management practices were assumed to be constant throughout the county and soil properties and irrigation water were taken as the principal causes of variation in productivity.

Information on soil properties of the cropland in the county was taken principally from the 1913 survey of the Cache Valley soils. Information on the irrigation water supplied by each irrigation company in the county was obtained from a survey of these companies made by the Utah Agricultural Experiment Station in 1945. The location of the areas irrigated by these companies was taken from a map made in 1939 in connection with a land-use planning project. All of the data on the cropland were checked by observation in the field and by information received from farmer leaders in the county.

Sub-areas of both irrigated and dry cropland were delineated so as to include land of similar productivity, based upon soil properties and irrigation water. There were 28 sub-areas of irrigated cropland and 13 sub-areas of dry cropland. The soil properties and irrigation water

were each given a percentage rating, and by multiplying these ratings together a rating was determined for each sub-area.

Yield estimates for six major crops were obtained from farmer leaders for each irrigated sub-area. These crops were weighted by acres grown and a crop yield index was calculated for each irrigated sub-area. For the dry cropland the yield of winter wheat was used as the basis for the index.

The sub-areas of the irrigated and the dry cropland were grouped into four classes according to the crop yield index.

Class I included the most productive and Class IV the least productive land in the county. Of the irrigated cropland there were 23,647 acres in Class I, 40,600 acres in Class II, 25,802 acres in Class III, and 18,930 acres in Class IV. Of the dry cropland there were 27,688 acres in Class I, 26,544 acres in Class II, 7,411 acres in Class III, and 17,785 acres in Class IV.

The coefficient of correlation between the ratings of physical factors and the crop yield indices of irrigated sub-areas was .75. The coefficient of correlation for dry sub-areas was only .35.

Class I irrigated cropland is located along the west Cache canal between Cornish and Benson, north and west of Smithfield, south west of Providence, and around Wellsville. Class IV irrigated cropland includes principally, the poorly drained soils on the valley floor and some of the coarse textured bench lands which have an insufficient water supply.

Class I dry cropland is located around Clarkston. Class IV dry cropland includes the poorly drained bottom lands and the gravelly bench land southwest of Mendon.

CONCLUSIONS

Any study is limited by the data on which it is based. It would have been desirable in a study of the productivity of the cropland in Cache County to obtain accurate data on all of the factors which influence productivity, and to obtain data on actual crop yields from small areas which were relatively homogeneous as to these factors.

This study was limited in time and expense and much of the data had to be taken from secondary sources. Some of these data were not as complete or accurate as was desired. The information on soils was taken principally from the 1913 Soil-Survey Report which is not held in high regard by soils people today. No information was available on variations in climate and management practices in Cache County. These factors had an influence on productivity, especially climate on the dry cropland, but could not be evaluated. Information on irrigation water was fairly accurate but was not as complete as would have been desirable.

Data were not available on actual yields of major crops that could be tied down to sub-areas. This made it necessary to base the classification of the cropland on estimated crop yields.

Despite the limitations of available data, it is the opinion of the author that there have been two important contributions made by this study. First, a method has been developed for determining productivity of cropland that is reasonably satisfactory for use in areas similar to Cache County. Second, the irrigated and dry cropland has been classified according to productivity. The results of this study, if made public, should enable farmers and others interested in agriculture to know which lands in the county are the most productive, the relationship of certain physical factors to low productivity, and the relationship of certain physical factors to the yield of specific crops. This knowledge would be helpful to the farmer in buying a farm, in raising crops best suited to the land on his farm, and in improving certain management practices, such as the over-irrigation of the higher lands with the resulting water-logging of the lands on the valley floor. It would be helpful to county agents in planning education programs and to other agencies in planning their activities.

A P P E N D I X

Table 1.- Calculation of crop yield index for sub-areas of irrigated cropland.

Sub-area	Crop	Standard yield	Number of estimates	Average yield in sub-area	Individual crop index	Relative weight of crop	Weight X crop index	Sub-area crop yield index
1	Alfalfa hay	2.3 T		2.3	96	26	24.96	
	Sugar beets	12.8 T		-	-	-	-	
	Spring wheat	30.0 bu		40.0	133	49	65.17	
	Barley	46.3 bu		55.0	119	19	22.61	
	Oats	52.8 bu		70.0	133	6	7.98	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			3			100	120.72	121
2	Alfalfa hay	2.3 T		2.7	113	47	53.11	
	Sugar beets	12.8 T		17.5	137	1	1.37	
	Spring wheat	30.0 bu		37.3	124	40	49.60	
	Barley	46.3 bu		48.3	104	10	10.40	
	Oats	52.8 bu		30.0	57	2	1.14	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			3			100	115.62	116
3	Alfalfa hay	2.3 T		3.0	125	47	58.75	
	Sugar beets	12.8 T		-	-	-	-	
	Spring wheat	30.0 bu		38.8	129	24	30.96	
	Barley	46.3 bu		61.2	132	24	31.68	
	Oats	52.8 bu		65.0	123	5	6.15	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			4			100	127.54	128
4	Alfalfa hay	2.3 T		3.6	150	57	85.50	
	Sugar beets	12.8 T		8.2	64	2	1.28	
	Spring wheat	30.0 bu		34.6	115	10	11.50	
	Barley	46.3 bu		50.6	109	26	28.34	
	Oats	52.8 bu		51.7	98	5	4.90	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			8			100	131.52	132

Table 1.- Continued

Sub-area	Crop	Standard yield	Number of estimates	Average yield in sub-area	Individual crop index	Relative weight of crop	Weight X crop index	Sub-area crop yield index
5	Alfalfa hay	2.3 T		3.7	154	46	70.84	
	Sugar beets	12.8 T		12.5	98	10	9.80	
	Spring wheat	30.0 bu		43.1	144	15	21.60	
	Barley	46.3 bu		55.6	120	20	24.00	
	Oats	52.8 bu		59.4	113	5	5.65	
	Potatoes	101.7 cwt.		171.2	168	4	6.72	
Total			8			100	138.61	139
6	Alfalfa hay	2.3 T		4.7	196	44	86.24	
	Sugar beets	12.8 T		18.6	145	21	30.45	
	Spring wheat	30.0 bu		46.2	154	7	10.78	
	Barley	46.3 bu		65.4	141	20	28.20	
	Oats	52.8 bu		68.8	130	5	6.50	
	Potatoes	101.7 cwt.		189.0	186	3	5.58	
Total			13			100	167.75	168
7	Alfalfa hay	2.3 T		2.5	104	30	31.20	
	Sugar beets	12.8 T		9.7	76	14	10.64	
	Spring wheat	30.0 bu		17.0	57	15	8.55	
	Barley	46.3 bu		35.0	76	30	22.80	
	Oats	52.8 bu		44.0	83	7	5.81	
	Potatoes	101.7 cwt.		80.0	79	4	3.16	
Total			6			100	82.16	82
8	Alfalfa hay	2.3 T		3.6	150	31	46.50	
	Sugar beets	12.8 T		13.3	104	3	3.12	
	Spring wheat	30.0 bu		33.3	111	40	44.40	
	Barley	46.3 bu		53.3	115	21	24.15	
	Oats	52.8 bu		46.7	88	4	3.52	
	Potatoes	101.7 cwt.		200.0	197	1	1.97	
Total			4			100	123.66	124

Table 1.- Continued

Sub-area	Crop	Standard yield	Number of estimates	Average yield in sub-area	Individual crop index	Relative weight of crop	Weight X crop index	Sub-area crop yield index
9	Alfalfa hay	2.3 T		2.9	121	35	42.35	
	Sugar beets	12.8 T		11.5	90	1	.90	
	Spring wheat	30.0 bu		35.5	118	27	31.86	
	Barley	46.3 bu		57.5	124	33	40.92	
	Oats	52.8 bu		28.3	54	2	1.08	
	Potatoes	101.7 cwt.		175.0	172	2	3.44	
Total			5			100	120.55	121
10	Alfalfa hay	2.3 T		3.8	138	52	71.76	
	Sugar beets	12.8 T		-	-	-	-	
	Spring wheat	30.0 bu		33.3	111	14	15.54	
	Barley	46.3 bu		58.8	127	31	39.37	
	Oats	52.8 bu		58.3	110	3	3.30	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			4			100	129.97	130
11	Afalfa hay	2.3 T		3.9	163	46	74.98	
	Sugar beets	12.8 T		14.0	109	6	6.54	
	Spring wheat	30.0 bu		35.0	117	10	11.70	
	Barley	46.3 bu		62.0	134	34	45.56	
	Oats	52.8 bu		64.0	121	4	4.84	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			6			100	143.62	144
12	Alfalfa hay	2.3 T		4.3	179	37	66.23	
	Sugar beets	12.8 T		16.7	130	8	10.40	
	Spring wheat	30.0 bu		46.3	154	15	23.10	
	Barley	46.3 bu		66.7	144	34	48.96	
	Oats	52.8 bu		85.0	161	1	1.61	
	Potatoes	101.7 cwt.		160.0	157	5	7.85	
Total			3			100	158.15	158

Table 1.- Continued

Sub-area	Crop	Standard yield	Number of estimates	Average yield in sub-area	Individual crop index	Relative weight of crop	Weight X crop index	Sub-area crop yield index
13	Alfalfa hay	2.3 T		2.7	113	48	54.24	
	Sugar beets	12.8 T		11.2	88	3	2.64	
	Spring wheat	30.0 bu		32.0	107	24	25.68	
	Barley	46.3 bu		48.5	104	23	24.15	
	Oats	52.8 bu		46.4	88	2	1.76	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			9			100	108.51	109
14	Alfalfa hay	2.3 T		2.8	117	28	32.76	
	Sugar beets	12.8 T		11.5	90	1	.90	
	Spring wheat	30.0 bu		29.0	97	22	21.34	
	Barley	46.3 bu		45.0	97	46	44.62	
	Oats	52.8 bu		60.0	114	3	3.42	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			5			100	103.04	103
15	Alfalfa hay	2.3 T		4.3	175	23	40.25	
	Sugar beets	12.8 T		16.3	127	22	27194	
	Spring wheat	30.0 bu		41.9	140	7	9.80	
	Barley	46.3 bu		60.6	131	26	34.06	
	Oats	52.8 bu		65.0	123	3	3.69	
	Potatoes	101.7 cwt.		189.0	186	19	35.34	
Total			8			100	151.08	151
16	Alfalfa hay	2.3 T		3.4	142	45	63.90	
	Sugar beets	12.8 T		11.0	86	22	18.92	
	Spring wheat	30.0 bu		27.5	92	10	9.20	
	Barley	46.3 bu		49.5	107	14	14.98	
	Oats	52.8 bu		53.8	102	2	2.04	
	Potatoes	101.7 cwt.		103.3	102	7	7.14	
Total			6			100	116.18	116

Table 1.- Continued

Sub-area	Crop	Standard yield	Number of estimates	Average yield in sub-area	Individual crop index	Relative weight of crop	Weight X crop index	Sub-area crop yield index
17	Alfalfa hay	2.3 T		2.8	117	41	47.97	
	Sugar beets	12.8 T		15.0	117	2	2.34	
	Spring wheat	30.0 bu		34.6	115	23	26.45	
	Barley	46.3 bu		50.0	108	31	33.48	
	Oats	52.8 bu		42.5	80	2	1.60	
	Potatoes	101.7 cwt.		146.6	144	1	1.44	
Total			9			100	113.28	113
18	Alfalfa hay	2.3 T		4.0	167	40	66.80	
	Sugar beets	12.8 T		14.1	110	14	15.40	
	Spring wheat	30.0 bu		42.3	141	14	19.74	
	Barley	46.3 bu		55.0	119	21	24.99	
	Oats	52.8 bu		55.5	105	5	5.25	
	Potatoes	101.7 cwt.		166.6	164	6	9.84	
Total			12			100	142.02	142
19	Alfalfa hay	2.3 T		3.7	154	49	75.46	
	Sugar beets	12.8 T		15.2	119	11	13.09	
	Spring wheat	30.0 bu		42.6	142	11	15.62	
	Barley	46.3 bu		60.0	130	24	31.20	
	Oats	52.8 bu		67.5	128	4	5.12	
	Potatoes	101.7 cwt.		150.0	147	1	1.47	
Total			6			100	141.96	142
20	Alfalfa hay	2.3 T		2.6	108	49	52.92	
	Sugar beets	12.8 T		11.5	90	9	8.10	
	Spring wheat	30.0 bu		36.0	120	10	12.00	
	Barley	46.3 bu		53.8	116	26	30.16	
	Oats	52.8 bu		60.0	114	5	5.70	
	Potatoes	101.7 cwt.		100.00	98	1	.98	
Total			7			100	109.86	110

Table 1.- Continued

Sub-area	Crop	Standard yield	Number of estimates	Average yield in sub-area	Individual crop index	Relative weight of crop	Weight X crop index	Sub-area crop yield index
21	Alfalfa hay	2.3 T		4.3	179	42	75.18	
	Sugar beets	12.8 T		13.9	109	7	7.63	
	Spring wheat	30.0 bu		42.2	141	22	31.02	
	Barley	46.3 bu		60.0	130	26	33.80	
	Oats	52.8 bu		64.4	122	2	2.44	
	Potatoes	101.7 cwt.		125.7	124	1	1.24	
Total			10			100	151.31	151
22	Alfalfa hay	2.3 T		3.5	146	45	65.70	
	Sugar beets	12.8 T		12.4	97	8	7.76	
	Spring wheat	30.0 bu		38.3	128	23	29.44	
	Barley	46.3 bu		57.2	124	17	21.08	
	Oats	52.8 bu		53.1	101	3	3.03	
	Potatoes	101.7 cwt.		166.2	163	4	6.52	
Total			13			100	133.53	134
23	Alfalfa hay	2.3 T		3.4	142	37	52.54	
	Sugar beets	12.8 T		13.8	107	13	13.91	
	Spring wheat	30.0 bu		33.7	112	24	26.88	
	Barley	46.3 bu		40.0	86	21	18.06	
	Oats	52.8 bu		38.3	73	5	3.65	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			4			100	115.04	115
24	Alfalfa hay	2.3 T		3.5	146	31	45.26	
	Sugar beets	12.8 T		14.0	109	19	20.71	
	Spring wheat	30.0 bu		41.4	138	29	40.02	
	Barley	46.3 bu		47.9	103	18	18.54	
	Oats	52.8 bu		50.0	95	3	2.85	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			7			100	127.38	127

Table 1.- Continued

Sub-area	Crop	Standard yield	Number of estimates	Average yield in sub-area	Individual crop index	Relative weight of crop	Weight X crop index	Sub-area crop yield index
25	Alfalfa hay	2.3 T		4.3	179	23	41.17	
	Sugar beets	12.8 T		15.4	120	16	19.20	
	Spring wheat	30.0 bu		49.3	164	35	57.40	
	Barley	46.3 bu		62.1	134	25	33.50	
	Oats	52.8 bu		65.0	123	1	1.23	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			7			100	152.50	153
26	Alfalfa hay	2.3 T		3.3	138	53	73.14	
	Sugar beets	12.8 T		12.0	94	3	2.82	
	Spring wheat	30.0 bu		30.0	100	12	12.00	
	Barley	46.3 bu		50.0	108	29	31.32	
	Oats	52.8 bu		50.0	95	3	2.85	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			2			100	122.13	122
27	Alfalfa hay	2.3 T		3.7	154	44	67.76	
	Sugar beets	12.8 T		-	-	-	-	
	Spring wheat	30.0 bu		39.5	132	22	29.04	
	Barley	46.3 bu		51.2	111	32	35.52	
	Oats	52.8 bu		52.5	99	2	1.98	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			6			100	134.30	134
28	Alfalfa hay	2.3 T		2.7	112	58	64.96	
	Sugar beets	12.8 T		-	-	-	-	
	Spring wheat	30.0 bu		27.0	90	38	34.20	
	Barley	46.3 bu		30.0	65	4	2.60	
	Oats	52.8 bu		-	-	-	-	
	Potatoes	101.7 cwt.		-	-	-	-	
Total			4			100	101.76	102

Table 2.- Correlation between ratings of physical factors and crop yield indicies of sub-areas of irrigated cropland.

Sub-area	Rating of physical factors	Crop yield index	Deviations from means		Deviations squared		Product of deviations
	X	Y	x	y	x^2	y^2	xy
1	41	121	-15.5	- 7.2	240.25	51.84	111.60
2	48	116	- 8.5	-12.2	72.25	148.84	103.70
3	44	128	-12.5	- .2	156.25	.04	2.50
4	53	132	- 3.5	3.8	12.25	14.44	- 13.30
5	72	139	15.5	10.8	240.25	116.64	167.40
6	80	168	23.5	39.8	552.25	1584.04	935.30
7	26	82	-30.5	-46.2	930.25	2134.44	1409.10
8	40	124	-16.5	- 4.2	272.25	17.64	69.30
9	63	121	6.5	- 7.2	42.25	51.84	-46.80
10	42	130	-14.5	1.8	210.25	3.24	-26.10
11	46	144	-10.5	15.8	110.25	249.64	-165.90
12	65	158	8.5	29.8	72.25	888.04	253.30
13	22	109	-34.5	-19.3	1190.25	372.49	665.85
14	47	103	- 9.5	-25.2	90.25	635.04	239.40
15	75	151	18.5	22.8	342.25	519.84	421.80
16	64	116	7.5	-12.2	56.25	148.84	- 91.50
17	58	113	1.5	-15.2	2.25	231.04	- 22.80
18	76	142	19.5	13.8	380.25	190.44	269.10
19	72	142	15.5	13.8	240.25	190.44	213.90
20	47	110	- 9.5	-18.2	90.25	331.24	172.90
21	86	151	29.5	22.8	870.25	519.84	672.60
22	60	134	3.5	5.8	12.25	33.64	20.30
23	39	115	-17.5	-13.2	306.25	174.24	231.00
24	65	127	8.5	- 1.2	72.25	1.44	- 10.20
25	82	153	25.5	24.8	650.25	615.04	632.40
26	72	122	15.5	- 6.2	240.25	38.44	- 96.10
27	58	134	1.5	5.8	2.25	33.64	8.70
28	39	102	-17.5	-26.2	306.25	686.44	458.50
Total	1582	3587			7763.00	9982.77	6585.95
Average	56.5	128.2			277.25	356.53	235.21

$\sigma_X = \sqrt{\frac{\Sigma x^2}{N}} = \sqrt{277.25} = 16.65$ Standard error in X

$\sigma_Y = \sqrt{\frac{\Sigma y^2}{N}} = \sqrt{356.53} = 18.88$ Standard error in Y

$R = \frac{\frac{\Sigma xy}{N}}{\sigma_x \sigma_Y} = \frac{235.21}{314.45} = .7480$ Coefficient of correlation

$R^2 = .5595$ Coefficient of determination

Table. 3.- Standard error of estimate of crop yield indicies of sub-areas of irrigated cropland.

Sub-area	Rating of physical factors	Crop yield index	Estimated index	Deviation from regression line	Deviation squared
	X	Y	Y'	y'	$(y')^2$
1	41	121	115.2	5.8	33.64
2	48	116	121.1	- 5.1	26.01
3	44	128	117.8	10.2	104.04
4	53	132	125.3	6.7	44.89
5	72	139	141.2	- 2.2	4.84
6	80	168	147.9	20.1	404.01
7	26	82	102.7	-20.7	428.49
8	40	124	114.4	9.6	92.16
9	63	121	133.6	-12.6	158.76
10	42	130	116.1	13.9	193.21
11	46	144	119.4	24.6	605.16
12	65	158	135.3	22.7	515.29
13	22	109	99.4	9.6	92.16
14	47	102	120.3	-18.3	334.89
15	75	151	143.7	7.3	53.29
16	64	116	134.5	-18.5	342.25
17	58	113	129.5	-16.5	272.25
18	76	142	144.5	- 2.5	6.25
19	72	142	141.2	0.8	.64
20	47	110	120.3	-10.3	106.09
21	86	151	152.9	- 1.9	3.61
22	60	134	131.1	2.9	8.41
23	39	115	113.6	1.4	1.96
24	65	127	135.3	- 8.3	68.89
25	82	153	149.5	3.5	12.25
26	72	122	141.2	-19.2	368.64
27	58	134	129.5	4.5	20.25
28	39	102	113.6	-11.6	134.56
Total	1582	3587			4436.89
Average	56.5	128.2			154.46

$Y = 80.97 + .836\ x$ Regression equation.

$Sy = \frac{\Sigma(y')^2}{N} = 12.59$ Standard error of estimate

Table 4.- Correlation between ratings of physical factors and crop yield indicies of sub-areas of dry cropland.

Sub-area	Rating of physical factors	Crop yield index	Deviations from means		Deviations squared		Product of deviations
	X	Y	x	y	x^2	y^2	xy
1	40	107	-28.8	- 6.2	829.44	38.44	178.56
2	68	111	- .8	- 2.2	.64	4.84	1.76
3	76	119	7.2	5.8	51.84	33.64	41.76
4	90	124	21.2	10.8	449.44	116.64	228.96
5	68	126	- .8	12.8	.64	163.84	- 10.24
6	86	122	17.2	8.8	295.84	77.44	151.36
7	72	84	3.2	-29.2	10.24	852.64	- 93.44
8	84	119	15.2	5.8	231.04	33.64	88.16
9	72	95	3.2	-18.2	10.24	331.24	- 58.24
10	20	94	-48.8	-19.2	2381.44	368.64	936.96
11	68	101	- .8	-12.2	.64	148.84	9.76
12	81	132	12.2	18.8	148.84	353.44	229.36
13	69	137	.2	23.8	.04	566.44	4.76
Total	894	1471			4510.32	3089.72	1769.48
Average	68.8	113.2			346.95	237.67	136.11

$$\sigma_X = \sqrt{\frac{\Sigma x^2}{N}} = \sqrt{346.95} = 18.63$$ Standard error in X

$$\sigma_Y = \sqrt{\frac{\Sigma y^2}{N}} = \sqrt{237.67} = 15.42$$ Standard error in Y

$$R = \frac{\frac{\Sigma xy}{N}}{\sigma_X \sigma_Y} = \frac{136.11}{387.27} = .3515$$ Coefficient of correlation

$$R^2 = .1236$$ Coefficient of determination

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