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University of Idaho Agricultural Experiment Station

Dry Farming in Idaho

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DRY FARMING IN IDAHO

by

Elias Nelson.

INTRODUCTION.

In the arid regions of the West the lands for which irrigation water may be supplied are but a small part of the vast domain of tillable lands. That profitable crop may be grown without watering on most of these tracts has been fully demonstrated by the results attained in the past. For successful dry farming suitable methods of handling the soil must be employed, and these necessarily differ somewhat from those pursued in humid climates or on irrigated lands. To expound the principles of dry land agriculture and to treat particularly of Idaho conditions is the purport of this bulletin.

There is a great need to-day of experimental data relative to dry farming. Investigations along that line have but recently been instituted at the experiment stations of the different Western states. In our state at the Auxiliary Experiment Station near Caldwell experiments in dry farming in connection with irrigation investigations were begun in 1907. This work is carried on in co-operation with the Office of Experiment Stations of the U. S. Department of Agriculture. The experiments are designed to throw some light on methods of cultivation for different dry land crops. The annual precipitation at the station is but 10.32 inches, hence the results obtained there should indicate incidentally what may be done in the dryest sections of Idaho. The land used was in sage brush when operations began in October, 1906, hence the work during 1907 was largely preliminary. On that account no report on the experiments begun is given in this bulletin. However, some references to certain results obtained are included.

HISTORY OF DRY FARMING.

The first attempts at dry farming in the arid West were made 40 to 50 years ago. The experiences of some of the pioneers in Utah and eastern Washington indicated that crops might be grown without irrigation. Failures quite often attended the first efforts of the settlers and these were due either to heavy seeding, poor preparation of the soil or attempts to grow crops every year. Those who persisted generally succeeded. The possibilities of dry farming, while known early, were not fully appreciated. Moreover, the stock industry and irrigation has absorbed popular attention over a large part of the arid West, hence the dry farming movement has not become general until in recent years. Some of the pioneers of Utah have been engaged in growing crops without irrigation for 44 years. Dry farming was practiced there in a limited way in the sixties and seventies while during the last twenty years it has been carried on extensively. In 1907 there were 200,000 acres under cultivation and the industry is being extended rapidly in that state. The annual precipitation in the dry farming districts of Utah ranges from 12 to 16 inches, and yields of wheat range from 20 to 35 bushels per acre.

In the Columbia Basin uplands the beginning was made about 35 years ago. To-day dry farming is carried on very extensively in the eastern portions of Oregon and Washington. Twenty-five million bushels of wheat are produced annually in that part of this region where the annual precipitation is less than 18 inches. In eastern Oregon 1500 acres of land are being dry farmed successfully with but 9 to 10 inches of precipitation, the average yield of wheat being 10 bushels per acre.

In the Great Plains region extending along the eastern border of the Rocky Mountains from the Canadian border to Texas, where the annual precipitation ranges from 12 to 15 inches, new methods are being introduced with notable success. The development there has been marked by some vicissitudes which have taught the farmers of that region some valuable lessons. In the early eighties there was a great wave of settlement extending over western Kansas and Nebraska, and between 1886 and 1889 large districts of Colorado were settled. A few years of abundant rainfall gave good crops. Dry years, however, followed with attending crop failurees. As a result large farming communities were depopulated. The practices of these early settlers were practically the same as those they had been wont to pursue in humid climates. For some years following those failures farming was carried on in an experimental way. New methods were tried and men persisted in their attempts to grow crops under arid conditions.

Among those who began to experiment and to study the relation of soil conditions to crop production no one is more prominent than H. W. Campbell. For many years he grappled with the problems of proper methods and suitable tools until in the nineties he was able to demonstrate the success of some practices he had adopted. Briefly, his system means fitting the soil for deep percolation of rain and maintaining a dust mulch on the surface to prevent loss of moisture by evaporation. In 1895 he first put on the market his invention, the subsurface packer, designed to establish good capillary connection between the furrow slice and the subsoil. Since that time Mr. Campbell has by means of lectures, publications and model farms done a great deal toward the advancement of farming in the Great Plains. While the Campbell method is adapted particularly to the soil and climatic conditions of that region, the fundamental principles are of universal application. As a result of the introduction of better methods and the recurrance of a period of more abundant rainfall the districts once deserted are again populated and farming placed on a permanent basis.

The interest manifested in dry farming at the present time is so great that certain railroads, the federal government and some states are lending aid to the development of the industry. In the Bureau of Plant Industry of the U. S. Department of Agriculture an office of Dry Land Agriculture has been recently created and in connection with that office 11 experiment stations for dry farming investigations have been established in the Great Plains region. In Utah the state legislature appropriated funds for the establishment and maintenance of 6 experiment stations in different parts of the state. These have been in operation for 5 years and have been of vast benefit. Largely as a result of state aid much land in Utah has advanced in price from $2.50 to $20.00 per acre. In Montana three stations are being maintained jointly by the Great Northern and Northern Pacific railroads and the state. In Wyoming two stations are suported in part by local interests and in part by the state and federal appropriations. Nearly all of the Experiment Stations in the arid states are investigating the science of arid agriculture.

DRY FARMNG IN IDAHO.

The "Panhandle" and a portion of central Idaho are humid and produce crops every year. In southern Idaho and the western part of Nez Perces County the annual precipitation is less than 15 inches, hence farming without irrigation may properly be termed dry farming.

In Idaho it is largely practiced in the mountain valleys and about the foot hills. These locations naturally attracted the settlers since the streams furnished water for stock and for irrigation in a limited way. Here dry farming has sprung up and is very successful. It has been extended about the foot of the lower mountains and is reaching out more and more into the open plains.

In the mountain valleys rich, alluvial soils occur along the streams and these have proved very productive. About the foot of the mountains generally occur residual soils formed by the disintegration of the rocks on which they rest. These soils usually contain considerable sand and coarse particles of earth; are easily handled and quite fertile. Quite often seepage from the slopes and mountains above brings the water table sufficiently near to the surface to furnish moisture to the roots of crops. Where such conditions obtain as good crops are usually grown as on adjacent irrigated land. Yields of 30 to 40 bushels of wheat are common and even 60 bushels per acre have been produced. Alfalfa gives more than one crop and produces several tons of hay per acre for the season. There are also instances of good orchards producing excellent fruit without irrigation but thoro cultivation is practiced. Where there is no underground supply of moisture to supplement the natural rainfall wheat yields from 20 to 30 bushels per acre while alfalfa gives one cutting for the season. The annual precipitation in the foothills where dry farming is now practiced on any considerable scale ranges from 12 to 15 inches.

Dry farming in Idaho dates back twenty years or more in some localities. The first attempts were made near Lewiston, Boise and Weiser. In southeastern Idaho the development of agriculture without irrigation began early and this portion of the state is taking the lead in dry farming in Idaho to-day. The soils here are generally deep and well adapted for dry farming. In Oneida County alone there are 30,000 acres farmed very successfully with a normal precipitation of 13 inches. In Bear Lake, Bannock, Fremont, Boise and Canyon counties there is considerable farming without irrigation.

The Snake River plains extend from east to west across the state as a rudely crescent-shaped area concave to the north. In the valleys extending into the mountains from these plains and about the foot of the neighboring mountains tracts of larger or lesser size are being farmed, but on the open plains there have been but few attempts to grow dry land crops. In the upper Snake River valley much land above the irrigation canals is being taken up and put under cultivation. Very good results have been secured there and the soils appear to lend themselves readily to dry farming. In the vicinity of American Falls large tracts of very suitable land are being brought under cultivation.

The plains extending from Hagerman to American Falls and some distance beyond have a clay loam soil of aeolian origin. This dust deposit laid down by the wind is homogeneous thruout. This is the prevailing type of soil in this region. A few tracts of slightly sandy land occur. Over the greater part the soil is deep. In some localities, however, it is shallow with a white lime formation near the surface and often the soil occurs as a thin covering over the lava rock. The soil is very productive and where sufficiently deep dry farming should be successful. Similar soils occur in Bannock, Bingham and Elmore Counties. The annual precipitation on these plains ranges from 9 to 12 inches. The depth to water varies from 50 to 300 feet or more.

On the plains of the western part of the Snake River valley comprising portions of Ada, Canyon and Owyhee counties, there is much variation in soils. Occasional areas of deep soil suited to dry farming occur. Most of the land, however, is underlaid by hardpan at a depth of from 18 inches to several feet. The surface soil is loamy and very fine—quite similar to that on the plains in the south central part of the state. A layer of clay occurs quite generally in the first foot of soil or in the upper part of the second. Here and there the clay appears on the surface and these patches are known as "slick" spots. There is much of this sort of land for which irrigation water will never be furnished. This soil does not absorb moisture readily and being shallow has a limited storage capacity. It is a productive soil but it is difficult to handle and to get into a good state of cultivation. These soils are of alluvial origin and are underlaid by hardpan, cement, gravel and sand. Considerable areas of sedimentary soils are also found in this part of Idaho. These are better suited to dry farming. There is a large tract of land of this character between the Boise and Payette Rivers that lies above proposed canals. Wheat and other cereals, potatoes, corn, sorghum cane and certain vegetables have been grown successfully on the divide between those rivers.

The wells on the plains of Boise and Payette valleys range in depth from 20 to 150 feet. From 10 to 14 inches of precipitation fall during the year.

At Notus in 1907, 15 bushels of barley per acre were grown on heavy unfavorable land. Near Weiser 15 to 25 bushels of wheat have been produced. At that place dry land alfalfa yields each year one crop of from three quarters to a ton and a half per acre. The results mentioned were secured on land where there is no moisture except that derived from rain or snow. Much larger yields have been got in this district where there is a subsurface supply of moisture. Watermelons weighing 30 pounds have been grown in Canyon County. About the base of Squaw Butte some very heavy clay soils are being dry farmed successfully.

With an average annual precipitation of 12.95 inches for southern Idaho dry farming should be successful with proper cultivation on all sagebrush land that has a tolerable deep soil.

Idaho contains large areas of timber lands and a considerable portion is mountainous; so that of the 57,000,000 acres comprising the state but 11,000,000 are classed as tillable lands. Irrigation canals, completed or under construction will cover three and a quarter million acres. In the northern or humid portion there are 1,461,000 acres in private ownership or homesteaded of which 592,000 are under cultivation at the present time. In the arid portion the acreage of non-irrigable lands appropriated is 1,613,000 of which 97,000 acres or 6 per cent are under cultivation. There are at least 5,000,000 acres of land in Idaho yet available for dry farming.

PRECIPITATION FOR DRY FARMING.

Of all the factors that figure in the promotion of plant growth water is an important one and more than any other concerns the dry farmer. Since the amount is limited it should be carefully husbanded to do full duty in crop production. Within certain limits yields increase with an increasing supply of moisture, so the amount of the annual precipitation is an important consideration. Yields, however, are not directly proportional, for the other factors vary and affects the results. Soils differ in retentiveness and capacity for storing water. Atmospheric conditions

Distribution of the Precipitation through the Year.

STATION.	November	December	January	February	March	April	May	June	July	August	September	October	Total
Fort Defiance, Ariz.,	0.7	0.7	1.0	1.3	0.9	0.6	1.1	1.0	**1.5**	**2.0**	**1.4**	0.6	12.8
Santa Fe, N. Mex.,	0.7	0.7	0.6	0.7	0.7	0.8	1.2	1.0	**2.8**	**2.4**	**1.5**	1.1	14.2
Amarillo, Tex.,	0.8	0.9	0.6	1.0	0.4	1.7	**3.6**	**3.0**	**3.2**	2.6	2.3	1.8	21.9
Garden City, Kan.,	0.4	0.7	0.4	1.3	1.0	2.3	**2.3**	**3.5**	**3.0**	2.1	1.8	0.8	19.6
North Platte, Nebr.,	0.4	0.5	0.4	0.4	0.8	2.1	**2.8**	**3.2**	**2.6**	2.3	1.4	1.0	17.9
Miles City, Mont.,	0.6	0.4	0.4	0.4	1.2	1.2	**2.1**	**2.2**	**1.3**	1.0	0.9	0.8	12.5
Denver, Colo.,	0.5	0.7	0.5	0.5	0.9	**2.0**	**2.5**	1.4	**1.6**	1.4	0.8	0.9	13.7
Lander, Wyo.,	0.6	0.8	0.4	0.7	**1.6**	**2.6**	**2.1**	1.2	0.8	0.6	1.0	0.1	13.4
Logan, Utah,	1.1	1.1	1.1	1.2	**1.8**	**1.8**	**2.2**	0.6	0.4	0.5	1.1	1.2	14.1
Weston, Ida.,	1.3	0.7	1.0	1.2	**1.7**	**1.7**	**2.1**	0.5	0.5	0.8	0.5	1.2	13.1
American Falls, Ida.,	1.3	1.3	1.2	1.2	**1.8**	**1.4**	**1.5**	0.9	0.5	0.5	0.7	0.9	13.2
Idaho Falls, Ida.,	1.1	1.3	**1.7**	1.4	**2.1**	1.2	**1.4**	1.3	0.5	0.8	0.6	0.8	14.2
Pocatello, Ida.,	0.5	0.9	**2.0**	**1.8**	**2.2**	1.5	1.2	1.1	0.6	0.6	0.9	1.0	14.3
Boise, Ida.,	1.2	**1.7**	**2.3**	1.6	**1.8**	1.1	1.6	0.8	0.2	0.2	0.4	1.3	14.2
Moscow, Ida.,	**3.3**	**2.8**	**2.8**	2.3	2.0	1.4	2.3	1.6	0.7	0.9	1.3	1.6	23.0
Ellensburg, Wash.,	**1.7**	**1.2**	**1.8**	1.2	0.4	0.6	0.6	0.4	0.2	0.2	0.5	0.5	9.3
Pendleton, Ore.,	**1.7**	**1.5**	**1.7**	1.5	1.5	1.2	1.5	0.9	0.4	0.5	0.9	1.2	14.5

The three months with the greatest Precipitation are printed in heavy type.

such as temperature, humidity and wind velocity vary the rate and amount of evaporation from the soil. All these factors have to do with the amount of moisture that will be retained for the use of crops. The precipitation does not determine the yield. It is the amount of available moisture the soil is capable of holding that is the real determining factor. Investigations by the Utah Experiment Station have indicated that an inch of rain stored in the soil is capable of producing 2½ bushels of wheat per acre. The yields very largely depend upon how much of the precipitation can be caught and retained in the soil. A certain amount of loss by evaporation between showers and in summer is unavoidable. Dr. J. A. Widtsoe has stated that from one-half to three-fourths can be conserved. If half is retained then with 12.95 inches, the average normal precipitation in southern Idaho, we should produce 32 bushels of wheat per acre every other year. Results secured by the best farmers in Utah and Idaho indicate that nearly half may do duty in crop production in actual practice, but taking the average yields in certain districts and comparing them with the average annual precipitation of those localities for two years it apears that but one-fourth is actually utilized or that only ⅝ of a bushel of wheat is produced for every inch of precipitation.

To absorb half or more of the moisture that falls requires a tolerably deep soil. To hold 8 inches of rain as available moisture the soil should be 4 feet deep and to take up 12 inches six feet or more.

DISTRIBUTION OF PRECIPITATION.

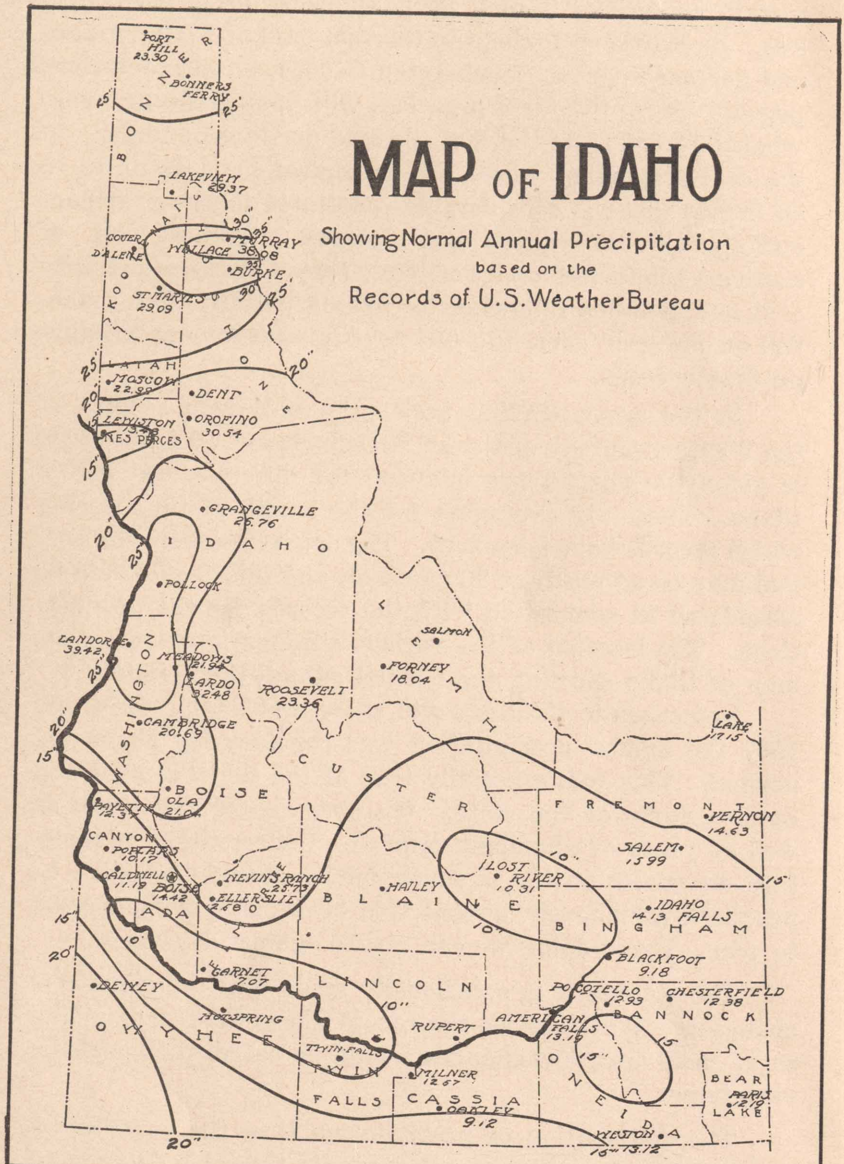
The distribution in the intermountain region and east of the Rocky Mountains is quite different as the accompanying table shows. In the Great Plains region the season of greatest precipitation is in June and July; in the intermountain region during the winter and early spring. In the Columbia Basin and northern Idaho it is from November to January; in central and southwestern Idaho during

December, January, and March and in southeastern Idaho and in Utah during March, April and May. From June to August we have very little rain or scarcely any. We find that dry farming is successful under these different conditions—both where 5 to 8 inches falls during the growing season as in the Great Plains and where there is only 1½ to 4 inches as in the intermountain region.

Experiments at the North Dakota station have shown that water stored in the soil before growth begins in spring is of more value for crop production than an equal amount falling during the growing season. It is difficult to make use of rain that falls in summer. If showers are heavy some water may go deep in the ground, yet evaporation at the surface disposes of a large part of it. Small showers which simply wet down to moist soil may occasion a loss from the deeper soil which otherwise would not have taken place for by restoring capillarity moisture rises to the surface and escapes. Summer rains, at least with us, have a low crop producing value and if light are of no benefit and may even be injurious. Since they destroy the dust mulch they are a detriment to the conservation of moisture on the summer fallow. In Idaho where the rainfall during the growing season is so light we must very largely depend upon moisture stored during the winter and early spring to nourish the crops. In bulletin No. 100 of the Utah Experiment Station it is stated that "from data so far collected . . . . . it would seem that it is almost necessary to have at least 4 inches of the annual precipitation during the growing period." There are, however, districts in eastern Oregon where normally but 1½ to 2 inches of rain falls from April to July inclusive. Tho spring and early summer rains are of undoubted benefit tolerably good crops may be grown where they do not occur provided there is an abundant supply of moisture stored in the soil.

THE PRECIPITATION IN IDAHO.

In a general way it may be said that when there is 18 inches or more a crop may be grown every year and under


MAP OF IDAHO
Showing Normal Annual Precipitation
based on the
Records of U.S. Weather Bureau
PORT HILL 23.30
BONNERS FERRY
BONNER
LAKEVIEW 29.37
KOOTENAI
MURRAY 38.08
WALLACE
BURKE
COUER D'ALENE
ST MARIES 29.09
SHOSHONE
LATAH
MOSCOW 22.98
DENT
NEZ PERCES
LEWISTON
OROFINO 30.54
GRANGEVILLE 26.76
IDAHO
POLLOCK
LANDORE 39.42
WASHINGTON
MEADOWS 21.94
ZARDO 32.48
ROOSEVELT 23.36
SALMON
FORNEY 18.04
LEMHI
CAMBRIDGE 20.69
BOISE
OLA 21.04
PAYETTE 12.37
CANYON
POPLARS 10.17
CALDWELL 11.19
BOISE 14.42
NEVINS RANCH 25.73
ELLERSLIE 26.80
ADA
CUSTER
BLAINE
HAILEY
LOST RIVER 10.31
LAKE 17.15
FREMONT
VERNON 14.63
SALEM 15.99
IDAHO FALLS 14.13
BINGHAM
BLACKFOOT 9.18
GARNET 7.07
DEWEY
OWYHEE
HOTSPRING
LINCOLN
RUPERT
TWIN FALLS
TWIN FALLS
MILNER 12.67
CASSIA
OAKLEY 9.12
AMERICAN FALLS 13.19
POCATELLO 12.93
CHESTERFIELD 12.38
BANNOCK
ONEIDA
WESTON 13.12
BEAR LAKE
PARIS 12.19

certain conditions it may be possible to do so even with less. In Northern Idaho, the western part of Idaho County and northern part of Washington County, humid conditions prevail. Here the farm practices will necessarily be somewhat different from those of the arid portions of Idaho. In the central portion where the precipitation is from 15 to 20 inches there is considerable successful farming without irrigation in the valleys and plateaux. Almost all of southern Idaho and a part of Nez Perces County are strictly arid and summer fallowing to carry a portion of the rainfall of one year over into the next is necessary to produce profitable crops.

In the accompanying table prepared from reports of the Weather Bureau of the U. S. Department of Agriculture is given the normal precipitation for different stations in Idaho. These are averagese for the length of time during which records have been kept. The departure from the normal may be as much as 30 per cent, and this fact should be considered in connection with the records for the new stations. The location of the various stations is given on the map of Idaho showing the normal annual precipitation.*

Reference to the table will show that during 1906 and 1907 the annual precipitation was considerably above the normal. This was especially true of the south central and eastern parts of the state. We may expect dry years as well as years of abundant rainfall. Conservation of moisture especially on the summer fallow should therefore be practiced assiduously irrespective of variations from year to year. By so doing we can insure against dry years.

The statement is occasionally made that the climate is changing. We have no records to show that such is the case. Any apparent changes should be ascribed to periodic variations.

The distribution of precipitation thru the year varies somewhat even in Idaho as is shown in the table on page 10

*This map was prepared by C. A. Donnel for the State Board of Horticultural Inspection. The figures have been added by the author.

Precipitation in Idaho, prepared from Reports of the U. S. Weather Bureau.

STATION	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Number of Years of Observation	Annual Precipitation		
															1905	1905	1906
Northern Section:																	
Dent	4.20	2.58	2.36	1.32	2.64	1.68	.62	1.50	.88	1.62	4.49	3.68	27.57	2		32.86	27.28
Kellogg	3.36	3.11	2.49	1.31	3.53	2.52	.44	1.24	1.42	2.91	3.72	3.40	29.45	3		31.92	25.75
Lakeview	3.38	2.94	2.63	1.63	2.79	2.15	1.16	1.05	1.85	2.08	4.13	3.58	29.37	11	28.38	27.60	30.00
Lewiston	1.14	1.16	1.14	1.01	1.87	1.20	.42	.37	.65	1.20	1.32	1.52	13.48	14	14.28	14.43	14.43
Moscow	2.84	2.30	2.00	1.37	2.31	1.60	.69	.90	1.30	1.63	3.29	2.76	22.99	15	19.77	26.93	23.90
Murray	4.62	3.57	3.56	2.21	3.24	2.74	1.43	1.44	2.31	2.63	5.89	4.44	38.08	14	26.75	34.62	31.75
Orofino	4.02	3.48	4.40	1.50	1.64	2.53	.54	.78	1.29	1.35	3.79	5.22	30.54	4			25.09
Porthill	3.08	2.08	1.47	.83	2.37	1.58	1.02	1.06	1.89	1.92	3.53	2.47	23.30	15	18.16	19.39	24.87
St. Maries	3.41	2.54	2.81	1.79	2.57	1.92	1.07	1.04	1.53	2.24	4.56	3.61	29.09	11	28.57	28.82	24.17
Central Section:																	
Cambridge	3.38	2.21	2.70	1.33	1.65	.80	.31	.53	.59	1.20	2.36	3.63	20.69	12	12.96	22.33	20.94
Forney	1.67	1.99	2.08	1.24	1.87	1.96	.95	.68	.76	1.02	1.91	1.91	18.04	11	14.45	21.03	24.10
Grangeville	2.20	1.45	3.26	2.57	3.38	3.47	1.40	.74	2.09	2.38	2.19	1.63	26.76	9	28.02		
Lake	2.61	1.72	2.61	1.13	1.37	1.23	.60	.71	.83	.98	1.26	2.10	17.15	15		21.89	21.67
Landore	5.68	3.99	5.44	2.41	3.78	2.77	1.00	.70	1.21	2.75	3.84	5.85	39.42	4	27.28	46.57	46.54
Lardo	5.69	3.57	4.78	1.28	2.52	3.35	.52	.47	.42	1.69	2.87	5.32	32.48	3		32.52	35.27
Meadows	2.85	2.61	2.76	1.26	1.67	2.19	.75	.57	.86	1.64	2.47	2.31	21.94	5		21.97	19.91
Ola	2.72	2.56	2.92	1.49	1.65	.58	.44	.50	.68	1.94	2.76	2.80	21.04	12	13.84		
Payette	1.49	1.61	1.48	.93	1.20	.69	.38	.28	.46	.85	1.25	1.48	12.37	15	8.86		9.95
Rosevelt	2.34	2.17	3.44	1.42	2.22	1.51	1.21	.46	.58	1.16	2.46	3.39	23.36	5	16.93	25.86	
Salmon	.89	.72	.88	.59	.89	2.10	1.27	.74	.18	.50	.89	.64	10.39	2		9.99	11.89
Vernon	1.62	1.57	1.97	1.22	1.70	1.26	.69	.47	.69	.94	.98	1.72	14.63	11		22.24	18.05
Southern Section:																	
American Falls	1.18	1.22	1.81	1.40	1.48	.87	.56	.48	.67	.89	1.27	1.36	13.19	15	10.48	16.66	20.48
Blackfoot	.70	.78	1.08	.85	1.30	.55	.47	.70	.33	.91	.67	.83	9.18	12	8.42	14.81	13.07
Boise	2.31	1.60	1.82	1.15	1.63	.81	.18	.18	.41	1.28	1.24	1.72	14.42	22	9.77	14.19	15.92
Buhl	.97	1.61	1.29	1.42	.47	3.18	.20	.34	.74	.46	.49	1.76	14.65	1			14.65
Caldwell	1.53	1.53	1.90	.81	1.44	.99	.10	.28	.25	.30	.56	1.50	11.19	3	10.35	13.24	10.30
Chesterfield	1.22	.95	1.70	1.10	1.81	.86	.47	1.05	.38	.82	.80	1.22	12.38	11	10.68	21.05	14.95
Ellerslie	1.48	1.11	1.98	.89	1.24	1.36	.30	.31	.26	.84	.80	2.01	12.58	3	7.38	14.75	16.03
Emmett	1.34	1.68	3.11	.56	.08	1.43	.51	.11	.07	.39	.88	2.66	13.59	1			13.59
Garnet	.71	.97	1.08	.73	.62	.65	.02	.11	.21	.75	.51	.71	7.07	8	3.87	8.20	12.35
Hotsprings	.95	1.50	1.69	.86	.44	2.01	.18	.50	.35	.58	.36	1.58	10.50	2		9.38	11.60
Idaho Falls	1.67	1.38	2.14	1.18	1.46	1.33	.54	.79	.59	.86	1.14	1.32	14.13	13	11.99	14.38	18.43
Lost River	1.12	.46	1.26	.62	1.40	1.99	.59	.42	.43	.54	.75	.73	10.31	13	10.31	15.74	11.40
Milner	.78	1.72	1.98	1.30	1.73	1.66	.05	.30	.34	.40	.79	1.52	12.57	4		13.87	20.71
Mountainhome	2.55	1.66	1.70	.92	.80	1.22	.32	.41	.26	.62	.64	1.84	15.09	2			15.09
Murtaugh	1.57	3.16	4.23	1.65	.73	3.33	.00	.75	.81	.48	.72	1.71	19.39	1			19.39
Nevins Ranch	3.20	5.40	3.50	1.47	1.97	1.54	.58	.43	.29	1.02	1.22	4.50	25.73	3			25.73
Oakley	.75	.70	1.21	1.02	.89	.77	.40	.63	.72	.75	.72	.56	9.12	15		13.65	16.53
Paris	1.14	.90	1.64	1.42	1.42	.58	.64	.70	.23	.81	1.00	2.13	12.19	13	12.90	17.84	
Pocatello	2.04	1.85	2.20	1.51	1.17	1.09	.63	.56	.88	.98	.55	.86	14.32	8	10.26	18.17	17.43
Poplars	1.26	1.25	1.77	.62	1.04	.56	.17	.26	.30	.76	.88	1.30	10.17	7	8.14	13.23	10.32
Rupert	.94	2.29	5.45	1.84	.77	2.40	.26	.62	.96	.83	.65	1.92	19.62	1			19.62
Salem	1.68	.79	2.67	1.46	2.49	1.56	.94	.73	.68	.69	.90	1.40	15.99	3		17.04	16.38
Standrod	1.48	1.66	2.92	1.66	2.74	1.56	.55	1.25	1.22	.78	1.54	.99	18.35	2		18.42	19.70
Twin Falls	1.18	2.00	3.40	.60	1.26	2.58	.12	.26	.32	.42	.60	1.57	14.31	2		11.71	18.35
Weston	.98	1.16	1.65	1.70	2.09	.52	.50	.75	.53	1.19	1.33	.72	13.12	10	12.66		
Average Northern Section	3.06	2.39	2.75	1.94	2.53	.99	1.03	.82	1.45	2.06	4.24	3.44	27.70		25.59	28.15	26.46
Average Central Section	2.87	2.19	2.95	1.43	1.76	1.42	1.03	.64	.85	1.26	2.07	3.14	21.59		16.54	24.14	23.46
Average Southern Section	1.48	1.80	1.78	1.22	1.36	.98	.47	.12	.53	.88	1.04	1.29	12.95		10.37	16.15	16.78
General Average	2.02	2.01	2.39	1.45	1.74	1.29	.70	.39	.80	1.27	2.12	2.24	18.42		15.68	20.69	20.47

It has been already noted that in the foothill districts more moisture than that derived from the clouds is often available to crops, this additional supply having its source in the water table underlying the land. Under such conditions uncultivated land may become dry a foot or two deep or even more, while if cultivated and a mulch maintained will remain moist to within a few inches of the surface irrespective of rainfall.

In the plains regions the water table rarely approaches near enough to the surface to be a source of benefit to crops. In many districts the soil in spring is moist to a depth of 18 inches or 2 or 3 feet. Below that the soil or whatever formations occur are always dry—in some instances as deep as a hundred feet or more. In the fall before the first rains all the moisture which percolated into the ground the previous winter and spring has generally been lost by surface evaporation. By fitting the soil in such districts to take up more water and harrowing to retain it, it is possible to accumulate moisture in the soil to a much greater depth, 4 to 6 feet or more, provided the soil is that deep. Under natural conditions, an amount of annual precipitation sufficient to moisten the soil 4 to 5 feet deep may not penetrate more than one-third that depth. This is because of runoff on uncultivated ground and because the moisture remains near the surface rather than percolating deeply into the soil. Evaporation thus disposes of much water between showers. Where the yearly precipitation is no more than 10 or 12 inches, the entire amount stored is generally used by a crop of grain leaving the soil quite dry at harvest. There are, however, soils in southern Idaho where uncultivated land does not dry out completely during summer even tho the underground waters are too deep down to moisten the subsoil. Such soils when brought under cultivation are not always exhausted of all the capillary water by crops.

SOILS FOR DRY FARMING.

Dry farming has been successful on various types of soil, both light and heavy. Sandy soils are more easily handled, make a better surface mulch and do not puddle as readily as clays or clay loams. Their capacity for holding moisture is much smaller than that of heavy soils yet they give up to crops quite as much water. Crops may reduce the moisture contents in a sandy soil from 18 to 4 per cent of the dry weight; in a heavy soil from 26 to 11 per cent. Light soils have not as strong capillarity as the heavy types. In a very fine soil capillary attraction may raise water from a depth of 6 feet or more while in a sandy soil moisture may not rise more than a foot or two, the distance depending upon the degree of fineness. Soils may be so porous as to allow water to percolate thru them and be lost by under drainage which would be a disadvantage. Heavy soils are somewhat difficult to handle. They can not be worked when at all wet and must be taken when just right. As a general thing the heavier soils are the more productive. Sandy soils are warmer and quicker and lend themselvess more readily to cultivation to conserve moisture.

It is quite necessary for successful dry farming that the soil be tolerable deep in order that sufficient moisture to produce profitable crops may be absorbed. The average soil in southern Idaho will retain about 3 inches of water in each foot of soil. Not more than 2 inches of this is released by the soil. Hence, to absorb 12 inches of precipitation at least 6 feet of soil would be required. Depth rather than the kind of soil is the important consideration. In so far as depth of soil has to do with production data so far obtained indicates that within reasonable limits 5 bushels of wheat should be produced for every foot of depth. While the outlook for dry farming on shallow soils does not seem to be good in the light of our present knowledge yet we would not assert that certain ones will not produce paying crops.

CONDITIONS OF WATER IN THE SOIL.

Water may occur in the soil in three different condition as regards its relation to the particles of soil and the roots of crops. The three forms are hygroscopic, capillary and gravitational.

Hygroscopic water is that which is found within the soil particles themselves. What we generally term "dry soil" contains from 3 to 6½ per cent of water. Under field conditions hygroscopic water is not evaporated. It requires artificial heat to thoroly dry a sample of soil. The roots of crops cannot take it up and plants wilt when there is hygroscopic water only in the soil.

Capillary water occurs as thin films over the surface of the soil grains and soils hold it against the force of gravity. This is the form of water that crops use and which furnishes the moisture condition of the soil most congenial to the growth of crops. It does not completely fill the pores and interstices among the soil grains. A part of the interstical space is occupied by air which is necessary for the breathing of roots of our ordinary crops.

The third form of water is the gravitational or that which may fill the soil to the exclusion of air and which percolates downward by the force of gravity. It is also called hydrostatic water or water of saturation. Roots need air as well as water. Plants do not thrive in a soil that is saturated and roots will not enter any part of the soil that is full of water. No soil nor any part of it that is saturated serves as a feeding area for our field crops. Land that is dry farmed usually contains no gravitational water. After a heavy rain, however, water may be present in this state in the surface soil. If the soil has sufficient depth and is of suitable texture the gravitational water percolates downward until disposed of as capillary water. If there is more than can be held as such the access joins the water table. It may accumulate above an impervious formation. Any that reaches a porous sand or gravel may be entirely lost unless that stratum is water bearing thruout. Gravitational water in arid climates is thus merely a transient condition unless supplied by seepage. Where the water table is near the surface the feeding area of the roots is limited to whatever depth of soil there is above it. The ground water may supply capillary moisture to the soil above. A water table within 6 to 8 feet of the surface with a soil having strong capillarity is for some crops at least as good as a water right. There are instances of land in Idaho so well supplied with moisture from below that irrigation is of no benefit. It is in the foothills that this condition is often found. On the open plains there is rarely a water table. Most of the arid land in southern Idaho has soil sufficiently deep and of such texture that it can dispose of all the rain that enters it and hold it as capillary water. Cultivation has a great deal to do with the amount that will percolate into the soil.

CAPILLARY ATTRACTION.

The translocation of capillary water in the soil is a slow creeping movement over the soil grains. It acts in any direction, upwards, downwards or laterally. It is this same force that draws water into a piece of lump sugar when it is brought in contact with water. It is the force that pulls the oil upward thru a lamp wick. The direction of the movement is always from the wet to the dryer part of the soil. During drying weather when surface evaporation is active the movement is upward. After a rain it comes into play to a greater or lesser degree in carrying water down into the soil. The movement may be toward the roots where moisture has been withdrawn. It is slowest where the soil grains are very small and the pores minute as in clay. It is more rapid in loams and sandy loams which have larger particles of soil. The movement is uninterrupted as long as the soil is uniformly firm and continuous. Air spaces, dry soil and impervious formations check the movement. Capillary moisture enters dry soil very slowly even tho it is firm. Dry, loose soil containing good deal of air is almost a complete check, hence the value of a dust mulch over fields as a means of conserving moisture. Capillarity is very slow where the particles of soil are dry and do not lie close together. Since water attracts water the soil if moist but not wet appears to hold on to the capillary water with tenacity, very little or scarcely any passing into the loose mulch above. Any condition of the bottom of the furrow slice such as the presence of clods with air spaces disfavors good capillary movement. It is important that moisture from rain may pass into the soil readily and that there be strong capillarity to bring moisture from the deeper soil to the roots that are nearer to the surface.

The amount of capillary water that any soil may hold depends upon its fineness or size of the soil grains. The smaller they are the greater is the number in any unit volume of soil and the greater is the aggregate surface that may be covered with films of water; hence heavy soil such as clay can hold much more water than lighter soils. Prof. F. H. King found that a clay soil 32 hours after a rain of 3.19 inches contained 26.57 pounds of water in one cubic foot, while a sandy loam contained but 18 pounds. Tho the heavier soils may have much more water the lighter ones yield their water more readily. Prof. King found that a crop of corn reduced the moisture contents in a clay soil from 26 to 11.79 per cent.; in a sandy soil from 18 to 4.17 per cent. The sandy soil yielded 13.83 pounds while the clay only 12.5 pounds.

The surface soil in the Snake River plains in Idaho will hold as capillary water 18.65 pounds of water in a cubic foot of soil or 22.46 per cent. of the dry weight. That is equal to 3.58 inches of rain.

CONSERVATION OF MOISTURE.

On uncultivated land in arid regions there is generally no accumulation of moisture. All the moisture which enters the ground during the season of greatest rainfall is usually lost from the soil by evaporation during the dry season or summer. There is considerable run off and the moisture that is absorbed is held near the surface where it is disposed of by evaporation. These are the usual conditions on average soils, there being some variations according as soils differ.

By means of proper methods of cultivation we can secure a greater depth of percolation and also prevent to a large extent the usual losses at the surface. We have observed that soils over which a surface mulch had been maintained during summer were moist 3 feet deep or more while adjacent ground not touched contained no moisture. By suitable methods of cultivation we can store in the soil half or more of the precipitation while if no particular pains are taken to conserve it all or nearly all may be lost.

The writer found that a certain deep clay loam soil in southern Idaho had become moist to the depth of only 18 inches during winter. When tested in April it contained 4.85 inches of water in the first 3 feet of soil. In the latter part of August it contained but 2.32 inches. The railfall during the period was 4.53 inches, thus making a total of 7.06 inches evaporated in three months. The soil was entirely dry in August and the 2.32 inches it did contain was hygroscopic moisture. The tests were made on unbroken ground.

On the summer fallow plats on the Auxiliary Experiment Station which had been disked and harrowed early in the season the moisture contents in June after the land had been plowed and a dry mulch established was 7.03 inches in three feet of soil. Late in September the contents were 6.55 inches showing a loss of only .48 inches.

The moisture contents on the new land plowed in spring and cropped during the season of 1907 were as follows:

	Planting time.		**Harvest time.**		**Difference.**	
	Per cent.	Inches	Per cent.	Inches	Per cent.	Inches
First foot	16.63	2.65	5.98	.95	10.65	1.70
Second foot	19.20	3.06	10.88	1.73	8.32	1.33
Third "	17.04	2.72	13.17	2.10	3.87	.62
Total inches		8.43		4.78		3.65

The soil on which these tests were made was 2 to 3 feet deep. In a more permeable soil more moisture would have been given up to the crop and there probably would have been more moisture in the ground at planting time which was in April.

The efficiency of cultivation to conserve moisture has been abundantly attested by the results secured by dry farmers. The office of cultivation is to open up the soil to receive moisture and to close it against evaporation. In Idaho the greater part of the precipitation comes in winter, hence to catch snow and rain fields should not go into winter smooth but more or less rough. If the ground is in a smooth condition in the fall is should be disked. Fall plowing leaves the land in good shape to absorb moisture. Land with clay soil which is likely to run together should be left as rough as possible. Unless the slope is considerable there is generally no runoff on cultivated land. If the plow furrows run lengthwise of slopes there will be less than if they run up and down. When the ground is frozen water from melting snow cannot enter the ground, so there may be some evaporation and possibly runoff which would otherwise not have taken place. Land that lies rough does not freeze as hard as that which lies smooth. It, also, thaws out quicker. In early winter and early spring moisture can enter the ground for it is not then frozen continuously. In the lower altitudes the ground is frozen only at times during the winter. Tho evaporation is small in winter, yet with clear weather, the ground bare, occasional winds and alternate freezing and thawing the soil often dries out even in February in those localities.

Capillary attraction as we have noted conveys water from grain to grain of soil and moisture thus climbs to the surface to escape into the atmosphere. This continues in a compact soil as long as the surface is wet or moist. Under arid conditions evaporation disposes of water at the surface faster than capillarity can supply it, hence on uncultivated ground the soil dries out quickly at the surface and may dry out a foot or more. After that the loss is small or even insignificent, at least in some of our soils, for capillary water does not enter dry soil readily and the subsoil holds on to the moisture it contains. The surface soil, once dry, thus acts as a mulch even tho it is firm. By stirring the surface and causing it to dry out quickly we establish at once a mulch which prevents the loss that otherwise would have taken place. This surface cultivation needs to be repeated after each rain of any consequence. With a good mulch over the surface the moisture is held well up in the soil. That is important for the elaboration of plant food is constantly going on in a moist, warm soil while in a dry one such changes are not taking place. On the summer fallow therefore moisture should, if possible, be kept within a few inches of the surface in order that the benefits to be derived from chemical and bacterial activities may be realized. This can be done by means of cultivation but not very effectively unless the soil is quite firm beneath the mulch. There may be an abundance of moisture deep in the soil but if the preparation is poor and the capillary connection not good moisture cannot move up fast enough to meet the needs of the crop. The surface mulch serves the twofold purpose of conserving moisture and of promoting fertility.

Plowing itself prevents loss of moisture from the subsoil as the soil stirred acts as a mulch. However, if there is no further cultivation the soil usually dries out as deep as plowed.

Cultivation of summer fallowed land should not be so expensive in Idaho as in regions of considerable summer rainfall. We usually do not have sufficient rain for weeks or even two or three months to settle the mulch. Whether or not it will pay to harrow occasionally, nevertheless, we are not in a position to say. Test made on the Experiment Farm near Caldwell indicated that the amount saved by frequent stirring of a lose dry mulch was a negligable quantity. Some of our successful farmers, however, make a practice of harrowing tho no rain occurs.

THE SUMMER FALLOW.

To grow profitable crops with a limited amount of rainfall summer fallowing is necessary. It may be every other year or every third year. It is primarily to store up moisture in the soil, that is carrying one year's precipitation over into the next. The matter of fertility is a secondary consideration and while added fertility is one of the benefits resulting from the summer fallowing it cannot be secured independently of the conservation of moisture. In fact whether or not there is any added fertility depends upon keping the soil moist.

It is not certain that summer fallowing will prove the most profitable under all conditions. Where the annual precipitation ranges from 15 to 18 inches every year cropping may be as profitable if suitable rotations are practiced. Where it is less than that and where there is no ground water as a reserve to be drawn upon we would recommend alternate year summer fallowing as the more certain and remunerative practice.

In southeastern Idaho and in the Great Basin fall plowing as against spring plowing has given the best results. Some farmers in Utah have practiced it for over 20 years and it is recommended by the leading authorities on dry farming in that state. The land there is plowed dry at any time after the crop is removed, from August to November, and left rough over winter. The weathering disintegrates the lumps of soil and if taken just right in spring will work down in a satisfactory manner. Thru the summer the fields are harrowed to maintain a mulch over the surface.

In the Columbia Basin spring plowing on the other land is almost a universal practice. The following method of managing the summer fallow has given the best results. Early in the spring the land is disked and then a smoothing harrow is used. This early cultivation conserves moisture and kills weeds. The land plows easier after the disking and by cutting up the stubble the straw is more completely covered. With the disk they get over the fields quicker than could be done with the plow and there is thus a gain in moisture saved. From 4 to 6 weeks later the land is plowed and then harrowed. Enough subsequent surface cultivation is given to preserve a mulch and keep down weeds. In connection with the plowing some farmers use the subsurface packer to firm the lower part of the furrow slice. This has the effect of preventing the soil stirred by the plow from drying out as completely as it does otherwise. Some disk in the fall the fields intended for spring crops.

Practices thus differ as to the time of plowing land to be summer fallowed. The results as shown by yields in comparative tests must determine the practice for various soil and climatic conditions. Experimental data are needed to throw some light on this point.

With fall powing there is more complete weathering of the soil and no packing is required. Utah farmers assert that more moisture is conserved with fall plowing but that might not be true under all conditions. It appears that the texture of some soils are seriously impaired by dry plowing.

Spring plowing appeals to many because the soil will at some time or other in spring crumble and work down in an ideal way. Where spring plowing is practiced it is advisable to disk in the fall.

Disking as soon as the crop is removed is a good practice. Usually there is no moisture to be conserved, but the disking is beneficial nevertheless. If the land is to be plowed in spring the soil is put in better shape to catch moisture from rain and snow. Furthermore, fall plowing, if that is the practice, will be easier and more satisfactory.

WEEDS.

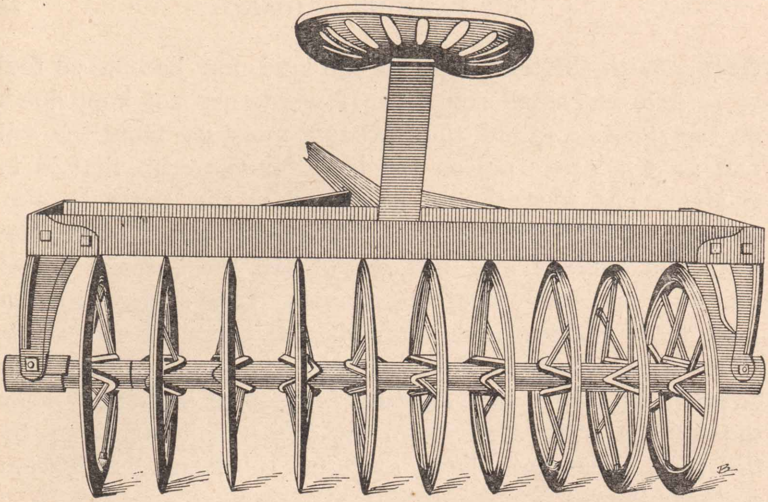
While many harrow the summer fallow with the avowed purpose of conserving moisture, yet such cultivation has generally in the first place been forced upon them by the necessity of eradicating weeds and keeping the land clean. With shiftless methods the land may become so foul as to give but small returns. If weeds are not kept down on the summer fallow they exhaust moisture from the soil and in a measure poison the land for the crop that is to follow. The idea should be to allow the seeds to germinate and then kill the weeds. The seeds sprout only when near the surface and the weeds are most easily killed just as they come out of the ground. Late spring plowing with early disking and harrowing disposes of the weeds effectively in eastern Washington. The early surface cultivation kills the weeds starting from seeds which are near the surface. The seeds from the deeper soil turned up by the plow germinate later and the subsequnt cultivation destroys them.

For killing weeds tools that cut and turn the soil are the most effective. In the Columbia Basin a home-made implement called a "slicker" and other more expensive tools as well are used to cut the weeds. Some farmers in Utah use a gang disk plow and run it shallow to kill weeds.

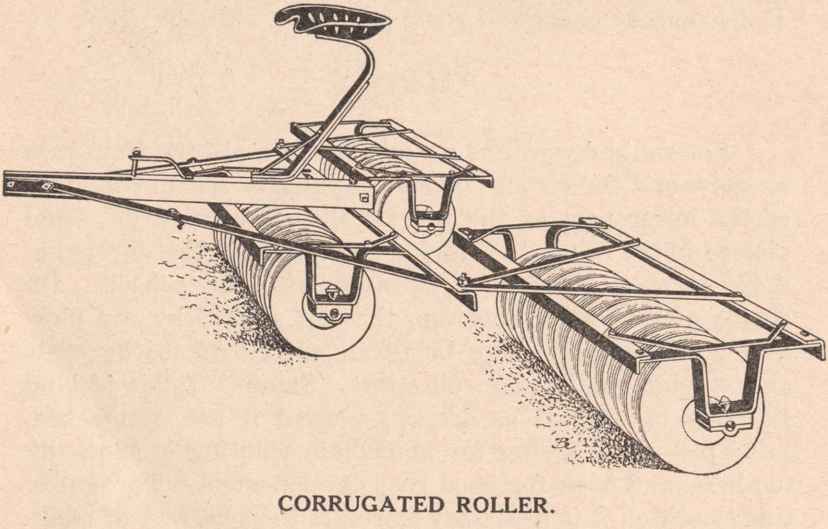
Leaving the summer fallow rough is a poor practice as weeds are permitted to flourish and do injury to the land. Not only that but there being no cultivation many seeds do not sprout and these come up along with the crop.

PACKING.

For rapid downward percolation of moisture from rain or snow and for strong upward capillarity a firm condition of the lower part of the furrow slice is necessary. Land plowed in the fall settles during the winter so that by spring there is good capillary connection with the subsoil. On spring-plowed land, however, the soil stirred by the plow is not firm enough there being air spaces caused by clods and stubble holding the soil apart. Summer fallowed land is likely to dry out as deep as plowed if not compacked. Land plowed in spring for immediate planting is generally too loose and open for good root developement. To remedy this condition it is necessary to resort to some way of pack-



SUBSURFACE PACKER.



CORRUGATED ROLLER.

ing the soil. The subsurface packer and the corrugated roller are both used for this purpose.

The subsurface packer was invented by H. W. Campbell of Nebraska and it is now largely used east of the Rocky Mountains. It has a series of wheels with wedge-shaped rims set on a shaft, each moving independently. The rims sink down 4 or 5 inches in the soil and close up the air spaces and make the soil firm, yet at the same time not packing the surface but leaving it loose. In the roller mentioned the corrugations are quite sharp and wedge-shaped. In the absence of either of these tools the disk harrow weighted down and the disks set straight may be used to firm the soil.

On land plowed in spring for the summer fallow the packer should follow the plow. The packing has the effect of holding the moisture nearer the surface and of preventing the lower part of the furrow slice from drying out. In connection with spring plowing for spring crops the corrugated roller may be used immediately after the drilling of the grain or the subsurface packer and used just after the plowing. This firming of the soil is a great advantage to the crop as the root developement is stronger, germination quicker and moisture can be brought up by capillarity in larger amounts. The packing will be most effective when the soil is just moist enough to handle well. It should not be done when the soil is wet as it may then puddle it.

Packing in connection with spring plowing at least on our lighter soils should be beneficial. Where the subsurface packer has been tried in the Columbia Basin the yields of wheat have been increased 25 per cent. The corrugated roller is being used with marked benefit in Sherman County, Oregon. East of the Rocky Mountains more than 1000 subsurface packers are in use. There spring plowing is advocated and the packer follows the plow on the land summer fallowed. The season of greatest rainfall there is in June and July and the plowing and packing fits the soil to catch this summer rainfall.

EVERY YEAR CROPPING.

Where crops may be grown every year fall plowing is to be preferred to spring plowing. It admits of more weathering of the soil; a firmer seed bed is secured, and the stubble plowed under will have a better chance to decay. Furthermore, the crop can be planted early in spring so as to make its early growth while moisture is abundant and cover the ground by the time drying weather sets in. Fall plowing nearly always gives better yields. With spring plowing packing of the soil is quite necessary as otherwise the soil is too loose for best results.

FERTILITY AND CROP ROTATION.

Analyses of the soils of Idaho show that they contain all the essential mineral elements in sufficient amounts. but that they are deficient in nitrogen and humus. To keep up the supply of organic matter which is the source of humus should be our chief concern. With an abundant supply of humus soil bacteria will thrive, and as a result of the changes they bring about there will at least in some soils with proper cultivation be sufficient nitrogen for the needs of crops. Stubble plowed under tends to replenish the supply of humus. This would especially be true where heading is practiced. The weathering that soils undergo with dry farming methods renders an abundance of mineral foods available. In Cache valley, Utah, the land is as productive to-day as it was 35 years ago. The fact that the wheat is headed and the straw plowed under no doubt has a great deal to do with the continued productivity of the land there. In parts of the Columbia Basin wheat land has maintained its fertility for 20 years or more and it is the firm belief there that it will continue to do so indefinitely. In the Red River valley of the North the land wears out in 15 years. In the Willamette valley wheat lands after 50 years of continuous wheat growing have ceased to be productive. In the Sacramento valley of California yields have steadily declined in the course of 50 years wheat growing under the summer fallow system. While the productiveness of the land has been maintained under a single crop system for 20 years or more in some localities, there should not be too much dependence on its permanency.

Continuous wheat growing is not a good system where crops can be grown every year. Wherever that is possible growing a cultivated crop such as corn or potatoes alternate years has been found vastly more profitable than a single-crop system as the fertility of the land is kept up better and the weeds are controlled. Some legume or nitrogen-gathering crop should enter into the rotation and be grown at certain intervals.

In the foothill districts, where the farms generally are small and where an underground supply of moisture often exists, there is no need of pursuing a single crop system. Diversified farming and crop rotation combined with some phase of animal husbandry should give larger returns. Growing wheat only, even on large farms, is a questionable practice, and is not necessary where one cutting of alfalfa per year can be secured and that is possible where good yields of wheat are produced. Alfalfa may be used in rotation with wheat and the land kept in alfalfa three years to as many as desired. With such rotation the fertility of the land will be maintained and the yields of wheat materially increased.

We have scarcely begun to prospect the possibilities of diversified dry farming, yet enough has been done by farmers here and there in testing different kinds of crops to indicate what may be done. Already there is a movement among dry farmers in Utah and elsewhere to combine stock raising with dry farming. Alfalfa and field pease can be grown anywhere in southern Idaho and in certain localities brome-grass and other grasses. Corn, Dwarf Milo and certain non-saccharine sorghums will succeed in the lower altitudes. With a variety of forage, such as it is possible to grow at least under the more favorable conditions, dairying can be carried on profitably. Wheat may be sown in fields separately fenced and used for pasturing in rotation. Field pease may be grown in connection with sheep raising and the sheep allowed to harvest the crop. Growing alfalfa for seed has proven a profitable industry in some localities in Idaho and Utah. Under dry farming moisture conditions are often very favorable for the production of good seed while under canals especial care in handling the crop is necessary. In suitable soils growing early potatoes could be developed into a profitable industry. Dry land potatoes always are of the best quality, so with some co-operation among farmers it should be possible to establish a special market.

DROUGHT-RESISTANCE.

There is a tendency of plants to adapt themselves to the climatic and soil conditions under which they grow. The native vegetation of arid regions have acquired certain characteristics and habits by reason of which they are able to flourish with a scant supply of moisture. The structure of the surface of the leaves and stems is such that they do not transpire as freely as plants growing in humid climates. The most striking characteristics, however, is deep rooting which enables them to draw moisture from a large area of soil and this is the main cause of their remarkable drought-resistance. The deep rooting is made possible by the greater permeability of western soils. Our subsoil is not as raw and unproductive as in humid climates. There are of course exceptions such as shallow heavy soils. For the feeding area of the roots to be limited by ground water near the surface is the exception with us.

It requires many years for crops from humid climates to adapt themselves to arid conditions, hence we should take advantage of any strain or variety which has already acquired drought-resisting qualities. Home grown seed should always be given the preference. We now have varieties of wheat grown in the intermountain region for 25 years or more and these are thoroly acclimated.

While our home grown varieties are good they are often displaced by valuable acquisitions from abroad. Many recent introductions have been grown in arid regions for centuries and the drought-resisting habit thoroly fixed. Such varieties are Kubanka and Turkey Red wheat and brome grass.

For dry farming use seed grown on dry land; never seed from humid climates or grown with irrigation. Early maturity is an advantage and that characteristic should be sought for in dry land crops. In seeding wheat or other cereals on dry land only half as much seed should be used as in humid climates or on irrigated land.

WHEAT.

It is generally conceded that winter wheat yields better than spring wheat. Usually there is a difference of from 4 to 5 bushels per acre.

On suitable soils it is possible to keep moisture near enough to the surface on the summer fallow to germinate wheat in the fall tho there be no rain. That has been done in localities where there is only 12 inches of annual precipitation. Failure to get a good stand is often due to inattention to the conservation of moisture. In some districts farmers sow wheat in dry soil and depend upon fall rains to bring it up. This is a successful practice in certain parts of eastern Oregon where fall rains do not fail. Not everywhere in southern Idaho does sufficient moisture come to ensure a stand in the fall, hence the importance of conserving moisture on the summer fallow. If the wheat does not sprout in the fall the crop for the next year is uncertain. If it does not come up until spring the yields are usually no better than on spring seeding.

The time to sow winter wheat is in September—early enough so it may stool before going into winter. If there is not moisture to bring it up early fall seeding is of no advantage. Should the seed lie too long in the ground before it germinates, there is a possibility of it becoming infested with smut even tho it had been treated.

The rate of seeding may range from 30 to 40 pounds per acre, the particular amount depending upon the average size of the berry and the stooling habit of the wheat. With an abundant supply of moisture more seed may be used than with a limited amount.

If hardy sorts are grown and the preparation of the land is good there should be no winter killing. Where wheat is sown in dry soil it occasionally happens that but a few inches of soil become moist in the fall. When such ground freezes there is likely to be some heaving which may destroy the wheat. A loose open condition of the lower part of the furrow slice may also cause heaving.

Harrowing wheat several times in spring is quite generally practiced. The spike-toother harrow is the implement used, the teeth being set to slant backward so as not to drag out too much wheat. Thin seeding is rare, hence dragging out a few plants need give no concern. By means of this harrowing a mulch is made and moisture thus conserved. Moreover, the stirring of the soil stimulates the growth of the crop. On some of our heavier soils that run together in winter the spike-toothed harrow can not be used to advantage. In fact sufficient harrowing to make a mulch would practically destroy all the wheat. Either we must invent a tool that will stir the soil without destroying the stand, or else use such land for spring planting.

Spring wheat may be grown where a stand of winter wheat cannot be secured in the fall. In eastern Oregon spring wheat is grown exclusively in districts of scanty rainfall. On some of our heavy soils spring wheat is being grown in preference to winter wheat.

The rate of seeding should be from 35 to 45 pounds per acre. Spring wheat does not stool as heavily as winter wheat hence more seed must be used.

VARIETIES OF WHEAT TO GROW.

To make wheat growing very successful in any region those varieties, one spring and one winter sort, among those that yield the best and that have the best milling qualities and therefore command the best price in the world's markets should be used by every wheat grower in order that the tonnage produced may be sufficient to attract buyers. The chief wheat growing belts have discarded many varieties and are confining wheat culture to one or two kinds. In the Dakotas Scotch Fife and Kubanka are taking the lead; in Kansas the Turkey Red is grown almost exclusively. Too many different kinds are grown in the intermountain region.

WINTER WHEATS.

TURKEY RED.

A bearded wheat with hard red berry and stems with but little foliage. This is perhaps our hardiest winter wheat. It does not shatter easily, is a good yielder and makes excellent flour. It has done well in the Columbia Basin and in Utah has outyielded all other wheats. It will without doubt become one of our leading winter wheats.

FORTY-FOLD.

Very hardy and adapted to a wide range of climatic conditions. A good yielder but shatters somewhat easily. It is a very early wheat. In the Columbia Basin it is reputed to have good milling qualities. It is quite largely grown in eastern Oregon and Washington. The Utah Experiment Station lists Forty-fold as the same as Gold Coin.

GOLD COIN.

This is the leading winter wheat in southeastern Idaho and northern Utah. It is one of the bests yielders. The Utah Experiment Station reports that it has a low percentage of protein which indicates poor milling qualities. We have met with a variety passing under this name which is a spring wheat.

LOFTHOUSE (WINTER LA SALLE).

This is a very profitable variety in northern Utah and ranks high as a milling wheat.

JONES FIFE.

This is one of the best yielding wheats in the dryest sections of Oregon and Washington: It has long, drooping heads and shatters easily. Its qualities as a milling wheat are fairly good.

ODESSA.

A popular winter wheat in some sections of Idaho. It is pronounced a good flour wheat by Utah millers.

CANADA HYBRID.

This variety is grown in Long Valley, Boise County, Idaho, and also in Utah and the Columbia Basin. It has a hard, red berry.

SPRING WHEATS.

KUBANKA.

A durum or macaroni wheat. It has large heads, long beards, unusually large flinty, yellowish berry and rather slender stems. This wheat is as yet little known in Idaho. In Utah, wheats of this type are among the bests yielding spring varieties. Kubanka wheat has already an established market. Twenty million bushels grown in the Dakotas in 1906 went to the foreign trade and 10,000,000 bushels were ground in Minneapolis. It has a high gluten content and on that account is largely used to grind with soft wheats from irrigated land.

Since the berry is large and since is does not stool as much as other wheats more seed than ordinarily sown must be used. It has been grown very successfully both in Canyon and Fremont counties.

BLUE STEM.

A smooth wheat with large, plump, whitish berry. This is the best wheat for flour grown in the intermountain region. It is often grown as a winter wheat but as it is not especially hardy occasionally winterkills. Seed grown on irrigated land should not be used for dry farming. There is an impression among some farmers that this is not a good dry land wheat. It has, however, been grown successfully near American Falls and also very largely in eastern Oregon and Washington. The Velvet Chaff Blue Stem grown east of the Rocky Mountains is a fife wheat, quite different from the western variety.

LITTLE CLUB.

A well known variety grown to a considerable extent in Idaho and very largely in eastern Oregon. It has a rather stiff straw and does not shatter readily. It is often sown in the fall and withstands the winters almost as well as the true winter wheats. It is a good yielder and ranks close to Blue Stem as a flouring wheat.

RED CHAFF.

This is practically the same as Little Club except for the color of the chaff.

JENKINS.

A club wheat with red chaff. It withstands dry weather somewhat better than the preceding.

EARLY WILBUR.

A club variety adapted to very dry localities, maturing 10 to 12 days earlier than other club wheats.

SONORA.

A very early wheat, having blunt heads, fuzzy chaff and small berry. There is a strain with red chaff and another with white. It does not stool quite as much as some other wheats. It is quite a popular wheat in Idaho and yields fairly well. Its earliness should recommend it for dry localities.

OATS.

Oats are not grown to a great extent without irrigation except in the favored localities. This is largely due to the fact that we have as yet no good winter oat adapted to our climate. In the foot hills yields of 50 and 60 bushels of spring oats per acre are frequently produced. The Sixty Days and Kherson oats are both early maturing varieties well adapted to arid conditions. Big Four and Black American are good varieties. In Utah a black variety of fall oats recently introduced from England has become very popular.

BARLEY.

Barley in many localities is as sure a crop as spring wheat. The Beardless and the Smooth Hulless are good varieties. We are in need of a suitable winter barley.

RYE.

Both winter and spring rye are grown to some extent in Idaho. Rye is generally the first crop planted in new localities as it is a surer crop than other small grain. It is often grown for hay and is sometimes used for pasture. But little rye is grown where dry farming is practiced on any considerable scale as other crops are more valuable and more profitable.

EMMER.

Spring emmer, incorrectly called speltz, is adapted to arid conditions. Emmer is really a hulled wheat. It has rather slender stems and bearded heads. When threshed several grains enclosed in the hulls cling together as one piece. The white spring varieties have been the most popular. Black winter emmer has been introduced recently and this promises to be of value for arid lands. The value of emmer depends upon it being able to outyield wheat as at has about the same feeding value.

POLISH WHEAT.

Also called corn wheat. This has large bearded heads with long, conspicuous chaff and very large, long, flinty berry. It is a drought-resisting crop but as far as we know it has no qualities recommending it above ordinary types of wheat. It has been used for the manufacture of breakfast foods.

POTATOES.

Potatoes are grown very successfully without irrigation in southern Idaho. For this crop use land summer fallowed the year before, and as they require a mellow soil plow again in spring. Plant 4 to 5 inches deep in rows 3 feet 10 inches apart with cuttings 18 inches apart in the rows. Harrow several times before they are up and until the tops are too large. After that cultivate between rows. Level culture should be given as that is more economical of moisture than ridging. Early varieties are the best. Early Ohio, Early Acme, Six Weeks and Early Eureka are suitable for dry farming.

ALFALFA.

Alfalfa being a deep rooted plant can draw moisture from the deeper soil hence is very drought-resisting. It has been grown without irrigation quite successfully in various parts of Idaho. In the more favored localities it yields two crops, the second crop often being harvested for seed. With a limited rainfall and no water table near the surface it generally gives but one cutting of from one to one and a half tons per acre.

In starting alfalfa experience has shown that best results are secured on land summer-fallowed the year before. It makes a much betted growth the first year on such land than on new land or land cropped the year before. The seeding should be early in spring. The best method of seeding is with a press drill that sows it in drill rows and covers the seed. Plant 2 to 3 inches deep. But 4 to 8 pounds per acre is required if a drill be used while if broadcasted at least twice that amount of seed is necessary. Too heavy seeding should be avoided for a thick stand does not give good results. A nurse crop should not be used as the supposed protection that such a crop affords does not compensate for the moisture which it exhausts from the soil and which might have been at the disposal of the alfalfa. With a nurse crop the alfalfa makes a lesser growth the first year than otherwise and the plants are spindling and do not branch as much at the crown.

Under the less favorable conditions at least no effort should be made to harvest a crop, but clipping it once or twice and leaving the cut foliage on the ground is a benefit. The young alfalfa may be harrowed several times to conserve moisture. The second year it should be disked in spring, the disks set nearly straight. After the second year it will withstand a thoro disking. Dry land alfalfa does not reach its full developement until the third year.

Seed grown without irrigation should always be taken in preferance to that from irrigated farms. "Dry land alfalfa" is simply the ordinary sort which has been grown on dry land and acquired marked drought-resisting qualities.

In the dryer localities alfalfa goes into a dormant condition soon after the crop is removed and may show no green leaf during the latter part of the season.

Turkestan alfalfa is a hardy strain valuable for high altitudes. The plant in every respect resembles the ordinary alfalfa and cannot be distinguished from it. The difference is in its inherent hardiness. The ordinary alfalfa is sufficiently hardy almost everywhere in Idaho, hence there seems to be no advantage in using the Turkestan variety. A great deal of the seed sold by seedsmen as Turkestan alfalfa is the common sort.

When purchasing seed examine it closely for dodder or love-vine. The seed of this weed has a grayish dull surface which is minutely pitted as a lens will show. In outline they are rounded and quite often angular. The alfalfa seed on the other hand is smooth and shining and kidney-shaped.

In growing alfalfa for seed the stand should not be thick. If moisture is abundant a first crop may be cut for hay and the subsequent growth be allowed to go to seed. If the crop is light and the soil dry when it begins to bloom, let it remain to be harvested for seed.

FIELD PEASE.

Field pease make a fair growth without irrigation. They are hardy and should be sown early in spring. The dwarf varieties are the best for dry farming.

DWARF MILO.

This is a drought-resisting crop that may be grown at the lower altitudes in the state. It is chiefly valuable for the seed and is inferior to Kafir corn as a forage.

WHITE DURRA.

This is a non-saccharine sorghum that has done well on dry land both in Canyon and Washington counties.

CORN.

Flint corn has been grown quite successfully without irrigation in Canyon County. It is more promising than the dent varieties.

HOME BUILDING ON THE ARID FARM.

For the greatest possible developement of the dry farming industry there must be permanent home building on the farm. To make the dry farm really attractive there should be opportunity to grow shade trees, a family orchard and a vegetable garden. That is generally not possible except with a limited water supply. However, wherever the water table is sufficiently near to the surface to be of benefit to a crop of grain, there shade trees and orchard fruits can be grown other conditions being favorable.

Tho every farm cannot be supplied with water for irrigation in a small way, yet there are locations where it can be secured. Pumping from wells by means of windmills and other power is possible where a good flow is struck at depths that are not too great. Some of the best land in Idaho lies just above irrigation canals and in many instances it would be quite practicable to elevate water for the irrigation of a few acres. There are also opportunities of supplying a limited amount of water for arid farms by means of storage of winter flow of rivers and creeks.

Water for household use and for stock is an absolute necessity for home building and the lack of it has been a serious drawback in some districts, greatly retarding the settlement of arid lands. Over the greater part of southern Idaho wells may be got at depths that are not prohibitive to the man of limited means. On parts of the Snake River plains in south central Idaho the expense of a well is considerable as it is often 200 to 300 feet to a sufficient flow.

ECONOMY OF PRODUCTION.

The yield alone does not determine the value of any particular system of cultivating the land. The cost of production with each particular method must also be taken into account and be considered in connection with the farm management.

In the favored localities where 30 bushels of wheat is produced the profitableness of dry farming is no matter of doubt. On the plains, however, where the yields may not be more than 15 bushels of wheat per acre and the gross receipts not exceed $10.00 per acre the cost of production must be reduced to a minimum in order that farming may be profitable. Tools that cover a wide strip at each stroke are means to this end, and each man employed should handle at least 4 horses. Traction engines generally reduce expenses one-half. The economy with which a crop can be grown is an important consideration. The yields may be small, but if the cost is reduced in proportion operations may nevertheless be carried on with profit. Where the margin of profit is small farming musts be on a large scale to be remunerative. The community idea of dry farming is growing and is a move in the right direction. Associations of homesteaders or of dry farmers owning patented land are being formed in Idaho and in Utah and tracts ranging from 1500 to 8000 acres being handled by steam plowing outfits. Such operations permit of great economies. The Utah Arid Farm Association on its farm in Juab County have made the record of plowing 80 acres in 24 consecutive hours at a cost of less than 50 cents per acre. The failure of many steam plowing outfits to do satisfactory work is usually due to incompetent engineers.

Under the less favorable conditions in Idaho where yields may be small and where water for domestic use is very expensive, operations must be on a large enough scale to justify the necessary expenditures for improvements and machinery. We must look to co-operative associations for the successful developement of dry farming on large tracts of open plains in Idaho.

Where the yields are fairly good a family can make a comfortable living on 200 or even 160 acres of land. That has been done both in Idaho and in Utah. Experienced dry farmers assert that one man with a team of 4 horses can easily handle 200 acres, one-half of the farm being in crop each year.

The following is an authentic record of the cost and profit of dry farming on 88 acres of land owned by J. G. Barnes of Kaysville, Utah. Ten crops were grown during a period of 20 years and the average yield was 22.1 bushels of wheat per acre. The averages per acre for the ten crops were as follows:

Gross receipts	$12.65
Cost of production and marketing	5.00
Net profits	7.65

A conservative estimate of the cost of producing wheat in Idaho would be as follows, threshing and marketing not included:

	Work performed by farmer.	Work contracted.
Disking	$ .30	$ .60
Plowing	1.00	2.00
Harrowing twice	.25	.50
Seeding and seed	.65	.95
Harvesting	.80	1.25
Total	$3.00	$5.30