3-1905

Bulletin No. 93 - Agricultural Reconnaissance of the Uinta Indian Reservation

W. W. McLaughlin

EXPERIMENT STATION

OF

The Agricultural College

OF UTAH.

BULLETIN No. 93.

AGRICULTURAL RECONNAISSANCE

OF THE

UINTA INDIAN RESERVATION.

MARCH, 1905.

LOGAN, UTAH.

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AGRICULTURAL RECONNAISSANCE OF THE UINTA RESERVATION

BY W. W. McLAUGHLIN.

The agricultural area of the Uinta Indian Reservation is within the Uinta Basin. Its center is about 105 miles east of Heber and 90 miles northeast of Price; the two nearest railroad stations. The Reservation contains in all some 2,650,000 acres; but from this must be deducted, by allotments to the Indians and for mountainous land, about 2,000,000 acres, leaving approximately 650,000 acres for agriculture. The best and greatest amount of this is to be found in the area bounded on the south by the Duchesne River, on the west by the Duchesne River and Rock Creek, on the north by the high Uinta Mountains, and on the east by the boundary of the Reservation. This is an area 25 by 40 miles, containing within its boundaries Fort Duchesne and the Whiterocks Indian Agency.

The whole agricultural area appears at one time to have been a large bench sloping toward the southeast, the topography of which has been greatly modified by the action of the rivers and their numerous tributaries. It consists of low lands traversed by streams, broad upland swales, large benches, and an occasional hill rising a little higher than its surroundings. The river bottoms are rather narrow, except at the junction of the Duchesne and Lake Fork and the junction of the Duchesne and the Uinta; here the width does not exceed six or seven miles. Th benches are more extensive. The Blue Bench and the upper part of the Uinta are the two most notable. The Dry Gulch area, including the east and west arms, is probably the largest division.

The climate of various parts of this section is somewhat variable, owing to the difference in elevation, which ranges from 5,000 to 7,000 feet. The liability of late and early frosts limits the adaptability of the upper sections for various crops. The difference in the soil is the most noticeable feature of the various elevations, as shown in going from the river bottoms to the adjacent benches. The difference in the soil conditions will, in all

probability, influence the cropping more than any other feature, as there are soils within this area representing the most productive as well as the most barren to be found in the state.

This entire area is covered with a scrub and scattering growth of white sage, rabbit brush, grease wood and shad scale. At one time parts of the valleys and benches afforded considerable bunch grass, but from overgrazing and lack of attention to the preservation of this natural pasturage, only a very coarse bunch grass is now growing upon the benches. In the bottoms, a limited amount of salt and oat grasses occur. The largest timber area within the state is to be found some forty miles to the north, but the timber within the agricultural area is represented by an occasional cottonwood along the river banks and a little scrub cedar on the upper benches.

Viewed from the west, the country looks like a great sandy bench cut by numerous large and small ravines. To the north, large, cedar-covered, red sandstone benches rise to an elevation of 8,000 feet and these are crowned by the high Uinta mountains. Looking down the country in a direction with the drainage, one is impressed with the vastness and monotony of the region. The only color in the panorama is the light gray of the vegetation and a dark color on the lower hills representing a growth of cedars. Yet, this same monotonous vegetation makes possible the wintering on the open range of horses, cattle and sheep.

The water of the rivers near the lower part of the reservation is somewhat turbid and has a slight saline taste, especially during the low water season. The geological formation favors this. However. it is not thought that the water acquires sufficient salt to render it undesirable for agricultural or domestic use.

Unless thoroughly hidden from view, there is no suitable building rock to be found within this area. This, together with the lack of lime rock and a scarcity of clay suitable for brick, will make building comparatively expensive.

There was some farming within this area previous to its being set aside as a reservation. This was done mostly by Indians and, up to the present, has been of the indifferent, unscientific and unprofitable kind. The present prevailing custom is for the Indian owner to employ a white man to run the farm, paying

him a definite share of the products. It is the exception for the white man and the Indian to agree for any length of time, thus resulting in a frequent change of tenants, and a frequently changing method of cultivation and farm management. All the farms visited by the writer show alkali; partly as a result of this lack of interest and care on the part of the farmer. An analysis of numerous soil samples shows the presence of more or less alkali in practically all the lower lands and on the lower part of the benches. Therefore, improper farming methods and any lack of natural drainage facilities will result in the concentration and rise of this alkali to the surface, rendering the soil more or less unproductive.

The market for the produce, which is mostly alfalfa and grain, at present, is at Fort Duchesne and the Indian agency, resulting in a concentration of the farming on areas surrounding the market.

It is not possible with the data at hand to say with certainty just what crops will prove the most satisfactory, but it is possible to say what crops will, in all probability, be best suited to this region, and the following list is given with the hope that it is not far wrong.

Wheat and oats, which are somewhat alkali resisting, will be profitable in all altitudes where there is a sufficient length of growing season for the maturing of the grain. Alfalfa produces two crops in nearly all sections and three in the lower districts. Alfalfa is not the best alkali-resisting crop and for that reason will not grow as luxuriantly in the lower and river bottom lands. It is more than probable that sugar beets, which is a good alkali-resisting crop, can be grown profitably upon the lower lands where the season is long enough for the beets to mature. The grasses, including timothy, red top and clover, can be grown in all sections. It is questionable whether other than the hardier fruits will do well. Other crops may be grown within this area. but the above list probably contains the more profitable ones. In conclusion it might be said that on account of the small amount of rainfall, agriculture without irrigation is impracticable,, and throughout much of this region, agricultural pursuits are restricted, also, on account of the liability of frosts in the more elevated portions where the soil conditions are the most favorable.

CLIMATE.

For the purpose of a more general understanding of the climate of the Reservation, it was deemed advisable to compare the temperature, precipitation and length of growing season of this section with various other sections in the state. These data, which are given in the following tables, have been compiled from the weather records and an average taken for the eight years ending Dec. 31, 1902. It was thought that the places enumerated in the following table represented enough different conditions to give the average reader a comparative idea of the climate of the Reservation.

Fort Duchesne on the east edge of the Reservation and Vernal 25 miles further east, are situated under similar conditions except at slightly lower altitude than the average agricultural area under consideration. Castledale, 80 or 90 miles further south, is very similarly situated. Heber, on the west side of the mountains, has a very different cimate; while Loa, at an elevation a little higher than the average elevation of the area, has a similar precipitation, but a shorter and colder growing season. Moab, in the southern part of the state, has a climate very much warmer than the Reservation. Logan has about the same length of growing season, but differs in precipitation and average monthly temperature. Salt Lake has a decidedly different climate.

A short review of Table No. 1 gives about the same annual temperature at Logan, Castledale and Vernal, Fort Duchesne, and Heber; Loa the coldest, and Moab the warmest. Fort Duchesne and Vernal have a minimum average considerable lower than Loa or any of the other stations, and a maximum average a little lower than Moab or Salt Lake, considerable higher than Loa or Heber and about the same as Logan. The temperature of Vernal and Fort Duchesne is low in the winter and high in the summer with a very uniform monthly variation.

Table No. 1 gives the elevation, average temperature for each month and for the year, the maximum and minimum monthly temperature, and finally the greatest monthly range of temperature:

TABLE NO. 1.

Average Temperature, Etc.

Station.	Elevation.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Average.	Annual		Greatest Range.
															Maximum	Minimum	
Castledale ...		26.8	29.7	37.8	45.7	55.8	65.8	69.4	67.5	59.4	49.0	38.3	25.5	47.6	73.1	21.0	52.1
Fort Duchesne	4,941	13.0	19.5	34.0	47.2	57.0	65.9	70.9	69.2	59.3	46.1	33.2	15.8	44.5	74.0	2.3	76.3
Heber	5,440	22.6	23.9	35.9	44.1	53.2	60.1	65.8	65.6	56.6	48.0	35.2	22.5	44.5	69.0	11.6	57.4
Loa	7,000	21.9	24.9	29.8	40.0	50.8	59.4	64.8	60.3	52.6	40.3	30.7	22.0	41.5	68.0	12.8	55.2
Logan	4,507	25.0	29.6	34.9	46.5	55.0	64.7	65.8	71.0	63.0	46.9	38.1	26.0	54.0	80.3	22.4	57.9
Moab	4,000	30.2	35.6	44.4	56.5	64.9	72.7	77.2	75.2	66.3	54.7	42.7	28.5	51.2	80.2	20.6	59.6
Salt Lake ...	4,345	30.5	34.4	39.6	49.8	57.7	68.0	75.0	70.0	64.1	51.9	42.2	31.3	46.6	76.0	4.8	71.2
Vernal	5,050	19.6	25.0	35.9	48.4	58.0	67.7	72.0	69.6	60.0	47.2	36.0	19.7	47.2	76.7	14.00	62.7

Table No. 2 gives the average dates of the last killing frost in the spring and the first killing frost in the fall, the average number of days between these dates and the maximum and minimum number of days between the dates of the frost.

TABLE NO. 2.

FROST DATA.

Number of days between last and first frosts.

Station	Last	First	Ave.	Max.	Min.
Castledale	May 29	Sept. 27	120	142	111
Fort Duchesne	May 11	Sept. 30	141	161	123
Heber	May 28	Sept. 6	100	115	83
Loa	June 3	Sept. 4	93	103	58
Logan	May 6	Oct. 9	156	189	119
Moab	Apr. 30	Oct. 12	166	201	132
Salt Lake	May 1	Oct. 19	171	206	150
Vernal	May 9	Oct. 1	145	181	113

Explanation of Table No. 2—Taking, for example, the station Fort Duchesne. the average date of the last killing frost as found in the third column is Sept. 30; average number of days in growing season, 141; maximum number for past six years 161, and the minimum number, 123. The average length of the growing season at Vernal and Fort Duchesne is sufficiently long for the maturing of most crops grown in Utah.

PRECIPITATION.

Table No. 3 gives the average monthly and average annual precipitation for each of these station for eight years:

TABLE NO. 3.

Average Annual Precipitation for Past Eight Years.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Average.
Castledale	0.23	0.78	0.37	0.79	0.17	0.16	0.59	0.88	0.68	0.56	0.76	0.06	6.03
Fort Duchesne.....	0.36	0.36	0.51	0.37	0.46	0.17	0.32	0.87	1.05	1.10	0.26	0.66	6.49
Heber	1.42	1.71	2.00	1.54	1.99	0.32	0.83	0.74	0.91	1.24	1.26	0.53	14.5
Loa	0.38	0.90	0.48	0.73	0.24	0.26	1.25	1.36	0.53	0.45	0.39	0.22	7.18
Logan	0.89	1.03	1.74	2.07	2.31	0.54	0.57	0.73	0.62	1.71	1.44	0.81	14.46
Moab	0.53	0.65	0.73	0.51	0.65	0.28	0.41	0.84	1.45	0.58	0.52	0.59	7.79
Salt Lake	0.79	1.73	1.84	2.02	2.34	0.59	0.55	0.76	0.47	1.35	1.34	1.12	14.00
Vernal	0.55	0.63	0.73	0.77	0.82	0.27	0.61	0.65	1.26	0.77	0.47	0.49	8.02

Table No. 4 gives the average precipitation during June, July and August, for each of the seven years ending December 31, 1902.

	Precipitation for June, July and August							A'vg.
Castledale	.96	.997	2.98	0.9	2.74	.01	.02	1.23
Fort Duchesne..	2.12	0.40	1.66	2.94	0.49	2.69	....	1.71
Heber	3.99	1.43	1.73	....	0.76	2.54	1.02	1.99
Loa	4.86	2.08	....	3.32	2.14	4.53	0.78	2.95
Logan	3.35	1.52	1.11	1.90	1.41	2.08	1.53	1.84
Moab	1.20	1.54	0.68	3.35	0.65	2.06	1.26	1.53
Salt Lake	3.07	1.54	2.98	2.44	1.12	2.02	1.08	2.03
Vernal	2.48	1.57	....	3.95	0.39	1.15	1.09	1.77

Table No. 5 gives the average monthly and annual depth of snowfall for the past five years.

TABLE NO. 5.

Average Snowfall for the Past Five Years. (Inches)

Station	November	December	January	February	March	April	Total	Total Max.	Total Min
Fort Duchesne	0.50	4.25	2.94	3.62	2.72	1.00	16.03	27.5	4.2
Heber	10.4	7.30	10.5	19.1	16.7	1.00	65.00	122.2	21.5
Loa	1.83	2.20	3.25	2.72	4.60	5.50	20.1	31.00	6.1
Moab	T	5.07	3.17	1.00	1.00	T	10.2	21.2	6.0
Salt Lake	7.60	6.88	4.60	11.9	10.8	4.66	46.44	72.00	33.0

The average annual snowfall at Vernal and Fort Duchesne is very small with the greater part falling early in the winter. A perusal of the table shows that while the stations on the west side of the range are having their heaviest snows. the stations on the east slope are having light snows.

Of the climate of this area, it might be said, in conclusion, that the *winters are rather cold with little snowfall, the summers are dry and warm, with very little extreme weather at any season.*

WATER SUPPLY.

The principal streams of this area are the Uinta, Duchesne, Lake Fork and Whiterocks Rivers. These streams possess numer ous tributaries which are fed by springs and the melting snows.

The Uinta River has it source on the southern slope of the Uinta Mountains, and flows in a general southeasterly direction, emptying into the Duchesne River about fifteen miles above its mouth. Its entire drainage area is included within the Reservation. The Uinta emerges from the canyon about ten miles northeast of the Agency, and the following table gives the discharge of the river just after leaving the canyon.

TABLE NO. 6.

List of Discharge Measurements of Uinta River Near Whiterocks, Utah.

Date.	Discharge.	Date.	Discharge.
1901.	Sec. ft.	1901.	Sec. ft.
April 8	110	August 26	261
April 15	142	September 2	263
April 22	153	September 9	210
April 29	186	September 16	178
May 7	254	September 23	169
May 14	634	September 30	170
May 31	496	October 7	179
June 6	308	October 14	165
June 15	278	October 21	168
June 26	250	October 28	185
July 1	255	November 4	164
July 8	275	November 18	144
July 15	242	November 25	144
July 22	222	December 2	153
July 29	253	December 9	185
August 5	229	December 17	189
August 12	226	December 23	137
August 19	464	December 30	122

Whiterocks River drains the country immediately east of the headwaters of the Uinta River, and has its source in the peaks of the Uinta Mountains, which attain elevations of over 13,000 feet. The general course of the river is southerly, and it empties into the Uinta through numerous channels between the Agency and Fort Duchesne. The following table gives the discharge some distance above the Agency.

TABLE NO. 7.

List of Discharge Measurements of Whiterocks River near Whiterocks, Utah.

Date.	Discharge	Date.	Discharge.
1901.	Sec. ft.	1901.	Sec. ft.
April 9	40	August 27	139
April 23	72	September 3	126
April 30	139	September 10	96
May 6	162	September 17	83
May 15	647	September 24	83
June 1	279	October 1	78
June 7	197	October 8	82
June 16	156	October 15	72
June 27	121	October 22	68
July 2	93	October 29	82
July 9	104	November 5	67
July 16	85	November 12	55
July 23	81	November 19	66
July 30	112	November 26	66
August 6	128	December 3	62
August 13	108	December 10	59
August 20	204	December 31	54

The Duchesne River has its source in the high peaks of the Uinta and Wasatch Mountains and flows in a general easterly direction, emptying into Green River three miles above the mouth of the White River. Practically the entire drainage basin of this river is included within the reservation. Strawberry Creek is one of the main tributaries and has its source in the Strawberry Valley which is one of the finest summer grazing sections within the Reservation. The area is of a rolling character in contrast to the basin of the upper Duchesne, which is distinctly mountainous.

The following data from Bulletin No. 37, part 3, United States Geological Survey, will give an idea of the flow of the tributaries of the Duchesne as observed in the fall.

"In Strawberry Valley, a number of small tributaries, averaging about one second-foot each, contribute to the supply of Strawberry Creek. In September, 1899, Current Creek was discharging 20 second-feet at the crossing of the Duchesne and Provo road. Red Creek, further to the east, was at the same date carrying a second-foot. Strawberry Creek, four miles above its mouth, was measured on September 10th and found

to be carrying 134 second-feet. Duchesne River immediately above Strawberry Creek was carrying on the same date 302 second-feet. Lake Creek is an important tributary of the Duchesne from the north. At the bridge near its mouth it was found to be carrying 128 second-feet on September 11th. The Station on the Duchesne River is located three miles below the mouth of Lake Fork at the highway bridge on the stage road from Price to Fort Duchesne."

The following table gives the discharge of the Duchesne on various dates. It must be borne in mind that these measurements are taken at a point below where the Strawberry and Lake Creeks enter the Duchesne River.

TABLE NO. 8.

List of Discharge Measurements of Duchesne River at Price Road Bridge, Utah.

Date.	Discharge.	Date.	Discharge.
1901.	Sec. ft.	1901.	Sec. ft.
April 6	264	August 9	
April 12	296	August 16	354
April 19	335	August 24	443
April 27	335	August 30	422
April 27		September 3	301
May 4		September 20	272
May 10		September 27	310
May 18		October 4	294
May 27		October 11	326
June 4		October 18	309
June 12		October 25	295
June 19		November 1	362
June 24		November 8	306
June 29		November 15	299
July 6		November 22	318
July 26		November 29	304
July 12		December 6	332
July 19		December 13	
August 2			

The following table gives the discharge of Lake Fork Creek at the highway bridge near its mouth.

TABLE NO. 9.

List of Discharge Measurements of Lake Creek, Utah, near Mouth, for 1901.

Date.	Discharge.	Date.	Discharge.
1901.	Sec. ft.	1901.	Sec. ft.
April 12	94	August 24	256
April 19	96	August 30	252
April 27	200	September 6	175
May 4	290	September 13	130
May 13	878	September 20	129
May 18	2,491	September 27	129
May 27	1,721	October 4	120
June 4	735	October 11	131
June 12	536	October 18	116
June 19	494	October 25	115
June 28	414	November 1	133
July 6	276	November 8	111
July 12	306	November 15	113
July 19	179	November 22	100
July 26	244	November 29	106
August 2	178	December 6	109
August 9	236	December 13	
August 16	162		

Table No. 10 gives the discharge of the Uinta River at Fort Duchesne; these measurements include the Uinta and Whiterocks Rivers.

TABLE NO. 10.

List of Discharge Measurements of Uinta River at Fort Duchesne, Utah.

Date.	Discharge.	Date.	Discharge.
1901.	Sec. ft.	1901.	Sec. ft.
April 4	88	August 28	134
April 13	105	September 4	146
April 20	95	September 11	106
April 28	166	September 18	103
May 3	340	September 25	105
May 15	1,089	October 2	102
May 29	883	October 12	106
June 5	330	October 16	108
June 8	295	October 23	101
June 14	266	October 31	132
June 20	193	November 6	116
July 3	140	November 13	102
July 11	177	November 20	104
July 17	91	November 27	108
July 24	76	December 4	157
July 31	76	December 11a	158
August 7	158	December 18a	137
August 14	91	December 27a	126
August 23	190		

a—Ice; results approximate.

It may be said in connection with this subject that this area is one of the best watered in the State; the fall of the country and rivers is such that canals can be taken out and the water carried upon the benches at a reasonable cost. The great fall in the rivers affords excellent opportunity for power sites, and the rugged contour of the country at the head of the streams offers excellent reservoir possibilities, which can be utilized without great expense.

The following table, No. 11, has been compiled from measurements taken during the season just past. These measurements were made and the table furnished by the Reclamation Service of the United States Geographical Survey.

TABLE NO. 11.

STREAMS; MONTHLY DISCHARGE—ACRE FEET, 1904.

	Strawberry	Currant Creek	West Duchesne	North Duchesne	Lake Fork	Rock Creek	Total
January	1670	1420	1360	2970	3560	7160	18140
February	1570	1400	1370	2960	3000	5720	16020
March	1670	1750	1380	2970	3060	5360	16190
April	5810	4220	2880	6080	9060	9040	37090
May	23050	10260	14680	35560	31320	25600	138470
June	8700	6040	10100	43960	46640	40360	155800
July	3620	2900	3440	15360	20720	28840	74880
August	2490	1330	1980	7200	10400	20760	44160
September	1760	1010	2800	4680	6360	13300	29910
October	1670	1050	1640	3260	4420	9840	21880
November—a	1620	1150	1340	3000	4000	8700	19810
December—a	1670	1300	1350	2990	3840	8040	19190
Total	55300	33830	44320	128990	146380	182720	591540

a—Estimated

The above table is in the acre-foot unit, whereas the previous tables were in the cubic-foot unit. An acre-foot is the amount of water necessary to cover an acre to a depth of one foot.

SOIL DIVISIONS

The soils of this area are divided into three, more or less, distinct classes: First, the soils of the upper part of the benches, adjacent to the foot hills and formed mostly from them; second the soils of the middle and lower benches; third, the soils of the river bottoms which are partly made from the benches, but mostly from the mountains, through the agency of the rivers.

The first-class is characterized by a rapid slope from the mountains; a larger and denser growth of sage brush; fewer evidences of alkali; the most striking feature is the red color.

The second-class is lighter in color; a little finer, and there is a less dense growth of vegetation.

The third-class is distinguished by a finer texture; less gravel; a noticeable amount of alkali; and an almost total absence of vegetation.

These classes of soils are distributed as follows: The first-class covers the upper part of all the benches, and the upper part of the Dry Gulch and Uinta areas; the second-class covers the middle and lower part of all the benches and the Dry Gulch County; the third-class covers all the river bottoms and the lower part of the Dry Gulch area.

ALKALI.

In the soils of Utah there is nearly always a superfluity of soluble salts, the chief ones being sodium chloride or common salt and sodium sulphate. As a rule, the lands are most alkaline in the lower and more level portions of the country, where the soils are heavier and the drainage poorer. In the virgin state, dry lands with good drainage invariably show an increase in alkali with depth of soil, while the reverse is true if the lands are wet and subject to great evaporation. The seepage waters and numerous springs to be found issuing from the sides of the large bench just west of the Uinta River have a disagreeable salty taste, indicating a considerable supply of salts within this bench land.

The soils have been formed by material brought down from the mountains by the disintegration of the material exposed upon and along the sides of the benches. The different kinds of soils are more or less intermixed and especially is this true in the river bottoms. In the lower lands the sediment is very deep, but as we

get near the foothills gravel and cobble rocks are plentiful. There are a few places where gypsum appears quite abundantly, and numerous outcrops of soft sandstone are to be found.

Table No. 12 gives the per cent of soluble matter, the approximate per cent of alkali chlorides, the stickiness, the baking tendency, and the location of the soil where the samples were taken.

TABLE NO. 12.

Group I—

Sample No.	Depth in feet.	Per Cent Soluble Matter.	Per Cent Alkali Chlorides.	Stickiness.	Baking Tendency.	Notes.
34009	0-1	0.03	0.02	315	481	Samples taken at junction of Duchesne and Strawberry Rivers.
34010	1-2	0.03	0.12	318	1026	
34011	0-1	0.13	0.08	684	4644	Samples taken at a point 7 miles up the Duchesne from its Junction with the Strawberry.
34023	1-2	0.11	0.07	441	3375	
34024	2-3	0.16	0.09	537	6000	
34025	3-4	0.23	0.15	607	4638	

Group II—

34026	4-5	0.20	0.12	789	8500	
34027	5-6	0.24	0.17	804	6300	
34057	0-75	0.36	0.18	403	1010	On side of Bench.
34059	0-1	....	....	484	2203	Samples taken on north side of Lake Fork Bottoms.
34021	1-2	0.03	0.02	717	2709	
34017	0-1	0.04	0.02	....	....	One-half mile southwest from Samples 34059, 34021 and 34022.
34018	1-2	0.05	0.03	371	3234	
34019	2-3	0.08	0.05	372	3750	
34045	0-1	0.04	0.02	772	5100	One-half mile southwest from the above samples.
34046	1-2	0.0	0.04	547	4790	
34047	2-3	0.08	0.04	638	3374	

Group III—

34070	0-1	....	....	465	2098	Samples taken from Southwest arm of Dry Gulch.
34071	1-2	....	....	487	2541	
34051	0-1	....	....	397	464	
34060	0-1	....	....	295	432	
34061	1-2	....	....	250	1693	
34062	2-3	....	....	256	1907	
34028	0-1	0.18	0.14	404	3335	South side of the same arm.
34029	1-2	0.12	0.10	545	3684	
34038	0-1	0.23	0.19	473	2106	Small valley immediately east of the same arm.
34039	1-2	0.28	0.24	410	2849	

34012	0-1	0.06	0.05	464	1715	Samples taken from the Government Farm arm of Dry Gulch.
34013	1-2	0.06	0.05	628	4450	
34014	2-3	0.05	0.04	430	2577	
34015	3-4	0.04	0.04	493	4093	
34016	4-5	0.04	0.04	215	2997	
34066	0-1	....	....	619	2776	
34063	0-1	....	....	374	2932	Samples from lower part of the above arm.
34064	1-2	....	....	583	3298	
34065	2-3	....	....	480	2332	
34042	0-1	0.04	0.03	623	1829	Samples from the middle of area at junction of South arm and Government Farm Arm of Dry Gulch.
34056	1-2	0.04	0.03	460	1170	
34043	0-1	0.06	0.04	725	6000	

Group IV—

			Less Than			
34020	0-1	0.03	0.02	548	458	Samples from the upper end of the Blue Bench. These samples are representative of this bench.
3406.	2-3	....	"	328	1672	
34049	3-4	....	"	475	834	
34052	4-5	....	"	433	910	
34044	0-1	....	0.02	387	508	Extreme northeast edge of the Blue Bench. This area is limited.
34048	1-2	....	"	295	1323	
34067	0-1	....	....	689	3238	Samples taekn out about 2½ miles below or south of Whiterocks.
34068	0-1	....	....	327	670	
34035	0-1	0.06	0.04	315	1400	These samples taken from the Bench just west of the Uinta River.
34036	1-2	0.04	0.03	264	2959	
34041	0-1	0.12	0.08	552	2122	
34054	1-2	0.08	0.05	397	2050	
34052	0-1	0.20	0.13	522	3356	
34053	1-15	....	....	436	2975	
34037	0-1	0.04	0.03	323	1008	Bench immediately north of the Duchesne River Bridge.
34040	0-2	0.08	0.06	473	2106	

TABLE NO. 13.

Physical Analysis of Soils from Uinta Indian Reservation

Group I—

Sample	Depth in Feet	Medium Sand	Sand Fine	Coarse Silt	Medium Silt	Fine Silt	Fine Clay	Note.
34009	0-1	56.16	25.98	14.17	3.80	1.51	1.537	Junction of Duchesne and Strawberry rivers
34010	1-2	42.51	28.98	6.71	3.88	4.43	10.703	
34011	0-1	13.71	22.23	18.27	3.61	1.67	27.288	Seven miles up the Duchesne from its junction with the Strawberry.
34024	2-3	17.44	37.11	12.51	8.62	5.09	17.150	
34025	3-4	22.4	24.41	14.26	9.54	4.39	20.021	
34026	4-5	14.65	31.48	11.86	8.73	6.00	21.397	
34027	5-6	9.63	28.79	14.13	7.59	7.95	21.039	

Group II—								
34017	0-1	11.38	12.03	12.19	11.88	16.61	30.814	North side of Lake Fork bottoms.
34018	1-2	15.72	20.67	5.17	3.85	3.08	35.645	
34019	2-3	19.36	18.33	14.35	10.01	3.98	15.112	
34022	2-3	29.55	41.38	1.99	3.01	1.78	18.317	Quarter mile west of Lake Fork.
Group III—								
34028	0-1	6.77	29.32	27.61	9.75	4.89	14.721	South side of southwest arm of Dry gulch
34029	1-2	0.60	20.07	29.13	10.18	2.22	24.299	
Group IV—								
34030	0-1	27.81	14.30	10.83	9.18	5.07	6.529	Bottom just north of Duchesne bridge.
34031	1-2	17.46	17.44	9.32	6.11	2.81	6.529	

SOIL CONDITIONS—(From Analysis.)

(The author is indebted to Director Widtsoe for this chapter.)
(See Tables 12 and 13.)

Group I represents the Duchesne bottoms above Strawberry river. Table No. 13 shows that the samples taken near the junction of the Duchesne and Strawberry rivers are to be classed among the sandy loams. In fact, the first foot contains only a trifle more than one and one-half percent of clay and is made up almost entirely of sand. Table No. 12 shows a small amount of alkali chlorides in the first foot of the soil, but in the second foot there is six times as much. Connecting this with the fact that the amount of clay increases with the depth, it is probably safe to conclude that large quantities of alkali are found to considerable depths and may be brought to the surface when water is evaporated from the soil.

The samples taken seven miles up the Duchesne bottoms from its junction with Strawberry river show more clay and should be classed with the heavy loams. Table No. 12 shows that the total percent of soluble matter increases with the depth. The alkali chlorides likewise increase with the depth. The rate of increase is not so great as in the soils lower down the Duchesne bottoms, but the total amount is greater. Samples 34011 and 34027, taken seven miles up from the junction of the two rivers, are probably more nearly representative of the whole river bottom than samples 34009 and 34010.

From the field notes and the analytical data, these will be quite heavy to work and liable to alkali trouble unless great precau-

tions are taken in using only moderate amounts of water for irrigation. It may be necessary in many cases to resort to under-drainage in order to remove the kind of alkali that these soils contain.

Group II represents the Lake Fork bottoms between Lake Fork Duchesne River and Blue Bench. Referring again to Table No. 13, it may be observed that the clay in these samples, especially near the surface, is exceptionally high, reaching in one case more than 35 per cent. The samples, therefore, taken from the north side of Lake Fork should be classed as extremely heavy clay soils. It is to be noted, however, that the clay diminishes somewhat with the depth and is replaced by fine sand. This may be due to the formation of these soils from washings from the neighboring hills and the sand and silt carried down by the river. Table No. 12 shows that the soils of Group II generally contain comparatively small quantities of soluble matter, but that the larger portion of the soluble matter is in the form of alkali chlorides, and will likely, therefore, appear on the surface as alkali. In general, these soils will probably give the farmer great difficulty because of their large clay content leading to great stickiness and baking tendency. Yet, judging from the data collected, they are probably safer agricultural soils than those represented by Group No. I. There can be little question about the intrinsic fertility of these soils, that is to say, they possess great amounts of plant foods that will last for very long periods.

It may be observed that sample 34057 was taken from the side of the bench immediately west of Lake Fork bottom and about seventy-five feet below the top of the bench. This is the material which is continually being washed down into the bottoms and represents, undoubtedly, a large portion of the material in the soils. It will be observed also from an examination of the analysis of this sample, that it is very rich in soluble matter and alkali chlorides, and it is probable that much of the alkali in the soils of Group II has been obtained from this bench.

Group III represents the Dry Gulch country. Only two samples were submitted to complete mechanical analysis, and are found in Table No. 13 under Group III. From the analyses there given, the soils of this group appear to be medium loams and should be worked with comparative ease. The main

consideration connected with the investigations of the soils in this group is that of alkali. Referring to Table No. 12 it is found that the samples from the south side of the southwest arm contain between 0.1 and 0.2 per cent of soluble matter, nearly all of which is in the form of alkali chlorides. This amount of alkali would undoubtedly make itself felt in a very short time after farm operations begin.

The next two samples taken from the small valley immediately east of the southwest arm of Dry Gulch contain even more alkali, going as high as 0.28 per cent, of which 0.24 is in the form of alkali chlorides. Unless exceptionably favorable drainage conditions exist in that particular locality, the farms will unquestionably be alkali-ridden in a short time.

The succeeding six samples were taken from the Government farm arm of Dry Gulch. The per cent of soluble matter is here very much smaller, but nearly all of it is in the form of alkali chlorides. While in this particular locality the alkali trouble will not be so serious nor will it appear as quickly, yet it needs to be guarded against.

The last three samples were taken from the middle of the area, at the junction of the Southwest arm and Government Farm arm of Dry Gulch. The per cent of soluble matter and alkali chlorides is about the same as found in samples taken from the Government Farm arm. Using proper precautions, the alkali need not rise in sufficient quantity to menace seriously the agricultural future of the district.

There is considerable gypsum in the country covered by the Uinta Reservation and its effect is felt in the quality and composition of the soils. Usually a large amount of gypsum indicates quite a large amount of alkali. The gypsum in the soils, under the influence of irrigation, becomes soluble and tends to escape in the country drainage. This frequently results in a sinking of the soil from time to time, and this is a source of annoyance and expense to the farmer. In general, it may be said that the soil of the Dry Gulch country is of good texture and of high fertility, but that locations must be chosen very carefully with respect to the predominating amount of alkali.

Group IV represents the benches. Only two complete physical analyses were made of the soils taken from this locality They agree in containing a very small per cent of clay and a

rather high per cent of sand, though there is a fair amount of silt present. The soils as analyzed must be classed as sandy loams. Six samples were analyzed from the upper end and extreme northeast edge of the Blue Bench. In no case did the alkali chlorides exceed 0.02 of one per cent to a depth of five feet. This indicates with considerable certainty that the alkali trouble need not be feared on the Blue Bench. On the bench just west of the Uinta River more alkali was found in the soil. An encouraging fact is, however, that in several cases more alkali was found in the top foot than at greater depths. This probably shows that the amount of alkali in the soil is small and by evaporation was concentrated near the surface. By proper methods of cultivation, the alkali could probably be so distributed through the soil as to have no adverse effect on plant growth. The bench immediately north of the Duchesne River bridge also contains considerable amounts of alkali and must be cultivated carefully in order to prevent the rise of the alkali. The bottom immediately north of the above bridge is heavily charged with soluble salts. Only about one-fourth of this material is in the form of alkali chlorides so that the alkali is probably of a mild kind; yet the amount of alkali in the soil will undoubtedly make farming somewhat precarious in the bottoms.

In general, the conclusion from the study of the soils of this region is that the soils are very much like those found in Carbon and Emery counties, and the agricultural difficulties there encountered will probabiy be met on the Uinta Reservation. The only really undesirable element in the soils of the Reservation is the alkali, and where that is not too abundant it will be possible, by proper methods of cultivation, to prevent any serious trouble from that source. All the soils possess high fertility and under favorable conditions should yield abundant crops.

SUMMARY.

The soils of the upper part of the benches are more desirable than the soils of the river bottoms.

The soils of the upper lands will be more easily handled than the soils of the lower areas.

There is more alkali in the bottom lands and especially where the drainage from the benches can reach the lower lands.

The danger from alkali is somewhat formidable in the lower lands.

There is some danger from frost on the upper lands.

The upper lands will require more frequent irrigation than the lower lands.

The upper lands will require more water than the lower lands.

The chance for drainage on the lower lands is rather poor and the expense attached would be much greater than on the upper lands

Checking the action of the alkali, most all the land is capable of high production.

The climate is equable during a greater part of the year, but the spring and fall is variable with no extreme weather.

The water supply is sufficient for all the lands.

There is but little building material within the agricutural area.

Winter grazing of stock is practicable.

Arid or dry farming will probably not be successful as the precipitation is low.

It will be easier and cheaper to get water upon the lower lands.

There are numerous opportunities for the development of water power.