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BUREAU OF SOILS—MILTON WHITNEY, Chief.

THE SOILS OF BUTTE VALLEY CALIFORNIA.

BY

W. W. MACKIE.

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., October 15, 1908.

SIR: I transmit herewith manuscript of an article entitled The Soils of Butte Valley, California, by Mr. W. W. Mackie, of this Bureau, and recommend its publication as advance sheets of the Field Operations of the Bureau of Soils for 1907.

Very respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE SOILS OF BUTTE VALLEY, SISKIYOU COUNTY, CALIFORNIA.

By W. W. MACKIE.

INTRODUCTION.

Butte Valley lies in eastern Siskiyou County, Cal. Its northern limits extend to a steep range of hills about 2 miles south of the Oregon line. On the eastern side of the valley the low Sheep Mountains separate it from Lower Klamath Lake, while on the west the higher Siskiyou Range separates it from the Shasta Valley. These ranges of mountains entirely encompass the valley, joining the spurs of Mount Shasta at the southern extremity. Over 100,000 acres are thus inclosed in a level basin which was at one time a lake. From Mount Shasta, 40 miles to the south, arise the streams which form Butte Creek, which enters the valley at its southern end, furnishing irrigation water for several hundred acres of alfalfa, timothy, clover, and grain crops. Another small stream, Praether Creek, flows into the western side of the valley from the Siskiyou Mountains, furnishing irrigation water and electric power for a dairy situated there. Butte Creek sinks soon after entering the valley, but Praether Creek flows directly into the southern end of Butte Lake. Butte

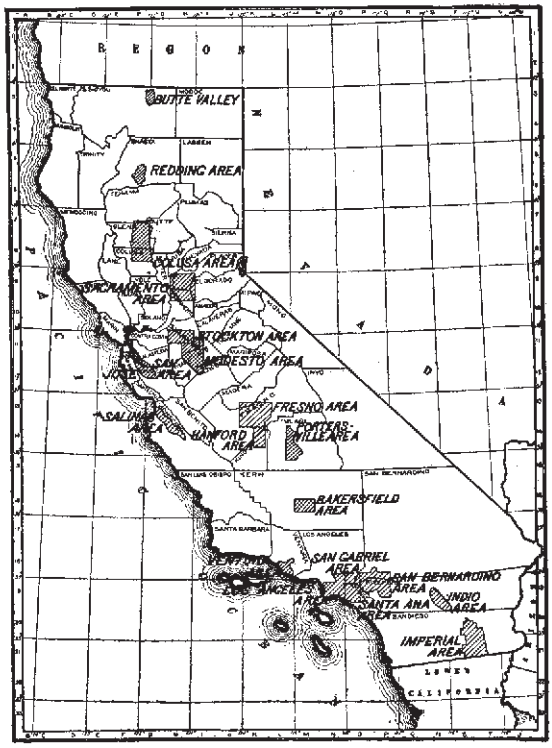


FIG. 1.—Sketch map showing location of Butte Valley, California.

Lake is situated in the western-central part of the valley and covers between 5,000 and 10,000 acres, according to the variation in the seasonal rainfall. Its waters are supplied by the run-off from the surrounding mountains, numerous springs, Praether Creek, and the

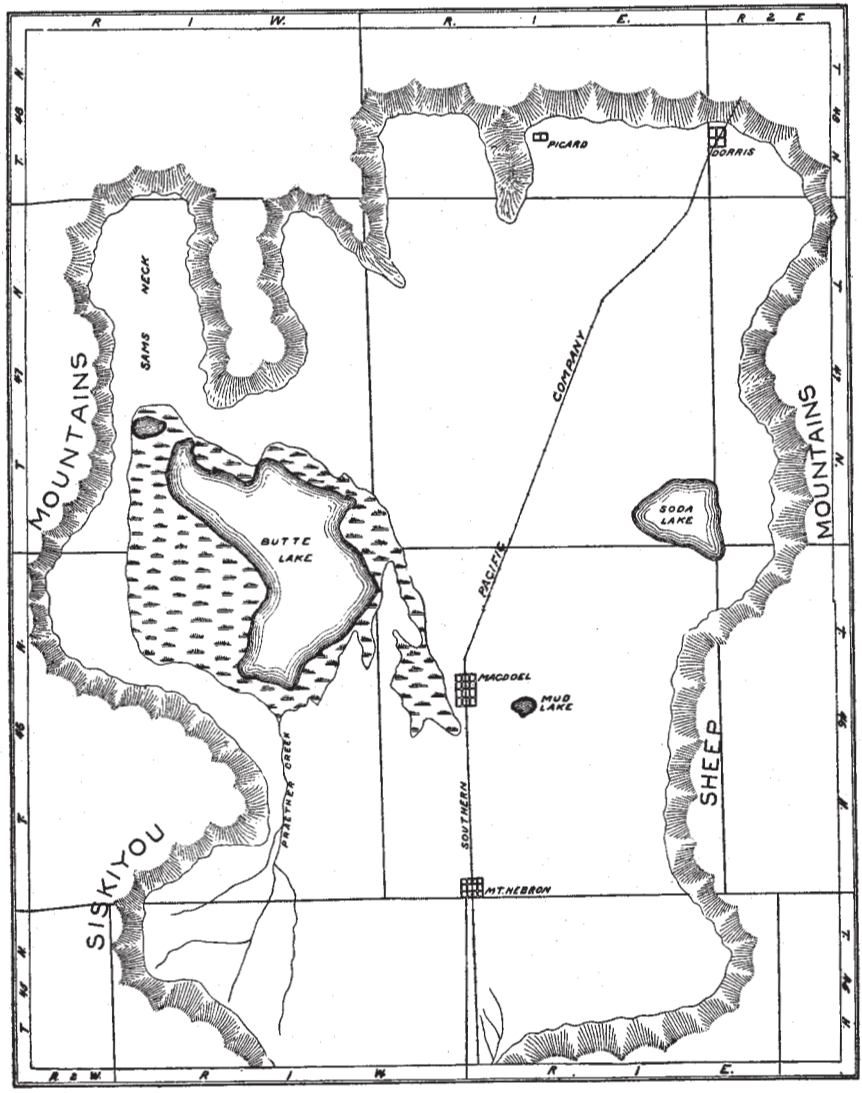


FIG. 2.—Map of Butte Valley.

subterranean waters from Butte Creek sink. Butte Lake has no outlet, but at one time undoubtedly flowed out through a little valley called Sams Neck into the Klamath River to the north. A later flow of lava shot across this arm, completely choking it and effectively

shutting off the outlet. Other lakes and ponds occur, namely, Alkali or Soda Lake, in the eastern part of the valley, covering 600 or 700 acres, and Mud Lake, just east of Macdoel, occupying about 40 acres. Springs burst forth from the basalt outcrop near the town of Macdoel, furnishing an abundance of excellent water.

Underground water, on account of the inclosed position of the valley preventing any sort of outlet, is found at a shallow depth, varying from 1 to 10 feet of the surface over the entire valley. It is uniformly abundant.

The timber and vegetation of the area are characteristic of this portion of California. The high Siskiyou Mountains are covered with a heavy growth of yellow pine, Douglas spruce, white fir, incense cedar, and tamarack pine, together with trembling aspen, maple, oak, wild cherry, and plum. The Sheep Mountains, to the west and north of the valley, are sparsely covered with juniper. Sagebrush (*Artemisia tridentata*) completes the covering of these hills and extends over the valley, except where it is too wet. Here it gives way to rabbit brush and occasionally to greasewood (*Sarcobatus vermiculatus*). The swamps are covered with tule-grass (Juncus), which furnish good grazing and wild hay. Butte Lake is full of tules (Scirpus) in its deepest portions, with tule-grass (Juncus) or open water in the shallows. The southern end of the valley is partly covered by yellow pine, in which several sawmills are operating. Large areas of wild currant appear on the high sandy soils about Macdoel. A number of wild grasses grow throughout the brush area, furnishing excellent feed for stock.

CLIMATE.

The climate of Butte Valley conforms closely to that of the Rocky Mountain and Great Basin regions in the States of Oregon, Washington, Idaho, Utah, and Colorado. The valley is situated almost exactly in 122° west longitude and 42° north latitude, at an altitude of about 4,200 feet above sea level. At this altitude the climate is cool in summer, with occasional snows in winter, and a large number of clear, sunny days throughout the year. The rainfall at Yreka, the county seat of Siskiyou County, situated 40 miles west of Butte Valley, averages, for twenty-eight years, 16.91 inches. At Klamath Falls, about 20 miles north of Butte Valley, the rainfall averages about 15 inches annually, varying between 20 inches for very wet years and 12 inches for dry years. This is probably very close to the rainfall for Butte Valley, but as no records have been taken until recently, no local data are available. The heaviest fall of rain occurs during the winter months, while the rainfall for the summer months of June, July, August, and September averages about half an inch

month. This summer rain is very beneficial to grass, forage crops, potatoes, and grain crops, which are planted during March and April, frequently enabling them to mature without irrigation late in summer or during September.

Like similar areas in this elevated region, frosts occur late in the spring and early in the fall. During the comparatively short summer season the growth of all vegetation is extremely rapid. This is due to the long, bright, clear summer days and uniformly warm temperature at this season. Oats and rye sown in April and May are ready for thrashing by September, and fruits are little, if any, behind those grown in warmer localities. The clear summer atmosphere produces a brilliant coloring in the apple and adds to its bright, clean appearance. Like similar areas of high altitude in Colorado and elsewhere, the sugar content of the sugar beet should be greatly increased. Plant diseases are rare, and crops are usually healthy and vigorous.

SETTLEMENT.

The settlement of Butte Valley began about 1880, when the abundance of feed, wood, and water attracted cattlemen thither. Large tracts were then bought for nominal sums and divided into half a dozen large cattle ranches, with headquarters in the edge of the timber on the sides of the valley. Considerable land on the higher, sloping, drier portions of the valley was not included and was later homesteaded by settlers, who began the cultivation of grain crops. This condition existed until a branch of the Southern Pacific Railroad was constructed through the valley to Klamath Falls, where the Klamath Falls reclamation project is in course of construction by the Federal Government. On the approach of the railroad some of the large ranches were subdivided and sold to actual settlers. This impetus to permanent agriculture led to the rapid erection of three towns in the valley—Dorris at the northern extremity, Mount Hebron at the southern end, and Macdoel in the central portion. Although a few months only have elapsed since the first small tracts were sold, the valley is dotted with homes.

SOILS.

The basaltic lava cap covering northeastern California, northern Nevada, Idaho, eastern Oregon, and eastern Washington, poured forth from many volcanoes, among which were Mount Shasta, Goose Nest, Mount Pitt, and Crater Lake, in the immediate vicinity of Butte Valley. Many rich and fertile valleys are found through this volcanic region, such as the Yakima and Wenatchee valleys of Washington;

the Baker, Grande Ronde, and Malheur valleys of Oregon; and the Payette and other valleys of Idaho, all noted for their grain, grasses, and fruits. Butte Valley, with its 90,000 acres of farm lands, is in many respects very similar.

The soils of the Butte Valley region are lacustrine or colluvial in origin, derived from the basaltic lava which forms the backbone of the mountains north of Mount Shasta and washed down into the valley and its slopes. Black scoria, or cinder, pumice, and volcanic ashes are of frequent occurrence and impart to the soils their gray color and light character. Accumulations of lime have been washed into the flat lake or valley, forming at a shallow depth in the soil a marly or clay marl subsoil. This stratum is quite general throughout the valley. It is usually but a few inches in thickness, though as it nears the hills it often becomes much thicker and more ashy or tufaceous in character. Water and roots usually permeate it easily, especially where it occurs in the sandy soils. The heavy loam soil often contains impervious layers of clay marl, but as this is found only in the worst alkali areas, it is readily detected and avoided.

The soils of the valley readily fall into two classes, depending on their texture. The light or sandy soils occur in the southern part of the valley and extend 2 or 3 miles north of Macdoel and along the eastern side of the valley; while the heavy or loamy soils are found in the lake region and over the valley floor north of Macdoel. To these classes of soils may be added the lake and marsh soils occurring in and around Butte Lake.

SANDY SOILS.

The sandy soils comprise about 47,000 acres of the valley, and of this area about 25,000 acres are level, arable land. The remainder is capable of cultivation and cropping, but is hilly or sloping and not suitable for irrigation.

According to texture, the sandy soils are divided into coarse sands, sandy loams, and fine sandy loams. The sand soils are found in the southern portion of the valley, about Macdoel and southward, where they are covered by the pines which grow far out on the valley floor. The sands usually occupy a more elevated position than the other soils and are well drained. These soils are readily recognized by the wild currant bush, which grows abundantly. The soil is dark gray to light brown in color, giving way to a lighter textured, lighter colored subsoil. In places a marly layer 4 to 6 inches thick is found. The water table is found at depths varying from 4 to 8 feet below the surface. The sand soils grow good crops of grain without irrigation. Cultivated crops, such as potatoes, beets, and all garden

vegetables, as well as alfalfa, clover, and timothy, do well. Berries of all sorts, apples, and pears will also grow well. The uneven topography and loose texture of these sand soils make irrigation by flooding difficult.

The sandy loam soils are found between Macdoel and Butte Lake, on the lower, more level portions of the valley. The wild currant occurs more rarely here, but rabbit brush and sagebrush are common. The soil is dark gray to dark brown, for the most part a sandy loam in texture, but becoming a fine sandy loam in the lower depressions near the swales or lake. It is about 30 inches in depth and underlain by a gray tufaceous subsoil which often becomes marly at 3 or 4 feet, below which a layer of black, water-bearing sand is usually found. In the depressions in this type alkali sometimes accumulates on the surface on account of the close approach of the water table. Such accumulations affect the surface layer of soil only, the lower depths being largely free from injurious salts. This body of sandy loam can be easily irrigated and produces good grain, alfalfa, timothy, potatoes, and vegetable crops especially. In years of abundant rainfall these crops do well under a system of dry farming without irrigation.

The sandy loam on the hill slopes bordering the valley is brown in color, often having a reddish tint. The subsoil at 3 feet is often heavier in texture and is commonly marly of a gray color to several feet in depth. Roots and water readily penetrate it. A large body of this variation of the sandy loam is found in the vicinity of Dorris. Good grain and potato crops are grown on it.

HEAVY SOILS.

The heavy soils occur in the lower portions of the valley north of the sandy loams above Macdoel. They consist of the gray loam and silt loam of the valley floor and the dark heavy loam of Sams Neck and in the vicinity of Butte Lake. In Sams Neck small adobe patches occur. These soils, exclusive of those found in Butte Lake, comprise about 30,000 acres, all of which is arable, irrigable, level land. The general topography is almost flat in appearance, but a slight rise north of Macdoel, passing toward Dorris, separates Butte Lake from Alkali Lake. Sagebrush of large size, rabbit brush, and occasional patches or streaks of greasewood are found. Low, shallow depressions occur, into which water finds its way during the wet season and is held for considerable periods of time on account of the poor natural drainage. Such places are sometimes barren and are always gray in appearance. This gray color has given rise to the supposition that the condition was due to alkali. It is really due to the accumulations of light gray

pumice and volcanic ashes which settle in the depressions. Such places are usually badly puddled and unproductive. Proper drainage would largely counteract this condition.

The soils vary in color from brown to gray, and in texture from loam to silt loam to a depth of 2 to 3 feet, where they are underlain by heavy reddish-brown or chocolate-brown loam or silt loam. At 4 feet in depth a marly or clay marl crust 4 to 6 inches thick is encountered, and this is usually underlain by water-bearing black sand or sandy loam. This sand is about a foot thick and in turn underlain by loam or silt loam. In the vicinity of the lakes the subsoil often changes to a chocolate-brown or brown clay loam. Near Alkali Lake is encountered a body of heavy brown impervious clay marl containing quantities of black alkali. This is an unusual occurrence. The loam in Sams Neck is dark brown in color, less marly in the subsoil, and free from alkali.

Alkali is sometimes found in this loam soil type. Such areas are easily distinguished by the growth of greasewood (*Sarcobatus vermiculatus*), as well as the occasional presence of salt grass. Loam soil containing injurious quantities of alkali is found extending westward or northwestward from Alkali Lake in intermittent strips over an area from 1 to 2 miles in width. The heavy greasewood patches contained from 0.37 to 0.50 per cent of alkali. The greater portion of the loam or heavy soils is free from injurious quantities of alkali, none appearing near the slopes of the valley. The greater part of the grain, mainly oats, produced in the valley is grown on these loam soils about Sams Neck, Picard, and Dorris. Alfalfa, sugar beets, clover, timothy, and potatoes are also well adapted to this soil.

LAKE AND MARSH SOILS.

The lake and marsh soils about Butte Lake, comprising about 10,000 acres, are too wet at present for tillage, but later may be partly or wholly drained. These soils are all loamy, except the sandy marsh soils near Macdoel, which are kept wet by springs. These latter soils are sandy loam. The western half of Butte Lake is considerably deeper than the eastern half, and often reaches a depth of 6 feet. The remainder of the lake is only 2 or 3 feet deep or less. The greater depth of the western portion favors the growth of large tules (Scirpus) and cat-tails (Typha). These form great masses of decaying matter, which gives the loam soil a friable mucky or peaty character and black color. These soils are extremely fertile, and when properly drained and cultivated produce immense crops of timothy, clover, redtop, potatoes, and all sorts of hardy vegetables, including celery and asparagus.

The eastern part of the lake contains soils of a gray puddled heavy loam character, which in spots grade into a gray clay loam. The subsoil is usually heavier in texture and lighter in color. Where covered with water, no injurious quantities of alkali are found except in the small clay loam spots. Along the borders of this soil, above the water line, alkali in moderate quantities sometimes occurs. The agricultural value of this heavy soil is readily determined by the growth of tule-grass (Juncus) which covers the better portions. The open water covers the poorer soils. The soil is adapted to the crops suitable to the other loam soils when properly drained and farmed.

The fertility of the soils of Butte Valley is everywhere evidenced by abundant crops of fruit, grain, grasses, and vegetables. The native vegetation, consisting of wild currant bushes, sagebrush, marsh-grass, buffalo-grass, and many other plants, shows all the soils to be productive, with the exception of those limited areas where alkali is found.

In the lower parts of the valley, as well as in the neighborhood of the lakes and swamps, quantities of rotted vegetable matter have produced large amounts of humus, or organic matter, in the loam soils found there. This humus, or organic content, ranges as high as 14 per cent in some of the muck soils. In the sand and sandy loams the humus is abundant and can usually be found to a considerable depth, imparting a dark color to the soil.

The formation of humus is greatly facilitated by the presence of an abundance of lime, which is everywhere common in the soils and subsoils. In the heavier soils lime is often concentrated about the third foot, occurring through 18 inches of the soil column. It also occurs in heavy subsoils in the form of concretions or small lenses.

In the sands and sandy loams lime is concentrated in the soil at a depth varying from 3 to 8 feet. This marl varies in thickness from one-half inch to 6 inches, although in the lower depths of the subsoil it sometimes occurs in strata 2 or 3 feet thick, when it includes large proportions of tufa. It is usually very soft and readily penetrated by roots and water.

The quantities of mineral plant food contained in the various soils of Butte Valley were determined by the official method, and the results are given in the table on page 13.

Results of chemical analyses of soils from Butte Valley, California.

Sample No.	Location.	Description.	Potash (K_2O).	Phosphoric acid (P_2O_5).	Lime (CaO).	Organic matter.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
[a] 17958	NW. sec. 4, T. 46 N., R. 1 W.	Soil, sandy loam, 0 to 12 inches.	0.29	0.06	.....	.....
17960	.....do.....	Subsoil, sandy loam, 24 to 36 inches.	.91	.08	.....	.....
17962	NW. sec. 36, T. 48 N., R. 1 W., near Dorris.	Soil, sandy loam, 0 to 12 inches.	.48	.06	1.79	.....
17965	.....do.....	Subsoil, sandy loam, 36 to 48 inches.	1.20	.11	3.98	.....
[b] 17968	NW. ¼ sec. 36, T. 46 N., R. 2 W.	Soil, sand, 0 to 12 inches.....	.34	.03	.....	.....
17971	.....do.....	Subsoil, sand, 36 to 48 inches..	.19	.04	.....	.....
17974	NW. ¼ sec. 5, T. 45 N., R. 2 W.	Soil, brown loam, 0 to 12 inches.	1.20	.21	1.92	.....
17977	.....do.....	Subsoil, brown loam, 36 to 48 inches.	1.33	.12	2.03	.....
17980	N. ½ sec. 9, T. 47 N., R. 1 W.	Soil, gray loam, 0 to 12 inches.	1.01	.09	1.61	.....
17983	.....do.....	Subsoil, gray loam, 36 to 48 inches.	2.55	.08	2.06	.....
[c] 17986	SW. corner of Butte Lake.	Soil, muck, 0 to 12 inches....	1.23	.20	.....	13.71
17987	.....do.....	Subsoil, muck, 12 to 24 inches	.55	.13	.....	10.31
17226	4 miles NE. of Macdoel.	Soil, gray, fine sandy loam, 0 to 8 inches.	1.04	.10	.....	.....
17227	.....do.....	Soil, silt loam, 0 to 24 inches.	2.42	.28	.84	.....
17228	.....do.....	Subsoil, silt loam, 24 to 48 inches.	1.85	.17	1.88	.....
17729	.....do.....	Deep subsoil, silt loam, 48 to 72 inches.	1.47	.27	.89	.....

[a] Distinctive vegetation, wild currant. [b] Distinctive vegetation, pine. [c] Tule swamp.

ALKALI IN SOILS.

After a careful study of the soils of the valley, it is very apparent that accumulations of alkali are not common, and, except for small areas in the immediate neighborhood of the lakes, it is not present in sufficient quantity to affect materially such crops as grain, clover, alfalfa, and sugar beets. Many analyses developed the fact that the alkali in the valley, on account of the predominance of lime carbonates, is largely black alkali, but in the sandy soils is nowhere deep-seated and in fact is found mainly in the first 2 inches in the first foot of soil or directly over the water table in a thin stratum in the subsoil.

On the loams at the north end of the Butte Valley alkali sometimes appears as a black crust in bare spots a few feet across, or on the sandy

loams on the borders of swamps, in white incrustations at the roots of the swamp grasses. Analyses of the soils in this locality and the growth of native vegetation and crops show only small quantities accumulated almost entirely in the surface crust. Such surface accumulations will yield at once to a system of flooding and drainage.

On the loams and heavier soils, alkali is concentrated below the surface in the heavy loam or silt loam subsoil in the second, third, and fourth feet. The first foot frequently consists mainly of white volcanic ash, or pumice, of a very fine sandy loam texture, which is sometimes mistaken for white alkali, but is very free from it, except in occasional low spots where water stands.

The worst alkali lands are plainly indicated by the growth of greasewood, where the quantity of alkali was found to range from 0.30 to 0.50 per cent. This greasewood land is found in the loam or silt loam soils between the north end of Butte Lake and Soda Lake in the east central part of the valley. It occurs in spots and strips among the sagebrush.

Analyses show the alkali to belong to the carbonate or black alkali type. The presence of the sulphates and chlorides, which are common forms of white alkali, is very limited. Common salt, sodium chloride, is very scarce and is not found in injurious quantities.

The remedy for injurious accumulations of alkali is efficient drainage, together with copious application of irrigation water to dissolve and wash out the alkali salts from the soil.

NATIVE VEGETATION AS A GUIDE IN SELECTING SOILS.

The native growth in the valley is an excellent guide in determining the various soils, their fertility, texture, depth, drainage, and alkali content. That portion of the valley covered with pine timber is usually underlain by sand or small gravel at 5 or 6 feet and is a deep porous soil with good underdrainage and usually free from marl. Other parts outside of the timber belt, covered with wild currant, incorrectly called "greasewood," consist of a well-drained sandy loam free from overflow. A heavy growth of sagebrush indicates a rich soil free from injurious amounts of alkali. Tule-grass (Juncus) indicates a swamp soil free from excessive amounts of alkali. Greasewood (*Sarcobatus vermiculatus*), however, shows that alkali is present, increasing in quantity with the size and quantity of greasewood. When greasewood is interspersed with rabbit brush the quantity of alkali is quite low and not prohibitive for ordinary crops. This native vegetation can guide the farmer in the direction of proper cropping. Thus, alfalfa grows best on level lands producing sagebrush, rabbit brush, or pine. Tule-grass (Juncus) land is too wet for it, and the pine land will need irrigation, while the remaining sandy

lands will need but little, if any, during normally wet years. Pine lands in the valley or lands covered with wild currant comprise the soils favorable for apples. The loams covered with sagebrush, rabbit brush, and similar growths are the soils favorable to sugar beets, grain, timothy, clover, and alfalfa, but not suitable for orchards.

IRRIGATION.

Irrigation has always been practiced to advantage in the valley since cultivation and cropping of the soils began. The sandy soils in the southern and the loam soils in the western parts of the valley, where small creeks and springs supplied water throughout the summer, were first irrigated. On account of the annual average rainfall dropping at times below 15 inches, irrigation will always be more or less necessary for securing heavy yields, especially with crops like alfalfa and sugar beets.

The whole valley floor is underlain by a water table at a depth varying from 1 to 10 feet. Over the main body of the level portion of the valley water is usually encountered from 4 to 6 feet from the surface. Crops of grain and alfalfa probably draw upon this supply directly. Other crops, such as potatoes, garden vegetables, or other cultivated crops, may secure a part of their moisture from this source when the soil is properly tilled.

This underground water is often under pressure, probably from the water which is lost at Butte Creek Sink. Such pressure is seen in the bubbling springs near Macdoel. As underground water is present over the whole valley at shallow depths, a great underground reservoir is always ready and available for pumping for the irrigation of crops. As the valley has no outlet, this supply will probably remain constant, varying with the annual rainfall.

QUALITY OF THE WATER OF THE VALLEY.

The waters in streams, springs, and wells, with the single exception of one spring at Mud Lake, were found to be quite pure and free from any injurious quantity of soluble salts. The springs contained on the average 20 parts of soluble matter per 100,000 parts of water, the surface wells from 10 to 40 parts per 100,000, and the streams from almost none to 10 parts per 100,000. These analyses show these waters to be quite pure and suitable for all domestic and irrigation purposes, especially the stream water, which is almost pure melted snow. In some of the alkali soils the wells contain considerably more alkali.

The water of Butte Lake, however, contains considerable quantities of alkali (120 parts of soluble salts per 100,000 parts of water), largely in the form of sodium carbonate, or black alkali. As a source

of irrigation water this lake is only available, therefore, for the better drained, loose sandy soils. Alkali Lake, situated in the east-central portion of the valley, is far too alkaline (305 parts of soluble salts per 100,000 parts of water) for either domestic or irrigation purposes. Mud Lake, a small pond covering about 40 acres in the low hills east of Macdoel, also contains very large quantities of alkali, and is unfit for either domestic or irrigation purposes. Cattle, however, drink these waters.

AGRICULTURAL CONDITIONS.

All the soils of the valley are well suited to grain crops, which have been grown to a limited extent for local demand for many years. Both heavy and sandy soils have produced good grain. The loams in the northern part of the valley at Picard and Sams Neck have been most extensively farmed.

Apple trees in the various small orchards in the valley have borne well, producing a fine, large, clear-skinned apple, free from all blemishes of insect and fungus pests and diseases. Every vegetable suited to the North Temperate Zone has been grown to surprising succulence and crispness. With these evidences and beginnings of agriculture before one, it is quite safe to predict the agricultural development of the valley.

Alfalfa, clover, and timothy will produce abundantly with little or no irrigation, according to the character of the soil and closeness of the ground water. Grains do well without water and will probably not need irrigation except in very dry years.

Sugar beets should prove a successful and profitable crop, and those grown experimentally have shown marked adaptation to the soil and climate. The level stretch of many thousands of acres, especially on the loam soils in the central and northern portions of the valley, when once cleared of sagebrush and other brushy growths, offer suitable soils for sugar beets. A promising crop for rotation with sugar beets is the Canada field pea, which will probably grow well in Butte Valley, for it has done very well in valleys of like altitude and climate in Colorado, as well as in several places in California. Great quantities of this seed are annually brought into California for use in growing this crop for green manuring purposes. The vine makes an excellent hay, especially for fattening young lambs for market. This industry alone has increased the value of the lands of the San Luis Valley in Colorado (a valley similar in many respects to Butte Valley) several fold. Canada peas and similar legume crops will enrich the soil and render it better fitted for sugar beets and grain crops.

Until such time as the tule-grass (Juncus) swamps can be drained and reclaimed for farming, they can be vastly improved for hay and pasturing purposes by sowing broadcast in the fall the seed of redtop

grass and velvet grass. These grasses make excellent feed and hay and will renew themselves by seed each year, thus permanently improving the swamp pastures where water does not stand too long or too deep.

Asparagus is another crop which will grow well if placed on the lower or more moist sandy loams. Some of the sandy loam tule-grass swamps if properly ditched and drained will undoubtedly produce excellent asparagus.

Hop soils are found in the sandy loam west of Macdoel, where the soil is loose and pliable and the ground water can be reached by the vine. The climate appears to be favorable to the production of a fine, bright hop. The poles necessary for the hop fields can be procured cheaply from the neighboring forests.

Potatoes grow well and should be a profitable crop on most of the soils in the valley where the soils are not too wet. When Butte Lake is drained the muck and loams now occupied by tules will produce excellent potatoes.

Garden vegetables have proven uniformly successful and excellent, especially cabbage, parsnips, turnips, beets, peas, and lettuce.

Apples will undoubtedly prove a valuable and extensively grown crop, for, except for occasional late spring frosts, the climate is ideal. Such small orchards as have been planted produce good crops of beautifully colored, clean, bright-skinned fruit. No pest affecting fruit or foliage has yet appeared, though caution should be exercised to prevent them from entering the valley.

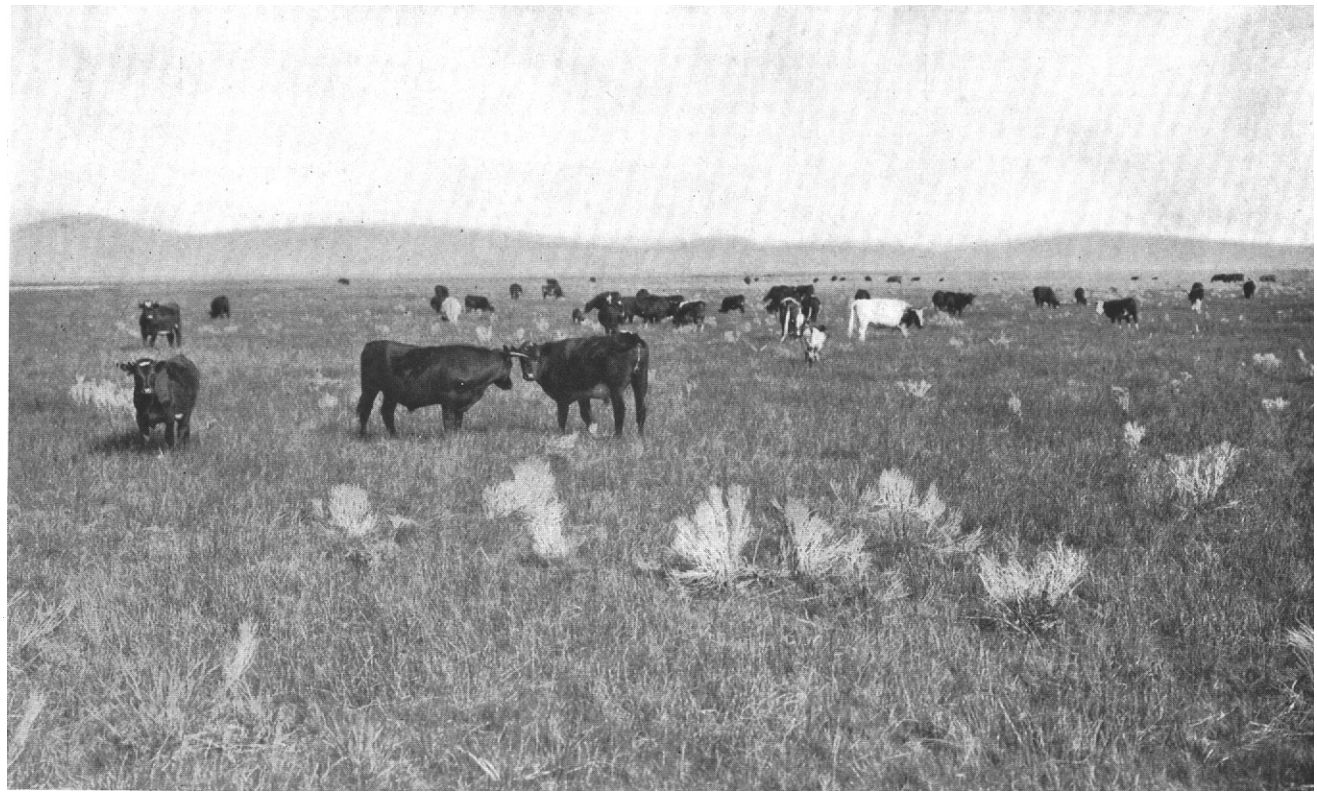
In selecting apple soils great care should be exercised, for not all soils in the valley are suited to the culture of this fruit. The apple soils are found principally along the edges of coves of the valley, but they extend for a mile or two into the valley in the sandy loams where drainage is good and the water table 5 feet or more below the surface. The sandy loams in the valley floor suited for apples are readily found by the prevalence of the native growth of wild currant or even of pine. Sandy loams on the slopes along the eastern side of the valley, even when far above the ground water, will produce good apples. The dark-brown and reddish-brown loams along the western edge and slopes should also produce excellent apples. These loams vary considerably from the loams in the flat floor of the valley in their porosity and mellowness and their freedom from volcanic ash or any trace of alkali. This is due to better drainage and greater depth of water. In summing up, it may be definitely stated that the apple soils occur about the edges of the entire valley, where the ground water is considerably below the surface, on all the pine lands of the valley floor, and on those sandy loams growing considerable quantities of wild currant, the presence of this plant indicating a sufficient

depth of water table. Great care should be exercised in avoiding soils where the water rises above 4 or 5 feet of the surface, for the apple likes well-drained soils.

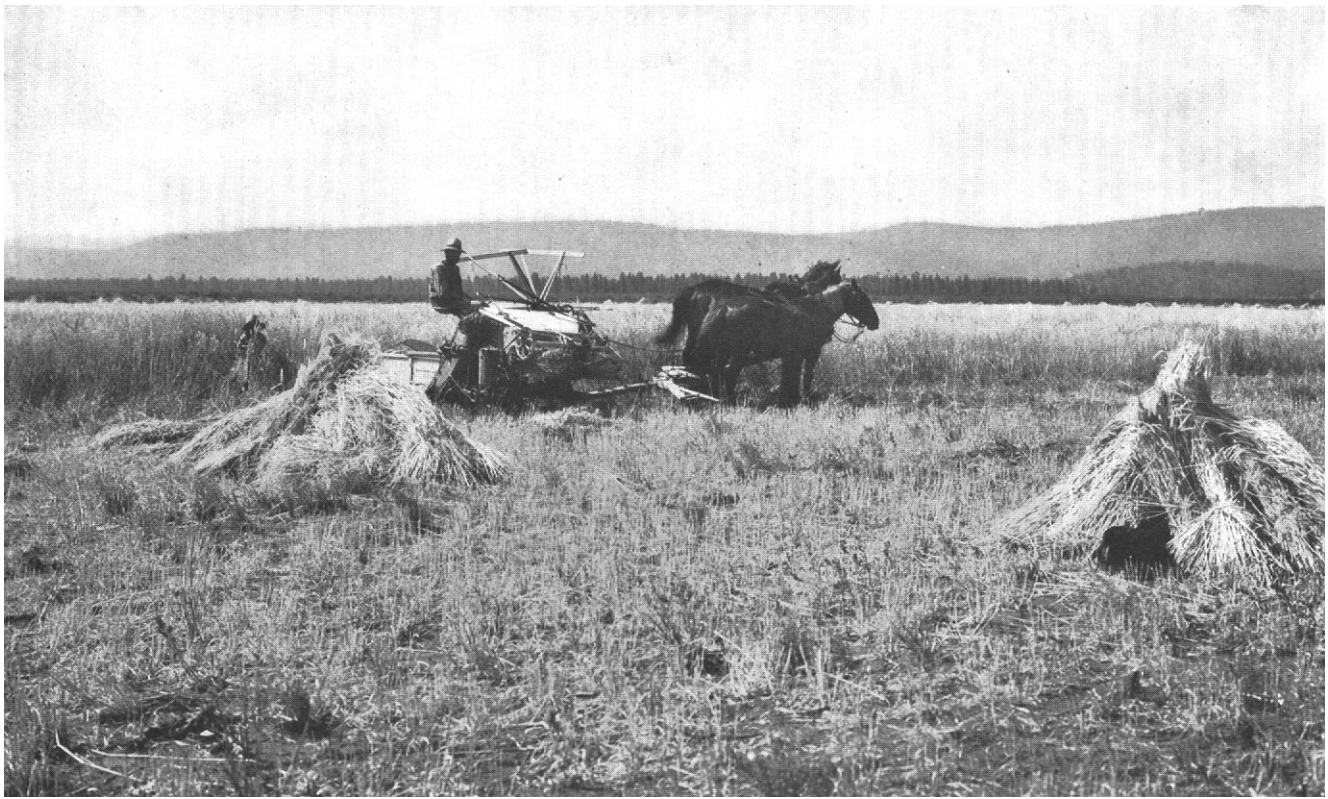
In extensive apple planting only three or four of the standard shipping and storing varieties well adapted to climates like Butte Valley should be selected. Among the foremost of these varieties may be mentioned the Spitzenberg, Newtown Pippin, Northern Spy, Jonathan, and Rome Beauty. Many other varieties which require full and bright color will do well, because a cloudless summer gives plenty of brightness and color to the fruit, but the main dependence should be placed on a few standard varieties.

Pears will grow on all soils suited to apples and perhaps also on wetter, heavier, and more alkaline soils. Cherries, however, need better drained, drier, and deeper soils than apples, with the water table at a good depth or a freedom from flooded condition at all times. The slopes of sandy loams about the valley are better suited to this fruit.

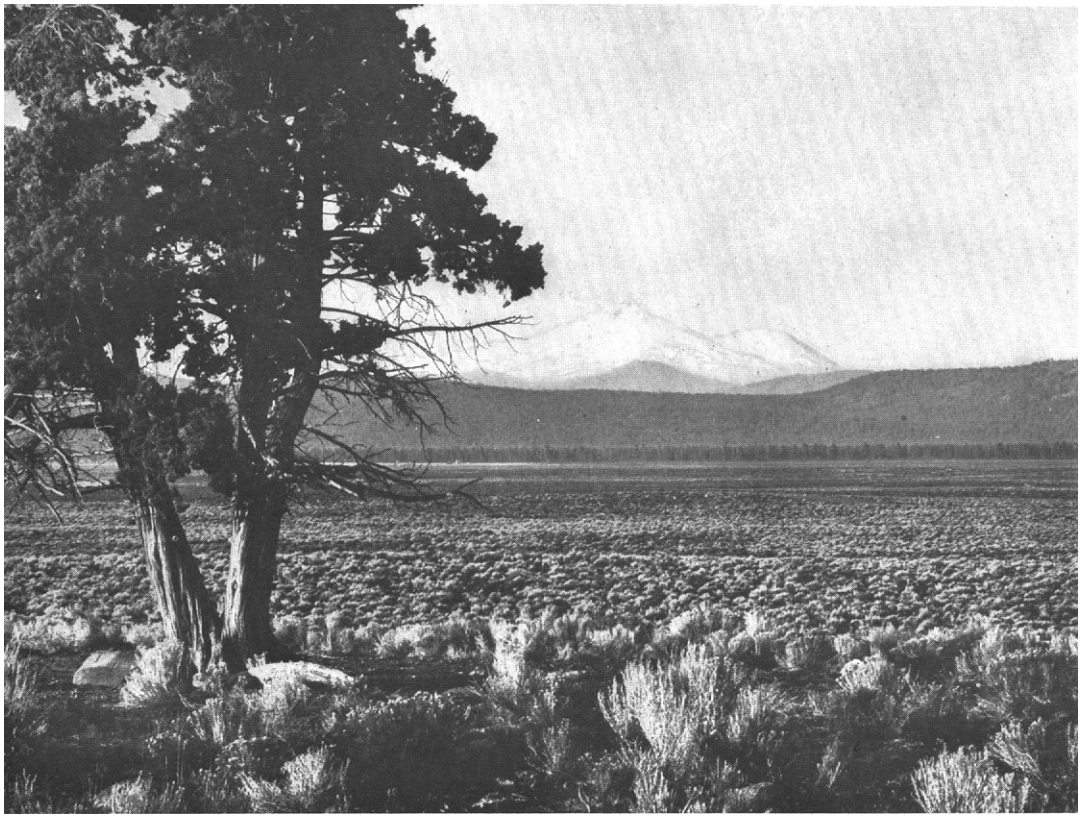
Plums, quinces, and berries, especially blackberries, raspberries, and currants, will also do well on the apple soil, and can be profitably grown between the rows of orchard trees during the years before the orchards come into bearing.



TULE-GRASS SWAMP, CHARACTERISTIC OF SANDY LOAM SOILS NEAR BUTTE LAKE.



HARVESTING THE FIRST CROP OF RYE WHERE SAGEBRUSH GREW IN APRIL.



BUTTE VALLEY, LOOKING SOUTHWEST TO MOUNT SHASTA. RABBIT BRUSH GROWING ON SANDY LOAM SOILS AND YELLOW PINE FORESTS ON HIGHER SLOPING LANDS OF THE VALLEY.

A POTATO FIELD ON LIGHT SANDY SOILS.

In many years no irrigation is necessary to insure heavy yields.

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