UNIVERSITY OF CALIFORNIA-COLLEGE OF AGRICULTURE.

AGRICULTURAL EXPERIMENT STATION.

REPORT

ON THE

AGRICULTURAL EXPERIMENT STATIONS

OF THE

UNIVERSITY OF CALIFORNIA,

WITH

DESCRIPTIONS OF THE REGIONS REPRESENTED.

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BEING A PART OF THE COMBINED REPORTS FOR 1888 AND 1889.

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THE SOUTHERN COAST RANGE STATION.

Location: Two miles north-northeast from Paso Robles, San Luis Obispo County.

The Coast Range Region at Large.—The Coast Range region forms a belt varying in width from forty to sixty miles, lying between the Great Valley of California and the seacoast. It is traversed by numerous more or less disconnected ranges, mostly trending parallel to, or at a small angle with, the coast line. From Mendocino County, inclusive, southward to the northern end of the San Bernardino Range, few points or crests exceed the height of four thousand feet, and most of the higher ranges remain between three thousand and three thousand five hundred feet. Many of these are very rugged and barren, and largely treeless; of the lower ranges, from two thousand to two thousand five hundred feet, many are rounded in outline, largely forest-clad, deeply covered with soil, and in the moister portion of the region susceptible of cultivation to the summits. The higher portions are thus far occupied as grazing grounds only, the bulk of the cultivated lands lying in the valleys or on the lower slopes and hill lands.

In conformity to the mountain ranges, the larger valleys also mostly trend more or less parallel to the coast; while those of smaller streams, descending from the outer slope of the Coast Ranges to the sea, generally open more nearly at right angles, thus giving free access to the coast winds. The latter condition determines very great differences in local and even regional climates; and as the California coast extends through nine and a half degrees of latitude (coextensive with the Atlantic Coast from Boston to Savannah, Georgia), with a rainfall ranging from eighty inches down to ten, it may readily be imagined that no *one* culture station can even approximately represent the Coast Range region *as a whole*. The Central Station at Berkeley, although geographically nearly central, north and south, really has an exceptional climate, dominated by the cool currents and summer fogs that enter through the Golden Gate, and thus represents only the immediate seaward slope of the central portion of the coast for a few miles inland. It thus becomes necessary to make a choice of such portion of the extensive region as seems to stand most in need of an experiment station for its immediate future, thus benefiting the largest number of agriculturists.

It has been thought that these conditions would be best fulfilled by the establishment of a culture sub-station at some point in the largest valley of the southern Coast Range—that of the Salinas River—representing a very large area of agricultural land, just being opened by the extension of the Southern Pacific Railroad, and but little tried as to its productive capabilities. As the needful offers of land and money for station buildings were made from the upper Salinas Valley, two personal visits to that region were made for the purpose of exploration and final location. The following description of the region, for the special benefit of which the "Southern Coast Range Station" was established, is based partly upon these visits, partly upon data obtained in connection with the census of 1880, and heretofore published in the reports of that work. (See Vol. 6, monograph on "The Physical and Agricultural Features of California.")

The Southern Coast Range region, as here understood (*i. e.*, exclusive of the "bay counties" north of the Bay of Monterey), embraces the counties of Monterey, San Benito, San Luis Obispo, Santa Barbara, and Ventura, with the extreme western portions of Stanislaus, Merced, Fresno, Tulare, and Kern that lie westward of the Great Valley.

The main mountain ranges of this region are, in the northern portion, and bordering the San Joaquin Valley on the west, the southern continuation of the Mount Diablo Range, which loses its identity in the lower, spreading ridges of southern San Benito; next to westward the (mostly treeless) Gabilan Range, flanking the Salinas Valley on the east; while the Santa Lucia Range and its offshoots lie between that valley and the coast, with a width of about thirty miles; high hills reaching to or within a short distance of the coast, the small coastward streams, being usually accompanied by valleys of greater or less width. The coast mountains are in places heavily timbered on their lower slopes and in the cañons with Monterey pine (*P. insignis*), Monterey cypress (*C. macrocarpa*), live oaks (*Q. agrifolia, Wislizeni*), blue, white, and black oaks (*Q. Douglasii, lobata, Kelloggii*), the California buckeye, laurel, etc. Farther southward, toward the junction of the Coast Range with the Sierra Nevada, we find a broad and extensive region of high mountains—the Sierra San Rafael—in the eastern part of Santa Barbara and northern part of Ventura Counties. merging on the southeast into the San Bernardino Range. Near the coast, in the southern part of Santa Barbara County, there is a small but rugged range, the Sierra Santa Inez, from two thousand to three thousand feet in height, trending nearly due east, parallel to the coast below Point Concepcion.

Climate.—The climate of the coastward slope of the outer range, and of the valleys opening directly upon the coast, is so different from that of the region to eastward of the Santa Lucia divide that a special station only could represent it. The direct influx of the trade winds imparts a moisture to the air and insures it a relatively steady temperate thermometric record, corresponding to the "bay climate" of the San Francisco region, with a rainfall but little lower; the average of fourteen years' observations at San Luis Obispo being twenty-one inches, against about twenty-four at San Francisco. Passing the crest of the Coast Range to eastward, we are at once transported to the dry atmosphere of the interior; but owing to altitude, the rainfall is greater (about fourteen inches against six) and the average temperature lower than in adjacent portions of the Great Valley. Hence here, as on the coastward slope, irrigation is not necessary for general field crops, although the command of irrigation water is always desirable.

Agriculture.—Until recently the western slope of the immediate Coast Ranges, and the valleys pertaining thereto, have been the chief agricultural districts of the region, the interior being given up to stock ranches. Carmel Valley, in Monterey County; the San Luis, Arroyo Grande, Santa Maria, and other minor valleys of San Luis Obispo County; the Santa Maria, Todos Santos, and Santa Inez Valleys, together with coast "vegas" of Santa Barbara and Carpenteria, in Santa Barbara County; finally the lower valley of the Santa Clara River, and the fertile coast plain of Saticoy and San Buenaventura, in Ventura County, have long been noted for their choice and abundant products, both of the field, dairy, and orchard, and have fed a heavy coastwise trade, to which the country beyond the crest of the Coast Range contributed only cattle, horses, and wool. The opening of the railroad to the upper Salinas Valley bids fair to change both the

nature and the quantity of the products of the interior country, and to place it on a level with the coastward slope as an agricultural region.

Rocks and Soils of the Region.—The greater part of the several ranges just mentioned is formed of rocks of the tertiary period, consisting of more or less calcareous sandstones, claystones, and clays; sometimes in their original, horizontally stratified condition, but oftener folded, faulted, and sometimes intricately contorted, and then often associated with various crystalline rocks, often granitic, but along the immediate Coast Range very generally serpentinous or talcose.

Of course the soils vary in accordance with the rocks from which they have been formed; those derived from the tertiary clays and soft claystones are predominantly "adobe" or heavy clay soils, mostly brown or blackish, and very commonly overlie the very rocks from which they are derived ("colluvial" and "sedentary"); they are found on the higher lands rather than in valleys, and usually appear on the "divides" and ridge lands generally, as well as in the higher valleys. On the coast slope the valley soils, owing to the more complex nature of the rocks, are predominantly loams, more or less heavy or sandy, sometimes ferruginous. In the interior region, the valley and mesa soils are almost throughout quite light, often gravelly. On the slope toward the San Joaquin Valley, the sand is derived from the tertiary strata forming the hills themselves, and is largely quartzose; while in the Salinas Valley, the soil is predominantly composed of *granitic* debris, derived from the granitic region about the heads of the river, being the northwestern end of the granitic mass that forms the San Rafael and San Bernardino Ranges. This granite weathers very rapidly, and has yielded prodigious masses of granitic sand and gravel, which have filled to great depths not only the plains of the upper Salinas, but form a very large ingredient of the valley lands down to the Bay of Monterey, and are doubtless largely concerned in the high productiveness for which that valley is noted in the portions that have been longer under cultivation, in northern Monterey.

It is not intended in this report to give a detailed description of the *whole* of the southern Coast Range region, but mainly of that portion represented by the station that has been established in the upper Salinas Valley. It is therefore to the latter that the details hereafter given mainly refer.

THE SALINAS VALLEY.—The Salinas Valley divides naturally into an "upper" and "lower" portion, differing considerably in climatic as well as in soil conditions.

The *lower valley* is a club-shaped area, widest at its lower end, extending from Monterey Bay southeastward about ninety miles, with a width of from twelve to eight miles for the first fifty miles, when (about San Ardo Station) it rapidly narrows, thereafter rarely exceeding one mile in width and frequently narrowing so that the broad, sandy bed of the river occupies the entire valley, while at the same time it rapidly ascends toward the point where, near the old Mission San Miguel, at an elevation of six hundred and sixteen feet, the plains of the upper valley begin. The narrow portion is not, however, a cañon, but is bordered by sloping hills rising rather gradually toward the crests of the ranges. The wider portion of the lower valley presents a terraced and almost treeless plain, with but a few live oaks, and sycamore, willow, and cottonwood along the river itself. The alluvial bottom lands here are from a quarter to half a mile wide, their soils rather sandy, and are bordered by a bench or second bottom of adobe soils, from one to two and a half miles wide. The river flows mostly on the west side of the valley, a region of mesa lands lying between it and

the Santa Lucia Range, still farther to westward. On the eastern side of the valley the adobe bench lands are again bordered by a sharply defined terrace ten to twelve feet higher, rising gently toward the Gabilan Range. The surface of this terrace is rather rolling, and its soils are coarse, red, and gravelly, affording excellent farming lands. Until within the last few years the valley above Salinas City was occupied chiefly as a stock range, it being reported that the high winds prevailing through the year rendered it unsuitable for farming purposes. Like many of the tales made current by the stockmen, *this* has vanished before a more impartial view of the situation; and the lower valley is being rapidly settled up along the railroad. Its rainfall is rather low, despite its full exposure to the ocean winds, being at Soledad only between eight and ten inches. Irrigation from the river is, however, perfectly practicable, if found necessary. Scarcely any affluents enter this part of the valley from the west side, the waters of the Santa Lucia Range all flowing to seaward. From the Gabilan Range quite a number of streams, but mostly of very small volume and intermittent flow, come in.

The Upper Salinas Valley may be said to begin where the larger affluents come in from both sides; the Nacimiento being the first to enter, at Bradley Station, from the west; and a short distance above, the Estrella and Huerhuero from the east. The Nacimiento has only a narrow valley and has in general the character of a mountain stream, as is the case with all the western affluents above; while the Estrella, Huerhuero, and their tributaries share the peculiarity of wide, sandy beds, in which the water is for long stretches visible only in time of flood, although easily reached and quite abundant in the sand with which their channels are filled. Even in the main Salinas this characteristic exists to such extent that considerable caution is required in fording at unknown points, although running water usually exists in it above the sand, throughout the season.

The table below gives in summary form the most important *meteorological* data thus far available for the upper Salinas Valley. It should be borne in mind that, as it happens, the years included within these observations were, throughout that portion of the State north of the San Bernardino Range, seasons of exceptionally light rainfall; while the reverse was true of the country lying to southward. Probably the average drawn by taking into calculation the extraordinarily heavy rainfall of 1889–90 would more nearly represent the true general average of the upper valley:

Table showing the Rainfall and Average and Extreme Temperature for Summer and Winter in the Upper Salinas Valley. From observations of two years from November, 1886, to December, 1888, inclusive.

Location.	Elevation—Feet.	Rainfall—Inches.	Winter Temperature.				Summer Temperature.			
			Average Maximum.	Average Minimum.	Extreme Minimum.	Average Mean.	Average Maximum.	Average Minimum.	Extreme Maximum.	Average Mean.
San Miguel	616	10.0	72.3	23.5	17.0	47 6	106.3	51.0	108.0	71.2
Templeton	.....	14.2	76.5	23.0	13.0	48.2	104.2	51.3	108.0	71.6
Paso Robles	.....	11.9	70.8	19.8	15.0	45.9	101.6	47.6	103.0	70.7

It is of some interest to compare these data with the corresponding ones for the Tulare Valley, nearly in the same latitudes. It is thus shown that on

the whole the upper Salinas Valley climate is materially cooler, as might be expected from its greater elevation and proximity to the coast. The extreme winter minima (so important in determining cultural possibilities) are about 4 degrees lower than the average of the three Tulare Valley stations (Fresno, Tulare City, and Bakersfield); on the other hand, the winter maxima average about 3 degrees higher. The winter means differ about 2 degrees in favor of the Great Valley. As to the summer, the extreme maxima are from 5 to 7 degrees lower in the Salinas region, the minima fully 10 degrees, the average mean for the summer nearly 12 degrees. Add to this a rainfall more than twice as great on an average, and (probably) a higher average of moisture in the air, and it becomes easily intelligible how the upper Salinas Valley can, for ordinary crops at least, do without irrigation; and how persons from the valley, as well as from the coast slopes, may be benefited by the climatic change to the Salinas plateau.

Agriculture.—The main *crop* of the upper valley, since pasturage has been largely superseded by agriculture, has thus far been grain; the usual first resort in a new region. But the obvious fact that the light, deep granitic soils of the Estrella Plains are not best adapted to grain culture, even if such use were otherwise profitable, early led to experiments in fruit growing; with highly encouraging results when it is considered that the pruning of the trees to high standards placed them under the grievous disadvantage of being liable to sunburn on the south and southwest sides. Some of the older plantings have been badly disfigured and injured from this cause; and yet the results have been both good in quality and profitable in the local markets. There can be no doubt that with the low pruning practiced elsewhere in the State, and here especially indicated by the shape of the natural tree growth (which is low and spreading), all kinds of deciduous fruits, the olive, the vine, and perhaps the citrus fruits as well, will find a congenial home here. Some experience leads to the belief that a late crop of Bartlett pears will be likely to prove particularly remunerative. In the bottom lands of the Salinas and Huerhuero, alfalfa, maize, sorghum, and other forage crops have given excellent results without irrigation.

Hydrographic Features of the Upper Salinas Valley.—The main river keeps along the foothills of the Santa Lucia Range, on the western border of the upper valley, and its extreme heads lie in a broken region to eastward of the Santa Margarita Ranch; far short of the heads of the Estrella, which reach at least twenty miles farther to the southwest, and should, according to geographical usage, constitute it the main river. Its inferior water volume has probably prevented the popular acceptance of this view. Between the heads of the two streams there intervenes a chiefly granitic mountain mass, which may be considered as the most northerly spur of the Sierra San Rafael. Emerging from its narrow valley above La Panza, San Juan Creek, the main head of the Estrella, still keeps to eastward along the foot of a hilly country until it is joined by Cholame Creek, which flows from the north around the most southerly spur of the Gabilan Range, here designated as the Cholame; then after flowing due west for eight miles, it continues northwesterly along the western foot of the Gabilan, joining the main Salinas near San Miguel.

Between the course of the Salinas and that of the Estrella, just debed, scrilies the main body of the "Upper Valley," which from Paso Robles across to the Cholame Range is about ten miles wide, and from San Miguel to the foot of the granitic hills to southward, about eighteen miles. It is in the main a gently rolling plain—"Estrella Plain"—rising

to about one thousand feet altitude in its higher portions, and into which several minor watercourses, among which the Huerhuero is the largest and best known, have cut narrow valleys, often little exceeding the width of the rambling, sandy channel itself. From these the rise to the level of the plain or mesa is usually by several well defined terraces or benches, showing clearly that at previous periods the water level was much higher, and has been lowered by successive breaks in the obstruction intervening between the upper and lower valleys. In fact, it is obvious that at one time the entire upper valley was practically a lake, during the existence of which the deep granitic sand, that forms the main body of the uplands, was brought from above and deposited in the bed previously scooped out in the deposits of (tertiary) clays, marls, and claystones, that even now form the bordering ridge on the east bank of the main Salinas, and which jut out here and there into the plain itself at the present time. But, from the existence of high bluff banks of clay and loam along the streams, underlying the granitic upland soil, it also appears that before the coming down of the flood of granitic sand there was a time when clayey and fine, sandy materials were chiefly brought down into the lake bed.

In the absence of a close examination of the country above, it is not possible to designate more precisely the sources of these several materials or the cause of the apparently sudden and complete change in the nature of the soils formed. What has been said will suffice for an understanding of the manner in which the several kinds of land are disposed with respect to each other. A cross-section of the country from Templeton and Paso Robles, on the Salinas, to the Huerhuero and beyond will illustrate this.

Templeton is situated on the west bank of the Salinas River, on a bench about thirty feet above the flood plain; this bench extends about five miles to westward, to the foot of the Coast Range, and has a gravelly loam soil, which, under good cultivation, is very productive. Like most of the upper valley, it bears a sparse but vigorous growth of white and blue oaks.

Crossing the river, we find a bluff about sixty feet high, composed below of horizontal beds of partly siliceous, partly calcareous claystone, with some marl beds containing oyster and other marine shells to show their origin; while the higher part of the bluff is composed of a puddingstone formed of white siliceous (hornstone) pebbles, similar to those that are abundantly found on the surface of the gravelly areas, on the Salinas slope, while they are wanting on the Huerhuero side. The soils become heavier as we ascend the divide, and on the latter a well defined brown adobe prevails, sometimes underlaid by a calcareous hardpan. Descending on the east slope toward the Huerhuero, we find on the higher portion of the slope the coarse, sandy, granitic soil overlying the adobe; lower down, the immediate slopes of the creeks and of the Huerhuero itself are formed of a rather sandy, yellowish loam, underlaid by gravel, and this sometimes by heavy, blue clay, near the water level. Trees and shrubs seem to grow on this loam wherever it is exposed, without reference to its depth below the surface of the stratum.

The town of *Paso Robles* is located on a bench very like that at Templeton, but of much less extent east and west; the town fronting on the river and leaning against the Coast Range in the rear, although with abundant room to extend up and down the river. Here also the same gravelly surface, underlaid by a substantial yellowish loam, is seen, and in the river itself we observe the same strata as near Templeton and above, viz.: whitish hornstone, overlaid by puddingstone made of similar materials, and whitish clays. Ascending the bluff on the east side, we see the gravelly slopes with more or less of dark-colored clay that has been washed

down from above, and then find ourselves in an undulating country—bunch-grass land dotted with oaks—in which the soil is largely adobe nearest the river, but alternates with sandy streaks as we progress eastward, until within a mile from the river we reach the regular granitic, sandy lands, with here and there hillocks of black or brown adobe land projecting above it. These grow fewer to eastward and are finally submerged altogether in the sandy mesa, which then continues to the Huerhuero, and beyond to the Estrella.

These hillocks are noteworthy for the luxuriance of their vegetation, and its freshness at the time when the sandy lands are already assuming their brown summer garb. The cause of this difference will be discussed below, in connection with the soils of the station.

Crossing the Huerhuero to eastward, we find the granitic sand filling the bed and forming terraces on the opposite side, the soils of which appear to be the same all the way to the top level of the mesa; nor, in digging down in the latter, is any material change observed for six or eight feet; nor does any important change seem to occur all the way from the Huerhuero to the Estrella, except that the tree growth, which, between the former stream and the Salinas is quite abundant, becomes thinner as the Estrella is approached. This is ascribed by the inhabitants to a diminishing rainfall as we go east, the immediate neighborhood of that stream being credited with less than two thirds of the rainfall observed near the Salinas. The Cholame Range, beyond the Estrella, is covered with a sparse growth of pine on its higher portions.

The tree growth of the entire region consists of scattered oaks or groups of oaks, thickly hung with lichen (*Evernia*), giving it a park-like and very attractive appearance. The ground is usually dotted with bunch grasses of various kinds, with much alfilerilla and a great variety of flowers, and affords fine pasture. The oaks are almost exclusively of two kinds: the white oak on the low land and in the gulches; the blue oak, magnificently developed, on the mesa land, whether sandy or adobe. The average density of the tree growth was well gauged on the station grounds, where about one hundred trees were grubbed out of twenty acres, or an average of five trees per acre.

Other Features of the Upper Valley Region.—As outlying portions of the upper valley, three regions require mention. One is the *Cholame Valley*, drained by the two creeks ("Big" and "Little") of the same name; the former heading about thirty-six miles to *northward* of its junction with the Estrella, on the eastern slope of the Gabilan; the latter (a much smaller stream) on the western slope of the border range of the San Joaquin Valley. These valleys comprise considerable bodies of excellent agricultural land, also in past times reported to be good for stock grazing only; but being now rapidly settled, with excellent results without irrigation. The soils are reported as being yellowish loams, without much gravel; therefore entirely different from the mesa soils of the Estrella Plain, but probably of the same character as the loam bluffs on the borders of the Huerhuero and its tributaries. Probably the Cholame country was too high to be overrun by the flood that carried down the granitic sand soils.

The other outlying area to be mentioned is the *Carisa Plain*, a valley or basin averaging about three hundred feet elevation above the Estrella Plain, and of considerable extent—said to be about ten miles wide by sixty in length. It lies to eastward across a low ridge from the upper San Juan Valley, and is bounded on the east by the western slope of the border range of the San Joaquin Valley. The drainage of this basin would naturally lie toward the north, and form an eastern affluent of the San Juan;

but it seems to have no natural drainage whatever, but instead, in its middle portion, a succession of salt marshes and lakes, five miles in length, having water only during the rainy season. It is stated that the prevailing soil of the Carisa Plain is a deep, friable loam, and on the rolling land, and part of the plain, a heavy, gray adobe, of course largely infested with alkali; but that, while no drinkable water exists on the surface, it forms a good sheep pasture in spring, the animals finding the necessary moisture in the succulent herbage. In summer it was said to be uninhabitable for lack of water, but this statement is denied by the large ranchers and settlers that have of late established themselves there.

It would seem amply worth while to make a close examination of this region to determine more accurately the nature of its soil, and especially the possibility of obtaining water from artesian wells. Its altitude is not so great as to render this improbable, considering that it lies considerably below the crests of several neighboring ranges.

The eastern slope of the Santa Lucia, or outer Coast Range, from which flow a number of lively permanent streams, such as the San Marcos, Paso Robles, and Atascadero Creeks, has along these streams some fine foothill country and valley lands; not in large bodies, but in the aggregate forming a considerable area of farming land of great fertility. As the rocks vary greatly from ridge to ridge, the soils of the valleys vary correspondingly; but perhaps the most common and important soil of the valleys is that resulting from the weathering of clay slate, which forms a rather heavy and (judging from the tree and shrubby growth upon it) a very substantial soil, often bearing enormous old white oaks, together with the coast live oak (*Q. agrifolia*). The results of cultivation and fruit planting on Baron von Schroeder's ranch, in the hills just west of Cashin Station, have been excellent, the main difficulty being in occasional late frosts where high hills adjoin the valleys. When the country is settled up, many pleasant homes will be made in these mountain valleys.

Location of the Station.—Since from the foregoing observations it appears that not only does the granitic soil occupy the largest area in the region, but that it is of considerable uniformity over its entire cross-section from the Salinas to the Estrella, it seemed proper to locate the station mainly with reference to this predominant soil, and in so doing to consider the convenience of proximity to the railroad. After examining many possible locations it was concluded to accept the offer of Mr. J. V. Webster, of Creston (who had taken the most lively interest in the matter), of a tract of twenty acres lying about two miles north of Paso Robles, three quarters of a mile east from the Salinas River, and about eighty feet above it, on the plateau level; on the main road from Paso Robles to the Huerhuero settlements, and within the region where the adobe knolls project through the granitic sand soil, so as to permit of a representation of both kinds of land within its limits.

The tract, as is shown on the plat (page 104), is a parallelogram one thousand seven hundred and ten by four hundred and ninety-five feet, the latter dimension representing its frontage on the public road, while the longer runs due north and south. The forward (southernmost) two thirds of the tract is practically level, and represents the typical soil of the plains to the eastward; while in the rear third there are two additional soil varieties, to wit: that of the swales in the sandy lands, and on the northwest corner, a triangular, sloping piece of heavy adobe clay land. The latter forms the foot of one of the hillocks already mentioned, on the top of which there is an extraordinarily luxuriant vegetation lasting far into the summer. In the northeast corner is included part of a "hog-wallow" area, the

soil of which is slightly heavier than that of the front portion, yet not materially different.

Details of the Soils of the Station.—The sandy loam which occupies the larger portion of the experimental tract, and is substantially the same as that of the "Estrella Plains" at large, consists, as already stated, mainly of granitic sand, intermingled with a larger or smaller proportion (according to location with respect to the adobe hills) of white hornstone and claystone debris, most of which are little if at all waterworn. A small but somewhat variable proportion of clay serves as a binding material, which gives the soil enough consistency to turn a furrow-slice, and to prevent leachiness. Grains of quartz, feldspar, and hornstone, from one eighth to as much as one fourth of an inch diameter, occur in the soil and give to the surface, after rains, the appearance of having been strewn with Liverpool salt; they form the bulk of the "coarse materials" mentioned in the analytical statement below. In the finer portions, black or rust-colored grains of partly decomposed hornblende are somewhat abundant.

The tree growth of the tract was almost entirely on the sandy land, forward of the swale, covering about fourteen out of the twenty acres; it consisted almost exclusively of the blue oak, with a few small white oaks; and a few of the larger trees of the former kind were allowed to remain in order to test their production of acorn mast, it being reported that such trees yield a larger amount of hog feed than anything else occupying a similar area. Some of these larger trees were five feet in diameter three feet above the ground, and many between four and five feet.

Aside from the timber growth, the ground was covered with a good deal of bunch grass and alfilerilla (*Erodium*), with the prevailing flora of the region—the several *Phacelias*, *Nemophila*, several *Gilias*, and the blue stargrass (*Sisyrinchium*).

The *surface soil* of the front portion (No. 1147), taken to the depth of twelve inches, is of a reddish gray, or fawn color, which deepens considerably on wetting by bringing out the color of the humus present; but it can hardly be said to assume any plasticity, and could evidently be safely plowed almost at all times.

Northward of the swale, crossing the station tract diagonally, and at about the same level as the front land, there is a piece of sandy land of a somewhat heavier quality than the former, and on which grew a few scattered oaks. Toward the northwest corner of the tract it is underlaid by the black adobe soil of the hillside; while toward the northeast corner it breaks into a "hog-wallow" or hillocky surface, which is common near the heads of the swales in the region. It has, of course, received some of the washings of the adobe hills to increase its clayey ingredient, and its flora differs correspondingly from the front land by the very common occurrence of the yellow hound's-tongue (*Amsinckia lycopsoides*, sometimes called "tarweed," but incorrectly, as it has no sticky secretion but only hooked bristles), which is more particularly at home on the adobe soils.

The soil of the back land (No. 1126) is a gray, silty one, having a certain proportion of coarse sand and gravel up to one fifth of an inch in diameter; darkens but little on wetting, and becomes only fairly plastic, so that it could always be plowed except when *very* wet.

The soil of the swale is more specially described hereafter.

The chemical analysis of these three soils resulted as follows:

Sandy Loam Soils. Experiment Station, near Paso Robles.

	No. 1147. 12 inches. Front Land.		No. 1126. 12 inches Back Land.		No. 1148. 12 inches. Swale Soil.	
Coarse materials >0.5mm	39.5		20.5		15.3	
Fine earth	60.5		79.5		84.7	
Analysis of Fine Earth.						
Insoluble matter	85.12	90.69	87.26	92.45	81.79	90.31
Soluble silica	5.57		5.19		8.52	
Potash (K_2O)	.68		.40		.60	
Soda (Na_2O)	.31		.35		.27	
Lime (CaO)	.34		.26		.41	
Magnesia (MgO)	.37		.32		.45	
Br. ox. of manganese (Mn_3O_4)	.04		.03		.04	
Peroxide of iron (Fe_2O_3)	3.83		1.68		3.26	
Alumina (Al_2O_3)	1.74		2.93		2.80	
Phosphoric acid (P_2O_5)	.07		.02		.06	
Sulphuric acid (SO_3)	.03		.05		.01	
Carbonic acid (CO_2)						
Water and organic matter	2.19		1.86		2.12	
Total	100.29		100.35		100.33	
Humus	.66		.55		1.16	
Ash	.79		.86		1.28	
Sol. phos. acid			.02			
Silica						
Hygroscopic moisture (absorbed at 15° C.)	1.84		2.50		3.43	

The sandy nature of these soils is well shown in the large proportion of inert matter and the low moisture absorption; the latter is so low in the front land soil, that but for the great depth at all points it would constitute a serious defect, and would necessitate very frequent irrigation. But as there is scarcely a noticeable change in the nature of the soil for eight feet and more, both moisture and nourishment can be sought by the roots independently of the surface soil. As a matter of fact, however, moisture sensible to the hand is always found in this land at a depth of six or eight inches, and the roots of the smaller plants are usually found, unhurt by drought or heat, much nearer the surface. It thus becomes intelligible how this land can be cultivated without irrigation, despite the long, hot, and rainless summer.

Chemically the soil (No. 1147) shows its granitic origin by the abundance of potash present, with, for California, a relatively small proportion of lime, which, however, does not amount to a deficiency in so sandy a soil, and still imparts to it the characters of a "calcareous" one. For so sandy a soil, again, the supply of phosphoric acid is quite large, especially in view of the great depth to which roots can readily go. The supply of humus is only fair and might advantageously (to moisture-retention) be increased. The soil is therefore a very good one of its kind, and likely to be lastingly productive.

As to the sandy soil of the back land (No. 1126), it will be noted that while it contains less of "coarse materials" than that from the front land, its inert portion is greater by nearly two per cent than in the latter; naturally its percentages of each of the soluble ingredients must be correspondingly smaller if the two soils are otherwise similar. The reduction in the essential ingredients is, however, greater than it should be on this ground, as will be seen on comparing the figures for potash and lime; the phosphoric acid percentage is extremely low, but as all of it is in the soluble form, the soil may not show a deficiency in this ingredient for some

time. Humus likewise is in small supply; the greater clayeyness of the soil is indicated by the higher figure for alumina, and for moisture absorption. Its dead gray tint indicates the relative lack of iron also, as compared with the soils of the adjacent land. Evidently this soil has derived no special benefit from the washings of the rich hilltops above, and thus appears to be on the whole of lower quality than the sandy land south of the swale.

Swale Soils.—There is a marked peculiarity about the soils of the swales of this region, that—rather than valleys with well defined water channels—traverse the sandy mesas of the Estrella Plains. These swales are peculiar in their flora as compared with the adjoining higher ground; their spring flowers are made up almost entirely of a few species, densely crowded together and drying up rather earlier than is the case on the higher ground. These species are the small "star sunflower" (*Baeria chrysantha?*), the small plantain (*Plantago Patagonica*), the purple flame flower (*Orthocarpus attenuatus*), the small-flowered white forget-me-not (*Eritrichium Californicum?*), and the cowslip (*Dodecatheon*). The soil, manifestly formed from the finer wash of the slopes, appears to consist very largely of fine silt with but little clay; becomes close and very hard-baked in summer, and during the rainy season develops the disagreeable peculiarity of "bogginess" to a degree that renders roads in or crossed by such swales almost impassable, and causes it to plow "like putty" when at all wet, sticking to the plowshare and often refusing to turn a furrow-slice. When well tilled the soil appears to produce well, quite equal to the uplands; but in order to get it into condition it would seem necessary to underdrain it, and this improvement has accordingly been made in the middle of the swale that crosses the experimental plot diagonally from northeast to southwest, by the laying of seven hundred and sixteen feet of three-inch tile. The experience of the season of 1889–90 will doubtless demonstrate the result of this experiment.

From its position and manifest origin, the swale soil (No. 1148) should represent the finer portions and leachings of the upland soils (Nos. 1147 and 1126); it should therefore contain more lime, magnesia, and alumina, and less inert matter; and as a result of its position should have more humus, and from that cause, as well as from the higher contents of clay, should have a higher hygroscopic power. It will be noted that this is precisely what is actually shown by the analysis; and although its contents of potash and phosphoric acid are somewhat lower than in the upland soil, these ingredients are doubtless more available. But these advantages cannot avail unless the land is kept in good tilth; and as this is difficult to do in unfavorable seasons unless the land is underdrained, the outcome of cultivation on these swales is thus far on the whole less satisfactory than on the higher ground.

The *mechanical* analysis of this soil, not made in full detail but only so far as necessary to prove its general character, gave the following result:

Mechanical Analysis.

Weight of gravel between 1.2mm and 0.6mm	15.3
Fine earth	84.7
	100.0

Mechanical Analysis of Fine Earth.

Clay	3.09
Sediment of <0.25mm hydraulic value	18.41
Sediment of 0.25mm	6.32
Sediment of 0.5mm	
Sediment of 1.0mm	10.34
Sediment of 2.0mm	7.84
Sediment of 4.0mm	8.00
Sediment of 8.0mm	10.04
Sediment of 16.0mm	10.69
Sediment of 32.0mm	22.77
Sediment of 64.0mm	
	97.50

It will thus be seen that this material, although working like a very heavy soil when wet, contains but a very small amount of clay, as might also be inferred from its still relatively low moisture absorption in presence of over one per cent of humus. It should also be noted that the sediments which form the greater part are very fine, and do not grade off gradually toward the coarser ones, of which there is but little present. In other words, these swale soils belong to that class composed, in analogy to putty, of a large proportion of fine matter with but a trifling amount of binding material (linseed oil or clay); hence, both materials "*work* like putty," resisting inertly the tool penetrating it and clogging it as it goes.

Adobe Soils.—As has been stated, the rear (northwest) corner of the tract contains about an acre of heavy, dark-colored, clay soil, in which deep sun-cracks are formed during the dry season. This patch of adobe land lies at the foot and forms part of one of the oft-mentioned knolls, rising about seventy feet above the general level of the tract, some five hundred feet to northward of the fence corner, and continued into a short ridge some seven hundred feet farther. The entire summit of this ridge is conspicuous for the luxuriance of its vegetation, which embraces a full assortment of the herbaceous plants of the region, closely set and much taller than anywhere else. Despite its elevation, moreover, this ridge and others like it continue green several weeks farther into the dry season than is the case with either the sandy uplands or swales adjacent. The same phenomenon extends (doubtless with the same geological formation) eastward to the Cholame country, according to reliable accounts received. The soil on these hilltops is intensely black when moist, but is filled with white specks ranging from about the size of ordinary rifle powder to that of a hazelnut. The greater part of these white grains is hornstone, rather soft, and in angular fragments; the rest is soft carbonate of lime, partly in the form of "agaric mineral." Both ingredients are obviously derived from the underlying stratified rock, in which the same ingredients alternate in the shaly-bedded layers. The soil is evidently a purely "residual" one, derived from the disintegration of these rocks, into which the subsoil, at several feet depth, forms insensible transitions. In its natural condition, filled as it is with a mat of roots, the soil appears like a sandy loam, easily tilled, but when wetted it becomes extremely adhesive and its color darkens perceptibly; it would manifestly be impossible to plow it in that condition. The analysis of this soil resulted as follows:

No. 1123. Black Adobe, from Hilltop near Experiment Station Tract.

Coarse materials>0.5mm	20.00
Fine earth	80.00

Analysis of Fine Earth.

Insoluble matter	55.43	73.38
Soluble silica	17.95	
Potash (K_2O)	.77	
Soda (Na_2O)	.64	
Lime (CaO)	5.97	
Magnesia (MgO)	1.03	
Br. ox. of manganese (Mn_3O_4)	.05	
Peroxide of iron (Fe_2O_3)	3.43	
Alumina (Al_2O_3)	5.99	
Phosphoric acid (P_2O_5)	.44	
Sulphuric acid (SO_3)	.07	
Carbonic acid (CO_2)	3.25	
Water and organic matter	5.25	
Total	100.27	
Humus	1.25	
Ash	.47	
Sol. phos. acid	.05	
Silica	.....	
Hygroscopic moisture (absorbed at 16° C.)	10.22	

The most prominent characteristics of this soil are its high contents of lime—nearly 6 per cent—and of phosphoric acid; the latter exceeding all soils thus far analyzed from the Pacific Coast, and approached by only few outside, in the United States. Of this large amount, five hundredths of one per cent (being as much as many good soils contain on the whole) is in the soluble condition. When at the same time we note the high contents of potash and of humus, and the large absorption of moisture (more than five times that of the sandy upland below), we cease to wonder at the luxuriance of the vegetation of these knolls, and the long continuance of their verdure in comparison with the other soils of the locality.

Brown Adobes.—While this hilltop soil is thus one of typical excellence, the area occupied by it is quite small as compared with the lighter colored, usually brownish or fawn-colored adobe soils that prevail on the lower ridges, and often form tracts of considerable extent; as for instance, on the dividing ridge between the Salinas River and the Huerhuero, opposite Templeton, and continuing northward nearly opposite to Paso Robles. The relation of this brown adobe to the profusely fertile hilltops is well shown on the experimental tract, where it forms the foot of the ridge, being clearly a sedentary soil derived from the predominantly clayey strata that underlie the calcareous deposits from which the hilltop soil has been formed. In other words, the brown adobe represents a lower geological level, and one at which the coherence and tenacity of the material has strongly resisted denudation.

These adobe tracts bear in general the same timber growth of blue oak as the granitic soil; the trees are, however, less abundant, and on the whole of inferior size. During summer it tends to open in wide sun-cracks wherever not well shaded or tilled; its natural herbaceous growth is characterized by the great prevalence of the yellow forget-me-not, or "tarweed" (*Amsinckia lycopsoides*), sometimes (as on the experimental tract) to the exclusion of all else, save some clumps of blue star-grass (*Sisyrinchium*). It bears the reputation of being a good wheat soil when well cultivated. On the flanks of the ridges composed of this soil and its underlying materials, the light, granitic soil overlies it. The following record and analyses exhibit its chemical characters:

No. 1149. Adobe upland soil, from the northwest corner of the experimental plot. A very heavy soil, deeply sun-cracked at the time the sample was taken; of a dark brown tint when dry, and cutting with a shiny sur-

face; almost black when wet, and becoming very tenacious when kneaded. Occupies the lower slope of the adjacent ridge for some forty feet upward; bears a few blue oaks, and is densely covered with the yellow forget-me-not, or tarweed (*Amsinckia*), very luxuriantly developed. Also, some blue star-grass, *Brodiæa*, *Plantago Patagonica*, *Plectritis*, and *Eritrichium*. Sample taken to twelve inches depth.

No. 1150. Adobe upland soil, from the broad dividing ridge between the Salinas River and Huerhuero Creek, five miles out from Templeton, on the Creston road; C. P. Huntington's land. Fairly timbered with blue oak; herbaceous growth nearly as in the preceding number. Appears to be not quite as heavy as the soil on the experimental tract; contains some white hornstone gravel in its upper portion, and seems to become rather heavier downward. Sample taken to the depth of twelve inches.

The chemical composition of these soils is given in the table following; the black hilltop adobe (No. 1123) being placed alongside for comparison:

Adobe Soils.

	No. 1123. 12 inches. Hilltop, near Experiment Station, Paso Robles.		No. 1149. 12 inches. Northwest corner of Experiment Station.		No. 1150. 12 inches. Upland, Huntington Tract.	
Coarse materials > 0.5mm	20.00		13.52		9.36	
Fine earth	80.00		86.48		90.64	
Analysis of Fine Earth.						
Insoluble matter	55.43	73.38	57.69	78.67	55.63	77.20
Soluble silica	17.95		20.98		21.57	
Potash (K_2O)	.77		.70		1.01	
Soda (Na_2O)	.64		.18		.33	
Lime (CaO)	5.97		1.09		1.31	
Magnesia (MgO)	1.03		1.04		1.26	
Br. ox. of manganese (Mn_3O_4)	.05		.04		.03	
Peroxide of iron (Fe_2O_3)	3.43		4.39		7.22	
Alumina (Al_2O_3)	5.99		9.16		6.78	
Phosphoric acid (P_2O_5)	.44		.08		.09	
Sulphuric acid (SO_3)	.07		.01		.04	
Carbonic acid (CO_2)	3.25					
Water and organic matter	5.25		4.67		4.50	
Total	100.27		100.03		99.77	
Humus	1.25		.47		.58	
Ash	.47		.21		.08	
Sol. phos. acid	.05		.03		.03	
Silica						
Hygroscopic moisture (absorbed at 15° C.)	10.22		11.14		10.78	

So far as the essential points are concerned, these soils are very nearly alike in composition as well as in other characters, while very unlike the black soil of the hilltop (No. 1123). Both are, however, well provided with the several ingredients of mineral plant food, and should be productive as well as durable under careful cultivation, which alone will render such heavy soils profitable. A larger proportion of lime would be desirable, especially in No. 1149, which is the more extreme of the two. Both contain much less humus than is desirable in such heavy soil, so that the addition of vegetable matter as well as of lime or marls would materially help their thriftiness. But as they stand, there is no reason why the production of grains as well as of fruits adapted to heavy soils—plums, pears, apricots, apples, etc.—should not be successful.

Improvements Thus Far Made on the Station Grounds.

The tract has been inclosed with a substantial "six-board" *fence*, of redwood posts, with Oregon pine planks. The latter had been so disposed that it was hoped rabbits would be excluded; but experience showed that this was not the case, and it became necessary to interpose in each of two lower spaces a strand of barbed wire. Unfortunately considerable damage to young trees and vine cuttings occurred before this additional protection could be given.

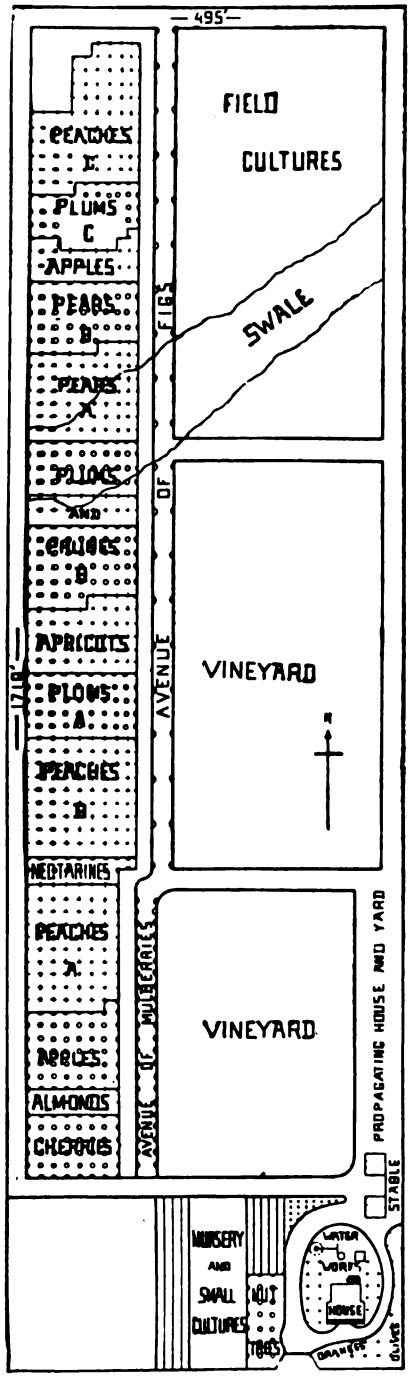
The *buildings* on the station grounds consist of a dwelling and a barn; the cost of the former was defrayed by subscription from citizens, chiefly of Creston, Templeton, and Paso Robles. The region being very thinly settled, more could not reasonably be expected, hence the barn was erected at the expense of the Station Fund.

The *dwelling house* is a neat two-story frame cottage, rustic-finished; dimensions, about thirty by thirty-eight feet, inclusive of verandas in front and rear; it has eight rooms and bath. The front faces south, toward the county road and main entrance. Several groups of oaks have been left standing around the house and outbuildings, for shade and protection from wind.

The *barn* is placed near the east line of the tract some distance in the rear of the house; is also rustic-finished, sixteen by sixteen feet, with three stalls, and hay loft giving room for five tons of (baled) hay. Adjoining the stable are *wagon* and *tool sheds*, each sixteen by fourteen feet; a space sixteen by forty-eight feet is in addition covered by a lean-to roof, forming an open shed, affording additional space for storing implements, etc., from the weather.

Between the barn and the house is a *dug well* about one hundred and five feet deep and four feet in diameter (with wooden curbing down to forty feet, and brick for seven feet from bottom), which, as a rule, contains about five feet of excellent water. It is at present raised by horse-power with a deep-well force pump into a redwood tank of three thousand gallons capacity, raised on a trestle twelve feet high, for the supply of house and stable. It is intended to supplement the horse-power, so far as the light winds prevailing in the region will permit, by a windmill, in order to save the time of team and men and obtain a larger supply; since at present the latter is too scanty to permit of its free use in such irrigation as is absolutely needful.

As this well is the first one sunk on the plateau near the river, its features and measure of success are of somewhat extended interest. Unfortunately the record kept by the well-digger is very unsatisfactory as to the nature of the materials encountered, but subsequent inspection coupled with it leads to the following result: The greater part of the material penetrated was bluish or whitish clay, very plastic; it alternates irregularly with thin-bedded strata of hornstone, mostly soft but some quite hard, and containing, or alternating with, more or less of calcareous materials. The water comes in through (mostly whitish) hornstone gravel, near the level of the Salinas River bed. It does not appear that any well defined fossils were found here, although at some points, as near Cashin Station above Templeton, oysters and other fossil shells are quite abundant in the siliceo-calcareous strata exposed in the streams. Hornstone gravel conglomerate crops out prominently on the bluffs of the river opposite Templeton, and also near Paso Robles, and doubtless represents the continuation of those found in the station well. The water is somewhat hard (calcareous), but good for all domestic uses.



PLAT OF THE TRACT OF THE SOUTHERN COAST RANGE STATION, UPPER SALINAS VALLEY.

Plan of the Grounds.—The plan adopted in laying out the tract for planting will be best seen from the foregoing diagram.

The space immediately adjacent to the house has been laid out with curved roads and walks, and planted with a variety of trees, as well as with such plants as, whether in propagation or permanent growth, require extra care and watering. Small cultures of all kinds occupy the southwest corner, left in blank on the plat, while between the house and the east fence, under the lee of the oak groves from the prevailing wind, there is a plantation of citrus fruits and olives.

In laying off the vineyard and orchard it was necessary, on account of the long rectangular shape of the tract, to extend these likewise, in order to cover the variations of soil that to a certain extent occur even in the sandy land; and for the same end the several fruits were not planted in solid bodies each, but somewhat subdivided, so as to show, as far as possible, the influence of soil variations. The heavy soil of the swale (see above, description of soils) was divided between pears and plums, as being most likely to succeed in it.

The plot on the northeast corner of the tract, reserved for field cultures, embraces a fair representation of the bulk of the lands likely to be used for such purposes; a somewhat heavier loam than the land occupied by the fruits, yet not of an "adobe" character.

The subjoined report of Inspector W. G. Klee, based partly on the data recorded by the station foreman, Mr. Cruickshank, partly on personal observations, supplies the details of the planting as well as a number of interesting culture data.

NOTES ON CULTURE EXPERIMENTS AT THE SOUTHERN COAST RANGE STATION DURING 1889.

By W. G. Klee, Inspector.

Small Grain.—A large variety of cereals, including thirty-three varieties of wheat, seventeen of barley, eight of oats, and a few of rye and spelt, were planted in small beds on the nursery grounds, it being very much too late in the season to attempt anything on a larger scale. The soil here is very sandy and becomes quite dry, and, taking in consideration that the grains were planted much later than is considered safe for wheat in this section, the results were not without value for future comparisons when planting will be done at the usual times. The following list and notes were furnished by the foreman in charge, Mr. R. D. Cruickshank:

Report on Grains and Forage Plants Grown in 1889.

Variety.	When Sown.	When Ripe and Cut.	Growth and Result.
Wheat.			
Red Sonora	Feb. 12	June 24	Medium.
Russian Red-bearded, Hessian fly-proof	Feb. 12	July 1	Very well.
Royal Australian	Feb. 12	July 1	Fairly well.
Rust-proof Indian wheat	Feb. 13	July 1	Crop good, considering quality of seed.
Whittington's wheat	Feb. 12	July 1	Fair crop.
White Bannat	Feb. 13	July 6	Poor.
Defiance	Feb. 12	July 6	Fair.
Gem or April	Feb. 13	July 6	Medium.
Chili	Feb. 12	July 6	Poor.
California (spring)	Feb. 12	June 24	Medium.
Petali	Feb. 12	June 24	Fair crop.
Palestine	Feb. 12		Failed.

REPORT ON GRAINS AND FORAGE PLANTS—Continued.

VARIETY.	When Sown.	When Ripe and Cut.	Growth and Result.
Missoyen	Feb. 12.	July 1.	First rate; this and Volo the two best.
Archer's Prolific	Feb. 12.	June 24.	Very well.
Pringle's Defiance	Feb. 13.	July 1.	Good.
Arizona (Indian seed wheat)	Feb. 12.	June 12.	Filled very poorly.
Volo	Feb. 12.	July 1.	Extra well.
Thuringian	Feb. 12.		Failed.
Tunisian	Feb. 12.		Failed.
Mold's Winter	Feb. 12.		Did not head out.
Propo	Feb. 12.		Destroyed by gophers.
Greek Atlanti	Feb. 12.		Ears did not fill.
Hallet's Pedigree of White Victoria wheat	Feb. 12.		Very few germinated.
Pringle's Best wheat	Feb. 12.		Destroyed by gophers.
Big White Club	Feb. 12.		Did not germinate.
Yellow Noe	Feb. 12.		Germinated weakly and died.
Golden Drop	Feb. 12.		Germinated feebly and failed to head.
Blood Red wheat	Feb. 12.		Failed because of poor seed.
Chiddam wheat	Feb. 12.		Grew feebly; destroyed by gophers.
Michigan wheat, mixed	Feb. 12.		Germinated, but grew poorly.
Rye.			
Saxon	Feb. 12.		Never germinated.
Excelsior Winter	Feb. 12.	July 6.	Did fairly well.
Barley.			
Nepaul	Feb. 12.	June 12.	Extra good.
Berkeley Hybrid	Feb. 12.	June 12.	Medium.
Early Black 2-rowed barley	Feb. 12.	June 12.	Medium.
Scotch 2-rowed	Feb. 12.	June 24.	Medium.
Large Naked 2-rowed	Feb. 12.	June 13.	Extra good.
Manchurian	Feb. 12.	June 13.	Very good.
Himalaya	Feb. 13.	June 13.	Very well.
Bluish barley	Feb. 12.	June 13.	This did best of all our barley; much admired by visitors.
Chevalier	Feb. 12.	June 24.	Only medium.
Imperial	Feb. 12.	June 24.	Medium.
Italian	Feb. 13.	July 13.	Nearly a failure.
Scotch Annate	Feb. 12.		Entire failure.
Six-rowed	Feb. 12.		Entire failure.
Carter's Prolific	Feb. 12.		Poor; plants eaten by gophers.
Six-rowed Winter	Feb. 12.		Entire failure.
Black 6-rowed	Feb. 12.	July 6.	Showed exceedingly well, but was mostly taken by birds before maturity.
Rice or sprat	Feb. 13.	July 6	Nearly a failure.
Oats.			
Scotch Hopeton	Feb. 13.	July 6.	Poor.
Surprise	Feb. 12.	July 1.	Very good.
Gray oats from Houdan	Feb. 12.	July 6.	Good.
Black Tartarian	Feb. 12.	July 6.	Very good.
Early August	Feb. 12.	July 6.	Very good.
Black oats from Coulomières	Feb. 12.	July 6.	Fair, but was taken by gophers.
Early oats from Etampes	Feb. 12.	July 6.	Short, not good.
Spelt.			
White Emmer	Feb. 13.	July 6.	Very poor.
White Silesian	Feb. 12.	July 6.	Very poor.
Grasses.			
Hungarian Brome	Feb. 13.		Doing well; much eaten by rabbits.
Tall oat grass (*Avena elatior*)	Feb. 13.		Grew fairly well; looks dry in September.
Japanese wheat grass (*Agropyrum Japonicum*)	Feb. 13.		Grew well, but is now quite dry.
Schrader's Brome grass	Feb. 13.		Seems to do well.
Chick pea (*Cicer arietinum*)	Feb. 13.	June 13.	Does remarkably well; finer crop than I have ever seen in India, although grown there in immense quantities for food for man and beast.
Snail clover (*Medicago turbinata*)	Feb. 13.	June 13	Did first rate, and likely to be a very useful addition to pasture.

REPORT ON GRAINS AND FORAGE PLANTS—Continued.

VARIETY.	When Sown.	When Ripe and Cut.	Growth and Result.
French lentils	Feb. 13..	June 13..	Did very well.
Tagasaste (*Cytisus proliferus albus*)	Feb. 13..	....	Germinated and came on well, but the rabbits have eaten it off. It would do well here.
Sainfoin	Feb. 13..	June 1 (flow'r'd)	Coming on well, and will stand drought.
Teosinte (*Reana luxurians*)	....	....	Will do well for this section. Has formed dense tufts six to twelve inches high, but without water grows rather slowly.

Corn.—All varieties planted have done poorly, the product not being worth mentioning. This is in part due to late planting, but it should be noted that this section is not considered good for corn (maize); the plant succeeds without irrigation only on the moist bottom lands, and nearer the coast, where the air is moister.

Sorghums and Sugar Canes.—This class of plants, which usually succeeds where Indian corn, for lack of moisture, cannot, has done proportionally better, but was evidently also planted too late. The leaves dried on the edges, and, except where receiving artificial watering, they cannot be said to have succeeded.

"*Kaffir Corn.*"—The latter seems to blight in bloom, and produces, even with irrigation, a poor head. Another season, with more timely planting and better prepared ground, is necessary to settle the adaptability of sorghums for the soil and location in question. Mr. J. V. Webster, the Patron of the station, living twelve miles east of this place, reports very good results with sorghum cane as fodder. Of those tried he finds the Early Amber the best. This, however, is on land having water at from five to six feet. White Egyptian corn blasts in bloom. Kaffir corn does not do well, also blasting in bloom, and its growth is very short. For swine feed Mr. Webster considers the Early Amber cane very profitable.

Grasses.—Of the grasses mentioned in Mr. Cruickshank's report, I found the Japanese wheat grass (*Agropyrum Japonicum*, Vasey) well started after the rains in October, as also Schrader's Brome grass and Sainfoin, while the tall oat grass (*Avena elatior*) had survived only in part. A full assortment of the best varieties of grasses and forage plants is now being planted at the station, and it is hoped that some of these will prove suitable. Those that survived last year will be planted on a larger scale. I find here, as in most places in California, the keenest interest in the subject of forage plants.

Bamboos.—Near the house and tank several bamboos were planted. Of some lately imported so called "Giant Bamboo," none grew. However, two varieties, transplanted from Berkeley—a Japanese named Metake and a Chinese large-growing kind—have succeeded well, with copious watering.

Orchard.

There have thus far been planted about four hundred varieties of deciduous fruit trees (including nuts), and a collection of small fruits.

Training of the Trees.—The low trunk system has been adopted uniformly for these trees, it having been proved by experience that the climate of the larger part of California demands it. Of failures from not following

this system there are ample illustrations in San Luis Obispo County, as in every county in the State. The trees were cut off at a uniform height of three feet, allowing a space of eighteen inches or less for trunk, and the remainder for the formation of a head.

Apples.—Ninety varieties, including crab-apples, have been planted, one of each. The collection embraces nearly all the varieties which have been found adapted to the various climates of the State; also some new introductions from Texas. With few exceptions the growth has been uniformly good, especially on the granitic, sandy land, less so on the heavy adobe. But one or two have died; no attacks from the flat-headed borer (*Chrysobothris*) have been noticed. The trees in the whole orchard have been shaded with shakes on the south and west sides.

Cherries.—Thirty-eight varieties were planted; a few duplicated on Mahaleb stock, but the rest on Mazzard stock, the kind now almost exclusively used in this State. The growth of these trees has been very good, only a few failures to be recorded; they were planted on well drained land.

Pears.—The collection embraces sixty-five varieties; besides these some seedlings of common and Japanese pear stock were planted for future budding. The growth of the pears has been only moderate; but very few have been lost, except of the small pear seedlings planted very late (in April). The soil in which the pears are growing is heavy. Although planted very late, the Japanese pear seedlings have done very well, and are promising.

Plums and Prunes.—The growth of these has been only moderate; of most of them poor. Of seventy varieties, yearling trees, one or two of each, fifteen have died. This must be chiefly attributed to very badly drained soil,* also to late planting. Of the sixty-two dormant buds on Myrobalan stock planted, only twenty-two made any growth, although the remainder are alive at the root. The chief cause of failure was too late planting, as the growth of the buds of the living trees has been pretty fair. The Japanese plums have done remarkably well on the whole. It is the intention to test the question of stock pretty thoroughly, in regard to prunes especially, and the kinds not represented will be planted this season.

The matter of grafting stock is very important in more than one respect. Not alone in regard to the adaptability of certain kinds to soil, but also in regard to their probable influence on the scion in time of ripening and development of the fruit. I learned on my visit this fall the singular fact of the comparatively late ripening of some French prunes near Creston, also their tenacity in remaining on the trees. Knowing that the same is the case in the upper San Joaquin Valley, I was curious to investigate further; and through the kindness of Mr. Cruickshank learned that such has been the experience in a number of localities in the county. There seems to be a parallel case here in two sections, in many respects very unlike. That is, we meet with late ripening plums, prunes, and pears both in the unirrigated tablelands of San Luis Obispo and in the irrigated or sub-irrigated plains of Tulare and Kern; while in both places peaches, apricots, and grapes, and almost everything else, seem to follow what one might think the natural course—early ripening, stimulated by heat. The case is a little difficult to explain, although the explanation may be that the high temperature produces a sort of resting period, and that its influence is felt chiefly on the fruits from the colder regions, such as pears and plums. Whatever the true cause may be, it is of consider-

*This portion of the grounds has now been drained by laying of tile drains, and it is hoped this will obviate future trouble of excess of water.

able practical importance to fruit growers, especially to the prune grower; and if certain stocks would cause the fruit to mature a little earlier and separate easily, so as to allow it to be shaken off, as is the universal practice in prune sections, it certainly would be of advantage by greatly reducing the cost of harvesting.

Peaches.—Some sixty varieties on peach root, with some on plum stock, have been planted. The growth of these yearling trees on the first named stock has been very satisfactory, the granitic soil suiting them well. The dormant buds on Myrobalan have, however, been very unsuccessful. The soil in the spot chosen is quite heavy and wet, and as they were planted very late it is difficult to say whether the failure is due to soil, late planting, or to unsuitable stock. It may be argued with reason that soil of a heavy nature is not suitable for the peach, and plenty of soil exists that is; but nevertheless, many a farmer and small owner might like to have a few peaches and not have any suitable peach soil. There is another and more formidable and less known reason why we ought to settle definitely which peaches will succeed on plum stock, namely, the appearance a few years ago of a peach root borer, closely allied to the peach borer of the Eastern States, and which has been very destructive in many sections. Using plum stock has been at the East one of the preventives for this pest. It is probable, of course, that our peach borer species will eventually spread all over the State, although indications are that it will prove very destructive only on heavier soils. The greater part of the dormant buds which failed will be replaced with yearling trees grown this year in Berkeley.

Nectarines.—The nectarines, of which ten varieties were planted, started well, but have been interfered with by "varmints," causing more than natural loss. A like number of nectarines in dormant bud on the Myrobalan stock did not fare much better than the peaches on the same stock.

Almonds.—The almonds, on the whole, have done remarkably well, the growth being very good—the strongest of any fruit tree planted. The foliage, also, is remarkably good, showing no sign of being affected by mites (red spiders), the natural enemy of this tree. In spite of the majority doing well, a few trees have been lost, for what reason I am not quite prepared to say. There were planted ten varieties, including our best California seedlings.

Apricots.—The collection of apricots, twenty varieties, on apricot root, has not been a success. A portion of the trees planted in stiff soil, bordering on the swale, have suffered severely. The young roots were evidently killed by the excess of water in the soil, and when the trees started out the foliage was blighted by the dry wind and hot sun. Mr. Cruickshank states that water stood here for a long time, and adds, that apricots generally do well about Paso Robles. The apricots on Myrobalan stock, dormant buds, did not succeed, numerically, better than other varieties, only seven out of twenty growing into trees. Taking in consideration, however, the late planting and the excess of moisture these little trees had to endure, the growth of the few surviving ones has been very fair, and will warrant the replacement of the dead ones by yearling trees from Berkeley. That the Myrobalan plum stock cannot be recommended for the prevailing soil (the granitic), at least not for peach and apricot, seems quite clear from the results of Mr. Webster, at Creston, who has a number of apricots on this stock. These trees have never done well, and are stunted beside other apricot trees planted later and on their own root.

Quinces.—These have made moderate growth with some irrigation. They have established themselves in the ground, and will probably get along

without water next season. Seven varieties besides the Japanese are on hand, all of which are living.

Walnuts and Pecans.—All the walnuts, including seven varieties of the English, two grafted on the California black walnut stock, have lived, receiving some irrigation. The growth, however, has been very slow, compared with that in the humid region on the immediate coast. In this section, as in all others sufficiently removed from the effect of drenching fogs, the walnut suffers invariably from the effect of the mites (red or white). The damaged leaves fall prematurely, and the tree becomes unhealthy. I believe that when this insect is held in check by frequent applications of clear water to the leaves, or washing with sulphide solutions, one of the difficulties of growing the walnut in the interior will be removed.

The pecans have almost all lived.

Filberts.—A number of varieties, six in all, were planted in the partial shade of oaks; but, in spite of frequent waterings, but few have lived. The air seems too dry for them. On north slopes, in the Coast Range, west of the station, the conditions seem more favorable.

Japanese Persimmons.—Some twelve varieties, imported direct from Japan, have, by irrigation, survived the summer, but have made very little growth.

Mulberries.—Mulberries of all kinds have grown well without irrigation; in fact, before the rains, were the brightest looking trees on the grounds. Their success is very encouraging to silk culture. The collection embraces almost all of the cultivated varieties.

Pomegranates.—A few bushes planted have done very poorly. I think the soil was a little too dry for them when planted.

Small Fruits.

Gooseberries.—Both American and English varieties were planted. In the fore part of the summer they did very well, but later on suffered severely from the heat, several dying. On low lands about Paso Robles, they do well.

Currants.—Most of these suffered severely from the heat, and many died.

Raspberries.—Some of these bore fruit, but afterwards died. They, like many other things, were undoubtedly planted too late.

Blackberries.—Nearly all of these died; chief cause, late planting, as blackberries well established do well here.

Strawberries.—What was said of blackberries refers equally to this fruit. With plentiful irrigation they do well.

Miscellaneous Trees.

The *Camphor Tree* planted died during the summer.

The *Strawberry Tree* (*Arbutus unedo*) has made a feeble growth.

Pawpaw (*Assimina triloba*).—Two trees of these; both died.

Black Wattle (*Acacia decurrens*).—Both trees died, evidently having suffered in transit.

Kai Apple (*Aberia Caffra*).—Both plants are doing well.

Citrus Trees.—In the southeast corner of the tract, near the house, and somewhat protected by the buildings and surrounding trees, have been planted a number of sour orange trees, originally imported from Florida, but grown one year at Riverside, San Bernardino County. These trees having come from Riverside without any ball of earth, in the month of April, were slow in starting; but the majority of them have leaved out quite well during the last months of the season. Being rather tender, it

has been found expedient to shade them with cotton cloth all around. These trees have been irrigated liberally. A few budded orange trees have also been planted.

Olives.—Of these some twenty varieties, mostly two-year old trees, grafted on the so called Redding Picholine, have been planted along the line of the east fence. They have been placed about thirty-two feet apart, to give ample room for future growth. They have done fairly well, and being now thoroughly established, will make a good showing next year. Of their adaptability to this section there is little doubt. They have received sparing irrigation.

Vineyard.

The vineyard, as the map shows, is divided into two parts by an avenue. The collection of vines consists of about one hundred varieties of wine, raisin, and table grapes, mostly belonging to *Vitis vinifera*, only a few American vines having been planted. About one third were rooted vines, most of which have established themselves, some of them making a good growth. The other part of the vineyard was planted with cuttings; of these the majority started well, but have suffered severely from the attack of rabbits; the fence, as stated elsewhere, was not quite close enough. The vineyard is planted eight by eight feet, with an avenue of sixteen feet; thirty vines of each variety. Of the following list of ninety-six varieties the proportion of growing and lost ones stands thus:

Rooted Vines.

12 varieties	No failure.
10 varieties	3 per cent loss or below.
8 varieties	10 per cent loss or below.
3 varieties	16 per cent loss or below.
1 variety	35 per cent loss.

Cuttings.

1 variety	None.
4 varieties	5 per cent loss or below.
5 varieties	10 per cent loss or below.
19 varieties	25 per cent loss or below.
12 varieties	35 per cent loss or below.
13 varieties	50 per cent loss or below.
8 varieties	65 per cent loss or below.
3 varieties	75 per cent loss or below.

It will be noted that the percentage of failure of rooted vines compared with the cuttings is very small, as might naturally be expected. They had, besides, in their favor, earlier planting. The majority of these vines were rooted at Mr. Webster's place, at Creston. The cuttings were sent from the experiment stations at Cupertino and Mission San José. A few were procured from elsewhere. It is amongst these the heaviest loss is noticeable, as they came much later than the rest. Some injury must be attributed to wild animals, such as squirrels, rabbits, and muskrats.

General Results.—When taking in consideration the unavoidable delay in collecting the large variety of plants, and also the late start in getting the grounds in order, the general results must be considered encouraging. The ground in the orchard and vineyard has been kept in good cultivation all summer, and no irrigation has been used except in cases mentioned. The place has a neat and attractive appearance. All trees and vines have been plainly labeled by Mr. Cruickshank, and bear testimony to care and forethought in their treatment.

APPENDICES.

1. Soil investigation; its methods and results.

2. List of trees and shrubs in the University grounds.

3. List of fruit trees in the station orchards.

4. List of varieties of grapevines represented at the several stations.

5. List of miscellaneous plants in the Garden of Economic Plants.

6. Account of expenditures from the United States Experiment Station Fund, for the year ending June 30, 1889.

LIST OF FRUIT TREES—Continued.

VARIETY.	Amador.	Paso Robles.	Tulare.
Nevadillo blanco	r	r	r
Manzanillo (No. 2, Bulletin 85)	r	r	r
Correggiolo	r	r	r
Razzo	r	r	r
Herveza	r	r	r
Obliza	r	r	r
Dalmatian	r	r	r
Lucques	r	r	r
Amellan	r	r	r
Lavanigno	r	r	r
POMEGRANATE.			
Sweet fruited	r	r	r
CURRANTS.			
Black Naples	r	r	----
Fay's Prolific	r	r	----
Cherry	r	r	----
White Grape	r	r	----
GOOSEBERRIES.			
Berkeley	r	r	----
Downing	r	r	----
Champion	r	r	----
BLACKBERRIES.			
Crandall's Early	r	----	----
Lawton	r	----	----
Wilson's Early	r	----	----
MULBERRIES.			
Lhoo	r	----	r
Nagasaki	----	r	r
White Mulberry	r	r	r
Italian	r	r	r
Russian	r	r	r
PLUM SEEDLINGS.			
Myrobalan	r	r	r
EXOTIC.			
Hovenia Dulcis	----	r	----

APPENDIX No. 4.

LIST OF THE DIFFERENT VARIETIES OF CULTIVATED GRAPEVINES AND TYPES OF WILD VINES (OF THE GENUS VITIS) REPRESENTED AT THE SEVEN DIFFERENT STATIONS.

BORDEAUX TYPE.

Cabernet Sauvignon.
Cabernet Franc.
St. Macaire.
Gros Verdot.
Petit Verdot.
Merlot.
Beclan.
Tannat.
Gamay Teinturier.
Gros Mancin.
Charbono.
Teinturier mâle.
Pied de Perdrix.
Malbeck.

Burgundy Type.

Pinot de Pernand.
Pinot de St. Georges.
Blauer Burgunder.
Meunier.
Chauché noir.
Robin noir (Pfeffer's Cabernet).

White Pinots.

Pinot Chardonay.
Pinot vert doré (?).

Southern French Type—*Red.*

Petite Sirah.
Mondeuse.
Bastardo.
Trousseau.
Cinsaut.
Matarò.
Ploussard.
Carignane.
Grenache.
Petit Bouschet.
Alicante Bouschet.
Tinta Val-de-peñas.
Aramon.
Mourastel.
Etraire de l'Adhui.

Southern French Type—*White.*

Roussanne.
Marsanne.
Clairette blanche.
Chauché gris.
Verdal.
Chasselas de Fontainebleau.
Early Silver Frontignan.
Ugni blanc.
Chasselas rose.

Sauterne Type.

Semillon blanc.
Sauvignon blanc.
Sauvignon vert.
Muscadelle du Bordelais.
Folle Blanche.
Burger.

Rhenish Type—*Red.*

Ruländer.
Affenthaler.

Rhenish Type—*White.*

Kleinberger.
Johannisberg Riesling.
Franken Riesling (Sylvaner).
Gewürz Traminer.
Zierfahndler (?).
Muscateller (Muscat blanc).

Hungarian, Austrian, and Tyrolean Type.

Peverella.
White Tokay.
Zinfandel.
Slankamenka.
Green Hungarian.
Lagrain.
Grüner Valtelliner.
Welsh Riesling.
Rothgipfler.
Bakator (rouge).
Kadarka.
Marzemino.
Blue Portuguese.
Gross blaue.

North Italian Type.

Nebbiolo fino.
Nebbiolo Bourgu.
Freisa de Montferrate.
Barbera fina.
Bonarda.
Barba corba gelata.
Provinante.
Aleatico.
Refosco.
Crabb's Burgundy (Refosco?).

Port Type.

Tinta de Madeira.
Tinta Amarella.
Tinta Cao.
Moretto.
Mourisco preto.
California Black Malvoisie.
Mission.
Black Prince.

Sherry and Madeira Type.

Boal de Madeira.
Feher Szagos.
Palomino.
Pedro Jimenes.
Verdelho.
West's White Prolific.
Beba.
Malmsey.
Peruno.
Mantuo de Pilas.
Mourisco branco.

TABLE AND RAISIN—*White.*

Muscat of Alexandria.
Huasco.
Canon Hall Muscat.
Bowood Muscat.
Almeria.
Pizzutello di Roma.
Steinschiller.
Gelbe Seidentraube (Lignanga).
White Vernaccia.
Golden Queen.
Sultana (round-berried).
Thomson's Seedless (oblong-berried Sultana).
White Corinth.
Syrian.
White Nice.
White Malaga.

TABLE—*Red and Black.*

Purple Cornichon.
Sabalkansky.
Black Ferrara.
Emperor.
Black Muscat.
Gros Maroc.
Black Morocco.
Blue Damascus.
Gros Colman (Dodrelabi).
Babarossa.
Black Hamburg (Trollinger).
Howland's Black Hamburg.
Rose of Peru.
Flame Tokay.
Black Corinth.

AMERICAN TYPE—*Improved.*

Faith.
Cunningham.
Herbemont.
Lenoir.
Amber.
Rulander.
Walter.
Martha.
Diana.
Moore's Early.
Isabella regia.

American Hybrids with Vinifera.

Cornucopia.
Autuchon.

TYPES OF WILD VINES.

American.

V. cordifolia (Michaux).
V. æstivalis (Michaux).
V. riparia (Michaux).
V. labrusca (Linneus).
V. vulpina (Linneus).
V. rupestris (Scheele).
V. candicans (Engelm.).
V. Solonis (Engelm.).
V. Monticola (Buckley).
V. Berlandieri (Planchon).
V. Floridana (Munson).
V. rubra (Michaux).
V. Arizonica (Engelm.).
V. Californica (Bentham).
V. cinerea (Engelm.).
V. Doaniana (Munson).
V. bicolor (Le Conte).
V. coriacea (Shuttleworth).
V. Champini (Planchon).
V. Munsoniana (Simpson).
V. Simpsoni (Munson).

Asiatic.

V. vinifera from Caucasus.
V. Romaneti, two varieties.
Spinovitis Davidii, two varieties.

APPENDIX No. 5.

LIST OF HERBACEOUS PLANTS IN THE GARDEN OF ECONOMIC PLANTS AT BERKELEY.*

GRASSES (*Graminæ.*)

Japanese wheat grass, *Agropyrum Japonicum;* Japan.
Blue stem, *Agropyrum glaucum;* Colorado.
Bunch, *Agropyrum divergens;* Oregon and Washington.

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* Trees and shrubs surrounding the garden are included in the lists of arboretums. Common kitchen vegetables, of which the variety changes from year to year, are omitted from this enumeration, as also are a number of common flowering plants used merely for ornamentation. Some are mentioned on account of their climatic significance. All here mentioned are fully hardy at Berkeley.