OASIS OF BISKRA, ALGERIA, SHOWING DATE PALMS.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 80.

B. T. GALLOWAY, *Chief of Bureau.*

AGRICULTURAL EXPLORATIONS IN ALGERIA.

BY

THOMAS H. KEARNEY,

Physiologist, Vegetable Pathological and Physiological Investigations, Bureau of Plant Industry,

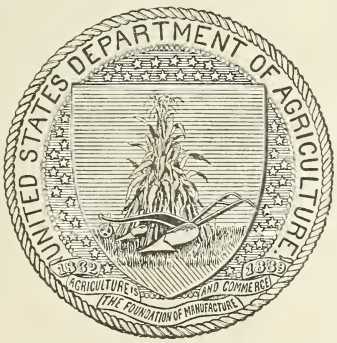
AND

THOMAS H. MEANS,

Formerly of the Bureau of Soils.

SEED AND PLANT INTRODUCTION AND DISTRIBUTION.

ISSUED AUGUST 19, 1905.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

BUREAU OF PLANT INDUSTRY.

B. T. GALLOWAY,
Pathologist and Physiologist, and Chief of Bureau.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.
ALBERT F. WOODS, *Pathologist and Physiologist in Charge, Acting Chief of Bureau in Absence of Chief.*

BOTANICAL INVESTIGATIONS AND EXPERIMENTS.
FREDERICK V. COVILLE, *Botanist in Charge.*

GRASS AND FORAGE PLANT INVESTIGATIONS.
W. J. SPILLMAN, *Agriculturist in Charge.*

POMOLOGICAL INVESTIGATIONS.
G. B. BRACKETT, *Pomologist in Charge.*

SEED AND PLANT INTRODUCTION AND DISTRIBUTION.
A. J. PIETERS, *Botanist in Charge.*

ARLINGTON EXPERIMENTAL FARM.
L. C. CORBETT, *Horticulturist in Charge.*

EXPERIMENTAL GARDENS AND GROUNDS.
E. M. BYRNES, *Superintendent.*

J. E. ROCKWELL, *Editor.*
JAMES E. JONES, *Chief Clerk.*

SEED AND PLANT INTRODUCTION AND DISTRIBUTION.

SCIENTIFIC STAFF.

A. J. PIETERS, *Botanist in Charge.*

W. W. TRACY, SR., *Superintendent of Testing Gardens.*
S. A. KNAPP, *Special Agent.*
DAVID FAIRCHILD, *Agricultural Explorer.*
JOHN E. W. TRACY, *Assistant Superintendent of Testing Gardens.*
GEORGE W. OLIVER, *Expert.*
W. W. TRACY, JR., *Assistant Botanist.*

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 24, 1905.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 80 of the series of this Bureau, the accompanying manuscript entitled "Agricultural Explorations in Algeria."

This paper was prepared by Thomas H. Kearney, Physiologist, Vegetable Pathological and Physiological Investigations, Bureau of Plant Industry, and Thomas H. Means, at that time in charge of Soil Survey, Bureau of Soils, and has been submitted by the Botanist in Charge of Seed and Plant Introduction and Distribution, under whose direction the explorations described were conducted, with a view to its publication.

The four half-tone plates are necessary to a complete understanding of the text of this bulletin.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

While the agricultural explorers sent out by this Office are, as a rule, sent for the purpose of securing some special seeds or plants desired for introduction into the United States, they are also expected to make themselves as familiar as possible with the agricultural practices of the countries they visit and with the crops that succeed under the conditions described. That some of the practices observed may be profitably followed in those parts of the United States having similar soil and climatic conditions is more than probable, and that certain of these crops will prove useful has already been demonstrated.

The American farmer of to-day wants to know what is being done elsewhere, and he is especially interested in hearing how other people meet difficulties similar to those with which he has to contend. The reports of our agricultural explorers, we believe, will therefore fill a distinct place in agricultural literature. This report points out clearly the close similarity in climate existing between certain portions of the Southwestern States and Algeria, making it plain that we must look to that country for the introduction of many useful plants into our arid and semiarid districts.

We have, indeed, already availed ourselves of the opportunities thus offered. The date palms so far secured have come largely from Algeria; certain grains from that country, now being tested, give promise of unusual value; and the writers of this report brought back a quantity of alfalfa seed from salt-resistant plants, which has already been tested and gives promise of decided usefulness in Arizona and California.

To throw as much light as possible upon the conditions under which crops are grown in Algeria, chapters upon the topography, climate, irrigation, and soils are included. These, together with the brief historical and political sketch, have been prepared by Thomas H. Means. The remainder of the report was written by Thomas H. Kearney.

The writers wish to acknowledge the services cordially rendered them by the following-named gentlemen in the prosecution of their work: Mr. Henri Vignaud, of the United States embassy in Paris; the Governor-General of Algeria, and the French Resident at Tunis; Dr. L. Trabut, of the botanical service of the government of Algeria;

the Commandant of the Bureau des Affaires Indigènes at Algiers; the commandants of the military circles of Biskra and Tougourt; Lieutenant Beréaud, Chef du Bureau Arabe at the latter place; M. Colombo, of the Compagnie de l'Oued Rirh at Biskra; Mr. Daniel Kidder, United States consul at Algiers; M. Vilmorin, of the seed firm of Vilmorin-Andrieux & Co., and M. Emerich, agent of that firm for America.

A. J. Pieters,
Botanist in Charge.

Office of Seed and Plant
Introduction and Distribution,
Washington, D. C., February 17, 1905.

CONTENTS.

ILLUSTRATIONS.

AGRICULTURAL EXPLORATIONS IN ALGERIA.

INTRODUCTION.

The principal object of the writers' visit to Algeria was to secure for trial in the "alkali" lands of the western United States seed of such of the important field crops as might show indication of an unusual degree of resistance to salt in the soil. There was reason to believe that in northern Africa, if anywhere in the world, useful plants would be found to have developed such resistance through long cultivation in saline soils under a dry, hot climate.

Agriculture is too new in the arid part of America to make it likely that races in which the quality of resistance to "alkali" has become fixed should as yet have arisen there without direct efforts to breed them. But in the Sahara Desert, and in adjacent regions, all the conditions are favorable to the production of such races through natural selection. There we find the greatest continuous body of desert land in the world. The cultivated soils and the water used in irrigation often contain an excess of soluble salts. Finally, agriculture has been practiced there for thousands of years, and well-marked varieties of various cultivated plants have been developed.

As a matter of fact, it is already known to the Department of Agriculture that such salt-resistant races exist in northern Africa. Several of the agricultural explorers sent out by the Department have reported this to be true of Algerian wheats and barleys. Mr. W. T. Swingle brought back with him from the oases of the Sahara seed of alfalfa that was growing in soils containing a high percentage of salt. It was desirable, however, to determine just how resistant this Algerian alfalfa is and to obtain a larger quantity of the seed, in order that it could be fairly tested in the southwestern United States.

It is believed that this object was accomplished. The fact that alfalfa in the oases withstands a greater amount of soluble salts in the soil than ordinary American alfalfa was established beyond reasonable question. A sufficient quantity of seed was obtained to insure a thorough trial of it in parts of our country where a similar climate

prevails. At the same time a careful search was made in various parts of Algeria for such other cultivated plants as might prove useful for salt soils. Incidentally the writers procured all possible information as to the character of the saline soils of Algeria, the way in which they are handled, and such attempts as have been made to reclaim them.

The coast region of Algeria strikingly resembles the corresponding part of California in climate, in physiography, and in the crops grown. The interior of California, and of the extreme southwestern United States generally, corresponds in many ways to the steppe and the desert regions of northern Africa. It is true that in some respects agriculture has reached a more advanced stage of development in California than in Algeria; yet there are probably some matters in which the French colony can give lessons to the American State. For this reason it seems advisable to present a sketch of Algerian agriculture as a whole, in addition to a more detailed account of the special subjects which the writers were sent out to investigate. The writers' stay in Algeria was limited to one month, from July 20 to August 20, 1902. It is fully realized that this length of time was entirely inadequate for anything like a thorough study of agriculture in the colony, especially as the mild winter permits crops to be grown at all seasons of the year. The date of the writers' visit to Algeria was determined partly by the necessity of reaching Egypt in time to study cotton at the height of its development, and partly by their desire to visit the oases of the Sahara at the season when the seed crop of alfalfa is being made. The information they could obtain by direct observation was necessarily fragmentary in the extreme. To supplement this, recourse has been had to the rather extensive literature of Algerian agriculture. In the preparation of this report the excellent work of Battandier and Trabut, entitled "L'Algérie" (Paris, 1898), has been freely consulted. Much information has also been drawn from papers upon special subjects by Doctor Trabut and others,[a] from the important "Manuel Pratique de l'Agriculteur Algérien" (Paris, 1900) of Rivière and Lecq, and from various other sources.

TOPOGRAPHY.

The French colony of Algeria is situated in northern Africa, between Morocco on the west and Tunis on the east. In general outline it is a rectangle, of which the greatest length—that from east to west—is about 650 miles. The area of Algeria is about 230,000 square miles, of which approximately 20,000,000 acres are under cultivation. The Mediterranean forms the northern boundary, while on the south the

[a] Published chiefly in the "Bulletin Agricole de l'Algérie et de la Tunisie."

frontier extends well into the great desert of Sahara, the present outposts being from 300 to 500 miles from the coast.

The vast desert to the southward cuts off Algeria physically as well as politically from tropical Africa. The influence of the sea upon its climate and the fact that almost unbroken overland communication with Europe by way of Morocco and Gibraltar has always been easy make Algeria rather an outpost of Europe than an integral part of Africa. In climate, physiography, flora, and agriculture Algeria is closely related to the countries that border the northern shore of the Mediterranean—Spain, southern France, and southern Italy. Indeed, geologists tell us that northern Africa was separated from southern Europe at only a comparatively recent period.

The part of the United States which Algeria most nearly resembles is California. The climate, agriculture, and state of development of the two countries are remarkably similar. In their general aspects they are much alike. In both, the coast region, being limited to a narrow strip by a range of mountains that parallels the seashore, has a comparatively mild, equable climate. In both countries this zone is preeminently adapted to fruit growing. Citrus fruits, olives, figs, and vines flourish there. A striking analogy exists between the great plain-like valleys of Algeria, occupied largely by vineyards and fields of cereals, and the San Joaquin and Sacramento valleys of California. Finally, the conditions obtaining in the Desert of Sahara are in great part reproduced in the Colorado and Mohave deserts. But to the steppe or high plateau region that occupies the central part of Algeria it would be more difficult to find a counterpart in California, portions of Nevada, Arizona, and New Mexico presenting a closer resemblance.

If we take into consideration biological—including agricultural—conditions, as well as the topographical features of the country, there are three principal regions into which Algeria can be divided for convenience of description. These are (1) the coast region, extending to the crests of the series of mountain ranges which follow the coast, (2) the high plateau or steppe region, occupying the central portion of the colony between the two great mountain systems and comprising the southern slope of the northern ranges and the northern slope of the southern chains, and (3) the desert region, comprising the Algerian Sahara and the southern slopes of the mountain system which forms the northern boundary of the Sahara.

The second and third regions are, on the whole, more homogeneous than the first, or, at any rate, their agricultural importance is too small to make it desirable to subdivide them. Three subdivisions of the coast region are, however, to be recognized, (1) the littoral zone, comprising the immediate coast and the lower slopes of the hills and mountains which border it, (2) the valley and plain zone, comprising

the larger, often plain-like, valleys of the coast region which lie inside the line of hills that follows the seashore, and (3) the mountain zone, including the higher elevations of the coast region southward to the crest of the ranges that form the northern boundary of the high plateau region.

COAST REGION.

The "Tell," as the coast region is known among the Arabs, is, from an agricultural point of view, the most important part of Algeria. A great proportion of it is capable of cultivation. It has been estimated that a population of 12,000,000 could be supported in this region alone. It strikingly resembles the Mediterranean coast of Europe, and is no less close in its likeness to the coast region of California, so that a description of one will answer in many respects for both. The immediate seashore is bordered by hills and mountains, such as the Sahel of Algiers, the lower slopes of which are occupied largely by orchards and vineyards. In the higher elevations in the mountains agriculture is more difficult. Here there are extensive areas of grass land, grazed by flocks and herds, and important forests. Opening back from the coast and mainly parallel to it are a number of large valleys. Some of these, like the Mitidja, near Algiers, and the Chéliff, in the western part of the colony, are so extensive and so level of surface as to be practically plains with great areas of cereals and vineyards. The San Joaquin and Sacramento valleys in California are remarkably like these great valleys of Algeria. Smaller valleys, like the Mina and the Habra, where the bordering ranges of hills and mountains are not so far apart and there is less level surface, may be compared to the Santa Clara, Pajaro, and Salinas valleys in California.

These valleys and the lower slopes of the hills and mountains are the most highly cultivated part of the country, and support the densest population.

The more distinctively mountainous regions are naturally less adapted to agriculture; yet in the country known as Great Kabylia, the "Switzerland of Algeria," which contains the highest mountains of the colony, there is a very large population, the greater part of which is devoted to farming. This district lies to the east of Algiers. It forms an arc, of which the Djurdjura range of mountains is the chord and the seacoast is the circumference. For a long distance the crest of the Djurdjura range does not fall below 4,000 feet, while there are several peaks that exceed 7,000 feet in elevation. Lella Khedidja, the highest summit, has an altitude of 7,611 feet. Between this great chain and the coast there is a succession of high ridges separated by deep, narrow valleys and gorges. Anyone who has seen both regions will be struck by the resemblance between Great Kabylia

and the Santa Lucia Mountains district of the western part of Monterey County, in California.

Numerous streams arise in the mountains of the coast region, traverse the Tell, and empty into the sea. Most of these are torrents, discharging large volumes of water in winter, but in summer dwindling to mere rivulets. Not infrequently no water is to be seen in the channel, but in that case it is generally to be found under the bed of the stream. Owing to their relatively great fall, and the denuded condition of much of the soil, the amount of erosion accomplished by Algerian water courses is disproportionately large. These characteristics are especially marked in western Algeria. In the eastern part of the colony, where the rainfall is better distributed and more of the surface of the country is forested, the flow of the streams is more regular. The small importance of Algerian water courses is doubtless to be accounted for by the fact that most of the precipitation occurs on or near the coast, while the interior of the country is extremely arid.

Only one river of the Tell region also traverses the high plateau region. That is the Chéliff, the most important water course in Algeria, which rises in the mountains that border the Sahara on the north. It has a total length of about 330 miles, draining an area of about 7,500,000 acres. Its flow in summer is only 100 to 175 cubic feet per second, although in winter from 500 to 2,000 cubic feet are discharged. It is obvious that only a small portion of the valley of the Chéliff can be irrigated throughout the year. Not even this stream is navigable, except, near its mouth, for small boats.

HIGH PLATEAU OR STEPPE REGION.

Between the two chief mountain systems of Algeria extends a vast region of elevated plains, with an average elevation of a little more than 3,000 feet above sea level. The greatest width of the high plateau in Oran Department is about 125 miles, whence it diminishes gradually toward the east until on the frontier of Tunis a narrow river valley is all that remains. In topography, and to some extent in vegetation, this region greatly resembles parts of Nevada and New Mexico. In its widest part it consists of a gently rolling expanse, sometimes without a hill to break the monotonous horizon. In other places isolated mountain groups rise like islands out of the sea. Near its northern and southern borders spurs from the mountain chains that bound it extend into the plain. Toward the east the mountains are higher and approach nearer together. In the Department of Constantine the distinctive character of the high plateau is lost, and it breaks up into a series of valleys a few miles wide, with gently sloping sides, separated by high hills and mountains. The great masses of the Aurés and

Babors groups, which border this part of the region, reach altitudes of 7,000 feet.

A marked feature of the steppe region is the frequently occurring "dayas" and "chotts"—salt ponds or lakes without outlet—which receive the drainage from the southern slopes of the coast mountains and the northern declivities of the Saharan range. They occupy basin-like depressions, and are often dry or merely marshy in summer, their beds being then covered with a shining crust of salt. The "bolson" plains of the Sonoran region in North America have a similar hydrography.

There is very little water in the high plateau region suitable for drinking or for the irrigation of crops. Occasional wells occur, and here and there are small pools where sheep and cattle drink. As a rule, however, travelers in this region must carry with them their supply of drinking water. Attempts to find artesian water have generally been unsuccessful.

In places the topography of the steppe region becomes almost identical with that of the desert—notably where areas of sand dunes occur and the vegetation is very scanty. Such localities differ from the desert proper only in their greater elevation and more severe winter climate.

DESERT REGION.

A considerable portion of the largest desert in the world, the Sahara, lies within the boundaries of Algeria. Contrary to the general notion, the mean elevation of this desert above sea level is considerable, being placed by some authorities as high as 1,540 feet. Broadly speaking, the surface of the desert is convex, the central portion being generally higher than the borders. The desert is commonly pictured as a vast billowy expanse of sand blown about by the sirocco and dotted with oases. This conception is only partly true. As a matter of fact, the topography of the Sahara is as diversified as that of most areas of equal extent in other parts of the world. In this respect it is to be compared with the desert regions of the southwestern part of the United States. The Sahara contains mountains nearly 7,000 feet high, upon whose summits snow remains throughout the winter. Other parts are considerably below sea level. Much of its surface is broken by ranges of sand dunes and of rocky hills, between which lie narrow ravines or wide valleys. In other quarters extensive plateaus occur. The courses of streams that must once have carried a considerable volume of water can be traced in many places. The infrequent rains that fall in the Sahara sometimes fill the bottoms of these channels with water for a few brief hours. But even such transient torrents can effect a tremendous amount of erosion in the loose soils of the desert, there being little vegetation to hold them in place. Lakes and ponds are numer-

ous in the lower portion. Here and there, but forming only a small fraction of the entire area, are oases, watered by springs and wells, where groves of date palms flourish.

Schirmer[a] gives a graphic description of the Sahara. He writes:

> The desert, more than any other part of the surface of the globe, has the appearance of immobility. The implacable climate has depopulated the land. The great plains have an aspect of absolute emptiness. The mountains are like skeletons from which the sun has devoured the flesh. The dunes look like solidified waves of dull gold. The absence of sound is such that, as one traveler has put it, "One hears the silence." Everything appears unchangeably fixed in the intense light.

Pomel estimates that only about one-ninth of the total area of the Sahara is covered with sand dunes. The higher dunes occur in more or less regular chains, which have often been likened to the waves of the sea, caught and petrified. These sand hills sometimes reach a height of 1,000 feet. Smaller dunes, very regular in their rounded outline, often cover extensive areas, as, for example, between Biskra and the Melrirh Chott. Dunes of this character are generally formed by various desert shrubs and herbs that are able to send up new shoots through the sand which drifts over them from time to time, thus continually raising the height of the dune. The largest sand hills are often formed about rocks and cliffs, which arrest the drifting sand. The soil of the dunes is a fine and remarkably homogeneous sand.

Contrary to the general notion, the larger dunes are not continually shifting their position, but are sufficiently permanent features of the landscape to have received in many cases names that are handed down by the Arabs from generation to generation. For this reason, and because drinkable water and vegetation are more apt to occur near the dunes than elsewhere, the caravan routes in the Sahara follow the dunes wherever possible.

In western Algeria the desert is high. Hills and mountains of sun-scorched rock, with smooth surfaces and sharp, unworn edges, rise out of stony plains. Jagged cliffs, often of the most fantastic form, stand sentinel over the deep canyons and gorges that have been cut out by occasional torrents. Oases are few and far between. This is, indeed, the most barren and inhospitable part of the desert.

Toward the east the altitude of the desert decreases until, near the frontier of Tunis, a region of chotts, or salt lakes, lying below sea level, is reached. During most of the year the bottoms of these basins are dry or, at most, muddy beneath a crust of glittering white salt, which gives rise to remarkable displays of mirage. But during the winter they are partly filled by streams that descend from the mountains on the west and north. The eastern part of the Sahara in Algeria is mainly flat or gently rolling. Its surface is covered with sand,

[a] Schirmer, Le Sahara, p. 139 (1893).

often collected into dunes of greater or less size (erg). There are also extensive areas where the nearly plane surface is composed of smooth rock or hardened alluvial clay (hamada).

A great valley, some 60 miles long and about 12 miles wide, known as the "Oued Rirh," forms the most valuable portion of the Sahara of Algeria. It is really the bed of an extinct river. It is largely below or only slightly above sea level, the maximum depression—the extensive salt lake known as "Chott Melrirh"—being 107 feet below sea level. Subterranean streams of considerable volume underlie the surface in this region. These are doubtless fed by water which flows down from the mountains and sinks through the desert sands until it meets an impermeable layer of clay or of rock, over which it flows. The Oued Rirh Valley has been described as a "small Egypt with a subterranean Nile." By means of wells this water has been utilized in the creation of oases, where hundreds of thousands of date palms flourish.

The idea, once generally held, that the entire Sahara is the bed of an ancient sea has been abandoned. Only for the part known as the Oued Rirh, a small fraction of the whole desert, is this theory still entertained by some authorities. Here there is a series of large salt lakes, some of them below the level of the sea, which extends across Tunis almost to the Gulf of Gabès.

CLIMATE.

The greater part of Algeria has a warm, temperate climate, very similar to that of California. The climates of both countries are determined in large measure by the combined influence of three factors—the ocean, the mountains, and the desert. In Algeria, as in California, most of the rainfall occurs during the mild winter, while the long summer is almost perfectly dry. Furthermore, the direction of the prevailing winds at different seasons is in both countries largely effective in regulating conditions of temperature and of rainfall. The lower part of the coast region has a wet and a dry rather than a warm and a cold season. The higher mountains, however, and the high plateau are characterized by a decidedly cold winter. Algeria would be wholly a desert were it not for the northwest winds, charged with humidity, which blow from the sea, especially during the winter and spring. Their influence is, of course, most marked in the coast region, which has, in consequence, the heaviest rainfall, the most humid atmosphere, and the most luxuriant vegetation of any of the three zones.

The mountain chains which follow the coast line intercept a large part of the moisture carried by the sea winds, so that, while their northern, seaward slope has a comparatively heavy rainfall, their

southern slopes and the high plateau region beyond are quite arid. What moisture passes across the mountains of the first system is largely withdrawn from the atmosphere when it reaches the second, which bounds the steppe region on the south. Consequently, the desert beyond receives an insignificant share of atmospheric moisture from the Mediterranean.

Winds that come from the opposite direction—out of the Great Sahara—are, of course, at all seasons extremely dry. It is in late summer—especially in September—that the dreaded sirocco, the hot, sand-laden wind of the desert, is strongest and most frequent. Then it blows for days at a time over the high plateau and the two mountain ranges that form its boundaries, into the Tell, and even across the Mediterranean into southern Europe.

The three principal physiographical regions coincide with the most important climatic regions of the colony. For a further examination of this subject it will therefore be advisable to take up each in its turn, beginning with the coast region, or Tell.

In the tables given below, climatic data from Algerian localities are copied from Thevenet's "Essai de Climatologie Algérienne." For comparison, data from various places in the western United States where similar conditions obtain are also included. These are taken from publications of the United States Weather Bureau. Much information regarding the climate of Algeria has also been drawn from the excellent little work of Battandier and Trabut, previously mentioned. Owing to the paucity of accurate records and the small agricultural importance of the high plateau region, no tables are given for that part of the colony. It should be remarked, however, that Sétif, which has an elevation of 3,560 feet, although here included in the tables for the coast region, is sometimes considered as belonging to the high plateau, and the climatic data from this point are doubtless fairly applicable to the uncharacteristic eastern portion of that region. Again, Bou Saada, figures from which locality are given in the tables of climate of the desert region, really belongs to the extremely desert-like portion of the high plateau.

COAST REGION.

TEMPERATURE.

The littoral zone of the coast region has a mild winter, resembling that of the California coast. Temperatures at noon of 70° to 75° F. for fifteen days or a month at a time are not of rare occurrence in winter. The temperature never descends much below freezing, and does not remain at that point for any length of time. Still, temperatures of 23° F., such as are sometimes recorded by thermometers placed 4 inches above the surface of the ground, can do considerable damage

to the winter crops of garden vegetables, although the soil itself is never frozen to any considerable depth. The cold often seems more intense than is actually the case, because of the humidity of the atmosphere and the lack of facilities for heating the houses. A temperature of 45° F. is considered very disagreeable. A few miles back from the shore line, behind the first range of hills, for example, in the Mitidja plain, near Algiers, light frosts are frequent and have been known to occur as late as May. Snow, which has never remained on the ground for an entire day at Algiers, has lain for three days to a depth of 7.5 inches in the country only a few miles back from the coast.

In summer, except during the sirocco, the shade temperature of the littoral zone rarely exceeds 86° F., but sometimes rises to 105° F. when the wind from the desert is blowing. At such times the nights are often as hot as the days. The moderate summer temperatures are largely due to the sea breeze, which rises every morning at about 10 o'clock. As far inland as the influence of this wind is felt comparatively mild summer temperatures prevail.

The climate of the littoral zone is much like that of the coast of southern Europe; but fall-sown crops mature even earlier than there, by reason of the milder winter and the higher temperatures in spring. Hay is harvested in May and cereals in June in this zone.

The valley and plain zone of the coast region has a more extreme climate than the littoral zone. This difference has already been indicated in comparing the Mitidja Valley with Algiers, on the neighboring coast. The great Chéliff Valley, farther west, presents a still more marked contrast. Here, owing to the greater dryness of the atmosphere, frosts are more frequent and more severe in winter and spring than along the coast. On the other hand, in summer the hills which bound these valleys on the north shut off the sea breeze, and the heat is consequently more intense. Sunstroke and prostration from heat are by no means unknown in the Chéliff Valley. The sirocco, also, is more severely felt than in the littoral zone, which is partly protected against this south wind by the rampart of hills that rises a short distance back from the shore. More elevated places, like Sétif, have even severer winters, resembling those of the high plateau region. Sharp frosts are frequent as late as April and May. The summer temperatures are often very high in the daytime, but the air is fresher than in the valleys and the nights are nearly always cool.

The mountain zone of the coast region is not dissimilar in climate to mountainous regions of southern Europe. The winter, especially at the higher altitudes, is much more severe than in the littoral zone. On the crest of the Djurdjura range, at 7,000 feet elevation, snow often reaches a depth of 3½ feet and remains on the ground until the latter part of July. The summer temperatures are almost invariably moderate in the mountain region, except when the sirocco is blowing.

The smaller relative humidity also contributes toward making the summer climate an agreeable one. Springs with a mean annual temperature of 45° or 50° F. are not infrequent at high elevations in the Djurdjura range.

TABLE 1.—*Mean temperatures (in degrees Fahrenheit) of localities in the coast region of Algeria, as compared with the California coast.*

Month.	Algeria.					California.					
	Oran.	Orléansville.	Algiers.	Fort National.	Sétif.	Los Angeles.	San Luis Obispo.	San Francisco.	Fresno.	Sacramento.	Colfax.
January	50.9	45.8	54.0	41.2	39.0	53.0	51.2	50.1	45.2	45.2	44.3
February	51.8	47.7	54.0	42.2	40.4	54.4	55.3	52.2	51.5	49.6	45.8
March	55.4	53.1	56.5	46.8	46.0	56.4	52.2	53.6	54.0	54.3	49.1
April	59.2	55.8	59.5	50.2	49.8	60.0	56.0	55.0	60.9	59.0	54.2
May	64.0	63.5	64.6	55.9	56.7	62.0	57.6	57.0	67.3	64.5	61.7
June	69.4	71.6	70.0	66.6	66.7	65.9	62.9	59.0	74.6	70.0	71.4
July	74.1	80.1	75.4	74.7	74.8	70.8	66.2	58.8	82.1	73.6	75.1
August	75.4	79.7	76.1	75.4	73.4	72.0	65.0	59.3	81.4	70.6	77.0
September	71.1	72.3	72.9	67.3	65.5	68.5	65.4	60.9	74.2	70.0	69.7
October	63.7	61.0	65.8	56.1	53.6	64.0	62.0	59.9	63.4	60.0	59.8
November	57.2	53.2	60.4	48.9	45.2	60.0	57.8	56.4	54.7	53.4	51.4
December	51.6	46.8	54.0	42.2	39.6	56.4	52.6	51.6	46.3	47.2	46.3
Year	62.0	60.9	63.6	55.6	54.2	62.0	58.7	56.2	63.0	59.7	58.8

A comparison of the temperatures of localities in Algeria and in California, as given in Table 1, is instructive. Of the Algerian stations, Oran and Algiers are situated on the seaboard, the first in western, the second in central Algeria. Data from these localities should be representative of conditions along the coast, except in the extreme eastern part of the colony. With them are to be compared San Francisco, San Luis Obispo, and Los Angeles, representing the coast of California. Orléansville is the metropolis of the great valley, or rather plain, of the Chéliff, the most important of the large inland valleys of the coast region in Algeria. Sétif, as has already been remarked, lies south of the mountain chain that bounds the coast region, and has an elevation of over 3,000 feet. Topographically, and in some of its climatic peculiarities, it belongs rather to the high plateau than to the coast region, although agriculturally it is more nearly related to the latter. Fresno and Sacramento are representative points in the two great interior valleys of California—the San Joaquin and the Sacramento. They should afford an interesting comparison, especially with Orléansville. Fort National, at an elevation of over 3,000 feet, in the heart of the most mountainous region of Algeria, is to be compared with Colfax, in the foothills of the Sierra Nevada, north of the center of California.

Oran has the same mean yearly temperature as Los Angeles, but has higher mean temperatures for the summer and lower for the winter months, so that Los Angeles has the more equable climate. At Algiers the yearly mean temperature is not very different from that at Oran, but the mean temperatures for the winter months are generally higher. San Francisco and San Luis Obispo fall considerably

below the Algerian coast towns in yearly mean temperature. The mean temperatures for the summer months also are decidedly lower at the California localities. The mean temperatures in winter correspond more closely.

Orléansville shows a remarkable resemblance in distribution of temperatures to the similarly situated town of Fresno, in California, and in this repect somewhat less to Sacramento. In yearly mean temperature, however, Orléansville is nearer Sacramento. Sétif, as would be expected, differs considerably from Orléansville, Fresno, and Sacramento in yearly and monthly means of temperature. Its resemblance to the high plateau is expressed in the fact that the nights are always cool in summer and the winter temperatures are low, falling at times to 12° F. The mountain stations, Fort National and Colfax, show a close approximation in monthly and yearly mean temperatures.

HUMIDITY.

The relative atmospheric humidity in the littoral zone is fairly uniform throughout the year. Owing to the proximity of the sea it is at all seasons considerable, the average for the year being 73 per cent. This condition of humidity is interrupted only when, generally in late summer and in early autumn, the sirocco blows for a day or more at a time. The humidity is far greater in the eastern than in the western part of the colony. The large percentage of moisture in the atmosphere causes the discomfort from cold in winter, and from heat in summer, to be out of all proportion to the actual temperature.

The dry season, so far as the littoral zone is concerned, owes its character to the lack of actual precipitation rather than to the absence of humidity in the air. Night fogs are frequent when east or northeast winds are blowing, and in August it is often 9 o'clock in the morning before they disappear. Dew is also copious at this season.

Atmospheric humidity, like precipitation, decreases as one goes farther from the coast. It is already perceptibly less in the mountains and in the great valleys of the coast region than along the seaboard.

PRECIPITATION.

In Algeria precipitation is almost synonymous with rainfall, except in the higher mountains, for elsewhere the amount of precipitation in the form of snow is unimportant. Hailstorms are fairly frequent, occurring, on an average, seven times a year. Market gardens of the littoral zone sometimes suffer severely from spring hailstorms, and, in exceptional localities, vineyards and orchards are occasionally damaged. Hail is more important for this reason than as contributing much to the total precipitation.

In the coast region of Algeria, as in many warm temperate and tropical countries, the distribution of the rainfall is more important

than that of heat in determining the characteristics of the principal seasons of the year. Its distribution is largely controlled by the direction of the prevailing winds. In winter strong northwest winds, blowing from the Mediterranean, are of frequent occurrence and bring most of the rainstorms. They begin in the autumn, sometimes as early as the first of September, and usually cease in May or June. Even in midwinter, however, a clear sky for fifteen or thirty days at a time is not a rare event. During the summer there is a light sea breeze during the day, but winds of greater violence come almost wholly from the south, and are dry and hot.

More rain falls annually on the coast of Algeria, especially on the eastern coast between Algiers and Tunis, than in a great part of Europe. Notwithstanding this, Algeria has a decidedly more arid summer than any part of Europe, except, perhaps, extreme southern Italy and portions of Spain. This is due to the unequal distribution of the rain among the different seasons.

In the littoral zone winter is a wet rather than a cold season. It is then that most of the native vegetation, as well as crops that are not irrigated, must make their growth. The dry season is a period of rest for soils that are not artificially watered. Light showers of brief duration, such as occasionally fall during the summer, are of small importance in their effect upon the climate and vegetation. In the large inland valleys of the coast region the summer drought is still more pronounced than on the coast.

In the mountain zone, particularly at the higher elevations, rain is more evenly distributed, and the seasons are more like those of middle Europe. The rainfall in March and April is particularly heavy. In Great Kabylia thunderstorms and hail, which in the littoral zone occur only in winter, are not infrequent throughout the summer. This, with the partial protection from the sirocco afforded by the higher ranges, makes the summer drought less pronounced than in the littoral zone and in the valley and plain zone. But the total amount of precipitation in summer is, after all, comparatively insignificant. Even in the mountains, summer retains its characteristics as the dry season of the year. In winter the rainfall is quite considerable. The northern slopes of the Djurdjura range receive the heaviest precipitation occurring in the country—over 40 inches a year. These high mountains form a barrier which intercepts most of the cloud-laden winds from the sea, so that the country immediately to the south of them is extremely arid.

Rainfall is very unevenly distributed in different parts of the coast region and even of the littoral zone proper. One reason for this is the great difference in latitude—about two degrees—between the easternmost and the westernmost point of the Algerian coast. While the total annual precipitation on the coast near the Tunisian border

amounts to nearly 40 inches, on the frontier of Morocco it is less than 16 inches. From year to year, also, the total amount and the distribution vary enormously.

TABLE 2.—*Rainfall (in inches) of localities in the coast region of Algeria, as compared with the California coast.*

Month.	Algeria.					California.					
	Oran.	Orléansville.	Algiers.	Fort National.	Sétif.	Los Angeles.	San Luis Obispo.	San Francisco.	Fresno.	Sacramento.	Colfax.
January	3.05	1.73	4.35	5.58	1.62	2.93	5.69	4.92	1.53	3.82	8.81
February	2.64	1.85	3.68	3.49	1.68	3.27	1.55	3.49	1.33	2.80	6.89
March	2.42	2.28	3.42	6.24	2.34	2.98	3.46	3.22	1.74	2.86	6.78
April	1.67	2.15	2.36	5.20	2.05	1.36	.93	1.84	1.11	2.13	4.48
May	1.42	1.38	1.40	2.99	1.82	.43	.35	.73	.50	1.01	2.36
June	.29	.55	.57	1.13	1.08	.10	.19	.14	.18	.17	.62
July	.07	.06	.06	.22	.28	.02	.01	.02	Trace.	.02	.03
August	.08	.08	.28	.28	.79	.03	.03	.02	.01	.01	.01
September	.65	.76	1.12	1.75	1.17	.08	.36	.22	.26	.32	.53
October	1.61	1.78	3.11	4.51	1.44	.74	1.62	1.02	.67	1.11	1.95
November	2.38	2.29	4.37	4.99	1.52	1.38	1.16	2.72	1.15	2.20	4.40
December	2.90	2.48	5.49	7.30	2.05	3.98	3.08	4.99	1.78	3.69	8.70
Year	19.18	17.39	30.21	43.68	17.84	17.30	18.43	33.33	10.27	20.14	45.56

When we compare Algeria with California as to rainfall, we find that the annual total precipitation at the two coast towns, Oran and San Luis Obispo, is very nearly the same. At Los Angeles it is somewhat less. January is the month of greatest rainfall at Oran and San Luis Obispo, February at Los Angeles. July is the month when the least rain falls at all three points. The precipitation is much heavier, and nearly the same in total amount at Algiers and at San Francisco. There is also considerable similarity in the distribution during the year of the rainfall at these two places.

The rainfall at Orléansville greatly exceeds that at Fresno, but is somewhat less than that at Sacramento. Sétif agrees closely with Orléansville in yearly total and in distribution of the precipitation. As for the mountainous districts of the two countries, as represented by Fort National and Colfax, there is a very close correspondence in yearly totals, but in respect to distribution the resemblance is less striking. The rainfall in summer at Fort National is greater and that in winter less than at Colfax.

WIND.

Winds from every point of the compass occur at different seasons in the coast region. As has already been mentioned, the characteristic winter wind is from the northwest, off the Mediterranean. This often rises to the height of a gale, and is of sufficient importance to decide the direction in which trees along the seashore are bent. West winds are also common in winter. In summer, the most violent wind is the occasional sirocco, from the Desert of Sahara, an extremely hot, dry wind, which sometimes blows day and night for several days at a time,

filling the air with the fine dust it carries. It often does great harm to crops, vineyards and ripening grain being particularly liable to injury. The sirocco also blows in winter, but its violence is less at that season and it is cooler and moister. The regular summer wind is, however, the sea breeze from the northeast, which springs up every morning and is of great importance in moderating the temperature. East winds are also frequent in summer. At night, on the other hand, the prevailing wind is from the south. Absolute calm is not infrequent. In proportion as we travel farther from the coast, the effect of winds from the sea becomes less perceptible and that of the desert winds more pronounced. This difference becomes strongly marked after the northern mountain system is crossed.

The sirocco is the most striking climatic feature in which Algeria differs from California. In southern California a wind from the desert, known as the "Santa Ana" wind, blows occasionally, but in duration and severity it is not to be compared with the Algerian sirocco.

HIGH PLATEAU REGION.

The small agricultural importance of the high plateau region makes it unnecessary to discuss its climate at any great length. Owing to its greater elevation and distance from the sea, conditions are more extreme than in the coast region. The winters are colder and the summers hotter. Winter temperatures as low as 7° F. have been known, while in summer a temperature of 105° F. is often experienced. Daily variations amounting to 85 degrees have been recorded. In its severe winters the high plateau region resembles the highest altitudes of the mountain zone of the coast region, but differs in its hotter temperatures in the daytime in summer. In the latter respect it resembles the desert region, but there the nights are warmer in summer and the winter is much milder. Battandier and Trabut[a] mention one point in the high plateau region, at an elevation of about 4,700 feet, where the mean temperature for ten years was about 44.5° F. in winter, 55.5° F. in spring, 79° F. in summer, and 62° F. in autumn. The yearly mean temperature was 62° F.

The rainfall is much less than in the coast region, but no exact data on this point are available. Rain falls usually in sudden and violent showers. Storms are more frequent during the summer than is the case along the coast. The amount of precipitation is trivial, although sometimes sufficient to moisten the ground. During the winter the soil, especially in depressions, contains enough water in occasional years to bring a crop of barley without irrigation. The atmospheric humidity is almost always very small.

[a] L'Algérie, p. 118.

DESERT REGION.

TEMPERATURE.

If we had no other data concerning the climate of the Sahara than the mean annual temperature, we should suppose it to be a very mild one. The variations from the yearly, monthly, and daily means are, however, enormous. Winter temperatures of 18° F. and summer temperatures of 112° F. are by no means uncommon. The daily range sometimes exceeds 86 degrees. The unshaded soil—sandy or rocky—becomes heated up to 160° F. At Biskra, which is by no means extreme in its summer climate, it is said to be possible sometimes to cook an egg in the sand. In the Oued Rirh region, on the other hand, ice sometimes forms in winter in the irrigation ditches. Evaporation is undoubtedly very great, but no accurate records of this phenomenon have been kept in the Sahara.

TABLE 3.—*Mean temperatures (in degrees Fahrenheit) of localities in the desert region of Algeria, as compared with similar localities in the southwestern United States.*

Month.	Algeria.				United States.			
	Tougourt.	Biskra.	Ouargla.	Bou Saada.	Yuma, Ariz.	Phoenix, Ariz.	Tucson, Ariz.	Volcano Springs, Cal.
January	47.3	50.5	46.8	44.4	54.1	49.8	49.6	55.9
February	49.8	53.2	51.8	45.8	58.6	54.3	53.6	60.5
March	54.9	58.3	59.9	51.1	63.9	53.9	59.4	68.4
April	64.0	63.1	66.4	56.8	69.9	67.0	65.6	79.7
May	74.8	71.8	73.6	65.1	76.9	74.4	74.5	87.5
June	86.0	80.6	82.4	75.0	84.4	83.9	84.0	96.6
July	92.1	87.1	90.7	83.1	91.2	90.2	87.7	101.3
August	85.1	85.8	86.0	82.8	90.4	88.2	85.9	99.7
September	83.7	78.8	78.1	73.0	84.3	81.4	80.8	89.5
October	68.4	67.6	63.5	60.3	72.4	69.3	70.4	78.4
November	58.5	57.2	52.9	50.0	62.3	58.5	58.5	67.0
December	48.9	51.3	45.0	44.0	55.9	52.3	51.6	57.4
Year	67.8	67.1	66.4	60.9	72.0	68.6	68.5	78.5

Of the stations in the Algerian desert comprised in the accompanying table of temperatures, Bou Saada, at an elevation of 2,194 feet, belongs rather to the high plateau region, lying north of the mountain chain which forms the boundary of the Sahara. It is in a region, however, where the conditions are entirely desert-like, closely resembling those of the higher western part of the Sahara. The other three stations are in the low eastern part of the Sahara proper. Biskra can hardly be regarded as a typical locality, being just within the limits of the desert, only a few miles south of the mountains which form the northern boundary of the Sahara. Biskra is 407 feet above sea level. Tougourt, 120 miles farther south, in the Oued Rirh country, is the center of some 40 oases, where hundreds of thousands of date palms are grown. Its altitude above mean sea level is 226 feet. Ouargla, well into the Sahara, 120 miles still farther south, has the same elevation.

Among the localities in the extreme southwestern United States selected for comparison, Tucson, Ariz., with an elevation of 2,387 feet, resembles in situation Bou Saada. Phoenix (altitude, 1,100 feet) may be compared with Biskra. At Yuma (altitude, 137 feet), and still more at Volcano Springs (228 feet above sea level), conditions would be expected to resemble in many respects those prevailing at Tougourt and at Ouargla. A comparison of the figures in these tables shows that the Colorado Desert in southern California is warmer than the Sahara in Algeria. Volcano Springs has an annual mean temperature 10.7° F. higher than Tougourt, and in summer the maxima are higher. The extreme minimum temperatures in Arizona and California are lower than those in the Sahara. For example, the lowest recorded temperature at Biskra is 29.7° F., while at Phoenix, Ariz., the minimum frequently falls to 25° F., and has been as low as 12° F.[a]

HUMIDITY.

While the actual amount of water vapor in the air is sometimes quite appreciable in the Sahara, the relative humidity is always low, because of the high temperatures. In summer the average relative humidity is only 28 per cent, and for this reason the excessive heat is less uncomfortable than would otherwise be the case. So extreme is the dryness of the atmosphere that one's skin is seldom wet with perspiration, even on the hottest days. Dew is rarely precipitated, and although freezing temperatures are by no means unknown in winter, white frost is not common. The sky over the Sahara is generally cloudless and very clear, particularly in the night time.

TABLE 4.—*Mean relative humidity (in percentages) of localities in the desert region of Algeria, as compared with Yuma, Ariz.*

Month.	Algeria.			United States.	Month.	Algeria.			United States.
	Biskra.	Ouargla.	Bou Saada.	Yuma.		Biskra.	Ouargla.	Bou Saada.	Yuma.
January	61.6	60.1	65.5	45.4	August	35.6	25.3	26.4	47.7
February	55.3	67.5	60.7	43.8	September	44.1	28.6	39.1	44.7
March	52.0	55.0	50.7	43.0	October	51.2	52.0	47.6	46.2
April	48.2	47.0	46.9	35.1	November	58.5	62.1	57.8	43.3
May	42.9	37.3	42.0	36.7	December	62.5	66.4	64.8	51.4
June	36.4	35.6	34.1	34.7					
July	32.6	29.4	25.4	42.8	Year	48.4	47.2	46.8	42.9

The three stations in the Algerian Sahara where records of relative atmospheric humidity have been kept all show an annual mean higher

[a] For a detailed comparison of the climate of the Algerian Sahara with that of the extreme Southwestern States, see Bulletin No. 53 of the Bureau of Plant Industry, U. S. Department of Agriculture, The Date Palm and Its Utilization in the Southwestern States, by Walter T. Swingle, 1904, pp. 52–70.

than that of Yuma, the only locality in the desert region of the southwestern United States where accurate records have been kept. But, while in winter the humidity is greater in the Algerian Sahara than in southwestern Arizona, in summer the reverse is true.

PRECIPITATION.

A widely received explanation of the peculiar conditions of the Sahara, as regards atmospheric water, is as follows: The central portion of the desert is sufficiently elevated to be considerably colder in winter than the Atlantic Ocean to the west and the Mediterranean Sea northward. Consequently, the general direction of winds in winter is from the center toward the edge of the desert, which precludes the possibility of much rainfall at that season. In summer, on the other hand, the normal winds blow toward the highly heated center of the desert, although there are occasional siroccos in the contrary direction. These normal summer winds from the Atlantic and Mediterranean would cause rainfall in summer were it not that physiographical conditions intervene to prevent this. Winds from the west encounter a cold current that follows the Atlantic coast of northern Africa, and the greater part of the moisture they carry is condensed before they reach the mainland. The high summits of the coastal mountain system of Algeria intercept and condense most of the water vapor that is brought in by winds from the Mediterranean. What little moisture escapes this barrier and crosses the high plateau is mostly given up when the mountains along the northern border of the Sahara are encountered. Furthermore, in the desert itself there are few mountains of sufficient elevation to condense what water vapor passes the second barrier.

Notwithstanding these conditions, rain is by no means unknown in the Sahara. Heavy precipitation sometimes occurs, but its distribution is very irregular, both in point of time and of place. Localities in the desert are known which have received no appreciable amount of rain for ten years or more. At other times a cyclone may cause a sudden heavy downpour. Violent torrents are formed and a great amount of erosion is accomplished in a few hours. The higher elevations of the isolated mountain masses of the Sahara have a somewhat more regular rainfall, but it is believed that, on the whole, evaporation exceeds precipitation in the Sahara, and that its aridity is steadily, although imperceptibly, increasing.

TABLE 5.—*Rainfall (in inches) of localities in the desert region of Algeria, as compared with similar localities of the southwestern United States.*

Month.	Algeria.				United States.			
	Tougourt.	Biskra.	Ouargla.	Bou Saada.	Yuma, Ariz.	Phoenix, Ariz.	Tucson, Ariz.	Volcano Springs, Cal.
January	0.61	0.67	0.50	0.79	0.48	0.80	0.79	0.25
February	.54	.68	.30	.79	.41	.70	.90	.39
March	.80	.69	.88	1.32	.27	.58	.77	.07
April	.44	.83	.36	1.56	.08	.30	.27	Trace.
May	.39	.72	.13	1.55	.03	.13	.14	Trace.
June	.04	.31	.11	.67	.00	.10	.26	.00
July	.03	.12	.00	.32	.13	1.03	2.40	.12
August	.02	.14	.00	.31	.33	.88	2.60	.09
September	.31	.80	.00	.91	.15	.64	1.16	.00
October	.43	.59	.22	.87	.23	.37	.64	.12
November	.54	.42	.50	.64	.26	.54	.81	.07
December	.88	.74	.61	.88	.46	.86	1.00	.52
Year	5.01	6.73	3.61	10.61	2.83	6.93	11.74	1.64

A comparison of precipitation in the Algerian desert and that of the southwestern United States is instructive and interesting. Bou Saada has approximately the same annual total as Tucson, which it resembles in situation and elevation, but there is the same difference in distribution as was noted in the case of atmospheric humidity. More rain falls in winter and less in summer at the Algerian than at the Arizona locality. At Biskra and Phoenix very nearly the same total amount of rain falls during the year, and the distribution at the two points corresponds more closely than as between Bou Saada and Tucson. At Ouargla and at Tougourt the rainfall is considerably greater in yearly total than at Yuma and at Volcano Springs. In distribution, however, these four stations resemble each other to a considerable degree. On the whole, if we consider only localities which represent the most extreme conditions in both great arid regions, it would appear that the desert country of the southwestern United States is decidedly drier than the Sahara of Algeria.

IRRIGATION.

Algeria is less fortunately endowed than Egypt as regards water supply. She has no large river like the Nile, containing even at its lowest stage a very considerable volume of water for irrigating purposes. On the contrary, the water courses of the French colony are of a torrential character, running high after heavy rains but dwindling to mere rivulets in summer. Most of them are short, rising in the mountain ranges of the coast region, and thus not draining a sufficiently large area to gather a great volume of water. Their fall is heavy, and they accomplish a vast amount of erosion, so that when high their waters carry a large amount of silt. Even the Chéliff, which has its source in the mountains that form the northern boundary of the Sahara and traverses the entire width of the high plateau, is

but an insignificant stream in summer. Rainfall is too scanty, even at a short distance from the coast, to feed large rivers. For this reason irrigation in Algeria must necessarily be on a more modest scale than in Egypt. As a matter of fact, the area under irrigation at present is only a small fraction of the total area of the colony.

The littoral zone of the coast region, particularly in the eastern part of the colony, receives quite enough precipitation in winter for the growing of most crops. In summer, however, there are very few parts of Algeria where field crops can be grown without irrigation, at least without a radical change in the methods of cultivation generally followed in the colony. Orchards and vineyards, however, can be made to pay in some places without artificial watering. This is notably the case in the mountain zone, where steep slopes, ill adapted to irrigation, are covered with fruit trees. In the valley and plain zone of the coast region irrigation is almost indispensable in summer, and even the winter cereal and forage crops are greatly benefited by an occasional watering. In the high plateau region nothing can be grown in summer without irrigation, and in winter it is only in an occasional depression that the natural moisture is sufficient to bring a crop. In the desert region artificial watering is at all times necessary for small crops, although sometimes it is of the simplest character. Thus, at the base of the mountains scanty crops of grains can be produced by throwing up a series of ridges to retain the sheets of flood water that in winter occasionally sweep down over the land.

There is no reason to believe that in ancient times, when northern Africa was the granary of the civilized world, conditions as to water supply were essentially different from those now prevailing, although there is evidence that, in eastern Algeria at least, crops were much more extensively grown without irrigation than is now the case. Under the Carthaginian régime, and later under the Roman rule, irrigation works abounded in the country that is now Algeria and Tunis. The remains of such structures, sometimes utilized as foundations for modern works, are numerous, particularly in the Department of Constantine and in Tunis. Indeed, more than one region that is now a barren desert must have been well populated and in a high state of cultivation two thousand years ago.

The works built at that period were generally of the simplest and rudest construction. Often merely a mass of earth or broken stone, held in place by a row of stakes, served to dam a small brook. For the most part these structures were evidently the work of the colonists who tilled the land under them, rather than of trained engineers. They were built sometimes by individuals, sometimes by associations. The plan usually followed was to dam up a mountain torrent near the point where it debouches upon the plain. In narrow ravines a succession of rough dams was often constructed, thus allowing the stream

to drop from terrace to terrace, leaving a tiny reservoir at each stage, from which water could be taken at need for irrigating small gardens and orchards. At the mouth of the ravine was a larger distributing reservoir, with a dam of stone and masonry, for diverting water into the irrigation canals, which branched out over the lower lands beyond. The safety of the larger dam was assured by the presence of these smaller reservoirs farther up the stream. By this method not only was water secured for irrigation, but the force of the current in times of flood was effectually checked. For a roaring, muddy torrent, sweeping all before it and carrying away great masses of the soil, was substituted a gentle stream of clear water, incapable of destructive erosion.

During the long centuries of Arab domination most of these irrigation works fell into ruin. Some, however, were patched up from time to time, and were used by the Arabs to irrigate their small fields and gardens. Soon after the French conquest the all-importance of some provision for the artificial watering of the land was perceived, and the construction of large storage and diversion reservoirs along Algerian streams was begun. At first this work was done by the engineer service of the French army.

COAST REGION.

Irrigation in Algeria to-day reaches its maximum development in the larger valleys and plains of the coast region. A number of important irrigation districts have been established, and reservoirs and canals have been constructed. At Marengo, on the Meurad, the first storage reservoir constructed by the French was finished in 1857. The dam, built of earth, is 266 feet long and 90 feet high. The barrage of the Cheurfas is built across the Sig, a short distance south of St. Denis du Sig. It took the place of a Turkish dam which was washed out in 1858. The present reservoir stores 2,400 acre-feet and supplies water for the irrigation of 5,000 acres in winter and 2,000 acres in summer. A larger dam, 6 miles farther upstream, was completed in 1884. This dam was of masonry, 98.4 feet high, 62.2 feet thick at the base, and 13.1 feet thick at the top. The capacity of the reservoir was calculated at 14,600 acre-feet. On February 8, 1885, the dam broke, carrying with it also that farther downstream. This break is said to have been caused by the infiltration of water through the rock around the dam. The foundation was of soft sandstone, in many places hardly sufficiently indurated to warrant its being called rock. The dam which was then built on the site of the older one is on the same general plan as its predecessor, but instead of being built on a straight line, the new portion is at an angle of 128 degrees with the old work, the angle pointing downstream. The object of constructing the dam in this way was to obtain a better foundation. It

is reported that seepage around and under the walls of the structure still causes trouble, and some engineers question the permanent safety of the work.

The largest storage dam in Algeria is that across the Habra River, 7 miles south of the town of Perrégaux. This structure, also, has been the scene of a catastrophe, and a much more serious one than that which occurred at St. Denis du Sig. The original dam, 1,506 feet long, was built in two sections at an angle of 30 degrees, with the angle pointing downstream. It was partly carried away on December 15, 1881, by excessive floods which overtopped the entire dam. This disaster is generally attributed to the giving way of the soft foundation material, and to water cutting around the east end through the soft material. As a result of the break in the eastern end of the dam 400 persons were drowned and immense damage was done to property.

The work of reconstruction was finished in 1886. The dam, as it now exists, is essentially in three parts. The spillway on the west end has a length of about 410 feet. The center of the dam crosses an island which divides the stream into two channels. The portion of the dam across the east channel is 13 feet higher than that over the west channel. The reconstructed dam has a height of 131 feet, is 1,443 feet long, 131 feet thick at the base, and 14.7 feet thick at the top. The highest part of the dam, in the eastern section, consists of a wall 7.9 feet high and 4.9 feet thick, resting upon the top of the dam proper. This was added to prevent overflow of the adjacent land by floods. The event has shown the wisdom of this precaution, for in 1900 water rose to within 2 feet of the top of the highest wall, and was 6 feet higher than the crest of the spillway. The total cost of the Habra dam, from the inception of the enterprise, has been about $1,080,000.

The reservoir formed by this structure has a capacity of 30,800 acre-feet, and is intended to provide for the irrigation of about 100,000 acres, although so large an area has never been taken up under it. The water from the reservoir is taken out at the base of the high or eastern portion of the dam. A complicated apparatus has been devised by which water passing through the sluice furnishes power to pump water into a tank, which is situated upon a hill about 100 feet high at the east end of the dam. The water thus elevated furnishes stored power for the operation of the sluice gate. The gate is supposed to be automatically raised and lowered as the water rises and falls in the reservoir, but the mechanism has never proved altogether satisfactory.

The Habra, with its tributaries, has a flow in summer of 18 second-feet, but during unusual floods the discharge has been known to exceed 25,000 cubic feet per second. Although the drainage basin above the Habra dam covers 3,859 square miles, the mean annual discharge of the stream is estimated to amount to only about three and one-half times the capacity of the reservoir. During the flood which occasioned the

breaking of the dam, caused by a 6½-inch rain over a great part of the watershed, the run-off in one night was more than three times the capacity of the reservoir.

Near the town of Relizane a small masonry dam has been built across the Mina River. This dam has a height of 45 feet above the the bottom of the rocky gorge in which it is built. It was originally planned to hold up a small storage reservoir, but this has become filled with sediment, and now the dam serves only for the direct diversion of the water of the stream. The discharge of the Mina is small. Though the canal system fed by this barrage covers an area of 20,000 acres, the land actually irrigated is not of large extent. The water of this stream, when examined toward the end of July, 1902, was found to carry 123 parts of soluble matter per 100,000 parts of water. Of this, 26 parts were bicarbonates, 1 part carbonate, 60 parts chlorids, and 36 parts sulphates.

Another masonry work of importance is that across the Djidiouïa River near St. Aimé, in western Algeria. It is 164 feet long, 55.8 feet high above the foundation, and 91.9 feet high, foundation included. The base has a thickness of 36.1 feet, and the top 13.1 feet. The reservoir has a capacity of 2,000 acre-feet, and is intended to irrigate from 7,500 to 10,000 acres.

Since it was built this reservoir has become almost completely filled with silt. In all reservoirs in Algeria the accumulation of silt has given trouble, but only at St. Aimé have attempts been made to remedy the evil. M. Jaudin, a hydraulic engineer, has invented a machine for stirring up and removing the silt. His apparatus consists of a metal tube or conduit 20 inches in diameter, the lower end of which penetrates the dam near its bottom. The free portion is kept afloat by buoys and is attached by flexible joints to a floating scow. The connections are made so as to allow the scow to float from side to side of the reservoir, and the end of the pipe can be raised and lowered as desired. The difference in level between the end of the pipe projecting through the dam and that attached to the scow produces a strong current through the pipe. As the pipe is moved along the mud is sucked into it and is carried below the dam. The clay drawn into the pipe is found to be so well packed and so stiff that it has to be cut out by a special cutting apparatus built like a steam screw. In spite of the cutting apparatus, the water thus removed carried only from 4 to 5 per cent of silt. The inventor claims that under favorable conditions he can remove water containing 16 per cent of silt. The expense of operating the apparatus is estimated at $35,000 a year, and the cost of installation for a fairly large dam would be $540,000. The inventor was under contract to remove the silt from this reservoir at 20 cents per cubic meter (15.4 cents per cubic yard).

28932—No. 80—05——3

In the Mitidja Valley, near Algiers, there is a reservoir which is capable of holding about 11,340 acre-feet of water. This is sufficient to irrigate 75,000 acres, but the area actually under irrigation is only one-third as large.

The irrigation works just described are more or less typical. At a number of other places dams are either in actual use or are under construction. Algeria has been unfortunate in regard to disasters to her irrigation works. This has tended to create distrust of them among farmers who practice irrigation. There were lean years for people who tried to farm below the canals while new works were building, and the memory of those trying times is still vivid. It seems that in the early days of colonization too much land was covered by the irrigation works. Consequently, there are now large uncultivated areas across which the canals and laterals have to be extended in order to reach land that is in crops.

There is reason to believe, as an eminent authority upon agriculture in Algeria has remarked, that more good might result from the construction of series of irrigation works on a small scale, after the fashion of the Carthaginian and Roman colonists, than from the building of elaborate engineering works such as have just been described. The peculiar torrential character of Algerian streams and the great quantity of silt they carry make them ill adapted to large structures of this kind; but small diversion reservoirs, that afford water only in winter, are a valuable supplement to the natural rainfall, particularly in the drier western part of the coast region. There it is found that one or two irrigations during the winter will very materially increase the yields of cereals and forage crops. Handled thus, with two irrigations in winter, an acre of wheat in the Chéliff Valley can sometimes be made to yield 44 bushels.

The most important direct diversion of water from a stream in Algeria is that on the Chéliff, 15 miles above Orléansville, where the irrigating water is taken from the west bank of the river by means of a canal with a capacity of about 50 cubic feet per second. One branch of this canal is carried across the river by a siphon to irrigate the right bank. On the left bank 6,000 acres, and 19,000 acres on the right bank, are irrigated by this canal. The entire system cost about $480,000. Those who use the water are required to construct the secondary canals, pay a rental to the government, and keep the works in repair. Of the 50 cubic feet of water per second available under this system, 13 only have been subscribed for, on account of the excessively high water rent asked. Similar difficulty in inducing farmers to subscribe to water at the rates demanded has been encountered elsewhere in the colony.

In the mountain zone, notably in Great Kabylia, there are many small diversion dams, cheaply constructed in narrow ravines out of

such materials as are ready to hand. By means of these, streams that in summer appear to be dry, but really carry subterranean water, are made to serve for irrigation at that season. The bed is dug out until rock bottom is reached. A dam is then roughly fashioned out of stones. The trunk of a tree is laid across the top, which is slightly higher than the general level of the stream bed, and clay and stones are piled up behind the dike; or, sometimes, a mere double row of stakes, filled in with clay and stones, is made to answer the purpose.

Various devices are in use in Algeria for preventing water that falls upon cultivated hillsides from running off too rapidly. Particular attention has been paid to this question in vineyards. Sometimes shallow basins are dug in the center of each quadrangle formed by four vines. Another practice, which is also followed by the Kabyles in their orchards, is to run horizontal furrows or trenches across the hillside at regular intervals, throwing out the soil on the downhill side. It has been estimated that, at a cost of about $3, from 9,000 to 10,000 cubic feet of water, enough to cover the land to a depth of from 2 to 4 inches, can thus be saved annually in each acre of vineyard. In olive orchards, which cover steep hillsides in some parts of the colony, V-shaped trenches, pointing downhill, are dug so that the point of a trench is situated near the base of each tree. The soil around the tree is kept loose in order to facilitate absorption of the water thus carried to it.

The market gardens of the littoral zone are generally irrigated by means of the "noria," a water-lifting machine that has been in use for ages in the Mediterranean region. It consists of a vertical wheel, to the rim of which buckets are attached, and which turns by interlocking its cogs with those of a horizontal wheel. To the latter an animal, usually a horse or a donkey, is hitched, and is driven around in a circle. A second animal is kept to relieve the first, generally every two hours. By means of the noria one horse can raise 150 gallons of water 11 feet in a minute, which is equivalent to 0.33 second-foot. The water is collected in a basin that generally holds from 1,000 to 1,800 cubic feet. Even field crops and vineyards can be profitably irrigated with the noria if the water supply is ample and the lift does not exceed 40 feet. But its greatest usefulness is in connection with the intensively cultivated and very remunerative truck crops. The noria is said to be more economical for raising water than any hydraulic machine, only one-fifth of the total power expended being lost. Near Algiers, where the irrigation of gardens is most expensive, the annual cost of watering 1 acre with the noria is placed at $65.

The water used for irrigation in the coast region, except in some of the valleys of western Algiera, is generally very good, rarely containing a harmful quantity of salts. However, no attention has been given to the matter of drainage of irrigated lands. Particularly in western

Algeria, large areas of once fertile soil have in consequence become subirrigated and salty. In many cases considerable tracts have had to be abandoned for this reason.

HIGH PLATEAU REGION.

A very insignificant area is irrigated in the high plateau region. There are almost no running streams, except after an occasional heavy rain in winter. The water of the chotts or lakes that fill the depressions is far too salty to be used for irrigating purposes. Here and there a small patch of grain, forage plants, or garden vegetables is watered from a well, but artesian water seems to be generally lacking.

DESERT REGION.

Oases of greater or less extent occur in all parts of the Sahara. They are particularly numerous, however, in the lower eastern portion. In the region known as the Oued Rirh, a larger percentage of the total area is occupied by cultures than anywhere else in the desert. The oases (see Pl. I), almost without exception, are probably of artificial origin. The date palm, to which they owe their life, is believed to have been introduced into Algeria by man. In some places near the base of the mountains, as in the region of the Zibans, there is flowing water on the surface of the ground which can be diverted directly into canals. At most, a few rude dams are needed to raise its level a few inches. Elsewhere wells must be dug and the water must generally be raised by hand or by the noria in order to water the crops. The source of the water thus utilized is to be looked for in the high mountains adjacent to the Sahara, where the rainfall is much heavier than in the desert itself. This water flows down to the lower levels, at first over the surface of the ground, then beneath it. Subterranean streams of considerable volume must occur in the eastern part of the Sahara. There is no foundation for the idea sometimes entertained that the oases are natural subirrigated spots in the desert. Most of the desert soils are too saline to permit of subirrigation without injury to the crops. As a matter of fact, agriculture would be almost impossible in the Sahara were not careful provision made for drainage.

From very ancient times irrigation has been practiced in the desert. When the Romans governed northern Africa the area under cultivation in the Sahara was much larger than it is to-day. By many centuries of practice the natives of the Sahara have acquired great skill in procuring and managing water for irrigation. The art of well boring, as originally practiced in the Oued Rirh, is a dangerous one. The work is begun by scooping out a hole in the sand, the sides of which are incased with wood as fast as the digging proceeds. Finally, a layer of rock or of stiff clay, overlying the sheet of water, is reached.

This is broken through with a few strokes of the pick, and if the water ascends with considerable force, as is sometimes the case, the well digger runs considerable risk of being drowned. In the more accessible parts of the Sahara, modern well-boring machinery has largely replaced the ancient method.

The natives are very jealous of the water that is obtained with so much difficulty, and numerous quarrels arise over its distribution. In the Zibans oases, where a system of canals exists, the water is controlled by an association which decides in what quantity and upon what days it shall be allotted to each person. It is measured by laying the trunk of a date palm across the top of an earthen dam in the canal. Notches, corresponding to the width of the hand with the thumb closed, are cut into this trunk at intervals. The amount which passes each of these notches represents one share of water.

In the Oued Rirh region, since the French occupation, a great many artesian wells have been bored, under the direction of M. Jus, who became famous through his connection with this work. The first was sunk in 1856. In 1898 there were 120 metal-cased artesian wells from 160 to 330 feet deep, in addition to 500 wells dug by natives. The total discharge of all these wells was about 140 cubic feet per second, yet so far the water supply has suffered no perceptible diminution. With the water thus obtained the area in date palms has been greatly extended during the past thirty years. It is estimated that during the last three decades the population of the Oued Rirh has doubled, and the wealth of the region has been increased tenfold. There are probably few other parts of the Sahara where such development is possible.

Unlike the irrigating water of the coast region, that used in the desert region generally carries a high percentage of salts in solution. In fact, the water with which various crops are grown in the Algerian Sahara appears to be saltier than that used for this purpose anywhere else in the world. So far as is known, 500 parts of salts per 100,000 parts of water is the maximum concentration of water which is used with success in the United States, and, under ordinary circumstances, 300 parts is the limit for successful crop production. In the Sahara, however, water containing as much as 800 parts of salts (half of the total amount being sodium chlorid) per 100,000 parts of water is applied to soils that are themselves highly saline. A variety of cultivated plants—various fruit trees, garden vegetables, and alfalfa—thrive under these conditions.

It seems a fair inference that the maximum amount of soluble matter which can safely be allowed in irrigation water has been underestimated by American writers. Where the soil is light and underdrainage is provided for, as is the case in the Algerian oases, it is

probable that many waters that have heretofore been condemned as too saline could safely be used in irrigating crops.

The date palm is the most salt-resistant cultivated plant of the Sahara, so far as is known. The maximum amount of salt in the irrigating water which this tree can endure without detriment to the crop has not been ascertained. It would appear, however, to be something less than 1,000 parts per 100,000, for water of a pond containing 1,044 parts per 100,000 of soluble salts, of which 1,036 parts was sodium chlorid, had been found to be too salty for irrigating a young date orchard.

A number of samples of artesian water used in irrigating the oases near Tougourt, in the Oued Rirh region, were taken by the writers and were analyzed in the laboratory of the Bureau of Soils of the Department of Agriculture. The results are stated in the following table:

TABLE 6.—*Chemical analyses of artesian water used in irrigating gardens in Saharan oases, Algeria.*

Constituent.	Well at Oasis Tabes-bes.	Well at Oasis Kudi Asli.	Well at garden of Ben Hadriah.
Ions:	*Per cent.*	*Per cent.*	*Per cent.*
Calcium (Ca)	9.92	4.19	9.86
Magnesium (Mg)	4.52	6.02	4.26
Sodium (Na)	14.03	20.48	14.18
Potassium (K)	4.27	2.35	2.72
Sulphuric acid (SO_4)	34.38	29.43	17.59
Chlorin (Cl)	28.06	36.21	27.05
Bicarbonic acid (HCO_3)	5.02	1.32	24.34
Conventional combinations:			
Calcium sulphate ($CaSO_4$)	33.04	14.23	24.90
Magnesium sulphate ($MgSO_4$)	13.63	24.29	7.04
Magnesium chlorid ($MgCl_2$)	7.23	4.41	16.72
Potassium chlorid (KCl)	8.12	4.48	5.19
Sodium bicarbonate ($NaHCO_3$)	6.92	1.81	33.54
Sodium chlorid (NaCl)	31.06	50.78	12.61
Total solids in 100,000 parts water	601.50	408.10	571.90

These are fair average samples of the irrigation waters in use, and do not represent by any means the maximum of salinity. Field tests showed as high as 816 parts to 100,000 in water in actual use on soils where garden vegetables were growing, while French authorities report the use of waters carrying 842 parts per 100,000.

SOILS.

The soils of Algeria are of many varieties and types, varying from the coarsest sands to heavy clays. The differences are due chiefly to two causes—the nature of the underlying rocks and the climatic conditions under which the soil was formed. Different classes of soils are found in each physiographic region and there are few types which are common to all three regions. In the littoral zone of the coast region much of the soil is of the adobe type, containing a considerable quantity of clay. In the alluvial bottoms, however, we find extensive areas of other kinds of soil. In the mountain zone the soils are not

for the most part adobe-like. On the high plateau the soils are largely colluvial. In the desert we encounter vast areas of light, sandy soils, but there are also extensive tracts of marls, clays, and alluvial soils.

Very few samples of soil were collected, as no general investigation of the various types was attempted by the writers. It was observed, however, that in Algeria there appear to be no important soils which are not represented in California and Arizona by very similar types. Observations were largely directed toward the comparison of Algerian soils and their productivity with corresponding soils in America under similar climatic conditions.

COAST REGION.

LITTORAL ZONE.

An important and characteristic soil of the littoral zone is a bright-red "adobe," very common in the vicinity of Algiers, near Oran, and elsewhere along the coast. It is sticky when wet and forms very hard clods when dry, cracking to a depth of from 12 to 24 inches. This soil is often naturally poor in phosphoric acid, nitrogen, and lime, but responds readily to treatment. Its potash content is generally adequate. It is an excellent soil for vineyards, except in cases where a lime "hardpan" occurs too near the surface. Some of the best wines of Algeria are produced on soil of this type. The American soils which most nearly resemble it are the San Joaquin red adobe, as it occurs in the San Joaquin and Sacramento valleys, and the Fullerton sandy adobe of the coast region of southern California.

A mechanical analysis of one specimen of this soil is given on page 40, under No. 7663. This sample was collected a few miles south of Oran, and represents the heaviest phase of this red soil. We have not found in America a type of red adobe in which the average clay content is so high. The black adobes of the United States are sometimes very clayey, but most American adobes contain more silt than clay. The same soil type was also observed at Arzeu, in western Algeria, at various localities near Algiers, and, to a less extent, around Tizi Ouzou, in Great Kabylia.

River bottoms in the littoral zone are characterized by soils that are quite different from the red, clayey type just described; and are, in fact, mere continuations of the soils of the next zone. They are usually alluvial deposits, clayey or marly in texture, and are quite fertile. They contain an abundance of potash, though they are sometimes deficient in phosphoric acid.

VALLEY AND PLAIN ZONE.

The large valleys, which in some cases are so extensive as to be virtually plains, contain a great variety of soils. The plains of the

Mitidja, Chéliff, Mina, Habra, and Macta are typical of many other valleys and plains in Algeria. As before mentioned, they are similar in many ways to the interior valleys of California. The soils are mainly alluvial and are generally heavy. Around Relizane and Perrégaux, where the writers made most of their studies, the soil is similar to the San Joaquin black adobe. In the Mitidja the heavier soils are well supplied with potash and are fairly well provided with nitrogen and phosphoric acid. In the Chéliff Valley these elements are less abundant.

Sample No. 7658, in the table given below, shows the results of a mechanical analysis of the heaviest of the valley adobes. This sample was collected from a field which was very fertile twenty years ago, but which has since been ruined by the rise of salts, and is to-day valueless. This soil, before it had become saline, had exhibited great fertility during a long series of years. In former years it yielded grain of a superior grade and good crops of cotton. Sample No. 7660 represents a type of this adobe soil of medium heaviness. Soil of this kind is often planted to vines, fruits, and olives. The sample was collected near Perrégaux, at La Ferme Blanche, headquarters of one of the largest vineyards in Algeria. A still lighter type, one closely approaching a sandy loam, is represented by sample No. 7661. This type is usually found in the higher portions of the valleys, and is planted to vines and alfalfa.

MOUNTAIN ZONE.

The soils of the mountain zone of the coast region can be divided into (1) valley soils and (2) soils of the hills and mountain slopes. The hills and mountains are covered with either residual or colluvial soils. As a rule, these soils are more or less gravelly or stony, and are light and well drained. The lower slopes frequently have heavier adobe soils, similar in character to the adobes of the lower slopes of the Sierra Nevada and the coast range in California.

The soils of valleys in the mountain zone are generally alluvial, being composed of the waste from adjoining hills and mountains. The smaller valleys have light, usually well-drained, soils containing some gravel.

TABLE 7.—*Mechanical analyses of coast region soils.*

No.	Locality.	Depth in inches.	Organic matter.	Gravel, 2 1 mm.	Coarse sand, 1 0.5 mm.	Medium sand, 0.05-0.25 mm.	Fine sand, 0.25 0.1 mm.	Very fine sand, 0.01 0.05 mm.	Silt, 0.05-0.005 mm.	Clay, 0.005-0.001 mm.
7658	Relizane	0-24	0.01	.....	0.08	0.12	0.66	2.00	40.22	56.92
7660	La Ferme Blanche, near Perrégaux	0-24	.22	.....	.08	.10	2.00	20.14	54.66	22.94
7661	Debrousseville	0-12	1.34	0.16	1.08	3.06	28.60	30.62	20.40	16.08
7663	2 miles south of Misserghin	0-18	1.41	.12	.58	1.94	6.60	6.36	35.76	48.64
7688	15 miles east of Batna	.....	.....	.32	.28	.34	1.74	6.04	45.56	45.48

HIGH PLATEAU REGION.

The soils of this region, derived largely from cretaceous and tertiary rocks, are in great part alluvial deposits washed down from the neighboring mountains. Particularly in eastern Algeria, soils very rich in phosphates occur. These would be extremely fertile if water wherewith to irrigate them were available. Calcareous hardpan underlies a great deal of the surface of the high plateau. Where this impervious layer is quite near the surface the vegetation is sparse and woody plants are absent.

The high plateau soils grade from stony soils on the lower slopes of the mountains, through sandy loams and loams, to heavy clay loams and clays in the bottoms of the depressions. These depressions, known among the Arabs as "chotts," are a conspicuous feature of the steppes. While occasionally filled with water, the bottom is commonly dry and covered with a layer of salt. The chotts greatly resemble the "playa" lakes of the Great Basin region in Utah and Nevada and of the "bolson" plains of the southwestern United States and Mexico. The soil in the bottom of the chotts is always heavy and impervious.

DESERT REGION.

The soils of the western part of the Algerian Sahara—which is of very little agricultural importance—more or less resemble those of the very arid parts of the high plateau. In the eastern part of the desert, where numerous oases occur, the character of the soil becomes a matter of greater practical interest. The combined area of all the oases amounts to but a small fraction of 1 per cent of the total surface of the desert. The limited localities where oases occur are determined by the presence of water rather than by any exceptional fertility of the soil. As a matter of fact, there are vast tracts in the Sahara which are, probably, naturally more fertile than the oases and require only water to make them extremely productive.

The field observations made by the writers were confined to a number of typical areas in the Oued Rirh country. There are found the most important oases that are easily accessible from the Mediterranean coast. They are situated in what is probably the hottest part of the desert and their elevation above sea level is only a few feet. In fact, several of the oases occur in a part of the basin that is below sea level.

As a rule the soils of the oases in the eastern Sahara are light in texture. Sandy loams and sands predominate, though here and there are found soils heavy enough to be classed as true loams. Gypsum is an important constituent of nearly all the soils examined, in some cases the subsoil being practically pure gypsum. This often acts as a cementing material, uniting the finer soil grains into aggregates which give the soil a much more sandy appearance than would be suspected

from the results of mechanical analyses. The data afforded by a number of analyses are given below.

The natural fertility of these sandy soils is not great. They are almost devoid of organic matter and after a few years of cultivation need fertilizing. This is supplied by the Arabs in the form of manure from donkeys, sheep, and camels. The soils of the date orchards that have been planted by the two French companies are also fertilized.

The following table gives the results of mechanical analyses of a number of samples of soil collected in the Oued Rirh region of the eastern Sahara. Chemical analyses have not been carried further than a determination of the water-soluble material.

TABLE 8.—*Mechanical analyses of soils from the Oued Rirh region in the Sahara Desert.*

No. of sample.	Locality.	Depth in inches.	Organic matter.	Gravel, 2–1 mm.	Coarse sand, 1–0.5 mm.	Medium sand, 0.5–0.25 mm.	Fine sand, 0.25–0.1 mm.	Very fine sand, 0.1–0.05 mm.	Silt, 0.05–0.005 mm.	Clay, 0.005–0.001 mm.
7686	Ourir. Hard crust among palms..	0–12	0.76	0.52	1.76	3.74	21.02	18.98	21.98	31.26
7687	Subsoil of 7686	12–26	.34	.20	1.88	1.84	29.52	21.42	15.48	25.40
7683	Ourlana palm orchard	0–12	.50	.54	.90	1.14	17.46	49.80	11.64	9.16
7684	Subsoil of 7683	12–36	.08	.48	1.64	3.70	36.84	29.30	7.64	9.92
7685	....do	36–54	.04	.86	2.50	2.84	18.74	36.40	19.40	9.14
7665	Ourlana among 13-year-old palms.	0–12	.14	2.46	3.96	8.06	32.52	33.56	5.42	14.02
7666	Subsoil of 7665	12–36	.04	1.10	4.46	5.74	31.70	40.94	4.52	11.54
7667	Tougourt amid good alfalfa	0–12	1.10	.20	1.32	3.98	34.44	37.98	9.52	12.56
7668	Subsoil of 7667	12–24	.59	.16	1.30	3.06	28.58	45.92	8.72	12.12
7669	Tougourt amid alfalfa	0–12	.73	.15	1.93	4.63	27.71	33.59	7.98	24.01
7670	Subsoil of 7669	12–24	.62	.73	2.51	5.37	32.12	33.27	5.85	20.15
7671	Tougourt amid alfalfa	0–12	1.47	.26	2.01	4.98	28.22	30.91	11.21	22.41
7672	Subsoil of 7671	12–24	1.35	.12	1.41	4.07	28.33	29.82	7.54	28.71
7673	Ta-bes-bes Oasis	0–12	.41	1.56	2.03	1.72	20.24	32.53	6.37	35.55
7674	Subsoil of 7673	12–24	.16	.35	1.27	1.33	25.94	34.40	6.57	30.14
7676	Kuda Asli Oasis	0–12	.66	1.12	4.76	6.75	28.58	32.60	7.97	18.22
7677	Subsoil of 7676	12–24	.35	1.39	3.27	4.39	20.38	26.42	15.76	28.39
7678	Dune sand, border of Djadja Chott	.....	.47	.00	5.08	12.80	51.54	18.40	1.22	7.62
7679	Oasis of Zoia de Temacin	0–12	6.30	.86	4.60	4.66	22.50	17.48	26.90	9.04
7680	Subsoil of 7679	12–24	.27	1.50	5.14	5.90	19.60	20.24	25.88	8.82
7681	Oasis of Zoia de Temacin	0–12	.44	1.54	6.16	4.24	22.70	39.10	14.50	5.76
7682	Subsoil of 7681	12–24	.21	.60	4.54	2.60	19.12	30.94	20.78	10.60

SALINE SOILS.

As in all arid countries, particularly where irrigation is practiced, saline soils are an important factor in the agriculture of Algeria. Extensive areas of the most fertile land of the colony have been injured by an excess of salts, and the alkali problem is to-day one of the most serious which confronts the Algerian farmer. Drainage is not generally practiced by the colonists in their large irrigation districts, and the lack of it has been the cause of a great deal of damage. On the other hand, the natives of the Sahara show the utmost ingenuity and skill in managing salty soils and in irrigating with saline waters. There is much in the methods practiced by these people that should interest the American farmer and that could be imitated by him with profit.

COAST REGION.

The littoral zone of the coast region comprises very little alkali or saline land. A few areas of salt marsh occur along the shore, but not much has been done toward their reclamation.

The most extensive areas of salt soil in the coast region are those found in the great valleys and plains. Certain of these areas have existed for a long time. Others, including some of the most serious, have been developed under irrigation within the last fifty years. The most important tracts of salt land seen by the writers were near the towns of Relizane and Perrégaux, in the Department of Oran.

At Relizane the area covered by the irrigation systems amounts to about 20,000 acres. As the water supply very frequently falls far short of the amount necessary for the irrigation of this large area, part of the land is ordinarily lying idle. The irrigation of surrounding fields, together with seepage from the canals and laterals, has so raised the water table in this uncultivated land as to permit a constant upward movement of the water by capillary force. The result has been that salts which were formerly confined largely to the subsoil, or which have been carried into the soil by subirrigation, have risen to the surface and have accumulated there. The same process of accumulation of salts in the upper layers of the soil has caused serious damage in many parts of western North America. Around Relizane the old story has been retold that land once fertile and producing luxuriant crops is to-day bare of everything but a few stunted salt-loving weeds. The remains of irrigating laterals, fences, and houses alone show that the land has ever been farmed.

At Perrégaux a similar state of affairs prevails, but a much larger area is affected. The salt land covers an extensive tract in the lower part of the valley and includes fields that a few years ago were highly productive. A few attempts at reclamation have been made, and some excellent fields were seen which were said to have been badly saline at one time; but no large areas have been improved.

The soil and other conditions of saline areas in the irrigated districts of Algeria have no important peculiarities which distinguish them from similar localities in America. The salts are generally "white alkali," i. e., salts of sodium (other than the carbonate), magnesium, and lime.

Chemical analyses of samples of these soils taken by the writers are given on page 46. The predominant salts are of the "white alkali" type, common salt (sodium chlorid) being the most abundant. Very little "black alkali" (sodium carbonate) has been found in the coast region of Algeria.

The question of salt land in Algeria has been discussed in a recent publication by Dugast, who devotes particular attention to the damage that has been wrought in the vineyards of western Algeria by the rise

of salts in the soil. We may be excused for quoting at some length from this author.[a]

It is sea salt—that is, true salt—that is generally found in Algeria, but magnesium salts have also been found in several vineyards. As for the alkali salts, or "black alkali," we have not yet come across them. They probably appear, however, when circumstances favorable to their formation exist. * * * But if their existence is transient, if washing does not take place to separate them from the other salts, it is difficult to determine their presence.

In 1876 Pichard called attention to the presence of carbonate of sodium in several waters in Oran Department, accompanied by sulphates of sodium and calcium and chlorids of calcium and magnesium, sometimes by small quantities of alkali nitrates and traces of ammonium salts. These waters give an alkaline reaction and contain from 0.2 gram to 20 grams of sodium carbonate per liter.

While the salt is directly harmful, it is also indirectly injurious by hindering the nitrification of the nitrogenous matter existing in the soil or added to it by manure. Hence it interferes with the alimentation of plants.

In vineyards salt manifests itself in spots which differ in aspect according as they are old or new. When the salt is in small quantities in the soil, or, rather, when the soil still contains a considerable proportion of water, or when, again, the salt reaches only a part of the zone of soil occupied by the roots, the spots are characterized by a simple wilting of the vegetation.

At other times the damage caused by the salt is sudden and much more pronounced. The places attacked then take the form of circular spots. The branches of the vines that bear grapes lose their leaves and dry up, and the grapes do not reach complete maturity.

In 1898 and in 1899, at the time of our visit [to the vineyards of Oran Department], we saw numerous spots presenting these characteristics. Such spots were occupied by vines loaded with grapes, but the branches had completely lost their leaves. All around them the vines were green and were well loaded with a good crop of grapes.

In the older spots, which are sometimes very extensive, most of the vines are dead. We find, however, here and there, some vines that have resisted the salt and have been able to put out badly developed branches bearing a few grapes of poor quality. These old spots, although due to salt, much resemble those caused by phylloxera.

The reclaiming of salt land is difficult to accomplish in Algeria. The rainfall is always insufficient to bring about reclamation, and the supply of irrigation water is also scanty.

For the present we must try to get along with the salt, doing our best to prevent its becoming too injurious. This can be done by working the soil to a depth of 20 inches, so that the rain water can be stored in that depth of the soil. In this way the fresh water can be prevented from penetrating sufficiently deep to dissolve the salt and by its presence it restrains the salt from rising. It is necessary, of course, by superficial cultivation to break up the capillarity of the soil, so as to reduce evaporation to a minimum.

Drainage ditches can also be used in certain lands for carrying off the salty water of the lower depths of the soil. Ditches can also be used in certain cases to prevent the invasion of new land by the sheet of salt water.

Saline soils of purely natural origin are found in and near the chotts which occupy depressions and receive the drainage of the surrounding land. In such places salt has been accumulating through long ages.

[a] Agrologie de l'Algérie, 1900, pp. 56, 58, 59, 71, 72, 77, 78, 80, 81, 89, 90.

In the dry season the bottom of the basin is covered with a crust of salt, in some cases of sufficient thickness to make its exploitation profitable. In the wet season this gives place to a shallow lake of salt water. A number of such chotts occur near the coast in western Algeria. The writers visited one large salt lake near Arzeu and another near Oran. At the Salines d'Arzeu great quantities of commercial salt are prepared. These chotts correspond to similar salt, soda, and "playa" lakes of Utah, Nevada, and other western States.

Many salt lakes also occur in the high plateau region. In the eastern part of the Sahara the chotts cover extensive areas south of Tunis and of the Department of Constantine. There they are below sea level, and the country around them is very hot and dry.

DESERT REGION.

The saline soils of the Oued Rirh region in the Sahara, so far as they were examined by the writers, generally contain a large amount of gypsum. (See p. 46.) Sodium chlorid and sodium sulphate are the next most abundant salts, while magnesium salts are present only in small quantities. The Saharan soils are usually of very light texture, and their proper irrigation demands large quantities of water. The water used contains a high percentage of soluble matter. Consequently, where proper drainage facilities have not been provided, the salt has accumulated in the soil to an injurious degree. Yet, by digging open drains 3 feet deep at frequent intervals and irrigating once a week or oftener, the natives of the Sahara are able to maintain gardens containing a variety of plants not particularly resistant to salts in the soil.

More than this, using strongly saline water (see p. 38) they are able to reclaim land that contains an excessive amount of salts. The writers visited a garden which had been established on the slope of the bed of a salt lake, in which alfalfa, various garden vegetables, and a variety of young fruit trees were flourishing. The reclamation of this piece of land had been accomplished in three years by irrigating twice a week during that period.

TABLE 9.—*Chemical analyses of saline or "alkali" soils from Algeria.*

No. of sample.	Locality.	Depth in inches.	Calcium (Ca).	Magnesium (Mg).	Potassium (K).	Sodium (Na).	Sulphuric acid (H_2SO_4).	Chlorin (Cl).	Bicarbonic acid (HCO_3).
7658	Relizane, 3 miles NW	0–24	7.28	4.53	3.08	18.48	27.31	34.22	5.10
7659	.....do	0–1	2.41	12.15	1.10	15.83	9.70	56.86	1.95
7665	Ourlana, among 13-year-old palms	0–12	23.27	.91	1.92	4.77	59.13	8.35	1.65
7666	.....do	12–36	23.46	.49	2.24	4.33	65.30	2.09	2.09
7667	Tougourt Oasis, amid good alfalfa	0–12	23.81	.89	1.82	3.52	66.22	1.87	1.87
7668	.....do	12–24	25.23	.66	1.51	2.63	65.96	1.87	2.14
7669	Tougourt Oasis, amid poor alfalfa	0–12	23.90	.88	1.82	3.28	66.49	1.24	2.39
7670	.....do	12–24	24.71	.58	1.76	2.84	66.69	1.26	2.16
7671	Tougourt Oasis, amid yellowing alfalfa	0–12	23.72	1.13	1.68	3.90	61.35	6.46	1.76
7672	.....do	12–24	24.67	.68	1.93	2.86	66.28	1.76	1.82
7673	Ta-bes-bes Oasis, amid alfalfa	0–12	20.27	1.61	2.10	1.34	61.38	4.96	3.34
7674	.....do	12–24	19.11	1.53	1.94	7.84	61.13	5.27	3.18
7675	Kuda Oasis	Crust.	.56	.66	.29	37.03	3.82	56.99	.65
7676	Kuda Asli Oasis, amid good alfalfa	0–12	16.03	3.27	4.47	6.86	56.18	7.96	5.23
7677	.....do	12–24	19.75	1.96	2.49	6.03	61.83	4.79	3.15
7679	Zoia de Temacin Oasis, amid good alfalfa	0–12	22.83	1.21	1.56	4.51	63.90	4.02	1.97
7680	.....do	12–24	24.00	1.05	.76	3.92	65.30	2.95	2.02
7681	Zoia de Temacin Oasis, amid yellowing alfalfa	0–12	22.72	.97	1.94	4.90	61.66	5.08	2.73
7682	.....do	12–24	24.01	1.17	1.48	3.33	64.79	3.60	1.62
7683	Ourlana, among 20-year-old palms	0–12	23.38	1.04	.92	5.15	59.47	8.54	1.50
7684	.....do	12–36	26.08	.98	.85	2.15	64.97	2.82	2.15
7685	.....do	36–54	23.06	.99	.99	4.92	63.74	3.71	2.59
7686	Ourir, among palms	0–12	16.73	4.11	1.77	10.89	24.13	41.35	1.02
7687	.....do	12–26	23.84	1.20	1.16	3.90	62.10	5.81	1.99

TABLE 10.—*Conventional combinations of the data in Table 9.*

No. of sample.	Per cent soluble matter.	Calcium sulphate ($CaSO_4$).	Magnesium sulphate ($MgSO_4$).	Magnesium chlorid ($MgCl_2$).	Potassium chlorid (KCl).	Sodium chlorid (NaCl).	Sodium bicarbonate ($NaHCO_3$).	Sodium sulphate (Na_2SO_4).	Other constituents.
7658	2.47	24.78	12.31	7.93	5.99	41.95	7.04	.....	.....
7659	6.14	8.17	4.91	43.78	2.11	38.36	2.67	.....	.....
7665	4.36	79.23	4.03	.18	3.67	10.65	2.24	.....	.....
7666	4.02	79.69	2.44	.....	4.23	.15	2.88	10.61	.....
7667	4.49	80.88	4.42	.....	3.56	.32	2.58	8.24	.....
7668	4.48	85.69	3.30	.....	2.90	.80	2.94	4.37	.....
7669	4.50	81.24	4.39	.....	2.57	.....	2.17	8.35	[a]1.28
7670	4.43	84.39	2.89	.....	2.66	.....	2.21	6.95	[a].90
7671	4.76	80.61	5.58	.....	3.19	8.19	2.43	.....	.....
7672	4.62	83.75	3.42	.....	3.70	.....	2.50	6.63	.....
7673	3.25	68.89	7.93	.....	4.03	5.03	4.58	9.54	.....
7674	3.39	64.97	7.55	.....	3.71	5.72	4.36	13.69	.....
7675	92.93	1.91	3.07	.16	.55	93.42	.89	.....	.....
7676	1.83	54.42	16.03	.....	8.50	6.43	7.19	7.43	.....
7677	3.05	67.01	9.64	.....	4.72	4.20	4.33	10.10	.....
7679	4.87	76.64	6.03	.....	2.95	4.35	2.71	6.32	.....
7680	4.72	81.65	5.19	.....	1.43	3.76	2.78	5.19	.....
7681	3.50	77.01	4.79	.....	3.71	5.48	3.76	5.25	.....
7682	4.44	81.64	5.54	.....	2.83	3.69	2.20	4.10	.....
7683	4.77	79.48	4.19	.79	1.76	11.73	2.05	.....	.....
7684	4.46	87.17	4.87	.....	1.61	3.40	2.95	.....	.....
7685	4.63	78.37	4.92	.....	1.90	4.62	3.54	6.65	.....
7686	6.99	34.20	.....	16.13	3.37	26.55	1.40	.....	[b]18.35
7687	4.82	80.99	5.93	.....	2.20	7.85	2.74	.29	.....

[a] Potassium bicarbonate ($KHCO_3$). [b] Calcium chlorid ($CaCl_2$).

SOIL MANAGEMENT.

ROTATIONS.

In the grain-producing districts of Algeria the rotation—if it can be called such—commonly followed consists of a year (winter) in a cereal crop followed by a year of fallow. In other words, the land lies idle

for sixteen or eighteen months out of twenty-four. This system was followed by the ancient Greeks and Romans, and is still in vogue among their descendants in the Mediterranean region. It is to be recommended only for countries where the rainfall and the supply of irrigating water are too scanty to permit rotation with a soil-restoring crop and where manure can not be had in any considerable quantity. Such is the case in the most important cereal-growing districts of Algeria. A larger net profit is often obtained from 2 acres of grain managed in this way than from 1 acre that is heavily manured. If deep and thorough plowing is included in this method of handling the soil, the benefit to the land that would accrue from the use of another crop in rotation can be partly compensated for.

No leguminous crop has yet been found which can be profitably grown on a large scale in Algeria in rotation with wheat and barley. The scarcity of irrigating water is chiefly responsible for this condition, and wherever water is abundant the question of rotation ceases to be a troublesome one. In that case a crop of horse beans or vetch—or, if manure is obtainable, of beets, potatoes, or tobacco—followed by two crops of grain is found to make a satisfactory rotation.

FERTILIZERS.

Whatever may have been their natural condition, the cropping of Algerian soils for thousands of years, often without intelligent effort to conserve their fertility, has resulted in greatly impoverishing them. In large areas the soil is low in phosphates and, to a greater or lesser extent, in nitrogen. Potash, on the other hand, is generally sufficiently abundant. In the coast region much of the soil can be benefited by liming.

During the first few years after the French conquest no particular attention was paid to questions of fertilizers and of rotation. Soon, however, under the influence of the more intensive farming practiced by Europeans, the yield of crops began to diminish, and it became necessary to look for a remedy. In the littoral zone of the coast region, where there is intensive cultivation of market gardens, orchards, and vineyards, the use of farm manure and of commercial fertilizers has become general. In 1896 the annual consumption of Algerian phosphates alone in the colony had reached 8,000 tons. In 1900 the total quantity of mineral fertilizers applied yearly to the soils of Algeria was estimated at 15,000 tons. The use of mineral fertilizers is limited almost entirely to the littoral zone.

In the large valleys of the coast region, where vineyards and fields of grain cover extensive areas, it is estimated that not one-twentieth of the total amount of cultivated land is given any fertilizer whatever. The supply of farm manure is exceedingly scanty, as the absence of cultivated forage crops prevents the raising of many cattle. Where

farm manure is obtainable it is thought to be more beneficial than any commercial fertilizer, since Algerian soils are often deficient in organic matter and manure has a very beneficial physical effect upon them. It is considered good practice to apply manure in the autumn, after a year of fallow, thus obtaining an abundant crop of wild forage the following winter. Grain is then grown during the second and third winters after the application of manure.

PREPARATION OF THE LAND.

CLEARING AND LEVELING.

In the coast region some of the best land is still covered with a dense growth of brush, comprising lentisk, jujube, heath, broom, and other characteristic shrubs of the Mediterranean region. This shrubby vegetation is luxuriant in proportion to the depth and fertility of the soil. Its removal generally costs about $16 an acre. In the neighborhood of cities this expense can partly be met by the sale of the wood removed and of charcoal made from it. It costs still more, from $20 to $24 an acre, to clear land which bears a heavy growth of dwarf palm, a deep-rooted plant that still covers extensive areas in Algeria. The roots of the palms can be loosened by means of a steam plow, and then removed with a pick. In the work of clearing land, Spanish, Moroccan, and Kabyle laborers are most expert.

Leveling is done with scrapers, which are generally drawn by horses. The average expense of leveling an acre, if two men and three animals are employed, is about $8.

PLOWING.

The Arab plow, generally used in Algeria, has the forward part supported directly by the yoke or harness of the animal which draws it, while the working part is limited practically to the share. The Kabyle plow consists of two pieces of wood (often the forked branch of a tree) meeting at nearly a right angle, the upright piece being shaped so as to serve as a handle, while to the horizontal piece the iron share is fastened. Two wooden projections at the end of the horizontal piece, just above the share, serve to widen the furrow that is made. The beam is fastened, by means of a peg, into the angle made by the two pieces. One end of the beam is fastened by a strap directly to the wooden yoke of the animal which draws the plow. One man works the plow, driving the animal with one hand and holding the handle with the other. The instruments used by the natives break up the soil only to a very small depth. Among the European colonists improved modern plows are now coming into use. On the largest farms steam plows, operated by two 16-horsepower engines, are sometimes used. In some of the larger towns steam plows can be hired.

For cultivating vineyards, American gang plows are preferred. The use of the disk harrow is widespread.

In preparing for a crop of cereals the land is generally not plowed until fall. This is, however, a bad practice, for if there are heavy rains early in the autumn the land is sometimes too wet to permit of plowing before the first of the year. If, on the contrary, the rains are unusually late, the soil may be too dry and hard to make early plowing possible. In consequence, the crop is sown late and is often dried up by the hot winds of late spring and early summer. Spring plowing in preparation for a winter crop is therefore highly recommended by the best authorities. It is pointed out that as a result of this practice the soil loses less moisture during the summer fallow, besides being in excellent condition to absorb the first rain that falls upon it in the autumn. It is, indeed, advisable to keep the surface of the soil in a well-pulverized condition at all times when there is no crop in the land.

Deep plowing is found to have, up to a certain point, the same effect as rotation and the use of fertilizers. Beyond that point, however, the yield of crops will diminish, no matter how thoroughly the land is plowed, unless some other means is taken to restore the fertility of the soil. At Sétif good cultivation is made to take the place of irrigation, and excellent crops of cereals and of leguminous food and forage plants are produced without artificial watering.

In preparing land that is comparatively flat, in order to establish market gardens, vineyards, and orchards, it has been found that a steam plow, turning the soil to a depth of from 20 to 24 inches, can be used to advantage. In lieu of this an ordinary plow, followed by a subsoiler, will answer the purpose. On hillsides that are too steep for the plow the soil is loosened with picks, usually to a depth of from 24 to 28 inches. The expense of preparing an acre in this way averages about $50. Sometimes the pick is also used for loosening the soil in orchards where the trees are set very close together and in market gardens. The plow used in market gardens is generally a very light one.

GENERAL ECONOMIC CONDITIONS.

HISTORICAL AND POLITICAL.

According to the census of 1896, the population of Algeria, excluding the army, was 4,360,000, of which 86 per cent was Mohammedan. The great importance of agriculture is shown by the fact that four-fifths of the inhabitants live by farming or by raising animals, almost the whole of the native population being thus employed. The total area now under French dominion is about 150,000 square miles, but a large proportion of this area is a barren desert, without water for

irrigation. An area of 3,460,000 acres, including most of the best arable land, is held by European colonists, while about 17,290,000 acres is still the property of natives. The remainder, including large forested areas and vast tracts of steppe covered with alfa grass, is government land. There is one inhabitant to every 17½ acres of land belonging to Europeans, and one inhabitant to every 5 acres held by natives.

California, with an area slightly exceeding that of Algeria (156,000 square miles), has a population of about 1,500,000. The combined populations of Arizona, California, Colorado, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming about equal that of Algeria. The traveler in Algeria does not, however, get the impression that the colony is well populated. On the contrary, it seems a new country, and capable of far greater agricultural development than has yet been attained.

LAND VALUES.

In a country like Algeria, where climate, soils, and crops, not to speak of means of communication and nearness to large commercial centers, vary so much in different regions, it is extremely difficult to generalize as to the value of the land. Within 20 miles of large towns, where there are good facilities for transportation by road or by railway, the best land is worth from $25 to $70 an acre. In proportion as remoteness from important centers and difficulties of communication increase, the value diminishes to $16 or less.

An acre in vines near Algiers, a region unaffected by phylloxera, is worth from $80 to $230. Orchard and truck land well supplied with artesian water sells for from $80 to $160, and the best market-garden land near Algiers at very much higher prices, sometimes as much as $230. Orange groves in full bearing are worth from $480 to $640 per acre. Olive orchards, in land of good quality but not capable of irrigation, range in value from $80 to $240 per acre. An acre of fig trees is valued at $115 to $230. Facilities for irrigation, of course, enhance these values.

FARM LABOR.

The great bulk of the farm work in Algeria is done by the native population—Arabs and Kabyles—either in the employ of European colonists or working for themselves on land they own or rent. The Kabyles, among whom the native agriculture of Algeria has reached its highest development, are generally more industrious and more skillful laborers than the Arabs.

Particularly in the littoral zone of the coast region, where the Euro-

pean population is densest, much of the labor in vineyards, orchards, and market gardens is performed by immigrants from southern France, Spain, Italy, the Balearic Islands, and Malta. In all those countries agricultural conditions resemble to a greater or less extent those prevailing along the African shore of the Mediterranean.

The wages paid native laborers vary according to the locality, the season, and the nature of the crop grown. Wages to natives are highest along the coast, where a day's labor in summer commands from 28 to 38 cents. Farther inland the wage varies between 24 and 28 cents. Harvest labor performed in the usual fashion, with a sickle, is paid at the rate of about 45 cents a day. When the scythe is used from 65 to 75 cents a day is earned. Laborers are sometimes employed by the month, receiving, without board, $6.50 to $7.50. If somewhat more skilled than the average they are paid as much as $9.50 a month, or a smaller wage is given, together with a ration of about 2 pounds of bread daily, and each month 2 quarts of olive oil and a few pounds of dried figs and semolina. For tending small flocks owned by Europeans the native receives from $1.50 to $2.75 per month with food, or $2.75 to $4.75 without food. The employer always retains half of the wage agreed upon until the expiration of his contract with the shepherd, as security for the proper care of his flock. Men whose families live in the neighborhood are found to be the most trustworthy laborers among the natives.

European workmen are more intelligent and consequently better paid than natives. Their wages are higher in eastern Algeria and in the interior, where the conditions are less attractive to Europeans than in western Algeria. The heavier kinds of farm labor, if done by immigrants, fall to the share of Spaniards and Italians. French laborers are generally engaged in such work about the orchards and vineyards as requires more intelligence, and as overseers and foremen. The market gardens of the littoral zone, where large quantities of vegetables are grown not only for consumption in Algeria but for export to Europe, are rented and farmed for the most part by Mahonnais (natives of the Balearic Islands) and by Maltese.

Unskilled Spanish and Italian laborers, working by the day and finding their own provisions, earn from 45 to 55 cents a day in winter and as much as 75 cents a day in summer. The day's work in winter lasts nine or ten hours, with an hour's rest at noon. In summer the workday is twelve or thirteen hours, but with two hours' intermission at noon and a quarter of an hour for rest in the middle of the morning and again in the middle of the afternoon. The same kind of labor, if employed by the month, commands from $5.50 to $11.50, board included. The more intelligent French laborers naturally receive much higher wages.

AGRICULTURE OF THE NATIVE POPULATION.

AMONG THE ARABS.

The Arab, as a rule, is lazy and shows little skill and initiative in his farming. He works only to keep from starving, his ambition being satisfied as soon as he has enough to keep body and soul together. The Arabs of the coast region are chiefly tillers of the soil, living in rude huts or "gourbis," while those of the high plateau and desert regions are for the most part nomadic shepherds, dwelling in tents; but both pursuits—agriculture and stock raising—are often combined in the same family.

Agriculture, as practiced by the Arab who has not been influenced by European methods, is of the simplest description. His plow is made with a few strokes of a hatchet from the branch of a tree, and usually has no metal about it. Hitching to this rude instrument a horse, a camel, or, perchance, his wife, he merely scratches the soil in the autumn and scatters his wheat or barley seed. He then goes over the field a second time with a plow, covering the grain to a depth of 3 or 4 inches. After that is done he folds his hands and waits for the crop which may or may not come, satisfied that he can do no more and that the result is in the hands of Allah. In the spring, before the ground has dried out, he puts in sorghum or Indian corn in a similar fashion. The yields of grain thus obtained are naturally scanty at best, while in dry years the crops sometimes fail entirely and there is much suffering among the Arab population.

In better soils, especially where a little water can be had without much labor, beans, chick-peas, and melons are grown. Near streams the Arab often has a small orchard of figs, pomegranates, oranges, and apricots, or a vegetable garden. None of these crops receive any particular attention, and the yield and quality of the product are generally far inferior to those obtained by skillful European farmers.

AMONG THE KABYLES.

The Kabyles belong to the ancient Berber race that inhabited northern Africa before it was conquered by the Arabs—before even the Carthaginians and the Romans occupied the country. Nowadays they are confined chiefly to the mountainous districts. Their principal territory is the region known as Great Kabylia, lying between the Djurdjura range of mountains and the sea. Here a dense population is crowded into a comparatively small area, much of which is so mountainous and rugged that even these dauntless farmers can not make crops grow upon it. Since the French occupation of Algeria, however, large numbers of Kabyles have left their mountain fastnesses, seeking work as farm laborers in the valleys and plains, or as porters in cities.

Many of these emigrants, however, spend only a part of the year in the lowlands, returning home with their savings and putting in the rest of their time cultivating their own land. Unlike the Arab, the Kabyle is a patient and persistent workman. He is a true mountaineer—frugal, temperate, and hardy.

It is astonishing with how little the Kabyle can sustain life. He often inherits the merest patch of land, or only a single tree—sometimes only a branch of an olive tree that has its roots in another man's land. With this slender patrimony and what he can make by hiring his labor to others, he supports himself and his family. Now that Kabylia is thoroughly pacified and the tribal wars that formerly waged between almost every two neighboring villages have ceased, there is a much larger acreage available for cultivation than was formerly the case. Every inch of arable land is put into crops. Grain and forage plants are grown in the river valleys and lower slopes, figs and olives on the steeper hillsides.

It is in horticulture, especially, that the Kabyles excel, the country they inhabit being better adapted to orchard than to field crops. They are expert in grafting and other horticultural processes. Olive culture is a specialty of these mountaineers. Every year they graft large numbers of scions of improved varieties upon wild trees, and thus constantly extend the area of their olive orchards. Fig trees are also planted yearly in large numbers. They are handled with great skill, caprification being carefully attended to. Of olive and fig trees, as well as of grapes and other kinds of fruit, there are a number of varieties that are more or less peculiar to Kabylia. The dried leaves of the fig and the twigs of the olive that are removed in pruning, as well as the leaves of the ash and the elm, are utilized by the Kabyles as forage for their domestic animals. It is said that two-thirds of the population of these mountains depend absolutely upon the olive and the fig for subsistence. Where these trees are present there are three or four inhabitants to every 5 acres, while in parts of Kabylia where they are wanting, from 5 to 7 acres of land are required to support each person.

The Kabyles do not raise cereals in quantity sufficient to supply their own wants, and they must draw upon other parts of the colony for grain. Flour is made into semolina or baked in an earthenware tray into a sort of unleavened bread. Flour made from beans, nuts, Indian corn, and sorghum is mixed by the poorer classes with barley flour. Often wheat, barley, beans, and other plants are grown together in the same field. Fruits, excepting olives, figs, and grapes, are generally of poor quality, although apricots, pomegranates, peaches, pears, apples, and, in some sheltered valleys, oranges are grown.

Wheat, barley, and beans are sown in the autumn, sorghum and Indian corn in the spring. Otherwise, all these crops are handled in

about the same way. Plowing is done with oxen, hitched to a rude, homemade plow of very ancient pattern, which turns up the soil to a depth of about 5 inches. The yoke is so adjusted that the steepest slopes and even the soil about the roots of a tree can be plowed. A man follows the plow, breaking up the clods with a pick. Sowing is done by hand. The fields are kept very clean, the weeds that are removed being used as forage. Harvesting is done with the sickle or even by hand. Grain is thrashed by treading out beneath the hoofs of oxen on a floor of hardened clay. It is winnowed by tossing into the air, the wind carrying away the chaff.

The valley lands are irrigated from the numerous streams that run bank full in the spring. The tiny garden, which every fairly well-to-do Kabyle possesses, is watered and manured with great care, and different vegetables follow one another in constant succession throughout the year. A plot of ground 40 by 80 feet is thus made to produce all the vegetables needed by a large family.

Owing to the small area of land in the mountains that can be spared for forage crops, the Kabyles purchase in the lowlands most of the animals they use in their farm work, fattening and reselling them when the spring plowing is over. Donkeys are generally used for carrying loads, and mules for riding. The Kabyle, unlike the Arab, takes the greatest care of his animals, stabling them at night in his own house and doing his best at all seasons to provide them with sufficient food.

AMONG THE SAHARANS.

The population of the oases in the eastern part of the Algerian Sahara, the only part of the desert that is of much agricultural interest, is of mixed origin. It combines strains of Berber, Sudanese, and Arab blood. In winter great numbers of nomadic Arabs descend into the Sahara with their flocks and herds, which range during the summer over the plains of the high plateau region. But there is also a resident population, which subsists entirely upon the products of the date palm and the various cultures that are grown in its shade. These, the true Saharans, are very skillful gardeners, understanding thoroughly the highly specialized culture of the date palm. They are adepts in the management of soils and irrigating waters that contain excessive amounts of salt. Despite these disadvantages, which are combined with the most unfavorable climatic conditions, they succeed in growing in the oases a variety of fruit trees, garden vegetables, forage plants, and cereals. Not only in their own gardens, but in the plantations of palms recently established by French capital, the labor is performed entirely by natives. The climatic conditions, together with the large quantity of more or less stagnant water that is always present, make the oasis environment, at least in summer,

entirely unfit for European labor. Indeed, the Arabs of the coast and high plateau regions are hardly better inured to the summer conditions, which only the thoroughly acclimated natives of the Sahara can endure without suffering.

CROPS OF THE COLONY.

The greatest wealth-producing crop of Algeria is the vine. The climate and soils of a great part of Algeria, as of California, are perfectly adapted to viticulture. The French colonists have put by far the greater share of their energy and capital into the growing of wine grapes. In 1898 the average annual value of the product of Algerian vineyards was estimated at $5,000,000. The red and the white table wines of the colony are steadily improving in quality and are coming more and more into favor among foreign consumers. There is also a considerable production of early table grapes for the markets of Europe.

Various orchard crops are likewise a source of revenue. First and foremost stands the olive. Algeria is extending year by year the area planted to olives, a product for which northern Africa has always been famous. As the inability of Italy and Spain to supply the world's demand becomes more and more evident, the export of olive oil from Algeria and Tunis will doubtless steadily increase. Citrus fruits, particularly mandarin and other oranges, are exported in considerable quantities. In this industry, however, Algeria finds herself in competition with Spain, Sicily, and other countries which have the advantage of a larger or at least a better distributed rainfall. Figs are grown in most parts of the colony. In Kabylia they are dried and prepared for export, although the finest sorts of figs for drying are not grown in Algeria.

A considerable variety of other fruits is grown, chiefly for domestic consumption, among which may be mentioned pomegranates, apricots, almonds, peaches, cherries, plums, apples, and pears. Tropical fruits, such as the banana, pineapple, guava, and avocado, can be produced in the open only in a very few localities along the coast, and can never become crops of the first rank. The kaki and the loquat are more promising.

A restricted yet important industry in Algeria is the production of dates. Especially in the Sahara, dates form a staple food of the inhabitants, who eat great quantities of the ordinary sorts. The finer varieties are now being grown in some quantity for export to Europe, and a considerable amount of French capital has been invested in this enterprise.

Market gardens occupy a considerable area near the sea. Large quantities of vegetables are grown, not only for the use of the home

population but for shipment to Europe to supply the winter and early spring markets. Of those which are exported, artichokes, potatoes, beans, and peas are the most important. The consumption of melons and watermelons in Algeria is very large during the summer.

The principal field crops of the colony are cereals. Wheat and barley occupy about 7,000,000 acres annually and supply a large export trade. Indian corn and sorghum are extensively grown by the natives. Cotton and sugar cane, crops to which Egypt owes so much of her wealth, are of small importance in Algeria. The only valuable "industrial" crops are tobacco and certain plants used in the manufacture of perfumery. The cork oak and the grass known as alfa, which contribute largely to the prosperity of the colony, are never artificially planted and hence are not, strictly speaking, agricultural products.

The acreage in forage crops is limited, particularly in summer, by the scanty water supply. Alfalfa is grown generally in small patches, although on the larger estates good-sized fields are sometimes put into this crop. Sulla has been frequently recommended but has not come into general use. The pods of the carob tree, or St. John's bread, are used for feeding stock. They are consumed in considerable quantities in the colony and are also exported. Sorghum is also grown extensively and affords a valuable supply of summer forage. In the autumn, in some localities, vetches are sown with oats or barley and are harvested in the spring. This mixture, either green or cured, is an excellent food for cattle. Oats are grown for export only, barley being the grain commonly fed to horses.

The greater number of the cattle and sheep of Algeria are raised upon the wild forage which covers the uncleared portion of the hills and plains or springs up in the cultivated fields after the crop of grain has been taken off. The supply of green pasturage is abundant during the winter and spring, but the hot, dry summer soon burns it dry. As cultivated forage is scarce in summer animals often have great difficulty in obtaining feed at that season.

GEOGRAPHICAL DISTRIBUTION.

COAST REGION.

The great diversity which the coast region exhibits in respect to climate, topography, and soils is paralleled by the great diversity of its agricultural conditions. A far greater variety of crops is grown there than in either of the other regions. The three zones—littoral, valley and plain, and mountain—are distinguished one from another by agricultural as well as by topographical and climatic peculiarities, so that it will be advisable to give a sketch of each in turn. Roughly speaking, the first is a zone of orchards and market gardens, the second

of grain fields and vineyards, and the third of tree crops at lower elevations, giving place to pasturage on the higher slopes and crests of the mountains. But this generalization must not be carried too far. The lines that separate the three zones are vague at best, and the industries especially characteristic of each are shared to some extent by all.

LITTORAL ZONE.

Along the shore of the Mediterranean is practiced the most intensive agriculture of the colony, if we except the oases of the eastern Sahara. The alluvial soils of the valleys, which usually expand into small deltas as they approach the sea, are largely occupied, especially in the neighborhood of the principal cities, by highly cultivated market gardens.

The lower slopes of the hills and mountains that border the sea are occupied by orchards and vineyards. At slight elevations we find a great variety of fruits, every sort, in fact, that is commonly grown in warm temperate countries. In addition to the great vineyards of wine grapes, excellent table grapes are grown for European as well as for Algerian markets. Oranges of several kinds are produced in considerable quantity. Lemons, apricots, nectarines, and almonds thrive. The Japanese persimmon, the loquat, the pecan, and other tree crops not yet widely cultivated in that part of the world, promise to become a source of wealth. A few peculiarly favored situations, well sheltered from cold winds in winter and from the sirocco in summer, are adapted to fruits of a distinctly tropical character, such as bananas, guavas, and avocados. Attempts are being made to produce some of these fruits under glass in marketable quantity.

It must not be supposed, however, that the littoral zone is devoted wholly to growing fruits and garden vegetables. Where sufficiently extensive areas of alluvial soil occur, cereals are grown, giving larger yields than elsewhere because of the abundant supply of water. For the same reason cultivated forage plants do better in this zone than in the others. Alfalfa is the most important perennial forage crop, while, for winter forage, barley, often sown with vetches, is much used. As is also the case to some extent in the other zones of the coast region, natural meadows, furnishing green pasturage all the year round, occupy marshy places. Where such meadows occur, live stock can be kept in good condition throughout the summer, which is seldom possible in the high plateau region.

An industry of secondary importance, yet bringing a considerable yearly revenue into the colony, is that of growing plants used in the manufacture of perfumery, notably the rose geranium.

VALLEY AND PLAIN ZONE.

The large valleys of the coast region, especially in the western part of the colony, of which the Chéliff may be taken as a type, are given

up in great part to grain production. Of the 12,500,000 acres in Algeria which bear a cereal crop every one or two years, by far the largest part is situated in this zone. Wheat, barley, and oats are grown, the last in much smaller quantity than the others and solely for export. The bulk of the wheat is of the hard or durum type, although soft wheats are also produced.

Where water for irrigation is to be had in summer—and this is the case in only a small fraction of the whole area—alfalfa, sorghum, and other forage plants, as well as tobacco, melons, etc., are grown. Cotton was extensively planted in some of the valleys of western Algeria during the civil war in the United States, and proved very remunerative for a while. Under present market conditions, however, it can not be grown with profit in the colony.

The wild forage that springs up on the extensive areas of grain land lying fallow every year is an important resource to the farmer, enabling him to keep his cattle in good condition during the winter. In summer, however, unless a forage crop is grown under irrigation, the conditions for animals in this zone are unfavorable.

MOUNTAIN ZONE.

The only extensive district of high mountains in Algeria where agriculture is highly developed is Kabylia. In discussing the agriculture of the "mountain zone" we are therefore, as a matter of fact, describing that district.

The lower elevations and the valleys of the larger streams present conditions not unlike those of the littoral zone. Even oranges can be grown in sheltered situations at low altitudes. On the higher slopes and the crests of the ridges, however, this is impossible. The nature of the surface is not adapted to large vineyards and grain fields; hence, agriculture becomes reduced to horticulture. Orchards of figs and olives cover the middle elevations, often on the steepest hillsides. Olive oil is produced in large quantities in the eastern part of this mountain region. It is extensively used by the inhabitants and is also an important article of export from Bougie, the principal seaport of the district. Other agricultural products of the mountain region which contribute to the export trade of the colony are dried figs, the pods of the carob, or St. John's bread, and capers. The last are not cultivated, but are gathered by women and children from the wild plants, the young flower buds being the part used in commerce. About 450,000 pounds of capers were exported in 1899. The mountaineers raise in small gardens such cereals, vegetables, and forage plants as they require for their own use. These gardens are generally situated at the bottoms of valleys and ravines, where some alluvial soil has collected.

The highest elevations of the mountain zone are not suitable for any sort of agriculture, but are largely covered with grass, which affords abundant pasturage to flocks of sheep and goats.

HIGH PLATEAU REGION.

In the typical steppe region of central Algeria agriculture is limited to occasional low places where, by means of the natural moisture of the ground or by irrigation with the water of a well, a crop of barley can be made in winter. If conditions are exceptionally favorable, a small garden can sometimes be established. At such points as Sétif and Batna, in the eastern part of the colony, there are extensive areas in winter cereals, where crops are produced without irrigation. But, as we have already seen, these places are not to be regarded as typical of the high plateau region. Agriculturally, they belong rather to the valley and plain zone of the coast region.

The two great industries of the high plateau region are grazing and the collection of alfa. Vast numbers of sheep and goats, as well as horses and camels, are pastured, especially in summer, on these elevated grassy plains. It is estimated that from 6 to 10 million head of sheep and 3,500,000 goats range the high plateau. These animals are almost without exception the property of Arabs. Many of them are wintered in the Sahara, and in spring are driven by their owners up to the high plateau, where pasturage is more abundant and the heat less intense. The hides, meat, wool, and other products of these animals are a very material source of wealth to the colony. Cattle are not raised in any considerable number.

Alfa, or esparto, covers vast areas of this region, often to the almost complete exclusion of other vegetation. The tough leaves of this grass form one of the most valuable exports of the colony, amounting annually to about $2,000,000. They are used in the manufacture of high grades of paper, basket ware, matting, hats, and cordage. The harvest takes place in the spring. Persistent exploitation is resulting in the rapid extermination of alfa grass, the more so because attempts to establish artificial plantations have so far been wholly unsuccessful.

DESERT REGION.

The oases of the Sahara, and particularly those of the depression known as the Oued Rirh, in the eastern part, are the only portion of the desert that is of much agricultural importance. There the presence of subterranean streams, carrying a considerable volume of water, has made it possible to plant thousands of date palms in groves of greater or less size.

Within the last three decades the sinking of a number of artesian wells in the Oued Rirh region has much increased the supply of water

for irrigating purposes. Consequently, it has been possible to create new oases and to extend greatly the area in date palms. Two French companies have set out many thousands of palms of the best varieties, especially the celebrated Deglet Noor, and have introduced improved methods of cultivation and management. Dates have always been an important article of export from the Sahara to other parts of Africa. Recently a large export trade with Europe has been developed.

A considerable variety of fruits, vegetables, cereals, and forage crops is grown among the date palms in the oases. These, however, do not afford products for export to foreign countries, but serve merely to supply the wants of the local population. The area available is too small to allow these subordinate cultures to attain any considerable magnitude, even cereals and forage plants being grown in gardens rather than in fields.

Oranges are grown in the oases at the foot of the mountains that border the desert, but do not succeed farther south because of the occasionally severe winter frosts. Olives for oil and the large sorts used for pickling, almonds, several kinds of figs and grapes, pomegranates, apricots, and other fruits are produced. The apricots grown are of a native type and are remarkable for the large size the trees sometimes attain. The different kinds of fruit trees are not set out in separate orchards, but are mingled together. The same system, or lack of system, is observed in the way garden vegetables are grown. Of these the more common are onions, broad beans, carrots, cabbage, tomatoes, okra, eggplant, pumpkins, cucumbers, melons, and peppers. Alfalfa is grown in small, carefully tended patches, and is cut many times during the year. The cereals chiefly grown are wheat and barley in winter, and sorghum and Indian corn in summer. On the northern edge of the Sahara, where the slope is considerable and occasional heavy rains in winter cause a sheet of flood water to sweep down over the land, this is taken advantage of in producing crops of grain in the open desert bordering the oases. Ridges of mud are thrown up at intervals, and are arranged so as to catch and retain for a while the flood water.

PRINCIPAL CROPS IN DETAIL.

FRUIT CROPS.

GRAPES.

Wine grapes.—Grapes have long been an important product of Algeria, for even before the French occupation about fifty varieties were known to the natives. In Kabylia particularly, well-defined local varieties had been developed. Some of these are grown only in that country, apparently, while others occur under different names in other parts of the Mediterranean region. Until within the last three

decades, grapes were grown chiefly for eating purposes, as the Mohammedan law forbids the use of wine. Since then, however, the planting of vineyards has made rapid progress among the colonists, and in 1900 nearly 350,000 acres, about one-tenth of the land owned by Europeans, was in vines. The estimated total value of Algerian vineyards is $114,000,000. Wine is now the most valuable product of the colony, the export amounting in 1899 to over 120,000,000 gallons. Most of the skill, energy, and capital of the French population is concentrated upon this crop. It has been computed that $6,650,000 is paid out annually in wages to the laborers in Algerian vineyards.

Fine wines and dessert wines form but a small part of the total yield, the Algerian product consisting chiefly of heavy-bodied and, in the case of red wines, deeply colored wines for blending purposes. These are being constantly improved in quality, and Algerian wines are now widely and favorably known in Europe—France, England, and Germany, especially, importing large quantities.

The varieties of wine grapes chiefly grown by European colonists are those of southern France. Carignane, from which red wine is made, is at present the favorite, and is being planted more extensively than any other variety. Other highly esteemed varieties that furnish red wine are Mourvèdre, Morastel, Aramon, Cinsault, and Ulliade (Oeillade). Carignane is notable for the rapidity with which it comes into bearing and for its large yields. At the same time it requires more care than some other varieties, and is subject to fungous diseases. Mourvèdre and Morastel, hardier varieties, but slower in developing and somewhat irregular in yield, are not as extensively planted as formerly. Cinsault and Ulliade are hardy varieties, and endure the trying conditions that prevail when the sirocco is blowing. The former, especially, is much grown. The latter is said to be very irregular in its yields. The variety known as "Petit Bouschet" is used for giving a deeper color to certain French wines made from other varieties.

White wines are made from the Clairette, Ugni Blanc, Semillon, and other varieties, while a native variety known as Feranah is highly esteemed by some vineyardists. All these, however, give rather light yields, so that the making of white wines from grapes having a colorless juice is now much practiced, the skins being removed before fermentation begins. Cinsault, Aramon, and Mourvèdre are especially used for this purpose. Excellent dessert wines are occasionally made from such varieties as Alicante and Muscat.

Vines are grown in nearly all parts of the colony, even in the extremely mountainous districts and in the oases of the Sahara; but the most extensive vineyards have been established in the great plains and valleys of the coast region, where the largest profits from the

growing of wine grapes have been realized. Deep alluvial soils, containing a considerable amount of clay and of organic matter, are found to give the largest yields. These soils retain enough moisture during the summer to prevent much harm to the vines from the sirocco. The better qualities of wine are, however, commonly produced on hillside vineyards, at altitudes not exceeding 3,000 feet. Some districts that are otherwise perfectly adapted to vineyards suffer so heavily from hailstorms in spring as to make them unprofitable for grape culture.

The vines are planted to best advantage in squares or in a quincunx, i. e., in squares with one vine at each corner and one in the center. It is very important to arrange the vines so that the vineyard can be plowed in both directions. It is considered advisable, under Algerian conditions, when planting in squares, to set the vines 5, or, for some varieties, 6 feet apart each way. The vines are set out during the months of January, February, and March. Pruning is generally done in the latter part of the winter. The varieties most commonly grown by the colonists, such as Carignane, are trimmed back close to the stump, leaving a circle of 5 to 8 spurs. When trimmed long, the canes are trained on wire or are supported by forked sticks. Among the Kabyles, the vines are generally allowed to grow on trees. Close trimming is said to increase the ability of the vines to resist drought, which is an important matter in Algeria. Grafting is resorted to when it is desired to replace the varieties in a vineyard with better varieties, and to render it more productive, March and April being the best months for this operation. In Algeria vines generally begin to bear in their fourth year, although a full crop is not obtained until the sixth or seventh year.

Late in the winter, after trimming is completed and before the buds have begun to start, the vineyards are plowed, usually to a depth of 6 inches. This should be done when the soil is fairly dry. Occasionally the plow is followed by a subsoiler. Vines send their roots deep into the soil in Algeria, so that there is little danger of injuring them by this treatment. A hoe or pick is used to loosen the soil around the roots of the vines. In some vineyards, in order to cover the roots, a cross plowing is then given which, like all subsequent plowings, is shallower than the first. During the summer the vineyard is given as many cultivations with the hoe or the scarifier as are necessary to rid it of weeds and to preserve a loose mulch on the surface of the soil that will keep down evaporation. Bermuda grass is often a serious pest in Algerian vineyards.

Although in vineyards careful cultivation will partly take the place of irrigation, the yield can almost always be increased by the judicious application of water. Irrigation in winter, so as to store up water in the soil, is recommended for such regions as the Chéliff Valley,

where the rainfall is small. The first irrigation in summer generally takes place when the grapes begin to color, and the second about two weeks before the vintage. About 2 acre-inches of water is used in flood irrigation, but only about 1½ acre-inches in furrow irrigation. It is desirable to follow each irrigation by a cultivation, in order to keep down weeds and prevent the surface of the soil from baking.

Nitrogenous fertilizers are needed in maintaining the wood growth of Algerian vineyards, and phosphoric acid is also often required to promote productiveness. Farm manure is much used and is applied at the rate of 12 to 18 tons per acre.

When wine making first began in the colony great difficulty was experienced in completing fermentation, and the quality of the wine was much impaired by the presence of unfermented sugar. This was due to the high sugar content of the Algerian grapes and to the high temperatures prevailing during fermentation. These difficulties have been largely overcome, however, by observing certain precautions. If the weather during the vintage is very hot, the grapes are gathered and put into the vats in the early morning while they are cool, and the temperature of the vats is kept down by causing cool water to circulate on the outside of them.

The fungous diseases, such as anthracnose, oïdium, and mildew, which attack vines in Algeria, have been more or less successfully kept in check by spraying. Not so, however, with phylloxera, which has wrought terrible havoc in the vineyards of Oran and Constantine departments since its first appearance in the colony in 1883. A very rigid inspection law has failed to put a complete stop to its ravages. The practice of flooding infected vineyards, which has given such happy results in southern France, can not be generally adopted in Algeria because of the scarcity of irrigating water. So far the vineyards of the central department, that of Algiers, have escaped damage from this destructive insect.

In the vineyards of western Algeria considerable losses have been sustained through the rise of salts in the soil. The effect of salt in the soil upon Algerian vineyards has been discussed by Dugast (see p. 44 of this report), who calls attention to the existence of occasional more resistant plants. In some districts the vines have been killed, while in less extreme cases the quality of the wine has been much impaired by taking up more or less of the salt contained in the soil. A French law forbids the sale of wine containing more than one part per thousand of sodium chlorid, but in some of the wine produced in Oran Department this percentage has been exceeded. It is considered safe to plant vines in any soil that is not too salty to permit a good growth of figs, pomegranates, alfalfa, or artichokes.

Table grapes.—Excellent table grapes are grown, some of which—the Cinsault, for example—are valuable also as wine grapes, while others, like the Golden Chasselas, are grown chiefly for the table. The latter is by far the most popular variety. It is an excellent grape, bearing shipment well. Grapes mature early enough for profitable exportation in the littoral zone of the coast region only. Near Algiers the Chasselas ripens in the first part of July and reaches the French markets in advance of home-grown grapes. Vines of this variety generally begin to yield freely in their fifth year. Reeds are usually planted as a wind-break, the same as in market gardens. An average crop from an acre is 3 tons of fruit. The first Algerian grapes that reach the Paris markets are said to bring as much as $26 per 100 pounds.

Table grapes grown elsewhere than along the coast ripen too late for export, but often find a good sale in local markets. The varieties peculiar to the colony are generally of inferior quality, although some of them are not without value. Those grown in Kabylia are nearly all pruned to long canes, and often ascend to the tops of tall trees. It is difficult to gather the grapes from such vines or to spray them when infected with fungous diseases.

Raisins are dried in small quantities by the Kabyles. Otherwise this industry has not developed in Algeria, although the climatic conditions would seem to be peculiarly favorable to raisin making.

OLIVES.

From the earliest times of which we have record the olive has been one of the most important products of northern Africa. The same varieties yield a higher percentage of oil in Algeria and Tunis than in southern Europe. The oil content varies greatly in different parts of the colony, but as high as 34 per cent has been obtained from olives grown in the oases of the Sahara. African oils have a higher margarin content and are more easily fixed at a temperature of 40° F. than oil made from European olives. The annual production of oil in Algeria is estimated at 13,200,000 gallons, the bulk of which is consumed in the colony. The export trade is as yet comparatively insignificant, amounting annually to only about $200,000. In fact, Algeria does not produce enough for home consumption, importing annually from 2,500,000 to 3,000,000 gallons of edible oils. The number of grafted olive trees in the colony is estimated at 4,500,000, the greater part of them being in Kabylia. Tunis, the olive-growing country par excellence of northern Africa, is said to contain some 15,000,000 grafted trees, covering about 500,000 acres. The olive is thoroughly at home in Algeria, especially in the Kabyle mountain district, where several local varieties exist, some of which are of considerable value.

Like some of the vines, some of the olive varieties are found only in the colony, while others, which have received local names in Algeria, are widely distributed in Mediterranean countries.

The olive grows wild in almost every part of Algeria, here and there forming actual forests, some of which were formerly of much greater extent than they are to-day. The fruits of these wild trees are worthless, but the stocks are much used for grafting with improved varieties. In Kabylia especially, the area in olive orchards is being rapidly extended by grafting wild trees.

The olive flourishes in a great variety of soils and is less sensitive than citrus fruits to cold and drought. Yet it has limitations, which must be considered when a new orchard is to be established. Well-drained soils, having a considerable slope, give the best results. The maximum oil production is said to be obtained from soils rich in lime. Sunny situations are to be preferred, although in districts subject to frosts in spring it is desirable that the trees should not be in a position where the first rays of the sun can strike them in the morning. A paying crop can not be expected in districts where temperatures as low as 25° F. or exceeding 105° F. are frequent.

In respect to elevation, olives will not thrive in Algeria at an altitude of much more than 3,000 feet, and appear to do best between 1,000 and 2,000 feet above sea level. In the immediate neighborhood of the sea the orchards suffer most from the ravages of certain insect enemies and of a bacterial disease. Olive orchards are particularly profitable in districts like the Chéliff Valley, where they can be irrigated three or four times during the winter. If irrigation in summer is also possible, the yield can often be doubled. At each watering, from 1.5 to 2 acre-feet is applied.

Where an orchard is to be started with young trees, these are set out in most parts of Algeria to best advantage at intervals of 30 feet, in rows 50 feet apart. Sometimes the quincunx plan is adopted. On irrigated land, about 40 trees to the acre is the proper number. Planting is done during the winter, preferably in December or January. After six or eight years an orchard started with trees 5 feet high and 2 or 3 inches in diameter will generally pay expenses, and in fifteen years it will be in full bearing.

Other cultures are not permitted in the orchard, unless the water supply is ample and the soil is either naturally very fertile or is well manured. Cereals are often grown among the trees, but this tends to diminish the yield of fruit, and is generally discontinued after the trees begin to bear. On the other hand, where water is plentiful, the growing of broad beans and similar leguminous crops in olive orchards is a good practice.

28932—No. 80—05——5

Fertilizers, applied in alternate years when the trees are not bearing, largely increase the yields. A good tree, if furnished about 500 pounds of farm manure every other year, will yield 550 to 650 pounds of fruit every two years. The average yield from a tree 20 years old appears to be about 175 pounds, from 12 to 15 per cent of the weight being oil. The best method of keeping the soil of an olive orchard in first-class condition is to give it a good plowing as soon as the harvest is over. During the summer two or three cultivations are given, in order to keep the surface well mulched and thus reduce evaporation. The harvest begins in October, green olives, for pickling, being the first that are gathered.

By far the greater part of the oil crop of the colony is obtained from fruit grown by the natives, who themselves manufacture two-thirds of the oil produced and also supply with fruit the oil mills that are operated by Europeans. European colonists have not, so far, devoted as much attention to olive growing as the importance of the crop would warrant. In western Algeria, however, in districts infected with phylloxera, olives are often planted in vineyards, so as to take the place of the vines in case the latter should be destroyed.

Olive growing is the principal industry of Kabylia. Very little care is there given to the cultivation of orchards, this being generally limited to a single plowing in spring. The furrows are run horizontally along the hillside, so that as much rain water as possible can be retained in the soil. The trees are pruned with a hatchet while the fruit is being gathered. The whole family—men, women, and children—take part in the harvest, which is a sort of festival, like the vintage in European countries. Hired pickers are paid with a certain proportion of the fruit they gather. A woman can earn, during the two months of the picking season, olives enough to yield about 15 gallons of oil, worth perhaps $6.

Europeans who manufacture olive oil purchase the fresh fruit from native growers, paying from 40 cents to $1 per 100 pounds. The fruit is brought to the mills in baskets made of reeds or of olive twigs. In every Kabyle village there is a small oil mill, the miller being paid for his work with the product of the second pressing. The strong flavor of the oil made by the natives, which is very unpalatable to Europeans, is due to the fact that the fruit is not pressed while fresh, but is spread out for several months after gathering on a surface of hardened clay, where it is exposed to the sun and weather. The Kabyles use oil almost wholly in place of butter and lard, frying food in it and eating it on bread and "couscous."

Olives for pickling are grown in Algeria only in a small way, generally in the gardens of natives.

FIGS.

The fig ranks next to the olive in importance among the orchard crops of Algeria. Like the olive, it is most extensively grown in the mountain zone of the coast region, although common in every part of the colony. In Kabylia no less than two dozen varieties, some of them of excellent quality, are known. Figs, both fresh and dried, form a large part of the food of the Kabyles, who also export to Europe a considerable quantity of the dried product. The finest varieties for drying, such as are grown near Smyrna, are not, however, grown in Algeria, except in an experimental way. Figs are cultivated in the shade of date palms in the oases of the Sahara; but neither in yield nor in quality do the desert-grown figs compare with those of the mountains. Fig trees do not endure well the severe climate of the high plateau.

In the larger valleys of the coast region heavy yields can be obtained under irrigation. Some varieties grown in Algeria bear two crops a year; others, only one. In establishing a fig orchard, either nursery stock, budded from 2-year-old wood, or root shoots from good trees are used. Budding is generally done in February or March. Growth is rapid, amounting often to 5 feet during the first summer. The trees, when old enough for the orchard, are set out in winter, generally about 30 feet apart. The only pruning done consists in removing the dead wood and the shoots at the base of the trunk. The orchard is occasionally given a shallow plowing or cultivation. In most Algerian soils it is found that fertilizers containing phosphoric acid and potash, if applied in late winter, materially increase the yield of fig orchards.

In Kabylia, where the acreage in figs is constantly being increased, this tree bears well up to an altitude of 4,000 feet. More care is given by the Kabyles to fig than to olive orchards. The trees are sometimes reproduced by cuttings, but preferably by root shoots. Pruning is done during the winter. In January or February the first plowing is given, and is followed by several others during the spring. Several varieties grown in that district require to be caprified. In other words, in order to set fruit, their flowers must receive pollen from those of the wild fig, and this is carried to them by a small insect (Blastophaga) which lays its eggs in the young flower clusters of the wild fig, or caprifig. The first caprification usually takes place in June, and the operation is sometimes repeated three or four times during the summer. The method of the Kabyles is to thread together a few of the "male" figs or caprifigs and hang the chaplets thus made over the branches of the trees, the flowers of which are to be pollinated. Caprifigs sometimes sell for 6 cents a dozen among the natives. In fig orchards managed by Europeans the expense of caprification is estimated at about $5 per hundred trees.

In the mountains the harvest of figs for drying, although at its height in September, covers a period of about three months, as the fruit does not all ripen at once. As fast as the fruit matures it is gathered and placed in shallow trays. These are spread out on the ground when the sun is shining, but are piled together in the evening and placed under shelter when it rains. The fruit is turned over from time to time until it is dry. Figs that are kept for home use or for shipment to other parts of the colony are split down the middle and pressed in a mortar into a compact mass. Those intended for export are packed at the seaports into crates holding 70 or 80 pounds, made of leafstalks of the dwarf palm.

CITRUS FRUITS.

Only a comparatively small portion of the total area of Algeria is suitable for citrus fruits. Even oranges can be grown successfully only in the coast region, up to an elevation of 1,700 feet or thereabouts, and in the northern oases of the eastern part of the Sahara, notably at Biskra. In the oases, however, they are not very satisfactory in yield or quality. The best orange-growing district is that around Blida, in the Mitidja Valley at the base of the Atlas Range. Here has been developed an excellent type of early-ripening, sweet orange, known as the "Blida," the harvesting of which begins in October. The Malta blood orange thrives both in the coast region and in the oases. Brazil, Portugal, Jaffa, and other races are also grown in the colony. The natives grow oranges mostly from seeds, so that the quality of the fruit they produce is generally very inferior; yet some of the native varieties, notably in Kabylia and in the mountain ravines near Blida, are said to possess considerable merit.

The expense of starting an orange grove in Algeria is sometimes lessened by growing truck crops in the young orchard for the first six years. This practice, however, is not recommended by the best authorities. A row of cypress trees is commonly planted as a windbreak around orange groves. The average profit from an acre of oranges is said to be only about $45 annually. The bitter orange (bigarade) is very hardy in the colony and is much used as a stock upon which to graft less resistant varieties. From its flowers perfumery is manufactured.

Mandarins, which are extensively planted in Algeria, generally pay better than ordinary oranges. One authority estimates that an acre of these fruits gives an average net profit of $60 to $90. The harvest of mandarins at Blida begins in November. Lemons are less extensively planted, although they are quite hardy and yield well in the littoral zone.

For the irrigation of citrus fruits in the manner usually practiced in Algeria—by means of shallow basins around the base of each tree—

from 1.5 to 2 acre-inches of water is used at an application. If the soil is very permeable, as is the case in the Blida region, the orchard must be watered every week. Otherwise, an irrigation every two weeks suffices. As to cultivation, a plowing in March to a depth of 1 foot, a second plowing in May, and a cultivation in August are recommended.

DATES.[a]

Except in a single locality, where peculiar conditions exist, the date palm does not ripen its fruit freely in the coast region. Nor is the high plateau, with its cold winters, adapted to this tree. The true home of the palm is the desert region, particularly the low, eastern part. (See Pls. I and III.) In the oases of the Oued Rirh district the finest varieties of dates—notably the celebrated Deglet Noor—reach the acme of their development.

The environment in which the date flourishes is a peculiar one. It can not grow in the dry desert if the ground water is beyond the reach of its roots unless it is copiously irrigated. To ripen the fruit of the best varieties, frequent summer temperatures of 105° to 110° F., together with a very dry atmosphere and a very small rainfall, especially in the autumn, appear to be necessary. It is obvious that this combination of conditions is not to be met with everywhere. The area which possesses the needed climatic requirements is almost limitless, but an abundant supply of water for natural or artificial irrigation is of rare occurrence in the desert.

There are a great number of varieties of the date palm in the oases of Algeria—probably at least 150. These are usually easily distinguished by the character of the fruit, whether long or short, thick or thin, light or dark, with a large or small stone, etc. One of the commonest types is Rhars, an early-ripening soft, sweet date not suitable for exportation, but very popular among the inhabitants of the Sahara. Dates of this kind are either eaten fresh or, pressed into a compact mass, are stored and carried from place to place, usually in leather bags. The Deglet Noor is the date which is most extensively grown for the European trade. Put up in small wooden boxes, with the dates attached to the branch upon which they grew, this fruit bears shipment admirably, retaining without difficulty its shape and firm texture. It is one of the finest of table dates, not only because of its flavor but for the reason that it is clean and easily handled. The fine color and the transparency of the flesh add further to its attractiveness. During the last two decades the two French companies that are

[a] For a full discussion of this interesting subject by Mr. W. T. Swingle, see the Yearbook of the United States Department of Agriculture for 1900, p. 453, and Bulletin No. 53 of the Bureau of Plant Industry, 1904.

engaged in date growing in the Algerian Sahara have set out thousands of Deglet Noor trees. The natives also have planted them in large numbers. Of still another type are the dry dates which furnish a large part of the food of the population of the desert and are transported by caravans to every part of northern Africa. They are not sirupy like the Rhars type nor richly flavored like the Deglet Noor, but are a wholesome food and can be kept for indefinite periods. The best sorts are eaten either fresh or dry, while from the starchy flesh of inferior kinds flour is made and baked into a sort of bread.

In addition to dates, the natives of the Sahara obtain various other useful products from the palms. Trees of inferior value are made to yield "lagmi," or palm wine, a sweet juice which is obtained in abundance by cutting the bud at the summit of the stem. The wood of the palm is used for building houses, bridges, and dams, as well as for fuel. The leaves serve for thatching roofs, while from their fiber matting, baskets, hats, fans, and other articles are manufactured.

LESS IMPORTANT ORCHARD CROPS.

A great variety of other fruits characteristic of warm temperate and subtropical countries are grown with more or less success in Algeria, but their importance is not sufficient to warrant much more than an enumeration.

The peach is most at home in sheltered ravines of the mountain zone, where it makes a rapid growth and yields well. It is grafted upon *Prunus mirobalan* in deep, rich soils, and upon the almond in thinner, limy soils. The fruit is often of fine appearance, but generally lacks flavor.

The apricot is also grown most successfully in ravines and on sheltered slopes at low elevations in the mountain zone. In the oases of the northern part of the Sahara it becomes a large tree and yields heavily, but the fruit is poor in size and quality. Nevertheless, dried apricots are much in demand in the markets of the Sahara. The apricot in the coast region is sometimes grafted on the plum.

The almond is one of the fruit trees that is best adapted to the drier parts of Algeria. Two principal types are cultivated—the thin-shelled Princesse, which is exported in some quantity as an early fruit, and varieties with harder shell, which are generally dried.

The cherry is most at home in the mountain zone, doing well on a variety of soils. There are cherry orchards of considerable value in some parts of Algeria.

The plum thrives in rather deep soils, especially in the mountainous parts of the colony. The Reine Claude gives excellent results under irrigation at moderate elevations in eastern Algeria. The growing of prunes has not become an industry in the colony.

The pear grows vigorously in ravines and on shaded slopes in the mountain zone, especially in deep loamy and clayey soils. There are a number of native varieties of small value. Improved European varieties rarely give satisfactory results.

The apple is even less successful in Algeria, save in a few exceptional localities.

Among fruits characteristic of warmer parts of the world, the pomegranate should be mentioned. It is very hardy as to climate, but needs a moist soil in order to give the best results. Under irrigation good yields can be obtained. A number of types are grown in Algeria, the best sweet fruit being exported and bringing a good price. The better sorts are propagated by cuttings. The spiny, unimproved type of pomegranate is much used as a hedge plant.

The Indian fig, or prickly pear, is abundant in the coast region, where it is almost perfectly naturalized. It also occurs in some of the oases, but the high plateau region is generally too cold for it. There are several different races, some with yellow, some with red fruit. A white-fruited variety, of very limited cultivation, is said to be the finest of all. Indian figs are highly esteemed by the natives and by Spanish and Italian immigrants, but are rarely eaten by the French.

Japanese (kaki) persimmons do well in most parts of the coast region and promise to become one of the important fruit crops of the colony. The loquat is more sensitive to cold, but thrives in the littoral zone. In a few sheltered places along the coast bananas can be successfully grown, the "fig banana" being the type that yields best in Algeria. There is only a small area where the cultivation of such tropical fruits as the guava, avocado, cherimoya, and pineapple is possible.

In the Aurès Mountains walnuts flourish. Plantations of chestnuts, established some years ago by the forestry service, are now bearing abundant crops. The acclimatization of the pecan is being attempted by the botanical service of the colony.

TRUCK CROPS.

A great many garden vegetables are grown in Algeria, among which may be enumerated artichokes, asparagus, beans (broad, kidney, and string), beets, Brussels sprouts, cabbage, cardoon, carrots, cauliflower, celery, chick-peas, chicory, cucumbers, eggplant, garlic, lentils, lettuce, melons, onions, peas, peppers, sorrel, spinach, squash, strawberries, sweet potatoes, tomatoes, turnips, and watermelons. Most of these are grown chiefly for the local markets. In the littoral zone, however, the production in winter of early vegetables for export to Europe is an industry of considerable importance, some 20,000 tons being shipped out of the country every year. Artichokes, potatoes, peas, and string beans are the most important of these. The growing of early tomatoes for export is also becoming a profitable industry.

Near Algiers especially, market gardens abound. There the industry is chiefly in the hands of natives of the Balearic Islands, while in western Algeria the gardeners are generally Spanish, and in the eastern part of the colony Italians and Maltese. Neither the natives nor the French colonists have gone into the business of growing truck crops for export, although Arab and Kabyle families usually have small gardens in which they raise vegetables for their own use.

There are a number of factors which combine to limit gardens as a commercial enterprise to the neighborhood of the seashore. Nowhere else, except in the Sahara, are the winters sufficiently warm to allow Algerian vegetables to be put upon the markets of Europe early enough to insure a remunerative price. As it is, the competition of the Riviera, and other parts of the northern shore of the Mediterranean, has in recent years cut down by 40 or 50 per cent the prices formerly obtained. Facilities for rapid transportation by water, such as are obtainable near the coast, are essential to the success of this industry. An abundant supply of water for irrigation is indispensable. Finally, the large quantities of manure, sewage, etc., that are applied to the gardens can only be had in the large cities of the seaboard. At Tunis, Archimedean screws placed in the drains are said to be used for lifting sewage on to the fields.

Market gardens are generally irrigated by means of the noria. For the first irrigation of the season about 2 acre-inches of water are applied, while in each subsequent irrigation about 1.5 acre inches are used. Except in the case of artichokes, which will stand heavy flooding, the irrigation of truck crops demands considerable skill. The flow of the water should be gentle, and it should be allowed to stand at only a small depth on the fields.

By abundant watering and heavy manuring and fertilizing, crop is made to follow crop with hardly any intermission. From gardens thus managed the profits are very large. A high rent—often $75 or more an acre—is demanded for the best market-garden land in the vicinity of large cities. The gardener who leases the land usually lives upon it with his family. Each small plat into which the garden is divided is usually surrounded by a wind-break of reeds, either the living plants being set closely together to form a hedge or a fence being made of the dead stalks. Sorghum and Indian corn are also used for wind-breaks.

Globe artichokes are the truck crop that is most largely grown for export. "Gros vert de Laon" (Large Green of Laon) and "Violet précoce de Provence," or "Violet hatif" (Early Violet of Provence), are the most popular varieties for this purpose. Artichokes are harvested throughout the winter, from October until April, the same plant yielding several heads in succession. The average yield from an established field is about 30,000 marketable heads to the acre.

The consumption of potatoes in the colony being larger than the quantity produced, there is a considerable importation of this vegetable. Yet the production of early potatoes, especially of the Holland or Royal Kidney variety, for export to European markets, is an important phase of Algerian truck growing. The largest tubers are shipped to England, while the Paris markets prefer those of medium size. The best prices are obtained for potatoes marketed during Lent, especially just before Easter, when from $2 to $3.50 per 100 pounds is paid in Paris for Algerian potatoes.

Potatoes grown for consumption in the colony are sown in seed beds in January and February, and are set out about the end of April. Yields of 9,000 to 17,500 pounds per acre are obtained. The prices paid in Algerian markets for spring potatoes range from 50 to 85 cents per 100 pounds.

CEREALS.

The principal cereals of Algeria are wheat, barley, and oats, which are grown only as winter crops, and sorghum and Indian corn, which occupy the land in summer. Of these, wheat and barley are by far the most important. Algeria raises most of the grain needed for home consumption, importing only a relatively small quantity of soft wheat, used in bread making. The colony exports large quantities of wheat, barley, and oats. The area each year in cereal crops is estimated at 7,000,000 acres, which is about one-third of the entire cultivated area; hence much more land is in cereals than in all other crops combined. The mean annual production in the years 1890–1895 was 64,331,000 bushels, and the total value of the annual product of cereals averages $45,000,000.

While more or less grain is produced in every part of Algeria, the largest proportion is raised in the valleys of the coast region, notably in that of the Chéliff. Owing to the generally poor preparation of the land for cereals, the exhausted condition of much of the soil, and the fact that neither manuring nor rotation is generally practiced, the average yields are too low to make these crops as effective as they should be in contributing to the wealth of the colony. Much the greater part of the grain is grown by natives and gives yields averaging 30 per cent lower than those obtained by European colonists. In districts where improved methods of cultivation, notably in respect to deeper plowing, have been introduced by the colonists, yields much higher than the average are obtained. The country around Sidi bel Abbès, in extreme western Algeria, and Sétif, on the edge of the high plateau in the eastern part of the colony, is especially notable in this respect. The acreage in cereals that is in the hands of the natives, who depend for their crops entirely upon the rainfall and take no steps to conserve soil moisture, naturally varies much more from year to year than that farmed by Europeans.

WINTER CEREALS.

Wheat.—The average area in wheat during the ten years ended in 1893 was over 3,000,000 acres. Of this about three-fourths was owned and farmed by natives. The area in wheats of the hard or durum type, as compared with that in soft wheats, was as five to one. Less than 7 per cent of the area in wheat that is farmed by natives is devoted to soft wheats, while the European colonists grow hard and soft varieties in about equal proportion.

Algeria possesses excellent races of durum wheat, for which this part of Africa was famous even in Roman times.[a] Often several varieties are mixed together in one field, although the Arabs are generally acute in distinguishing the different types. Some of the most widely grown Algerian hard wheats have long, black beards. Some have short, others long heads. In some varieties the grain is short and thick, in others it is long and narrow. Types in which the grain is clear and amber colored are particularly valuable for making macaroni and semolina, considerable quantities of which are manufactured in the colony. Semolina forms the basis of "couscous," the national dish of the Arabs. Large quantities of Algerian hard wheats are also used at Marseille in the manufacture of macaroni and similar products, for which they are considered nearly, if not quite, equal to any in the world.

Authorities agree that the types of hard wheat already existing in the colony answer all requirements, and that it remains only to practice careful seed selection in order to improve the yield and to secure pure strains.

Several native races of soft wheats are also grown, including both bearded and beardless types. Soft wheats introduced from Europe have not, as a rule, proved a success. When grown near the coast they often fall a prey to rust, and are also liable to dry up without ripening when the hot weather begins in the spring. Recent experiments with the Richelle varieties, however, have indicated that this type is well adapted to Algerian conditions, giving good yields at several points.

Wheat, which is commonly broadcasted, is always sown in the fall, generally in November, after the rains have begun. In very dry years the soil is sometimes not in a condition for plowing in preparation for a crop of grain until well into the winter. This entails late sowing, which often greatly diminishes the yield obtained.

The harvest takes place in May or June, according to altitude, there being about four weeks' difference in time between the earliest and the latest localities in the colony. A native takes from three to five

[a] For descriptions and illustrations of the varieties of Algerian wheats, see C. S. Scofield, Bulletin No. 7, Bureau of Plant Industry, U. S. Department of Agriculture, 1902.

days to harvest an acre of wheat with a sickle, the implement that is still used in the greater part of Algeria. Recently, however, the combined reaper and binder has come into use in some places. Thrashing is done as soon as possible after the harvest and in a very primitive way. The sheaves are spread out on a floor of hardened clay, which is unsheltered from the air and sunshine. They are placed in concentric circles, with the heads turned inward. Horses, mules, or sometimes oxen, are then driven around on the floor, again and again, until the grain is beaten out. Sometimes the animals are hitched to a stone roller. Two men with three horses can thus thrash out 40 bushels of wheat a day, or if a roller is used, 70 bushels. About 5 cents a bushel is paid for thrashing wheat. The modern thrashing machines that are used in a few localities handle as much as 750 bushels in a day.

On the large estates wheat is cleaned by means of fans. Generally, however, a method is used which has been practiced for ages in the Mediterranean countries—that of pitching into the air the mixture of grain and chaff, the wind carrying away most of the latter. This can be done to advantage only on days when the wind is favorable. The straw is carefully saved and stacked, to be used as fodder, the stack being usually protected by a covering of dried mud mixed with short straw.

An ingenious contrivance for storing grain is in use among the Arabs. A piece of high ground having been selected, a hole 10 to 18 feet deep and 6 to 10 feet wide is dug, with a narrower opening. The interior is thoroughly dried by burning in it straw or brush, and is then lined with a layer of matting and straw about 6 inches deep. The carefully dried grain is packed closely into this cellar, the mouth of which is then covered with straw, matting, and finally with clay. Earth is then shoveled over the top to hide the whereabouts of the store. Grain can be kept for long periods without deterioration in this unique sort of granary. The Kabyles generally use earthenware jars for storing grain.

The average yield of wheat obtained by European colonists is about 15 bushels per acre, although under the most favorable conditions very much higher yields are sometimes had. The natives, on the other hand, are well satisfied with a yield of 8 or 9 bushels.

Wheat receives irrigation in only a few districts, notably in some of the large valleys of western Algeria. A marked increase in yield is the result. An irrigation in the early autumn at the rate of 3 or 4 acre-inches puts the land into good shape for plowing and sowing. The distribution of rainfall during the winter regulates subsequent irrigation, which does not exceed 2.5 acre-inches at each application.

Barley.—The area in barley averaged during the ten years ended in 1893 over 3,500,000 acres, 93 per cent of which was owned and cultivated by natives. Barley is even better adapted than wheat to native

agriculture, being more drought resistant and requiring less preparation of the soil. The average yield for the entire colony is about 25 bushels per acre, but European colonists sometimes obtain 40 or 50 bushels. Barley forms a large part of the food of the native population and is also invaluable as forage, being almost the only grain that is fed to animals. Of the annual product of nearly 30,000,000 bushels, about one-eighth is exported. Much of this goes to northern France and to England, in which countries it is used in brewing. Algerian barleys are in high favor with European brewers, rather because of their cheapness than their quality. Improved races, like Chevalier, do not generally succeed in Algeria, being too liable to shatter; yet in some localities certain of the two-rowed European brewing barleys have given good yields. Naked varieties having an easily shelled grain are those generally grown by the natives to serve as food. They are very early and yield heavily.

Oats.—Compared with wheat and barley, oats are an unimportant crop in Algeria. The average annual acreage from 1884 to 1893 was only 114,000; i. e., less than 4 per cent of the area that was in wheat and less than 3 per cent of that in barley. Oats are grown almost exclusively by European colonists for export to Europe. Before the French conquest this cereal was practically unknown in Algeria. It is there considered by some authorities to be more resistant to drought and to salt in the soil than is either wheat or barley. It also requires less preparation of the soil and gives larger yields on newly cleared and poorly prepared land, being less likely to be choked by weeds. It can be sown up to the end of January—much later than wheat. The harvest takes place about the middle of May, and the average yield is 45 to 55 bushels per acre. Oats are said to be very susceptible in Algeria to the attacks of ergot and of rust, and for this reason the common winter oat is the only variety that can usually be grown at a profit.

SUMMER CEREALS.

Sorghum.—Two varieties of sorghum are grown, chiefly by the natives. These are white sorghum, the "bechna" of the Arabs, which is much used by the better class of Kabyles as a substitute for wheat flour in making "couscous" and bread; and black sorghum, or "dra," from the seeds of which the bread of the poorer natives is made. Black sorghum is also fed to animals; the leaves and stalks are a valuable resource at a season when green forage is scarce in Algeria.

If there is plenty of rain in April and May, and occasional showers in June, a good crop of sorghum can be made without irrigation. The heavier alluvial soils of the valley bottoms are considered best adapted to this crop, which is most grown in the mountain zone of the coast region. Sorghum is sown in April and ripens in August.

In good years 18 to 26 bushels of grain are obtained from an acre. During the ten years ended in 1893 the average area in sorghum was 75,000 acres.

Indian corn.—In the irrigated soils of the large valleys Indian corn is the most profitable summer cereal, but without a good water supply it is rarely a paying crop. For this reason, and because of the scarcity of manure, comparatively little is grown. The average area grown by natives during the ten years ended in 1893 was 20,000 acres. The variety known as "Quarantain" is esteemed for its earliness; "Caragua" for its large yields. Yields of 22 to 30 bushels per acre are obtained under irrigation, and the grain sells for about $1 per bushel. Algeria exports an insignificant quantity of this grain. Among the natives, especially in the Kabyle mountain districts, the roasted ears of maize are much esteemed as food, but with European colonists it is not in favor as a table vegetable.

FORAGE CROPS.

WILD FORAGE.

Two sorts of wild forage are to be distinguished—that of fallow fields and that of natural meadows.

Fallow-land forage.—After the removal of the winter crop of cereals wild plants of various sorts, including a great variety of Leguminosæ, spring up amid the stubble, especially when the autumn rains begin. This wild forage is generally most luxuriant during the first winter following the crop of grain. If the land is then left fallow for several years in succession a gradual deterioration of the wild forage, both in quality and in quantity, is observable. This can be prevented in large measure by occasional plowing. An application of farm manure at the rate of about 10 tons per acre will cause large yields of natural forage to be produced for two or three years, besides putting the land into excellent shape for two successive crops of cereals at the end of that period. Forage of this kind is generally pastured. If made into hay, it is usually fed on the farm, not being of a sort that is well adapted for baling and shipment.

In the oases of the Sahara, Bermuda grass, which the natives esteem as a forage plant, abounds. Almost every roadside and ditch bank is occupied by this grass. It is either grazed or is cut and fed green.

Forage of natural meadows and prairies.—The slopes of the hills and mountains of the coast region and the steppes of the high plateau, like the great plains of the Western States, are still covered in great part with a growth of grasses and other native plants, the value of which is enhanced by the presence of numerous species of vetch, clover, bur clover, and other Leguminosæ. In the high plateau region large flocks of sheep and goats are pastured upon the natural herbage of the range, generally obtaining no other food.

Two sorts of natural meadow are to be distinguished—such as occupies land that is dry during the summer and such as is moist throughout the year. The first type covers by far the greater area. As in California and in countries where most of the rain falls during the winter months, the herbage is parched and brown in summer. With the first autumn rains, however, a sudden transformation takes place. The grass turns green as if by magic, and innumerable flowering plants spring up to beautify the land.

During October, November, and December, in the coast region, cattle and other stock are turned out to graze upon this tender young growth. At its best, 5 acres will support 6 head of cattle. During the latter part of the winter and in the spring it is more profitable to keep animals off the natural meadows, allowing a hay crop to be made. The greater part of the hay of the colony is produced by the dry meadows of the coast region. This is the hay that is purchased for the cavalry service of the army, and it is exported in considerable quantity to France in years when the crop of that country is short.

Artificial treatment of these natural meadows is rarely attempted, yet in many cases occasional irrigations, plowings, and manurings would very largely increase the yields obtained. In some places it might be advantageous to seed to wild grasses and forage plants of better quality than those now occupying the land. Without treatment of any kind, however, natural meadows will last a long time in good soil—sometimes twenty years without serious deterioration.

Meadows that are moist and green throughout the year produce more abundant but coarser forage. A cutting of hay is sometimes taken in spring from such meadows, but during the rest of the year they are used as pastures. They are a valuable resource in summer, when most of the grass land is scorched and dry.

In the coast region, hay is cut between the middle of April and the middle of May, the date of harvest varying considerably in different years and at different altitudes. The scythe is generally used, a native workman receiving from 65 to 75 cents for cutting an acre. There are some localities, like the Mitidja Valley, near Algiers, where the nature of the ground permits the use of a mowing machine, which reduces the cost to about 30 cents an acre. The average yield of hay from an acre of natural meadow is a little more than 1 ton.

In the drier valleys, like the Chéliff, the hay can be gathered into double swaths by the horserake the day after it is cut. Two or three days later it can be stacked in ricks. The rick ordinarily contains from 2 to $2\frac{1}{2}$ tons, and is generally covered over with a thatch composed of the coarse grass known as "dyss" (Ampelodesmos). In case it is not convenient to place the rick on high ground, care is taken to surround it with a trench to carry off the rain water. One end of the rick

always faces the west, the direction from which come the heaviest rainstorms. Hay is taken out as required at the other end. In favorable seasons 2½ tons of hay can be cut, cured, and stacked at an expense of less than $5. Hay is usually baled at a cost of about 5 cents per bale of 110 pounds. Near the larger cities it is hauled at the rate of about 30 cents a mile for an ordinary wagonload.

The prices paid for green forage and for hay in Algeria are based upon those offered by the government, which purchases large supplies for the cavalry service of the army. Various stipulations are made as to the quality of the forage to be delivered, and as these rules are also followed by most private buyers it will be interesting to enumerate some of them. Hay is rejected if it consists of but one valuable species, if it has been mixed after cutting, and if it contains various coarse weeds, notably thistles and plants of the parsnip family, poisonous plants, grasses like foxtail with sharp-pointed beards that injure the mouths of animals, various salt-loving weeds, and coarse marsh plants. The hay must, of course, be well cured, perfectly dry, and reasonably free from dust. A veterinary surgeon is detailed to inspect the hay before it is purchased.

CULTIVATED FORAGE.

The area which is adapted to the cultivation of forage plants in Algeria in summer is limited by the scantiness of the water supply at that season. Only in the valleys of the coast region, where irrigation is practiced, can such crops be grown on an important scale. Hence, in the total production of forage in the colony, cultivated plants play a much less important part than wild vegetation.

LEGUMINOUS CROPS.

Alfalfa, or lucern.— In Algeria, as in the arid part of the United States, alfalfa is the most valuable cultivated forage plant for perennial meadows. It is grown extensively in the irrigated valleys of the coast region. In the high plateau region little alfalfa is cultivated, but in some of the oases of the desert region it is the most important forage crop. Often in the coast region and always in the Sahara, alfalfa is grown in small, carefully tended patches. (Pl. V, fig. 2.) Fall sowing is generally practiced, although in elevated regions like that around Sétif, where early frosts are likely to occur, it is sometimes advisable to sow in the spring. In that case, however, the seed must be put in as early as possible, as otherwise the young plants suffer from the dry, hot weather of the later spring months.

The seed is often put in in rows, thus permitting the frequent cultivation and weeding of the fields. Otherwise, weeds, especially Bermuda grass and chicory, choke out the alfalfa. If sown broadcast an

occasional harrowing is necessary to keep down the weeds. In case the fields are infested with dodder, the worst enemy of alfalfa in Algeria, these methods are not efficacious and other means must be taken to get rid of the pest. When the drill is used, about 18 pounds of seed to the acre are sown, but if broadcasted, about 22 pounds. Occasionally alfalfa is put in—preferably in January or February—with oats or barley, the latter serving as a cover crop for the young alfalfa; but this practice is condemned by the best authorities. Well-kept alfalfa meadows last twelve years or longer in Algeria.

Alfalfa is generally cut with a scythe. A native laborer can cut a little more than an acre a day, and receives about 45 cents an acre for the work. When a mowing machine is used the cost of cutting an acre is about 25 cents. In the oases of the Sahara a sort of sickle, with a nearly straight blade having a serrated edge, is used in cutting alfalfa.

The alfalfa crop is irrigated in Algeria both by flooding and by the furrow method. The latter requires less water, but gives the best results only in rather light soils. Flooding is the preferable method if the irrigating water is decidedly saline. From 3 to 4 acre-feet are put on at each irrigation.

Under irrigation, with a watering given every week or so throughout the summer, seven or eight cuttings can be taken, yielding a total of 7 or 8 tons of hay per acre. In soils of the littoral zone that retain a fair amount of natural moisture throughout the summer, alfalfa can sometimes be grown without irrigation. Three cuttings, aggregating 3 or 4 tons of hay, besides a considerable amount of pasturage, can be obtained under such conditions.

Most of the alfalfa in the coast region of Algeria is derived from the "Lucerne de Provence," a race that is grown in southeastern France. This showed itself from its first introduction to be perfectly adapted to conditions in that part of the colony. On the other hand, seed of alfalfa brought from Poitou, in western France, considerably north of Provence, does not succeed nearly so well in Algeria. A native drought-resistant strain is grown without irrigation in the neighborhood of Sétif, in the eastern part of the high plateau region. This variety may prove valuable in parts of the Western States where water for irrigating is not available. Turkestan alfalfa is being tested in Algeria and gives indication of being well adapted to the drier parts of the colony, particularly where the soils are somewhat saline. A fair stand has been obtained near Algiers without irrigation. The alfalfa that is grown in the oases of the Sahara appears to be decidedly resistant to the presence in the soil and irrigating water of large amounts of salt. (Pl. IV, fig. 2.) At Rouïba, near Algiers, the writers saw trial patches of alfalfa grown from seed obtained from the United States, from Tougourt in the Algerian Sahara, and from Turkestan

all grown without irrigation. That from the Sahara seemed to thrive better at Rouïba than the American sort. The leaflets are shorter, broader, and hairier than those of the American plants.[a] The Turkestan alfalfa seemed to be earlier in maturing its seed than either of the other sorts. Doctor Trabut, the Government Botanist, thinks it will grow with less water than other kinds of alfalfa, and that it may consequently prove valuable for the steppe or high plateau region of central Algeria. Although the stand grown from Turkestan seed was less than one year old and had received no irrigation whatever, it was in fairly good condition. It is, however, very liable to infection with a rust (*Pseudopeziza trifolia*). Doctor Trabut finds this very frequently the case with plants brought from extremely arid regions into the more humid climate of the coast region in Algeria.

At Tougourt, in the Algerian Sahara, alfalfa is grown in most of the gardens, generally in the shade of date palms, in small patches from which other plants are excluded. It is usually grown in plats about 20 feet long and 6 feet wide, with a low ridge of bare soil 4 feet or so wide between each plat. The top of the ridge is usually white with an efflorescence of salts. The seed is sown in the autumn in rows a foot or so apart, barley being generally sown with the alfalfa and harvested the following spring. Thenceforward the alfalfa grows alone, and the stand is usually allowed to occupy the ground 4 or 5 years. It is then plowed under, and other cultures—generally garden vegetables—take its place. By this system the roots of the alfalfa plants probably do not have time to grow down into those depths of the subsoil which are saturated with water from the almost constant irrigation given in these gardens.

Every week during the summer one or two irrigations are given the alfalfa, which is tended as carefully as any garden vegetable. With such frequent irrigation a great number of cuttings is possible, especially as the stems are cut whenever they reach a height of about 2 feet. One native grower stated to the writers that he obtained as many as 24 cuttings during the year, but this was doubtless an exaggeration. The stems are cut off very close to the ground by means of a curved iron knife with serrated edge. They are tied in small bunches, 7 or 8 inches in diameter, the ends of which are placed in running water to keep the alfalfa fresh and attractive looking until it is ready to be sold. In the market at Tougourt such a bunch sells for 1 cent. So far as we could learn, alfalfa is always fed green in these oases, and is

[a] At Yuma, Ariz., during the last two years, alfalfa from Turkestan, from the Algerian oases, and from Utah was grown side by side. No constant differences as to hairiness could be detected, but the leaflets of the Algerian seem to be generally broader than those of the Turkestan and Utah sorts. The Algerian sort seems also to grow faster and to promise larger yields than the others.

never made into hay. As it grows more or less throughout the winter, a sufficient supply of green forage can generally be obtained at all seasons.

The alfalfa grown at Tougourt is of fine quality, succulent, thin stemmed, almost perfectly smooth, and having large, thin leaves. These qualities are doubtless mainly due to its being more or less shaded by the date palms and to the frequent watering it receives; for, at the experiment station at Rouïba, alfalfa from Tougourt had wiry stems and was hairier even than the American alfalfa grown beside it.

The crust of salt that often covers the ditch banks and strips of bare soil between the plats of alfalfa is sufficient evidence that the soil of the oases is very saline. The water used in irrigating likewise has a high salt content. Yet there are reasons for believing that the amount of salt to which the plants are actually exposed during germination and while still very young is not so great as would at first appear to be the case. The soil is light and loamy, and hence easily drained. Especial attention is given to this matter by the Arabs, drainage ditches being dug in the gardens at frequent intervals. These end blindly, as there is no natural outlet for them. Nevertheless, they must have a considerable degree of efficiency, for the alfalfa that is nearest the ditches is always in decidedly better condition than that which is farther away. With this provision for drainage and the very frequent irrigations given, it is probable that a very considerable amount of salt is leached out of the uppermost layers of the readily permeable soil. The date palms that shade the ground do their part by keeping down evaporation and thus retarding the return of the salts to the surface. Finally, the oasis soils are very rich in gypsum (calcium sulphate). This, as is well known, neutralizes to a considerable degree the harmful effect of other salts in the soil.

At the small oasis of Kuda-Asli, a few miles from Tougourt, alfalfa was found growing in the open, unshaded by palms or other trees. Examination of the soil showed that the plants were making a fairly good growth, although the stand was thin, in the presence of 1.36 per cent of salts in the first foot of soil. A good growth occurred in the presence of 0.9 per cent in the first and 0.5 per cent in the second foot. Finally, an excellent stand had been obtained in soil that contained from 0.4 to 0.6 per cent of salts in the first and second feet. The water used for irrigating this field contained 460 parts of salt per 100,000. The soil is a sandy loam, and is so full of gypsum that at a depth of about 2 feet a veritable hardpan of this substance is encountered. The presence of this dense stratum would be expected to interfere seriously with drainage, to which the texture of the soil is otherwise well adapted. Consequently, notwithstanding the conditions mentioned in the preceding paragraph as tending to counteract

to some extent the effect of the salt, it would seem to be beyond question that this alfalfa is a distinctly resistant race, and is able to endure more salt in the soil than the alfalfa ordinarily grown in the United States. A small quantity of seed, reported to have been harvested last year from this patch, was secured for trial in this country.

Horse beans (*Vicia faba*).—The horse bean is a form of the broad bean, having more numerous and smaller pods. It requires deep, strong soils, containing a considerable amount of lime. When grown as a forage crop it is sown, sometimes mixed with barley or oats and sometimes alone, in rows about 2 feet apart. When the pods begin to turn brown the beans are harvested, spread upon the ground to dry, and then thrashed. The coarse, black straw, mixed with other forage, is fed to animals. The seeds are a valuable feed for milch cows, but discretion must be used in feeding them. Horse beans yield about 10 tons of green forage and 22 to 28 bushels of seed per acre.

Sulla (*Hedysarum coronarium*).—This leguminous plant has been highly recommended for Algeria, but is generally found difficult to grow and uncertain in yield. It is a deep rooting plant with erect stems 2 or 3 feet high. In the green state it is said not to be relished by animals; but if cut before flowering and made into hay or ensilage it constitutes an excellent forage. It is, however, very difficult to cure without losing the leaves. A further objection is that, while occupying the land two years, only one cutting can be taken. A good stand is nevertheless very productive, the average yield being, according to one authority, 5½ tons of hay to the acre.

Fenugreek (*Trigonella fœnum-græcum*).—This plant is very useful as a green manure crop, especially on tobacco land, for which purpose it is recommended to be sown with horse beans. The forage is much relished by cattle, but is said to give a disagreeable flavor to beef. The aromatic seeds are considered stimulating and fattening when added to other forage.

Berseem (*Trifolium alexandrinum*).—Berseem promises to be a valuable forage crop under irrigation in parts of Algeria where the winters are mild. It is most likely to succeed near the coast and in the oases of the Sahara, especially as a green manure crop for orchards. A good stand has been obtained near Algiers by sowing as early as July, four cuttings having been taken before the end of May.

Vetches.—Vetches are sometimes grown alone, but their trailing habit makes them difficult to cut. They are best handled when sown with barley or oats, this mixture forming one of the most valuable winter forage crops of the colony. Winter vetch (*Vicia sativa*) is the species most used, the hairy vetch (*V. villosa*) not having proved a success. The seed is sown in October and November at the rate of 70 pounds of vetch and 25 to 35 pounds of oats or barley to the acre. Vetch seed is rather scarce and high priced. The crop is harvested

in April or early in May, when the vetch is in blossom and the cereal in milk. It is ordinarily fed green, although this can be done with perfect safety only after allowing it to wilt for a few hours. The mixed hay furnished by vetch with barley or oats is far superior to that of the natural meadows. In seasons when the rainfall has been plentiful, yields amounting to 1½ or 2 tons per acre are obtained. The largest yields are given by land that has previously been manured at the rate of about 1,000 cubic feet of farm manure to the acre. In very wet springs hay of this kind is difficult to cure, the vetch having a tendency to rot and drop its leaves. This crop leaves the land in excellent shape to be put into grain the following winter.

The botanical service of the Algerian government has been experimenting for several years with a variety of leguminous plants that promise to be more or less useful as forage and green manure crops. For the latter purpose, especially in vineyards, lupines, horse beans, fenugreek, vetches, peas, and lentils are recommended.

TREE CROPS AS FORAGE.

In the coast region, especially in the mountain zone, a number of trees contribute to the supply of forage. The Kabyles, having little room for field crops, feed the leaves of various trees to their animals. The leafy twigs of the olive, removed in pruning, and the leaves of the elm are thus utilized. Dried fig leaves serve in winter as a substitute for hay. In the handsome ash of his mountains the Kabyle has a veritable overhead meadow, which yields him a constant supply of green forage. The most important of arboreal forage plants is, however, the carob.

Carob, or St. John's bread.—The pods of this small tree, which resemble those of the American honey locust in having their seeds surrounded by a sweetish pulp, are highly esteemed throughout the Mediterranean region as food for cattle. There are also improved varieties, which are used in some countries as human food. The carob flourishes throughout the coast region of Algeria. European colonists have not given it much attention, but, especially in mountainous districts, it is much valued by the natives, who not only plant orchards of carobs, but, with a little care, succeed in obtaining good yields from wild trees. From Bougie, the seaport of Kabylia, considerable quantities of the pods are exported to Europe.

The best results are obtained by top-grafting scions of improved races upon seedling trees. The pollen is borne upon separate individuals, so that care must be taken to have male trees in every plantation. The largest yields are obtained by following the Spanish practice of grafting a branch from a male tree upon the base of the trunk of a fruiting individual. The establishment of a plantation of carobs is therefore a somewhat troublesome undertaking. After six

years the trees, as a rule, begin to bear fairly well. In fifteen or twenty years they are in full production, single trees of that age sometimes yielding 650 pounds of pods. In some races the pods are 10 inches long, their sugar content sometimes reaching 44 per cent.

The harvest takes place at the beginning of autumn. Poles are used to knock down the pods, which are spread out to dry in the shade. When thoroughly cured they are collected into stacks, which must be opened from time to time to prevent fermentation. Carobs after being crushed and mixed with coarser fodder constitute a very palatable and nourishing ration for live stock, especially for work animals.

Indian fig.—The Indian fig, or prickly pear, (*Opuntia ficus-indica* and *O. tuna*) is thoroughly at home in the coast region of Algeria, where it frequently attains the size of a small tree. Spineless varieties are a valuable resource for feeding live stock in summer, when green forage is generally scarce.

The Indian fig will grow in the stoniest, most sterile soils, and under such conditions will produce from 9 to 11 tons of green forage every two years. In good land still larger yields are obtained. This plant responds well to manuring and to a moderate amount of irrigation.

The feeding value of the large flattened joints of the stem is not great, about 65 per cent of their weight being water. For this very reason, however, they form an excellent ration, especially for milch cows, when mixed with dry feed, such as chopped straw, bran, oil cake, and the pods of the carob tree. A little salt is often added to the mixture. Grandeau, the well-known agronomist, speaks of the Indian fig as the "forage beet of warm regions." It is estimated that 75 pounds of the stems, together with an equal weight of straw, are equivalent in feeding value to 100 pounds of good hay. Hogs are extremely fond of the fruits.

MISCELLANEOUS CROPS.

TOBACCO.

Tobacco has long been cultivated in Algeria, where oriental types were grown by the natives before the French occupation. The first colonists introduced a considerable number of varieties, but only one of these, believed to be derived from Paraguay tobacco, is now extensively grown. The area annually planted to tobacco amounts at present to only 12,000 to 15,000 acres, most of which is in the Department of Algiers. The colony is said to produce each year from 11 to 13 million pounds of tobacco. This would mean an average yield per acre of 888 pounds, which is much higher than the average in most tobacco-growing countries. The yield from irrigated is said to be about double that from unirrigated land.

The quality of the product depends largely upon the locality. Some of the best Algerian tobacco is grown in the Kabyle mountain district, where the soils seem to be peculiarly well adapted to this crop. Much of the product of western Algeria is defective in combustibility, being grown in saline land, where it absorbs considerable salt. Soils containing more than 1 part per 1,000 of sodium chlorid are considered unsuitable for tobacco. Excessive irrigation also injures the quality, although increasing the yield, of much of the tobacco grown in that part of the colony. The finest tobacco is generally grown without irrigation. In the oases of the Sahara, snuff tobacco is cultivated by the natives.

The type of tobacco ordinarily grown in the colony has a wide, very compact flower cluster and crowded narrow leaves. Plants of this type are thought to suffer less from wind than broader leaved forms. For several years the botanical service of the colony has been carrying on experiments in crossing various high-grade foreign tobaccos with this Algerian type. It has been found that while most of the uncrossed foreign varieties are not well adapted to Algerian conditions, the crosses seem almost as much at home as the Algerian parent, and often retain the desirable qualities of the imported variety.

The best Algerian tobacco has an agreeable, sweet aroma, suggesting that of some Turkish varieties. It is especially suitable for cigarettes and smoking tobacco, very little being used in the manufacture of cigars.

FIBER PLANTS.

The production of vegetable fibers on a commercial scale is now limited to alfa grass and the dwarf palm, the latter yielding "vegetable horse hair." As neither of these plants is cultivated, they are discussed in this report under the head of "Forest products."

Flax, jute, hemp, sisal hemp, manila hemp, and ramie have all been tried from time to time, but the cultivation of none of these fiber plants has passed the experimental stage. The scarcity of water in summer is generally the most serious obstacle, but there are also other practical difficulties. The Algerian government is now offering a bounty to growers of flax and hemp. Cotton growing was an important industry during the American civil war, but has since been abandoned.

PERFUME PLANTS.

In the coast region, particularly in the littoral zone, the growing of plants used in the manufacture of perfumery is one of the most important of the minor agricultural industries.

The principal perfume plant of the colony is the rose geranium. It is propagated by cuttings, which are set out in December or January. Plantations, once established, continue to yield profitable crops for from four to eight years, those in heavier soils being the more last-

ing. Under irrigation three crops can be obtained each year, and the average total yield from an acre is said to be about 12 tons of leaves annually. The oil produced in one year by an acre of rose geranium is estimated to average about 25 pounds, but in rare cases is as high as 50 pounds. Some Algerian distilleries have an annual output of 2 tons of oil of geranium. In recent years the fall in price of this perfume has caused the acreage in rose geranium to be greatly reduced.

Among plants grown for the perfume obtained from their flowers are *Acacia farnesiana* and the bitter orange (bigarade). The latter yields orange-flower water and "Essence de Néroli." The leaves of *Eucalyptus globulus* are also used to some extent in making perfumery.

LIVE STOCK.

The live-stock industry is very largely in the hands of the Arabs. They raise practically all the sheep, goats, camels, horses, and donkeys, and much the greater number of the cattle of Algeria. The colonists usually buy from the natives the beef cattle which they fatten, and also their work animals. The natural forage of the country is, as has been previously stated, the principal resource of the raiser of live stock, cultivated forage plants playing an important part only in irrigated districts of the coast region. There the business of fattening cattle that have been raised on the wild forage of the hillsides and steppes has attained some importance.

The high plateau region, like many districts in the western part of the United States, is for the most part a "range," where animals are driven from place to place and pastured upon the natural herbage. Sheep and goats in vast numbers—about three-fifths of the total number in the colony—graze on the elevated plains. Cattle, however, are few. The flocks are the property of nomadic Arabs, Europeans having taken no part in the pastoral system of the steppe region, except in so far as to purchase the product. The conditions as to climate and food supply are often severe. In summer the herbage, except in moist depressions, is parched and brown, and water is very scarce, while the winters are rigorous. As yet, little has been done in the way of providing shelter and artificial sources of water for animals pastured on the high plateau.

Sheep and goats furnish the inhabitants of the high plateau region with almost everything they use, affording skins for their tents and vessels for holding water, wool and leather for their clothing, and meat and milk for their food. Goats are raised chiefly to supply the necessities of the natives, although their skins are exported in considerable quantity. Sheep, on the other hand, furnish a very important export trade in meat, hides, and wool. It is estimated that between 6 and 10 million sheep and 3½ million goats are annually pastured upon the elevated plains of Algeria.

CATTLE.

The greater number of the cattle raised in Algeria belong to a well-marked North African type—perhaps a subtype of the Spanish cattle—of which various races are distinguished. The best defined of these are the Guelma and the Moroccan races. They are rather small in size and of good shape, with rather long body, full flanks, large, well-formed chest, rather small belly, and erect, curved horns. In color they are usually dark, having black head and legs and dark gray, fawn-colored, or red back and flanks. They are hardy animals, habituated to the severe conditions under which they ordinarily live. Owing to the small amount of food obtainable during the long, dry summer they are small and slow in maturing, requiring usually six years to reach full development. In spring, when the natural pasturage is abundant, and at other seasons, if supplied with cultivated forage, they fatten rapidly. If given plenty of green forage and a small amount of grain, a steer can usually put on 400 pounds of meat without difficulty. When well treated, Algerian cattle make excellent work animals, but the cows are generally poor milkers.

Cattle are purchased from the Arabs for fattening, usually in the late summer or early autumn, and at a price of $9 to $13 per head. They are pastured during late autumn and winter on uncleared land or fallow grain fields. At the beginning of spring they are usually very thin, but fatten rapidly from that time on. After three months of spring pasturage they often weigh enough to be sent to the butcher. A large number go to the markets of the colony, but there is also a considerable export of live cattle. At Marseille, Algerian cattle sell on the hoof at the rate of $9.50 to $10.50 per 100 pounds. At this price there is a good profit in cattle fattened in the pasture, but not when fattened in the stable.

Improved European races of cattle are not generally adapted to the trying climatic conditions of Algeria; nor can they, like the native cattle, endure well the periods of scanty food supply that these conditions impose. Only in the restricted areas, where irrigation allows of the constant production of forage of good quality, is anything to be expected from the introduction of foreign breeds. In such localities crossing high-bred races with the hardy Algerian cattle may prove advantageous in increasing the milk and beef producing capabilities of the latter.

HORSES.

It is estimated that there are 210,000 horses in Algeria, four-fifths of which are the property of natives. Algerian horses belong to the African type, with an admixture of Arabian blood. In its most typical form the horse of Algeria is rather small and light, but is very

hardy and capable of much work. The Arabs generally use horses to draw their plows.

The eastern part of the high plateau region is the center of horse breeding in Algeria. The Arabs of the Sahara obtain almost all their horses from that district. The industry of raising horses is, however, on the decline, the prices brought by good animals having fallen 100 per cent or more in the past ten or fifteen years. A mare of good pedigree and known for the excellence of her progeny can now be bought for about $150. The increasing popularity of the mule as a work animal, both among natives and Europeans, is partly responsible for this state of affairs.

DONKEYS.

There are some 275,000 donkeys in Algeria, almost all of which are the property of natives. In the coast region they have largely replaced the camel as a beast of burden, although the latter still retains its usefulness in the high plateau and desert regions. Wherever the use of wagons for transportation is precluded by the lack of good roads the donkey is employed.

MULES.

Of the 150,000 mules that existed in Algeria in 1900, less than one-fifth belonged to Europeans. The high plateau region, around Sétif and Constantine, produces the best mules of the colony. Mules are used by European farmers to draw their wagons and plows, and by the natives for riding and for carrying loads. A hardier and more robust animal is obtained if the donkey parent is of Algerian rather than of European origin.

CAMELS.

It is the one-humped Arabian camel, or dromedary, that is common in Algeria. The Mehari race of the dromedary is especially adapted to travel in the Sahara, making, without difficulty, marches of 70 miles a day for several successive days. Camels are, of course, well known for their endurance, getting along for considerable periods without food or water. They can carry for long distances loads weighing 300 pounds and more. Camels are raised and are used only by the Arabs. A good animal will sometimes bring $60. In agricultural work the camel is of practically no importance, except as a means of transportation.

SHEEP.

In is estimated that in ordinary years the flocks of the colony represent a total value of $28,500,000, which is almost wholly the property of natives.

Three principal races of native sheep are distinguished in Algeria—the Kabyle, or Berber, which is peculiar to the mountain region; the Barbary, a large-tailed race, which is most common in eastern Algeria; and, best of the three, the Arab, which is rapidly supplanting the others. The Arab race is that which is usually found in the large valleys and plains of the coast region and also in the high plateau region. The small, slender tail is a distinguishing mark of this race. The head is sometimes brown or black and sometimes white, the white-headed type being the finest of Algerian sheep. The short, dense, more or less curly, rather fine fleece of the Arab sheep is in marked contrast to the long, straight, coarse wool, resembling goat hair, with which the Kabyle sheep is covered. The best quality of wool is produced in the larger valleys of the coast region.

The colonists formerly purchased from the natives nearly all the sheep they fattened. There is a growing tendency, however, to raise sheep on the farms of the coast region. Sheep that are bred where they are fattened are found to give when only 14 months old from 6½ to 9 pounds more meat than 2½-year-old sheep that have been purchased from native shepherds.

The white-headed Arab type of Algerian sheep shows an approach to the Merino. Crossing with the latter race is found to give a superior animal, which produces not only more meat, but wool that is better in quality and about 50 per cent greater in quantity. Careful selection among the mixed native races can also be counted upon to enhance greatly the value of the meat and wool produced by Algerian flocks.

GOATS.

The natives usually pasture goats together with sheep and cattle, but this is from every point of view a bad practice. Except for their large milk production, goats are not held in much esteem among the European colonists. To the natives, however, their skins, hair, and meat are invaluable. The fact that they can pick up a living in places where cattle or even sheep can not obtain sufficient food is a strong point in their favor. Two races occur in Algeria—the Kabyle goat, with long hair and horns, and the hornless Arab race, which gives more milk.

FORESTRY.

GENERAL CONDITIONS.

According to official estimates there are about 8,000,000 acres of forest land in Algeria, of which about 60 per cent belongs to the coast region, or Tell. The term "forest land" is used, however, in its widest sense, land bearing a shrubby growth of lentisk, dwarf oak, olive, myrtle, dwarf palm, etc., such as occupies vast expanses in the coast region, being included. The steppes of the high plateau region,

which are covered with coarse grasses and herbs, possess no forest in the strict sense of the word. Only here and there, in depressions, straggling shrubs and small trees of betoom (*Pistacia atlantica*) and of juniper are found. Yet considerable areas of this character are officially designated as "forest." In the desert region, except on the highest mountains, nothing resembling a forest occurs, the native vegetation being limited to scattered shrubs and coarse grasses, with an ephemeral growth of small herbs that spring up after the infrequent showers. The true natural forest is confined almost wholly to the mountains, especially those of the coast region and of the eastern part of the high plateau.

The forests of the colony are of various types, which owe their characteristics not only to natural conditions of climate and of soil, but also to the direct or indirect agency of man. In many localities only scattered old trees remain, the intervening spaces being occupied by brush or by a carpet of grass. Sometimes there is almost no vegetation except an occasional tree, and in such land active erosion takes place. This condition has probably been brought about for the most part by reckless exploitation or by fires which are often kindled by the natives in order to provide their flocks with the more abundant pasturage that springs up afterwards. The admission of flocks into the public forest reserves is frequently a cause of the rapid disappearance of the young trees, especially when goats are pastured among them. On the other hand, particularly at high elevations in the mountains, there are dense forests where the trees reproduce themselves freely; but this type is the exception rather than the rule.

The forests also differ in the diversity of species composing them. Sometimes large areas, especially at the higher elevations, are occupied almost solely by a single species. Sometimes while one kind of tree predominates, others are present in smaller numbers. Less often several species are mingled together in nearly equal proportion, forests of this type being most frequent in the littoral zone.

The composition of Algerian forests as to species depends upon climatic and soil conditions, and upon the altitude. Well-defined zones, each characterized by some one predominant species, succeed each other at different elevations in the mountains. From sea level up to about 2,500 feet, cork oak, olive, and Aleppo pine are the principal elements, the last being the most widely distributed tree in the colony. Here the forest is most apt to be mixed with a shrubby growth, made up of various species characteristic of the so-called "maquis" of the Mediterranean region.

From 2,500 to 4,000 feet, *Quercus ballota*, a kind of live oak, often predominates. The sweet acorns of this tree are much relished by the Kabyles, who make a practice of selecting and preserving such individual trees as bear the best nuts.

Between 3,500 and 6,000 feet, the handsome Zen oak (*Quercus lusitanica* var.) forms heavy forests of good-sized trees, usually 50 to 70 feet high. In one locality Zen oak covers an area of 10,000 acres.

Finally, at elevations of 4,000 to 6,000 feet, occur magnificent forests of Atlas cedar, a short-leaved variety of the cedar of Lebanon. The total area occupied by this tree approximates 90,000 acres. It usually forms an open forest, the trees being separated by expanses of grass land and low brush. Unfortunately, this superb tree shows very little tendency to reproduce itself. The Atlas cedar lives to a very great age. Individual trees of unusual size, distinguished, like some of the "big trees" of the Sierra Nevada, by particular names, are made the goals of pilgrimages by tourists.

Besides the species already enumerated, the following are noteworthy, either for their abundance or their economic value: Ash (*Fraxinus kabylica*), arbor vitæ (*Callitris quadrivalvis*), juniper (*Juniperus oxycedrus* and *J. phœnicea*), and fir (*Abies numidica*). The chestnut, almond, cherry, fig, and carob are all represented in the mountains of Algeria by wild forms.

Especially in the large valleys of the coast region, such as the Habra, Chéliff, and Mitidja, the planting of trees to furnish timber for construction and firewood, as well as for shade and protection against winds, has been extensively practiced. Species of Eucalyptus, notably *E. globulus* (blue gum) and *E. rostrata* (red gum), are most used. The latter has proved to be the better adapted to Algerian conditions, and is now rapidly replacing the blue gum. *Eucalyptus robustus* and, to a lesser degree, *E. occidentalis* are said to be the species that succeed best in saline soils. The colonists began in 1860 to plant Eucalyptus in large numbers, but when it became apparent that the value of the wood for building purposes had been overestimated, these trees somewhat declined in favor. Nowadays, however, their utility in other respects is generally appreciated.

A large part of the forest land of Algeria, including vast areas covered with brush and grasses, as well as much true forest, is owned by the government. A code of forest laws modeled upon those of France governs their administration. The penalties against starting forest fires are very severe, but are difficult to enforce, because of the mountainous character of much of the country, the frequent absence of facilities for travel, and the active or passive opposition of the Arab population, which is largely devoted to raising live stock. It has been necessary to open much of the public domain to flocks owned by the natives. Although regulations have been established which, if strictly enforced, would prevent serious damage from this cause, as a matter of fact the forests often suffer severely. But in some areas, where it has

been possible to prevent grazing during longer or shorter periods, considerable reforestation has taken place.

Forest land belonging to the government, particularly such as bears a growth of cork oak or of alfa, is often leased for a nominal rental to companies or to individuals who exploit these products. Some of the most valuable forested areas are the private property either of Europeans or of natives.

FOREST PRODUCTS.

Following the loose application of the term "forest" that prevails in Algeria, there will be discussed under this head commercial products that are furnished not only by trees, but also by the grass known as alfa, and by the dwarf palm. As a justification for this arrangement, it should be stated that both of these plants occupy extensive areas which are officially designated as forest land, and that neither of them is ever cultivated.

FUEL.

Most of the trees—and many of the shrubs—native in Algeria supply the inhabitants with firewood and with charcoal, which, as in all Mediterranean countries, is much used for fuel. The expense of clearing land is often partly met by the sale of the firewood and charcoal obtained in the process. In some of the large valleys of the coast region, where there is little natural tree growth, plantations of eucalyptus are useful as a source of fuel.

TIMBER.

Most of the wood for construction used in Algeria is imported from northern Europe and from Austria, the natural resources of the colony in this respect having been little developed. Probably this is partly due to the scarcity of water and the consequent absence of large perennial streams, which render difficult and expensive the transportation of logs from the mountains. Artificial plantations have been of little value as a source of building timber, eucalyptus wood particularly being deficient in durability.

Some of the native timber trees promise well, and may some day come into extensive use. Live oak (*Quercus ballota*) and Zen oak (*Q. lusitanica*) furnish an exceedingly hard wood that is somewhat difficult to work. Wood of the Zen oak is particularly valuable for making brandy casks. The extremely durable wood of the Atlas cedar is excellent for railway ties, and is sometimes used in cabinetmaking, its pleasant odor enhancing its value for the latter purpose. Long immersion in water renders it almost indestructible. Arbor vitæ has a beautifully colored wood, variegated with numerous knots, and is highly esteemed by cabinetmakers.

CORK.

The total area occupied by the cork oak in Algeria is estimated at 1,025,000 acres, of which 725,000 acres are being exploited at the present time. About 60 per cent of the entire area belongs to the public domain. The total production of cork in 1899 amounted to 15,900 tons. It is estimated that if all the cork oak of the colony were in a productive state an annual revenue of from $2,000,000 to $4,000,000 could be derived from this source.

The cork oak ranges from sea level up to about 4,500 feet, the largest forests being found in the mountains of the coast region in northeastern Algeria, the western part of the colony being generally too dry for this tree. It avoids limestone, attaining its highest development on soils derived from the Numidian sandstone, where these soils are underlain by a subsoil heavy enough to retain considerable water.

The tree is usually of medium height and size, but its trunk sometimes reaches a circumference of more than 30 feet. The largest individuals are invariably hollow. The crooked trunk and irregular branching give this tree an unkempt, straggling appearance. The evergreen foliage resembles that of the live oak of the Southern States. The wood is of little value, the important products of this tree being cork and tan bark.

Well-managed forests of cork oak are kept free from undergrowth, thus diminishing the likelihood of loss from fire, to which they are peculiarly liable. The danger is greatest in September, when the sirocco is blowing. Fires are often wantonly kindled in the oak forests by malcontent natives and spread with terrible rapidity, frequently devastating vast areas. Only natural forests are exploited in Algeria, no attempt ever having been made to establish artificial plantations.

In bringing a forest of cork oak into condition for exploitation the first step is to remove the layer of old or "male" cork which forms under natural conditions. This operation, which requires considerable skill, is performed in the spring when the sap is beginning to rise. The subsequent yield depends largely upon the way in which this work of "demasclage" is done. It is advisable to put back into place the layer thus removed, fastening it around the trunk by means of wire and leaving it there for about two years: otherwise the trees are very liable to injury from dry, hot winds and from fire. Wrapping the trees in this way also prevents a second development of the worthless male cork.

The new cork which now begins to form is alone of commercial value. It is deposited at the rate of from 0.04 to 0.12 inch annually, and the first harvest is taken when the layer of cork has reached a thickness of about 1 inch. Thereafter the cork is removed every

eight or ten years, the later crops yielding a better product than the earlier ones. The expense of each harvest from a single tree is about 2 cents.

Individual trees differ greatly in the rate at which cork is formed. As a rule, the best product is that which develops most slowly. Rapidly growing cork is more abundantly veined with loose tissue, which diminishes its value. The cork is sometimes seriously injured on the tree by the ravages of ants, which build galleries in it. The tree has also other insect enemies.

The cork, when cut, rolls up into tubes of the size of the trunk from which it was taken. It is first pressed out into sheets, then boiled, and finally the crust of bark is removed by scraping. Boiling increases the bulk by about one-fifth and renders the cork more elastic.

An acre of cork oak in full production yields a net annual revenue of about $2. The product from a single tree is worth from 4 to 10 cents a year after all expenses are deducted. Algerian cork sells at from 3½ to 10 cents per pound.

TAN BARK.

The forests of Algeria furnish a large amount of bark for tanning. The annual export of tan bark, chiefly to Great Britain and Italy, amounts to about $200,000. A considerable quantity is also consumed in the colony itself, the manufacture of leather being an important industry among the natives.

Most of this bark is furnished by several species of oak. The Kermes oak (*Quercus coccifera*) ranks first in production, the bark of the root being used. The forests of cork oak, especially those belonging to natives, also furnish a large quantity. The collection of the bark is generally done in such a way as to kill the tree, although if proper precautions were observed the forests could be exploited for tan bark without diminishing their production of cork. The bark of this oak yields about 19 per cent of tannin. A single tree will furnish several hundred pounds of bark, a ton of which sells for from $22.50 to $37.50.

Various tannin-producing plants, such as Australian species of acacia, which furnish the wattle bark of commerce, canaigre, and the Valonia oak, have been recommended for cultivation in Algeria, but none of these has yet become of practical importance. In Tunis experiments are being made by the government in the cultivation of the Sicilian sumac (*Rhus coriaria*), the powdered leaves of which are a valuable material for tanning.

ALFA.

The Arabs use the word "halfa" in much the same way as the term "bunch grass" is used in the western United States to designate any coarse, rush-like grass that grows in tufts. The "alfa" of the French

colonists signifies, however, only the species known in Spain as "esparto" (*Stipa tenacissima*). The tough, fibrous leaves of this grass are used in manufacturing paper, basket ware, hats, cordage, etc. It is a long-lived plant, having strong, much branched rootstocks, which give it a good hold upon the soil. The young plant forms a dense tuft, which later takes the form of a hollow circle, as the stems in the center die out. This in turn becomes broken up into separate tufts, each of which is the starting point of a new circle. The leaves are like those of many other so-called "steppe" grasses, being flat and green during the rainy period, but turning yellowish white and rolling up into quills when the dry season sets in. They average from 20 to 30 inches in length, and end in long, sharp points. The leaves last about two years. The older ones are often infested with fungi, which usually attack first the point of the leaf.

Alfa grass covers large areas in Spain and in northern Africa. In Algeria it is most characteristic of the high plateau region, where it often occupies, almost alone, enormous expanses of the undulating plains, forming the so-called "sea of alfa." It is not, however, confined to the high plateau, and even reaches the seashore in extreme western Algeria. It ascends in the mountains to a maximum elevation of 6,000 feet. Where the average annual rainfall exceeds 20 inches a year alfa does not flourish. It prefers a dry, sandy soil, and will not endure the presence of any considerable amount of salt. In moist depressions, where the soil is clayey, other species take its place.

It is difficult to obtain an accurate estimate of the total area occupied in Algeria by this grass. Some authorities give 12,500,000 acres in the high plateau region alone, but this is doubtless an exaggeration. The alfa land of the colony belongs partly to the government and partly to individuals or private companies. The government concedes the right of exploitation for the modest sum of about 1 cent per acre. The holders of concessions, in their turn, usually sublet their rights to a contractor.

A stand of alfa in its natural condition is less valuable than one from which the leaves are regularly harvested. In the former case there are many more or less worthless old leaves mixed with the young leaves. When the exploitation of a stand is begun it is customary to burn it over so as to destroy the coarse old leaves. Thereafter, if the crop is harvested every season, only small, fine leaves, much stronger and more uniform in length than the older ones, are obtained. By firing a tract repeatedly for several successive years "white alfa," with extremely fine, flexible, light-colored leaves, is produced. Long-continued exploitation of a stand, without allowing it any rest, greatly weakens the plants. In fact, alfa has in this way been virtually exterminated in some of the more accessible areas.

As attempts to form artificial plantations of alfa have not so far proved successful, there is danger of the total annihilation of this industry, which, after stock raising, is the mainstay of the population of the high plateau region. To prevent this consummation, a closed season of four months has been established by law. Alfa can not be legally harvested or purchased from gatherers in the high plateau region during the months of March, April, May, and June. In the coast region the closed season extends from the middle of January to the middle of May.

The contractor who undertakes to harvest alfa puts up a barn on the tract and secures Spanish or Arab laborers, whom he provides with food and water, to gather the leaves. Alfa harvesters sometimes come long distances with their families, attracted by the high prices paid for this work. A good laborer can gather, in a day, 650 to 900 pounds of green leaves, for which he is paid nowadays at the rate of about 18 cents per 100 pounds.

The gathering of alfa is still done exactly as classical writers described the process in the times of the Romans. The harvester starts out early in the morning and selects a spot where there is plenty of the grass. Fastened to his left hand by a leather thong is a stick about 16 inches long. With his right hand he seizes a cluster of the tough leaves, rolls them obliquely around the stick, and gives a strong pull with both hands. This breaks off most of the blades at the point where they join the sheaths, although some of the sheaths generally come up with the blades and must be broken off by a second pull. The leaves are packed as fast as they are gathered into baskets, which are then carried to the barn. The green alfa sent in by each harvester is weighed and is then stacked in ricks. When dry it is sorted to remove any sheaths and branches that may still be attached to the leaves. It is baled under a hydraulic press and the bales are secured with hoops. The product is then ready for transportation to the nearest seaport.

Algeria now exports annually nearly 80,000 tons of alfa, which is approximately 35 per cent of the entire output of alfa-producing countries. The total value of the export from Algeria is nearly $1,500,000 a year. England is the largest purchaser, taking, indeed, nearly 90 per cent of the entire world's supply of alfa. France and Belgium also import considerable quantities.

More than 90 per cent of the total amount of alfa produced is used in the manufacture of superior grades of paper. Paper made from the leaves of alfa is strong, transparent, of a silky texture, and very light in proportion to its thickness. It is preferred to any other for printing costly books and engravings.

The best grades of alfa, however, are used in making basket ware, hats, and matting, bringing a price almost twice as great as is paid for

that used in paper manufacture. The finest baskets are made from the "white alfa." Rope, brooms, and other articles are also manufactured from the leaves of this grass.

DWARF PALM.

The leaves of the dwarf palm (*Chamærops hystrix*) are much used by the Arabs for thatching their huts, making crates in which fruit is packed, etc.; but the only product of this plant which enters largely into commerce is the fiber, which constitutes about 40 per cent of the weight of the fresh leaves. Under the name of "vegetable hair" this fiber is exported in considerable quantity. It is used for stuffing mattresses and upholstered furniture. A cheap grade of rope, selling for about 80 cents per 100 pounds, is also made from it. The dwarf palm, like alfa, is never cultivated, only the natural growth being exploited. While alfa is preeminently a plant of the high plateau the dwarf palm belongs to the coast region, where it formerly covered vast expanses. Although still abundant, this plant is rapidly disappearing as more and more land is brought into cultivation. Commercial exploitation has helped to accelerate its destruction, there being numerous factories in Algeria for separating the fiber.

○

FIG. 1.—SALT LAND, NEAR RELIZANE, IN THE COAST REGION OF ALGERIA.
This land, formerly cultivated, is now covered with a growth of salt-loving weeds.

FIG. 2.—VINEYARD OF WINE GRAPES IN THE MITIDJA PLAIN, NEAR ALGIERS.

FIG. 1.—GARDEN OF THE KAÏD AT TOUGOURT, SHOWING CABBAGE, PEPPERS, AND OTHER VEGETABLES GROWN IN THE SHADE OF THE PALMS.

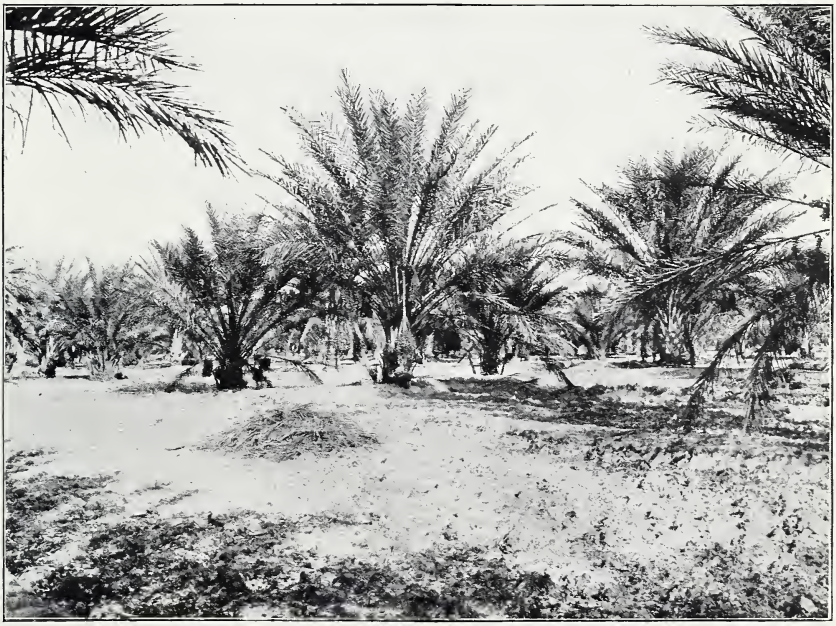


FIG. 2.—DATE PALMS PLANTED IN VERY SALTY LAND BY A FRENCH COMPANY AT OURLANA, IN THE SAHARA.

FIG. 1.—VALLEY OF THE HABRA BELOW THE RESERVOIR DAM, NEAR PERRÉGAUX, SHOWING WIDTH OF FLOOD PLAIN AND SMALL SIZE OF THE STREAM IN SUMMER.

FIG. 2.—ALKALI-RESISTANT ALFALFA, NEAR TEMACIN, ALGERIAN SAHARA.