Issued September 20, 1915.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL RECONNOISSANCE IN ALASKA, WITH AN ESTIMATE OF THE AGRICULTURAL POSSIBILITIES.

PART I. COOK INLET-SUSITNA REGION.
PART II. YUKON-TANANA REGION.
PART III. COPPER RIVER REGIONS.
PART IV. COMPARISON OF ALASKA WITH FINLAND AND PARTS OF SIBERIA.

BY

HUGH H. BENNETT AND THOMAS D. RICE.

[Advance Sheets—Field Operations of the Bureau of Soils, 1914.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1915.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., February 11, 1915.

SIR: In the spring of 1914 the Department of Agriculture received a request from the honorable the Secretary of the Interior that an expert of the Department of Agriculture be appointed to investigate and report upon the possibilities of agriculture in certain portions of Alaska. These regions were being considered as possible routes for the construction of a railroad, which the President was authorized by Congress to build.

In June, 1914, Messrs. Hugh H. Bennett and Thomas D. Rice, of the Bureau of Soils, proceeded at your direction to Alaska for the purpose of studying the climate, soils, crops, and other conditions bearing upon the possibilities of agricultural development in these several parts of the Territory. Three months were spent in the field making reconnoissance soil surveys and gathering other material for a report.

The results of these investigations are embodied in the accompanying manuscripts and maps, which I have the honor to recommend be published as advance sheets of Field Operations of the Bureau of Soils for 1914, as provided by law.

Very respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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SOIL RECONNOISSANCE IN ALASKA, WITH AN ESTIMATE OF THE AGRICULTURAL POSSIBILITIES.

By HUGH H. BENNETT and THOMAS D. RICE.

INTRODUCTION.

The existence of a vast mountainous area along the southern coast of Alaska, with numerous lofty, snow-covered peaks and huge glaciers, necessarily unfit for human habitation, is apt to give one unfamiliar with the complexities of the topography and climate of the Territory as a whole the impression that Alaska is a region of inhospitable mountains, glaciers, and snow, without farming possibilities. In a measure this is true, for there are in the Territory immense areas of rugged mountains, including the loftiest peaks upon the North American Continent, and great wastes of snow-clad and precipitous land, wide stretches of bleak tundra and mountain skirting the Arctic Ocean, innumerable bodies of water-soaked Muskeg, and many glaciers of almost incredible magnitude. Nevertheless there are millions of acres of relatively low, smooth land and gentle slopes in various parts of the country which are topographically and climatically suited to farming. That this is true is not a matter of conjecture, for many valuable food products both for man and animal are now being successfully grown. Farming in a region so far north may seem astonishing until one is acquainted with the equable summer climate, the long hours of summer daylight, and the good quality of the soil.

Those who are thinking of going to Alaska for the purpose of engaging in agricultural pursuits should give careful consideration to the conditions—the topography, climate, population, soil, crops, means of travel and transportation, markets, and tendencies of mining development. It would be unwise for the prospective agriculturist to rush into this country without some preliminary knowledge of the true conditions. The same is true of all new regions.

In the regions dealt with in this report it must be remembered that as yet strictly pioneer conditions obtain, that settlement is largely confined to communities in the vicinity of mining camps, that much of the country is inaccessible owing to the absence of roads and railroads, and that home markets are restricted to the present small population.

Every indication is that agricultural development must be gradual, must grow with the construction of highways and railways, with the development of mining industries and accompanying increase of population. If large numbers, without sufficient capital, should "stampede" to these lands with the idea of immediately establishing profitable farms for themselves, it is believed that there would be only disappointment for many. A careful study of the conditions before undertaking farming operations here is therefore urgently advised.

The purpose of this report is to present such available information regarding crops and those characteristics of surface configuration, climate, and soil, and conditions of transportation, markets, mining industries, and settlement as may have important influence upon the agricultural development of the region.[1]

The prospects of success for farming depend, so far as sale of surplus products is concerned, upon finding a local market among a population attracted by mining resources and fisheries. In other words, these regions of Alaska will probably not for some time export agricultural products, at least not on an important scale. Exportation of such products must await the building of a system of railways and highways and probably, also, the establishment of cheaper transportation.

A briefer report, with reconnoissance soil maps, outlining the apparent possibilities of farming in the several regions visited was submitted in January to the Interior Department for the use of the Alaska Engineering Commission in connection with their report to the President. This commission made preliminary railway-line surveys during the summer of 1914 through several regions, including the Susitna-Broad Pass-Nenana route to Fairbanks, the Copper River-Tanana route, and others. The President, after considering the respective merits of the several possible routes, decided to build a railroad along the Susitna-Broad Pass-Nenana route, the line to begin at Seward, on Resurrection Bay, and to follow the present line of the Alaska Northern Railroad to Cook Inlet, thence up the Susitna Valley, through Broad Pass, and down the Nenana River to the Tanana River. A branch line will tap the Matanuska coal fields, and other branch lines and extensions may be built.

The topographic and geologic maps of the U. S. Geological Survey greatly facilitated the field investigations and made possible the construction of reconnoissance soil maps covering much wider areas

[1] The act passed by the Sixty-third Congress at its second session, providing for the construction of a railroad or railroads in Alaska provides, among other things, that the President be empowered "to designate and cause to be located a route or routes for a line or lines of railroad in the Territory of Alaska * * *, to be so located as to connect one or more of the open Pacific Ocean harbors on the southern coast of Alaska with the navigable waters in the interior of Alaska, and with a coal field or fields so as best to aid the development of the agricultural and mineral or other resources of Alaska, and the settlement of the public lands therein * * *."

than could possibly have been covered without them. A timber map of Kenai Peninsula made by the Forest Service helped in making the reconnoissance soil map of that region. The Alaska Engineering Commission paid the expenses of the work and rendered valuable assistance in the prosecution of the field work, supplying boat transportation and camp supplies and granting the privilege of drawing upon the caches of the survey parties. The members of this commission are William C. Edes, Chairman, Lieut. Frederick Meares, and Thomas Riggs, jr. The valuable work accomplished by the several stations of the Alaska Agricultural Experiment Stations, under the direction of Prof. C. C. Georgeson, of this department, afforded much assistance in studying crop production.

The investigations of this reconnoissance were directed specifically toward those areas embracing the largest extent of farming land. It was not possible in the time available to visit a number of localities outside the areas discussed, in which there are agricultural lands and where some crops are now grown.

The field work was begun at Knik on the 26th of June. A few days were spent in studying the soils and agriculture on both sides of Knik Arm; then Rice, the writer, and a guide, with camp outfit and pack horse, made a trip up the Matanuska Valley to a point about 3 miles above Chickaloon. Returning to Moose Creek, a trail was followed from there to mile 22 on the Willow Creek wagon road, and from there the party crossed the Little Susitna River on the wagon road, ascended the high benches on the north side of the river, followed these several miles in a westerly direction, recrossed the Little Susitna, and returned to Knik by the wagon road.

On July 14 Rice, the writer, and two assistants from Knik, Stanton Shafer and W. A. Johnson, left Susitna Station on a stern-wheeler of the Alaska Engineering Commission, carrying an 18-foot rowboat and camping supplies for four weeks, ascending the Susitna River to a point about 3 miles below Indian Creek and 10 miles or more above the area including land of farming possibilities. Descending the river in the rowboat, camps were made at various points along the banks, from which trips were made across the bottoms, benches, and Muskeg on both sides of the river. Arriving at Susitna the evening of August 5, the party divided two days later, Rice going up the Yentna River with Shafer and Johnson and the writer across the trail to Knik.

Ascending the Yentna by power boat to a point about 15 miles above McDougall, near the confluence with the Skwentna River, Rice proceeded by foot as far as Nugget Creek, a tributary of Cache Creek, lying to the north of Peters Hills. He then returned to Ship Creek, the headquarters of the commission, and later pro-

ceeded to various points on Turnagain Arm and Kenai Peninsula by boat, and made such examinations of the soils of those sections as time permitted. It was not possible to see as much of Kenai Peninsula as was desired, but it is believed that a satisfactory reconnoissance soil map was made of that region through the investigations made, aided by a timber map of the Forest Service.

The writer sailed from Knik Anchorage for Cordova on the 16th of August, and on the 20th went over the Copper River and Northwestern Railroad to Chitina. The trip from Chitina to Fairbanks was made by automobile, opportunity being thus afforded to examine the soils in the Copper River Basin and along the bottoms of the Delta and Tanana Rivers. The soils and agriculture of the Fairbanks district were studied both in the bottoms and uplands by automobile and boat trips and on foot. With Fred Date and two pack horses, a trip was made from Fairbanks to Nenana by way of the Goldstream Creek Valley and Minto Flats, and from Nenana up the Nenana River to the benches above the "thirty-mile" road house. Returning to Nenana, a motor boat was secured on which the trip was made down the Tanana to Hot Springs, stops being made at Tolovana and other points. Spending about two days at Hot Springs, the writer took a river steamer to Fort Gibbon, and left that place September 16 on the trip up the Yukon River to Whitehorse. On this trip stops at Rampart, Eagle, Dawson (in Yukon Territory), and other places allowed time for taking samples of the more important soils seen along the river. Whitehorse was reached September 29, and on the same day the trip was made over the White Pass & Yukon Railroad to Skagway and an ocean steamer immediately taken there for Seattle.

On returning to Washington, the soil maps were assembled and the report written.[1]

[1] The report was written by Mr. Bennett, who had charge of the expedition.

PART I.—COOK INLET-SUSITNA REGION.

GEOGRAPHY.

The Cook Inlet-Susitna region, as referred to in this report, comprises the low country bordering Cook Inlet and its tributaries, northward from Kachemak Bay on the east side and from the vicinity of Tyonek on the west side of the inlet. The region thus considered is located between parallels 59° and 63° north latitude and meridians 148° and 152° west longitude. (See Pls. A and B.) That portion represented by the smooth low country—benches, stream bottoms, and lower, gentle slopes—having a topography and climate favorable to agriculture, represents the area with which this report is particularly concerned. The inclosing mountainous country is without important farming possibilities, and, therefore, will be given but little consideration.

Cook Inlet itself is a broad reentrant body of salt water, narrowing northeasterly toward its inland extremity, the head of Knik Arm, which, as a boat goes, is about 200 miles from the mouth of the inlet, on the Pacific Ocean, at the extreme southern end of Kenai Peninsula. The ocean end or mouth of the inlet is on the south Alaskan coast (commonly called southwestern Alaska), between the extreme end of Kenai Peninsula, on the east, and that great western projection, the Alaska Peninsula, at its point of mergence with the mainland mass, on the west. Taking the southern extremity of Kenai Peninsula as marking the point of entrance, the mouth of Cook Inlet is approximately 1,384 statute miles northwest from Seattle. The established steamship routes between these points, however, are somewhat circuitous, the ships passing through the winding channels and straits of the "inside passage" along a large part of the route. The sailing distance from Seattle to the head of navigation on Knik Arm, by Juan de Fuca Strait and outside, is 1,682 statute miles.[1] As measured on the fifty-ninth parallel the lower end of Kenai Peninsula is approximately 1,050 miles west of Seattle, being close to the meridian of the Hawaiian Islands.

Near its head the inlet has two large arms, Turnagain and Knik. The former swings around as a fiord into the Kenai Mountains, reaching almost across to an arm of Prince William Sound. The head of

[1] Table of Distances in Nautical and Statute Miles via the shortest navigable routes, Bureau of Navigation, Hydrographic Office, Navy Dept., No. 117 (1912).

Knik Arm is about 92 miles north from Seward, which town is located on Resurrection Bay. The Matanuska River enters this arm at its head. The Susitna River, the principal tributary, enters Cook Inlet opposite the mouth of Turnagain Arm. Kachemak Bay is an important arm near the entrance of the inlet. There are other indentations of the shore line, but they are of less importance.

PHYSIOGRAPHY.

Cook Inlet is bordered by steep slopes of the confining highlands, by low and high benches with abrupt escarpments, and by low bottom lands. The greater part of the shore line is fringed with bench lands which range in width from a mile or less to 35 or 40 miles. The bench escarpments at the shore range to considerably more than 100 feet in height, their average being probably between 50 and 100 feet.

The benches of the Susitna River and its tributaries are in reality a continuation of those fronting on the inlet. (See Pl. I.) Thus we have, contiguous to Cook Inlet, a great irregular plain, continuous but for the interruptions of connecting bodies of water, and essentially uniform in its principal topographic characteristics. This plain rises through successively higher benches, steplike, from a few feet above high tide to a maximum elevation averaging probably about 1,200 feet above sea level, where there is a mergence with the flanking mountain slopes. The greater part of the bench lands, including that of Kenai Peninsula, is probably about 25 to 200 feet above sea level. In some places benches evidently related to those covering the lower and greater part of the plain attain elevations of 2,200 feet.[1] These outer benches are narrower and stand higher above each other than those of the lower part of the plain. They likewise rise in steps, but are by no means uniformly flat across their tops; in fact, they are mostly moderately rolling to strongly rolling. A common characteristic of the benches of the Cook Inlet-Susitna plain, along stream courses, is their arrangement in V-shaped fashion, converging upstream, with their escarpment lines spreading out symmetrically from the apex downstream.

In a panoramic view from the surrounding mountains the lower country appears as a level plain, with mixed forest and treeless areas, dotted with lakes and flanked by steep slopes of mountains and high benches. (See Pl. II, figs. 1, 2, and 3.) Much of it is practically level, there being many places where at a distance of 10 miles or more from the water front it is impossible to find elevations sufficient to afford a view across the intervening wooded flats. On the other hand, there are many places, even along the water front, where the surface configuration is moderately rolling, hillocks, ridges, bench escarpments, lakes, and open, low flats of Muskeg occurring in intricate association.

[1] See Geology and Coal Fields of the Lower Matanuska Valley, Alaska, Bul. U. S. Geol. Survey No. 500 (1912).

There are large tracts of land throughout the Cook Inlet-Susitna plain which are admirably suited, topographically, to agriculture. On the other hand, there are broad stretches, including much low, marshy Muskeg, and isolated, inaccessible bodies of well-drained hillocks and ridges, over which agricultural operations are virtually impossible and certainly impractical. Especially is this true in the broad belt between the Susitna and Kahiltna Rivers; between Knik and the Susitna River; along the Yentna; between Willow Creek and Montana Creek (tributaries of the Susitna) and over the interior portion of the Kenai Peninsula benches. The lands of most promising agricultural possibilities are found most extensively immediately along Cook Inlet, its arms and tributaries, and along the margins of the plain.

The Cook Inlet-Susitna plain is confined on the east by the Kenai, Chugach, and Talkeetna Mountains, and on the west and north by the Alaska Range and the Chigmit Mountains of the Aleutian Range. Along the lower part of the inlet steep slopes of the highlands come to the edge of the water, in places without intervening benches. Numerous conspicuous peaks of the surrounding mountains can be seen from any part of the lowland country where the timber growth does not shut off the view. Mount McKinley, the highest peak on the North American Continent (20,300 feet), can be seen on clear days, it is said, from a point on Cook Inlet near Kenai, at a distance of approximately 200 miles. It is very conspicuous on clear days from the mouth of the Susitna River at a distance of about 130 miles.

From Kachemak Bay to Turnagain Arm, on the Kenai Peninsula side, the inlet is bordered by comparatively level bench lands which extend back from high or low escarpments along the shore to the foot of the Kenai Mountains, in places 35 to 40 miles in width. Turnagain Arm is nearly inclosed by steep slopes, the cultivable lands being confined to low, narrow benches and the flats about the mouths of streams entering the arm. Knik Arm, on the other hand, is surrounded by bench lands with steep, high escarpments along most of its shore line. (See Pl. III, fig. 1.) On its east side the benches are comparatively narrow, about 6 or 7 miles across in the wider places, but on the west they are very broad, extending across to and merging with the benches of the Susitna River. There are benches on the west side of the inlet below the mouth of the Susitna River, but here the width is not so great as on the opposite side. Rather prominent benches extend up the Matanuska Valley, nearly to the point where the river issues from a box canyon. The Susitna River benches reach to a considerable distance above Talkeetna (at the forks of the Chulitna, Susitna, and Talkeetna Rivers) or about 85 to 90 miles above the mouth of the Susitna. They

continue even farther up the Chulitna. Benches also follow up the Yentna River for a distance of 50 miles above its confluence with the Susitna, and have an important occurrence along the tributaries of the Yentna—the Skwentna and Kahiltna Rivers and Clear Creek.

Numerous rivers and streams have cut channels through the Cook Inlet-Susitna plain. Near the foothills the streams flow through prevailingly deep gorges, but as they approach the large bodies of water their banks become lower and their flood plains wider. As a rule the flood plains of the streams of this country are narrow.

DRAINAGE CONDITIONS.

That portion of the Cook Inlet-Susitna plain which is subject to inundation by stream overflow comprises an inconsiderable area when compared with the large extent of land which is removed from any possibility of overflow. These flood-plain lands occur in the lowest bottoms as comparatively narrow strips immediately fringing the stream banks. A glance at the accompanying reconnoissance soil map gives, under the name of Susitna soils, an idea of the relatively small area comprised in the stream bottoms, although this general map does not show all of the small strips of bottom land. The most important areas of the stream bottoms are found along the Susitna and Yentna Rivers and their tributaries. The delta of the Susitna is the most extensive body mapped.

In time of high water, resulting from heavy summer rains and the rapid melting of snow and ice in the surrounding mountains during periods of hot weather, together with some damming of water by ice jams during the spring break-ups, overflows spread out over the bottoms to varying depths, depositing silt and very fine sand, and generally receding within a day or two. Owing to the sandy and gravelly nature of the soils, the bottom lands drain out quickly with the recession of overflows, at least to such an extent that water does not stand long over the surface, except in depressions. It is only along the large streams, having their sources far back in the snow-covered ranges, and those having tributaries leading out from glaciers, that important overflows occur. Most of the smaller streams rising in the lower slopes of the mountains and in the bench lands carry considerable water, especially in the spring and early summer, but their banks are rarely overflowed.

As a rule the stream bottoms of this region are much better drained than the average bottom lands of streams in the humid portions of the United States. These lands, however, largely remain quite moist through summer, and the lowest depressions are mostly permanently soggy or covered with water. There are included strips of deep sand and soils underlain at shallow depths by gravel which have excessive drainage. On these, crops suffer from lack of moisture in dry seasons.

HIGH BANKS OF THE SUSITNA RIVER AT SUSITNA STATION.

This river is bordered by high banks (Knik soils) for much of the distance between Susitna Station and the upper limits of the lower benches above Talkeetna. Elsewhere the areas contiguous to the river consist of low Susitna soils partly subject to overflow.

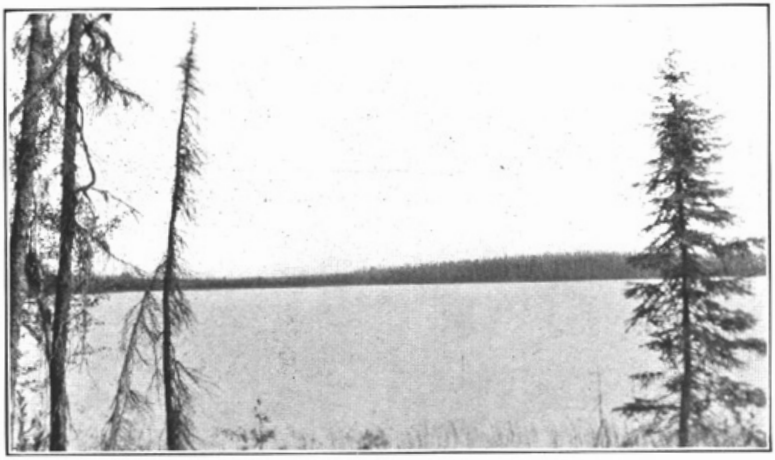


FIG. 1.—CHARACTERISTIC TOPOGRAPHY OF THE LOW BENCHES OF THE SUSITNA VALLEY IN BACKGROUND ACROSS LAKE.

FIG. 2.—LAKE 2 MILES EAST OF MOUNT YENLO.
Such lakes are very abundant through the Susitna Valley.

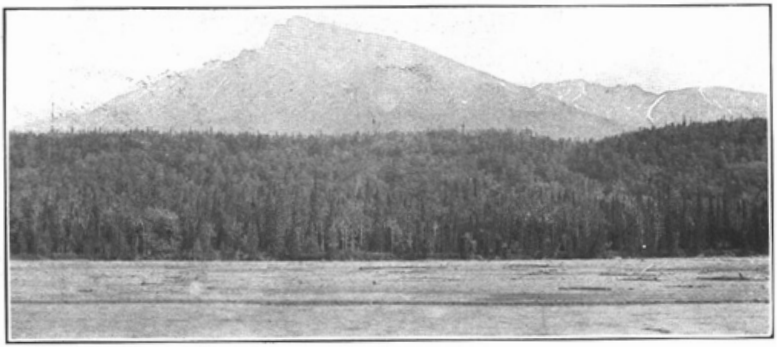


FIG. 3.—BENCHES ON SOUTH SIDE OF MATANUSKA RIVER, ABOVE HEAD OF KNIK ARM.
Note comparatively level surface of the Cook Inlet-Susitna plain, the wooded area in the middleground.

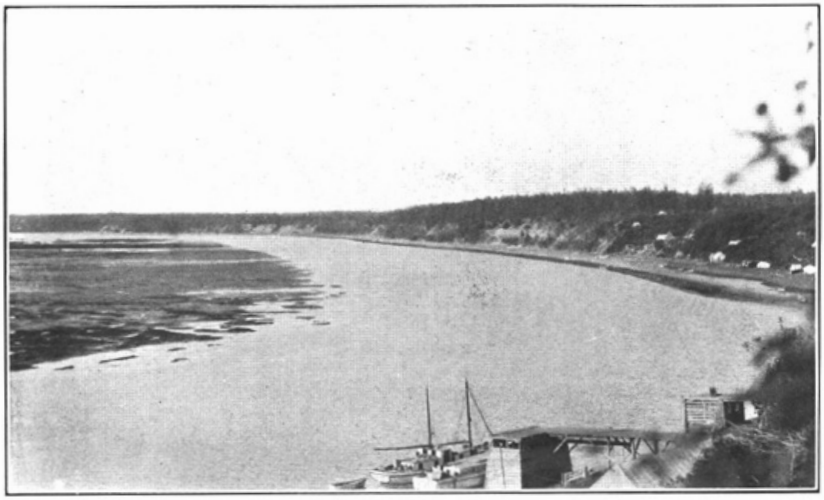


FIG. 1.—HIGH BENCHES BORDERING KNIK ARM.

The village of Knik is at the extreme right. To the left are seen the mud flats partially exposed just before low tide stage is reached. At high tide there is 15 or 20 feet of water at the Knik docks; at low tide there is no water.

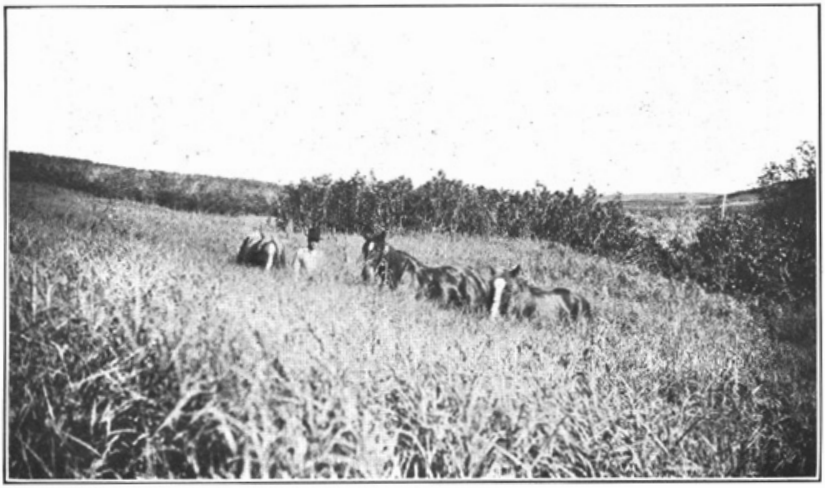


FIG. 2.—"REDTOP" ON SLOPES OF COTTONWOOD CREEK, A TRIBUTARY OF PETERS CREEK, AT AN APPROXIMATE ELEVATION OF 2,000 FEET.

This grass is plentiful in many places above timber line.

A TYPICAL ASPEN GROVE, LOWER MATANUSKA VALLEY.

Aspen is one of the characteristic trees on shallow soils having gravel or sand near the surface. Forests of this tree are common on the better drained lands of the Cook Inlet-Susitna region.

On the other hand, numerous swales and depressions will require ditching for the establishment of drainage conditions favorable to agricultural use of the land, except for pasturage and hay production. Probably 75 per cent of the bottoms is sufficiently well drained to admit of cultivation without ditching.

Throughout the main body of the plain, the nonalluvial portion, there are large bodies of both extremely poorly drained land and of well-drained land, and also less important areas possessing intermediate drainage and still others having excessive drainage. These varying conditions of moisture are determined very largely by position and character of soil material. It is true that some land remains quite moist on account of an underlying stratum of ice, but the total area where such conditions exist is of comparatively small extent in any one locality. The land that does have ice near the surface in late summer is not all especially moist in the overlying material, such as, for example, the moss-covered benches in places along Montana Creek.

The good agricultural lands—the benches, hillocks, and ridges—are largely occupied by the Knik soils (see description in the following chapters), which mostly have well-established drainage, even in localities removed from streams. All of these lands are gravelly in the substratum, and, on that account, possess internal or downward drainage as nearly perfect as is possible, except where the subsoil is frozen. No ditching is necessary here, except to give an outlet to the lower depressions. On the contrary, the problem is to conserve moisture rather than to provide means of removing an excess of it. The deeper loams, such as the typical Knik loam, hold sufficient moisture, especially with proper soil management, to meet the requirements of all crops in ordinary seasons. There are, however, occurrences of shallow soil overlying gravel beds which dry out so rapidly, under cultivation, that crops are injured by much shorter periods of drought than on the deep loams.

It is estimated that more than 75 per cent of the more valuable farming land of this region is well drained and capable of conserving ample moisture for crop needs.

On the other hand, about one-third of the area of the Cook Inlet-Susitna plain, including the Susitna and Yentna Valleys, is represented by low, treeless flats of Muskeg ("tundra," see p. 62), consisting of peat bogs which in the summer are either saturated from the surface downward or are covered with water. Portions of this type of land appear to represent a kind of floating bog; that is, accumulations of peat masses over water. At any rate, there is so much water in the peat or beneath it that one's weight causes the surface to quake for a distance of 50 feet or more, and if one steps

suddenly and heavily the supporting mass is likely to give way. Some streams have their sources in these Muskeg flats, but many of the areas are surrounded by higher land which completely cuts off drainage, and in other cases previously existing outlets have been choked with accumulations of peat resulting from encroachment of water-loving vegetation.

The Muskeg, besides being valueless for any important agricultural purpose, practically shuts off from access included islandlike bodies of well-drained, good soil. The construction of roads necessary to reach the inclosed areas would entail more expense than their size would warrant, at least until the more accessible well-drained lands have been occupied.

The Muskeg and included lakes, together with the inclosed, isolated well-drained land, comprise an area estimated at about one-half of the total extent of the lower benches. For the present all of this can be counted as having little value, aside from the pasturage that would be afforded in case of the development of an important stock industry and the hay which could be harvested in a small way by the use of scythe or sickle. Nothing else of important agricultural value could be accomplished upon the Muskeg without improvement of the drainage by extensive canaling and ditching; and, until the large area of valuable well-drained land is occupied, there is no reason for undertaking extensive and difficult drainage operations to reclaim land which, on account of its peaty character, probably can never be of great value. Some small areas of Muskeg were seen where a single ditch about 16 inches deep at the head, passing approximately through the center, had effected fairly good drainage, and on these marsh grass was being cut with the scythe. Grass is also cut, locally, from these meadows without preliminary drainage.

These peat bogs thaw out quickly in the summer; no ice was found in them by the latter part of July within 40 inches of the surface, except around the edges, where the moss stood a little above the general level. The absence of ice and the porous character of the peaty material would make possible a rapid removal of the water upon the construction of adequate outlets.

There are many tracts of land, some of considerable size, where the drainage conditions are intermediate between those of the marshy Muskeg and the well-drained Knik soils. These bodies occur as low-lying land, along gentle slopes, and over undulating and flat country, frequently adjacent to Muskeg. Where there is thick moss ice is not infrequently found within 40 inches or less of the surface, but elsewhere its presence that near the surface is very exceptional. Much of this kind of soil is mucky and soggy, but the subsoil is of a gravelly character, making possible easy drainage. In most cases the drainage can be greatly improved or adequately established for all agricultural

purposes simply by burning over the land in dry seasons. Ditching, however, will be necessary before ample drainage can be everywhere established. The subsoil ice will sink rapidly as soon as the moss is removed.

Ice is common within 3 feet or less of the surface between Montana and Willow Creeks. It was found in abundance within about a foot of the surface along the banks of the Susitna River, near the mouth of Willow Creek, in August. The ice here and in many other areas of mossy lands seen in the valley unquestionably is of a permanent character, and probably its level never sinks to more than 3 feet below the surface. Ice was found during early July within less than 3 feet of the surface in a mossy area near Knik Arm in the vicinity of Knik, but in August it could not be reached with a 40-inch auger in the same place. Ice was not found in the subsoil of land not covered with thick moss, except in very rare instances on northerly slopes.

There are some wet slopes and shelf situations which could be drained by hillside ditching or, in some places, even by removal of the vegetation. Such wet land is confined principally to northerly slopes. The high benches reaching up the slopes of the confining uplands are very largely well drained, and mostly are occupied by soils which conserve a good supply of moisture.

To sum up, the Cook Inlet-Susitna region includes extensive areas of both well-drained land and land of extremely poor drainage. The former represents the good farming land, while the latter, in its natural condition, is worthless, except for grazing. Agricultural operations of the immediate future, will not be concerned to any considerable degree with the problem of drainage.

VEGETATION.

Most of the conspicuous plants seen in the Yukon-Tanana portion of interior Alaska were also seen in the Cook Inlet-Susitna region, and in addition several others of common occurrence were found, such as devil's club, a variety of blueberry locally known as huckleberry, and a shrub of the heath family called "buckbrush" (*Menziesia ferruginea* Smith).[1] On the other hand, several common plants of the interior were not noticed in the Cook Inlet country, as, for example, the very common sedge of the "niggerhead flats" and the locally abundant "wild peas" (*Astragalus williamsii* Rybd., and *Hedysarum mackenzii* Richards). There is also some difference between the two areas in the distribution of vegetation. Alder, for example, instead of being most abundant on slopes above timber

[1] This and most of the other plants, the botanical names of which are given in this report, were identified from specimens collected by the writer by Mr. F. V. Coville, Botanist in Charge, Economic and Systematic Botany, Bureau of Plant Industry.

line, as is true in the Cook Inlet-Susitna region, in the Alaskan interior is most plentiful along stream banks and over the stream bottoms, being very scarce and scrubby on the slopes of the highlands. Flowers also appear to be very scarce over the higher elevations of the interior, while in the Cook Inlet-Susitna region many different flowers are found in abundance up to the line of summer snow. In the main, however, the vegetation of these two widely separated regions is strikingly similar.

The lower levels of the Cook Inlet plain are either forested or covered with low muskeg vegetation; the higher benches are mostly heavily timbered, with occasional glades covered with native redtop, while the mountain slopes are occupied by a fairly dense growth of trees up to elevations of approximately 1,200 to 1,800 feet. Above this timber line there are dense thickets of alder, interspersed with occasional grass-covered openings (see Pl. III, fig. 2) and peat bogs; and, finally, above the alder zone the surface is mostly bare of vegetation, except for moss, lichens, and flowers. Snow covers the higher peaks throughout the summer, and scattered patches linger in shaded situations almost down to the upper limits of the alder thickets.

The character of the soil and drainage has much to do with the kind and size of plant growth here; also, there are noticeable variations in kind and size of plants from place to place without accompanying soil variation of importance.

Spruce is the most abundant tree in this region. (See Pl. V, fig. 1.) It is found in all parts, ranging in size from mere scrubs less than an inch in diameter (even in case of old trees) on moss-covered peaty lands to tall trees 24 inches in diameter on the deep loams and alluvial soils. Between these extremes there are many variations in the size of this tree. On the shallow loam and very fine sandy loam the trees rarely exceed 10 inches in diameter. Where moss is thick and ice commonly present within the 3-foot soil section, dense thickets of small spruce are common. Here the trees may be fairly tall, but most of them are less than 6 inches across the stump. The largest spruce trees were seen in the Susitna Valley on the deep loams and alluvial soils, along the shores of Turnagain Arm and over portions of Kenai Peninsula. On the bench lands on the east side of Knik Arm, which country is included in the Chugach National Forest, even the best drained loam soils are occupied by spruce trees which, as a rule, are no larger than mere poles, such as can be thrown down with the hand after the surface has been burned over. The small scrubby trees are black spruce (*Picea mariana*), the large ones white spruce (*Picea canadensis*).

Birch is second to spruce in point of abundance. The tree is closely associated in occurrence with spruce, much more so than is the

aspen. It is found throughout the entire region. Like spruce, it is largest on the well-drained deep loams and in the alluvial bottoms. The trees frequently attain a diameter of 20 inches in the Susitna Valley, and range up to 16 or 18 inches in diameter over the rolling soils of the Matanuska and Knik sections. On shallow soils the trees are generally small. Scrubby varieties are common in the grassy glades of the higher slopes, while a dwarf variety is abundant on Muskeg.

Aspen ("poplar" or "quaking asp") is locally abundant, particularly on the shallow, well-drained soils having gravel or sand near the surface. (See Pl. IV.) The tree, however, is not confined to the thin soils; in fact, the largest specimens were seen on deep loams, growing in dense forests practically to the exclusion of other trees. These forests of tall, straight-bodied trees, with grayish to greenish-yellow bark, are very beautiful.

Cottonwood is almost entirely confined to the alluvial lowlands. The trees attain a diameter of between 2 and 3 feet, and grow relatively tall. This is one of the most conspicuous trees on the innumerable islands and over the low bottoms of the Susitna River.

Willow of several varieties grows in abundance upon the river bars and islands, along the edge of stream banks, and through stream bottoms, often in almost impenetrable thickets. Also, it flourishes in clumps and thickets over occasional wet flats at considerable distances from streams. Scrub varieties are plentiful on the higher slopes, being found scatteringly even above the zone of alder thickets.

Alder is another plant which grows abundantly on the river islands and stream bottoms. It is the most common plant fringing the immediate banks of streams and shores of islands. Here it attains its largest development. The thickets of alder which are almost universally encountered just above timber line are frequently a mile or more in width. In these places many of the alders grow in sprawling fashion, having been borne down apparently by snow. It is extremely difficult to penetrate these thickets; in fact, progress through them consists principally of crawling, climbing, and falling. It is noticeable that alder does not prefer those situations where moss is abundant.

The common undergrowth of the forested areas consists of moss, "Indian paint berry" (*Cornus canadensis* L.), ferns, "high-bush cranberry" (*Viburnum pauciflorum* Pylaie), "low-bush cranberry" (*Vaccinium vitisidaea*), club moss (*Lycopodium annatinum* L.), Hudson Bay tea (*Ledum decumbens* (Ait.) Lodd and *L. groenlandicum* Oeder), "buckbrush" (*Menziesia ferruginea* Smith), and "joint grass" (*Equisetum sylvaticum* L. and *E. palustre* L.), together with wild rose, blueberry, huckleberry (a variety of blueberry), and currants. The

habitat of some of these varies with the soil and moisture condition, as, for example, the wild rose and huckleberry are present on the better-drained soils, where ice is not reached within 3 feet of the surface during late summer. Others, such as "Indian paint berry" and "joint grass," are found under almost all conditions of drainage and soil. Devil's club and another large-leafed plant somewhat resembling devil's club, although thornless, are locally abundant in moist situations, both in the openings and through the timber. Devil's club was found in abundance locally over the loam soil of the Susitna River valley, and also in the alder thickets above timber line, at least 20 miles above Talkeetna. Under the descriptions of the various soils of the region the distribution of these plants is treated more specifically.

In the less shaded situations and openings native redtop (several varieties of *Calamagrostis*) is the most abundant vegetation, occurring in rank, dense meadows, often 5 to 6 feet high. (See Pl. V, fig. 2.) Other plants, such as bluebell, fireweed, lupin (*Lupinus nootkatensis unalaschensis* S. Wats) and "wild pea" are of common occurrence in such places. Flags, violets, asterlike flowers, and several other flowers grow in profusion along with Hudson Bay tea, moss, and lichens on the highland slopes. Here moss is abundant in tussocks, which give the surface a peculiar hummocky character.

The most common vegetation of the Muskeg is sphagnum moss, dwarf birch, blueberry, *Empetrum nigrum* L., "squawberry" (*Rubus chamaemorus* L.), *Myrica gale* L., *Spiraea steveni* (Schneid.) Rybd., Hudson Bay tea, and "slough grass." Various other shrubs and flowering plants are also common.

Along Turnagain Arm spruce and hemlock of large size make their appearance. It is said that both of these trees attain diameters of 4 feet or more in places, as along lower Glacier Creek.

The vegetation of Kenai Peninsula is controlled by the physiographic features and the climate. Within the Kenai Mountains are forested areas and barren uplands. The better growth of trees is restricted to the bottoms and lower slopes, timber line being at a general altitude of about 2,000 feet. Spruce grows in suitable places throughout the mountain valleys, but attains size and numbers sufficient to make fair timberland only in some of the valleys on the Pacific coast and on Turnagain Arm, where many trees are 3 or 4 feet in diameter.[1]

The localities including the occurrence of these larger trees apparently represent a zone in which the typical Cook Inlet-Susitna vegetation begins to merge with the typical outer coastal vegetation.

The flora of the Cook Inlet region is quite different from that of the coast farther south, although many species are common to both regions. The difference is largely in the reduction of the number of coniferous trees in the Cook Inlet region and the

[1] Martin, G. C., Johnson, B. L., and Grant, W. S., Geology and Mineral Resources of Kenai Peninsula, Alaska: Bul. U. S. Geol. Survey No. 587, p. 27.

corresponding increase in deciduous trees; but other features somewhat transitional between the heavy saturated forest of the southern coast and the treeless tundra of the north are numerous. The flora of the mountainous district about Turnagain Arm is, of course, different from that of the coastal plains of other parts of the Inlet.

The low country near Hope consists of a grassy tide flat, about 50 acres in extent, and a few miles of forest and occasional small swamps along the lower part of Resurrection Creek. Balsam poplars, paper birches, alders, and willows abound near the streams, and spruces (*Picea canadensis* and *Picea sitchensis*) and hemlocks (*Tsuga mertensiana*) are common on the slopes and slightly elevated flats. A third species of spruce (*Picea mariana*) is found in the small peat bogs, where smaller Hudsonian plants, such as Labrador tea (*Ledum*), crowberry (*Empetrum*), and dwarf birch (*Betula glandulosa*) are in profusion. The hemlock is much the most abundant of the large trees, but it is exceeded in individual size by the spruces. The conifers ascend the mountain slopes to about 2,000 feet, but above that point rapidly disappear. Beyond this elevation are alder thickets, small patches of dwarf willows and birches, and vast stretches of waving grass from 1 to 3 feet high. Still higher, the slopes and rounded backs of the ridges are cushioned with a mass of heather and heatherlike shrubs, chiefly *Empetrum nigrum*. This extends up to an approximate altitude of 5,000 feet, above which there is very little or no plant growth. The whole country is characterized by the abundance of high grass; otherwise it is a typical Hudsonian-Alpine region.[1]

The Cook Inlet-Susitna region locally includes an abundance of good spruce timber, valuable for building purposes (see Pl. VI), crossties, and mine timbers. It is sawed into lumber by steam and whip saws at various points. There is also much birch which is suitable for lumber. Some cottonwood is sawed for use in house interiors.

Large tracts were seen where forest fires had destroyed tremendous quantities of valuable timber. Every year these fires contribute toward the destruction of the forests. They are started sometimes accidentally and at other times purposely, both with and without the object of serving an important purpose. Considerable timber is destroyed by homesteaders who burn over the land in the process of clearing. The trees are so shallow rooted that a fire started in a dry season will frequently cause the largest forest trees to fall, particularly in those places where there is only a thin soil over the gravelly stratum and where moss is abundant. The shallow roots are thus burned, and the tree, losing its ground support, falls.

CLIMATE.

The latitude of the Cook Inlet-Susitna region gives it long winters, short summers, and great variation in the length of the day between winter and summer. About the summer solstice the sun is below the horizon for only a few hours, and during this time there is no real darkness. The climate is influenced by two principal factors: The

[1] Osgood, Wilford H., Natural History of the Cook Inlet Region, Alaska: North American Fauna, Bureau of Biological Survey, U. S. Dept. of Agriculture, No. 21, p. 53.

relatively warm waters of the Pacific on the south and the great barriers of the Alaska Range on the west and north, and of the Kenai, Chugach, and Talkeetna Mountains on the east.

The region owes its moderately warm and comparatively even temperature to the current of warm water, known as the Japan Current, flowing around the southern shore of Alaska. The moisture-laden winds from these waters sweeping against the cold mountain barriers precipitate their moisture over the entire region. The effectiveness of these mountains as barriers to the passage of moisture is indicated by the veil of fog and cloud that hangs so frequently over the southern slopes of the peaks in contrast with the much more prevailingly clear atmosphere and cloudless skies of the northern slopes. The modifying influence of the surface features and of the warm coastal waters gives the region a climate of temperate summers, moderately cold winters, and heavy to moderate rainfall—a climate lacking the extremes of cold and the light precipitation that characterize the great interior valleys of the Yukon River and its tributaries. The mountain ranges also protect the region from the fierce blizzards of the Arctic regions. It is safe here to undertake long journeys at any time, a condition that does not prevail on open continental plains much farther south.

Besides these agencies operative over large areas there are a number of local features that modify the climate in different localities, such as elevation, the partial obstruction of sunlight by intervening mountains, and the proximity of local bodies of water, glaciers, and passes or fiords carrying cool winds. These features control the movements of air currents and especially influence the occurrence of early and late frosts. A slight change from the prevailing climatic condition from these causes will render farming in such localities precarious. Therefore all modifying influences should be carefully taken into consideration by the settler, even if the latitude and elevation would indicate a climate more favorable than that of other successful farming communities. Differences due to local influences can be noted in the climate around different parts of Cook Inlet. The temperature prevailing along Knik Arm is more equable than that about Turnagain Arm. It is reported that the northern shore of Knik Arm is more favored than the southern shore, and the occurrence of frost observed during the past season (summer of 1914) seems to substantiate this claim. There was a frost in August along Ship Creek which, about 5 miles back from the shore, killed some tender forms of vegetation, while there was no frost on the northern side of the arm thoroughout the summer.

The precipitation becomes progressively lighter from the coast toward the interior.

There are years of abnormal seasons here just as in other parts of the world. Damp cloudy weather, for example, prevailed over the region during most of the summer of 1912. The spring of 1914 was about two weeks late, delaying the planting of crops generally.

All of the systematic information concerning the climate of the southern part of Alaska is comprised in the notes of several scientific expeditions, and in the records kept at a few stations by voluntary observers under the direction of the Weather Bureau. The data of the expeditions consist of records kept by constantly moving observers during the summer months, and have little value except as an indication of the possible climatic conditions. As a rule, parties penetrating this region have been favored by a large proportion of fair days during the months of June and July, but they have encountered much rain and cool weather in late August and September.

Of the permanent station records, or those of the Weather Bureau, those of Tyonek, Kenai, and Sunrise are probably most representative for the region as a whole. The Tyonek data, collected during a period of 9 years, probably are most indicative of the climate prevailing along the north shore of Cook Inlet and over the southern part of the extensive lowlands of the Susitna Valley. At Sunrise, although observations have been carefully taken during a long period, the climate is so modified by local conditions that the results of the observations are not applicable to any considerable territory. The data collected at Seward, which are also given below, are not representative of the climate of any large areas of farming land in the Cook Inlet-Susitna country, but serve as a check upon the other stations, give the climatic characteristics of the coastal region near the entrance of Cook Inlet, and show the modifying influence of the warm waters of the Pacific Ocean. The Sitka records for precipitation, temperature, and frost show in a still more striking manner how the climate of the coast country is tempered by the ocean currents. The records for Sitka and those for Fort Liscum are given to show the much more rainy and warmer climate of the southern Alaska coast. The records for Chickaloon are meager. The climate here would naturally not be considered as representative of the lower Cook Inlet-Susitna plain, owing to the greater elevation (about 1,000 feet above sea level) and to the location of the station in a pass where cool winds frequently sweep down from the mountains.

The tables following, compiled from the records of the Weather Bureau, show the mean monthly and annual temperatures, the absolute maximum and minimum temperatures, and the monthly and annual precipitation:

Normal monthly, seasonal, and annual temperature and precipitation at Tyonek.

[Length of record, 9 years.]

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Mean snowfall, unmelted.[1]
	° *F.*	° *F.*	° *F.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	18.5	49	−21	1.21	1.54	1.72	13.2
January	11.5	38	−27	1.68	2.69	3.08	16.9
February	18.6	49	−25	0.98	0.52	0.52	12.6
Winter	16.2			3.87	4.75	5.32	42.7
March	25.3	58	− 9	0.91	0.47	1.09	13.2
April	35.2	59	− 1	0.99	0.60	0.71	10.4
May	45.2	74	22	0.46	0.29	0.38	0.7
Spring	35.2			2.36	1.36	2.18	24.3
June	53.4	91	33	1.05	0.72	0.00	0.0
July	57.0	82	38	2.66	1.05	2.93	0.0
August	58.3	76	31	4.41	4.94	5.40	0.0
Summer	56.2			8.12	6.71	8.33	0.0
September	48.9	79	22	3.82	4.22	6.56	0.0
October	36.2	61	5	3.37	2.53	4.96	5.2
November	25.2	47	−13	1.27	0.60	0.94	9.9
Fall	36.8			8.46	7.35	12.46	15.1
Year	36.1	91	−27	22.81	20.17	28.29	82.1

[1] Included in mean precipitation.

Normal monthly, seasonal, and annual temperature and precipitation at Sunrise.

[Length of record, 8 years.]

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Mean snowfall, unmelted.
	° *F.*	° *F.*	° *F.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	17.7	48	−26	4.85	3.36	8.48	24.8
January	9.1	44	−29	2.50	0.54	2.12	26.5
February	17.0	51	−27	2.55	1.05	1.93	16.3
Winter	14.6			9.90	4.95	12.53	67.6
March	23.7	58	−23	2.05	2.71	1.64	20.0
April	32.7	57	− 4	2.68	0.68	3.41	9.4
May	43.1	76	24	1.58	2.27	0.84	Trace.
Spring	33.3			6.31	5.66	5.89	29.4
June	49.6	79	27	1.22	1.96	0.69	0.0
July	53.5	76	34	2.05	1.79	1.40	0.0
August	52.3	78	31	3.07	3.06	4.46	0.0
Summer	51.8			6.34	6.61	6.55	0.0
September	44.4	72	17	3.03	2.64	1.86	1.2
October	34.5	59	2	4.86	2.56	4.36	5.6
November	22.3	51	−15	4.14	0.40	9.47	15.2
Fall	33.7			12.03	5.60	15.69	22.0
Year	33.3	79	−29	34.58	22.82	40.66	119.0

Normal monthly, seasonal, and annual temperature and precipitation at Kenai.

[Length of record, 9 years.]

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Mean snowfall, unmelted.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December	12.7	45	−43	1.02	0.19	1.41	10.1
January	10.3	49	−42	0.65	0.64	0.29	7.3
February	18.3	48	−46	1.01	0.07	4.92	10.0
Winter	13.8			2.68	0.90	6.62	27.4
March	24.2	59	−34	0.83	0.32	0.57	7.0
April	33.9	68	−17	0.65	0.85	0.46	3.3
May	43.7	79	20	0.85	0.30	0.84	Trace.
Spring	33.9			2.33	1.47	1.87	10.3
June	49.6	87	28	0.92	0.06	0.84	0.0
July	53.6	82	27	2.16	1.66	1.06	0.0
August	53.9	78	25	3.39	4.85	6.26	0.0
Summer	52.4			6.47	6.57	8.16	0.0
September	46.0	75	11	3.06	2.23	0.78	0.0
October	32.4	60	− 5	2.29	1.69	2.92	4.5
November	21.1	46	−27	2.12	0.64	2.16	9.4
Fall	33.2			7.47	4.56	5.86	13.9
Year	33.3	87	−46	18.95	13.50	22.51	51.6

Normal monthly, seasonal, and annual temperature and precipitation at Seward.

[Length of record, 4 years.]

Month.	Temperature.			Precipitation.	
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Mean snowfall, unmelted.
	°F.	°F.	°F.	Inches.	Inches.
December	26.2	45	− 5	10.03	15.3
January	18.6	43	− 8	1.76	17.3
February	25.5	44	−12	5.27	15.8
Winter	23.4			17.06	48.4
March	29.8	49	− 7	2.72	12.7
April	35.5	56	10	2.92	0.8
May	43.0	75	26	2.55	0.0
Spring	36.1			8.19	13.5
June	48.2	84	32	2.40	0.0
July	54.1	83	40	2.00	0.0
August	55.5	85	36	3.76	0.0
Summer	52.6			8.16	0.0
September	48.6	84	27	4.59	0.0
October	38.4	55	11	8.42	0.5
November	30.4	49	9	6.97	2.2
Fall	39.1			19.98	2.7
Year	37.8	85	−12	53.39	64.6

Normal monthly, seasonal, and annual temperature and precipitation at Fort Liscum.

[Length of record, 11 years.]

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Mean snowfall, unmelted.
	° *F.*	° *F.*	° *F.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	23.5	43	−13	8.10	6.22	7.13	72.1
January	20.4	45	−14	7.65	1.98	1.75	83.4
February	20.5	45	−12	5.02	5.11	10.14	53.5
Winter	21.5			20.77	13.31	19.02	209.0
March	25.6	54	− 8	5.74	4.27	6.04	67.1
April	32.8	53	2	3.92	5.08	0.82	33.3
May	42.1	71	25	3.52	3.15	4.05	0.7
Spring	33.5			13.18	12.50	10.91	101.1
June	49.7	79	30	2.74	2.99	2.83	0.0
July	51.7	82	32	5.13	5.60	11.25	0.0
August	50.0	80	30	8.14	2.59	10.61	0.0
Summer	50.5			16.01	11.18	24.69	0.0
September	44.6	84	17	8.82	5.71	11.98	1.6
October	35.7	57	10	9.47	8.01	16.77	11.4
November	25.6	47	0	5.69	2.21	7.94	41.6
Fall	35.3			23.98	15.93	36.69	54.6
Year	35.2	84	−14	73.94	52.92	91.31	364.7

Normal monthly, seasonal, and annual temperature and precipitation at Sitka.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Least monthly precipitation.	Greatest monthly precipitation.
	°*F.*	°*F.*	°*F.*	*Inches.*	*Inches.*	*Inches.*
December	36	59	5	8.77	1.71	20.21
January	32	56	− 4	7.70	1.45	15.97
February	34	58	− 3	6.58	1.29	18.84
Winter	34			23.05		
March	36	65	− 1	5.74	.47	16.00
April	41	70	15	5.62	1.37	12.14
May	47	80	28	4.14	1.31	10.35
Spring	41			15.50		
June	51	84	30	3.46	.75	9.80
July	55	87	34	4.30	.45	10.89
August	55	83	30	6.93	1.50	20.96
Summer	53			14.69		
September	52	80	28	10.17	2.43	25.52
October	46	70	22	11.64	5.04	24.82
November	38	60	1	9.25	.45	20.51
Fall	45			31.06		
Annual	44	87	− 4	84.30	.45	25.52

Summary of meteorological observations at Chickaloon, Alaska, for parts of 1907 and 1908.

Month.	Temperature (°F.).						Days with precipitation.	Total snowfall (inches).	Clear days.
	6 a. m.			Noon.					
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.			
1907.									
October 25–31	36	10	27	42	17	32	3 (snow)	9.75	1
November	34	− 3	15	40	3	15	4 (snow and rain).	13.75	12
December	36	−30	8	32	−28	10	3 (snow)	9.50	18
1908.									
January	29	−26	8	30	−15	15	8 (snow)	23.75	12
February	32	−21	10	46	− 6	36	5 (snow and rain).	8.75	14
March	30	− 3	13	43	10	32	7 (snow)	30.00	15
April	42	8	29	52	36	44	4 (snow)	4.25	20
May	50	32	42	64	46	55	3 (rain)		14
June 1–25	62	44	52	78	50	61	0		12

Summary of meteorological record at Chickaloon, Alaska, March, 1910, to March, 1911.

Month.	Temperature (°F.).			Total rainfall (inches).	Snow (inches).			Days with 0.01 inch or more precipitation.	Clear days.	Partly cloudy days.	Cloudy days.
	Mean.	Maximum.	Minimum.		Total snowfall.	On ground on 15th of month.	On ground at end of month.				
1910.											
March	26.3	50	−12	0.03	7	38	32	2	17	6	8
April	27.7	54	− 8	.20		30	12	2	15	9	6
May	44.9	78	24	.12				2	11	11	9
June	50.7	71	26	1.19				7	6	8	16
July	57.2	84	38	1.42				10	11	7	13
August	53.7	79	30	.49				4	13	10	8
September	46.9	84	21	1.46				8	11	9	10
October	29.8	55	− 7	.71	5		3	3	8	10	13
November	14.7	34	− 5	.27	6.5	4	6	3	17	4	9
December	7.8	34	−25	.51	9	9	11	3	16	4	11
1911.											
January	3.6	29	−33	.84	13	12	19	4	18	4	9
February	13.7	42	−28	2.47	24	22	24	9	9	5	14
March	14.1	43	−27	1.15	18	34	30	6	16	4	11

The modifying effect of local surface features is shown by a comparison of the records of the four stations of Tyonek, Kenai, Sunrise, and Seward. The mean annual temperature at Sunrise is nearly 3° lower than at Tyonek, and the precipitation is nearly 12 inches greater. This difference for stations separated only by Cook Inlet is accounted for by the location of Sunrise in a deep fiord subject to winds blowing alternately from the warm waters of Cook Inlet and

from the cool, high mountains and glaciers at the head of Turnagain Arm. Greater extremes of temperature occur at Kenai than at Sunrise, but the annual mean is about the same. The lower temperatures recorded at Kenai appear to bear out the observations of settlers, that the bench lands on the west side of Kenai Peninsula are somewhat exposed to cool winds. The data for Fort Liscum, Seward, and Sitka show the milder temperature and heavier precipitation due to the modifying influence of the ocean currents and the high coastal mountain barriers.

The southern part of Cook Inlet is free from ice during the entire winter, but in the northern end ice usually forms sufficiently to be a hindrance to navigation by the first to the middle of November, and breaks up usually in April. The Susitna River clears of ice ordinarily between May 15 and June 1, and remains open until the middle of October or the first of November.

In the Susitna Valley ground ice is commonly present through the summer at depths ranging from about 12 to 40 inches in those places where there is a thick covering of moss. In late summer ice can rarely be found within 3 feet of the surface of the well-drained soils, either in open places or in timber, except where thick moss is present. Usually after the land is cleared and exposed to the sun, thawing takes place in early summer to a depth of 3 feet or more. Even where ice is present below the soil it is not considered a disadvantage, as it has little or no chilling effect upon the plants, and many farmers hold the belief that its constant thawing furnishes moisture for the growing crop.

The records of precipitation for all stations around Cook Inlet show marked seasonal variations as being characteristic of the different sections. The spring and early summer have the lowest average precipitation, while the months of July, August, and September everywhere have the heaviest rainfall. The normal low precipitation for the early summer is not usually detrimental to crop growth, as would be the case with scanty rainfall in regions farther south, since the average low temperature and the rather weak sunlight result in a slow rate of evaporation. Notwithstanding the effects of these agencies, droughts of some severity have occurred in this region since farming was begun. During the summer of 1913 a prolonged drought seriously affected crops upon the shallow and sandy soils along the northern shore of Knik Arm.

The heavy rainfall in the latter part of the summer comes, for the most part, as slow rains with much cloudy weather. The frequency of rains and intervening periods of cloudy weather make the curing of hay difficult at times, requiring the employment of special methods, such as the use of the hay tedder or the placing of the hay on racks or in specially constructed barns favoring the draining out of water and

the circulation of air. This feature of the climate is the greatest apparent detriment to the development of the cattle-raising and dairying industries, since large quantities of hay are required to carry stock through the long winters. That such a condition does not preclude the possibility of stock raising and dairying is shown by the important development of these industries in countries of similar disadvantages, as Norway and Finland. The use of silos for the storage of green feed will likely be found of great assistance in connection with the raising of cattle. The methods necessary to employ in making hay are discussed elsewhere in this report.

The following tables give the average number of clear, partly cloudy, and cloudy days for the several stations in this region:

Average number of clear, partly cloudy, and cloudy days, and days with rain or snow at Tyonek for the period 1909 to 1913, inclusive.

Month.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.	Month.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
January	15	6	10	7	July	17	5	9	7
February	12	2	14	5	August	10	6	15	17
March	17	4	10	4	September	11	7	12	12
April	16	6	8	4	October	13	5	13	10
May	17	6	8	3	November	13	6	12	4
June	20	4	6	5	December	15	3	13	6

Average number of days clear, partly cloudy, cloudy, and rainy or snowy at Sunrise for the years 1904 to 1906 and 1908 to 1911, inclusive, and 1913.

Month.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.	Month.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
January	13	4	14	14	July	6	9	16	13
February	12	4	12	10	August	8	7	16	18
March	13	5	13	11	September	9	5	16	16
April	8	6	16	13	October	8	3	20	18
May	10	8	13	14	November	10	5	16	14
June	12	7	11	11	December	9	5	17	16

Average number of days clear, partly cloudy, cloudy, and rainy or snowy, at Sitka, for the period 1900 to 1913, inclusive.

Month.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.	Month.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
January	7	5	19	16	July	7	8	16	16
February	8	6	14	13	August	5	8	18	17
March	10	5	16	16	September	5	9	16	17
April	5	10	15	17	October	4	7	20	23
May	6	9	16	16	November	6	6	19	16
June	7	7	17	14	December	4	5	22	20

The records of the last killing frost in the spring and the earliest in the autumn are not available for the Cook Inlet stations, so that the data as to the length of the growing season are based principally upon the reports of the settlers. The season at Seward, as given by the records of the Weather Bureau, has ranged from 146 to 177 days, with a period of 135 days in which no frost has been recorded, but about the interior portion of the Cook Inlet-Susitna region the number of days without frost is smaller. A considerable variation due to local influences is noticeable at several points. For example, the north side of Knik Arm has enjoyed longer periods free from frost than the south side, and homesteaders have taken up the land more rapidly on this account. The average growing season over the Cook Inlet-Susitna region lasts from about the middle of May to the latter part of August or first of September, although frosts have been known to occur within these dates. The usual growing season of 90 to 110 days is as long as that over portions of the northern part of the United States, but the conditions are more favorable in this more northern section for the reason that the actual period of plant growth is greatly increased by the many hours of sunlight.

It can be safely asserted that the average growing season is sufficient for the maturing of potatoes, the early varieties of small grains, grass, and a large number of vegetables and small fruits. Grain for hay can be produced every year even in those localities subject to unseasonable frosts. It is advisable to start crops as early in the spring as possible and to grow the early-maturing varieties. Potatoes can be sprouted indoors before planting and cabbage, cauliflower, and other plants can be started in a hothouse and transplanted. As a rule the last frost in the spring and the first in the fall are light and do little damage to ordinary crops. Potatoes are usually not thoroughly matured when struck by frosts, but it is a common practice to leave them in the ground for several weeks, and while this practice is not favored in warmer climates, many state that the frostbitten vines do not injure the tubers.

The following tables show the length of the periods between the first and last killing frosts at Seward and Sitka. These records are representative of the mild climate along the southern coast.

Length of growing season at Seward and Sitka.

Year.	Dates of first and last killing frosts at Seward.		Days between frosts.	Dates of first and last killing frosts at Sitka.		Days between frosts.
	Last in spring.	First in fall.		Last in spring.	First in fall.	
1908	Apr. 24	Oct. 16	174	May 1	Oct. 21	172
1909	Apr. 25	Sept. 27	154	Apr. 20	Oct. 10	172
1910	May 11	Oct. 5	146	Apr. 24	Oct. 27	185
1911	...do....	Nov. 5	177	May 3	Nov. 6	186
1912	Apr. 24	Sept. 24	152	Apr. 9	Nov. 9	213
1913	.....	.....	.....	May 5	Sept. 1	118

FIG. 1.—SCRUB SPRUCE (BLACK SPRUCE), SUSITNA VALLEY.

A characteristic growth on Peat, with ice near the surface throughout the summer.

FIG. 2.—A GLADE OF "REDTOP" IN SLIGHT DEPRESSION ON KNIK LOAM IN THE SUSITNA VALLEY.

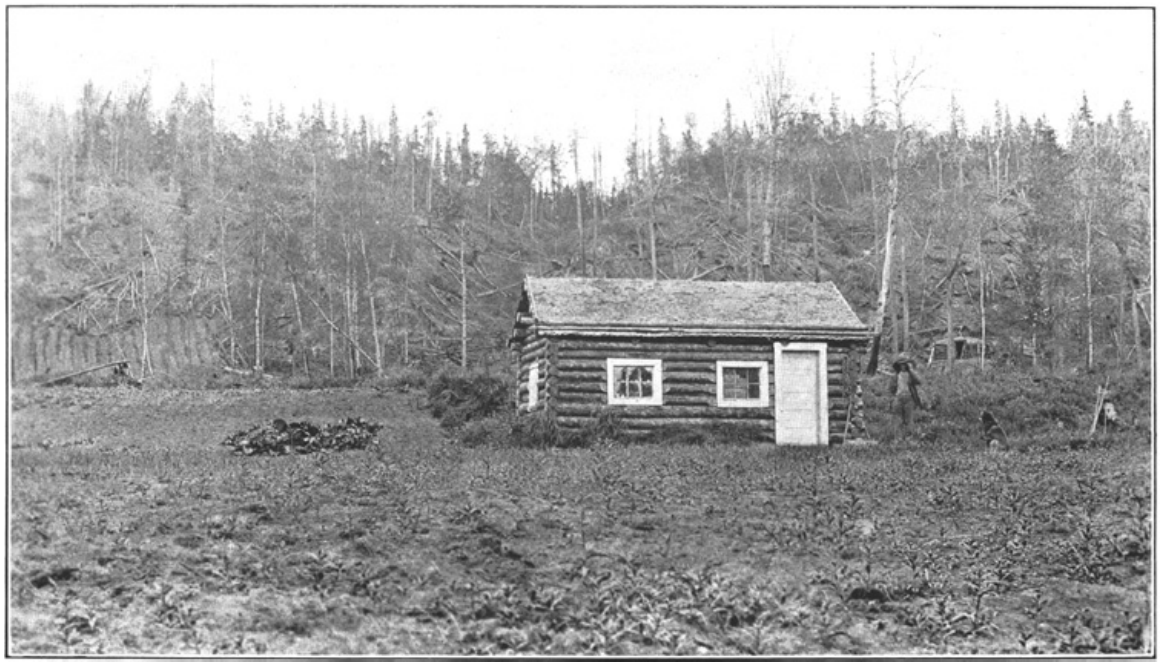
These glades are abundant through the dense spruce-birch forests.

VILLAGE (KNIK) IN THE COOK INLET-SUSITNA REGION.

The buildings are built of native lumber, mostly spruce.

STRATIFICATION OF MATERIALS WHICH GIVE RISE TO THE KNIK SOILS.

This exposure is in a bank of the Susitna River near the mouth of Willow Creek. Sand and gravel constitute most of the material beneath the surface layer.



HOMESTEADER'S CABIN AND FARM NEAR FLATS OF THE LOWER MATANUSKA RIVER, NORTH SIDE.

On the escarpment between the lower level and the higher bench in the background is shown a small field of young potatoes. Potatoes yield well on these well-drained southerly slopes.

The following table is given for a convenient comparison of the more important climatic data of the interior and Cook Inlet portions of Alaska with those of Washington, D. C., and Finland:

Summary of climate of interior Alaska, Cook Inlet, Washington, D. C., and Finland.

	Temperature.				Precipitation.		
	Mean annual.	Mean summer.	Maximum.	Minimum.	Mean annual.	Mean summer.	Snowfall.
	° *F.*	° *F.*	° *F.*	° *F.*	*Inches.*	*Inches.*	*Inches.*
Interior Alaska (Fairbanks)	24.2	57.1	86	−65	11.62	4.81	42.8
Cook Inlet (Tyonek)	36.0	56.0	91	−27	23.00	8.00	82.0
Washington, D. C.	54.7	74.7	104	−15	40.80	11.79	23.4
Finland (range of stations reporting)	28–41	58–60	.....	.....	11.8–33.4	.....	6–59

SOIL MAP.

The accompanying reconnoissance soil map is intended only to show the approximate distribution of the more important bodies or districts of the principal soils. The base map was compiled from maps constructed by the U. S. Geological Survey. In delineating the areas of soils on this reconnoissance map much assistance was derived from both the topographic and geologic maps of the Geological Survey.[1]

SOILS.

The Cook Inlet-Susitna benches and lowlands embrace a considerable variety of soils, ranging in composition from silt loam through fine sand to peat, and in drainage, from well-drained bench land to water-soaked marsh. There is a sufficient area of productive soil of good drainage and topographic features in this region for the development of an important agriculture, the greater part of the land requiring only to be cleared of timber, undergrowth, moss, and any thick covering of vegetation that may be present, to be put in readiness for cultivation. There are other areas, however, which must be ditched to make them ready for the plow. There is also a very large extent of marsh land, Muskeg, associated with the soils of good drainage and intermediate drainage, which is so swampy in character that extensive drainage operations, possibly of a prohibitively expensive nature, are necessary for its reclamation.

The material contained in this report regarding the soils was obtained by field investigations carried on in accordance with the

[1] Brooks, A. H., The Mount McKinley Region, Alaska, Prof. Paper U. S. Geol. Survey No. 70, 1911; Martin, G. C., and Katz, F. J., Geology and Coal Fields of the Lower Matanuska Valley, Alaska, Bul. U. S. Geol. Survey, No. 500, 1912; Paige, Sidney, and Knoff, Adolph, Geological Reconnoissance in the Matanuska and Talkeetna Basins, Alaska, Bul. U. S. Geol. Survey, No. 327, 1907; Capps, Stephen R., The Yentna District, Alaska, Bul. U. S. Geol. Survey, No. 534, 1913.

methods employed by the Bureau of Soils of the U. S. Department of Agriculture. These methods include examinations of the soil and subsoil of representative areas, and the classification of the soil material into series, or groups of soil types. Those soils having a similar color or range of color and structure in the surface section and in the subsoil, a closely related origin, and similar drainage conditions are grouped in a single series. The series, then, includes several types of soil differentiated upon the basis of texture; that is, the relative content of the various grades of sand and of silt and clay. Thus we have soil types of various textures grouped under a single series name, as, for example, the Knik series, comprising well-drained friable bench soils having a brown surface color, a yellowish-brown subsoil color, and a characteristic gravelly or sandy substratum (see Pl. VII), includes the Knik loam, Knik silt loam, Knik fine sandy loam, and possibly other members which were not encountered on the routes followed. Another common feature in connection with the Knik series is the frequent presence of a thin layer of gray silt loam or silty loam at the surface, which contains considerable volcanic material.

The percentage of the various sizes of soil particles is determined by mechanical analysis: the mechanical separation of the soil into classes of particles having a range of diameter arbitrarily adopted by the Bureau of Soils, and the weighing of these separates. Under the descriptions of the soil types, following, the results of mechanical analyses of samples of the surface soil, subsurface, and subsoil sections are given. The table below gives the range of diameter and names of the different grades of soil material—the separates made by mechanical analysis:

Name and size of the several textural classes of soil material.

	mm.		mm.
1. Fine gravel	2 to 1	5. Very fine sand	0.1 to 0.05
2. Coarse sand	1 to 0.5	6. Silt	0.05 to 0.005
3. Medium sand	0.5 to 0.25	7. Clay	under 0.005
4. Fine sand	0.25 to 0.1		

The Susitna series includes alluvial bottom lands of friable structure, fair to good drainage, grayish color in the soil and bluish gray to greenish gray in the subsoil, and having a gravelly substratum. Of this series there were found the fine sand, very fine sand, very fine sandy loam, and silt loam. A few patches of loam, fine sandy loam, and gravelly sand were seen, but not in sufficient areas to warrant much attention.

Only one type of the Chickaloon series was seen—the Chickaloon loam. This is closely related to the Knik loam, the chief difference being a black mucky loam surface soil instead of the brown loam surface soil of the Knik type.

Minor variations in the types, which have no agricultural significance, such as slight differences in color and drainage, are simply mentioned in the descriptions of the soils in the report; but there are other variations, without accompanying difference in the soil material itself, such as those of topography and depth of soil, which do have some bearing upon the agricultural value of the type, and which are considered of sufficient importance to warrant special recognition. Variations of this kind are handled as phases of types and are shown separately on detailed soil maps, wherever possible. The soil of the Knik loam, high-bench phase, is essentially identical with that of the typical Knik loam, in so far as the material goes, but it has a more uneven surface configuration, and its less accessible situation makes the land of somewhat less value than the typical Knik loam. The shallow phase of the Knik loam also is composed of the same soil material as the typical development of the type, but its shallower depth makes it less retentive of moisture, and consequently, less productive.

In addition to the various soil types which fall into natural groups or series, there are other classes of material which are not considered as true soils. These classifications, as found in the Cook Inlet-Susitna region, represent material which, wherever found, individually possesses essentially the same definite character, without any range through the various grades of texture as in case of the soil series. These classifications may be considered as soils in process of formation, that is, material going through those preliminary stages of weathering necessary to the evolution of true soil. These are Muskeg, Peat, and Muck.

Muskeg consists of peaty marsh material—partially decomposed vegetable remains existing under water-soaked conditions. Peat represents partially decomposed vegetable matter, existing under poor drainage, but not necessarily marsh conditions; while Muck represents more completely decomposed vegetable matter mixed with some mineral material. In time all of these accumulations of vegetable matter may assume more the characteristics of a loam soil. Muck represents a much nearer approach to that stage than either Peat or Muskeg.

Exclusive of Muskeg and Muck, there are two broad divisions of soil in the Cook Inlet-Susitna country: (1) bench-land soils, and (2) stream-bottom soils. The former division comprises the Knik and Chickaloon series, and the soils represent material which evidently has undergone considerable attrition by water or glacial action or both, mixed, especially in the surface portion, with varying quantities of volcanic matter. Both the common gray silty surface layer and the brown loam stratum beneath contain considerable quantities of volcanic particles. In the coarser textured subsoil there is much

less of this volcanic material, as shown by mineralogical analyses. It is not at all surprising that so much volcanic matter is present in the soils of this section, in view of the recent distribution of just such material by the eruption of Mount Katmai on the Alaska Peninsula in 1912, following which volcanic dust is reported to have fallen in a quite noticeable quantity at Knik. The recent eruption of Redoubt Volcano, on the west side of the inlet across from Kenai, also contributed some volcanic material.[1]

The coarse substratum of the soils of this region carries material from varied sources, as shown by the great variety of rounded cobbles and gravel present, including diorite, several kinds of granite, quartz, greenstone, black, brown, and reddish rocks, conglomerates, and breccias.

The bulk of the material of which these benches are composed was probably placed here as both morainic and outwash material, the upper, stratified portion as outwash deposits. The Kenai Peninsula bench material (Kenai lowland), which undoubtedly is of similar origin to that of the Susitna and upper Cook Inlet benches, is described as having been placed as till in the lower part and as outwash material in the upper or stratified portion. There is considerable volcanic material in the surface layer.

The Quaternary deposits of the Kenai lowland are chiefly if not wholly of glacial origin and were evidently laid down at about the time of the maximum glaciation of the district. They consist of a basal and, in general, thick sheet of till (Pl. XXI, B, p. 92), in most places overlain by stratified sands and gravels whose surface is well terraced. These deposits extend throughout the greater part of the Kenai lowland and are strikingly different from the glacial deposits of the Kenai Mountains. The glacial deposits of the mountains are very thin and irregular and are closely related in volume and character to the local topographic and lithologic features. They are the characteristic products of a system of local actively eroding alpine glaciers. The glacial deposits of the lowland are such as would be laid down near the lower end of a large stagnant ice mass whose load had been derived from many sources and had been carried far, finely ground, and deposited not only by the melting away of the glacier itself but by the action of streams that were bringing large amounts of glacial detritus from more or less distant points.[2]

On the benches the bulk of the soil material in the section overlying the coarse substratum is composed of particles smaller in size than medium sand. In other words, the greater part consists of silt, clay, and very fine sand. The subsoil or substratum contains some silt and clay, but here sand and fine sand, gravel, and cobbles largely preponderate. The permeable nature of the soils, coupled with the gentle character of the rainfall, has the effect of preventing

[1] Brooks, A. H., The Mount McKinley Region, Alaska, Prof. Paper No. 70, U. S. Geol. Survey, 1911, p. 110.

[2] Martin, G. C., Bul. U. S. Geol. Survey No. 587, p. 95: Geology and Mineral Resources of Kenai Peninsula, Alaska.

serious erosion. Comparatively steep slopes can be cultivated freely without danger of being followed by harmful washing. (See Pl. VIII.)

The alluvial soils represent sediments which have been laid down by overflow waters from streams. These soils include material brought down in suspension from the various areas through which the drainage waters flow and from the disgorging glaciers. Only a small percentage of the particles in the alluvium is larger than fine sand; most of it consists of fine sand, very fine sand, and silt. These alluvial soils, like the bench lands, are underlain by a coarse stratum consisting of a mixture of sand, fine sand, small and large gravel, and cobbles of varied mineralogical character.

The material from which the soils of the region are derived has undergone more or less change through processes of weathering since its deposition. That of the better-drained sunny situations has undergone changes which tend most to fit the resultant soil for crop production. In those situations where soggy or water-logged conditions prevail the changes have tended rather in the opposite direction; but where the drainage is good, organic material from plants has intermingled with the surface soil in such a way as to give it a desirable mellow character, and with the aeration made possible by good drainage chemical changes have taken place which have been of the kind that promote the development of soil conditions favorable to plant growth. Such a condition in the soil is commonly indicated by a uniform color in the material—the absence of conspicuous mottlings in the coloring. In the more poorly drained areas the material, although probably identical originally in many instances with that of the well-drained situations, has not made such favorable advance, and the color is more mottled, indicating that the aeration has been imperfect. Here also there is more mucky or peaty matter on the surface, evincing retarded decomposition. The exclusion of air from the material by water thus retards or inhibits those processes of oxidation which are considered essential to the perfection of plant-requirement conditions in the soil—in other words, stops development of the productive capacity of the soil.

In many wet places there are deep accumulations of peaty material, consisting mostly of moss, which has changed but little from its original state, even at depths of 2 feet or more, where obviously the vegetable matter has lain for a very long time. There are many moss-covered areas where the subsoil is permanently frozen. Here the action of both external and internal forces is reduced to a minimum, air is excluded, and there is no material movement of water in any direction. Such material may be considered as existing in a state of quiescence in so far as regards processes of weathering.

The peaty material classed as Muskeg freezes in winter and thaws in summer. This change from the frozen to the soft, saturated condition probably has the effect of gradually reducing the vegetable particles to a pulpy consistency, yet at depths of 3 feet moss is frequently found in the marshes which shows little change from its original structure.

The beneficial effect of aeration is evinced by the improvement which the soils of the region, including deep, mellow, well-drained soils, have almost invariably shown in the crops produced, without fertilization, under continued cultivation. Most crops, according to experience, have shown some improvement in quality, increase in yield, or earliness of maturity from year to year. Such improvement could not be expected to go on indefinitely, but there is no question that with the removal of the vegetation and the opening up of the soil by plowing, processes immediately start up, evidently connected with aeration, which are conducive to changes equivalent to a sanitation of the soil, or at least to changes favorable to plant development. This improvement is hastened materially by applications of wood ashes, which, together with the indications of a prevailing acid condition of the soils, suggests the need of lime.

Practically all of the soils of the region are strongly acid, even those having good drainage. In fact, the older soils on the high benches are noticeably more acid, as a rule, than the recently formed alluvial soils. That there is more leaching of the alluvial soils caused by the overflows and subsequent draining out of the soil probably accounts for the more nearly neutral condition of the bottom lands. On the other hand, the comparatively little leaching which takes place in the bench lands, on account of the slow distribution of the rather light precipitation, the rank growth of vegetation, and the surface accumulation of vegetable mold, acting as a barrier against air penetration, represent conditions which might be expected to favor the development of acidity in the soil. It was thought possible that the abundance of volcanic material may have had some connection with the acid characteristic, but mineralogical examinations of representative samples have not revealed the presence of inorganic matter to which any unusual properties of acidity can be ascribed.

Chemical analyses show that all the soils have a good lime content, more than the average of the soils in the humid portions of the United States. The lime, however, is evidently present in combinations of low solubility, inasmuch as heavy applications of lime are required to correct acidity. The analyses also show the soils of this region to have a good or normal chemical composition, comparing favorably with that of important farming soils in the United States. The components shown in the table of analyses below represent the total amounts present as determined by the fusion method. This method

makes no distinction between the soluble and insoluble constituents, but the favorable yields of crops can be taken as measuring, in some degree, the availability of plant food.

The results of chemical analyses of the important types of the Cook Inlet-Susitna country are given in the table on page 40, along with, for the sake of comparison, results of analyses of several valuable farming soils of the United States, and the results of mineralogical examinations of representative samples of soils appear on page 42.

Results of mechanical analyses of a number of representative samples of these soils are given under the type descriptions in the following chapters. In these chapters the soils are described in detail, and their agricultural value is brought out so far as this can be done with the information at hand. The soils described occur as definite, well defined types, and were seen in areas of sufficient extent to warrant their recognition as important soils.

The following table gives the areas of the principal soils and groups of soils in the Cook Inlet-Susitna region, as estimated on the basis of reconnoissance investigations:

Areas of principal soils in Cook Inlet-Susitna region covered by reconnoissance soil map, with lowest estimate of the area of each available for cultivation.[1]

Classification.	Square miles.	Per cent.	Lowest estimate of area available for cultivation.	
			Square miles.	Acres.
Muskeg and included soils [2]	2,280	38.8	.....	.....
Knik loam (mainly)	1,975	33.6	1,300	832,000
Knik loam, high-bench phase (mainly)	960	16.3	400	256,000
Knik loam, shallow phase (mainly)	190	3.2	175	112,000
Susitna soils (mainly)	415	7.1	100	64,000
Knik fine sandy loam (mainly)	60	1.0	50	32,000
Total	5,880	.....	2,025	1,296,000

[1] The region covered in these estimates is restricted to the lowlands and benches lying north of Kachemak Bay, on the east side of the inlet, and north of Tyonek on the west side.

[2] Extensive drainage operations will be required to reclaim Muskeg, and to make available the included well-drained soils (Knik).

KNIK LOAM.

The type of soil classed as Knik loam is the most extensive of the well-drained soils in the Cook Inlet-Susitna region. It occupies the greater part of the moderately high benches, hillocks, and ridges, nearly all of the high benches, and much of the low benches, and is, therefore, widely distributed. Its mechanical composition is the best, from the standpoint of crop production, of all the important soils in this region. The type represents the most valuable soil of this part of Alaska.

Chemical analyses of important soils of the Cook Inlet-Susitna region, Alaska—Fusion analysis.[1]

Soil type and section.	No. of sample.	Location of sample.	SiO_2.	Fe_2O_3.	Al_2O_3.	TiO_2.	CaO.	MgO.	Na_2O.	K_2O.	N.	P_2O_5.	Organic matter.
Knik loam:			*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Surface soil	590101	6 miles above mouth of Ship Creek.	66.21	3.53	13.68	0.84	2.22	1.12	3.49	0.90	0.13	0.19	5.75
Subsurface	590102	.....do.....	63.45	5.58	15.56	.77	1.74	1.77	3.18	1.09	.08	.29	1.91
Surface soil and subsurface	590104	2 miles east of Moose Creek crossing.	54.68	4.72	11.63	.70	2.36	1.28	3.36	.32	.55	.16	14.61
Subsoil	590105	.....do.....	61.42	4.48	17.01	.67	2.74	1.45	3.20	1.04	.18	.22	5.62
Chickaloon loam:													
Soil	590106	1½ miles northeast of Moose Creek crossing.	54.40	4.95	11.37	.73	2.03	.89	3.12	.52	.57	.19	20.63
Subsoil	590107	.....do.....	55.56	5.89	13.35	.70	2.45	1.38	3.18	1.08	.30	.24	.....
Soil and subsurface	590108	1 mile northwest of wagon road over Little Susitna River.	51.09	4.64	10.79	.71	1.56	.86	2.69	1.21	.48	.21	22.36
Subsoil	590109	.....do.....	54.00	5.27	16.59	.54	2.30	1.14	3.20	1.16	.27	.27	.....
Susitna very fine sandy loam:													
Soil	590110	20 miles east of Knik	63.95	6.36	14.14	.85	4.04	2.45	3.85	1.28	.03	.30	.87
Subsoil	590111	.....do.....	62.27	6.36	16.70	.64	3.52	2.41	3.42	1.54	.04	.25	.....
Knik loam:													
Surface soil	590112	18 miles above mouth of Kashwitna River.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Subsurface	590113	.....do.....	.....	.....	.....	.....	1.89	.77	.....	.94	.53	.22	21.14
Surface soil	590117	5 miles above mouth of Montana Creek.	.....	.....	.....	.....	1.94	.91	.....	1.88	.17	.19	27.81
Subsurface	590118	.....do.....	.....	.....	.....	.....	3.48	1.04	.....	1.50	.08	.22	6.37
Surface soil	590120	Near mouth of Clear Creek.	.....	.....	.....	.....	2.10	.80	.....	1.88	.11	Trace.	8.13
Lower subsurface	590122	.....do.....	.....	.....	.....	.....	2.59	1.54	.....	.88	.11	.25	4.10

[1] Inorganic constituents determined by R. F. Gardiner and C. F. Miller, and organic matter by W. B. Page, in the laboratory of the Bureau of Soils.

Chemical composition of important types of soil in the United States[1]*—Fusion analysis.*

Soil type and section.	No. of sample.	Location of sample.	SiO_2.	Fe_2O_3.	Al_2O_3.	TiO_2.	CaO.	MgO.	Na_2O.	K_2O.	P_2O_5.	Organic matter.
Norfolk sandy loam:			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Soil	1	Eastern North Carolina (Coastal Plain).	94.50	0.83	2.07	0.71	0.39	0.09	0.11	0.10	0.06	1.13
Subsoil	2	.....do.....	85.30	1.91	8.82	.91	.38	.19	.07	.12	.04	.29
Decatur clay loam:												
Soil	3	Northeastern Alabama (Limestone Valleys).	79.35	4.44	8.89	1.15	.63	.39	.24	.67	.18	1.96
Subsoil	4	.....do.....	74.81	5.28	12.80	1.28	.40	.33	.16	.75	.15	.93
Marshall silt loam:												
Soil	9	Northwestern Missouri (Loessial region).	73.61	3.54	9.67	.71	1.08	.77	1.03	2.28	.22	4.29
Subsoil	10	.....do.....	71.43	4.28	13.44	.77	1.40	1.28	.63	2.03	.16	2.72
Gloucester stony loam:												
Soil	11	Southern New Hampshire (Glacial region).	65.68	5.67	14.15	.79	1.36	.83	1.39	2.16	.15	7.07
Subsoil	12	.....do.....	73.80	4.37	13.24	.71	1.19	.39	1.75	2.22	.11	1.39
Carrington loam	13	Southern Wisconsin (Glacial region).	73.50	4.30	9.10	.59	.94	.71	1.67	2.03	.24	4.94
Cecil clay:												
Soil	15	Southern North Carolina (Piedmont Plateau).	66.49	7.43	17.11	1.02	.36	.31	.16	.62	.17	1.26
Subsoil	16	.....do.....	44.15	16.23	27.58	1.14	.44	.09	.15	.61	.15	.27

[1] These analyses are taken from Bul. No. 122, U. S. Dept. of Agriculture, The Inorganic Composition of some Important American Soils. See also, Field Operations, Bureau of Soils, for detailed description of the types analyzed.

Results of mineralogical examinations of samples of representative soils of the Cook Inlet-Susitna region.[1]

[A indicates that the mineral is abundant, Pre that it is predominant, S that it occurs in small amounts, VS in very small amounts, T in traces, P indicates the presence of the mineral without reference to quantity, and (?) that the mineral is probably present, but that the data obtainable were not sufficient to identify it beyond doubt.]

Sample number.[2]	Isotropic material.	Quartz.	Mica.	Muscovite.	Biotite.	Femic mineral.	Hornblende.	Augite.	Feldspar.	Orthoclase.	Microcline.	Plagioclase.	Albite.	Oligoclase.	Andesine.	Labradorite.	Olivine.	Calcite.	Apatite.	Magnetic iron ore.	Tourmaline.	Epidote.	Zircon.	Rutile.	Garnet.	Corundum.	Remarks.
590101	A	A	....	....	....	....	S	....	....	VS	....	VS	....	....	....	....	....	....	....	T	....	S	T	T	....	....	
590110	S	S	....	S	T	....	C	....	....	VS	....	P	....	VS	....	....	....	S	....	S	....	S	T	T	....	....	
590112, No. 4 sand	P	P	....	P	....	....	P	P	....	P	....	P	P	....	....	....	....	....	....	P	....	....	....	....	....	....	Great many inclusions, mainly of hornblende, present, mainly in the isotropic material; partly of volcanic origin.
590112, No. 5 sand	P	A	....	P	....	....	P	P	....	P	....	P	P	P	....	P	....	....	....	P	....	....	....	....	....	....	This sample very similar to foregoing one; partly of volcanic origin.
590112, silt	Pre	P	....	P	....	....	P	....	....	P	....	P	....	P	P	....	....	....	....	P	....	....	P	....	....	....	Inclusions, probably due to finer state of division, less common than in the two preceding; at least partly of volcanic origin.
590113, No. 4 sand	P	15	....	....	P	....	P	....	....	2	....	P	....	....	P	P	....	....	....	P	....	P	....	....	....	....	Inclusions, usually of hornblende, common; semicrystalline material present; partly of volcanic origin.
590113, No. 5 sand	P	12	....	1	P	....	P	P	....	4	....	P	....	P	P	P	P	....	....	P	....	....	P	....	....	....	As above; partly of volcanic origin.
590113, silt	P	10	....	P	P	....	P	....	....	P	....	P	....	P	....	....	....	....	....	P	....	....	....	....	....	....	Inclusions not so common as in preceding samples; semicrystalline material present; partly of volcanic origin.
590114, No. 4 sand	P	40	....	....	P	....	P	....	....	6	....	P	....	P	....	P	....	....	....	P	T	P	....	....	....	....	Isotropic material not at all abundant.
590114, No. 5 sand	P	20	....	1	P	....	P	P	....	1	....	P	....	P	....	....	....	....	....	P	....	P	P	P	....	....	

590114, silt	P	[4]15	....	P	P	....	P	P	....	P	....	P	....	....	....	P	....	....	....	P	T	P	....	....	....	....	
590115, No. 4 sand	P	[4]56	....	P	P	....	P	....	....	[4]2	T	P	....	P	P	P	....	....	....	P	T	T	....	P	(?)	....	
590115, No. 5 sand	P	[4]60	....	P	P	....	P	P	....	[4]6	T	P	....	P	....	P	....	....	....	P	....	P	P	....	(?)	....	
590115, silt	P	[4]40	....	[4]1	P	....	P	....	....	[4]8	....	P	....	P	....	P	....	....	....	P	T	T	T	T	....	....	Magnetic material present in smaller quantity in silt than in No. 4 and 5 sands.
590116	VS	Pre	....	T	S	VS	S	....	....	VS	....	S	....	S	S	VS	....	....	....	A	....	T	....	....	....	....	
590117	Pre	S	VS	....	....	....	S	....	S	....	....	....	....	....	....	....	....	....	....	P	....	....	....	....	....	....	The hornblende often shows evidence of magnetic corrosion; semicrystalline material is present; partly of volcanic origin.
590118	Pre	P	....	VS	VS	....	A	....	....	....	....	S	....	....	S	....	....	....	T?	S	T	....	....	....	....	....	
590119	S	Pre	....	S	S	....	S	....	S	....	....	....	....	....	....	....	....	....	....	S	....	T	T	....	....	....	
590120	Pre	S	T	....	....	....	S	....	....	VS	....	S	....	....	VS	....	....	....	....	S	....	....	T	....	....	....	
590121	Pre	S	....	S	S	....	S	....	....	S	....	S	....	....	....	S	....	....	....	S	....	....	T	T	....	....	
590122	S	Pre	....	S	S	....	S	....	....	S	....	S	....	....	....	VS	....	....	....	S	....	VS	T	T	....	....	
590123	T	Pre	....	VS	S	....	A	....	....	VS	....	VS	....	S	....	....	....	....	....	A	....	S	VS	....	....	....	
590124	S	S	....	A	A	....	S	....	....	VS	T	VS	....	....	....	....	....	....	....	S	VS	VS	T	....	....	....	
590125	T	Pre	....	A	A	....	S	....	....	S	....	S	....	VS	....	VS	....	....	....	S	T	S	T	....	....	T	
590131	T	Pre	....	VS	VS	....	S	....	....	VS	....	VS	....	....	....	T	....	....	....	S	....	VS	T	....	....	....	
590132	T	Pre	(?)	....	....	....	S	....	....	T	....	S	....	....	....	....	....	....	....	S	....	S	T	....	....	....	

[1] Analyses by W. H. Fry, in the laboratory of the Bureau of Soils.
[2] For name and location of samples see tables of chemical and mechanical analyses of soil samples.
[3] For definition of No. 4 sand and other textural classes of soil material see table of textural classes p. 34. For the proportion of the various textural classes in the soils see tables of mechanical analyses under the soil type descriptions.
[4] Per cent.

There are many slight variations in the color of the material through the vertical section and in the thickness of the various strata constituting the body of the soil. These minor variations are matters of interest rather than of important agricultural significance.

The most common characteristics of the Knik loam are a gravelly substratum beginning within the 3-foot section, a gray surface soil containing volcanic material, which is quite powdery when dry, a loam of friable structure through the main portion of the soil section, that is, between average depths of about 3 and 24 inches, containing volcanic material, and having a decidedly acid character.

The typical Knik loam consists of a gray silt loam to silty loam, underlain at about 1 inch to 4 inches by brown or coffee-brown, mellow loam which shades off into yellowish-brown loam, this in turn grading at any point from about 12 to 26 inches into yellowish-brown or greenish-yellow fine sandy loam to loamy fine sand, containing small and large gravel. Large cobble stones are present in this lower coarse stratum, these being more abundant in the lower subsoil or deep substratum. A surface covering of dark-brown to black vegetable mold is usually present. The coffee-brown layer, in many places, is absent, while again it is not encountered in the immediate subsurface, but at a lower depth, underlying a layer of yellowish-brown loam. This stratum has the brownish color characteristic of coffee grounds, and it ordinarily is more compact than either the soil above or below. This layer is very similar to the common coffee-brown hardpan stratum of Florida soils.[1] It carries a large amount of organic matter, much more than either the overlying gray or yellow layer or of that beneath it. This organic matter may have been placed in this stratum through vegetative influence prior to the deposition of the overlying material.

The gray surface layer ranges in texture close along the border line between a loam and silt loam, averaging, probably, a silt loam. There are numerous places where it is definitely a loam, as in case of sample No. 590112, while in many other places it represents a normal silt loam, as with sample No. 590120. The brown compact layer nearly always has the texture of a loam, but its large organic-matter content causes it to appear in the results of mechanical analyses as a clay loam or clay, as for example, in the case of sample No. 590113. This stratum contains 21.14 per cent of organic matter, and but little clay, although the analysis gives it an apparent content of 33 per cent clay. The organic matter was present in the original sample either as very fine particles or it was reduced in texture by the abrasion resulting from the shaking of the sample in water in the process of mechanical analysis. Microscopic examinations of representative samples reveal the presence of considerable volcanic material in the gray surficial

[1] See Leon sand, Bul. No. 96, Bureau of Soils, U. S. Dept. of Agriculture.

layer and also in the underlying section of loam. The sand, gravel, and cobbles of the lower subsoil and substratum represent material which apparently has undergone abrasion through both glacial and water action. In this coarser stratum there is comparatively little volcanic material.

The Knik loam was examined in numerous places over the Cook Inlet-Susitna plain, through the Matanuska, Susitna, and Yentna Valleys, on the east side of Knik Arm, and on Kenai Peninsula. There is much of the type on the east side of Knik Arm, most of which conforms closely with the typical soil, as described above.

A slight variation was seen in places along Ship Creek, as, for example, on the ranch of Mr. J. D. Whitney, about 6 miles above the mouth of this creek. In several places examined here the soil is a gray silt loam to silty loam, underlain at one-half inch to 3 inches by yellowish-brown friable silty loam, which, at 8 to 12 inches, passes into yellowish-gray silt loam to silty clay loam. At about 20 to 36 inches below the surface gravel and cobbles appear, and these increase in quantity below the 3-foot section. The interstitial material of this gravelly stratum carries considerable clay, making the subsoil of this phase the heaviest of any of the variations in the type, in fact, the heaviest of any soil seen in the region, except a few unimportant spots in the Knik silt loam type. There is probably very little of this phase. Agriculturally, it seems to have a value about equal to that of the typical soil, although it likely would not warm up so early in the spring.

Extensive areas of the type occur in the lower Matanuska Valley, above Cottonwood, and from the Cottonwood section northward nearly to the Little Susitna River. Much of the soil in the Matanuska country is a brown loam of quite friable structure, grading at about 5 to 6 inches into yellowish-brown light loam to silty loam, and this, at about 15 to 28 inches, into mottled grayish, yellowish, and occasionally greenish loam, with greenish to yellowish fine sandy loam or loamy sand in the lower part, where, also, gravel and, frequently, bowlders are present. Only a very thin layer of gray silt loam is present in most places in this locality, and there are spots where it is entirely absent. Irish potatoes of excellent quality are grown on this development of the type.

Another variation was seen in rather moist places in the Matanuska Valley, where alder and devil's club are common. This consists of a dark-brown to black loam an inch or so deep over brown to mottled grayish and brownish silt loam, which extends to a depth of about 16 to 18 inches without important change, except that the lower part is more yellowish or shows, frequently, a greenish cast. This generally overlies yellowish-brown or yellow friable loam, which either extends without change to a depth of 3 feet or passes into

gravelly fine sandy loam to gravelly sand of a yellowish-brown to slightly greenish or bluish color.

In the Susitna Valley the most extensive areas of the type were found near the main stream below Willow Creek and above Montana Creek. Here there is much of the typical soil. The gray surface layer is rarely absent, and the coffee-brown layer is more common than in the Matanuska and Knik Arm sections.

There are considerable bodies of Knik loam on both sides of the Yentna River from the Kahiltna River north to and above the confluence of the Skwentna and Yentna Rivers. In this section there seems to be more variation in the type than elsewhere. In places the gray surface layer is entirely absent, yet it averages considerably deeper in this part of the region than elsewhere. About 1 mile below the mouth of the Skwentna River a representative area, for this general section, showed the following characteristics: A grayish silty loam, grading at about 6 to 8 inches into light-brown silty loam, and this at about 28 inches into yellowish-brown fine sandy loam to gravelly loam.

The typical Knik loam is also found on Kenai Peninsula in large bodies. At the village of Kenai the surface to a depth of 1 or 2 inches consists of a brown silty loam with a high organic content. This overlies light-gray silt loam, which, at about 5 inches, passes into brown silty loam. In turn, this is underlain by yellowish-brown fine sandy loam at a depth of about 2 feet, and between 30 and 36 inches a mixture of sand and gravel, with some finer particles, is encountered. The type is most abundant along the water front of the peninsula and adjacent to the streams. Toward the center of those portions of the Kenai Peninsula not ramified by streams the type gives way to Muskeg.

As roughly estimated, there are approximately 1,820 square miles of the typical Knik loam in the Cook Inlet-Susitna region. At least 1,300 square miles are considered as constituting good farm land available for cultivation without drainage. In some places topography has imposed an unfavorable climate, but most of the land is well exposed to the sun and is not subjected to unusual winds and unseasonable frosts. A very large part of the Knik loam is topographically suited to farming; much of it is practically level, but hillocks, ridges, and rather steep slopes are of frequent occurrence in many parts of the region. Practically all of the type could be cultivated, since rains are not likely to cause severe washing even on the steeper slopes. There are many isolated bodies of comparatively small size occurring as islandlike areas surrounded by Muskeg. These are very largely shut off from immediate occupation, inasmuch as their development would necessitate the construction of roads over marshy country, where road building would be a difficult and ex-

pensive task. Such detached areas are of common occurrence in the country between the Susitna and Yentna Rivers.

Most of this type is timbered. Spruce, birch, and willow are the principal trees. Aspen is common, but its distribution is more local. Spruce attains a diameter of upwards of 24 inches in many parts of the Susitna and Yentna Valleys. It grows smaller in the Matanuska Valley, and still smaller on the south side of Knik Arm. There is much valuable spruce timber over large portions of the type which is suitable for building purposes, crossties, and mine timbers.

Birch nearly everywhere occurs along with spruce, although it is not so abundant. It attains its largest size on this soil in the Susitna and Yentna Valleys. The larger trees are 20 inches or more in diameter. Aspen is very abundant in groves, in some of which no other trees are seen. The exclusive growths of this tree could not everywhere be ascribed to any apparent soil peculiarity, although it seems to prefer a shallow, well-drained soil, such as that having gravel near the surface. There is also some cottonwood on the type, in places 2 feet or more in diameter near the ground. These trees are not widely distributed over this soil; in fact, they are found only occasionally in moist situations.

Alder grows in dense, rank thickets on some of the moist slopes and is present scatteringly over portions of the level benches. There is not much willow, except where moss is plentiful, and here it is of sparse occurrence. Much timber has been destroyed by forest fires. This destruction goes on year after year without much consideration of the consequences by the inhabitants.

Native redtop flourishes everywhere in the open places, and where there is not a thick growth of trees. It is also fairly plentiful through some of the forests.

Currant, huckleberry, Indian paint-berry, ferns, "joint grass," wild rose, and high-bush cranberry constitute an undergrowth which in places is difficult to penetrate. Other plants that are less plentiful but still common are Hudson Bay tea, buckbrush, mountain ash, and devil's club. Moss and club moss are rather scarce, except on the northern slopes. They seem to be most abundant in the Matanuska Valley and along Knik Arm.

Everywhere in the virgin forests there is an accumulation of vegetable mold, often 6 or 8 inches deep. This represents the vegetative remains from a prevailing growth possessing an almost tropical density and luxuriance. (See Pl. IX, fig. 1.)

Ice is rarely present within 40 inches of the surface in late summer. That found was confined principally to areas on northerly slopes where moss is abundant. Drainage of the type is well established. Occasional rather small depressions and strips along slopes are soggy

through the summer. The soil, properly managed, conserves moisture in adequate quantity for the demands of crops through normal seasons.

The Knik loam is the soil which will play the most important part in the building up of an extensive agriculture in the Cook Inlet-Susitna region. It is the best farming soil of the region and at the same time is the most extensive type and the most accessible. There are no large sections in which the type does not occur. In the main it lends itself to easy cultivation, owing to its favorable physical character and smooth topography. It is not a difficult task to clear this land, because of the shallow depths to which the roots of trees penetrate, coupled with the fact that burning over, during dry seasons, clears away the bulk of the undergrowth. The soil is so well supplied with organic matter that burning over will not likely effect any material damage; in fact, the ashes thus produced have been found to have a decidedly beneficial effect on the soil. Coarse organic matter plowed under in too liberal quantity is not helpful to the land, owing to the slowness of decomposition processes in this climate. The type is everywhere decidedly acid. It is much in need of lime, as indicated by the good effects resulting from applications of wood ashes. Lime-requirement determinations of samples of the virgin soil showed the amount required to correct acidity in an acre-foot to be very large. Sample No. 590120 required 6.2 tons of calcium carbonate to correct acidity of an acre-foot, while sample No. 590121 (subsurface of No. 590120) required 10.9 tons of calcium carbonate to neutralize a corresponding section of that material. In practice not so heavy applications will be necessary, since the lime of ashes resulting from burning over the land will have considerable effect, while oxidation of organic matter in the soil resulting from better aeration consequent upon cultivation will further minimize acidity, according to experience, and thus reduce the quantity of lime needed. Experience also shows that the condition of the soil improves with cultivation, which fact undoubtedly has some connection with the improvement of the acid condition of the virgin soil, or that unfavorable condition typified by acidity, through processes of weathering made possible by breaking the land. Furthermore, the estimate for lime requirement is for an acre of soil 1 foot deep, when it is practically certain that not so deep a section should be considered in the actual field practice of liming. Nevertheless, a soil so acid can not but be benefited by lime, and it is certain that liberal applications could be made to advantage. Two tons of air-slaked burned lime per acre in all probability would not be too much, yet lighter applications likely would have some beneficial result.

New ground should be broken some time before planting. Summer or fall breaking at least a year before crops are planted has been

found the best practice. In this way the material is turned up to the air, permitting aeration and more freedom for the pulverizing action of frost. Plowing, experience indicates, should be about 4 to 6 inches deep. It is rarely advisable to turn up in a single season a large quantity of raw subsurface material of soils of a strongly acid nature. Probably not more than 1 or 2 inches of the material lying below the original depth of plowing should be brought to the surface in any one year.

Although the Knik loam has a good organic content, it is quite likely 5 or 6 years of cultivation will so reduce this humus supply that additional organic material will be needed in order to maintain the most favorable soil tilth. This could be accomplished to best advantage by adding manure. In the absence of this, green vegetation plowed under would undoubtedly have a helpful effect. The legumes are always preferable for this purpose, partly for the reason that some nitrogen is stored in the soil by the plants belonging to this family. The wild pea (*Lathyrus maritimus* (L) Bigel.) and a white clover which locally thrives in patches would seem to be valuable plants for this purpose, although no attempt has been made to establish these as field crops. Common vetch thrives in the interior of Alaska and would undoubtedly succeed here, proving not only a good forage crop but a good soil builder. Applications of manure and wood have increased the yields of crops in all cases. Commercial fertilizers have been tried only in a small way, not sufficiently to decide their value.

Native redtop grass (*Calamagrostis scabra* Presl., *C. canadensis* (Michx.) Beauv., and *C. inexpansa* Gray) grows profusely in open places throughout the entire extent of the Knik loam. It spreads over burned areas rapidly in luxuriant growth. In the big "burn" south of Willow Creek, near the Susitna River, however, this grass has not yet spread over the entire area. It appears to be encroaching upon the center from the edges as if the seed were being gradually distributed by the wind.

This soil is ideally situated for the production of potatoes. The quality of the product is good, particularly from those sunny fields which have been cultivated several years. Such potatoes are mealy and dry and keep well. Those from new ground, especially from northerly slopes and moist places, are more soggy, undoubtedly on account of retarded growth resulting from too much moisture and lack of sunshine. Best results are had on the sunny southerly slopes and flats, where there is no unusually chilling wind or susceptibility to early frosts. Excellent yields are obtained, 250 to 300 bushels per acre having been grown without the use of fertilizer. The potatoes are large and of good shape.

Barley and oats do especially well. In case of the early varieties there is no trouble in getting the crop to mature before frosts, provided early seeding is practiced. Oats are more extensively grown than any other grain. The crop is largely cut for hay. Early varieties of wheat unquestionably would succeed, but little attempt has been made to grow this crop. Some patches of rye were seen, but the crop does not seem to do so well as other grains, possibly owing to seeding at the wrong time or to selection of unsuited varieties. Fall seeding, after danger of germination is past, may be found the best method of handling rye and wheat.

A large number of vegetables of fine quality are grown by homesteaders and residents of the small villages. Among these are cabbage, garden peas, beets, cauliflower, spinach, lettuce, onions, turnips, radishes, carrots, parsnips, rhubarb, and kohl-rabi. A considerable number of flowers are grown in nearly every yard. Of these pansies, nasturtiums, sweet peas, and poppies are conspicuous for their wealth of bloom.

A plant which all indications point to as having possible value as a field crop is the wild pea (*Lathyrus maritimus* (L.) Bigel.). This grows rankly and abundantly on the gravelly escarpment of Knik Arm and ripens an abundance of seed by the middle of August. No attempt has been made to develop this plant as a field crop. This is true, also, in the case of the white clover which in many parts of the region flourishes in small volunteer patches without any attention whatever. Canada field peas succeed on the type. This legume and vetch may largely meet the requirements of the region for good leguminous forage and soil-improving crops.

The Knik loam, then, is a good agricultural soil well suited to potatoes, a large number of vegetables, grain, native grass, several legumes, and flowers. The soil is easily manipulated, requiring but light teams and plows for proper tillage.

The type is somewhat like the Plainfield loam of the United States, which is an important agricultural soil occurring on glacial terraces in stream valleys of the North Central States.[1] The Plainfield soils however, do not have the gray surface layer nor the brown hardpan stratum.

[1] The soil of this type (Plainfield loam) is a light-brown medium loam, about 10 inches in depth, underlain by a yellowish-brown or yellowish subsoil of slightly heavier texture, though containing a small proportion of sand and fine gravel. The gravel content increases below 18 inches and frequently grades into a gravel bed. The soil is easy to cultivate and the underlying gravel gives good drainage. In prolonged dry seasons crops are likely to suffer somewhat from lack of moisture, but in seasons of normal moisture the type is a good general-purpose soil, being particularly well adapted to corn and potatoes. The topography varies from level to somewhat undulating. (Bul. No. 96, Bureau of Soils, U. S. Dept. of Agr.)

The Knik loam, that portion of the type having the gray surface layer and the brownish subsurface in particular, possesses, so far as can be determined by the available data, all the characteristics of the typical podsol soils of northern Russia. The gray surface layer beneath the vegetable mold, the brown subsurface rich in organic matter, the highly siliceous character of the material of these layers as shown by chemical analysis, the accumulation of iron oxide in the brown subsurface layer and the strongly acid reaction as shown both by the litmus and lime-requirement tests, all of which are features well developed in this type of soil, are the characteristic features of the podsol soils,[1] where typically developed. These features are more perfectly developed in this soil than in any soil yet identified by the Bureau of Soils. Soils possessing some of the characteristics of the podsols occur in the northern part of the United States, especially in the lake region and in the Pacific Northwest, but here the podsol characteristics are not so completely developed as in the Knik loam.

Knik loam, high-bench phase.—The high-bench phase of the Knik loam differs from the typical soil mainly in topography. It occurs on the high benches lying against the slopes of the surrounding mountainous country. These benches extend up to an elevation approximating 2,000 feet.

Although some of the benches are flat-topped, many are undulating to rolling, and in places depressions separate or partly separate one bench from the next above. There are many steep slopes on the sides facing the valleys, some so steep that cultivation with hand tools will be the only practical way of handling them. A much larger proportion of this land can be cultivated than would be possible with many soils of similar topography because of the resistance the type offers to erosion. This power of withstanding the washing effects of rains and melting snows is due to the capacity of the soil to absorb large quantities of water, coupled with the slow, drizzling nature of the rains in this region. About half of the high bench land is available for cropping, representing an area of approximately 256,000 acres. The higher, less accessible areas and those occurring in situations where the climatic environment is not especially favorable are best suited for timber and pasturage.

In this phase the depth to the gravelly substratum averages deeper than in the typical Knik loam, and the compact brown layer resembling incipient hardpan seems to be of more frequent occurrence. A representative boring shows a gray silt loam to silty loam, underlain at about 1 to 3 inches by coffee-brown loam of noticeable compactness, which in turn overlies yellowish-brown friable loam at an average depth of about 8 inches. Between depths of about

[1] K. Glinka, Die Typen der Bodenbildung, pp. 66–100, Berlin, 1914.

20 and 36 inches the yellowish-brown loam grades into yellowish-brown and greenish coarser material; first into fine sandy loam or sandy loam, and then into a mixture of gravel, sand, fine sand, and silt, frequently with cobbles in the lower part. The substratum consists of a mixture of yellowish sand, fine sand, gravel, and cobbles, along with some finer material. This coarser underlying layer is rather variable in color, ranging from yellowish-brown through greenish-yellow to bluish or mottlings of these colors.

Most of the high benches are heavily timbered with white spruce and birch ranging in diameter up to about 24 and 20 inches, respectively. These trees become much more scrubby up near the zone of alders, which almost everywhere fringe the upper limits of the main bodies of forests. There is much less aspen than on the lower-lying soils. A dense undergrowth is usually present. In this "buckbrush" (*Menziesia ferruginea* Smith), alder, devil's club, high-bush cranberry, low-bush cranberry, huckleberry, wild rose, mountain ash, and several unidentified plants constitute the principal undergrowth. Moss, club moss, and ferns are quite plentiful in many places, particularly on the northerly slopes and in moist situations. Joint grass and Indian paint-berry grow abundantly nearly everywhere. Redtop is another plant which is very plentiful through the entire extent of this phase, being most abundant where the tree growth is scattering. Dense masses of this grass are found in many openings where mowing machines could be successfully operated.

Ice is not infrequently encountered within 40 inches or less of the surface. It is more commonly present than in areas of the typical soil. In the late summer ice was not found in any of the burned-over areas within 40 inches of the surface. Its presence in the soil apparently has no important significance from the point of view of agriculture.

This soil has the same crop adaptation as the typical Knik loam, and methods of soil management required by the typical soil are equally applicable to it, except that more of the work over the steeper slopes will have to be done with hand-operated tools.

This phase occurs as a kind of highland rim around practically all of the lower more plainlike part of the region. It is found in strips varying up to several miles in width.

Knik loam, shallow phase.—The shallow phase of the Knik loam, as the name indicates, differs from the typical Knik loam principally in the shallow depth of the soil overlying the gravelly stratum. In the material itself there is no important difference. The occurrence of this coarse underlying stratum near the surface has a marked effect upon the moisture-holding capacity of the soil. Percolation is so rapid and aeration so complete that crops suffer from dry weather much quicker than on the deeper soil. The maintenance

of a liberal supply of organic matter and frequent shallow cultivation of crops succeeding deep preliminary fall or late summer plowing will probably be found the best means of improving the naturally poor moisture-holding capacity of this soil.

The Knik loam, shallow phase, is largely confined to the Susitna Valley and the low lands between Kenai and Chickaloon Bay.

Most of this soil consists of a brown loam which quickly passes into lighter brown or yellowish-brown light loam, which, in turn, grades at about 6 to 10 or 12 inches into yellowish-brown, greenish-yellow, bluish, or grayish fine sandy loam to loamy fine sand containing gravel. With increase in depth, there is a progressive increase in the quantity and size of the gravel until the lower portion of the 3-foot section frequently is a mere mass of cobbles, gravel, and sand, with very little interstitial fine soil material. The gray surficial layer so characteristic of the typical soil is often present in this phase, but there are many areas, some of considerable size, where it is not found, or at least not in its characteristic gray development. Where moss is thick, the upper loam material is usually of a coffee-brown color.

The surface configuration of this phase averages more nearly level than that of the typical development of the type. The vegetation is quite different. Moss is present in thick layers over extensive bodies of this land. Beneath this, even within a foot of the surface, ice is present in many places throughout the summer season. Here the vegetation consists principally of scrub spruce, with scattering small birch and willow. Low-bush cranberry, Hudson Bay tea, and a plant resembling club moss (*Empetrum nigrum* L.) are plants which are present nearly everywhere, especially over the moss-covered areas. The undergrowth is so low that the forests have an open appearance.

Aspen is far more abundant than on the deeper soil, although it is not so large in size. It often occurs over considerable tracts as an almost exclusive growth, except for the abundance of Hudson Bay tea, blueberry, and low-bush cranberry. Also, there are dense forests of spruce and of birch growing to the practical exclusion of other trees and having a much smaller average size than is true in general of these trees in the region. Again, there are groves of mixed birch and aspen, and still others of mixed birch, aspen, and spruce. Variations from exclusively spruce forests to forests made up wholly of birch or aspen, or of varying mixtures of these trees, can be found in a great many places over this soil.

The shallow phase of the Knik loam is adapted to the same crops as the typical soil, but vegetables are more likely to give best average yields. Grain crops will suffer in dry seasons. The native redtop will grow everywhere, but it will produce lighter yields than on

deeper soils. The habitat of the wild pea (*Lathyrus maritimus* (L.) Bigel.) is on soil not very different from this phase. The indications are that it could be grown as a field crop on land of this kind.

Crops will mature earlier on the shallow phase, owing to the better aeration of the soil and its power of warming up earlier in the spring. There should be no trouble in maturing the early varieties of grain in every normal year. Heavy manurial applications will be required and frequent replenishment of the humus supply will be found necessary for best average yields. Plowing should be moderately deep, probably 5 or 6 inches the first year, in preparing the land, and this should be done in the fall or summer preceding a crop. Cultivation should be shallow in order to maintain a mulch favoring the retention of moisture.

The following table gives the results of mechanical analyses of samples of the surface soil, subsurface, and subsoil of the typical Knik loam and its high-bench phase:

Mechanical analyses of Knik loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
Typical:			*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590101	About 6 miles above mouth of Ship Creek.	Surface soil, gray loam to silt loam, 1 to 2 inches.	0.2	1.4	1.7	14.3	17.0	53.8	11.4
590102	do	Subsurface, yellowish-brown loam, 2 to 10 inches.	.2	1.9	1.4	10.6	24.0	50.0	11.9
590103	do	Lower subsurface, pale yellowish gray silt loam, 10 to 26 inches.	.5	1.0	.6	3.2	7.0	68.0	19.6
590112	About 18 miles east of mouth of Kashwitna River.	Surface soil, gray loam, 0 to 2 inches.	.2	3.2	2.4	17.5	10.6	49.6	16.2
590113	do	Subsurface, coffee-brown loam, 2 to 8 inches.	.3	2.3	2.6	13.6	12.3	35.6	[1] 33.0
590114	do	Lower subsurface, yellowish-brown loam, 8 to 20 inches.	.6	4.0	6.2	19.2	15.0	39.3	15.8
590115	do	Upper subsoil, yellowish-brown fine sandy loam, 20 to 28 inches.	1.2	7.4	12.6	35.2	9.4	22.4	11.9
590116	do	Lower subsoil, greenish-brown fine sand, 28 to 36 inches.	.7	8.6	17.6	56.7	6.0	6.2	4.4

[1] The high clay content of some samples, as shown in the results of mechanical analyses, is incorrect, owing to large amount of organic matter present, much of which is reduced to a fine texture in the process of analysis and enters the clay separate in the results. Sample No. 590113, for example, shows a content of 33 per cent clay, although it unquestionably does not contain nearly so much clay.

Mechanical analyses of Knik loam—Continued.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
Typical—Con.			*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590117	About 5 miles above mouth of Montana Creek.	Surface soil, gray silt loam, 0 to 4 inches.	.5	1.4	1.4	9.1	13.4	61.5	12.6
590118	do	Subsurface, brown loam, 4 to 14 inches.	.0	.8	.9	18.8	17.6	53.6	8.5
590119	do	Lower subsurface, brown or greenish-brown loam to silt loam, 14 to 20 inches.	.2	1.1	1.0	5.2	12.6	73.4	6.3
590120	Near confluence of Chunitna Creek and Talkeetna River.	Surface soil, gray silt loam, 0 to 4 inches.	.2	1.0	1.1	12.4	14.4	62.7	8.0
590121	do	Subsurface, yellowish-brown loam, 4 to 12 inches.	.2	1.2	1.6	16.4	21.4	49.2	10.0
590122	do	Lower subsurface, brown loam, 12 to 18 inches.	1.4	2.4	1.2	8.4	22.4	56.6	7.5
590123	do	Upper subsoil, greenish-yellow fine sandy loam, 18+ inches.	7.0	8.6	4.5	17.2	21.3	33.8	7.9
High-bench phase:									
590161	About 2 miles southwest of Kahiltna Bridge.	Soil, dark-brown loam, 0 to 5 inches.	.0	1.0	2.6	17.0	12.4	53.1	13.8
590162	do	Subsurface, brown loam, 5 to 15 inches.	.1	.6	1.4	26.3	17.4	45.2	9.1
590163	do	Subsoil, yellowish-brown loam, 15 to 26 inches.	.5	1.4	1.5	18.5	14.6	53.9	9.5

Average mechanical analyses of typical Knik loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
590101, 590112, 590117, 590120.	Surface soil	0.3	1.7	1.7	13.3	13.9	56.9	12.0
590102, 590113, 590118, 590121.	Subsurface	.2	1.5	1.6	14.9	18.8	47.1	15.9
590103, 590114, 590119, 590122.	Lower subsurface	.7	2.1	2.2	9.0	14.2	59.3	12.3
590115, 590123	Upper subsoil	4.1	8.0	8.5	26.2	15.3	28.1	9.9
590116	Lower subsoil	.7	8.6	17.6	56.7	6.0	6.2	4.4

KNIK FINE SANDY LOAM.

The Knik fine sandy loam, but for its sandy texture, is very much like the shallow phase of the Knik loam. The gray surface layer is present in places, but it appears to be absent more frequently than in case of the heavier soils of the Knik series.

The typical Knik fine sandy loam is a brown, mellow fine sandy loam, which grades at about 6 to 10 inches into greenish-brown or yellowish-brown fine sand to loamy fine sand, with coarser sand and gravel present in the lower subsoil. In places this lower subsoil is a loose fine sand of a bluish to greenish color, but gravel is generally present below 24 inches. On the trail between Susitna Station and Knik there was found a considerable area of this type having the gray surface layer so characteristic of the Knik series. About 6 or 7 miles east of Susitna the type consists of a gray silt loam or silty loam about 2 inches deep, overlying yellowish-brown, heavy fine sandy loam, which passes into greenish loamy fine sand at about 12 to 18 inches. This material becomes looser with increase in depth, and grades into fine sand or sand, with occasional included strata of very fine sandy loam, and with gravel at lower depths. Where there is a thick covering of moss, as is frequently the case over level areas and northerly slopes, the color of the upper fine sandy loam material is a darker shade of brown or coffee brown. About 10 or 12 miles up Kashwitna River there is much of this darker brown phase, with a covering of 6 to 10 inches of moss. Here the soil is a coffee-brown loam, which passes at about 5 to 8 inches into fine sand or loamy fine sand of a lighter shade of coffee brown. This in turn grades into greenish or yellowish-brown fine sand to loamy fine sand, with gravel and coarser sand in the lower part of the 3-foot section. Often a thin gray layer of silt loam or silty loam overlies the coffee-brown layer. Where the moss covering is thick, ice may be found in the subsoil in late summer.

Over the mossy areas there is always a plentiful growth of scrub spruce, usually accompanied by some small birch and willow, together with Hudson Bay tea, blueberry, and low-bush cranberry. In general the vegetation is quite similar to that on the shallow phase of the Knik loam. The trees are mostly spruce, and they are either decidedly scrubby or average very much smaller than those on the deep Knik loam. Aspen is found in dense thickets, often with few other trees present; also in forests with birch and some spruce. In other places birch grows almost exclusively. There is rarely such a dense undergrowth as characterizes the deep loam of the series, although the various plants common to that soil are found scatteringly over the type. Some cottonwood was seen mixed with spruce and birch along the western escarpment of Knik Arm.

The largest area found is that in the vicinity of Knik. Other areas were seen in the Susitna and Yentna Valleys, but these were scattered and mostly not very extensive. The type, so far as found, is confined to the lower benches.

The surface of much of this soil is essentially level; the remainder is undulating. All of it is topographically well suited to cultivation, and most of it has good drainage. Crops suffer more from lack of moisture in seasons of continued drought on this type than on the shallow phase of the Knik loam. Ordinarily the yields are light where manure has not been used. The fact that crops mature early on this warm-natured soil in some measure compensates for the light yields and the damage resulting at times from drought.

All of the crops of the region can be grown on the Knik fine sandy loam. The common wild pea (*Lathyrus maritimus* (L.) Bigel.), which was seen in such profuse growth on the escarpment of Knik Arm, should do well on this type, it would seem, since the textures of the soils are quite similar. Should the plant prove a successful field crop, it could be used to great advantage for building up the productiveness of the soil and, at the same time, supply valuable forage. The Knik fine sandy loam will likely need vegetable matter badly after 4 or 5 years of cultivation, and should this wild pea succeed as well under cultivation as in the natural growths on the gravelly escarpment of Cook Inlet, as above the village of Knik, for example, it would meet this requirement satisfactorily. In addition, it would undoubtedly supply much valuable nitrogen, gathered from the atmosphere.

As shown by increased yields, this soil responds readily to liberal treatment with barnyard manure. Potassic fertilizers, tried in a small way, are said to have given good results with potatoes and a number of vegetables. Soils of this kind generally are benefited by turning under green vegetation, such as will, through rapid decay, provide the humus necessary to effect a loamlike condition favorable to the conservation of moisture.

In the manipulation of this soil, according to experience, fall plowing is advisable. This should be done to a depth of about 5 to 7 inches after the first crop, that is, after a preliminary breaking approximating 4 or 5 inches deep. During the growing season frequent shallow cultivation will be the best practice.

Near Knik, barley was perfectly matured this year (1914) shortly after the middle of August, producing a good yield of plump berries. Wheat has been ripened in an experimental way at Knik. Among the successful vegetables seen were cabbage, lettuce, turnips, carrots, kale, garden peas, beets, and radishes. Potatoes of splendid quality are grown on this soil, and the yields are surprisingly large. Tomato and string-bean vines were seen in luxuriant growth in gar-

dens at Knik, but these did not mature fruit. The early varieties planted at an early date on steep southward-facing slopes probably would stand a good chance of producing satisfactory fruit.

Owing to the invariably acid condition, treatment with lime is generally needed. Like the other soils of the region, the type improves in certain respects with cultivation. Crops are said to yield more, to mature earlier, and to be of better quality in fields which have been under cultivation two or three years.

The following tables give the results and average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Knik fine sandy loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590131	About 1 mile southwest of Knik (cultivated field).	Soil, brown fine sandy loam, 0 to 6 inches.	0.3	3.6	8.0	24.0	20.6	37.2	6.7
590132	.....do.....	Subsoil, yellowish to greenish-brown fine sand to loamy fine sand, 6 to 30 inches.	.3	4.8	16.4	57.4	6.8	10.4	3.9
590133	About 1 mile southwest of Knik (virgin soil).	Soil, gray silt loam 0 to 1 inch, yellowish-brown fine sandy loam, 1 to 10 inches.	.1	.9	3.1	19.4	35.0	34.6	7.2
590134	.....do.....	Subsoil, greenish-brown fine sand to loamy fine sand, 10 to 36 inches.	.2	2.6	11.9	63.2	8.2	10.6	3.3

Average mechanical analyses of Knik fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
590131, 590133.....	Soil.....	0.2	2.2	5.6	21.7	27.8	35.9	6.9
590132, 590134.....	Subsoil.....	.2	3.7	14.1	60.3	7.5	10.5	3.6

KNIK SILT LOAM.

The Knik silt loam has a rather small development in scattered areas. It is so closely associated with the Knik loam in occurrence and grades into that type so imperceptibly that it would be difficult to show all the areas, even on a detail soil map. The physical properties of these two soils are so similar that there can not be any great difference in their agricultural value. The only important physical

difference is in the texture; the silt loam contains 10 to 15 per cent more silt and considerably less sand than the loam.

The Knik silt loam was seen in a number of places in the Matanuska Valley below Chickaloon. Here the soil is a gray silt loam 1 to 4 inches deep, overlying yellowish-brown friable silt loam, which passes at variable depths, usually between 18 and 30 inches, into yellowish-brown or slightly greenish-brown gravelly loam to gravelly sandy loam. A few unimportant patches were seen in which the lower subsurface consists of silty clay loam.

This soil supports the same type of vegetation as the Knik loam. Its drainage is prevailingly well established. The topography varies from nearly level to rolling.

Owing to its fine texture, the Knik silt loam will likely be more inclined to compact under cultivation than the coarser textured soils and will therefore require more intensive tillage for the maintenance of a good mellow tilth. Otherwise the requisite treatment will be practically identical with that of the Knik loam. The type is adapted to the same crops as the Knik loam, but with good management somewhat better yields may be expected, partly because the soil will hold more moisture through dry seasons.

CHICKALOON LOAM.

The Chickaloon loam really represents Knik loam with a deep, black, mucky surface soil. It is confined largely to situations which are permanently moist. Most of it occurs on shelflike positions, in depressions, and on gentle slopes. A representative 3-foot section shows the following characteristics: About 8 to 10 inches of black, mucky loam, overlying dark-brown loam, which grades through yellowish-brown to slightly greenish brown friable loam into a stratum of greenish and yellowish or mottled gravelly loam to gravelly sandy loam. About a mile northeast of the Willow Creek wagon-road crossing over the Little Susitna River, the soil is a black, mucky loam 5 to 8 inches deep, overlying dark-brown or coffee-brown loam grading at about 15 inches into yellow or yellowish-brown loam, which, in turn, passes below into yellowish fine sandy loam to gravelly loam or sandy loam. In places a gray silty layer is encountered just beneath the black, mucky surface.

The type occurs mostly as scattered benches in association with the high-bench phase of the Knik loam. Much of it is found on northerly slopes in rather cool situations. On account of its scattered occurrence, prevailingly unfavorable location, and wet condition, the Chickaloon loam is not a very important type. With the establishment of good drainage undoubtedly it would produce satisfactory crops of potatoes, cabbage, lettuce, celery, cauliflower, and onions, that is,

where the exposure admits of sufficient sunlight. The characteristic growth is alder, devil's club, redtop, currant, spruce, and birch.

The proper drainage could probably be effected by digging ditches along the upper margin following the slope contours. If necessary, others could be dug at lower levels. These ditches would cut off at least a part of the seepage.

The soil is very acid, and heavy applications of lime would be required to correct this acidity, according to the results of lime-requirement determinations (see table on p. 96). Of course in practice not so much lime would be necessary as these determinations indicate, since the estimate was made for an acre of soil 1 foot deep, and since, also, the method of lime-requirement determination includes neutralization of all the acid present in the soil, including that in the organic matter present, and this would probably not be necessary in actual practice. Three or four tons of burnt lime per acre would not be too heavy an application.

There is a phase of the type which occurs in lower situations and which approaches closely the characteristics of Muck. Perhaps there is as much of this low, flat phase as of that portion described above. This lower phase has the same value for crops, but it has an advantage of topography which makes it more accessible and easier to cultivate. Ditching would be necessary to prepare this soil for cultivation. Those areas of the type which can not be satisfactorily ditched could be used for pasturage and for the production of native redtop hay.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Chickaloon loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590106	1½ miles northeast of Moose Creek crossing.	Soil, black mucky silt loam, 0 to 10 inches.	0.2	0.6	0.7	6.4	18.3	50.4	[1] 23.0
590107	.....do.....	Subsoil, yellowish - brown loam, 10 to 30 inches.	.2	1.0	2.2	23.0	20.9	35.3	17.3

[1] The results of mechanical analyses of the surface section of this soil (sample No. 590106) are somewhat misleading, in that more clay than is really present is indicated by the analyses. The reason for this is that much of the large quantity of organic matter present (20.63 per cent in sample No. 590106) enters into the clay separate as determined by mechanical analysis. There really is very little clay in this surface soil, or, for that matter, in any part of the soil section.

MUCK.

Muck was found only scatteringly and in rather small bodies. The largest tracts are probably not much more than 25 to 30 acres in size, and in the majority of cases the areas are much smaller, frequently including not more than an acre or two.

Typical Muck occurs in situations where permanently moist conditions prevail, and where the topography permits the washing in of some soil material. The bulk of the component material consists of well-decomposed black vegetable matter—remains of trees, grasses, shrubs, and moss. There is present in the true Muck some mineral matter or soil material which is thoroughly incorporated with the organic matter. The content of such mineral matter ranges from about 10 per cent up to 50 or 60 per cent of the soil mass by weight, though averaging probably not more than 15 to 20 per cent. A sample taken 3 miles east of Knik contains 49.14 per cent organic matter. The Muck grades into loam so imperceptibly that it is not everywhere an easy matter to draw sharp lines of separation. On the other hand, the frequently associated Peat is so distinctive in character that it is ordinarily easy to identify it, although frequently occurring with the Muck in such a patchy way that it would be impossible to separate the two even on a detail soil map.

Several patches of Muck were seen between Knik and Chickaloon. That in the low, wet flats mostly consists of black muck, underlain at any depth between 12 and 20 inches either by brownish mucky material or by dark-brownish loam. Gravelly loam or gravelly sandy loam is usually reached in the lower part of the 3-foot section. A good many patches of this material were found on slopes, particularly in association with the high-bench phase of the Knik loam. There is not much difference between the Muck as found in these different positions. Probably the slope occurrence contains more soil material and averages shallower. Coffee-brown to yellowish-brown or mottled loam is reached on the slopes at any point from about 10 to 20 inches, generally with gravelly material at about 24 to 30 inches. Frozen material is found within less than 40 inches of the surface in places during late summer, especially on the northerly slopes.

There is a peculiar development of Muck overlying Peat along the foot of some slopes where there is a large amount of seepage. This phase is well developed along the foot of the bluff back of the village of Susitna. Here the soil is a dark-brown to black muck, underlain at about 5 to 10 inches by brownish peat. The mucky surface covering appears to have resulted from an overwash of soil material from adjacent slopes.

A gradational phase between loam and Muck is found in many low situations having a flattish to undulating surface. In such areas

moss is abundant over the surface and the drainage is imperfect. About 3 or 4 miles west of Knik there is an area of such a phase which consists of black muck to mucky loam, underlain at 12 to 20 inches by brownish to yellowish loam, passing below into gravelly loam or gravelly sandy loam. In this phase there is more soil material than in the more representative areas. Here Hudson Bay tea, blueberry, and scrub spruce are plentiful.

The characteristic growth on Muck consists largely of devil's club, alder, birch, spruce, redtop, and a thornless plant resembling devil's club.

Muck was seen in cultivation in several places, in some of which it had been tilled for several years. Some good vegetables were seen on it. Cabbage, rhubarb, lettuce, and onions seem to do very well after the land is drained and cultivated two or three years. Near Susitna, on an area of the Muck-Peat phase which had been ditched and spaded, much subsoil having been thrown to the surface, the results were not satisfactory the first year (1914). Cabbage, potatoes, snap beans, carrots, and peas had a yellowish, unhealthy appearance when seen in early August. It is believed the very acid condition of the material, or perhaps those conditions of which the acidity is merely the index, accounts for such unsatisfactory growth of plants. With good drainage and liming, Muck generally proves a valuable soil, particularly for such vegetables as cabbage, beets, lettuce, cauliflower, onions, and celery; and there is no reason why this land can not be successfully used in the Cook Inlet-Susitna country for these crops. Native redtop thrives and probably will be the best crop for a large proportion of land of this sort, especially where thorough drainage is difficult.

MUSKEG.

Muskeg has a larger area than any other class of land in the Cook Inlet-Susitna region, except possibly the Knik loam. There are large bodies and numerous small ones in the Susitna and Yentna Valleys, along the lower Little Susitna River, and on Kenai Peninsula. The low country between the Susitna River and the Yentna and Kahiltna Rivers appears to consist mostly of Muskeg.

Associated with the Muskeg is a considerable total area of low, wet, moss-covered peaty land, the surface of which is a little higher and better drained. There are also many small areas, and some of larger size, of better drained soils, mostly Knik loam, which are surrounded or practically surrounded by Muskeg.

Muskeg is locally styled "tundra" and "swamp." It differs from true tundra, as found in the regions about the mouth of the Yukon River and northward, in that it characteristically occurs as level areas of a very marshy nature, whereas tundra proper is not necessarily marshy, and its surface is often uneven. As a matter of fact,

Muskeg is nothing more than a type of marsh. It could be properly designated by several names, such as peat bog, marsh, and morass. It consists of peat so saturated with water as to have a very boggy character when thawed out, during the summer. In many places the peat mass seems to be underlain by water, that is, to consist of floating bogs. Here examinations with the soil auger show a comparatively firm mass of peat about 3 feet thick over water, or material containing so much water as to have a fluid character. In many places of this kind the impact of one's foot sets up a quaking or undulating motion of the surface to a distance of 50 feet or more. It is very easy to mire in such places, if one does not step softly and upon the more turf-bound portions of the surface.

The typical Muskeg occurs as treeless, low flats, mostly covered with low shrubs or heather (see Pl. IX, fig. 2), surrounded, or partly surrounded, by higher land in such a way as to give the areas the appearance of lakes. Much of this marsh does represent former lakes which have been filled or covered by the accumulation of the remains of plants encroaching gradually from the shore. One of the most common features is the presence of numerous small lakes interspersed through the grass and shrub covered Muskeg. Some of these lakes have been formed by the closing of outlets by vegetable accumulations, while others represent portions of former lakes not yet completely covered by the encroaching vegetation.

The material consists of brown or coffee-brown fibrous peat so free from mineral matter that no grit can be detected by chewing. Frequently sphagnum moss is found 2 feet or more below the surface with its original structure distinctly preserved, although more or less softened. Much of the material, however, lying below a depth of about 6 to 10 inches shows decomposition to have made considerable progress, it having a fine-textured, pulpy consistency. The immediate surface is quite thoroughly decomposed in many places and has a decidedly black color, especially where living moss is not abundant. A very large proportion of the mass is derived from sphagnum moss, but there are present the remains of the other plants growing with the ubiquitous moss. Most of these plants appear to have followed the encroachment of the moss, judging by the unusual predominance of moss through the vertical section. On the other hand the moss may have spread out over the remains of an advance type of vegetation, such as the common water lilies and other plants that grow in the lakes.

There are many small hummocks or tussocks and winding miniature ridges over the surface and slightly elevated rims around the edge of lakes 5 to 10 inches above the prevailing surface level. On these higher portions of the surface low shrubs have established themselves in dense growth, practically to the exclusion of other plants. The

commonest of these are dwarf birch, blueberry, Hudson Bay tea, *Spiraea steveni* (Schneid.) Rydb., *Myrica gale L.*, and *Empetrum nigrum L.* These shrubs are seldom higher than 2 feet. There are also occasional scrub spruce and birch and clumps of these, especially on hummocks where loamy material underlies the moss or peat. Where these shrubs are thick, the surface is drier and offers much safer footing than the mossy and grassy lower places. Over the wetter portion between the hummocks and miniature ridges slough grass (*Carex* sp.), branchless joint grass, a short plant resembling bulrush, and several sedges and other grasses represent the dominant plants, aside from the abundant moss. There are occasionally very narrow and winding strips where vegetation is very scarce, the surface being mostly covered with dark water carrying much organic matter in suspension. Travel across the Muskeg marshes in summer time is always very tiresome, progress being retarded by the impediment of shrub growths and by the boggy character of the material beneath.

Streams head in some of the Muskeg areas. The water in these has a characteristic dark color like that in the lakes of the Muskeg country and resembling the dark waters so characteristic of the Coastal Plain streams of the southeastern portion of the United States. The lakes are shallow as a rule and many of them have gravel bottoms. Fish were seen in many of these, even in those which were completely surrounded by Muskeg. Many of the areas of Muskeg in the Susitna Valley are elliptical in shape, the axis paralleling the general trend of the valleys.

In its present condition Muskeg is not only valueless itself for agricultural purposes, aside from some possibility of grazing and supplying hand-cut hay from the slough-grass areas, but it shuts off numerous bodies of good Knik loam, making them inaccessible. Expensive drainage operations will be necessary before any but small isolated areas can be reclaimed for farming purposes. Even when the land is reclaimed it is not likely to prove especially productive, although oats, native redtop, and slough grass could be grown for hay. Of the vegetables that might succeed, cabbage, onions, and celery would seem the most promising; at least these crops do succeed on soils of high organic content in various parts of the United States.

It is said that in Finland drained Peat lands which have been burned over are successfully farmed, the burning being repeated at intervals for the purpose of renewing the productivity of impoverished fields. Fair oats were seen on burned-over Peat near Fairbanks, Alaska.

To sum up then, Muskeg can not be counted as a very valuable soil asset in any immediate agricultural development of the region.

FIG. 1.—BIRCH AND SPRUCE FOREST, WITH UNDERGROWTH OF TROPICLIKE DENSITY, SUSITNA VALLEY.

Dense vegetation of this character is typical of the well-drained loam soil of this region.

FIG. 2.—MUSKEG BORDERED BY FOREST OF SCRUB SPRUCE (BLACK SPRUCE).

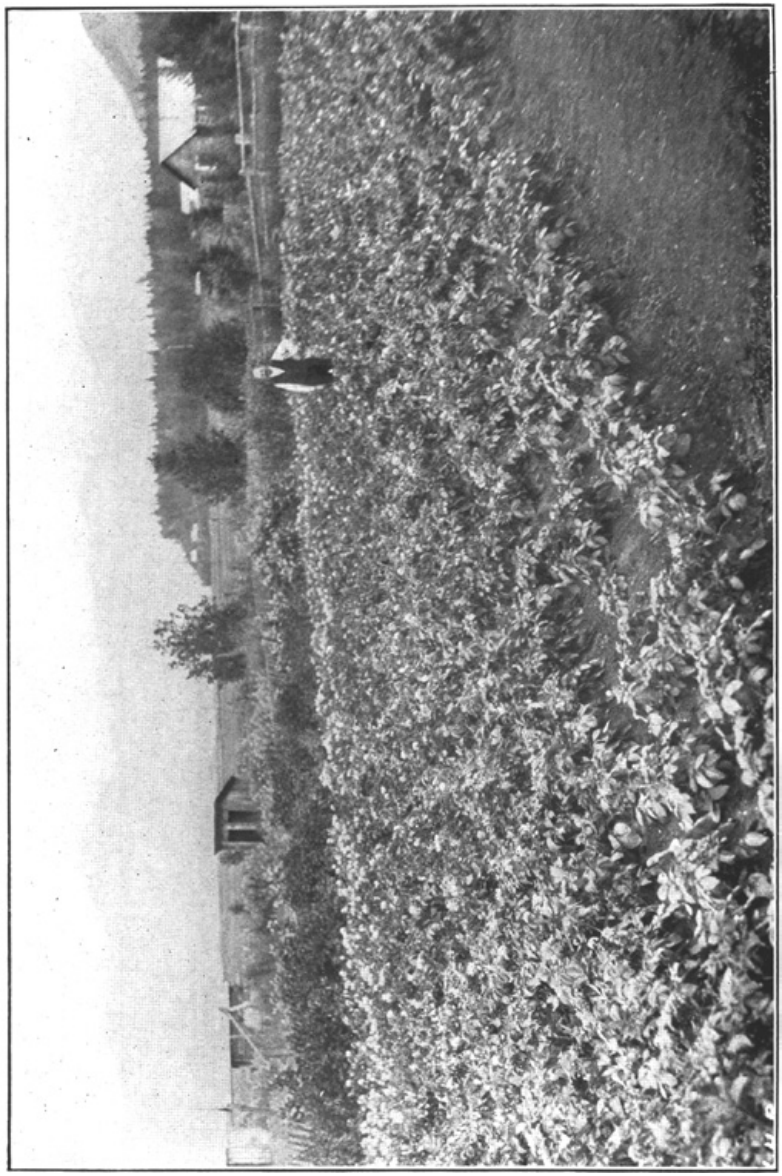
The Muskeg is treeless, shrub-covered marsh. The spruce is growing on moss-covered peat and loam soil, most of which is frozen throughout summer at 1 to 2 feet below the surface.

FIG. 1.—RUGGED MOUNTAINS OF ALASKA RANGE, FROM UPPER GRANITE CREEK, A TRIBUTARY OF KAHILTNA RIVER.

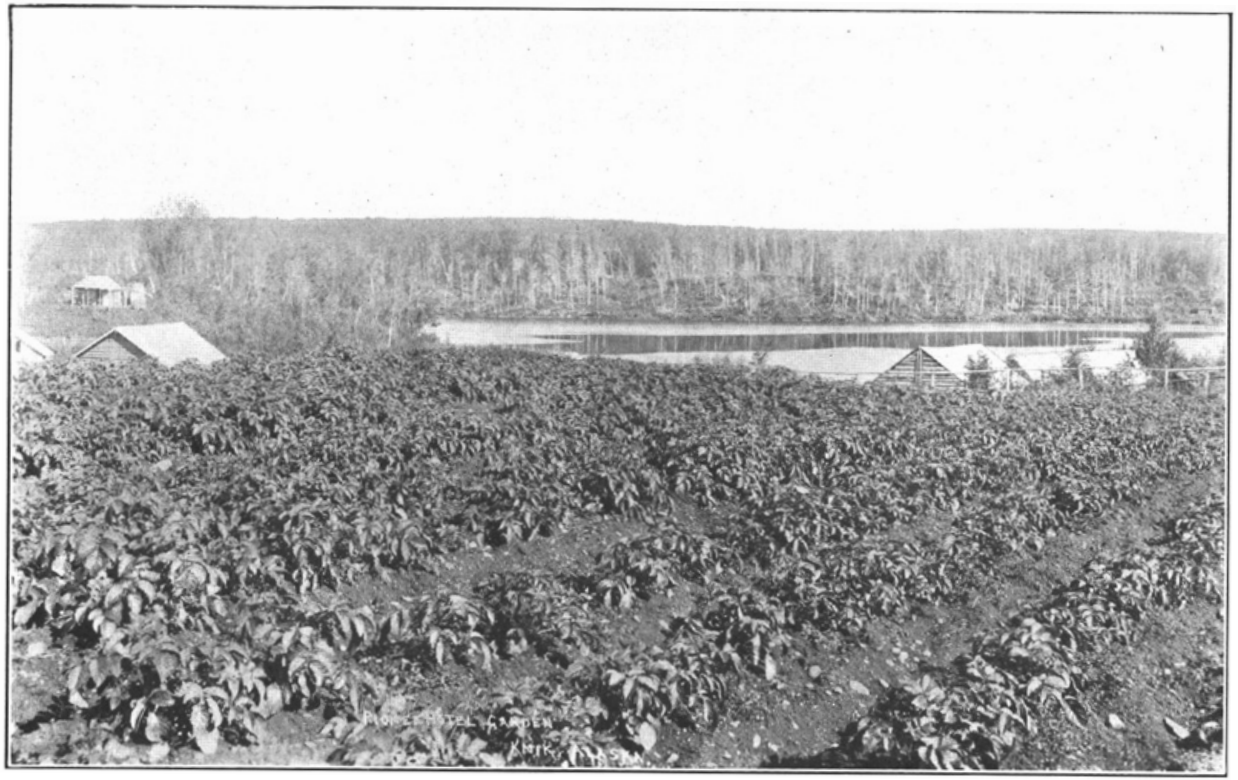
There are immense areas of such bleak, uninhabitable mountainous country bordering the agricultural lands described in this report.

FIG. 2.—ALASKA RANGE, HEAD OF RUSTY CREEK, A TRIBUTARY OF VALDEZ CREEK.

Grass lands extend far up the valleys of many streams heading in these snow-covered mountains.



POTATO FIELD AT HOPE, ALASKA.



POTATOES ON THE KNIK FINE SANDY LOAM AT KNIK.

The sky line of the background shows the general level of the benches bordering Cook Inlet.

PEAT.

The low, flat areas bordering the bodies of Muskeg and lakes are mostly covered with Peat. Here the organic material varies from 8 or 10 inches to 3 feet or more in thickness. Below this a yellowish to greenish or mottled loam is generally encountered. Ice is commonly present at depths varying from about 15 to 30 inches, and in this respect Peat differs from Muskeg, which thaws completely to depths of 4 or 5 feet or more by midsummer.

The Peat is composed very largely of sphagnum moss. It is usually but little decomposed even at depths of 2 or 3 feet. At these lower depths the moss has the original structure and apparently has changed only to a slight degree in color and in strength of fiber. It is very tiring to walk over these Peat lands, since the foot at each step sinks into the spongelike mass.

The areas of Peat stand a little above the Muskeg, and are better drained. They are almost invariably covered with a sparse to thick growth of scrub spruce. There is an undergrowth consisting mostly of Hudson Bay tea, blueberry, squawberry, and *Empetrum nigrum* L.

Peat is not much more valuable than Muskeg, inasmuch as the mossy material is not sufficiently decomposed and carries too little mineral matter to have much value for crop production. By burning over such areas in dry seasons or stripping off the moss it would be possible to bring into cultivation some of the underlying loam soil. Probably several years of cultivation or heavy liming would be required before crops would make favorable growth on such reclaimed land.

Another development of Peat is found in shoulderlike situations and depressions on the mountain slopes. These areas really approach Muskeg very closely in character; they are deep and very wet throughout the summer and support about the same vegetation. A number of flowers are usually present in these places, such as flags, a yellow-petaled flower resembling the blossoms of the worts, and an asterlike flower. These bogs are mostly surrounded by alder. They are of even less value than the Peat found in the lower country, owing to the unfavorable high situation.

The deepest Peat beds seen are those of the bogs occurring on the slopes and those included under the classification of Muskeg. Other heavy beds may occur elsewhere.

SUSITNA FINE SAND.

The Susitna fine sand is confined to the low bottoms and islands of the larger streams. Most of it is subject to overflow by the streams,

but the material is so loose in character that all of it, except that occurring in depressions, drains out quickly with the recession of overflow water.

This is a soil type where the problem concerning successful agricultural utilization is one of conserving moisture rather than of improving drainage conditions, aside from what may be done to prevent overflows.

The typical Susitna fine sand is a grayish fine sand, usually a little compact in the immediate surface, owing to the presence of some silt and vegetable matter. Beginning a few inches beneath the surface there is not much change downward until a stratum of coarse sand and gravel is encountered. This coarser stratum ordinarily is reached in the lower subsoil or just below the 3-foot section. The color of the subsoil is characteristically bluish gray to slightly greenish gray. In wet depressions the color of the surface material is dark, while the subsoil frequently shows a mottled grayish, bluish, and brownish color. Often there is present a thin surface layer, 1 or 2 inches thick, of brownish or dark-grayish silt loam to very fine sandy loam. In cultivation this layer would be mixed with so much of the subsurface fine sand by ordinary plowing that the texture would be changed to loamy fine sand. In places there is present a thin layer of brownish vegetable mold and occasionally some black mucky material, but such material is much less in evidence on this soil than on the Knik loam.

The most conspicuous tree is cottonwood. This grows to a greater height than the associated trees, and frequently has a diameter of more than 2 feet. Considerable alder and willow occur with the cottonwood. In places spruce of large size is found; also some birch and aspen are occasionally seen, especially where gravel occurs near the surface. High-bush cranberry, devil's-club, redtop, and other plants of the common regional undergrowth are locally plentiful. On a somewhat higher level, where overflows are not so frequent, spruce and birch are more abundant and cottonwood is less plentiful. In open places, especially on the islands and bars of the larger streams, a number of native plants, such as Indian potato and wild pea, grow luxuriantly.

The Susitna fine sand is not a very productive soil. Its structure is so loose that both drainage and aeration are excessive. The type, however, seems to be more productive than sands of similar texture occurring in large areas in the United States, such as, for example, the Norfolk fine sand of the Atlantic and Gulf Coastal Plain.[1] The Susitna fine sand carries a much larger quantity of minerals other than quartz than the Norfolk fine sand, which fact may have some connection with the higher productivity of the former.

[1] See Bul. No. 96, Bureau of Soils, U. S. Dept. Agriculture.

At the village of Susitna some good vegetable gardens were seen on this soil. Cabbage, beets, garden peas, lettuce, radishes, and turnips were doing well, especially where the gardens had been manured. Potatoes do fairly well, but they are said not to possess so good quality, especially on fresh land, as those grown on the well-drained Knik soils in sunny situations. It is generally admitted by those who have had experience with this soil that crops suffer on it in dry seasons. This susceptibility to drought will in all likelihood increase with cultivation, as the rather small content of organic matter will be depleted by the more active aeration resulting from cultivation. By turning under liberal quantities of green vegetable matter, the moisture-holding capacity of the soil could be materially increased. Oats, rye, or, perhaps better still, some of the native legumes could be used to good advantage in supplying needed organic matter.

This soil ranges from almost neutral to slightly acid. Applications of lime apparently are not needed as badly as on the Knik soils, but it is not unlikely that moderate additions of lime would help to bring new land into the best condition for crop production.

Some of the native plants growing on this soil which horses were seen to eat with apparent relish are: A blue-flowered small wild pea (*Lathyrus palustris* L.), a blue-flowered bunch plant (*Astragalus elegans* (Hook) Sheldon), a white-flowered plant (*Phaca americana* (Hook) Rybd.), joint grass (*Equisetum palustre* L.), and wild potato or Indian potato (*Hedysarum americanum* (Michx.) Britton). The roots of the Indian potato have a rather pleasant taste, and the Indians are said to be very fond of them.

The Susitna fine sand is closely related to the Tanana fine sand of the Tanana Valley, on which the two promising forage crops collectively known as wild pea (*Astragalus williamsii* Rydb. and *Hedysarum mackenzii* Richards) flourish. There is every reason to believe these plants would succeed on the Susitna fine sand of the Cook Inlet-Susitna region, and should they be found good field crops they likely could be introduced to advantage.

It is interesting to note in the following table, giving a mechanical analysis of this soil, the high content of fine and very fine sand, the two classes constituting 91 per cent of the body of the soil. It is not often that soils are found which carry so little of the finer grades of material, silt, and clay.

Closely associated with this type are many patches of Susitna very fine sandy loam, very fine sand, and silt loam. The relative abundance of the fine sand increases toward the banks of the larger streams, the finer textured soils being more abundant farther away from the stream.

The following table gives the results of a mechanical analysis of a representative sample of Susitna fine sand:

Mechanical analysis of Susitna fine sand.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
590130	Susitna.....	Soil and subsoil, gray to bluish-gray fine sand, 0 to 36 inches.	*P. ct.* 0.0	*P. ct.* 0.2	*P. ct.* 0.8	*P. ct.* 56.4	*P. ct.* 34.9	*P. ct.* 7.0	*P. ct.* 0.5

SUSITNA VERY FINE SAND.

The Susitna very fine sand occurs in the first bottoms of streams in close association with the Susitna fine sand, from which it differs but little, except in its finer texture. The typical soil is a grayish very fine sand, which grades below into grayish or slightly greenish to bluish very fine sand to fine sand. A porous stratum of coarser material—sand, gravel, and cobbles—is present in the lower subsoil or just below the 3-foot section. The surface soil to a depth of an inch or two is usually a little more loamy than the subsurface material on account of the presence of more silt and organic matter.

The vegetation conforms closely to that on the Susitna fine sand. In crop adaptation also the type is much like the fine sand, but the yields will probably average slightly larger, owing to the fact that this finer textured soil will retain moisture better. Under cultivation it will be necessary to add vegetable matter now and then to avoid the development of excessive looseness in the material and consequent increased likelihood of crop injury by drought. The plowing under of green vegetation will be the best means for replenishing the organic supply—that is, where manure can not be obtained.

SUSITNA VERY FINE SANDY LOAM.

The Susitna very fine sandy loam occupies a considerable proportion of the bottoms of the smaller streams, such as those of Fish, Sunshine, and Montana Creeks and Kashwitna River. There is also a considerable extent of it over the flats of the Matanuska River near the head of Knik Arm. The soil grades into the Susitna silt loam on one side and into the Susitna fine sand and very fine sand on the other. Where there is much organic matter in the surface soil it is frequently difficult to distinguish the Susitna very fine sandy loam from the Susitna silt loam. All of these soils are found in intricate association in many places.

The typical soil is a grayish-brown to brown very fine sandy loam to loamy very fine sand, having frequently a bluish or greenish cast.

This passes below, first, into very fine sandy loam or loamy very fine sand of a grayish, bluish, or greenish color, and finally into loose fine sand or a mixture of sand and gravel. This lower stratum is usually reached at an average depth of about 36 to 40 inches. There is present in a good many places a thin surface layer of gray silt loam or silty loam resembling the gray layer so common at the surface of the Knik soils. Plowing to ordinary depths would turn to the surface sufficient of the subsurface sandy material to change the texture of those areas having this gray silty layer or a common brown silty layer at the surface to the texture of very fine sandy loam. There are numerous imperfectly drained patches having a thin covering of dark mucky material or vegetable mold.

On the Knik flats the dominant soil, the Susitna very fine sandy loam, is a grayish to bluish-gray very fine sandy loam of a high silt content, underlain at about 8 to 12 inches by bluish or greenish silt loam to very fine sandy loam. Gravelly material is not always reached within the 3-foot section, but it is frequently present at about this depth. Some of the soil in this locality contains considerable alkali, enough to give a whitish color to portions of the dry surface soil. A field of young oats was seen here in which the plants appeared to be suffering from the effect of this alkali.

The following analyses show the parts per 100,000 of various water-soluble salts in the soil and subsoil of samples taken from this area. In the case of the field in which the oats were growing, the results indicate the presence of sodium bicarbonate ($NaHCO_3$) in quantities which would be considered dangerous to plant growth, at least, on heavy textured soils.

Alkali analyses of samples of Susitna very fine sandy loam.

[Parts water-soluble salts per 100,000.]

Kind of salt.	Sample No. 590110.	Sample No. 590111.
$CaSO_4$	85	62
Na_2SO_4	18	.....
$NaHCO_3$	99	99
NaCl	46	30
$CaCl_2$	.....	16
Per cent total solids	0.25	0.22

This type has good drainage over most of its area. It is partly subject to overflow, but this does not constitute a very serious problem, since the overflows are generally shallow and of brief duration, and the land dries off rapidly with the recession of the water. Much of the type probably is never inundated.

The vegetation consists principally of large spruce and birch. These trees are abundant, and a large proportion of them are of suf-

ficient size for lumber and crossties. There is also much cottonwood, alder, and willow. High-bush cranberry, joint grass, Indian paintberry, club moss, and redtop are plentiful.

The more poorly drained areas, especially those subject to overflow, probably are most valuable for the production of hay and for grazing. Redtop grows in such abundance and size that yields of 3 tons or more per acre could be cut.

The better drained areas will be found well suited to the production of vegetables, oats, barley, and, probably, of certain forage crops, such as the native legumes. With careful management crops should not suffer from lack of moisture. Nevertheless it will be a part of good practice to plow under, occasionally, some vegetable matter, or to make applications of manure. Most of the soil is acid, indicating a need of lime. There would probably be no need of lime in those places where the soil is alkaline, such as that in parts of the Matanuska Flats. Applications of wood ashes are followed with good results.

As is the case with the soils of this region generally, the plowing of new land at least a year before the crop is put in will likely be found a very good practice.

A number of native plants were seen which were eaten by horses, such as wild pea, Indian potato, and the others mentioned under the description of the Susitna fine sand. Experiments should be made with these plants to determine their possibilities as field forage crops. With a good forage crop of the legume family this soil could be counted upon as possessing much value for the production of stock feed. It is capable of producing large yields of both grass and grain hay. The type should prove durable under cultivation, especially if legumes are used in rotation with other crops.

The following tables give the results and average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Susitna very fine sandy loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
590110	About 20 miles east of Knik.	Soil, greenish-gray very fine sandy loam, 0 to 8 inches.	0.0	0.2	0.2	9.0	31.0	55.6	4.2
590111	.....do.....	Subsoil, bluish-gray silt loam, 8 to 36 inches.	.0	.0	.1	.7	4.0	78.2	17.1
590128	Near Talkeetna ...	Soil, gray silt loam 0 to 3 inches; dark-brown very fine sandy loam, 3 to 8 inches.	.3	1.1	1.0	9.2	37.0	40.2	11.1
590129	.....do.....	Subsoil, mottled brown and yellowish-brown very fine sandy loam, 8 to 30 inches.	.1	1.0	1.2	23.8	41.0	29.7	3.9

Average mechanical analyses of Susitna very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
590110, 590128.....	Soil.....	.7	0.6	0.6	9.1	34.0	47.9	7.6
590111, 590129.....	Subsoil.....	.1	.5	.6	12.2	23.0	53.9	10.5

SUSITNA SILT LOAM.

The typical Susitna silt loam is a brownish silt loam, underlain anywhere at from about 5 to 10 inches by yellowish-brown loam, fine sandy loam, or very fine sandy loam, which either continues to a depth of about 3 feet or grades into loamy fine sand or loamy very fine sand. A gravelly and sandy stratum is commonly encountered at a depth of about 3 feet, but there are places where silt loam is found in the lower subsoil, underlying material of a more sandy character. On the higher levels, where overflows are not likely to occur, there is frequently found a layer of grayish silt loam or silty loam over the subsurface brownish silt loam. In these places the brownish silt loam beneath the surface quickly changes below to yellowish brown, and this at about 8 to 14 inches is underlain by grayish to yellowish, and sometimes greenish, fine or very fine sandy loam, loamy very fine sand, or loamy fine sand. There are a good many strips along the smaller streams which consist of a mottled brown and rusty-brown silt loam, grading below, first, into mottled brownish and grayish or drab silt loam, and then into very fine sandy loam of about the same color. In the bottoms of Chunilna Creek (Clear Creek), near its confluence with the Talkeetna River, the soil is a dark-bluish silt loam to a depth of about 20 or 30 inches, below which gravelly material is present.

Spruce up to a diameter of 24 inches is plentiful over both the lower and higher levels; also, much birch is common throughout the extent of the type. Cottonwood of large size is frequently seen, especially in the lower overflowed bottoms. Alder and willow are also abundant on the lower levels. High-bush cranberry, currant, Indian paintberry, wild celery, devil's club, short fern, and joint grass are conspicuous plants over both the lower and higher levels of this type. There are also present in the higher places considerable moss, club moss, and low-bush cranberry.

While there are some depressions which have imperfect drainage, the greater part of the type is well drained. Portions of the lower level are liable to overflow from the streams, but such overflows are commonly not of long duration and would not seriously interfere with the use of the land for pasturage and hay. Some ditching will be necessary to perfect drainage over occasional depressions and some of the flat situations.

A considerable proportion of the soil needs only to be cleared in order to fit it for cropping. The type when properly handled should give good results with most of the vegetables of the region as well as grain and forage crops. Native redtop everywhere grows profusely. Potatoes possibly would grow rather too slowly, especially on new land, to be of the best quality. In older fields, of good drainage, it is probable that a potato of fairly good quality could be produced. Applications of lime and wood ashes undoubtedly would be followed by increased yields. The soil is prevailingly moderately acid, and there is no question that an addition of lime or wood ashes will have a beneficial effect. New land should be plowed at least a year before the ordinary cultivated crops are planted.

This should prove a durable soil under cultivation, and there should not be need of replenishing the supply of humus at so frequent intervals as would be necessary on the sandy types. This will depend, however, to some extent on the depth to the underlying sandy stratum. Where the sandy material lies near enough to the surface to be plowed up, in all probability it will be necessary to add organic matter or manure occasionally to prevent the soil from assuming an unfavorable structural condition.

The following tables give the results and average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Susitna silt loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590124	Mouth of Willow Creek.	Soil, brown silt loam, 0 to 10 inches.	0.0	0.3	0.2	3.0	17.0	67.1	12.1
590125	.....do.....	Subsoil, mottled brown, rusty brown, and grayish fine sandy loam, 10 to 36 inches.	.0	.5	1.9	42.2	24.2	26.2	4.9
590158	About 4 miles up Skwentna River.	Soil, brown silt loam, 0 to 16 inches.	.1	1.0	1.6	17.2	10.6	55.9	13.5
590159	.....do.....	Upper subsoil, light-brown fine sandy loam, 16 to 26 inches.	.2	2.0	5.0	39.9	11.0	35.2	6.9
590160	.....do.....	Lower subsoil, brownish silt loam, 26 to 36 inches.	.2	.6	1.2	10.2	10.2	68.4	9.3

Average mechanical analyses of Susitna silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
590124, 590158.....	Soil.....	0.1	0.6	0.9	10.1	13.8	61.5	12.8
590125, 590159.....	Subsoil.....	.1	1.2	3.4	41.1	17.6	30.7	5.9
590160.....	Lower subsoil	.2	.6	1.2	10.2	10.2	68.4	9.3

MUD FLATS.

Fringing the shores of Cook Inlet there are in many places narrow strips of flat land which are subject to tidal inundation. The lower levels of these are covered by water daily, but the higher portions are submerged only at times of highest tides.

The material composing these "mud flats" consists of water-laid deposits, principally of silt and very fine sand. This was deposited at flood tide from the muddied waters of the inlet, and largely represents the inwash of the tributary streams. A considerable part of the sediments is derived from the glaciers of the Matanuska basin and of the Mount McKinley region. The waters of all the large tributaries are heavily laden with suspended matter, bringing enormous quantities continually into Cook Inlet, especially during the summer, when the glaciers are discharging water at the maximum rate. Matanuska River, for example, carries in its swift waters so much fresh glacial material during summer that the water has a pronounced grayish color like that of the suspended matter. The water of the Susitna is more of a dun or grayish-brown color, probably because of the large intake from drainage basins without important glaciers and of the dark water from peat bogs. At the confluence of the Chulitna and Susitna Rivers the grayish water of the former, conveying much glacial outwash, contrasts strongly with the dun-colored water of the latter stream. Some of the swiftest streams of the region, such as Kashwitna River and Moose Creek, are almost clear, even at flood stage. In winter, when the glaciers are quiescent and the streams are frozen over, the inflowing waters are less voluminous and much clearer.

This great load of water-borne material pouring into Cook Inlet and kept in continual agitation by tides has the effect of keeping the water extremely muddied at all times. Each inundation by the rushing, turbid flood tides deposits additional sediments over the flats, and thus they are being gradually built higher. Water-loving vegetation establishes itself as the surface of the accumulating mud approaches the level of daily high tide and lends assistance in the building process. This unceasing process of sedimentation apparently is gradually adding to the area of the flats, at least in places, as, for instance, the upper end of Knik Arm, which seems to be filling with mud at a rapid rate.

Over the higher flats various grasses and salt-tolerant plants are plentiful. Beach rye is one of the common plants here. Good grazing is afforded by the vegetation of the mud flats, even after frost, and considerable good hay is procured from them. The higher areas are firm and comparatively dry at most times, so that mowers can be used readily and stock can graze without danger of miring.

The material is predominantly a silt loam, with enough fine and very fine sand present to give some areas the texture of a loam. There is little change in texture through the vertical section. In the surface the characteristic color is dark gray or drab, but in the subsoil there is much mottling with bluish and brownish colors. The content of water-soluble salts is rather high, particularly in the lower situations, where inundations by the salt water of the inlet are of daily occurrence and the drainage is necessarily imperfect.

TALKEETNA LOAM.

There was seen in several places above timber line a soil which consists of black or brownish vegetable mold, overlying a layer of grayish silt loam, about 1 to 4 inches thick. Beneath this, coffee-brown loam is encountered, which passes below into lighter brown or yellowish-brown loam to silt loam. Bedrock is reached at any level from near the surface to about 3 feet.

This type of soil is bare of vegetation in places, particularly at the higher elevations, but much of it is covered with sphagnum moss, arctic or reindeer moss, and Hudson Bay tea, dwarf birch, a variety of flowers, and other low vegetation. Such land, so far as seen, can not be said to have any important agricultural value, owing to its inaccessible location and unfavorable climatic environment. Patches of snow are seen nearly to the lower limits of this soil in late summer, in places obstructed from the sun. The type lies outside of the area including the more valuable agricultural lands of the Cook Inlet-Susitna region.

There is probably considerable variation in the soil occurring over the mountainous country. This description is of a definite type, which was found in a number of places, and it is given simply as a matter of interest. It is possible that at lower elevations the same soil may be present, and that it may produce redtop abundantly.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Talkeetna loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590126	Top of mountain, about 15 miles northwest of Talkeetna.	Soil, grayish loam, 0 to 4 inches	1.4	3.6	1.4	17.0	14.4	43.7	18.5
590127	.....do.....	Subsoil, brown loam, 4 to 30 inches.	2.6	5.1	2.5	10.4	13.8	47.3	18.5

MOUNTAINOUS AREAS.

The mountainous areas surrounding the Cook Inlet-Susitna region are largely unsuited topographically for farming, and much of the country is climatically unfitted for crop production. Plate X, figure 1, shows rugged mountains which have no possible agricultural value. Plate X, figure 2, shows valueless mountain wastes in the background, but in the foreground is shown the head of a valley like many of those in which grasses extend far back into the mountainous areas.

There are numerous places through the mountains where fair to good grasses, both redtop and bunch grass, thrive. During the summer feed has been found for the pack horses of various expeditions in many places above the timber line. Grass is reported to occur in abundance in many valleys and on the lower slopes of these mountains. Vegetables and grain for hay undoubtedly can be grown in the bottom lands of a number of streams flowing through these highlands.

The principal soil seen in the mountainous country contiguous to the Cook Inlet-Susitna lowlands is the Talkeetna loam. At the higher altitudes many of the mountains are permanently covered with snow.

The mountains surrounding the Cook Inlet-Susitna lowlands belong in the Pacific Mountain System, which, in a broad belt of a maximum width of nearly 300 miles (across Kenai Mountains and the Alaska Range along the one hundred and fiftieth meridian), sweeps around the entire southern Alaska coast in a great crescentic curve from the southern boundary of the Territory to the end of the Aleutian Peninsula. In this system there are many peaks rising to altitudes of 10,000 to 20,000 feet, numerous glaciers of enormous size, large snow fields and deep fiord indentations of the coast. This high mountainous area is bordered inland by a still vaster physiographic province, the Central Plateau Region, which, though dominantly mountainous, has a much milder relief. In this intermountain region (the Rocky Mountain System lies to the north of the Plateau) there are no glaciers or permanent snow fields.[1]

The Kenai Mountains on the south of Cook Inlet, representing an extension of the St. Elias and Chugach Ranges, are described by Martin,[2] as follows:

> Kenai Peninsula includes two geographically dissimilar and sharply separated districts, the Kenai Mountains and the Kenai lowland. The former, embracing about 6,500 square miles, includes all the mountainous or eastern and southern parts of the peninsula; the latter comprises about 2,900 square miles in the western part of the peninsula bordering Cook Inlet north of Kachemak Bay. The boundary between these districts lies along an approximately straight line connecting the heads of Kachemak and Chickaloon Bays, both of which are branches of Cook Inlet.

[1] Brooks, Alfred H., Alpina Americana Number 3, American Alpine Club, 1914.
[2] Bul. U. S. Geol. Survey No. 587, p. 22.

The Kenai Mountains have a general altitude of from 3,000 to 5,000 feet above sea level, the maximum being about 6,400 feet. These mountains constitute a rugged mass which is apparently without very orderly arrangement of form and drainage. The higher peaks are irregularly distributed, linear ridges are seemingly absent, the slopes are steep, and the drainage systems are irregular. * * * The southern and eastern parts of the mountains are now occupied by glaciers, which in each part consist of one great central ice mass from which many large valley tongues radiate and near which lie smaller separate glaciers.[1]

The principal rocks found in this region by the geologic reconnoissance are: Slate, graywacke, granite, greenstone, conglomerate, limestone, and diorite.

To the north and northwest of the Cook Inlet-Susitna lowland stretches the Alaska Range in the shape of a crescent, its lofty snow-covered peaks constituting surface features of great conspicuousness and scenic grandeur. Between the lowland of the Susitna Valley and the higher alpine portion of the range there is a belt of foothills, such as the Yenlo Hills near the Yentna River, and the Dutch and Peters Hills between the Kahiltna and Tokichitna Rivers. These hills are of smooth outline and most of them reach elevations of 3,000 to 4,000 feet, although there are some rougher peaks 5,000 feet high.[2]

In the higher and more rugged alpine portion of the Alaska Range beyond the foothills, there are almost countless peaks ranging in elevation between 8,000 and 20,000 feet, including Mount McKinley, 20,300 feet, and Mount Foraker, 17,000 feet, in elevation. Glaciers and permanent snow fields characterize considerable portions of this range.

The most widespread rocks of the range appear to be of a granitic character. There are also slate, shale, sandstone, conglomerate, and limestone; andesitic, dacitic, and trachytic rocks; dioritic intrusives; graywacke, greenstone, quartzite, and cherts.[3]

The Chigmit Mountains of the Aleutian Range, lying on the lower west side of Cook Inlet, are described by Brooks,[4] as follows:

The mountains lying west of Cook Inlet and along the Alaskan Peninsula are of different character from those described above. Here the relief is less, and the crest lines more subdued. Many of the prominent peaks are active or extinct volcanoes. The name Aleutian Range has been given to the general highland belt which forms the backbone of the Alaskan Peninsula and whose northern terminus coalesces with the southeastern part of the Alaska Range. In general it is characterized by prominent peaks distributed along a northeast-southwest axis, connected by crest lines of no great altitude. The range is broken into mountain groups by broad, low gaps and separates the drainage into Bering from that into the Pacific. Mount Iliamna (10,017 feet) and Mount Redoubt (10,198 feet), both active volcanoes, are the most prominent peaks of the northern part of the range, here called the Chigmit Mountains. At Cape Douglas

[1] Martin, G. C., Bul. U. S. Geol. Survey No. 587, p. 22: Geology and Mineral Resources of Kenai Peninsula, Alaska.

[2] Capps, Stephen R., Bul. U. S. Geol. Survey No. 534: The Yentna District, Alaska.

[3] See Professional Paper, U. S. Geol. Survey No. 70: The Mount McKinley Region, Alaska.

[4] Alpina Americana Number 3, pp. 5-6.

is another group of mountains 6,000 to 7,000 feet high. In the same axes, but 75 miles to the southwest, lies Katmai Volcano, known for its violent eruption of June 6–8, 1912. Still farther to the southwest are innumerable other volcanic peaks, of which Shishaldin (9,387 feet) and Tsanotski (8,088 feet) on Unimak Island are best known through their volcanic activity. The little-explored Aleutian chain contains many extinct and several active volcanoes.

The geology of the Aleutian Range is relatively simple. A broad arch of Mesozoic sediments, complicated in places by minor folds and dislocations, forms the main structional feature of the range. Through this igneous rock has at many places broken to the surface. This igneous material has been piled up around craters as volcanic lavas and ashes. In the Aleutian Islands the sediments forming the arch are below sea level and only the volcanic material is visible. Here and there masses of granite have invaded the sediments and some of the older volcanics. Glaciation has played only a minor part in the sculpturing of these mountains.

The highlands north of Knik Arm and east of the Susitna Valley are comprised in the Talkeetna Mountains. The interior of these has been described as "an extremely rugged area," with the higher peaks of the central portion attaining elevations of 8,000 to 9,000 feet. The principal rocks in this group consist of granite, shale, sandstone, conglomerate, arkoses, andesitic greenstone, dacite, and rhyolite and associated tuffs, micaceous schists, graywacke, diorite, and basaltic lava.[1]

AGRICULTURE.

INTRODUCTION.

The benches and bottoms of the Cook Inlet-Susitna region include an estimated area of 2,025 square miles of land which needs only clearing to be made ready for cultivation, in addition to which there exists a further area that could be made ready for farming by improving the drainage. The remainder of the low country, the entire area of which approximates 6,039 square miles, consists mostly of marsh (Muskeg), whose drainage would require extensive ditching, and which even when drained would not become especially good farm land. By reclaiming these bodies of marsh, however, some included areas of good soil, now practically inaccessible, would be made available for farming.

About one-half of the best class of farming land lies in the Susitna and Matanuska Valleys; the other half is situated on Kenai Peninsula. Until railroads are constructed a large part of this will be too inaccessible to encourage occupancy.

As determined by the reconnoissance survey of this region, the lowest estimate of the area of land that could be farmed without costly drainage is 1,296,000 acres. This would provide for 4,050 farms of 320 acres each. With the land that could be reclaimed by

[1] See Bul. U. S. Geol. Survey No. 327· Geologic Reconnaissance in the Matanuska and Talkeetna Basins, Alaska.

drainage there would be room for about 10,000 farms of 160 acres each, or a farming population, counting 5 persons to the farm, of 50,000.

The limitation on crop production imposed by climate, the restriction upon commercial disposition of products by distance from market and costly transportation, and the present inaccessibility of much of the land suited for farming are the more important factors confronting agricultural development. The climate can not be adjusted to crops, but crops can be adjusted to the climate, as shown by experience. Successful marketing of farm products will be determined by such factors as the character and quantity of the products, cost of transportation, and the development of home markets through an increase of population. Obviously, marketing of products in the concentrated form, as butter and cheese, will more likely afford a margin of profit over transportation charges.

There is no question as to the possibility of establishing farms which will be practically self-supporting—farms that will produce all the milk, butter, cheese, meat, and potatoes needed. A number of farmers have cleared and put into cultivation fields of 15 to 30 acres or more, and are not only producing all the potatoes and vegetables required by themselves, but have a surplus for sale at the villages. They are also growing oats and barley for hay and are cutting the native redtop and marsh grass for horse feed. There are successful gardens at Knik and other villages and a number of market-garden farms near these small towns.

Probably 500 acres, at least, are now under cultivation in the Cook Inlet-Susitna region; the lowest estimate of land cleared for cultivation is 1,000 acres. The greatest activity is centered about Knik. The most extensive development at any considerable distance from the villages is that in the Cottonwood section along Knik Arm to the northeast of Knik. Here men who had previously devoted most of their lives to prospecting and mining are comfortably supporting themselves by the products of the farm, with the assistance of some earnings derived from outside work.

There is a flat in the vicinity of Seward at the head of Resurrection Bay containing about 35 square miles. Here there is a heavy stand of hemlock and spruce. The vegetation is of the coastal type, and hence this region belongs in a different vegetative province from that described above. Some land has been cleared near the railroad running inland from Seward (the Alaska Northern, to be a part of the line to be built by the United States Government) where there are some thrifty market gardens and good native-grass meadows. Other areas of land capable of being farmed are reported as existing in various parts of the Kenai Peninsula and in other sections near the

area discussed in this report.[1] Piper discusses the grasses and grasslands of Kodiak Island and various places along the South Alaska coast.[2]

The interest recently shown in farming here indicates that the building of railroads and highways will be followed by activity in the opening and operation of farms. In several parts of the region cabins have been built and land has been cleared during the year. There are records of about 150 homestead claims at the office of the United States commissioner at Knik, and still other settlers have not yet recorded their claims.

At present farming in this country is only in the beginning—in the pioneer stage. It is only within the last few years that the land has been cultivated except in vegetable gardens. Vegetables have been grown and hay cut for a number of years about the mining centers and trading posts, such as Sunrise, Hope (see Pl. XI), Susitna, Kenai, Knik, and Seward, but the development of the last few years has been an important step forward—the opening of farms with the purpose of developing them for permanent occupation.

AGRICULTURAL OUTLOOK.

Enough has been accomplished by the pioneer farmers of this region to demonstrate that a number of crops can be successfully produced. It has been shown that potatoes of fair to good quality can be produced without fertilization; that cabbage, turnips, garden beets, onions, lettuce, cauliflower, kale, radishes, and several other vegetables are grown with good results and that small grain, particularly barley and oats, succeed, producing good hay or matured grain. In addition, native redtop, which makes good hay, grows luxuriantly on all soils that have been cleared or burned over. There are natural meadows of this grass, amounting to thousands of acres, which in many places will yield from 2 to 3 tons of hay per acre. This grass has spread itself over the entire region. It occurs far up the slopes, even above the line where cultivation could be safely carried on. In addition to the enormous amounts of hay that can be cut from the natural meadows without the expenditure of much labor this grass will afford excellent summer pasturage. There are also other native plants which are valuable as feed for both horses and cattle.

Although little has been done with stock, it has been shown that cattle can be raised here. Horses are kept with but very little trouble; they maintain themselves in summer, but must always be fed during the winter. There may be a few places where they will

[1] See map and report, Geology and Mineral Resources of Kenai Peninsula, Alaska, Bul. U. S. Geol. Survey, No. 587, and also other maps and reports of the Geological Survey covering areas in this region.

[2] Grass Lands of the South Alaska Coast, Bul. Bureau of Plant Industry, U. S. Dept. of Agriculture, No. 82.

be able to get some winter grazing. Cattle have been raised at Ninilchik in a small way for a long period of years. Part of the work at the Kenai experiment station was with the raising of stock and the production of dairy products. A small dairy herd was maintained exclusively on native pasture and feed produced locally, and it was determined that cattle could be raised in this locality and butter and cheese of good quality made from the milk.

There remains much to be done in the matter of adjusting varieties of crops to the conditions and in working out the best methods of soil management; in fact, only the first steps have been taken toward the development of agriculture, but these first steps have shown conclusively that farming is practicable. An experiment station in the Knik section would give much assistance to the region in determining the best varieties of crops to grow here and in putting into the hands of farmers the seed of such varieties. At Kenai an experiment station was maintained until 1908.[1]

All grains will produce good hay, even with unseasonable frost. Barley, oats, and wheat have been matured at Knik, but only in an experimental way. There is every reason to believe that the early varieties of grain can be ripened annually throughout that portion of the region not subject to chilling winds and unseasonable frosts.

When the country is opened to settlement by the building of a railway with branch lines and the construction of wagon roads there is likely to be established, gradually, an agriculture of considerable importance. This, it is believed, will eventually include either stock raising or dairying, or both, as the principal source of income. Agricultural development unquestionably will be gradual—a slow growth accompanying the construction of highways and railroads, the expansion of mining and fishing industries, and increase in population attracted by these industries. The conditions of climate, transportation, markets, soil, and crop production should be carefully studied by the prospective farmer before going to the region for the sole purpose of engaging in agricultural pursuits. The immigrant farmer should also be provided with capital to purchase such supplies and implements as will be needed until land can be cleared and crops produced.

POTATOES.

The potato is a very successful crop of the Cook Inlet-Susitna region (see Pl. XII), doing particularly well on the mellow Knik loam in sunny situations. It can be grown on all the soils, even on Peat, if adequate drainage is provided. But the quality is decidedly better when grown on the well-drained soils, such as the loam and fine sandy loam of the Knik series. To produce the best tuber the crop must start early and make steady growth, otherwise it does not

[1] See reports of Alaska Agricultural Experiment Stations, U. S. Dept. of Agriculture.

mature properly. A well-drained, well-aerated, warm-natured soil, so situated as to receive a full share of sunshine, best meets these requirements. New land is said to give a potato of inferior quality as compared with that grown on land which has been under cultivation for several years. Some difference in quality can also be ascribed to the variety; the early varieties will produce the best potatoes for the table. Experience indicates that an important advantage in the matter of insuring maturity is gained by sprouting seed potatoes before planting.[1] Those having an undesirable soggy nature can be used for stock feed.

Yields of 250 bushels or more per acre are made on the Knik loam without the addition of fertilizer. Potato production by the best farmers on the best soils has been thoroughly successful, both as regards the quality and yield of tubers, and since the good potato soil, the Knik loam, has an extensive development throughout the Cook Inlet-Susitna country, it follows that this crop will have an important place in the development of agriculture here.

Varieties most commonly planted are the Early Rose and Early Ohio. In one instance a farmer stated that he had developed on his farm a variety which was considerably earlier than his other potatoes. Potatoes of this variety were large enough to eat on the 28th of July, though planting this year (1914) was two or three weeks late, owing to an unfavorable spring.

OTHER VEGETABLES.

Cabbage of excellent quality is grown on the Knik loam and fine sandy loam (see Pl. XIII, fig. 1). The crop also does well on the Susitna soils where the drainage is good. Muck land would likely give good results when drained, especially if limed or given heavy applications of wood ashes. Additions of manure and wood ashes have been followed with good results wherever made for this crop.

Cauliflower, kale, spinach, and kohl-rabi have proved successful on the same soil and with about the same treatment as employed in the production of cabbage. Lettuce of both the loose-leaf and head varieties is easily grown. The product is crisp and delicious, and the yields have been very good in all cases. This year lettuce is reported to have been ready for the table on June 7 from seed sown May 12. The variety known as romaine is also successfully grown.

Radishes and certain varieties of turnips succeed where not attacked by root maggots, a pest which appears to be troublesome to these crops throughout Alaska. No effective method of combating root maggots has come to the attention of the writer. It is believed by

[1] See annual report of the Alaska Agricultural Experiment Stations for 1912.

some that less damage is done where wood ashes have been liberally applied. This suggests that additions of lime might have some remedial effect. The Petrowski turnip is quite resistant to the maggots, and rutabagas ordinarily are not injured so much as the common turnips.

Among other successful vegetables are onions, beets, carrots, parsnips, rhubarb, and garden peas. It is believed that celery could be grown with very satisfactory results.

Spinach, onions, turnip greens, and radishes were being sold from local gardens at Knik by the 26th of June this year (1914). These crops were planted about the middle of May.

GRASS AND FORAGE PLANTS.

As already stated, native "redtop" (*Calamagrostis inexpansa* Gray, *C. scabra* Presl., and *C. canadensis* (Michx.) Beauv.) occurs abundantly throughout the region. Some varieties are found scatteringly even on Muskeg. This grass attains a height of 5 or 6 feet and grows so thick that a man in it may be hidden from view at a short distance. (See Pl. XIII, fig. 2.) There are many places where probably as much as 3 tons of hay can be mowed from natural meadows with but little preliminary clearing. Redtop springs up plentifully in every clearing and over every "burn." In the open places the plants average larger than those grown in the shade of the forests, where redtop is of very common occurrence.

The supply of this grass seems almost unlimited. It occurs over the stream bottoms, benches, and up the slopes, even above timber line. Whether constant cutting will injure the stand or not has not been determined. It seems probable that sufficient seed would be distributed by winds to reestablish a good sod in a very short time.

It is said that trouble is had in curing redtop hay in this region on account of rainy and cloudy weather. While it is true that much unfavorable weather will be encountered, there is no question as to the possibility of curing redtop hay under normal conditions. By keeping the uncured hay stirred at intervals with a tedder, when mowing is followed by rain, it is probable that all of it could be saved under ordinarily bad weather conditions, since the grass could thus be kept from heating or molding until sunshiny weather sets in. Only a few hours of sunshine are required to cure it thoroughly. The green hay also could be saved by raising it upon racks, such as can be easily built of poles or upon wires stretched at convenient places, as is commonly done in Norway. Samples collected by the writer at 10 o'clock on a partly cloudy day were well cured by 5 in the afternoon of the same day. Well-cured redtop hay was seen on several farms.

Other forage crops of the region can be handled in the curing process just as is redtop.

Redtop and other crops also could be stored green in silos. Where dairying is carried on, silos will probably be found necessary for the most profitable management of the industry.[1] Pit silos elsewhere have proved satisfactory where the ground formation is suitable and there is no danger from seepage. Sites admirably suited to such silos could be found throughout the region, in or near the abundant bench escarpments, with their well-drained, gravelly substrata.[2]

It is believed by some that redtop hay is of low nutritive value, but this contention is not substantiated by the results of feeding or analysis. Horses and cattle thrive on the green grass in summer and relish the hay in winter. The hay has been used in various parts of Alaska as an important winter stock feed. When cut at the right stage of development, which seems to be about the time the seed begins to show signs of ripening, experience has shown that this is a valuable hay; but if not cut until killed by frost or until the stalks have attained a tough, woody growth, the product may not be expected to prove very nutritious.

Redtop hay does not of course constitute a balanced ration, but it has nevertheless been proved a valuable feed—a part of a good ration. Chemical analyses show that the composition of the plant, harvested before complete maturity, is very much the same as that of timothy and other cultivated hay grasses (see p. 86). Digestibility is a very important factor in measuring the nutritive value of hays; in this case the results of actual experience with feeding stock indicate a satisfactory digestive quality.

Slough grass or marsh grass (*Carex physocarpa* Presl. and *C. variabilis* Bartley) is a valuable plant which thrives in marshy places. It is abundant even on portions of the Muskeg. It has been cut for hay by a number of farmers and has the reputation of making very good feed if cut just after the seed is well formed. Some of those who have used this hay for feeding cattle in the Tanana Valley state that it makes an excellent hay, even better than the native redtop. One disadvantage of this slough grass is the difficulty of harvesting it, owing to its marshy habitat—the impracticability or impossibility of cutting with machinery. When ditched it may be possible to use mowers on these marsh lands, otherwise the hay must be cut by hand. Perhaps the best method of utilizing this grass is to pasture it.

Bunch grass (*Festuca altaica* Trin.) was seen in a few localities. It was most plentiful in the country about 6 miles above the mouth

[1] See Farmers' Bulletins Nos. 556 and 578, The Making and Feeding of Silage.

[2] See report on construction of pit silos at the Plains substation, Bul. No. 200, Colo. Agri. Exp. Sta.

of Ship Creek. This grass is said to be relished by horses both before and after frost.

Native grasses are abundant, especially in the Cook Inlet region, which contains broad areas of natural grassland. There is also a considerable aggregate area of patches of grassland in the mountain province, especially around timber line (Pl. XII, A, p. 34) and in the upper timberless parts of the valleys. There is no difficulty in finding good forage for horses during the summer in almost any part of the peninsula, except along the rockbound coast. Considerable hay is made in the peninsula, especially in the vicinity of Hope, Sunrise, and Seward. In the Sunrise country native hay in stacks brings $10 to $12 a ton, and late in the winter occasionally $20 a ton.[1]

Among the other native plants which are eaten by horses are joint grass (*Equisetum palustre* L., and other varieties), growing abundantly throughout the region; small wild pea (*Lathyrus palustris* L.), locally abundant on open bottoms and slopes; large wild pea (*Lathyrus maritimus* (L.) Bigel.), locally plentiful on gravelly slopes; *Astragalus elegans* (Hook) Sheldon, growing on sandy alluvial soils; wild potato or Indian potato (*Hedysarum americanum* (Michx.) (Britton), growing in bunches on sandy and silty alluvial soils; and beach rye (*Elymus arenarius* L.), growing on mud flats.

Joint grass is a succulent plant, valuable for grazing purposes while green; after frosts it is very light and apparently of little value. The wild pea is greatly relished by horses, and undoubtedly would be by cattle. Wild pea was found a valuable milk producer at the Kenai station.[2] Should these or either one of them make good feed for cattle, and at the same time prove successful field crops, the question of supplying cattle with feed of high protein content would not be formidable. They will at least be valuable where found growing in the undomesticated state. In addition to their probable forage value these legumes unquestionably would add humus and nitrogen to the soil.

The small pea (*Lathyrus palustris* L.) does not seed so heavily as the large variety (*Lathyrus maritimus* (L.) Bigel.) and is not so promising as a field crop. The latter plant grows in various parts of the Pacific Coast region, in Canada, and in Europe, but no records of its use as a field crop are available. In view of its heavy production of seed there seems no reason why it should not be a successful cultivated crop; it should, by all means, be tried.

Beach rye has proved a satisfactory hay. Its distribution is restricted principally to the low mud flats bordering Cook Inlet and its arms. Some of the grasses growing on these flats are said to be relished by horses for considerable periods after frost.

The value of Indian potato and several other of the common plants for cattle could not be learned, although horses relish them, at least while green.

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[1] Bul. U. S. Geol. Survey No. 587, pp. 28–29.

[2] See annual report of Alaska Agricultural Experiment Stations for 1907, p. 63.

Several native plants of possible value as cultivated crops should be experimented with, and their value for forage and as soil builders determined. Herein lies an important field for experiment-station work.

In addition to the regional plants the wild peas of the Tanana Valley (see p. 162) may be found, on trial, to be valuable crops for this portion of the Territory. Canada field peas have been grown with at least fair results, indicating that this will be a valuable forage crop. Bluegrass and a white-blossomed variety of clover, locally called white clover, were seen in luxuriant growth over small areas where the seed had been accidentally scattered. No domestic vetch was seen growing. The variety *Vicia sativa* L., which does so well on the Tanana bottom soils, would likely succeed here. Thrifty bunches of timothy were found in many places where the seed had been scattered from imported hay. In those cases encountered, however, where timothy had been sown, very poor results were obtained. These trials were on a very thin, rather droughty soil, recently brought into cultivation. There is reason to believe the crop would succeed on land which has been cultivated longer, especially on the deeper loams, where lime and manure have been applied.

Oats and barley are frequently cut in the milk stage for hay, producing a very valuable product. Hay of this kind can be successfully produced throughout the reigon, grains making especially good growth on the Knik loam. Rye has been grown in a small way and some good volunteer patches were seen. Seeded in the fall, this crop also may prove a valuable hay producer. The root crops, potatoes, carrots, turnips, and beets, would contribute largely to the supply of stock forage.

In the two tables following are given (1) the analyses of the more important grasses of the region, samples of which were collected in various stages of development, and (2) analyses of a number of common feeding stuffs. It is recognized that the nutritive value of feeds can not be determined solely from the results of chemical analysis, but the results may have at least a suggestive value. For example, if a plant is shown to contain a high percentage of fiber it may be safe to infer that its feeding value is low.[1]

[1] See Analysis of Feeding-Stuffs, Bul. No. 169, New Hampshire Agri. Expt. Sta.; and also Digestive Experiments with Texas Feeding-Stuffs, Bul. No. 166, Texas Agr. Expt. Sta.

Analyses of air-dried samples of forage plants collected in the Cook Inlet-Susitna region and the Tanana and Yukon Valleys, Alaska.

[Analyses made by the Bureau of Chemistry.]

Species.	Location.	Condition of grass when collected.	Moisture.	Ash.	Ether extract.	Protein.	Crude fiber.	Nitrogen-free extract.
Native redtop:			*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
Calamagrostis scabra.	Susitna Valley....	Green; seed beginning to mature; grown in open.	3.68	3.80	1.38	7.88	37.44	45.82
Calamagrostis canadensis.	.....do.....	Green; seed well formed, but not matured; grown in shade.	5.31	5.32	1.91	8.25	33.17	46.04
Calamagrostis scabra.	Knik Arm.....	Green; well flowered..	4.02	3.78	1.62	8.25	38.94	43.39
Calamagrostis canadensis.	Tanana uplands...	Slightly frosted.....	4.82	7.88	2.05	8.16	33.80	43.29
Calamagrostis canadensis.	Tanana bottoms..	Moderately frosted....	4.88	5.58	2.22	4.11	32.09	51.12
Calamagrostis canadensis.	.....do.....	Severely frosted.....	5.71	2.95	1.25	3.16	43.66	43.27
Slough grass:								
Carex physocarpa	Knik Arm.....	Green.....	5.76	6.90	1.92	12.63	.....	.....
Carex utriculata..	Tanana bottoms..	Slightly frosted.....	5.19	6.58	2.35	6.05	28.13	51.70
Carex utriculata..	Yukon bottoms...	Severely frosted.....	5.25	7.02	1.97	6.59	28.71	50.46
Niggerhead grass (a sedge).	Tanana Valley....	Green.....	5.42	2.94	2.45	8.06	27.76	53.37
Joint grass (Equisetum palustre).	Knik Arm.....	.....do.....	7.79	15.68	2.07	11.91	16.68	45.87

Composition of common feeding stuffs.

[Analyses from Farmers' Bulletin No. 22, "The Feeding of Farm Animals."]

Hay.	Ash.	Fat.	Protein.	Fiber.	Nitrogen-free extract.	Water.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
True redtop (Agrostis alba).....	4.9	2.1	8.0	29.9	46.4	8.7
Timothy (Phleum pratense).....	4.5	3.0	6.0	29.6	41.9	15.0
Orchard grass (Dactylis glomerata).....	6.0	2.6	8.1	32.4	41.0	9.9
Bluegrass (Poa pratensis).....	7.0	3.6	6.3	24.5	34.2	24.4
Barley.....	5.3	2.5	9.3	23.6	48.7	10.6
Oats.....	6.1	2.7	7.4	27.2	40.6	16.0
White clover.....	8.3	2.9	15.7	24.1	39.3	9.7
Vetch.....	7.9	2.3	17.0	25.4	36.1	11.3
Roots and tubers:						
Beets.....	1.0	.1	1.5	.9	8.0	88.5
Turnips.....	.8	.2	1.3	1.2	5.9	90.6
Rutabagas	1.2	.2	1.2	1.3	7.5	88.6
Carrots.....	1.0	.4	1.1	1.3	7.6	88.6
Potatoes.....	1.0	.1	2.1	.6	17.3	78.9
Grain and seed:						
Barley.....	2.4	1.8	12.4	2.7	69.8	10.9
Oats.....	3.0	5.0	11.8	9.5	59.7	11.0
Cotton seed.....	4.0	20.1	19.6	18.9	28.3	9.1
Milk:						
Whole milk.....	.7	3.7	3.6	.....	4.9	87.2
Skim milk.....	.7	.9	3.3	.....	4.7	90.4

GRAIN.

Early varieties of barley and oats mature on the well-drained lands where the rays of the sun are not obstructed by the topography. There are localities where cold winds and unseasonable frosts are likely to prevent maturity, but on most of the better-drained lands the conditions favor the ripening of these crops. Plate XIV shows a field of oats on a well-drained southerly slope, where the early varieties of this crop may be expected to reach complete maturity in years of normal seasons.

On the Knik fine sandy loam near Knik a good crop of barley was matured this year well before frost, producing plump, hard grains. The plants tillered well and the heads were large. This was the third successive crop on the same farm from the original seed. A small patch of wheat sown on the Knik loam at Knik about the 1st of July is reported to have gone through the winter in good condition, but to have been practically ruined by the thawing and freezing of the following spring. The crop might have been saved by rolling to prevent the heaving out of the plants. On the other hand, it is possible that had the seed been sown late in the fall, after danger of the grain's sprouting had passed, the plants would have made an early start the following spring and reached maturity ahead of frost. This method of late fall seeding may be found advisable with those grains or varieties of grain which are inclined to mature slowly.

It is probable that grain sufficiently hard for milling could be grown in the more favorable portions of the Cook Inlet-Susitna country, especially when the earliest, best varieties for the region are grown; but it is not improbable that it will be found more economical to use all grain produced for stock feed. It may be found cheaper to import breadstuffs from the grain ports on the Pacific coast of Canada and the United States, especially in view of the available water transportation between Cook Inlet and these ports. It will be advisable in case hog and poultry raising are undertaken to mature some grain for feed.

FRUIT.

Strawberries have been grown successfully, but as yet little attention has been devoted to the crop. Not a single wild strawberry was seen in the region. Wild raspberries were seen in many places. Under cultivation these undoubtedly would give very satisfactory results.

Wild currant, low-bush cranberry (*Vaccinium vitisidaea*), high-bush cranberry (*Viburnum pauciflorum* Pylaie), and several varieties of blueberry grow abundantly and fruit well. The low-bush cranberry makes an excellent jam, and the high-bush is used considerably for jelly. The blueberry which thrives on Muskeg and mossy areas is not

so good as the variety found abundantly on the well-drained soils, although both are eaten. The latter berry is sometimes called huckleberry. The common wild currant is an excellent fruit.

Indians eat the squawberry (*Rubus chamaemorus* L.), which thrives on Muskeg and moss lands. The raw fruit of this plant has an insipid taste.

STOCK RAISING AND DAIRYING.

As stated above, the raising of cattle and the production of milk and butter on locally produced feed was successfully carried out on Kenai Peninsula by a branch of the experiment station, which was maintained there for several years.[1] The results of the experiments here were summarized as follows:[2]

* * * it was proved that cattle can be raised in that location (at Kenai), and that butter and cheese of good quality can be made from the milk of cattle kept there. A small herd was maintained exclusively on native pasture and on the feed produced at the station for several years. The cattle had to be fed for seven months in the year, but if hay is provided this long feeding period is no obstacle to successful dairying. Fourth, it was proved that hay can be made not only from the native grass, which is abundant wherever the spruce forest does not usurp the surface of the land, but that grain hay can be made in abundance with certainty and success every year. For this purpose oats were seeded in the early spring and cut for hay when in the milk stage.

Piper,[3] in his report on the grass lands of the south Alaskan coast, says:

Kadiak Island, which lies off the mouth of Cook Inlet, is about 100 miles long by 50 miles wide. It is mountainous in character, the hills rising more or less gently from near the seashore to heights of 1,000 to 3,000 feet. * * * This island, like most of the Alaska coast, is much cut into by long, narrow bays, into most of which flow streams. The flat lands lying at the deltas of these streams are, as a rule, very heavily covered with grasses. The slopes also, up to an altitude of 1,500 feet, are well grassed, except where there are thickets of alder or willow; but these slopes are usually too steep to utilize otherwise than by grazing. The total area of these hillside lands is much greater than that of the approximately level stretches, in the proportion of at least 20 to 1.

On the hillsides the principal grass is bluetop (*Calamagrostis langsdorfii*), which often covers large areas in a pure growth. This was exceedingly fine on hillsides burned over in March, by which means the old straw and moss were destroyed, thus permitting better drainage and making the soil warmer. In such places this grass is often six feet high. On the contrary, if the hills are burned over in June the fire is likely to kill the grass roots as well as the moss, with the result that fireweed usually takes possession of the ground.

Other grasses than bluetop on the hillsides are relatively unimportant, though sometimes considerable areas of Siberian fescue occur, and on the higher slopes are a number of low grasses of forage value.

On the flat lands before mentioned the tall beach sedge (*Carex cryptocarpa*) forms a broad fringe along the shores of the bays and sloughs, especially on lands which are occasionally covered by tidewater. Back of this sedge, beach rye (*Elymus mollis*)

[1] The Kenai Experiment Station was closed in 1908, and the equipment of live stock transferred to a new station on Kodiak Island.

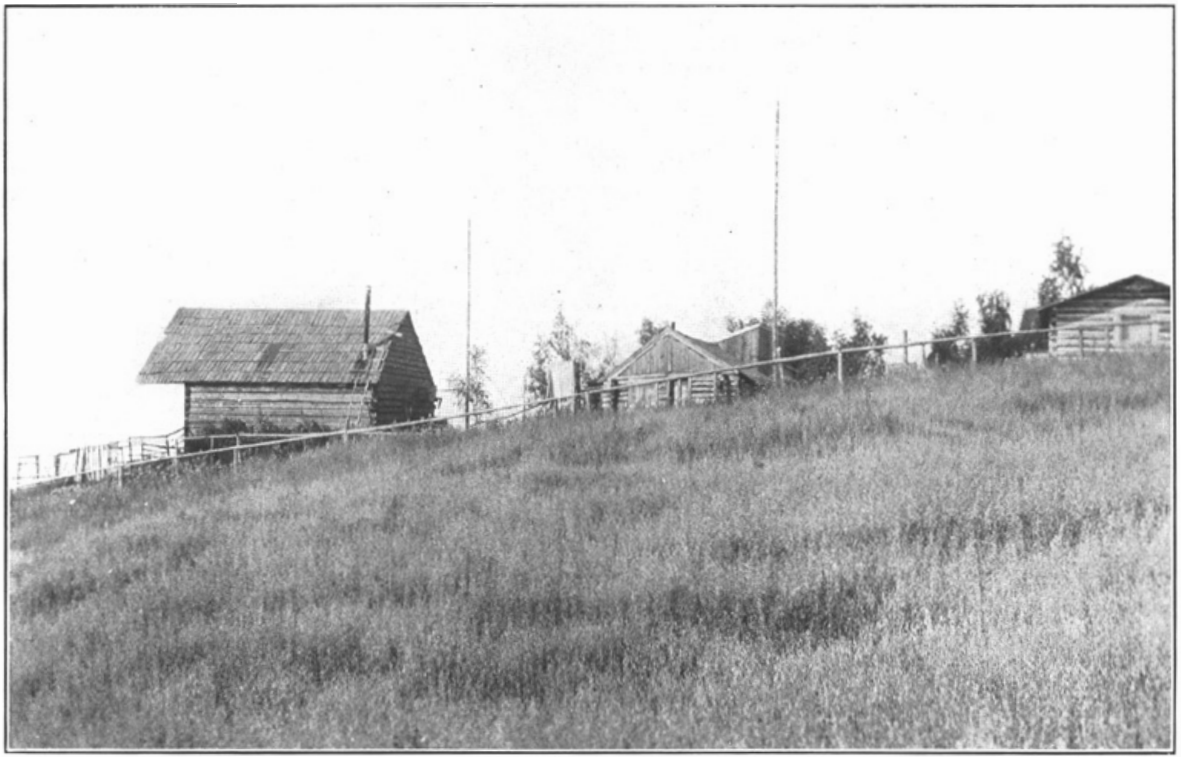
[2] Annual Report, Alaska Agricultural Experiment Stations, 1908, pp. 20–21.

[3] Bul. Bureau of Plant Industry, U. S. Dept. of Agr., No. 82, pp. 11–12.

FIG. 1.—CABBAGE ON KNIK LOAM 5 MILES ABOVE MOUTH OF SHIP CREEK, SEPTEMBER 5, 1914.

FIG. 2.—NATIVE "REDTOP" (CALAMAGROSTIS SP.) ON KNIK LOAM, AUGUST 7, 1914.

This valuable hay grass grows luxuriantly in every opening throughout the Cook Inlet-Susitna region where the drainage is not very poor and the surface is not covered with moss. It frequently attains a height of 5 or 6 feet.



OATS ON WELL-DRAINED SLOPE AT KNIK. (CROP OF 1914.)

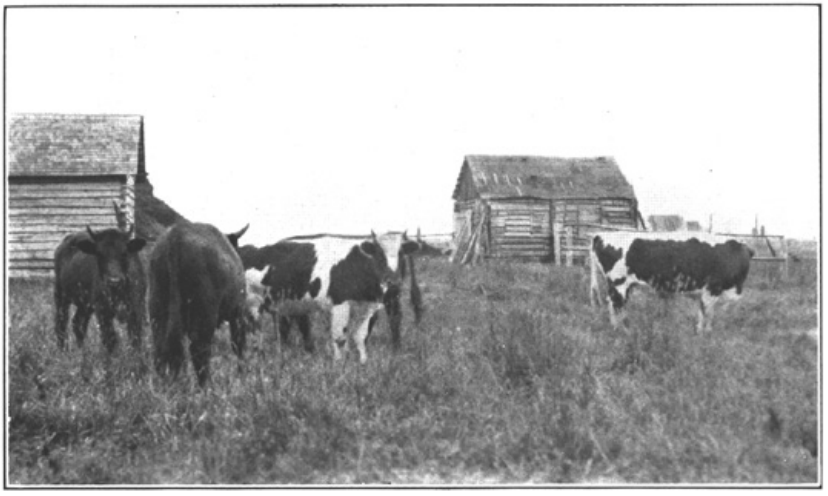


FIG. 1.—CATTLE AT NINILCHIK, SEPTEMBER 18, 1914.

The progenitors of this herd are said to have been brought to Kenai Peninsula a hundred years ago. They are pastured in summer and fed on locally produced feed during winter.

FIG. 2.—LAND UNDER CULTIVATION AND IN PROCESS OF CLEARING.

In the background are shown the flats of the lower Matanuska River, looking south.

EFFECTS OF FIRE ON SHALLOW KNIK SOIL NEAR KNIK.

The shallow-rooted trees, including birch and spruce, fell as a result of a fire which in the spring of 1914 covered approximately 50 acres at this place, leaving very few trees standing.

forms a more or less broad zone, often mixed with patches of a coarse bluegrass (*Poa glumaris*). In the still drier portions bluetop occupies the ground almost exclusively. The three plants mentioned furnish the great bulk of forage on Kadiak Island, and, indeed, on most parts of the Alaskan coast, but the bluetop is more abundant than all of the other grasses combined.

Bluetop has slender stems and thin leaves, thus curing very readily and making a sweet and palatable hay. Beach rye, on the contrary, has thick stems and thick leaves, in consequence of which it cures slowly. Beach sedge has a three-sided, solid, pithy stem, and is therefore very difficult to dry. All three of these plants grow so luxuriantly that they often yield 3 tons of hay or more per acre.

Of forage plants other than grasses the lupine and fireweed * * * are both abundant. In a green state they are readily eaten by sheep, but cattle prefer the grasses.

In portions of the island which have been more or less closely grazed for some years it was noticeable that the taller wild grasses had largely disappeared, being replaced principally by bluegrass (*Poa pratensis*) and wild barley (*Hordeum boreale*). Cattle seem to be much more fond of the former than of the latter grass, although in parts of northern Europe the wild barley is considered a most excellent grass.

All of Kadiak Island, except a small portion in the extreme northeast, is practically timberless, as are most of the adjacent islands. In the valleys, however, there is usually a small number of cottonwoods and willows, and on wet slopes, scrub willows and alders form dense thickets. Afognak Island, however, which lies northeast of Kadiak, is quite densely covered with spruce.

The grass of the island was practically all destroyed by the deep mantle (about 8½ inches on level land) of volcanic ash which covered Kodiak Island during the eruption of Katmai volcano in 1912. This necessitated removing the station cattle from the island to be wintered. But the grass is reestablishing itself rapidly. The 1913 report of the Alaska Agricultural Experiment Stations, in describing the work for the year at the Kodiak live-stock and breeding station, says:

The work of reclaiming the station from the choking influence of the volcanic ash was continued throughout the summer with gratifying results. There is now scarcely a doubt that when vegetation is reestablished there will be a better soil to work with and the pastures will be better than ever before. The volcanic ash is totally devoid of nitrogen, and this element must be supplied before vegetation can be restored, but wherever it is supplied grasses and silage crops are doing well. The old sod of native grasses which was covered up is, of course, rich in nitrogen, and it was found that wherever the plowing was deep enough to turn up from 1 to 3 or 4 inches of soil so as to mix it with the ashes, grasses and grains did better than they did on the old sod or than they do on the bare ashes. The problem is then to find a tool, a sort of subsoil plow, which will reach into the surface of the old sod.

On the slopes and hillsides the ashes have largely disappeared. In wet weather the rain washes them down to the lower levels, and in dry weather the winds blow them off, to be deposited elsewhere, as in the case of light drifting sands, only these ashes are lighter and finer and blow about more readily than any sort of drift sand. The net result of the operations of nature, therefore, is that the native vegetation has been so far uncovered on the steeper slopes and hillsides as to be fully reestablished, and the ashes are in a measure stimulating the growth in these places so that the pasture is better than ever, while on the lowlands and level areas the ashes have settled to a depth of from 8 to 16 inches, and more in places. The low places have been filled up, and hummocks and irregularities of the surface have in a large measure

disappeared, so that the land can now be cultivated and seeded, which was impracticable before the ashes fell by reason of the tangle of roots, small bushes, and dead grass. It is now possible to establish clovers and cultivated grasses, which was not possible before without at least first clearing, leveling, and breaking the surface at the expenditure of much labor and money.

There is no doubt about the possibility of producing in this region the necessary feed for stock from the native grasses and forage plants and from grain, root crops, and cultivated legumes. As a matter of fact, the possibilities of the soils in this direction are so great that the raising of stock, or dairying, or both, appears to be the most promising line of agriculture—the most practical way of utilizing to best advantage the crops to which the soils are best adapted. As between dairying and the raising of beef, beyond the production of sufficient meat to supply the local demand, dairying seems the most promising industry for the region.

With an increase in population more potatoes and vegetables will be needed for home consumption, and in time it may be profitable to export such products; but the development of a dairying industry and possibly the production of beef appear to be the most practical way of producing products for exportation. It is true that grain can be ripened, certainly the early varieties, over much of the country; but there are places where it is not likely to mature under ordinary conditions and others where it is likely to be damaged by unseasonable frost. On the other hand, excellent grain hay can be produced throughout the region; it may even be possible to grow such hay on drained Muskeg land. The limitations imposed upon crop production by climate over portions of the region thus do not preclude stock raising and dairying.

Any development of the dairying and stock-raising industries will likely be gradual, and carried on in conjunction with the production of potatoes, vegetables, grain, and forage. Some capital will be needed, of course, before the homesteader can accomplish much with these industries. Most of the farmers already on the ground, however, are planning to put stock on their farms—cattle, sheep, or hogs, or all of these. This year 5 cows, 6 hogs, 2 calves, and 1 bull were brought to Knik to be placed on a ranch in the Cottonwood section. Twice cattle have been brought to Knik and carried out to the Willow Creek District, where they were maintained upon native grasses and slaughtered from time to time for sale to miners. Some cattle have been raised at Ninilchik for a long time, but the herd here does not seem to be making particularly good progress, probably on account of insufficient care and inbreeding. The animals are rather small. They are said to be the progeny of stock brought here by the Russians about a hundred years ago. (See Pl. XV, fig. 1.)

At times during the winter season stock will probably be able to get some grazing, but in the country seen it is evident that the bulk

of winter feed must be supplied them. There may be certain grasses or plants of the wild-pea nature in some parts of the lowlands or valleys of the surrounding highlands which will supply winter grazing. It has been pointed out that an abundance of good feed can be harvested from the native grasses and cultivated crops—a sufficient amount to supply the needs of stock; but it may be found advisable at times to use some concentrated feedstuffs, such as cottonseed meal.

It may be found that the thick-haired breeds, such as the Galloway, will prove best suited to the conditions, although there is no question that other breeds can be raised. It will be advisable to construct warm barns for housing the animals in winter. Very satisfactory barns could be made of the native timber, as is done in the Tanana Valley and in the Klondike region of Yukon Territory, where buildings of spruce logs, chinked with moss, have proved thoroughly satisfactory for cattle, hogs, and horses.

Hogs could be easily raised in conjunction with dairying, especially where butter and cheese are made, the skim milk being used in feeding them. In addition to the forage that could be provided, it would likely be necessary to use some grain in feeding hogs.

In considering the advisability of attempting stock raising and dairying, the value of the by-products, such as barnyard and stable manure and skim milk, must not be lost sight of.

Inasmuch as sheep have been successfully raised on Kodiak Island, it would seem that these animals could be successfully raised in the Cook Inlet-Susitna region.[1]

If the 1,296,000 acres of the better grade of farming land in the Cook Inlet-Susitna region should ultimately be devoted principally to cattle raising and dairying, 162,000 animals could be maintained, allowing 8 acres to the animal. Counting one-sixth of these ready for slaughter as 2-year olds, 27,000 would thus be ready for sale or shipment each year. In beef this would amount to 8,100 tons for the 2-year olds if they should weigh 600 pounds each.

In the production of dairy products a herd of 162,000 would be divided about as follows: Cows, 113,400; yearlings, 32,400; and 2-year olds, 16,200. Giving 6,000 pounds of milk per year each, 113,400 cows would produce 680,400,000 pounds, or 340,200 tons, of milk. This converted into butter, at the rate of 3.7 per cent, would amount to 12,587 tons; if converted into cheese at the rate of 9 per cent, it would amount to approximately 30,618 tons.

In giving these figures it is not meant to predict the attainment of such an ideal development of the industry, but simply to point out the possibilities of such industries provided they should be under-

[1] See Domestic Breeds of Sheep in America, Bul. No. 94, Bureau of Animal Industry, U. S. Dept. of Agr.; also Bul. No. 20, The Management of Sheep on the Farm.

taken, proved successful, and pushed toward maximum development. Should the industry prove profitable—if the farmer could ship beef or dairy products and receive something over the cost of production and transportation in repayment for his efforts—there undoubtedly would be established important industries along these lines, even should the Alaskan have to be contented with a much smaller margin of profit than the cattleman or dairyman living close to large markets. Some cattle and dairy products will be produced here, undoubtedly. If the production should only meet the demand of the farmer and villager, the industry would not be very large; if enough should be produced to supply a largely increased population attracted by developments in the mining of coal and other minerals, the importance of the industry would be proportionately greater; if there should be found a profit in the exporting of beef or dairy products, then the industry would become of considerable importance, provided railroads and highways are constructed to open up the country.

POULTRY.

Chickens and ducks have succeeded here. At present there are very few in the region, but this is largely due to the pioneer conditions which have obtained—the failure to attempt poultry raising rather than the failure of attempts.

CLEARING LAND.

Clearing land in the Cook Inlet-Susitna country generally will not be found a very difficult task. (See Pl. XV, fig. 2.) The trees are prevailingly shallow rooted and on that account the stumps can be removed with comparatively little difficulty. When the land is burned over in dry seasons, many of the trees fall, tearing out their roots, especially where a deep covering of moss or vegetable mold allows the burning to reach a considerable depth. (See Pl. XVI.) There are areas where the trees are so small that they can be uprooted with the hand after a fire and the land cleared at a rapid rate. It has been found possible to burn out the dry stumps satisfactorily by heaping fuel about them. Where the necessary fuel is not at hand the stumps could be dug out at a fairly rapid rate, since the roots lie close to the surface. The employment of stump pullers, of course, would expedite the removal of these. Those areas supporting the larger trees will, of course, require more labor, and here stump pullers or blasting will be necessary for expeditious progress. This work can be advanced at times when the attention of farmers is not demanded by other duties.

Burning over the land will be advisable in clearing much of this country, since the fire removes much of the undergrowth, moss, and coarse vegetable matter, such as would not soon decay if plowed

under, the processes of decomposition being slow in this climate. It is never a good practice to plow under moss and the coarser vegetation in this region. Fires started for the purpose of facilitating clearing should not be permitted to spread beyond the areas to be cleared, inasmuch as such careless procedure is likely to cause the destruction of much valuable timber.

The trees are all soft and therefore easy to cut. Brush could be cut and piled in the winter and made ready to burn the following spring, at which season the ground is likely to be in the driest condition. In places moss will be found so thick and damp that it can not be effectively removed by burning. In such places it will be necessary to remove it.

DRAINAGE.

Comparatively little of the good farming land needs artificial drainage. Where such drainage is necessary it could be accomplished satisfactorily by ditching. The amount of excavation would depend on the character of the surrounding topography. In case of the stream bottoms main ditches could be easily carried to the streams, and, with some laterals, will be sufficient to effect satisfactory removal of excess water. There are some deep basinlike depressions, however, of a pothole character, where it would be very difficult to get outlets, owing to the depth to which the ditches would have to be carried in getting through the surrounding highland.

To reclaim the large bodies of Muskeg, extensive canaling and construction of lateral ditches will be necessary. Such work would be costly, and with the large available area of well-drained land, coupled with the additional area which can be drained at comparatively little expense, there would be no pressing need to undertake such reclamation. Small isolated areas of Muskeg, of course, could be drained here and there.

CULTIVATION.

Owing to the fact that newly-plowed virgin land in this portion of Alaska generally does not give the best results with crops, it is unquestionably advisable to break new ground at least a year before putting in a crop. This gives some time for the improvement of the soil by the ameliorative action of the air. Those lands having a thick covering of moss, a frozen subsoil, or imperfect drainage would likely give best results if plowed at least two years before putting in the crops.

As a rule preliminary plowing should be about 4 to 6 inches deep. After this, the plowing could be gradually increased to any desired depth at the rate of about an inch a year. It is not advisable to turn up much fresh soil material in any one year, since time is

required to bring such material into good crop-producing condition. If newly-plowed land is left with a rough surface, the material will be more likely to undergo the desirable crumbling and fining processes induced by freezing and thawing, and thus be reduced more quickly to a good pulverulent structure.

Cultivation should be shallow and frequent during dry seasons in order to prevent excessive surface evaporation of soil moisture. Shallow plowing is further advisable in that it does not break so many of the plant roots. The texture and structure of the soils of this region are such as to favor easy tillage. Efficient plowing can be accomplished with light teams and implements.

MANURIAL TREATMENT.

Applications of manure and wood ashes have in all cases been followed with increased yields. Additions of barnyard manure or some form of commercial fertilizer may be found necessary, in order to secure good yields, after the land has been cropped for a number of years. Barnyard manure is ideally suited to the soils, that is, when thoroughly decomposed and not too coarse. Unless stock and dairying industries are developed there will not, of course, be much manure of this kind, and if cultivation is continued it will be necessary to supply vegetable matter from some other source. This could be accomplished by plowing under green vegetation. The legumes are admirably suited to this purpose, since they will supply not only vegetable matter but some nitrogen. It is not at all unlikely that the best soil management will require the growing of an occasional legume crop in rotation with those nonleguminous.

There has been too little experience with commercial fertilizers to lead to any definite conclusions regarding their value. The little experience that has been had indicates some benefit from applications of those carrying potash salts. Undoubtedly nitrogenous fertilizers will be beneficial, if not necessary. In supplying nitrogenous fertilizers the refuse from the great salmon canneries of the Alaskan coast, practically all of which is now wasted, could probably be drawn upon advantageously.[1] It is estimated by Turrentine that the annual waste of the Alaska canneries amounts to approximately 70,000 tons of fish scrap.

If potash is needed resort may be had to the kelp groves along the Alaskan coast. Valuable groves have been found near the shores of Kachemak Bay, and in numerous places elsewhere along the Pacific shores.[2]

The products of the proposed combined fish-rendering and kelp-drying plant may be disposed of separately to mixers of fertilizers, or they may be mixed and retailed

[1] See Utilization of the Fish Waste of the Pacific Coast for the Manufacture of Fertilizer, Bul., Bureau of Soils, U. S. Dept. of Agr., No. 150.

[2] See Potash from Kelp, Report, Office of the Secretary, U. S. Dept. of Agr., No. 100.

directly to the consumers as so-called complete fertilizers. The mixture of fish scrap and dried kelp would contain ammonia, potash, and phosphoric acid (bone phosphate), the three substances regarded as essential ingredients of a complete fertilizer. Such a fertilizer, from the conventional point of view, would be regarded as deficient in phosphoric acid, that ingredient being added usually in larger proportion than the potash or nitrogen. To make it conform to that formula, acidulated phosphate rock could be added. However, this ratio is purely conventional and may be disregarded.

Practically all of the soils of the region would be benefited by lime, as indicated by the results where wood ashes have been applied and by the determinations of the lime requirements of representative samples of the soil. These lime-requirement determinations indicate a very great need of lime in most cases. The figures given in the table below, however, can not be considered as representing the exact quantity of lime that should be used in practice, since these are based upon the amount of lime required to neutralize the soil to a depth of 12 inches. In farm practice only the surface 4 or 5 inches, probably, should be considered, at least in the first application; and there may not be found need for complete neutralization of the soil. A great many crops thrive on soils of a more or less acid nature and some appear to prefer such conditions.[1] In the determinations considerable lime is required to neutralize the acids present in partially decomposed vegetable matter, but it does not necessarily follow that this should be accomplished in the treatment of farm land.

The beneficial effects of lime are not always due solely to the correction of acidity or the supplying of needed plant food. Freshly reclaimed Muck lands, for example, whether acid or not, are usually benefited by additions of calcareous material. It seems that where a soil is benefited for crop production by increased stirring and aeration, applications of lime usually hasten such ameliorative processes in the soil as are induced by the mechanical manipulation of the soil.

Burned lime will probably be the better form in which to make the applications, since it is quicker to act than the ground limestone. Two tons per acre of good burned lime in the air-slaked state would be a moderate application for most of the types. Heavier applications could be safely made, but this amount will be sufficient, at least for an initial treatment. Lighter applications would afford some benefit, but the indications are that most of the land will require at least 2 tons per acre. Such an application has reference to high-grade lime, or lime that runs 75 per cent or more of calcium oxide or calcium carbonate, according to whether the form is quicklime or air-slaked lime. If the lower grades are used, obviously heavier additions will be required.

In case lime can not be procured from local limestone, wood ashes would be the most satisfactory substitute, that is, if importation of

[1] The Agricultural Utilization of Acid Lands by Means of Acid Tolerant Crops: Departmental Bul. No. 6, U. S. Dept. Agr.

lime is prohibitively expensive. The location of limestone is given in the report on the geology of the Lower Matanuska Valley.[1] The writer found in the canyon of the small stream about 2½ miles north of Chickaloon a limestone portions of which analyze 21 per cent of calcium carbonate. This is a low-grade limestone rock, but it might be used should beds richer in lime not be found within reasonable distance of the future railroads.

Lime requirement of representative soils of the Cook Inlet-Susitna region.[1]

[Quantity of lime required to neutralize 1 acre of soil to a depth of 1 foot.]

Soil type and section.	No. of sample.	Location of sample.	CaO.	$CaCO_3$.
Knik loam:			*Tons.*	*Tons.*
Surface soil	590101	6 miles above mouth of Ship Creek	5.2	10.5
Subsurface	590102	.....do	2.6	5.2
Soil	590104	2 miles east of Moose Creek Crossing	35+	70+
Chickaloon loam:				
Soil	590106	1½ miles northwest of Moose Creek Crossing	26.0	52.0
Do	590108	1 mile northwest wagon road over Little Susitna River.	35+	70+
Susitna very fine sandy loam, soil.	590110	20 miles east of Knik	None.	Alkaline.
Knik loam:				
Surface soil	590117	5 miles above mouth of Montana Creek	7.8	14.0
Subsurface	590118	.....do	5.6	9.9
Surface soil	590120	Near mouth Chunitna Creek	3.5	6.2
Subsurface	590121	.....do	6.1	10.9
Susitna silt loam, soil	590124	Mouth of Willow Creek	4.3	7.8
Susitna fine sand, soil and subsoil.	590130	Susitna	2.6	4.6
Knik fine sandy loam, soil	590131	1 mile southwest of Knik	4.3	7.8

[1] These determinations were made by R. F. Gardiner and C. F. Miller in the laboratory of the Bureau of Soils.

SETTLEMENT AND GENERAL DEVELOPMENT.

The region was settled by the Russians, who were chiefly interested in the fur industry. They established missions and trading posts at various places along the shores of Cook Inlet, and carried on considerable trade with the natives, but did little toward the development of agriculture.

Meanwhile, fur-trading posts had been built at several places on the Cook Inlet shore of the peninsula. The excellent timber on Resurrection Bay was not overlooked by the Russians, who established a shipyard there. Here the first vessel built in Alaska was launched in 1795. Feeble attempts to establish other industries on the peninsula were also made by the Russians. In 1793 the first agricultural colony was settled, on the east shore of Cook Inlet. The descendants of these and other colonists who followed still hold these lands and are among the few evidences of the Russian occupation of Alaska.[2]

[1] Geology and Coal Fields of the Lower Matanuska Valley, Alaska: Bul. No. 500, U. S. Geol. Survey.

[2] Brooks, A. H., in Geology and Mineral Resources of Kenai Peninsula, Alaska, Bul. No. 587, U. S. Geol. Survey, p. 15.

Following the purchase of Alaska by the United States in 1867 the Americans entered the region and took up the lines of industry followed by their predecessors, trading with the natives and buying their furs in exchange for articles of merchandise. At one time the Alaska Commercial Company, an American company, which succeeded the Russian fur trading company, had stations or substations at Knik, Hope, Sunrise, Beluga, Tyonek, Susitna, and Talkeetna.

Large quantities of furs were annually exported. A merchant who has been in business at Knik for about 28 years states that, in the early days at least, 1,000 marten, 1,000 mink, and 300 fox pelts, along with other furs, were bought at that place every year. Some of these were brought in from the Copper River country through the Matanuska Valley.

Those connected with the trading posts necessarily lived a life of isolation, being placed practically outside the bounds of civilization. Supplies were brought in and furs shipped out once every year, by schooner.

The immigration of Americans, attracted by the discovery of gold, was followed by a decrease in the harvest of furs, the Indians being less inclined to trap with the opportunity of making a livelihood by working occasionally for the whites. Notwithstanding this and the inroads made upon the supply of fur by past activities, some pelts are annually brought in by both Indian and white trappers.

Some placer and coal mining was attempted by the Russians on the Kenai Peninsula about the middle of the last century. These attempts appear not to have been attended with much success. At various times since the American succession lignitic coal has been worked in a small way in the Kachemak Bay section. In 1890 three Americans are reported to have obtained some gold by working beach gravels near Anchor Point on Kenai Peninsula. Discoveries of gold along Turnagain Arm in 1894 attracted considerable attention to this field, and since 1896 placer mining has been carried on here. Later discoveries started mining in other parts of the region. Gold was found in the Willow Creek district in 1898 and in the Yentna River basin in 1904. The Willow Creek district began with placer mining operations, but subsequently it has developed principally as a lode mining district.[1]

The high-grade coals of the Matanuska field have not been worked further than the taking out of small quantities for testing purposes. During the winter 1913–14 about 1,000 tons were carried by sleigh to navigable water, later transported to Knik Anchorage, and shipped

[1] Brooks, A. H., The Mount McKinley Region, Alaska: Prof. Paper No. 70, U. S. Geol. Survey, 1911, pp. 155–156.

to the United States for trial in the Navy.[1] The coal can not be mined commercially, of course, until a railroad enters the field. For a time the coal lands were withdrawn from entry, and only during the present year (1914) did Congress make provision for leasing. For these reasons the coal fields have remained undeveloped.

POPULATION.

The development of the mining industry has caused a considerable increase in the population of the region, especially in recent years. The present population of Knik is about 250. In addition, about 125 men were engaged this year in the mines of the Willow Creek district and about 75 others in developing prospects there. It is estimated that about 100 men went out of Knik this summer on prospecting expeditions. In the Yentna River district, chiefly along Cache and Peters Creeks and their tributaries, approximately 200 men were this year engaged in mining, developing, and prospecting. Sunrise and Hope are small mining centers on Turnagain Arm, with perhaps a total population in both districts of approximately 200. At Kenai, on the Kenai Peninsula, there are probably not more than 150 inhabitants; at Ninilchik there are not quite so many. The permanent population of the village of Susitna is about 125 to 150. It is reported that 25 to 30 prospectors ascended the Susitna River this year. These represented "stampeders" attracted by reports of the gold discoveries in the Broad Pass section. A number came into the Knik section this year to take up homesteads.

At the larger villages there are stores, schools, churches, and comfortable hotels. Road houses are operated along the Willow Creek road for the convenience of travelers. Several others are kept open in winter along several of the winter trails.

The whites are mostly of American birth, although there are a number of foreigners—Swedes, Germans, Finns, and others. Most of these have come to Alaska in search of gold, and there are but few who have been here for any considerable time who have not prospected for "quartz" or placer or for coal and copper.

The estimated native population (mostly Indians with some mixed-breeds) is as follows: Susitna, 90; Talkeetna, 10; Croto, 20; Chitina, 10; Tyonek and Beluga, 150; Point Possession, 25; Ninilchik, 90; Kenai, 100; and about 110 along Knik Arm, principally at Knik and Old Knik.[2]

[1] Port tests and steaming tests at speeds of 20 knots, 15 knots, and 10 knots were made of 586 tons of this coal on the U. S. S. *Maryland* in November, 1914, with satisfactory results, the efficiency of the coal being found very close to that of Pocahontas (W. Va.) coal and much better than that tested from the Bering River (Alaska) field. The naval board making these tests reported in part as follows: "The board finds that this sample of Matanuska coal tested is suitable in every respect for use in the naval service." See report Philip Andrews, Captain, United States Navy, to the Secretary of the Navy, Congressional Record, Sixty-third Congress, Third session, pp. 6169–70.

[2] These population figures represent estimates secured from residents acquainted with the Cook Inlet region.

The chief occupation of the natives is hunting and fishing. They go on long trips to their hunting grounds in search of moose, bear, caribou, and mountain sheep. In winter they make expeditions in search of furs. A considerable number of Indians perform at intervals various kinds of work for the whites. They make and sell a good many snowshoes, in the manufacture of which much skill is shown. Moccasins and birch-bark canoes also are made by the Indians, chiefly for their own use. Their efforts in agriculture have been of negligible importance. They should be encouraged in gardening and in the acquirement of habits of thrift.

MEANS OF COMMUNICATION.

Mail is received at Knik about every 10 days during the summer, coming by ocean steamers, which anchor near the lower end of Knik Arm. Arrangement has been made for the winter of 1914–15 by which mail is to be carried every two weeks on dog sleighs over the trail from Seward to Knik, and from there, by way of Susitna, across the Alaska Range to the Kuskokwim country.

Steamers arrive and leave Knik Anchorage for Seattle about every 8 or 10 days during the period from about the first of April to about the first of November. Small power boats from Knik, Susitna, and other points meet the ocean steamers at Knik Anchorage for the purpose of carrying freight, passengers, and mail to their various destinations along the navigable waters of the region. Navigation is closed by ice at Knik about the first to the middle of November and opens usually from about the first to the middle of April. The Susitna River is navigable for light-draught, strong power boats as far up as Indian Creek, about 100 miles from its mouth, beginning about the first to the middle of May, and closing with the freezing over of the river between the middle of October and the first of November. There are stages of low water during this period when navigation is extremely difficult or impossible. The Yentna is not so swift as the Susitna, at least in its lower part, and power boats make good progress as far up as the forks of the Skwentna.

Navigation on Cook Inlet is impeded somewhat by the strong tides. At Knik, for example, where the water at high tide is about 15 to 20 feet deep, there is no water whatever at low tide. Boats have no trouble ascending to this point with the tide, but against it headway is difficult. With each tide a bore enters Turnagain Arm, and at times is dangerous to small craft, necessitating their waiting outside until the incoming tide has passed. Rip tides and winds also offer some difficulty to small boats.

A good wagon road has been built by the Alaska Road Commission from Knik to the Willow Creek mining district. There is a fairly good trail up the Matanuska Valley from this village which can be

traveled in summer by horses. Pedestrians make summer trips over the Knik-Susitna trail and other trails, but these are always difficult to travel at this season, owing to the abundance of marsh and swamp and the swift currents of streams. Traveling in winter is much easier because of the freezing over of the lakes, marshes, and streams. The heavier supplies are mostly taken by sleigh to outlying districts at this time of the year. Prospectors, however, frequently make long trips in summer over the most difficult ground, "packing" heavy outfits of food and implements.

GAME AND FISH.[1]

Game is fairly plentiful throughout the region, and is abundant in many localities. Kenai Peninsula, for example, is said to be the best hunting ground for moose in the world. The animals range over the entire area of timber and Muskeg lands. Fresh moose meat can frequently be obtained at the villages during the open season. At one village alone it was said that about 70 carcasses were disposed of yearly, the meat selling at 12½ cents to 15 cents a pound. The adult animals dress 400 to 1,000 pounds.

Black and brown bear are also found throughout the region. Their tracks and paths were seen plentifully among the alder thickets, peat bogs, moss, and heather of the higher slopes, and were common in the wooded areas below. A number of bear were seen in the Peters Hills country. The brown or Kodiak bear are among the largest and most powerful of the bear family. They have the reputation of being dangerous at close quarters or when wounded.

Mountain sheep are plentiful in certain portions of the mountains. They are killed in considerable numbers, their meat being considered the best of all Alaskan game. Caribou are also found in various localities. Rabbits are numerous, particularly about cultivated fields. They do some damage to crops.

Of the game birds, several species of grouse are abundant in the timber and ptarmigan in the mountains. In summer large numbers of waterfowl visit the region, including ducks, geese, brant, and swan. Plover, snipe, and curlew are the common shore birds of the game order.

The streams abound with trout and grayling. During the spawning season there are large runs of salmon up every stream of any importance. These fish wear themselves out in their journey against swift water and over bowlder-strewn ripples, and are finally swept downstream dead and dying, by the thousands. Large quantities are annually caught and dried in the sun for food for both man and dog. The salmon-canning industry of the Alaskan coast reaches enormous proportions, the total pack for the year 1913 being 3,746,493 full cases, of a total pack of 8,063,447 cases for the entire Pacific

[1] See North American Fauna, Bul. No. 21, Bureau of Biological Survey, U. S. Dept. of Agr.

coast that year.[1] The industry is widely distributed through the islands and fiords of southern Alaska and in the Bristol Bay region. There are canneries on lower Cook Inlet at Seldovia and Port Graham.

The game and fish of this region are likely to constitute an important asset for a long time, if properly protected. The inhabitants of the country, recognizing the value of the game resources, are generally inclined to hunt in a sportsmanlike way. A good many bear are killed, perhaps uselessly, on the theory that this animal is a menace to the community rather than of value for game purposes. With the opening and settlement of the country the bear will retreat to the mountains and higher valleys and probably never prove harmful to any important degree.

Stringent game laws are in force for the protection of both game animals and game birds.[2] In a sparsely settled country of this kind violations of game laws can not easily be prevented; but as a rule there seems to be here no general determination to violate the spirit of these laws. Moose, mountain sheep, and grouse are too freely killed out of season in some sections.

BIRDS OTHER THAN GAME.

Among the common nongame birds of the region are several species of loon, owl, hawk, sparrow, jay, crossbill, warbler, chickadee, thrush, Alaska bald eagle, gull, cormorant, woodpecker, northern raven, and blackbird.[3]

INSECTS.

Mosquitoes are very abundant everywhere in spring and summer. In June and July they are so numerous that it is necessary to protect one's self with nets and gloves at all times, if any comfort is to be had. In August they disappear rapidly. Where the land is cleared off or burned over they are much less plentiful. Horseflies, large black flies, and two small flies or gnats called "no-see-ums" and "white stockings" are troublesome at times.

FURS.

The principal fur-bearing animals [4] of the region are muskrat, mink, marten, ermine, lynx, fox (red and cross), and bear. There are some beaver, wolverine, and silver-gray and black fox, but few of the pelts are obtained. Land otter and wolf are said to inhabit the region, but they seem to be scarce. It appears that the sea otter has been practically exterminated. It is claimed that the fur-bearing animals of the region have increased in numbers within the last few years.

[1] Bul. No. 150, Bureau of Soils, U. S. Dept of Agr.
[2] See Report of the Governor of Alaska on the Alaska Game Laws, 1914.
[3] See North American Fauna, Bul. No. 21, Bureau of Biological Survey, U. S. Dept. of Agr.
[4] Ibid.

SUMMARY.

The agricultural lands of the Cook Inlet-Susitna region are comprised in the plainlike country and adjacent bench lands bordering Cook Inlet from Kachemak Bay northward and extending up the Susitna and Matanuska Valleys. The unfavorable climate and topography of the surrounding mountainous country restrict the farming possibilities to this low country, the approximate area of which is 6,000 square miles. At least one-third of this area, amounting to a little more than a million and a quarter acres (1,296,000 acres, the lowest estimate), consists of arable land possessing topographic and drainage characteristics and chemical and physical properties quite favorable to farming. About one-half of this good land occurs in the Susitna and Matanuska Valleys.

The remainder of the lowland country largely represents Muskeg or marsh, isolated areas in the Muskeg, and areas of unfavorable topography. Extensive drainage operations will be required to reclaim the marsh land, and to make available the included well-drained land.

The climate is characterized by long, cold winters and short summers of moderate temperatures. At Tyonek the mean summer temperature, based on records covering nine years, is 56° F. The maximum temperature recorded is 91° F. and the minimum −27° F. The mean annual precipitation here is 23 inches, while the mean of the three summer months, June, July, and August, is 8 inches. The snowfall is 82 inches.

The growing season begins some time in May and continues until the first of September. Under normal conditions killing frosts are not likely to occur over the greater part of the region during this period. There are, however, localities of peculiar climatic environment where chilling winds or unseasonable frosts are likely to injure crops at any time. The long hours of summer daylight add to the growing season. Ground ice is of common occurrence near the surface in many places where there is a thick covering of moss, but this is not detrimental to crop production. The ice thaws rapidly as soon as the moss is burned off or stripped from the surface, soon sinking beyond the depth of winter freezing.

The following crops have proved successful in this region: Potatoes, a large number of vegetables, small grain, and grass. Native redtop grass (several species of *Calamagrostis*) grows abundantly throughout the region. Cut at the right time this grass makes good hay, both the results of actual feeding and chemical analysis indicating good nutritive values. This grass yields 3 tons or more of hay per acre, and it will afford feed and pasturage for a large number of animals.

Early varieties of barley and oats mature, producing good yields of grain. Wheat and rye have been matured, but these crops do not

seem to be so promising as oats and barley. All small grains will produce good yields of hay, even in years of abnormally early frost.

Over 200 bushels of potatoes per acre are grown on the good soils, without fertilization. The potatoes are of good quality when started early and grown on well-drained soils in sunny situations. This crop will succeed throughout the region on the better grades of land, such as the extensive Knik loam type.

Cabbage, turnips, lettuce, beets, spinach, garden peas, carrots, and a number of other vegetables of good quality are easily grown on all of the arable soils.

Cattle have been raised on a small scale at Ninilchik for years. The agricultural experiment station maintained for several years on the Kenai Peninsula successfully raised cattle and produced milk, butter, and cheese of good quality on pasturage and locally produced feed. Elsewhere no important effort has been devoted to the live-stock industry; but enough has been accomplished at Ninilchik and Kenai to show that there is no question regarding the possibility of raising stock and producing dairy products in this region. The native grasses will afford large quantities of hay, as well as good summer pasturage. Native hay supplemented with locally produced grain hay and root-crop forage will provide feed necessary for the long winters. From the latter part of May until some time in September the animals will maintain themselves on native pasturage. The only means of economically utilizing the abundant native grasses and the large yields of grain hay and root-crop forage the soils are capable of producing appears to be in the raising of stock and dairying. The necessity of feeding stock upward of 7 months in the year, however, imposes more restrictions upon the industry than are encountered in warmer regions and in those climates where the animals maintain themselves most of the year upon ranges.

The climate and soil make possible the establishment of an important agriculture in the Cook Inlet-Susitna region. Development will follow along pioneer lines at first, leading eventually to the establishment of many comfortable homes, supported largely by the products of the farm. The possibilities of raising stock and dairying point to the furtherance of agriculture, eventually, to a position of importance considerably beyond a self-supporting stage. The building of a railroad through the Susitna and Matanuska Valleys will make accessible a large area of good farming land, and, unquestionably, settlement will follow, probably at a rapid rate. Already 150 homesteads have been registered along Knik Arm, and others have been taken up. A number of prospectors and miners, most of whom previously had not been identified with agriculture, are now supporting themselves in the neighborhood of Knik largely with the products of their farms, assisted by the earnings of a few days' outside work during the summer.

The most promising line of agriculture for this country appears to be that which will center about dairying. With an increase in the population accompanying a development of coal mining in the Matanuska field, further developments in the placer and lode mining of gold, and expansion of the fisheries, there will be an enlarged market for beef, dairy products, potatoes, vegetables, and hay. For exportation those products of a more concentrated form, such as butter and cheese particularly, obviously will be the more likely to yield a margin of profit over the cost of transportation. Profitable exportation of farm products may depend upon the establishment of cheaper transportation to the outside markets.

An experiment station in the upper portion of the Cook Inlet region could give much assistance in the matter of ascertaining the best varieties of crops to grow here, in putting the seed of such varieties in the hands of farmers, and in working out other problems connected with the agricultural development of the region.

Before going to Alaska to farm it would be strongly advisable for the prospective immigrant to make a careful study of the geography of the region, its climate, soils, crops, transportation facilities, market conditions, and population; and sufficient capital should be available to carry the new farmer through a period of one or more years during which he will be busy clearing land and constructing necessary buildings.

PART II.—YUKON-TANANA REGION.

DESCRIPTION OF THE AREA.

The Yukon-Tanana region of this report comprises (1) the lowlands of the lower Tanana River, from the vicinity of McCarty to the Yukon River, known as the Tanana Flats; (2) the lowlands of the Yukon River, chiefly comprised in the Yukon Flats; and (3) the area of highlands or hill country between the Tanana and Yukon lowlands, the Yukon-Tanana uplands. (See Pls. A. and B.) This region represents a portion of the Central Plateau region of Alaska—a vast crescent-shaped territory, lying between the Pacific Mountain system on the south and the Rocky Mountain system on the north, extending from Bering Sea to and beyond the International Boundary line between Alaska and Canada. The included bottom lands are comparatively level, being topographically well suited to cultivation in their entirety. The surface of the uplands in this Central Plateau is not smooth in the sense usually associated with plateau regions, but the topography is very much more subdued than that of the rugged, lofty mountains of the Alaska Range to the south, and there are many areas smooth enough for cultivation. The permanent snow fields so common in the Pacific coast mountain system do not occur in this region.

North and west of the rugged, snow-covered ranges of the Pacific Mountain system the aspect of the country changes abruptly. A rolling upland about 200 miles wide, deeply dissected by well-developed drainage systems, with stream valleys and broad lowlands, and diversified by scattered mountain masses and isolated peaks that rise above the general level, stretches from the Pacific Mountain system on the south to the Rocky Mountain system on the north, and from the lowlands which skirt Bering Sea to beyond the international boundary.

One traversing the valleys and lowlands only of this central province might describe it as an agglomerate of hills, ridges, and mountains irregularly distributed and without system, but from a higher altitude the tops of the hills and ridges appear to mark a gently undulating plain. From about the level of this plain the drainage channels are almost entirely hidden, and the upland surface sweeps off to the horizon, broken only here and there by peaks or mountain masses which rise above the general level.[1]

The climate of the region and the topography, soils, vegetation, and agriculture of the several subdivisions are described in the chapters following.

[1] Brooks, A. H. The Geography and Geology of Alaska; Prof. Paper No. 45, U. S. Geol. Survey, p. 36.

In discussing the area as defined above, it is not meant that this includes all of the agricultural land of interior Alaska. This is simply the area to which the investigations were specifically directed. Farming lands are reported to exist in considerable areas along the upper Tanana River, and good grazing is said to be available about the headwaters of White River, in the Mentasta Pass section and in other places outside the limits of the area described.

CLIMATE.

The climate of the interior of Alaska is characterized by short summers of moderately warm temperatures and long winters of very cold temperatures, with long hours of darkness, corresponding to the lengthy duration of summer daylight. Shut off from the influence of the warm waters of the Pacific, which moderate the climate of the southwestern Alaskan coast, the Yukon-Tanana country has winters which are much colder than those to the southwest. Also the precipitation is very much below that of the coast country.

The absolute maximum and minimum temperatures for Rampart and Fairbanks (from seven-year records) are 96° F. and −68° F. and 86° F. and −65° F., respectively, as against corresponding temperatures of 91° F. and −27° F. and 85° F. and −12° F., respectively, at Tyonek (nine-year record) and Seward (four-year record), in the Cook Inlet region. The annual amounts of precipitation at Fairbanks and Rampart for the same period are 10.35 and 11.62 inches, respectively, against 22.81 and 53.39 inches, respectively, for Tyonek and Seward. Still wider differences are shown in the records of southern Alaska, as, for example, at Sitka the maximum is 87° F., the minimum −4° F., and the annual precipitation 84.3 inches. The maximum and minimum annual precipitation records reported by these observation stations are as follows: Rampart 15.53 and 5.32 inches, and Tyonek 28.29 and 20.17 inches. The corresponding records for the Fairbanks and Seward stations are incomplete. In these precipitation records snowfall is included, approximately 10 inches of snow being equivalent to 1 inch of rainfall. The average annual depth of snowfall, based on the same observations, is 52.8 inches at Rampart, 42.8 inches at Fairbanks, 82 inches at Tyonek, and 64.6 inches at Seward.

The light precipitation of the Yukon-Tanana country, as based on the Rampart and Fairbanks records, 10.35 and 11.62 inches, representing the respective annual means, would seem to be too low for safe crop production; and, but for the interposition of a number of important factors influencing moisture conditions, the rainfall would fall far short of crop requirements. The most important of these factors probably is the slow rate of evaporation during the growing season resulting from the moderate temperatures, the considerable

total period of cloudy weather, and comparative freedom from heavy winds. Other factors which help in making the normal supply of moisture adequate for crop production are as follows: (1) a large part of the rainfall comes in the months when it is most needed—that is, in June, July, and August; (2) the soil is frozen for long periods, and the thawing in the spring tends to establish a condition of soil structure which promotes absorption of the slowly melting snow; and (3) the slow, drizzling character of the rain favors its absorption and retention by the soil. Briefly stated, a large part of the water falling upon the surface, both as rain and snow, is taken up by the soil.

Of the total 10.35 inches of rainfall at Rampart, 4.3 inches fall in the months of June, July, and August; while of the 11.62 inches at Fairbanks, 4.81 inches are credited to these months—in short, approximately two-fifths of the precipitation comes during the growing season. Heavy downpours of rain are practically unknown, a fact which has much to do with the negligible harm occasioned by erosion. All of the soils seen have a physical constitution well suited to the absorption of rainfall, and many of them possess textural and structural characteristics admirably suited to the retention of moisture. It is true percolation is rapid in the deep sands, or would be with the lowering by clearing and cultivation of any subsoil ice that may be present, and that the loss of moisture by too excessive aeration is favored by the nature of such loose soils; yet much better yields are obtained from these soils than the same treatment gives with the same crops on similar land in the United States.

Dry seasons do occur which cause crops to suffer from lack of moisture, but these are not of such long duration, except in abnormal years, as to effect any great diminution in the average of crop yields. Dry weather in late spring and early summer sometimes checks plant growth to such an extent that low yields are made or that subsequent abundant moisture prolongs the growth, thus decreasing the chance of maturity by increasing the danger of injury by frosts. Injury to crops by spring droughts can be made less likely by practicing deep fall plowing and maintaining a good supply of organic matter in the soil—in brief, by putting the soil in the best possible condition for storing and conserving moisture.

Drizzling rains and cloudy weather are common in the summer season and militate to some extent against prompt curing of hay; yet experience shows that hay can be cured even when cut under very unfavorable conditions—as, for example, when the hay in the swath is subjected to several days of rain. To overcome such untoward weather conditions in the curing of hay, it is necessary to stir it in the field repeatedly with tedder or pitchfork or to place it upon some support which will allow the water to drain out. Freshly

cut vegetation does not deteriorate here as rapidly in rainy weather as in a warmer climate.

Local differences of climate, due largely to local peculiarities of topography and the resultant influence upon air drainage and wind movement, have a marked effect upon crop production. It is commonly stated that crops grown in the Tanana bottoms mature slower than those on the southerly slopes of the highlands and that frosts are likely to occur here at an earlier date. If this is true, it is probably due, to a considerable degree, to the settling of a cold stratum of air over the bottoms, although inadequate drainage of the soil may account for some imperfection of quality.

The cold winds which are reported as retarding plant growth in the pass followed by the Tanana Valley Railroad from Ester Siding to the Goldstream Flats can be accounted for, it seems, only as representing the influence of local characteristics of topography—a valley configuration favoring a sweep of wind between the valleys of the Tanana River and Goldstream Creek, caused, likely, by differences in the temperature of the air in the two valleys. It was noticed that crops in this pass had been killed on a sunny southerly slope on well-drained Fairbanks silt loam at a much earlier stage of development than the same crops growing elsewhere in similar positions and on similar soil. A number of other instances were noted in the hilly country north of Fairbanks where influences of local topography upon air drainage must have accounted for the variable effects of frost upon crops growing on similar soils in similar situations with respect to exposure to the sun. Potatoes, for example, were seen with green foliage at short distances from others which, the same day, on the same soil, occurring in the same relative situation, showed severe effects of frostbite, and still others, growing under practically identical conditions, which were only slightly frosted. These potatoes were in practically the same stage of development.

A notable example of local peculiarities of climate is that of the chilling winds which sweep down from cooler high valleys through the lower valley of Delta River into the warmer Tanana bottoms. Here the unfavorable wind would in itself prove detrimental to crop production.

Still another climatic effect of position is the relative coolness of northerly slopes and narrow, shut-in valleys, where there is less sunshine. Over these more shaded areas the vegetation is prevailingly quite different from that of the sunny slopes facing southward, being of a hardier type, with moss, lichens, Hudson Bay tea, and hard, scrubby spruce predominating.

Another important difference of climate is due to elevation. The higher, wind-swept peaks of the mountainous country between the

Tanana and Yukon Rivers are either bare of vegetation or support only a sparse growth of the scrubby and hardy forms. One of the conspicuous features of a landscape in the highlands is the gradual thinning out of the tree growth and the diminishing size of the trees with ascent of the slopes.

There are several hot springs in the region, the warm water from which has a strong influence upon the vegetation close by. At Hot Springs, corn, pumpkins, and other crops which do not succeed in the region out of doors are grown over a small area adjacent to the stream of warm water flowing from a hot spring. The area of land thus favorably affected by warm spring water unfortunately is of an almost insignificant extent.

The presence of ground ice, which frequently begins within 8 to 40 inches of the surface and extends to great depths, in some cases to bedrock several hundred feet beneath the surface (as shown in mining excavations), does not have the deleterious influence upon crop production that might be expected at first thought. On the contrary this substratum of ice is believed by some to constitute an actual advantage in that the thawing material supplies more or less moisture to growing crops. Nevertheless, the ice stratum is a disadvantage in some cases, as, for example, there are many bodies of land which have poor drainage because of the prevention of percolation by the congealed subsoil.

There is much variation in the depth to ice. It is nearest the surface where less sunlight and air penetrate the soil, as in the case of the fine-textured soils and those covered with moss, peat, or thick mats of grass and those shaded by dense forests or by the intervention of contiguous higher lands. There are comparatively few places where ice is not reached at some depth, but its surface level varies considerably even where the character of soil and exposure to sunlight are exactly the same. Ice was reported to have been found in a cellar excavation near Fairbanks at about 6 feet at one point and at a considerably lower depth in another part of the same excavation, where both the overlying and underlying soil was of uniform character, that is, fine sand. On the same farm no ice was found in a well 30 feet deep, where sand was underlain by gravel. This would indicate that the character of the substratum may have an important influence upon the formation of soil ice. Plate XVII shows the uneven surface level of underground ice in a fresh exposure caused by the caving of the banks of the Tanana River.

On moss-covered lands and peat and muck bogs ice is generally reached in late summer at 20 inches or less beneath the surface; on the northerly slopes it is found ordinarily within 3 feet of the surface, frequently at much shallower depths, even where the land has been

burned over, while on the southerly slopes it is rarely found within 40 inches of the surface, and in some places excavations have not shown its presence within 6 feet of the surface.

By simply burning the land over the ice level is invariably lowered; with subsequent clearing it is lowered still farther, and with cultivation its level drops again, the thawing advancing so rapidly that it is only in rare instances that ice is found within 40 inches of the surface of a newly cultivated field in late summer. The presence of ice in the substratum is therefore not a problem which presents any serious difficulties to plant growth; in fact, it is so easily controlled or lowered that it ordinarily would give little or no concern to the farmer. With clearing and cultivation the subsoil soon thaws to a level below the depth of ordinary winter freezing, which is about 4 or 5 feet.

Observations at Rampart during the period from 1906 to 1910, inclusive, show the length of the growing season to range from 84 to 107 days, and at Fairbanks for the period 1908 to 1912, inclusive, to range from 77 to 132 days. Owing to the length of the summer day this period of freedom from frost is comparable to a much longer season in lower latitudes, such as are thought necessary for agriculture in the continental United States. There is really no darkness in midsummer at this latitude. The long duration of sunlight adds very considerably to the growing season, a fact which in some measure explains the crop possibilities of this far northerly region almost bordering upon the Arctic Circle.

The early frosts, which do no more than slightly nip the tops of foliage, actually do little injury to most crops. Potatoes thus nipped by frost are said to be benefited rather than injured, the killing of the tops hastening, as believed, the maturity of the tubers. Grain for hay appears to be in no way damaged even by comparatively heavy frosts, except when these occur at an unusually early date or before the grain is well into the milk stage. Some valuable grazing plants, however, such as the tender "redtop" and "joint grass," deteriorate rapidly after frost.

In order to make the greatest possible use of the growing season land should be prepared in the fall so as to expedite early spring planting. It would seem reasonable that some advantage in the matter of getting an early start in the spring would be gained by seeding grain crops in the fall so late that the plants would not come up until spring.

The length of the growing season is indicated in the following table of records made at the agricultural experiment stations at Rampart and Fairbanks:

Length of growing season at Rampart and Fairbanks.

Year.	At Rampart.					At Fairbanks.		
	Last spring frost.		First autumn frost.		Days between frosts.	Last spring frost.	First autumn frost.	Days between frosts.
	Date.	Temperature.	Date.	Temperature.				
		°F.		°F.				
1906	May 20	23	Aug. 25	25	96			
1907	May 21	25	Sept. 6	24	107			
1908	May 19	30	Aug. 31	29	103	May 11	Sept. 8	119
1909	May 29	30	Aug. 24	27	86	May 15	Aug. 1	77
1910	May 28	28	Aug. 21	27	84	May 22	Aug. 21	90
1911						May 12	Aug. 31	110
1912						May 12	Sept. 22	132

In the winters ice 3 to 6 feet thick usually forms on the larger lakes and streams. Streams like the Yukon, which have an appreciable current, freeze in most places to a depth of 3 to 4 feet. At some rapids, however, as on the Yukon a short distance below Dawson, Yukon Territory, and on other streams, the water never freezes. Quiet bodies of water sometimes freeze to a depth of 6 feet.

On the smaller streams ice formed in the channel frequently obstructs the water underneath and causes it to overflow the surface, where it freezes, thickening the mass greatly. These accumulations of ice, known as glaciers, often form in masses so great that they are not entirely thawed until far into the summer. In many places they seriously obstruct mining and in others they favor it by prolonging and equalizing the stream flow.

The freeze-up of the navigable streams has such an important economic effect upon commerce in Alaska that it has resulted in the general recognition of two seasons—the "open," during which the Yukon is open to navigation, and the "closed," during which the Yukon is either filled with floating ice or is frozen over. In the following tables are given records collected by agents of the Northern Commercial Co. on the break-up and freeze-up of Alaskan streams. The dates given show remarkable uniformity as compared with those of streams in more southern latitudes.

In April and early in May the sun gradually becomes higher and its rays warmer until the accumulated snow and ice begin to melt. The tributary streams slowly increase their discharge into the large streams, raising the ice sheet until it can no longer remain intact and breaks away from the shore. This parting of the ice from the shore, or the break-up, indicates that the open season is at hand and is a momentous event for the people of the interior. Once broken up, the ice starts on its way to the sea, attended by an almost unimaginable spectacular display of tremendous forces. From bank to bank the huge moving ice cakes grind upon each other with an awe-inspiring exhibition of resistless force. At places the ice pack is obstructed, but sooner or later it forces its way past the obstacles and moves on, carrying away every movable thing in its path. When, after 7 to 12 days, the river is finally free, the "open season" has commenced and the river boats may venture from their winter quarters. The records show that on the Yukon the break-up usually occurs about May 12 and that navigation may start about May 20.

The date of the freeze-up is not quite so uniform as that of the break-up, but it usually occurs near the last of October or the first of November. The ice commences running in the river, and with the increasing cold the mass grows in size until it solidifies in a complete sheet and becomes anchored to the shore. Thereafter the river is closed to navigation.[1]

[1] Ellsworth, C. E., and Davenport, R. W., Water-Supply Paper, U. S. Geol. Survey, No. 342, pp. 20–22, 1915.

The table following gives the dates of break-up and freeze-up on the Yukon and Tanana Rivers:

Dates of break-up and freeze-up on Yukon and Tanana Rivers.

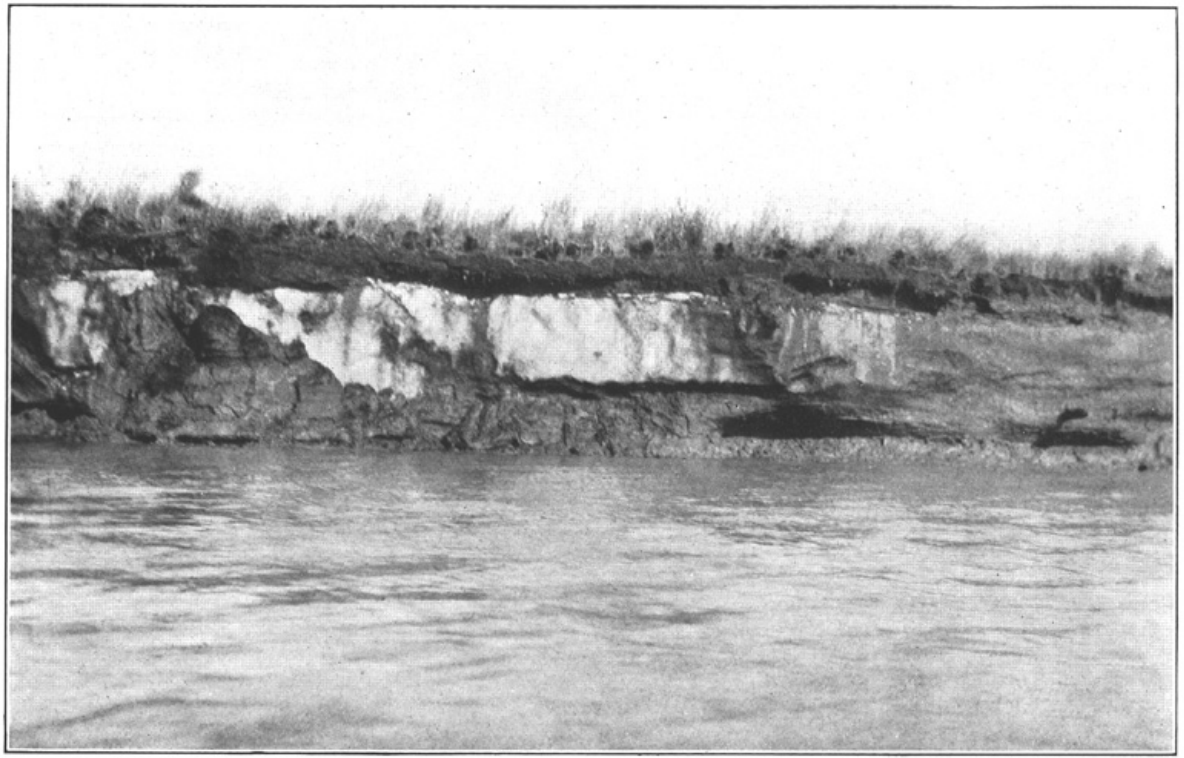
Year.	Yukon River at Rampart.		Yukon River at Fort Gibbon.		Tanana River at Fairbanks.	
	Break-up.	Freeze-up.	Break-up.	Freeze-up.	Break-up.	Freeze-up.
1898	May 22	Oct. 15	.....	.....	.....	.....
1899	May 19	Nov. 6	.....	.....	.....	.....
1900	May 15	Nov. 3	May 8	Oct. 30	.....	.....
1901	May 24	Nov. 8	May 24	Nov. 3	.....	.....
1902	May 21	Nov. 9	May 13	Nov. 7	.....	.....
1903	May 19	Oct. 24	May 22	Oct. 21	May 7	Nov. 13
1904	May 11	Nov. 11	May 7	Nov. 4	May 3	Oct. 27
1905	May 16	Oct. 29	May 12	Oct. 26	May 8	Oct. 14
1906	May 13	Nov. 10	May 16	Nov. 9	May 1	.....
1907	May 10	Nov. 2	May 6	Oct. 27	Apr. 30	Oct. 16
1908	May 14	Oct. 29	May 22	Oct. 26	May 3	Oct. 20
1909	May 17	Nov. 6	...do.....	Nov. 3	May 9	Oct. 10
1910	May 18	...do.....	.....	Nov. 4	May 10	.....
1911	.....	.....	May 11	Nov. 8	May 6	Nov. 4
1912	.....	.....	May 3	Nov. 4	.....	.....

A brief review of the weather conditions and their effects upon cropping methods and results at the Fairbanks Agricultural Experiment Station since the beginning of the field work in 1908 is quoted below:

The season of 1913 opened several days later than that of 1912. The last snow left the south-slope fields on May 6 and a week later left the north-slope fields. Seeding began on May 19. The weather continued dry and cold through May, very dry and hot through June and until July 19, when a copious rain cooled the atmosphere and stimulated plant growth. During the greater part of June and much of July the atmosphere was filled with haze or smoke, which proved very detrimental to some crops, especially potatoes. From July 19 the weather continued wet, with little sunshine, until September. There was a light killing frost on August 14, which damaged corn, beans, and buckwheat. From August 27 to 30 a cold wave swept over the country, carrying with it a snowstorm without precedent within the knowledge of the earliest settlers. About 4 inches of snow fell at the station, while in the neighboring hills there was a fall of some 2 feet, which did not entirely leave the high ridges. Prospectors reported that from 4 to 5 feet of new snow fell in the mountains during the last week of August.

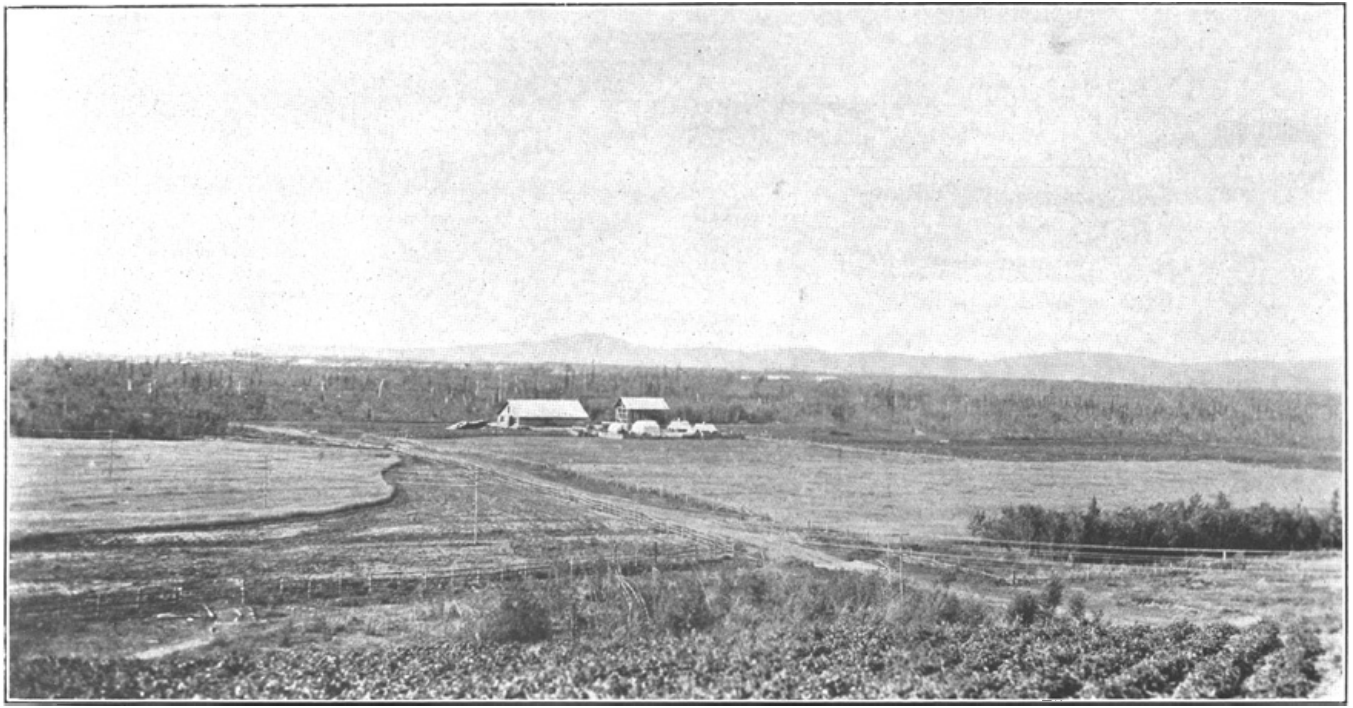
During this storm the temperature at the station fell to 26° F. on the night of August 27, with all the vegetation covered with wet snow. The records for August 28, 29, and 30 show respective temperatures of 26°, 25°, and 30° F. This storm killed the potatoes all over the valley and practically ruined the grain crops that had not already matured, so that they had to be cut for hay.

The month of September was dry and quite favorable for curing the hay crop. One and a half inches of snow fell on September 28, but soon left the fields. Light freezing weather prevailed more or less thereafter, but plowing could be continued until October 9, when hard freezing weather set in.



ICE IN FRESHLY CAVED BANK OF TANANA RIVER BETWEEN TOLOVANA AND HOT SPRINGS, SEPTEMBER 14, 1914.

Permanent ice extends to great depths over much of the region. When the land is cleared and cultivated thawing from the top causes a rapid lowering of the ice level, it soon dropping below the depth of winter freezes. The presence of ice is not detrimental to plant growth; in fact some consider it an advantage in that it supplies some moisture during dry periods.

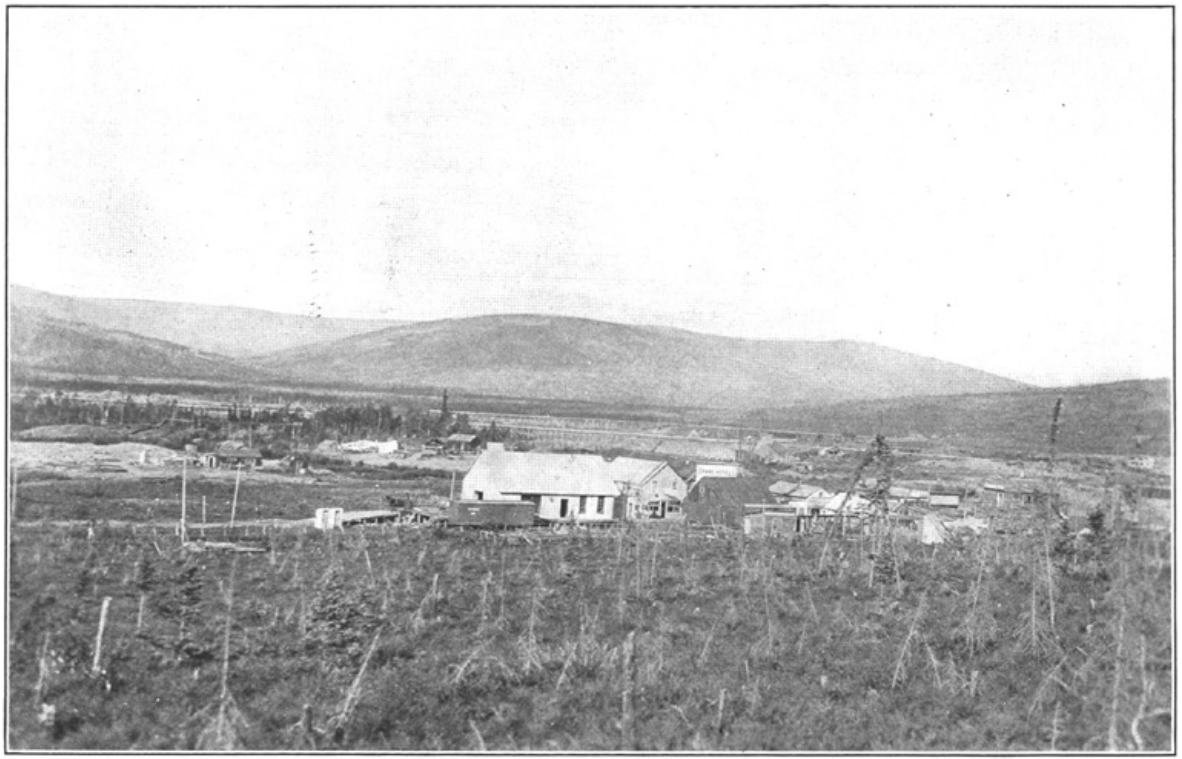


FARM ON THE TANANA BOTTOMS NEAR FAIRBANKS.

Showing the characteristic flat surface of the Tanana bottoms.

TANANA RIVER NEAR MOUTH OF SHAW CREEK, SHOWING MANY CHANNELS THROUGH THE FLATS.

The Yukon and Susitna Rivers through their broader bottoms are similarly divided into many distributaries with intervening low bars and islands.



TOPOGRAPHY OF HILL COUNTRY ABOUT CHATANIKA.

On the smooth lower slopes facing southward there is much land suitable for farming. Chatanika is one of the important placer mining camps of the Fairbanks district. The mining is confined to the flats of Chatanika River shown in the center of the picture.

During the five months from May 1, which covers somewhat more than the actual growing season, there were 53 clear days and 39 partly cloudy days. The extreme temperatures for the five months, respectively, were as follows: May, 75° and 17°; June, 88° and 42°; July, 83° and 39°; August, 76° and 25°; September, 66° and 20° F., with a monthly rainfall, respectively, of 0.49, 0.44, 2.25, 3.70, and 0.51 inches, totaling 7.39 inches for the five months.

In 1912 seeding began on May 1, which is many days earlier than for any other year since the station was established. The early summer was warm and dry, while the latter half of the season was cold and cloudy, there being practically no sunshine after the month of June. The atmosphere continued very smoky all summer after the volcanic eruptions on the coast early in June, and what little sunshine there was had little effect on the growing crops.

A light frost occurred on June 8 and another on August 21, followed by several light killing frosts in the lowlands, doing more or less damage to crops. Potatoes at the stations were killed by frost on September 25, 1912, almost a month later than in 1913.

During the five summer months of 1912 there were 22 clear days and 51 partly cloudy days, with extreme temperatures as follows: May, 76° and 26°; June, 84° and 31°; July, 85° and 40°; August, 78° and 31°; September, 64° and 28° F., with monthly rainfalls of 1.22, 3.15, 0.82, 0.96, and 1.16 inches, totaling 7.31 inches. The snowfall for 1912 was 40 inches, adding 2.89 inches of moisture. There was very little freezing weather until after the middle of October, and plowing could be continued until October 20.

In 1911 the season opened a little later than usual. Seeding began on May 16, although much of the ground could not be seeded until two weeks later. The weather continued wet and cold until June, and warm, dry weather ensued, continuing until far into August. Then cold, rainy weather set in, making it very difficult to cure the crops. On August 31 potatoes and other tender plants were killed all over the valley. The temperature fell to 28° F. at the station on that date, while 20° F. was recorded in the lowlands. Nearly all of September passed with little or no frost and the ground did not freeze sufficiently to stop plowing until October 20.

During the five summer months of 1911 there were 51 clear days and 40 partly cloudy days with the following respective extreme temperatures: May, 59° and 26°; June, 82° and 31°; July, 84° and 36°; August, 85° and 28°; September, 80° and 22° F., and a respective monthly rainfall of 0.16, 0.00, 2.16, 2.30, and 1.60 inches, totaling 6.22 inches. The snowfall for 1911 was about 27 inches, adding 1.92 inches of moisture.

In 1910 seeding started on May 16. The season was quite favorable to growing crops during the early summer, while the latter half was cold and dry for the most part, with several killing frosts during August. Potatoes were killed on August 29 at the station, but portions of the crop on higher ground were not killed until September 18.

During the five summer months of 1910 there were 64 clear days and 45 partly cloudy days. The respective extreme temperatures were as follows: May, 76° and 24°; June, 86° and 35°; July, 86° and 36°; August, 76° and 30°; September, 78° and 12° F., with a monthly rainfall, respectively, of 0.39, 2.16, 0.46, 1.69, and 1.91 inches totaling 6.61 inches for the five months. The snowfall was about 40 inches, adding 2.84 inches of moisture.

The early summer of 1909 was very dry. Seeding began on May 22. Much of the seed did not germinate until after a rainfall later in June, which was too late for the grain to mature. Seeds that started early came to maturity. Potatoes were slightly frosted August 25, but were not killed until September 16.

During the five summer months of 1909 there were 77 clear days and 53 partly cloudy days. The respective extreme temperatures were as follows: May, 74° and 26°; June, 77° and 35°; July, 82° and 43°; August, 76° and 28°; September, 74° and 11° F., and the respective monthly rainfall was 0.38, 1.64, 1.90, 1.78, and 3.90 inches, totaling 9.60 inches for the five months. The snowfall was about 54 inches, adding 3.76 inches of moisture.

The season of 1908 opened very late and continued cold, with showery weather, all through May. Very little soil was in condition to work when seeding started on May 26. The remainder of the summer was too dry for the crops. Nineteen hundred and seven was an unusually wet year, which left the ground very wet for a beginning in 1908. With a wet spring and an exceptionally dry summer 1908 was the most unfavorable year during the life of the station.

For the five summer months there were 68 clear days and 59 partly cloudy days. The respective extreme temperatures were as follows: May, 74° and 30°; June, 83° and 35°; July, 79° and 40°; August, 80° and 31°; September, 64° and 15° F., and the monthly rainfall, respectively, 0.52, 0.96, 0.73, 0.71, and 1.57 inches, totaling 4.49 inches for the five months.[1]

Further information relative to the climate of the region can be gained from a study of the climatological data presented in the tables following:

Normal monthly, seasonal, and annual temperature and precipitation at Rampart.

[Length of record, 7 years.]

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Mean snowfall, unmelted.[2]
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	−12.4	30	−59	0.89	0.32	1.26	9.6
January	−21.9	38	−68	.94	.84	1.17	9.8
February	− 9.5	42	−64	.57	.08	.44	7.0
Winter	−14.6			2.40	1.24	2.87	26.4
March	5.7	51	−45	.53	.36	1.17	6.2
April	22.0	65	−31	.33	.07	.02	3.7
May	46.3	85	15	.56	.20	.44	.5
Spring	24.7			1.42	.63	1.63	10.4
June	58.6	91	27	.89	.98	1.64	.0
July	60.0	92	32	1.49	.71	2.29	.0
August	55.5	96	25	1.65	.62	3.38	.0
Summer	58.0			4.03	2.31	7.31	.0
September	40.9	85	7	1.14	.43	2.52	2.6
October	19.6	54	−28	.72	.45	.65	7.2
November	− 2.9	37	−56	.64	.26	.55	6.2
Fall	19.2			2.50	1.14	3.72	16.0
Year	21.8	96	−68	10.35	5.32	15.53	52.8

[1] Rept. Alaska Agr. Expt. Sta., 1913.

[2] Included in mean precipitation.

Normal monthly, seasonal, and annual temperature and precipitation at Fairbanks.

[Length of record, 7 years.]

Month.	Temperature.			Precipitation.	
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Mean snowfall, unmelted.
	°F.	°F.	°F.	*Inches.*	*Inches.*
December	− 7.4	43	−58	0.84	9.9
January	−19.7	34	−65	1.16	11.0
February	− 3.5	43	−57	.23	3.0
Winter	−10.2			2.23	23.9
March	8.2	46	−56	.57	5.0
April	26.0	60	−32	.35	2.6
May	47.8	81	24	.36	Trace.
Spring	27.3			1.28	7.6
June	58.0	86	31	1.43	.0
July	59.7	86	30	1.60	.0
August	53.5	85	19	1.78	.0
Summer	57.1			4.81	.0
September	41.6	80	11	1.52	.7
October	25.6	67	−21	.71	5.4
November	.9	46	−54	1.07	5.2
Fall	22.7			3.30	11.3
Year	24.2	86	−65	11.62	42.8

Normal monthly, seasonal, and annual temperature and precipitation at Tanana.[1]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Least precipitation.	Greatest precipitation.
	° F.	° F.	° F.	*Inches.*	*Inches.*	*Inches.*
December	−13.4	30	−68	0.65	T.	1.61
January	−15.9	35	−76	.77	0.05	3.16
February	− 5.3	41	−68	.62	.08	1.63
Winter	−11.5			2.04		
March	7.6	53	−57	.61	T.	1.16
April	22.6	63	−39	.20	.00	.77
May	44.7	81	11	.95	.16	1.57
Spring	25.0			1.76		
June	58.4	90	26	.73	.20	2.06
July	59.2	89	32	2.01	.96	4.90
August	52.4	90	18	2.42	1.13	3.80
Summer	56.6			5.16		
September	39.2	78	3	1.18	.35	2.32
October	22.0	67	−27	1.04	.22	4.40
November	− 1.7	37	−55	.79	.03	3.42
Fall	20.9			3.01		
Year	22.5	90	−76	11.97	7.85	13.79

[1] This record covers a period of 154 months between 1882 and 1913, inclusive.

Normal monthly, seasonal, and annual temperature and precipitation at Eagle.[1]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Least precipitation.	Greatest precipitation.
	° *F.*	° *F.*	° *F.*	*Inches.*	*Inches.*	*Inches.*
December	−11	40	−68	0.51	0.07	1.10
January	−17	41	−75	.48	.06	1.45
February	− 5	45	−74	.37	T.	1.23
Winter	−11			1.36		
March	10	56	−56	.52	.00	2.19
April	26	64	−38	.43	.00	1.19
May	45	84	10	.85	.28	2.87
Spring	27			1.80		
June	57	92	24	1.40	.37	2.35
July	59	91	29	1.99	1.06	2.56
August	52	86	18	2.27	.95	4.73
Summer	56			5.66		
September	41	79	2	1.36	.01	3.38
October	24	68	−28	.99	.13	2.96
November	2	48	−52	.51	.21	1.27
Fall	26			2.86		
Year	24	92	−75	11.68	8.28	13.46

[1] Record complete, 1907 to 1913, inclusive; previous thereto very broken.

SOIL MAP.

The soil map of the Yukon-Tanana region accompanying this report is a reconnoissance map intended to show only in a general way the distribution and approximate extent of the important soils and groups of soils. Only portions of the region were examined, but it is believed these were representative areas and that the information secured was sufficient to determine the character of the more important types of soil and to make a fair approximation of their relative extent.

Without the aid of the topographic and geologic maps of the U. S. Geological Survey[1] this reconnoissance soil map could not have been made. Both the topography and geology were used as a basis for outlining the areas and for judging the character of the land over those areas not examined.

[1] Prindle, L. M., A Geologic Reconnaissance of the Fairbanks Quadrangle, Alaska. Bul. No. 525, U. S. Geol. Survey, 1913; Capps, Stephen R., The Bonnifield Region, Alaska. Bul. No. 501, U. S. Geol. Survey, 1912; Prindle, L. M., A Geologic Reconnaissance of the Circle Quadrangle, Alaska. Bul. No. 538, U. S. Geol. Survey, 1913; Maddren, A. G., The Koyukuk-Chandalar Region, Alaska. Bul. No. 532, U. S. Geol. Survey, 1912; Eakin, Henry M., A Geologic Reconnaissance of a part of the Rampart Quadrangle, Alaska. Bul. No. 535, U. S. Geol. Survey, 1913.

THE TANANA BOTTOMS.

GEOGRAPHY.

The Tanana bottoms, as referred to in this report, comprise that portion of the flat lowlands bordering the lower Tanana River from McCarty, near the fork of the Tanana and Delta Rivers, down to the confluence of the Tanana and Yukon Rivers, at Fort Gibbon. This great body of bottom land has a straight-line length from McCarty to Fort Gibbon of approximately 205 miles and a maximum width of about 70 miles in a north-south direction in line with the Nenana River. By the Tanana River McCarty is about 317 miles above Fort Gibbon. The area is of irregular shape, narrowing almost to the point of disappearance near Cosna and widening above and below this point. Roughly, it embraces 7,000 square miles.

The main body of the lowlands lies within the parallels 63° 45″ and 65° 20″ north latitude and the meridians 145° and 152° west longitude. The northern boundary, therefore, is 1° 10″, or approximately 81 miles south of the Arctic Circle (66° 30″). McCarty, near the eastern edge of this area, is approximately 212 miles north of Valdez, which is situated near the northern extremity of an arm of Prince William Sound.

From the Tanana region there are three lines of travel to the coast—one, by the Valdez-Fairbanks wagon road, to Valdez, on the Pacific coast; another, by boat down the Yukon River from the mouth of the Tanana, to Bering Sea; and a third, up the Yukon to Whitehorse, at the head of navigation on the Yukon, and thence by the White Pass & Yukon Railroad, to Skagway, on the Pacific coast of southern Alaska. The rivers are closed by ice usually from some time in October to about the first or middle of May.

PHYSIOGRAPHY.

As roughly outlined on the reconnoissance soil map of the Yukon-Tanana region, the Tanana bottoms include some bench lands or terraces and isolated elevations, such as Clear Creek and Wood River Buttes. The characteristic surface configuration of these lowlands is very nearly level. (See Pl. XVIII.) There are, however, numerous slight depressions and elevations, stream channels and abandoned stream channels, imperfectly developed drainage ways and swales, and hummocks and faint ridges. There is a gradual rise in the surface or a rise by minor terraces toward the foot of the confining uplands. These surface inequalities are of little or negligible importance from the viewpoint of tillage. In fact, this great body of land may be considered as having essentially a level surface. Seen from a commanding elevation, the broad bottoms stretch away in panorama as a vast level wooded plain, with occasional treeless

areas and lakes. The Tanana River, which follows close to the northern edge of the bottoms throughout most of its course, is split into many channels passing between numerous islands and bars, many of which are of considerable size and occupied by dense forests. (See Pl. XIX.)

These lowlands are as a whole called the "Tanana Flats." Certain portions are designated by local names, as, for example, the bottoms near the mouth of Tolovana River are called the "Tolovana Flats," while the section about Minto Lake is spoken of as the "Minto Flats."

The principal affluents of the Lower Tanana are the Big and Little Delta Rivers, Wood, Nenana, Kantishna, Cosna, Chena, Salcha, Chatanika, and Tolovana Rivers. Some of these enter the Tanana approximately at the foot of the uplands, while others flow for many miles across the bottoms before entering the main river. These have prevailingly low banks through the bottoms. In places the channels are divided and there are many islands and bars.

Drainage Conditions.

Although considerable portions of the Tanana bottoms are occasionally overflowed by the main river and its tributaries, by far the greater part is not subject to overflow. This year (1914) unusually heavy rains in August occasioned the submergence of considerable low areas adjacent to the stream channels. At Fairbanks the water flowed through the streets of the city, while in the vicinity of Munsons a wide strip of land was inundated, and the cutting back of the banks of the Salcha River caused the destruction of several houses in this little village.

A large part of the bottoms consists of well-drained land and land which, although poorly drained, is not subject to overflow. The most poorly drained areas are the depressions and flats without well-established drainage outlets and those having ice near the surface. These occur throughout the bottoms as small to moderately large strips and bodies. They are wet or swampy in summer and over them a moisture-loving type of vegetation prevails. There is here, however, little or no land that could not be readily drained by ditching and clearing. Small ditches leading into natural drainage outlets or into canals would remove surplus water from most of these wet situations. Sufficient drainage could be easily accomplished by clearing and ditching to admit of agricultural utilization of most of the land.

The sandy soils and higher flats are naturally well drained—they are ready for cultivation except for the necessary clearing. In fact, some of the deep, loose sandy lands have excessive drainage, or would have if cleared and brought into cultivation.

A factor which governs the present drainage condition of much land in the Tanana bottoms is the frozen condition of the subsoil. The upper level of this soil ice is reached at variable depths, being nearest the surface where the vegetation is thickest and most effective in keeping out sunlight and air, such as the thick layers of moss. Where a covering of moss or peat existed ice was reached in many places at a depth of 1 or 2 feet in August and September. Where there is a dense growth of grass, as in the occasional natural meadows of redtop, it was encountered at about 30 to 40 inches below the surface, while in some of the densely forested areas the frozen material was reached in a good many places within 40 inches or less of the surface. On the other hand, ice was absent in the 40-inch soil section through much of the timbered country where the undergrowth is scant, and in practically all of the recently burned-over and sparsely timbered lands having only a thin vegetative covering. Ice probably underlies practically all of the bottoms, at some depth. Freshly exposed sections of the Tanana River banks, resulting from the caving in of the earth, showed in many places a substratum of congealed material (see Pl. XVII). The upper surface of this stratum as shown in these exposures is decidedly uneven, dropping off from near the surface of the ground to a depth of 8 feet or more and rising toward the surface within a short distance.

The level of ground ice is lowered by burning over the land; and with clearing and cultivation, thawing is accelerated, the ice level quickly dropping below the depth of winter freezing. In no cultivated fields could ice be reached with a 40-inch soil auger. It is obvious that the drainage condition of land having ice near the surface will be improved by the lowering of the ice level, provided the topography or situation with respect to drainage outlines favors the removal of the excess water.

Burning over the surface also improves the drainage of land not having ice near the surface. Many instances were noted where burned-over land was better drained than exactly the same soil occupying exactly the same topographic position, and having a considerable covering of vegetation but no ice within 40 inches of the surface.

VEGETATION.

The greater part of the Tanana bottoms is timbered. Spruce, aspen, birch, and cottonwood constitute the important trees, with much willow and alder occurring in thickets and as an undergrowth. Spruce is the most abundant tree throughout the bottoms, dominating the more important forests and frequently growing to the exclusion of other trees. There are few large timbered tracts in which this tree is not present. It varies in size from a very small tough scrub (black spruce), on wet peaty and mucky lands and on soil having ice

near the surface, to trees 24 inches across the stump (white spruce) on well-drained sandy and silty soils. Much of it is of sufficient size for lumber and crossties. Birch is common on the silty soils of the entire bottoms. It appears to be most abundant and larger on the silt loam land near the foot of the uplands, where it attains a diameter of about 14 to 16 inches. Scrubby birch is likewise abundant on all of the soils, especially those of imperfect drainage. Aspen is also widely distributed through the bottoms. It is most abundant on well-drained shallow soils overlying sand and gravel, and especially abundant on such lands as the gravelly soils along the Nenana River. This tree attains a diameter of about 16 inches on the heavier soils. Most of it, however, is found on the sandy soils and is of rather small size. Cottonwood is mainly confined to the sandy soils near the streams. There are many strips of forest composed almost exclusively of cottonwood (poplar) fringing the banks of the Tanana. The tree frequently grows to a diameter of 2 feet or more. Willow and alder are abundant in nearly all of the wet depressions; they are common as thickets and in scattering growth over most of the wet flats, and are quite numerous near the banks of streams. These constitute a common undergrowth even on the well-drained sands, where spruce is dense and of large size.

The best timber of spruce, birch and poplar grows in the valleys of the streams, particularly along the Tanana, and excellent stands of birch and aspen are found also on the easterly and southerly slopes of creeks which have a silt soil. This is particularly true in the Fairbanks district. Black spruce predominates in the more poorly drained situations. Here, as farther south, it is characteristically a swamp and muskeg tree, though in some places abundant on hill and mountain slopes. Tamarack grows sparsely in river and creek valleys, but is nowhere of particular importance.[1]

High-bush cranberry (*Viburnum pauciflorum* Pylaie) is locally plentiful over the better drained sandy soils. Wild rose is almost universally present, except in the wet situations. Low-bush cranberry (*Vaccinium vitisidæa*) is not so numerous as on the hill slopes, but is abundant in some of the wet situations and is of occasional occurrence through the woods, especially in the spruce forests, where there is considerable moss. Hudson Bay or Labrador tea of two varieties (*Ledum groenlandicum* Oeder and *L. decumbens* (Ait.) Lodd), wild sage (*Dasiphora fruticosa* (L.) Rydb.), and blueberry are abundant, especially where the tree growth is scattered. Moss is widely distributed, but is not so thick over the Tanana Flats proper as on the northerly slopes of the hills and in the bottoms of the streams flowing through the hilly country. Dwarf birch (*Betula rotundifolia* Spach and probably others) is frequently seen on rather wet lands. Native redtop (several species of *Calamagrostis*) is abundant in the frequent openings—those places where the timber

[1] Kellogg, R. S., The Forests of Alaska, Bul. No. 81, Forest Service, U. S. Dept of Agr., 1910, p. 19.

has not established itself densely or has been removed by fire or ax. Joint grass (*Equisetum* sp.) is very plentiful throughout the forested portions of the entire lowlands region.

In the following chapters, describing the several classes of soils, the distribution of vegetation is presented in more specific relation to environmental influences, particularly of soil and drainage.

Soils.

The soils of the Tanana bottoms are prevailingly sandy, either from the surface downward or in the subsoil portion. There is little land which does not have sand in the subsoil, and a large proportion has sand over the surface, or from near the surface downward.

The soil material of the Tanana bottoms proper consists chiefly of very fine sand, fine sand, and silt, with some minute flakes of a micaceous character. These materials are mixed in varying proportions and are more or less intermingled in the surface soil with varying quantities of vegetable matter in different stages of decay. There is frequently a covering of vegetable mold, muck, and peat. The inorganic material, silt, sand, and gravel, represents sediments which have been transported by water from the drainage basins of the various streams entering the lowlands, while the organic material represents particles of plants, grasses, leaves, twigs, and moss, in process of decomposition. The inorganic materials are varied in point of origin, having been washed from widely separated upland areas—from soils of residual origin, and from glacial material. These, however, have been mixed in varying degrees, and on the whole there is marked physical uniformity in the soils throughout the bottoms.

Silt is most abundant in those places where overflow water has flowed least rapidly. The reverse is true with sand. These different sizes of soil particles occur as intimate mixtures and in distinct interstratified layers throughout the vertical soil section. Gravel is not nearly so abundant as on the bench lands of the Cook Inlet-Susitna region of south Alaska, yet it is locally abundant here in the subsoil or substratum of the soils and on river bars. It is abundant, for example, in places along the Nenana River some 8 or 10 miles above its mouth and along the slough above Fairbanks.

The Tanana soils differ from the corresponding stream-bottom soils of the Cook Inlet-Susitna region, the Susitna soils, in having a very noticeable content of micaceous particles and much less gravel in the 3-foot section, and in being less acid. Otherwise there is considerable similarity between the alluvial soils of the two regions.

Silt loam, very fine sandy loam, and fine sand frequently occur in intimate association with each other, the silt loam characteristically occurring over the more nearly level areas and in the depressed situations, the very fine sandy loam over nearly level flats, and the fine

sand and very fine sand on somewhat hummocky areas and near the banks of streams. The most extensive types are the Tanana very fine sandy loam, silt loam, and fine sand.

The following table gives the results of chemical analyses of samples of representative soils of the Tanana bottoms and other divisions of the Yukon-Tanana region:

Chemical analyses of important soils of the Yukon-Tanana region, Alaska—Fusion analysis.[1]

Soil type and section.	No. of sample.	Location of sample.	K_2O.	P_2O_5.	N.	CaO.	MgO.	Organic matter.
Gilmore silt loam:			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Soil	590140	Slope just west of Fox	1.26	0.05	0.06	1.57	1.92	2.51
Subsoil	590141	.....do	1.80	.13	.03	1.99	1.99	.....
Tanana silt loam:								
Soil	590142	Fairbanks	2.10	.08	.07	1.80	3.75	2.79
Subsoil	590143	.....do	1.24	.12	.01	2.65	2.02	.43
Fairbanks silt loam:								
Soil	590146	Fairbanks Experiment Station, in timber.	1.44	.38	.07	2.24	1.62	2.72
Subsoil	590147	.....do	1.38	.08	.04	1.99	1.53	1.96
Soil	590148	Fairbanks Experiment Station, in field.	1.40	.49	.08	2.03	1.58	2.35
Subsoil	590149	.....do	1.32	.11	.03	1.90	1.63	.80
Goldstream silt loam:								
Soil	590153	Lower Goldstream Flats.	1.02	.25	1.06	3.23	1.37	40.65
Subsoil	590154	.....do	1.36	.09	.08	2.63	1.71	2.56
Tanana fine sand, subsurface.	590155	Minto Flats	1.18	.08	.03	2.97	2.02	.30
Nenana silt loam:								
Soil	590156	30 miles above mouth of Nenana River.	1.80	.14	.10	2.92	2.27	2.28
Subsoil	590157	.....do	1.50	.18	.03	1.46	1.21	.....
Rampart silt loam:								
Soil	590164	Rampart Experiment Station, on bench.	1.64	.13	.08	2.08	1.24	3.78
Subsoil	590165	.....do	1.78	.15	.06	4.25	1.90	.98
Soil	590166	Rampart Experiment Station, foot of bench.	1.44	.20	.38	3.04	1.54	12.65
Subsoil	590167	.....do	1.70	.19	.10	2.61	1.41	.....
Yukon silt loam:								
Soil	590168	Rampart Experiment Station, on river flats.	1.44	.22	.38	2.97	.80	15.52
Soil	590169	150 miles above Rampart, on Yukon Flats.	2.00	.21	.42	3.20	2.00	18.90
Subsoil	590170	.....do	1.75	.17	.15	5.56	2.22	.....
Gilmore silt loam:								
Soil	590171	½ mile north of Hot Springs.	1.79	.08	.07	1.53	1.58	2.03
Subsoil	590172	.....do	3.32	.10	.04	1.33	.58	.....
Fairbanks silt loam:								
Soil	590173	Hot Springs	1.80	.44	.10	1.82	1.25	4.10
Subsoil	590174	.....do	1.84	.18	.06	1.88	1.60	.....

[1] Analyses, except organic, made by R. F. Gardiner and C. F. Miller, and organic matter determined by W. B. Page; in the laboratory of the Bureau of Soils.

The table on pages 124–125 gives the results of mineralogical examinations of representative samples of soil from the Tanana bottoms, the highlands between the Tanana and Yukon Rivers, and from the benches and bottoms of the Yukon.

The following table gives the areas of the principal soils and groups of soils in the Yukon-Tanana region covered by the reconnoissance soil map:

Areas of principal soils in Yukon-Tanana region covered by reconnoissance soil map, with an estimate of the minimum area of each available for cultivation.

Classification.	Square miles.	Per cent.	Lowest estimate of area available for cultivation.	
			Square miles.	Acres.
Mainly Gilmore soils and stony mountainous areas	11,368	43.9	2,500	1,600,000
Tanana soils (mainly)	7,553	29.2	3,500	2,240,000
Mainly Yukon soils (south of Yukon River)[1]	4,119	15.9	.....	.....
Goldstream silt loam (mainly)	1,053	4.1	250	160,000
Fairbanks silt loam (mainly)	816	3.2	733	469,120
Nenana silt loam (mainly)	579	2.2	100	64,000
Rampart silt loam (mainly)	400	1.5	100	64,000
Total	25,888	.....	7,183	4,597,120

[1] The Yukon soils are not included in the estimate of present available agricultural land on account of their northerly latitude. It can not be denied, however, that they possess farming possibilities. According to the work of the U. S. Geological Survey there is considerably more of the Yukon soil ("Yukon Flats") than is shown on the reconnoissance soil map.

TANANA VERY FINE SANDY LOAM.

The Tanana very fine sandy loam in its most typical development is a dark-brown to dark grayish brown very fine sandy loam, underlain at depths ranging from about 4 to 10 inches by grayish-brown very fine sandy loam to loamy very fine sand, frequently mottled with grayish and rusty-brown colors. The subsoil material extends to a depth of 3 feet or more without important change, except that thin strata or pockets of rather loamy or silty very fine sand are encountered at variable depths, in some areas. Small micaceous particles are disseminated through both soil and subsoil, occasionally being present in sufficient quantity to impart a greasy feel to the material. In many places there is a thin surface layer of black mucky loam, the thickness of which increases as the drainage becomes more imperfect.

Results of mineralogical examinations of samples of representative soils of the Yukon-Tanana region.[1]

[A indicates that the mineral is abundant; Pre that it is predominant; S that it occurs in small amounts; VS in very small amounts; T in traces; P indicates the presence of the mineral without reference to quantity, and (?) that the mineral is probably present, but that the data obtainable were not sufficient to identify it beyond doubt.]

Sample No.[2]	Isotropic material.	Quartz.	Muscovite.	Biotite.	Femic mineral.	Hornblende.	Augite.	Orthoclase.	Microcline.	Plagioclase.	Albite.	Oligoclase.	Andesine.	Labradorite.	Olivine.	Calcite.	Apatite.	Hematite.	Magnetic iron ore.	Tourmaline.	Epidote.	Zircon.	Rutile.	Garnet.	Corundum.	Zoisite.	Monazite.	Remarks.
590142	T	A	A	A	...	S	...	T	...	T	...	...	...	T	...	...	...	...	VS	...	VS	T	T	...	...	...	...	
590143	T	A	A	A	...	S	...	VS	...	T	...	T	T	T	...	T	...	...	S	...	VS	T	...	...	...	...	...	
590146	VS	A	A	A	...	S	...	VS	...	VS	...	...	...	...	(?)	...	...	...	VS	...	VS	VS	...	...	(?)	...	...	
590147	T	A	A	A	...	S	...	VS	...	P	...	...	...	...	...	...	...	...	VS	T	VS	T	T	...	...	...	...	
590154	T	A	A	A	...	S	...	S	...	P	...	VS	...	VS	...	...	T	...	T	...	T	T	...	...	...	T	...	
590155	S	Pre	A	A	...	S	...	S	...	P	...	...	...	T	...	...	...	VS	VS	...	T	T	...	...	...	...	...	Some hematite may be altered to limonite or other hydrate.
590164, No. 4 sand.[3]	P	P	P	P	...	P	...	(?)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Much organic matter present.
590164, No. 5 sand.	P	[4] 70	[4] 4	P	...	P	P	[4] 3	[4] 3	...	P	P	...	P	...	...	...	...	P	...	P	P	P	...	...	...	...	
590164, silt.	...	[4] 50	[4] 5	P	...	P	P	[4] 8	...	...	P	P	...	P	...	...	...	...	P	P	P	P	...	...	...	P	...	
590165, No. 4 sand.	[4] 1	[4] 50	[4] 15	[4] 2	...	[4] 10	P	[4] 1	...	P	...	[4] 1	...	...	...	P	...	...	P	...	P	P	...	...	P	...	...	
590165, No. 5 sand.	...	[4] 60	[4] 9	P	P	P	P	[4] 8	...	P	P	P	...	P	...	P	...	...	P	...	P	P	...	P	...	P	...	
590165, silt.	...	[4] 75	[4] 5	P	...	P	P	[4] 4	...	P	P	P	...	P	...	P	...	...	P	...	P	P	P	...	...	...	T	
590169, No. 4 sand,	VS	P	P	P	...	P	...	P	...	...	...	...	...	P	...	...	...	...	...	...	...	...	...	...	...	...	...	Much organic matter present.

590169, No. 5 sand + silt.	S	S	S	VS	....	S	....	S	....	P	....	.....	....	T	....	....	....	.....	VS	....	T	.....	....	....	....	....	....
590170.....	S	S	VS	VS	....	S	....	S	....	P	....	.....	....	VS	....	A	....	.....	A	....	T	.....	....	....	....	....	....
590173.....	S	S	S	VS	....	S	....	VS	....	P	....	.....	....	.....	....	....	....	.....	T	....	T	T	T	....	....	....	....
590174.....	S	S	S	S	....	VS	....	VS	....	P	....	.....	....	.....	....	....	....	.....	T	....	T	.....	....	....	....	....	....

[1] Analyses by W. H. Fry in the laboratory of the Bureau of Soils.

[2] For name and location of samples see tables of chemical analyses (p. 122) and of mechanical analyses of soil samples, under soil type descriptions.

[3] For definition of No. 4 sand and other textural classes of soil material see tables of textural classes, p. 34. For the proportion of the various textural classes in the soils, see tables of mechanical analyses under the soil type descriptions.

[4] Per cent.

Locally there are minor variations in this type, especially in color and depth of the soil section. At Birch Lake Road House, for example, the soil is a moss-covered, black, mucky, very fine sandy loam, underlain at about 15 inches by yellowish-brown to grayish-brown very fine sand with some gravel in the lower subsoil. The drainage here is rather imperfect, owing principally to the presence of ice at a depth of about 10 to 20 inches. A garden on this phase had been effectively drained by a surrounding ditch about 2 feet deep, and was producing good vegetables, the ice having been lowered since cultivation to about 30 or 40 inches. On the Ester Road, between Fairbanks and the agricultural experiment farm, there is an area of Tanana very fine sandy loam which consists of black muck or mucky loam about 3 or 5 inches deep, overlying yellowish-brown or mottled yellowish-brown and drab very fine sandy loam, grading at about 12 to 15 or 20 inches into brownish and bluish fine sand to very fine sand. Frequently the immediate surface soil is a silt loam.

The Tanana very fine sandy loam is easily worked, and light teams and implements would give efficient tillage. When cleared and properly drained the level of the frozen subsoil material is lowered and the soil warms up early. Most of it occupies positions high enough for good natural drainage, but in places there is a covering of moss or other vegetation, or of muck, which prevents thawing in the subsoil and thus retards drainage. The greater part of the type thus needs only to be cleared in order to be put into condition for farming.

The vegetation varies considerably, owing chiefly to differences in the moisture condition. Where good drainage obtains spruce is the dominant tree, occurring with a fair sprinkling of birch and an occasional cottonwood and some undergrowth of willow and alder. Willow, Hudson Bay tea, blueberry, dwarf birch, and wild sage are present in many of those places where large trees are not abundant. Aspen is seen in places, but it is not so abundant as on the Tanana very fine sand. Redtop is usually present in burned areas and fireweed is also frequently seen in such places. The former, however, does not grow so rank and dense as on the silt loam.

The surface of the type is level to slightly hummocky, and ordinarily a little higher than that of the associated bodies of Tanana silt loam.

In agricultural value this soil ranks between the Tanana silt loam and the Tanana very fine sand. Potatoes yield very well and appear to be of a better quality, more mealy, than those produced on the silt loam, probably because of the better drainage condition. Oats and barley and all the vegetables grown in the region do well, as do also a large number of flowers. Before any attempt is made at farming, except in the production of hay and the use of the land for pasture, all wet tracts must be properly drained.

Under cultivation the humus content will gradually be reduced, and unless this is replenished occasionally the soil will assume a loose structure not favorable to the retention of moisture. Applications of barnyard manure or other fertilizer will increase the yields of all crops. The soil is only moderately acid, indicating that lime is not badly needed, at least not for the purpose of correcting acidity. This, however, does not mean that lime could not be used to advantage, since applications of lime are frequently beneficial in effects aside from the mere correction of acidity. Wood ashes invariably increase the yields.

The type has a wide distribution throughout the Tanana bottoms from the vicinity of McCarty to the Yukon River. It usually lies adjacent to the Tanana silt loam or between that type and the Tanana very fine sand, but it is by no means confined to such places. It appears to be less extensive than the fine sand, and possibly there is not so much of it as there is of the silt loam, but it is, nevertheless, of sufficient extent and productivity to constitute an important soil.

The following tables give the results and average results of mechanical analyses of samples of the soil and subsoil of the Tanana very fine sandy loam:

Mechanical analyses of Tanana very fine sandy loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590150	McCarty.....	Soil, dark brown very fine sandy loam, 0 to 10 inches.	0.4	1.0	0.6	5.2	33.0	55.4	4.3
590151	.....do.....	Subsoil, brown very fine sandy loam, 10 to 36 inches.	.1	.3	.1	4.6	42.0	49.4	2.9
590175	On flats at Hot Springs.	Soil, brown very fine sandy loam to silt loam, 0 to 6 inches.	.2	.6	.5	3.8	27.1	59.0	8.4
590176	.....do.....	Subsoil, grayish-brown very fine sandy loam, 6 to 36 inches.	.0	.2	.3	19.5	38.9	38.6	2.6

Average mechanical analyses of Tanana very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
590150, 590175.....	Soil.....	0.3	0.8	0.5	4.5	30.1	57.2	6.3
590151, 590176.....	Subsoil.....	.1	.2	.2	12.0	40.4	44.0	2.8

TANANA SILT LOAM.

The Tanana silt loam, characteristically, consists of a mottled brownish and grayish silt loam underlain at about 5 to 10 or 15 inches by brownish-gray or grayish-brown or mottled brownish and grayish very fine sand, loamy very fine sand, or very fine sandy loam, with frequent inclusions of thin layers of mottled rusty brown and drab or grayish silt loam or loam. The material is micaceous from the surface downward, but mica was not found in sufficient quantity to give the material a greasy feel.

There are local variations in the type, aside from those of drainage, which are of little importance in their relation to agriculture. Frequently the subsoil shows a greenish cast and occasionally a faint shade of blue in the more sandy strata. Over the lower flats, where the drainage is imperfect on account of inadequate slope or drainage outlet or the presence of ice in the subsoil, there is nearly always a black surface layer of muck or mucky silt loam ranging from about 1 to 6 or 8 inches in thickness. Those areas with muck a foot or more deep would be classed in a detailed survey as Muck.

An important phase of the type occurs in drainage-way depressions, where a saturated condition permanently obtains in summer from the surface downward. In the slough-grass meadows of Dilley's ranch, near the mouth of Chena River, this phase occurs as a mottled rusty-brown and grayish silt loam overlying, at a depth of about 10 to 34 inches, mottled brown, rusty-brown, and gray or drab very fine sandy loam, alternating with layers of silt loam having either the same mottled color or a decidedly bluish color. In another part of the same meadow, near-by, the soil is a dark mucky silt loam about 5 inches deep over mottled rusty-brown, brown, and drab silt loam, beneath which at about 12 to 20 inches mottled rusty-brown, brown, and drab very fine sandy loam is encountered. This overlies grayish silty very fine sand and bluish silt loam.

The timber growth on the typical soil is spruce and birch, the latter being more abundant and larger than on the sandy Tanana soils. Low-bush and high-bush cranberry is abundant on the type and redtop flourishes in the open places. Some wild currant was seen. As the drainage becomes poorer, willow, cottonwood, blueberry, Hudson Bay tea, and various other moisture-loving shrubs become more plentiful, while spruce becomes less abundant, and birch diminishes in size. The lowest, wettest phase, referred to above as the slough-grass phase, is mostly treeless. This phase usually supports a rank growth of slough grass (*Carex* sp.) and an occasional clump of willow, with frequently an inclosing fringe of redtop. Aspen is not present on the type to any considerable extent.

This soil was seen in important bodies in the vicinity of Fairbanks and along the Valdez trail, between Fairbanks and Hot Springs, and

at other points through the lowlands. Small patches of irregular shape are of very frequent occurrence. The type has a wide distribution and evidently embraces a large total area. It seems to be most extensive along the outer edge of the bottoms.

With any important extension of agriculture over the Tanana bottoms, this type will necessarily constitute a very important if not the most important soil for farming purposes. The wettest areas can be drained, as shown by results obtained with ditches on the slough-grass phase of Dilley's ranch. It may not be found advisable, however, to drain many of these wet areas, on account of their excellent adaptation to slough grass, further than to bring about a proper condition for economic harvesting of the grass. Redtop will give splendid results over all of this type. It is estimated that from 1½ to 3 tons of redtop hay per acre can be easily produced, and from 2 to 3 tons of slough-grass hay. Oats and barley are being grown successfully on a number of farms for hay. Heavy yields are generally obtained without the use of fertilizer.

All of the vegetables grown in the region are successfully produced on this soil. Cabbage, lettuce, and beets seem to do especially well. Good yields of potatoes are made, but they are said to be frequently of a rather soggy nature. Such an undesirable quality likely could be improved by establishing more nearly perfect drainage and by growing the earliest varieties. It is said that the quality of potatoes is better from those fields which have been under cultivation for several years.

While the soil, so far as examined, is only moderately acid to litmus paper, additions of lime undoubtedly would be beneficial to crop production. That beneficial results always follow applications of wood ashes indicates that lime or potash or both are needed. Applications of barnyard manure have been found to increase yields of all crops.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Tanana silt loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590142	Fairbanks.....	Soil, mottled brown and grayish silt loam, 0 to 10 inches.	0.0	0.2	0.2	3.3	22.5	70.0	3.6
590143	.....do.....	Subsoil, brownish-gray very fine sand, 10 to 36 inches.	.0	.0	.1	26.7	51.2	20.6	1.3

TANANA VERY FINE SAND.

The Tanana very fine sand is the most extensive soil in the Tanana bottoms. More of it was seen than of all the other bottom soils combined. It occurs through the entire extent of this great lowland area, but is relatively more abundant along the streams, where there are many broad belts which do not include any important bodies of other soils.

Where typically developed the Tanana very fine sand consists of a rather dark grayish brown to slightly greenish brown very fine sand, passing, usually between depths of 15 and 30 inches below the surface, into yellowish-brown or greenish-brown very fine sand to loamy very fine sand. Thin layers and lenses of very fine sandy loam are present in the subsoil of some areas. Occasionally the subsoil is somewhat coarser in texture, consisting of fine sand. Mottlings of gray, drab, and rusty brown are common in the subsoil of the more poorly drained portions of the type, the mottling becoming more intense with deficiency of drainage. Frequently the immediate surface soil, that is, the true soil material underlying any covering of vegetable mold that may be present, has a loamy character owing to the presence of a small amount of silt. Particularly is this true in the more nearly level areas and the depressions. This loamy stratum, however, is rarely deeper than about 3 to 5 or 6 inches. Mica flakes are invariably present throughout the soil section. These are often abundant, but the quantity is rarely sufficient to give a distinctly greasy feel, such as characterizes micaceous soils in general.

As is true with the other bottom soils of the Tanana series, the lower, wetter situations and moss-covered flats, with ice near the surface, have a covering of black muck or mucky loam, usually not more than 2 to 5 inches deep. The proportion of this mucky phase, however, appears to be relatively small.

The surface of the Tanana very fine sand is decidedly flat in perspective, but a close view reveals slight hummocks or swales and depressions over the greater part of the type. These inequalities of surface, however, are generally too slight to have any very important bearing upon tillage operations. A very large proportion of this land can be plowed with ease. The actual manipulation of the soil is very easy on account of its loose structure. Many low strips along streams and in swales or sloughlike situations are subject to overflow. Probably more than 75 per cent of the type has good to excessive drainage, and most of the wet places could be brought into good condition in this respect with an expenditure of comparatively little effort. This can be accomplished by ditching the depressions, or simply by clearing off the moss and vegetation, or burning the muck covering of those areas which have ice within 3 feet or less of the sur-

face. There are many small basinlike or pothole depressions that could not be so readily drained, owing to the difficulty of getting ditches through or around the associated hummocks. Where the subsoil consists of the coarser grade of sand, such as that, for example, along the Valdez trail about 12 miles southeast of Fairbanks, or where gravel is plentiful in the substratum, as in places along the Nenana River, crops would suffer from an extreme diminution of the moisture supply during long dry seasons unless the soil has been well supplied with vegetable matter, such as can be incorporated with the soil by plowing under green crops, as vetch, wild pea, and oats.

Ice lies much less frequently within the 3-foot section of this type than in the heavier Tanana soils. It is only where there is a covering of moss or muck or a very dense growth of spruce that frozen material is likely to be reached within 30 or 40 inches of the surface. At a point about 5 miles north of Birch Lake, on the Valdez trail, ice was found between 24 and 30 inches in those lower situations supporting a growth of scrubby birch, willow, and spruce, and having 4 or 5 inches of moss, with considerable low-bush cranberry, as a blanket-like mass covering the soil. Cultivated fields show that the ice will thaw quickly to a depth of 40 inches or more. Thawing to this depth, or even greater depths, would likely take place in any part of the type during the first season of cultivation or even after burning over the land.

Spruce attains a surprisingly large size on this soil, showing no more tendency to scrubbiness over large areas than on the heaviest types, perhaps not so great a tendency. Trees 18 inches or more in diameter near the ground are common in many places. Birch is of some local importance, but it is considerably less abundant over this land as a whole than on the more loamy soils. Near stream banks alder is very common, and also large cottonwood trees. High-bush cranberry is plentiful in many of the spruce forests, and wild rose is a conspicuous plant over nearly all portions of the type. Glades or sparsely timbered areas are of rather frequent occurrence in the flats at some distance from stream channels. In these there is an abundance of Hudson Bay tea, blueberry, dwarf birch, wild rose, and wild sage, with frequently a scattering of scrubby spruce, birch, and willow. Joint grass is plentifully and widely distributed.

The Tanana very fine sand is less productive than the heavier members of this group of soils, as would naturally be supposed, but it is more productive than soils of similar texture occupying great areas in many parts of the United States, especially in the Atlantic and Gulf Coastal Plain region. The material is very much more complex mineralogically, or at least the soil contains a much larger percentage of minerals other than quartz, than the extensive sands

referred to, as for example, the Norfolk fine sand of the Southern States.[1] It is more retentive of moisture than the loose Norfolk sand, which is due probably both to the rather more loamy nature of the soil material and to the climate, with, perhaps, some relationship to an underlying impervious stratum of ice.

Potatoes of medium to good quality are readily produced on the Tanana very fine sand, and yields are obtained of a size rather surprising, especially in the absence of manurial treatment, for a soil of such sandy character. Oats and barley succeed, although the yields average much lighter than on the Tanana silt loam and very fine sandy loam. Vetch does well. A field of this crop (*vicia sativa* L.) sown with oats produced good yields of hay this year at Fairbanks.

Two plants locally called wild pea (*Astragalus williamsii* Rydb. and *Hedysarum mackenzii* Richards), were seen in abundance on the Tanana very fine sand along the Nenana River. These were so highly relished by our pack horses and those of the Alaska Engineering Commission as to indicate the possibility of employing them as field forage crops and in rotations for the maintenance of soil productiveness.

All the vegetables grown in the Tanana Valley can be produced on this type. Turnips grow to an enormous size, and good crops of carrots, peas, lettuce, radishes, and parsley were seen in a number of gardens.

Additions of manure have been found to increase the yields of all crops. Soils of such a sandy composition generally are benefited by plowing under green vegetation to supply humus. Oats, vetch or the wild peas of the region undoubtedly would improve the crop value if plowed under in all cultivated fields at intervals of two or three years.

TANANA FINE SAND.

The Tanana fine sand is similar to the Tanana very fine sand, except in texture. It averages a little higher in elevation, but is often so intimately associated with the very fine sand that it would be impracticable to separate the two types even in a detailed soil map.

The most extensive body of this soil was found in the Minto Flats, beginning abruptly as a slightly elevated flat along the line of junction between the Goldstream and Tanana bottoms, 10 to 12 miles south of Minto. Here the soil is a brownish silt loam to loamy fine sand, underlain at 2 to 8 inches by either a faintly bluish or greenish-brown loose fine sand. At a depth of about 20 to 26 inches pockets or layers of bluish to greenish silt loam are frequently found. There are places where the bluish fine sand passes below into loam or silty, greenish-brown fine sand. Where the bluish fine sand persists downward the silt content

[1] See Soils of the United States, Bul. No. 96, Bureau of Soils, U. S. Dept. of Agriculture.

is lower in the deeper subsoil. In places the surface soil of small patches had a reddish-brown color, representing, apparently, the result of oxidation caused by forest fires. In those places where spruce and large aspen are present the surface soil is deeper and more silty, varying from brown silt loam to brown loamy fine sand about 8 to 15 inches deep, overlying a subsoil like that described above. Along the lower edges and in the deeper depressions, where the entire soil section is predominantly moist, the fine sand is usually covered with black muck.

The Tanana fine sand was seen in a number of places, in the flats about Fairbanks, along the Nenana River, and on the trail near McCarty. Along the Nenana River some areas were encountered which have gravel within the 3-foot section.

Over most of the type the surface is sufficiently elevated and the ice deep enough to admit of rather excessive drainage. Ice was not found within 40 inches of the surface in any burned-over land, nor was it reached anywhere at that depth in the late summer, except where there was a covering of moss, muck, or peat. But little of the type has such a covering. Hummocks, faint ridges, swales, and slight depressions are rather characteristic, but these are not so pronounced but that the surface at a short distance appears to be level.

The characteristic growth on the areas seen is aspen of prevailingly small size. Much of that part of the type on the Minto Flats supports an almost exclusive growth of aspen. Scrub spruce, birch, and some cottonwood were seen near the banks of streams. Large spruce on this soil is indicative of either a more loamy and deeper surface soil or of a considerably higher content of silt and very fine sand.

This type has the same crop adaptation as the Tanana very fine sand, but it is not so retentive of moisture, and crops accordingly can not be counted upon to withstand the effects of prolonged droughts so well as on the very fine sand. After a few years of cultivation this soil would unquestionably lose its natural supply of organic matter, or, with the practical depletion of the humus, would assume a very unfavorable loose structure. Continued successful utilization will largely depend on the maintenance of sufficient vegetable matter in the soil to keep the material in the loamy condition favoring the maintenance of the moisture necessary for crops during periods of slight rainfall. Liberal additions of manure will also be necessary for the continued production of good yields. The soil is practically neutral, and likely lime will not be needed.

For grain this land may not prove of much value without fertilization; the yields will average too low. Vegetables, however, can be

grown quite successfully, and certain wild legumes, both called "wild pea" (*Astragalus williamsii* and *Hedysarum mackenzii*), grow so luxuriantly on the very poorest phase of this type as to point strongly toward the possibility of developing them as important forage and soil-improving crops. They are both much relished by horses after killing frosts. Belonging to the leguminous family, they would probably add nitrogen to the soil and also valuable organic matter, even should they be cut for forage or grazed.

The table following gives the results of a mechanical analysis of a representative sample of the subsurface of this type:

Mechanical analysis of Tanana fine sand.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590155	Between Ohio Road House and Little Goldstream, on flats.	Subsurface, greenish-brown to bluish-gray fine sand, 8 to 36 inches.	0.0	0.4	3.2	79.2	8.6	6.7	1.7

PEAT.

Comparatively small bodies of Peat were seen in several places in the Tanana bottoms. There is a fair-sized area along the Ester Road between Fairbanks and the agricultural experiment farm. The material of this consists of black finely decomposed organic remains overlying, at shallow depths, dark-brown fibrous peat consisting mostly of sphagnum moss. No grit could be detected in this material even by chewing it. This area had been burned over, but ice was still present in late summer at a depth of about 2 feet. Only a very sparse timber growth occurs here, and this consists of scattered spruce and birch of a very scrubby nature. Sphagnum moss, Hudson Bay tea, blueberry, and dwarf birch are abundant. Redtop is also fairly abundant. The land is probably best suited to pasturage and the production of redtop hay. Oat hay could be grown.

BENCHES OF THE LOWER TANANA REGION.

Geography.

A number of distinct benches occur along the outer edge of the Tanana bottoms and along several of its tributaries. The most extensive of those seen were found between Beal's Cache near the confluence of Jarvis Creek and Delta River, above Thirty-Mile Road

House on the Nenana River, with one at Overland Road House, another on the south side of the Salcha River, and several on the south side of Goldstream Creek.

Physiography.

The bench crossed by the Valdez-Fairbanks trail between the forks of Delta River and Jarvis Creek is flat-topped, though sloping toward the forks, where it drops suddenly about 50 feet to the first bottoms. The soil here is essentially the same as that on the benches near the Thirty-Mile Road House on the Nenana River, and it has been given the name Nenana silt loam.

Three main benches were seen on the Nenana River, beginning just above the Thirty-Mile Road House. The first rises from the bottom lands by a sharp escarpment approximately 20 feet high, a second rises by a similar escarpment above the first, and a third 30 to 50 feet above the second. These include several subsidiary benches. The two lower terraces have a smooth surface, almost level, but the higher one is somewhat hillocky, with included depressions of wet, dark-colored soil. There is not much variation in the soil of the better drained portions of these benches.

Soils.

The Nenana silt loam is closely related physically to the Knik silt loam of the Cook Inlet region, having a brownish surface soil and a gravelly or sandy substratum. It carries, however, a noticeable amount of micaceous material, whereas there is little of such material in the Knik soils. The Minto silt loam is very much like the Fairbanks silt loam, but it occurs on terraces. The Salchaket silt loam also occurs on terraces. Its subsoil is of a sandy nature and the drainage is not perfectly established.

Nenana silt loam.

The soil of the Nenana silt loam consists of a brownish yellow silt loam, grading through yellowish-brown silt loam into a gravelly stratum at about 18 to 30 inches. Just above this gravel layer, which consists of small rounded gravel, sand, and silt, the material is in places somewhat sandy and the color varies to a greenish brown. Minute mica flakes are present through the soil section. The presence of these represents the chief apparent distinction between this type and the Knik silt loam of the Cook Inlet-Susitna region.

The characteristic growth consists of small spruce, aspen, and birch. Hudson Bay tea is rather common. A legume (*Lupinus nootkatensis unalaschensis* (S.) Wats.) grows plentifully in places on these terraces, as for example, just above the Thirty-Mile Road House on the Nenana River. Our pack horses refused to eat this plant. It had been seriously frosted at the time.

There is undoubtedly a large extent of the Nenana silt loam along the margins of the Lower Tanana bottoms. The topography and physical character of the soil fit it admirably for tillage. No farms were seen on it, but grass, grain (at least for hay), potatoes, and vegetables should succeed in those places where the climate is not unfavorable owing to the elevation or to a peculiar configuration of the adjacent highlands, such as would cut off sunlight or allow chill winds to sweep down through the higher gaps and valleys.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the type:

Mechanical analyses of Nenana silt loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct*
590156	About 30 miles up Nenana River, on bench.	Soil, brown silt loam, 0 to 15 inches.	0.1	0.4	0.2	1.4	7.6	78.2	11.9
590157	.....do.....	Subsoil, yellowish-brown, fine sandy loam, 15 to 30 inches.	2.2	5.6	5.2	23.6	16.2	38.2	8.9

SALCHAKET SILT LOAM.

The Salchaket silt loam, as seen on the benches near Overland and Munsons Road Houses, consists of a brown silt loam carrying in places considerable very fine sand. The subsoil, beginning at a depth of about 15 to 20 inches, is a grayish-brown or yellowish-brown very fine sandy loam to loamy very fine sand, showing the presence of minute mica flakes. These benches or terraces are nearly level and extend about 20 to 30 feet above the bottoms. They are well drained near the bluff line, but include wet land back from these. Spruce and birch are fairly abundant.

Land of this kind, when it has been properly drained, should prove valuable for all of the crops grown in the Alaskan interior. The extent of the type could not be estimated on the basis of the investigations made. It may be found in important developments along streams like the Salcha River.

MINTO SILT LOAM.

The Minto silt loam was found on the flat and hummocky or hillocky benches bordering the Goldstream bottoms from the vicinity of the Ohio Road House to the top of Nenana Hill near Nenana.

These benches are not continuous, the uplands coming down to the flats between detached areas in many places. The areas vary in size from less than a hundred acres to a square mile or more. One of the largest is that just back of the Ohio Road House. This is nearly level and has a steep escarpment along the edge of the bottoms, 40 or 50 feet high in some places. There are some included subsidiary benches, a few low hillocks and slight depressions. Between the thirty-first and thirty-fifth mileposts on the winter trail from Fairbanks there is considerable level bench land associated with the hillocks. Through these some low, wet willow flats and "niggerhead" flats occur. Much of the country in the vicinity of Maiden Creek appears to be of a bench configuration, although it is partially rolling, owing to the presence of hillocks and depressions.

The better drained portion of these benches is occupied by Minto silt loam. This soil is found over much of the level areas, on practically all of the hillocks, along the edges of the benches near the drop to the bottoms and on the slopes. A darker mucky phase is present over those level and depressed portions not having proper drainage outlets or sufficient slope to allow the removal of excess water.

The typical Minto silt loam is a brown to dark-brown silt loam overlying yellowish silt loam having in places a greenish or bluish cast, and containing some mica flakes and very fine sand. This soil in its physical characteristics is closely related to the Fairbanks silt loam, which occurs on many of the adjoining gentle slopes and lower hills.

The more poorly drained dark phase of the type is a black muck or mucky silt loam, underlain at a depth of 2 to 6 inches by dark-brown silt loam, which passes below into lighter brown or yellowish-brown silt loam, in places showing greenish and bluish colors and mottlings of rusty brown or grayish.

On some of the small detached benches between the Little Goldstream and the Tanana River the soil is predominantly a brown or dark-brown silt loam resting on mottled brownish and grayish silt loam grading beneath into very fine sandy loam. These areas are rather closely related to the Salchaket silt loam.

On the typical brown Minto silt loam the principal vegetation is spruce and birch of fairly good size. Small scattered willow, redtop, fireweed, Hudson Bay tea, wild sage, wild rose, low-bush cranberry, joint grass, and aspen are also present. There is very little moss on the type. Ice is rarely reached within less than 30 or 40 inches of the surface. On the darker phase scrub spruce, willow, Hudson Bay tea, blueberry, joint grass, and moss are plentiful. Here ice is reached within the 3-foot section.

Most of the Minto silt loam is topographically suited to cultivation. Wet areas would require drainage such as could be accomplished easily by ditching. Clearing would not be difficult and the soil is susceptible to easy cultivation. Redtop flourishes everywhere, except in the thickly timbered areas. There is no doubt that grain, potatoes, and vegetables would do well, probably about the same as on the Fairbanks silt loam. Some portions of the benches shaded by the steep slopes to the south would not be the most favorable for farming, owing to lack of sunshine. Such a disadvantage is an incident of position and not the fault of the soil. The extent of this type in the region is not known. There may be much of it in sections not seen. At any rate there is enough to make it an important soil even should it be found only along Goldstream Creek.

BOTTOMS IN THE YUKON-TANANA UPLANDS.

In the hilly and mountainous country lying to the north of the lower Tanana bottoms and stretching over a vast area toward the Yukon River there are many large creeks, some of which are called rivers, which with their numerous tributaries spread out through the region to form a rather intricate drainage system. The main drainage lines of the Tanana drainage basin flow southwestwardly to the Tanana River, while those of the Yukon Basin flow northwardly and northwestwardly to the Yukon River. The reconnoissance survey of the region made by the U. S. Geological Survey shows that these streams are very largely bordered by strips of bottom land, varying in width from mere ribbons to a mile or more.

SOILS.

The soils occurring in these bottoms were examined along several of the streams in the Fairbanks section and in considerable detail along Goldstream Creek, and there was found rather marked uniformity in the physical complexion of the materials composing them. Here the soils are much more silty than in the Tanana bottoms; there is more uniformity in the material through the 3-foot section; the drainage is prevailingly much poorer; the depth to frozen material averages considerably shallower; moss and peat are more abundant; and the timber growth is sparser and very much more scrubby. Gravel was not found in the 3-foot section of these soils.

The principal soil type found is a silt loam. This was seen in large areas along Goldstream Creek and has been given the name Goldstream silt loam. Peat and Muck have also an important representation through these bottoms, according to the areas examined.

GOLDSTREAM SILT LOAM.

The soil of the typical Goldstream silt loam is a black mucky silt loam, ranging from about 4 to 10 inches deep. The subsoil consists of yellowish-brown to greenish-brown or faintly bluish silt loam of a friable structure. This continues downward without much change, except that very fine sand and minute mica flakes become more conspicuous in the lower subsoil of a good many areas. Frequently there is a layer of dark-brown silt loam beneath the mucky surface soil, and this grades either into a subsoil as described above or into mottled brownish, yellowish, and greenish silt loam. The lower subsoil is bluish or mottled brownish and bluish in some places. Frozen material is found anywhere from about 15 to 40 inches below the surface, coming nearest the surface where the mucky layer is deepest. The average depth to ice is much shallower where the land has been burned over.

This character of land occurs most extensively in the wider stream bottoms nearest the foot of the uplands. While mostly too flat for good drainage, it often has a faint slope streamward. This is the best drained of the Goldstream bottom soils with the exception of a higher phase of the type having a thinner surface covering of muck, which was seen in several places along the outer edge of the lower Goldstream Flats.

There is a large area of a mucky phase of the type. This occurs in the lower situations having poor drainage. It remains permanently saturated and at times is covered with water. Most of this wet, mucky phase consists of black muck about 6 to 12 inches deep, overlying black or very dark brown mucky silt loam which passes below into greenish-brown, bluish, or mottled brownish and bluish silt loam. In places greenish-brown or bluish or mottled brownish and yellowish material is found just beneath the muck. There is over much of this land a rather thick covering of moss. In late summer ice is usually reached at a depth of about 10 to 18 inches except in burned-over places, where the congealed material may be as low as 3 feet.

On the Goldstream Flats, near Fox, the soil consists of a black mucky loam 6 or 8 inches deep over dark-bluish silt loam, overlying ice at about 30 inches. "Nigger heads" are abundant here, and there is some scrub spruce. This mucky phase was seen on a number of small streams north of Fairbanks and along Chatanika Creek.

The characteristic growth over the Goldstream silt loam is scrub willow with a scattering of scrub spruce and occasional thickets of this tree along with some very scrubby birch and cottonwood. Hudson Bay tea, blueberry, and wild sage are fairly abundant. Redtop grows luxuriantly, especially over the burned areas. This is mostly a large-stemmed species which grows in large bunches. Large bodies of this grass were seen along lower Goldstream Creek, resembling

fields of grain. Much of the mucky phase of this type is covered with "nigger heads"—roundish, compact tussocks of grass, which stand 8 or 10 inches above the surface of the ground. These "nigger-head" flats are mostly treeless, with the exception of small scattering spruces. It is difficult to walk over such land in summer, since the tussocks are often so thick that it is necessary to step on them, and this causes them to bend over and turn the foot, or else the foot slips off into the soft muck between. Moss is also abundant on this phase, and, where deep, there is not infrequently a layer of peat immediately beneath the mossy surface. Clumps of alder are common in wet situations where there is not much moss. Blueberry and dwarf birch are fairly abundant over portions of the mucky phase.

The utilization of the Goldstream silt loam, except for pasturage, will require burning and ditching in order to destroy the excess of vegetable matter, which decays slowly, to induce thawing of the congealed subsoil, and to remove excess moisture. A minimum of work will be necessary to put the land in condition for hay—that is, native redtop hay—which can be produced in heavy yields over all the type. The production of hay very likely would be the best use for much of the type, certainly for a large part of the mucky phase.

Sufficient drainage to meet the needs of oats, barley, and vegetables should not necessitate any great expenditure of effort, particularly in view of the proximity to streams and the ease with which the soil can be excavated. The prevailing scanty and scrubby tree growth can be easily cleared away. The root system is so shallow and the trees so small that a large proportion of them will either fall as the land burns over or can subsequently be pushed down by hand. It is believed that ditches not more than 2 or 3 feet deep and placed at comparatively wide intervals will be sufficient to drain the typical soil. The "nigger-head" or mucky phase will probably require closer ditching.

The soil is rather acid, and applications of lime would undoubtedly improve its condition for most crops. This is true generally with reclaimed wet lands of an acid nature, especially mucky lands. There is such an excess of decomposing vegetable matter over the mucky phase that burning over would constitute an advantageous step in preparing the soil for crops. The ashes thus formed would have a beneficial effect upon crops.

Good yields of grain and vegetables should be secured from both the better-drained soil and the wet mucky phase, where proper drainage conditions have been established. This soil unquestionably will prove good, durable land under cultivation. The type includes a large total area, widely distributed through the region between the Tanana and Yukon Rivers.

The table following gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Goldstream silt loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590153	Between Ohio Road House and Little Goldstream, on flats.	Soil, black mucky silt loam, 0 to 6 inches.	0.4	2.6	2.6	7.0	6.6	63.2	17.5
590154	.....do.....	Subsoil, dark-brown silt loam, mottled with yellow, 6 to 36 inches.	.0	.1	.1	1.0	25.4	67.0	6.5

MUCK AND PEAT.

Bodies of both Muck and Peat were seen in various places along the Goldstream Flats. Some Peat was found near Chatanika on the Chatanika Flats.

Muck consists of black, finely decomposed vegetable matter carrying in its representative development some earthy material or grit. The material of this character ordinarily extends to a depth of 18 to 36 inches or more without important change, except that the lower part is frequently frozen, and beneath this silt loam, like the subsoil of the mucky phase of the Goldstream silt loam, is usually found. The Muck is usually saturated from the surface downward at all times in the summer, and without exception, according to examinations made, ice occurs within the 3-foot section in all but some of the burned areas, and it is generally present within that depth even in these.

Much of this Muck is covered with willow and alder, growing in thickets, or with sparsely distributed scrubby willow. There are many included "nigger-head" flats over which vegetation other than the "nigger-head" sedge is practically absent. Redtop flourishes in the burned portions, growing thickly in large clumps.

Necessary drainage for farming purposes could be accomplished by ditching, and where this is done cabbage and lettuce, and probably other vegetables will give heavy yields. Oats also will succeed, at least to the extent of making good yields of hay. No barley was seen on the Muck, but there appears to be no reason why it should not be grown, at least as a hay crop. For pasturage no drainage would be necessary, but for the use of a mower the wetter portions would need some drainage.

Liberal additions of lime have been generally found beneficial to crops on reclaimed Muck land, and it is believed that lime could be profitably used here, provided it could be brought to the farm without too great expense.

Peat consists of black, finely divided vegetable matter which quickly grades down into dark-brown or coffee-brown fibrous or imperfectly decomposed organic remains consisting mostly of sphagnum moss. Ice is reached ordinarily between 10 and 18 inches below the surface where the land has not been burned over; it averages about 2 feet where burned. On an area of the Goldstream Flats near Ester Siding a field which had been burned 2 years previously had a fair crop of oats this year (1914), with ice at an average depth of 2 feet. It was reported by the grower that a good crop of oat hay had been obtained the first year after burning and that a fair, though not so good, crop was made the second year. It was noticed that small pothole depressions a foot or more deep were common in this field, which was said to have been level immediately after burning over. These undoubtedly have resulted from the thawing of the subsoil material and subsequent sinking in of the surface.

A body of Peat was found in the Goldstream Flats about 12 miles from Nenana. This occurs around a shallow lake of the kind that is rather common through the flats of the streams in the hill region.

Redtop is plentiful over the Peat areas, as are also moss and clumps of scrub spruce, and there is an occasional birch on some of the higher hummocks. A number of low shrubs are also common. The flourishing condition of the redtop indicates the probable best use of this land—that is, for pasture and hay.

YUKON-TANANA HILL REGION.

Physiography.

In the uplands between the lowlands of the Tanana and Yukon Rivers there are gentle, moderately steep, and very steep slopes, culminating in elevations over 5,000 feet high in the mountains to the north of the upper Chatanika and 4,000 feet high in Chena Dome, situated about 40 miles northeast of Fairbanks. The summit of Sawtooth Mountains, about 36 miles north of Tolovana, is 4,808 feet high, while Pedro Dome, approximately 15 miles north of Fairbanks, is 2,661 feet high. The elevation at Fairbanks being only about 500 feet, it is thus seen that there is a considerable rise of elevation in some directions through comparatively short distances. On the other hand, there are in certain directions wide areas with much lower dominating elevations, 2,000 feet being the maximum for considerable stretches of country. The summit of the Birch Hills northeast of Fairbanks is 1,175 feet. Between Fairbanks and Gilmore,

about 9 miles to the northeast, 1,925 feet is the highest point along the trail which crosses over the hills.[1]

The country is very hilly, the somewhat winding ridges having along their crests peaks of various altitudes, and spurs of irregular shape and direction reaching out between the small affluents of the main interridge streams. A widespread drainage system ramifies these uplands.

Within this vast hilly and mountainous region of over 10,000 square miles, in the area shown on the accompanying reconnoissance soil map, there is a large area of land wholly unfitted for agriculture by reason of its steepness of slope, stoniness, thinness of soil, and the unfavorable climate of the higher elevations, northerly slopes, and shaded valleys. On the other hand, much of the southerly slopes can be used very successfully for general farming, while a considerable proportion of the cooler northerly slopes can be used for native hay, grain hay, and pastures. (See Pls. XX and XXI.)

Geology of the Hill Region.

According to geologic reconnoissance, the rocks in these highlands range in age from Tertiary to probably pre-Ordovician. From some distance west of Chatanika River to the Tanana bottoms the principal rocks are schistose quartzite and quartz-mica schist, with some dioritic and granitic intrusions, and greenstones. To the west of this schist belt conglomerate, sandstones, graywacke, greenstone, and argillites predominate, with some dioritic and granitic intrusives, shale, slate, and limes.[2]

Drainage Conditions.

The drainage is well established over this area, with the exception of some low, gentle slopes, swales, and flattish situations having ice close to the surface, the total area of which is of relatively insignificant extent. As a matter of fact, much of the upper slopes, where there is only a shallow covering of soil over bedrock, is so excessively drained that crops could not but suffer from lack of moisture in dry seasons. The surface run-off generally would be so rapid but for the light and drizzling nature of the rainfall that ruinous erosion would necessarily follow cultivation. Only slight effects of erosion, however, were noticed, and these were in roadways and trails on the Fairbanks silt loam.

Climatic Influence.

The climate of the hilly and mountainous region has a most important bearing upon the agricultural possibilities, and is a controlling

[1] See topographic map in A Geologic Reconnaissance of the Fairbanks Quadrangle, Alaska, Bul. No. 525, U. S. Geol. Survey, 1913.

[2] Ibid.

factor in the character of vegetation. There are important local climatic variations, as well as considerable variations between the warm, sunny, lower slopes of southerly exposure and the colder northerly slopes, shut-in valleys, and wind-swept high elevations. In the low pass (Hooligan's Pass) from the Tanana Flats to the Goldstream Flats along Happy Creek, by Ester Siding, as already noted, it is said that cold winds sweep through during the summer, much to the disadvantage of crops. The vegetables seen here on the southwesterly slope were more severely damaged by the early frosts than on similar positions elsewhere in this section. Decided differences in the effects of frost in different localities of the highland country on the same soils at about the same elevation and position with reference to sunlight exposure were also observed. Potatoes were seen which had been killed almost to the ground, while at a short distance the vines showed no signs of frost on the same day, although the soil and position were practically identical.

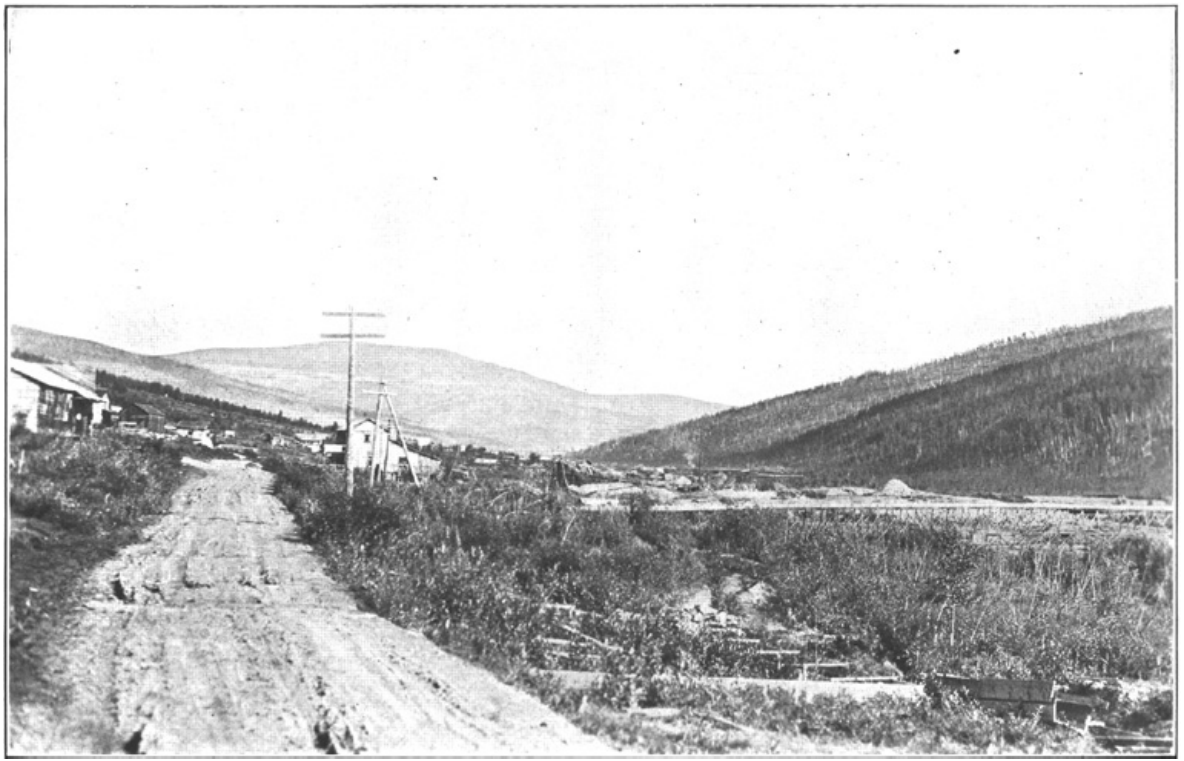
Vegetation.

The vegetation on the southerly slopes is usually very different from that on the northerly slopes, there being more and larger birch and spruce and less moss, Hudson Bay tea, and blueberry in the latter situations. Also, the timber growth becomes more stunted and sparser with increase in elevation, disappearing completely on the highest peaks. Frozen material is reached much nearer the surface on the mossy, northerly slopes, being encountered here usually at depths ranging from about 8 to 24 inches.

Soils.

The character of the uplands seen to the north of the Tanana bottoms, below McCarty, coupled with the information contained in the topographic and geological maps of the U. S. Geological Survey covering this region, show that there is a very large total area of farming land occurring on the gentler slopes of these highlands. This includes large areas of silt loam and loam, occupying the southerly slopes, which can be cultivated easily and without danger of being followed by serious erosion.

By far the greater proportion of the highlands is covered with residual soil derived from micaceous schist and other rocks. These soils thin out toward the tops of the high hills and mountains, ranging from a depth of 3 feet or more to the thinnest veneer over bedrock. In many places at these higher altitudes there is only a very thin mantle of soil or else rock outcrop. The silty material of the surface soil, or much of it, is probably of wind-blown origin, similar to that of the Fairbanks silt loam; but the gritty subsoil material and probably most of that of the loam type is evidently derived from the associated rocks. The principal types are the Gilmore silt loam and loam.

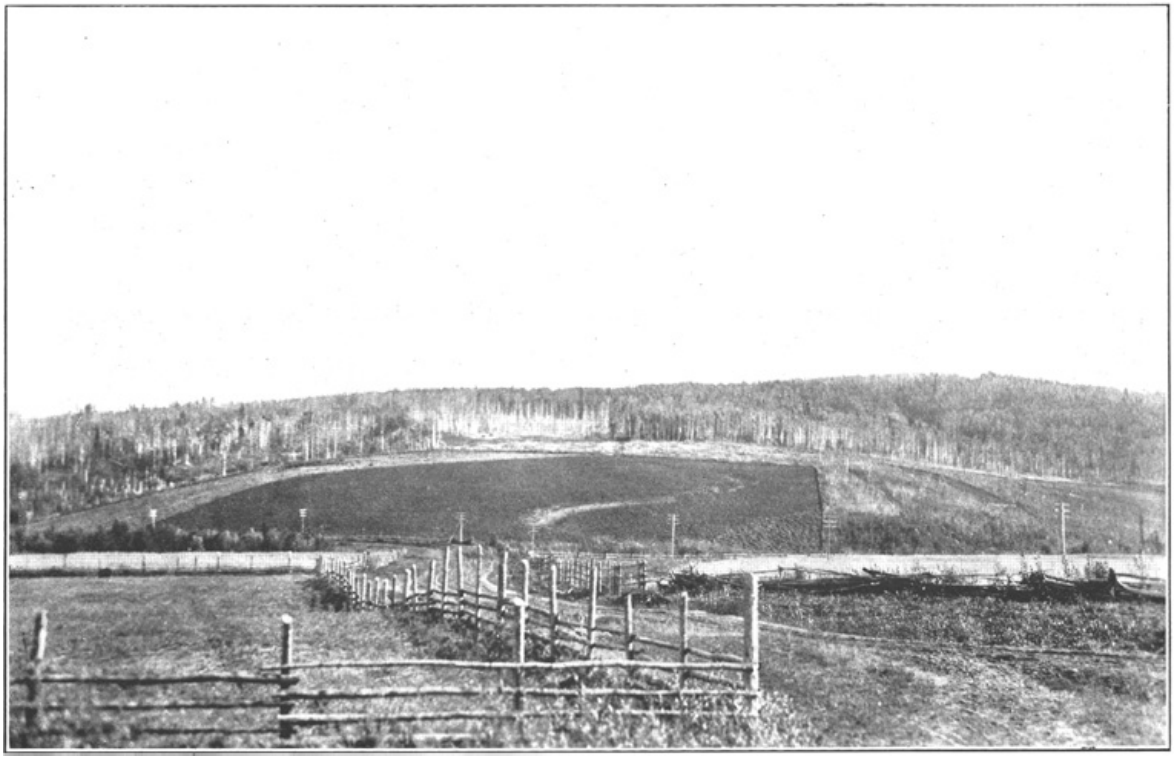


SLOPES IN THE BACKGROUND TYPICAL OF THE HILL REGION NORTH OF FAIRBANKS.

The soils here are predominantly residual (Gilmore soils). This is a view near Cleary City on the road connecting "the creeks," or placer mining district, with Fairbanks.

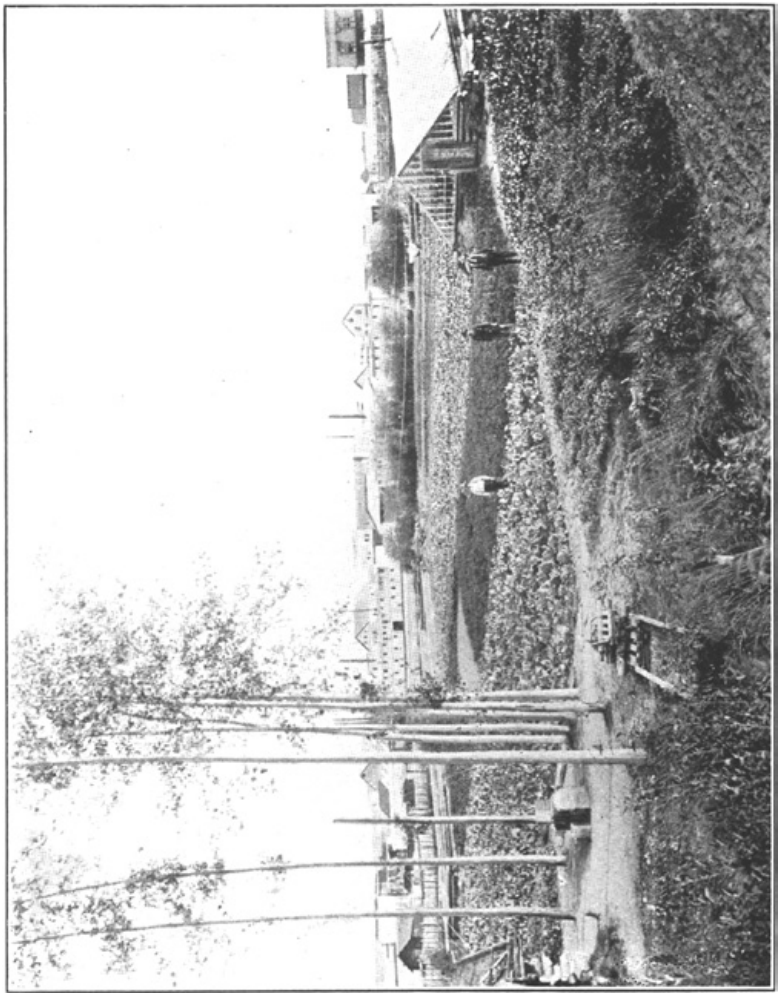
CLEARING LAND ON A HOMESTEAD IN THE BIRCH HILLS SECTION NEAR FAIRBANKS.

Showing the characteristic birch forest of the Fairbanks silt loam. The wood is sold at Fairbanks for firewood.



FAIRBANKS SILT LOAM IN THE BIRCH HILLS NEAR FAIRBANKS, AUGUST 31, 1914.

Large field in the middle distance is in potatoes.



VEGETABLE GARDEN ON TANANA SOILS. (FAIRBANKS IN BACKGROUND.)

There is a very important silty soil (Fairbanks silt loam) along the lower slopes, especially those facing the larger stream bottoms. This silty soil appears to be of eolian origin. The soil layer thins out as the elevation increases, giving way to the residual soils on the slopes above. There are some areas of slide and colluvial soil (Chatanika silt loam) along the lower slopes.

FAIRBANKS SILT LOAM.

The soil of the typical Fairbanks silt loam is a brown, mellow silt loam about 6 to 10 inches deep. This has a floury feel and a somewhat grayish cast when well dried out. The subsoil is a yellowish-brown to yellow silt loam, moderately compact in places, and noticeably friable when disturbed. In many places the subsoil has a greenish cast, and occasionally the lower portion is quite compact and has a pale-yellow color mottled with gray. Very small micaceous particles are disseminated through the entire soil section. The content of these is high enough to give the subsoil of some areas a greasy feel. The presence of very fine sand imparts marked friability or loaminess to the lower subsoil of some areas.

In cultivated fields the color of the surface soil assumes a lighter shade of brown, and the material is inclined to compact and crust slightly after a few crops have been taken off, especially where no attempt has been made to replenish the humus supply. On the other hand, the color of the surface soil and subsoil is much darker in the more poorly drained situations, and frequently shows mottlings in the subsoil. On the southerly slopes the soil is more typically developed, possessing a browner color in the surface and a good yellowish-brown or yellow color in the subsoil, while on the northerly slopes, where ice averages much nearer the surface and the drainage is poorer, both the soil and subsoil are darker and the latter is more mottled. On the lower northerly slopes and benchlike positions, and in swales and other positions where excessive moisture conditions prevail, there is generally a shallow covering of black muck or mucky silt loam. Little of this dark phase of the type is present on the southern slopes, since the soil here mostly has perfect drainage.

The depth of the silt-loam stratum, from which the Fairbanks silt loam is derived, varies considerably with position on the slope and to some extent with proximity to large stream bottoms. It averages deepest on the gentler slopes and is more widely distributed and deeper near the bottoms of such streams as the Tanana River. Large bodies were seen in which the silt loam subsoil extends downward uniformly to 40 inches or more, and exposures 6 or 8 feet deep were seen. Generally the depth of the silt material decreases with the ascent of slope, although there is, from place to place, much variation in the

depth. For example, on the hill just northeast of Fairbanks the silt stratum was found to be 40 inches deep near the foot of the slope, while at a short distance above this it was only about 12 inches deep. On a flattish shoulder still higher it was 28 inches deep, still farther up where the slope was quite gentle it was 3 feet deep, and on the hilltop near the triangulation tower it was only 12 inches deep, while at a short distance down the slope, eastward from this point, it was 3 feet deep.

In the typical soil, as developed over the southerly slopes, ice is generally absent within 40 inches of the surface in late August and early September, even in unburned dense forests, whereas on the northern slopes, particularly in the unburned areas, ice is almost invariably found within that depth. A homesteader about 5 miles east of Fairbanks, on a south slope of typical Fairbanks silt loam, said that no ice was encountered in digging a cellar 6 feet deep, yet on the northern slope facing this, and in practically the same relative position, ice was reached about 12 inches beneath a thick layer of moss, and at 24 to 30 inches a few feet away where the land had been burned over.

The silty material overlies residual products, usually with a sharp line of separation—an abrupt passing from material of one kind to that of another of unmistakably different character. Some examinations showed a gradation from the typical silt stratum to the typical residual substratum through a thin intermediate layer of mixed silt and residual products.

In the Fairbanks section the underlying residual material consists mostly of light-brown or grayish-brown to pale-yellowish incompletely decomposed rock, decidedly micaceous and texturally ranging from gritty loam to a mass of disintegrated rock. At Hot Springs, on the hills just north of the village, the residual stratum varies from yellowish-brown loam or gravelly (angular rock fragments) loam to grayish clay loam. The rock from which this material is derived principally consists of monzonite, which is quite different from the schistose rocks of the Fairbanks country.

The Fairbanks silt loam grades off into strictly residual soil in such a way that it would be difficult to determine definite lines of separation in many places. The areas of purely residual soil and those of the typical silt loam are generally separated by a gradational soil—that is, one having a covering of silt loam over residual material, or a soil representing a mixture of materials from the two types.

The principal trees on the Fairbanks silt loam are birch, spruce, and aspen. On the southerly slopes the trees are larger and the forests more dense, birch being the most abundant. Within short distances the growth frequently shows variations, ranging from (1) dense growths of almost exclusive birch (see Pl. XXII), through (2) dense spruce and birch intermixed, or (3) spruce, birch, and aspen inter-

mixed, to (4) dense spruce. Scattered alder is occasionally seen in the birch and spruce forests, and is much more abundant on the northerly slopes. High-bush and low-bush cranberries are plentiful, the former being much more abundant on the southerly slopes and the latter on the northerly slopes. Native redtop, fireweed, and wild rose are plants of wide and plentiful distribution in openings, particularly those recently burned over. The redtop grows in large, separate bunches and in meadows where the grass is more evenly distributed. Moss is rarely seen on the southern slopes, but it is common on the northern slopes.

On the northern slopes spruce is the dominant tree. Its size here averages smaller than on the southerly slopes, ranging down to a scrubby growth, particularly where thick moss is present. Birch is present and also aspen, but the size of these is smaller than on the southerly slopes. Thickets of alder are of common occurrence on the northward-facing positions, especially where there is not much moss. Hudson Bay tea, blueberry, low-bush cranberry, and joint grass are distributed abundantly over these less sunny situations. Redtop is much less plentiful here and of a smaller and more scattered growth.

The Fairbanks silt loam was found in considerable areas in the vicinity of Birch Lake in the Birch Hills section north and northeast of Fairbanks, in the vicinity of Ester Siding, on the slopes of Goldstream Valley, and in the Hot Springs section. The geological maps of the U. S. Geological Survey, both detailed and reconnoissance,[1] covering the region between the lower Tanana River and the Yukon River, show a wide distribution of the formation to which this soil is ascribed, that is, the Pleistocene deposits. The deposits thus classed probably would include the Minto and Salchaket bench soils, the Rampart bench soils, and the Chatanika or slide soils.

The Fairbanks silt loam, however, is not a terrace soil; it is distinctly a slope soil. (See Pl. XXIII.) In physical characteristics it conforms very closely with the brown loessial soil, Knox silt loam,[2] which is one of the great farming soils in Illinois, Indiana, Iowa, Missouri, Nebraska, and Wisconsin. It is believed that the material entering into the composition of this type represents wind-blown deposits. The soil is deepest and most abundant on the lower, smoother slopes facing broad stream bottoms; it thins out with rise in position and on the steep slopes where most active erosion is possible; it is strikingly uniform in character under similar drainage conditions, and occurs over residual material from which it differs utterly in both physical and mineralogical aspects, and from which it is separated by a sharp line of demarcation. Clouds of dust are common

[1] See Bul. U. S. Geological Survey No. 525.

[2] See Bul. No. 96, Bureau of Soils, U. S. Department of Agriculture.

over the bars and shores of streams like the Tanana on dry, windy days. This dust was seen in process of transportation by wind from the Tanana bottoms up over the slopes of the adjacent highlands during the progress of this reconnoissance.

The Fairbanks silt loam is the best all-around agricultural soil seen in the interior of Alaska. It is well drained, yet retentive of moisture, shows only a moderate degree of acidity in either the surface soil or subsoil, is easy to cultivate, and is productive. It is said that even the freshly-exposed subsoil produces well, although in general farm practice fresh subsoil material is not considered as possessing the proper requirements for successful plant development, especially in regions where the rainfall is sufficient for crop needs, and where the soils are at all acid. The Fairbanks experiment station is located on this type; the buildings and older fields are on the typical soil, with a good southerly slope. There are a number of homesteads with cultivated fields on the Fairbanks silt loam, particularly in the Birch Hills section.

Crops seem to mature earlier on this soil in its occurrence on sunny slopes facing the south than on the much lighter textured soils of the bottoms. This, apparently, is due to the better air drainage and warmer environment. Potatoes grown on the southerly slopes of the type are generally recognized as possessing a better quality than those from the soils of the stream flats and northerly slopes, being more mealy and less soggy, it is said. About 200 bushels of potatoes per acre are readily produced without any kind of fertilizer treatment. Heavier yields are obtained with applications of manure. Certain varieties of oats, wheat, rye, and barley have been matured annually at the Fairbanks experiment station, although in years of abnormally early cold temperatures, as in 1913, the crops are apt to be damaged. The later varieties may be injured in the average year by frosts, that is, the grain may be caught in the milk stage and thus not permitted to mature. Such damage, however, does not mean that good crops of grain hay can not be produced, even of the late varieties. Barley can generally be matured, as can also several varieties of oats, rye, and wheat.

At the experiment station good crops of red clover and alfalfa have been grown, but these are apt to be winter-killed, at least this is true of the varieties thus far tried. The Siberian variety of alfalfa passed through the winter of 1913–14 successfully on similar soil at the Rampart station, which is 30 or 40 miles farther north. Buckwheat does well; at least, it produces a heavy growth of vegetation, and can be counted as a valuable crop in supplying the vegetable matter needed for rehabilitating those fields impoverished by long cultivation. Some of the grain matures under normal conditions.

All the vegetables grown in the region give good results on the Fairbanks silt loam, especially cabbage, celery, carrots, beets, and lettuce. A large number of flowers are grown very successfully.

A compact soil condition, accompanied by a thin surface crust, was noticed in one of the older fields at the Fairbanks station this year. This condition appeared to have been brought about by a reduction or change in the organic matter in the soil through continued cultivation. Such an unfavorable soil condition could be remedied or prevented by maintaining a proper supply of organic matter, as can readily be accomplished, probably, by turning under and incorporating with the soil such green vegetation as buckwheat, vetch, and oats. Applications of lime also would likely retard the tendency of the soil to compact, at least it would cause the particles to flocculate. Lime-requirement determinations indicate that a ton of air-slaked burnt lime per acre will be enough, at least for an initial application. It is noticeable that wood ashes have a beneficial effect. Barnyard manure increases yields and goes far toward the maintenance of a good condition of tilth.

Cultivation is easily performed with moderately strong teams. Preliminary breaking probably should be about 5 inches; later, plowing should be deepened gradually to perhaps about 8 inches. Cultivation should be shallow after crops have advanced sufficiently to have their root systems developed near the surface.

The following tables give the results and average results of mechanical analyses of samples of the soil and subsoil of the Fairbanks silt loam:

Mechanical analyses of Fairbanks silt loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590144	About 6 miles northeast of Fairbanks.	Soil, brown silt loam, 0 to 8 inches.	0.1	0.8	1.0	2.2	21.7	69.7	4.8
590145	.....do.....	Subsoil, yellowish-brown silt loam, 8 to 36 inches.	.2	.3	.4	1.0	19.7	70.8	7.4
590146	Fairbanks experiment station, forested area.	Soil, brown silt loam, 0 to 10 inches.	.2	.4	.7	4.6	21.4	63.6	8.9
590147	.....do.....	Subsoil, yellowish-brown silt loam, 10 to 36 inches.	.1	.2	.3	1.2	15.6	74.6	7.8
590148	Fairbanks experiment station, cultivated field.	Soil, brown silt loam, 0 to 8 inches.	.2	.7	.8	2.2	12.5	72.3	11.1
590149	.....do.....	Subsoil, yellowish-brown silt loam, 8 to 36 inches.	.0	.3	.4	1.0	11.3	77.6	9.3
590173	Lower slope just northeast of Hot Springs.	Soil, brown silt loam, 0 to 6 inches.	.1	.4	.4	1.9	12.5	71.9	12.4
590174	.....do.....	Subsoil, yellowish-brown silt loam, 6 to 36 inches.	.2	.2	.2	1.5	13.7	76.7	7.0

Average mechanical analyses of Fairbanks silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
590144, 590146, 590148, 590173.	Soil.....	0.1	0.6	0.7	2.7	17.0	69.4	6.8
590145, 590147, 590149, 590174.	Subsoil..	.1	.2	.3	1.2	15.1	74.9	7.9

CHATANIKA SILT LOAM.

The Chatanika silt loam is a soil which is not likely to be found in very extensive areas. The type includes so many variations in character and depth of soil from place to place and so many variations in the character of the material through the vertical section that it would be extremely difficult to accomplish satisfactory mapping of the several variations in any detail. The dominant soil is probably a silt loam.

The type occurs as rather narrow undulating strips along lower slopes near drainage lines, and apparently consists of both colluvial and slide material, the latter representing a mass of soil moved from a higher to a lower position, through the upsetting of the equilibrium of the mass in its original position by some ground disturbance or weathering process, while the former simply represents accumulations of soil fallen or washed from higher to lower slopes.

A representative occurrence of this slide material lies near the head of Alder Creek. Here is plainly seen the line of detachment, where the mass of soil broke away and slid from its original position to a lower level, leaving an abrupt escarpment above exposing a section of the silt loam surface covering and the micaceous residual material below. In places the transported mass has not been changed in any important way from its original soil condition, as shown here by the character of the soil above the line of fracture and in the mass that broke loose. In another place, however, some residual material had been mixed with the overlying soil, apparently as a result of the movement. Several borings on the slopes here showed a black mucky silt loam, underlain at about 5 to 10 inches by bluish to mottled drab and brownish silt loam, carrying considerable material from the underlying associated rocks.

That examined at Cleary City appeared to be of a colluvial nature, with much variation in character, especially in the vertical section. The surface soil here is predominantly a black mucky loam, overlying a mixture of silt, micaceous residual material, and decomposing vegetable matter, which in turn rests upon a stratum of brown peat, and this upon a layer of dark silt loam. A section of 5 feet or more exhibits strata of brown silty material, dark organic matter and

silt mixed, and brown peat, showing that the soil has accumulated gradually by movement of material from above. The mixing of soil and organic matter as seen here evidently could have been done only by the gradual transportation of soil material from the slopes above.

About one-half mile north of Cleary City the soil is a brownish silt loam, or mottled rusty brown and drab silt loam, with many spots having a black mucky covering as deep as 5 or 6 inches.

On the gentle slopes along the foot of the ridge bordering the Tanana bottoms west of Little Goldstream, the soil varies from black mucky silt loam to brownish silt loam, overlying yellowish and greenish silt loam containing considerable micaceous and rock particles, such as are found in the residual subsoil material of the adjacent uplands. This gritty silt loam in places passes below into silt loam without any intermingled rock particles. The variation in the vertical section here is due to overwash of material from the hills to the rear. Some of this variation, including a range from mainly silt loam to a mixture of silt and residual particles, is evidently due to the variable character of the material brought down from different localities. Places were seen where fresh deposits had been recently spread over the green grass of the slopes.

The principal vegetation on the Chatanika silt loam is alder, willow, birch, dock, Hudson Bay tea, fireweed, redtop, and moss. Most of the soil is imperfectly drained. There are some quite marshy spots kept wet by seepage. By digging ditches along the upper edge of the areas, the seepage waters could be largely controlled. Such ditches, with others placed at proper distances, would effect sufficiently good drainage to admit of successful farming operations.

This soil will produce good crops of grain, at least for hay, and redtop, cabbage, lettuce, rhubarb, and other vegetables. Potatoes should yield well, but the quality would likely depend upon the completeness of the drainage. Lime undoubtedly would improve soil of this kind. The land should prove productive and durable.

The table following gives the results of a mechanical analysis of a sample of the soil of this type:

Mechanical analysis of Chatanika silt loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590152	Between Cleary City and Chatanika.	Soil, dark brown silt loam, 0 to 10 inches.	0.2	2.0	1.6	4.6	13.8	64.7	13.2

GILMORE SILT LOAM.

The soil of the typical Gilmore silt loam is a brown silt loam carrying considerable micaceous particles, while the subsoil, beginning anywhere from 4 or 5 inches to 10 or 15 inches below the surface, is a yellowish-brown to grayish-brown micaceous gritty loam. Ordinarily the subsoil contains about 20 to 50 per cent of partially decomposed fragments of the underlying rock, consisting in the areas seen mostly of schist. In places the residuary fragments are of a bluish to black color, and the material has a greasy or graphitic feel. Bedrock is reached frequently within the 3-foot section. On some of the steep slopes, especially in the higher positions and on some of the valley walls, rock is present in sufficient quantity to constitute a stony type of soil or in places even Rough stony land. The Gilmore silt loam averages deeper than the loam member of the series and occupies gentler and lower slopes.

The subsoil material is obviously derived largely from the underlying rock, which consists mostly of micaceous schist. The surface soil probably contains some loessial material in places.

Practically all of this type has good drainage, and the soil seems to conserve moisture in amounts sufficient to meet the needs of crops in ordinary seasons. Ice is not encountered within the 3-foot section on the slopes having a southerly exposure, but it is of common occurrence on the northerly slopes.

Spruce is the dominant tree. It is largest on the southern slopes. Birch, alder, and willow are of scattered occurrence, the last two being quite abundant in the less sunny situations. Redtop does well where there is considerable sunshine and is rather widely distributed. Hudson Bay tea, fireweed, and dock are plentiful. On the northern slopes spruce is abundant, but it tends toward a scrubby growth. Here also moss, Hudson Bay tea, blueberry, and dwarf birch are much in evidence.

This is a good farming soil, easy to cultivate, where the slope is not too steep, and possessing considerable fertility. Large areas are available for cultivation over wide stretches of country. The type is suited to the same crops as the Fairbanks silt loam, although not quite as heavy average yields are likely to be obtained. Grain and grass probably will not yield so heavily, but there may be a compensating advantage in the way of earlier maturity—that is, where matured grain is desired. In a field near Fox, potatoes of excellent quality were produced this year. These had a very desirable white, mealy flesh when cooked. The yields obtained were quite satisfactory.

On the thin phase, that having rock near the surface, crops may be expected to suffer in dry seasons. Frequent shallow cultivation and the maintenance in the soil of a good supply of organic matter, such as can be placed there by plowing under some green crop, are

A HOMESTEADER'S FARM NEAR FAIRBANKS.

[A number of grain and vegetable crops are shown here. The flat land in the foreground represents Tanana bottom soils, around the buildings in the middle distance is a lower slope area of the Fairbanks silt loam, and in the background are higher slopes of Fairbanks silt loam. The soil here is covered with a characteristic growth of birch, with some intermingled spruce.]

the most efficient means for minimizing crop injury resulting from lack of moisture. Additions of manure will increase the yields of all crops. The soil is somewhat acid, at least in places, and additions of lime would likely be beneficial.

The tables following give the results and average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Gilmore silt loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590140	On slope west of Fox.	Soil, brown silt loam, 0 to 8 inches.	3.4	3.2	1.4	3.6	9.8	68.5	10.1
590141	.....do.....	Subsoil, yellowish-brown loam, 8 to 20 inches.	8.6	8.6	3.5	12.0	11.8	48.2	7.6
590171	One-half mile north of Hot Springs.	Soil, brown to yellowish-brown silt loam, 0 to 18 inches.	1.6	.9	.4	1.0	12.0	73.1	11.1
590172	.....do.....	Subsoil, yellowish-brown gravelly loam, 18 to 24 inches.	16.9	13.3	4.5	11.2	9.7	37.4	7.0

Average mechanical analyses of Gilmore silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
590140, 590171.....	Soil.....	2.5	2.0	0.9	2.3	10.9	70.8	10.6
590141, 590172.....	Subsoil.....	12.8	10.9	4.0	11.6	10.7	42.8	7.3

GILMORE LOAM.

The Gilmore loam contains more residual material than the silt loam. In fact, it seems to be derived very largely or wholly from the underlying rocks, which are the same as those occurring beneath the Gilmore silt loam. The soil does not average so deep to bedrock, it is not so retentive of moisture, and the slopes are not so gentle as in case of the Gilmore silt loam; nevertheless there is a large total area that can be successfully used for farming.

The characteristic soil is a brown loam 4 to 8 inches deep, overlying yellowish-brown, gritty, micaceous loam, which usually passes into a mass of disintegrated rock within the 3-foot section. Mica and other fragmental particles of rock are ordinarily conspicuous in the soil from the surface downward.

The usual place of occurrence is above the Gilmore silt loam on slopes somewhat steeper than those characteristically occupied by the silt loam. Bedrock is often if not usually present within less than 3 feet of the surface. It approaches the surface as the elevation and steepness increase, and there are outcrops of rock on many of the high points and steeper slopes. Also rock fragments are of much more common occurrence than in the silt loam type.

The growth is practically the same as that on the silt loam, but the trees are more scrubby and more scattering.

The crop value of the type averages lower than that of the Gilmore silt loam. Potatoes and other vegetables will give fair to good returns with good treatment. Manure will increase the yields of all crops considerably. While redtop is fairly abundant, it does not grow so tall nor so thick as on the silt loam. Oats and other grain will produce fair crops, according to the depth of soil and its treatment.

Land of this kind will be found much in need of humus after a short period of cultivation, owing to the fact that it has such good aeration. This can be supplied by plowing under green oats, buckwheat, and other vegetation.

AGRICULTURE.

INTRODUCTION.

A large proportion of the bottoms of the lower Tanana River, together with much of the uplands between these bottoms and the bottoms of the Yukon River to the north, constitutes good farm land, in so far as measured by soil characteristics, drainage, and surface configuration. The area to which the investigations were particularly directed is largely included between the parallels 64° and 66° and the meridians 145° and 152°, and comprises approximately 20,000 square miles.

To the north of parallel 66°, particularly in the Yukon Flats, with its immense body of comparatively level land, extending from the vicinity of Circle to the neighborhood of Fort Hamlin, there is a large extent of land which, but for its northerly latitude, would be included within the region under discussion. It is not to be understood by this that farming is impossible north of 66°; as a matter of fact, some gardening is carried on, and grass thrives up to and north of the Arctic Circle.

The great problems confronting the development of an important agriculture in the Yukon-Tanana region are the limitations on crop production imposed by the climate, by restricted markets, and by costly transportation. With a thorough understanding of the conditions of the region, including a knowledge of the soils and of the crops and crop varieties best suited to these and to the climate,

together with improvement and cheapening of transportation, it is believed settlement will be undertaken gradually over the better lands, and that the country eventually will reach a position of agricultural importance corresponding with the development of the mining industries.

The limitations imposed upon crop production by climate are best revealed by a careful consideration of the climatic data presented in a separate chapter, in connection with the actual cropping results of the agricultural experiment stations at Fairbanks and Rampart, and of the farmers of the region.

The most extensive agricultural operations undertaken in Alaska are centered about Fairbanks. A considerable number of homesteaders now in this section are chiefly or wholly busied with farming pursuits, and many others carry on some farming or gardening (see Pl. XXIV), or raise hogs and poultry in conjunction with their other interests. There are in the immediate vicinity of Fairbanks three dairy farms, a number of large market-garden farms, and farms producing grain, hay, and potatoes, as well as numerous small gardens. On the slopes, and to a lesser extent, on the bottom lands of the streams along which the placer-mining operations of the Fairbanks district are carried on, potatoes, a number of other vegetables, and grain for hay are produced in a considerable number of fields, ranging in size from a fraction of an acre to 10 acres or more. There are some farms in the region which comprise in the neighborhood of 50 acres of cultivated land. It is believed that considerably more than a thousand acres of land are under cultivation in the Fairbanks district alone. Wild hay is cut throughout the Fairbanks section for use on the farm and for sale to owners of stock. All of these farm commodities find ready sale in the local markets at prices which have generally proved remunerative to the producer.

Also, vegetables and hay are grown at various other points between McCarty and Fort Gibbon, as, for example, at such places as Richardson, Munsons, Piledriver, Chena, Nenana, Tolovana, and Hot Springs.

It is estimated that in the neighborhood of 700 tons of potatoes were grown in the Fairbanks district this year (1914). It is claimed that enough hay (wild grass and grains cut green) was harvested this year to feed the stock of the entire region, although some oats and other feed were shipped in. With respect to fresh vegetables the district is easily self-sustaining. In addition, considerable milk, butter, and eggs are locally produced. A number of ranchers and keepers of road houses raise poultry and hogs, while chickens are quite commonly raised by those not otherwise identified with agricultural pursuits. There were this year, in the district, according to estimate, about 300 hogs and 40 head of dairy cattle.

AGRICULTURAL OUTLOOK.

That crops can be successfully produced in the Yukon-Tanana region is an established fact. Corn can not be matured here, it is true, nor apples, and other crops by nature unsuited to the climate, nor is it likely that such crops will ever be grown with much success, but it is a fact that a number of crops which stand in the first rank as food crops for both man and stock are actually being grown very successfully.

The principal crops of the region are potatoes, vegetables, grain (as yet grown chiefly for hay), and native hay. Successful results have been had with all of these, and, in addition, a number of varieties of grain have been matured for seed and experimentally to determine the possibilities of the country. Although agriculture is in a pioneer stage, it can not be denied that much has been accomplished toward solving the problems of crop production, both through the excellent work of the agricultural experiment stations at Fairbanks and Rampart and by the farmers themselves. (See Pl. XXV.) Some agricultural problems have been attacked with more directness of purpose and have been more nearly solved than in many of the old farming sections of the United States. For example, growers generally have concluded, on the basis of results obtained, that the well-drained silt loam of the southward-facing slopes is the best potato soil of the region, both with respect to yield and quality.

While it has been conclusively demonstrated that this is a region of important crop-growing possibilities, much remains to be done to establish an agriculture of large proportions. A type of agriculture that would be largely self-sustaining is an assured possibility; this has been demonstrated by actual field results, and there is every reason to believe that the Yukon-Tanana region could support or largely support a population several times larger than the whole number of people at present in Alaska. This would mean increased growing of the present crops and the raising of stock.

There is much to be done, however, before extensive farming operations can be carried on. Seed of those varieties best adapted to the conditions, those that will mature and yield best, must be put in the hands of farmers. In this task the experiment stations are busily engaged. Varieties of grain, potatoes, and other crops which have at least proved successful already have been determined through experimentation at these stations. It remains for seed of these best-known varieties to be made available for farmers, and for the farmers to be made acquainted with those cultural methods which are most fitted to the climate, the soil, and the particular crop to be grown. The farmer must acquaint himself with those local peculiarities of climate which often affect crop production to a marked degree, and with the requisites of the different soils in the matter of drainage,

fertilization, and tillage. There must be a market for the surplus products of the farm in addition to the home market. Before this can be found transportation facilities must be improved and rates reduced. A farming population must be directed to the land, and roads built through unpopulated sections embracing favorable agricultural lands as an incentive to their development.

It is likely that the building of the railway from the coast to this region will give a decided impetus to agricultural activities; but obviously it would be unwise for outsiders to rush to this region without capital and some knowledge of the conditions. The establishment of a substantial, permanent agriculture here will depend undoubtedly upon gradual development accompanying the opening of highways and railways, the expansion of mining, and increase of population and markets; and the bringing about of such agricultural development probably will require the efforts of that type of farmer who will be satisfied, at least for a time, with the production of sufficient meat and other food to meet his immediate requirements.

Potatoes.

The potato is an established crop in this region; its production has advanced far beyond the experimental stage, except as relates to improvement of yield and quality on certain soils. This year's crop (1914) at Fairbanks will largely meet the demand of that district.

At one time there was much prejudice or complaint against the quality of the home-grown potato and large shipments came in from the continental United States. The people have gradually learned that the best home-grown potatoes are of good quality, and there is not likely to be much further complaint against the local product, nor is it likely that there will ever again be any considerable importations. Even the crop of 1912, grown under abnormally bad seasonal conditions—a dry, hazy summer, with unusually early killing cold—found a receptive market. It is true that the quality of the potatoes does vary considerably—from inferior to very good—but these variations are due to the soil, local climatic environment, the season and the variety grown. Soggy potatoes are as a rule produced on cold-natured land of imperfect aeration and drainage; abnormally early cold weather, late springs, and cool, cloudy summers in some years cause an inferiority of product, particularly in case of the late or slow-growing varieties; and the natural coolness of some localities is not at all conducive to good quality. On the other hand, the well-drained silt loam (Fairbanks silt loam) of the southerly slopes gives good yields—the yields range from 200 to 300 bushels per acre—and the tubers are satisfactory in quality, where early varieties are grown. Also, potatoes of good quality are grown on the southward-facing residual soils—

the Gilmore loam and Gilmore silt loam—and on the well-drained soils of the Tanana bottoms. No trouble is experienced in keeping potatoes through the winter in dry, warm houses, cellars, or excavations in hillsides.

Among the favorite varieties grown are the Irish Cobbler, Early Ohio, Early Market, Burpee Early, Ohio Junior, and Eureka.

The results of carefully conducted experiments strongly indicate the advisability of sprouting before planting.[1]

At the Fairbanks station an increase in the yield of potatoes of 80 bushels per acre over the crop of the preceding year followed an acreage application of 150 pounds of sodium nitrate. Market gardeners and ranchers generally have found that applications of barnyard manure increase the yield of the crop. No conclusive data could be procured as to the effect of phosphatic and potassic fertilizers. It is possible that the former would hasten maturity of the crop in a way that might prove a decided advantage, on late soils particularly. Plowing under green manuring crops, such as buckwheat, oats, or vetch, undoubtedly would increase the yields and perhaps the quality, since a more friable soil would result from such procedure—a soil better able to store and conserve moisture and better suited to that circulation of soil atmosphere and moisture which accompanies or effects the most desirable physical condition of the soil. A leguminous crop, such as vetch, would be preferable as a source of green manure, owing to the nitrogen that would be added to the soil in its root nodules.

This region embraces many thousands of acres of high-grade potato land—hundreds of thousands of acres that will produce a crop which, if not entirely of the best table quality, will, at least, prove valuable for stock feed. Even the deep sandy soils of the Tanana bottoms give surprisingly good yields of potatoes, and these frequently are of good quality. Almost unlimited quantities of potatoes could be grown for stock feed, and the cheap production of this crop on a large scale points convincingly to the possibilities of stock raising. Hogs and cattle relish the boiled potato and would derive from it considerable nourishment, although potatoes alone would not constitute a complete ration for the animals.

Other Vegetables.

Cabbage succeeds wonderfully well on all those soils of good drainage and moisture-holding capacity. The open-structured sandy lands require liberal additions of manure for good yields, and in dry weather the plants will suffer from lack of moisture if a plentiful supply of humus is not maintained. The silt loam of well-drained slopes and the silt loams and very fine sandy loams of well-drained

[1] See Annual Report of the Alaska Agricultural Experiment Stations for 1911, p. 17.

situations in the bottoms are the soils which are most likely to prove satisfactory for cabbage. (See Pl. XXVI.) The crop, however, can be grown on the wet mucky lands and other soggy types following the establishment of good drainage, while the deep sands will respond satisfactorily, provided heavy applications of manure are made.

Cabbages grown in this region are invariably of excellent quality, and heavy yields are usually obtained. Good, solid heads of phenomenal size are the rule. The Early Jersey, Wakefield, Henderson's Succession, and Winningstadt are the favorite varieties.

With but little effort enough cabbage can be grown to supply the needs of a very much larger population with both the fresh product and sauerkraut. It seems that some use could be made of the crop, or at least the refuse portion and culls, for stock feed.

Cauliflower and kale also do well on the same soils as those used for cabbage. Root maggots are said to have affected cabbage and cauliflower in some gardens, but these plants are not injured as much as radishes and turnips by this destructive pest. Spinach and Swiss chard are successfully grown.

Lettuce of several varieties has been grown very successfully on practically all kinds of land. Large, solid heads of a desirable crispness are grown with but little difficulty, doing especially well on the well-drained Tanana bottom soils. Garden peas also thrive, doing especially well on the soils of good drainage. (See Pl. XXVII.) Seed of the earliest varieties are reported to have ripened. Both the ordinary garden beet and sugar beet are successfully grown on all the well-drained lands. They are particularly thrifty on the Fairbanks silt loam and the Tanana silt loam and very fine sandy loam. In addition to its value as a table vegetable, the beet could be used as an important article of feed for stock.

Turnips give good to phenomenal results on all well-drained soils, except where attacked too severely by root maggots. Certain varieties, as the Petrowski, are not damaged seriously by the maggot. Rutabagas also are not so apt to be injured by this troublesome pest. On the whole turnips, the maggot-resistant varieties particularly, have generally proved very successful. Individual roots of a yellow variety of turnip weighing over 5 pounds were seen in several gardens in the Fairbanks and Hot Springs sections. These yellow turnips are solid throughout, crisp, and unusually sweet. Other varieties also were seen growing to an exceptionally large size and possessing good quality. Without fertilization the crop usually does well, while with moderate additions of manure the thinnest soils give surprisingly large yields.

Carrots of unusually large size and good quality are grown. Parsnips, parsley, rhubarb, radishes, and onions are among the other vegetables which succeed.

Celery of delicious quality, crisp, white, and of large size, is grown with comparative ease. Liberal use of manure is essential to its best success. Golden Self-blanching, White Plume, and Red Ribbon are among the varieties grown.

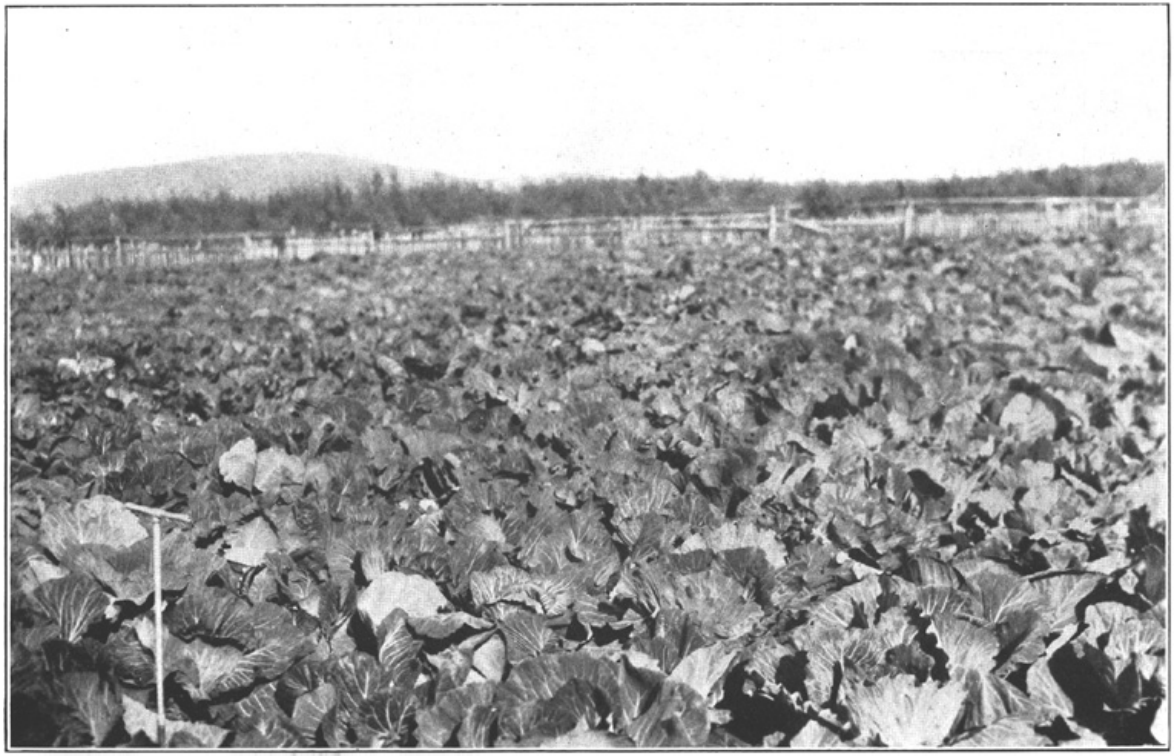
Grass and Forage Plants.

Native redtop (mostly *Calamagrostis canadensis*) grows profusely in sparsely timbered places over the sunny bottoms and hillsides throughout the region, being especially tall and dense in burned-over areas. On the northerly slopes the grass is not infrequently abundant, but it averages sparser and shorter than in the more sunny situations. Even on muck and peat bogs this plant frequently grows in luxuriance. Yields of 1 to 3 tons per acre can be procured from many natural meadows where little or no preliminary preparation of the land is needed, as, for example, over much of the lower Goldstream Flats. The grass flourishes both in large, scattered bunches and in meadows of uniform dense growth.

Redtop is cut in many places for use on the farm and for sale to mine operators and others owning horses and cattle. This year redtop hay is selling at $30 to $40 a ton; in previous years it has sold for considerably higher prices. Thousands of tons of this hay go to waste annually in situations where it could be easily harvested. Many large burned tracts were seen having a level to only moderately sloping surface where redtop could readily be cut with machinery with but little preliminary clearing.

Conclusive information could not be ascertained relative to the permanency of stand where the grass is mowed constantly. If there should be found a strong tendency for meadows to thin out with continued cutting, other fields could be utilized until such impoverished meadows have reestablished themselves naturally. The grass springs up voluntarily and plentifully everywhere immediately upon the clearing off of a shading growth of timber or brush. There is no question about the ability of the soils to produce this hay in great abundance; in fact, there are few places where the hay can not be harvested in large quantities from natural meadows, prepared for mowing with very little trouble.

Statements are sometimes heard to the effect that the native redtop hay is of poor quality, but such conclusions evidently are based either upon complete ignorance of the subject or upon such misleading information as the occasional instance of a wornout pack horse, left in the wilderness to eke out a living, succumbing to the severities of winter. It would be, in the wilder sections, almost marvelous for the unprotected animal to exist unassisted through the long, formidable winters of interior Alaska, yet there are instances of horses having maintained themselves here through winter, unsheltered and



CABBAGE FIELD ON TANANA VERY FINE SANDY LOAM NEAR FAIRBANKS, SEPTEMBER 2, 1914.

A SECTION OF THE FAIRBANKS EXPERIMENT STATION.

In the foreground garden peas and other crops; in the background a typical growth of birch. The soil here is the excellent type, Fairbanks silt loam.

NATURAL MEADOW OF "SLOUGH GRASS" (CAREX SP.) NEAR MOUTH OF CHENA RIVER, ABOVE FAIRBANKS, SEPTEMBER 3, 1914.

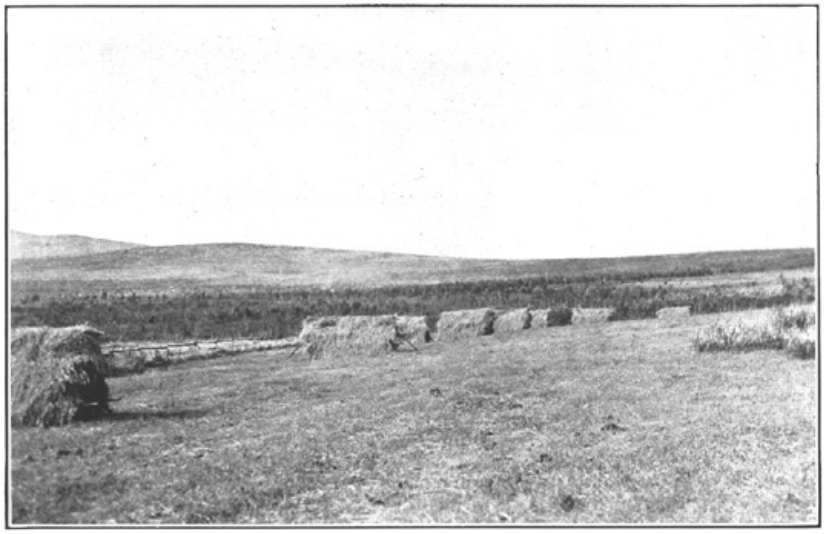


FIG. 1.—CURING GRAIN HAY NEAR CLEARY CITY, ALASKA, SEPTEMBER 1, 1914.

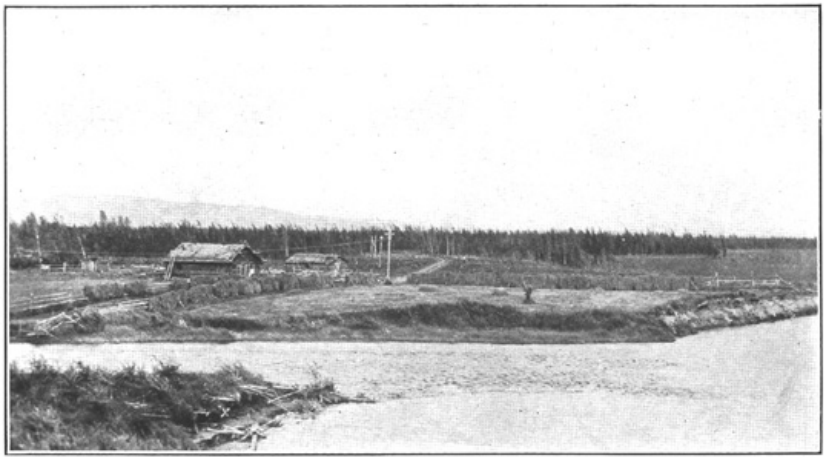


FIG. 2.—RANCH AT MOUTH OF SHAW CREEK, ON THE TANANA.

Note the method of preserving hay during rainy seasons. In this case the hay is simply thrown upon the fence, allowing the water to run out.

without feed, except such forage as the desolate winter wilderness affords. Horses performing hard travel after a time weaken if supplied with no other feed than the dry, frost-bitten grasses of the trail. In the summer season, however, horses carrying heavy packs over difficult trails and across rough country with no trails get along splendidly with no other feed than the native grasses, mostly redtop.

Horses have been left to winter on White River for several years with few losses, and it is said that if they are strong and in good condition when winter sets in the chances are that they will come out all right in the spring, but a much more favorable wintering locality is the region of Kluane Lake. Prospectors using horses leave Nabesna River for Valdez about August 25, or not later than September, while those on White River remain until October, without danger of lack of feed on the trail to White Horse. The working season on White River is thus considerably longer than that on the Nabesna or anywhere in the Copper River basin.[1]

Native redtop hay cut in proper season, some time after the seed is well formed and before killing frosts, has been shown by actual use to constitute a hay of at least middling good quality. Chemical analyses show it to contain more protein than the true redtop of the "States" (*Agrostis alba*), and also to equal the protein content of bluegrass, timothy, and orchard grass. Analyses also show it to compare favorably with these grasses with respect to content of crude fiber. (See results of chemical analyses, page 86 of this report.) Digestibility must be taken into consideration in estimating the value of a hay. The results with hay actually fed stock can certainly be taken as something of a guide to the digestive quality of the product. With this grass the feeding results, where a good grade of the hay is used, attest its satisfactory digestive quality and all-round good nutritive value. Where this grass is cut at the proper stage of growth the hay compares favorably with other hay. It is not to be supposed that the tough, woody grass, killed and hardened by severe frost and otherwise impaired by processes of weathering, will make a palatable, digestible feed.

Another important native grass which grows in abundance in wet places, such as shallow lakes, is slough grass (mostly *Carex utriculata*). Plate XXVIII shows a typical natural meadow in a wet depression of silt loam soil. This grass is cut for hay and has the reputation of having a good feed value even after it is severely frosted. Horses and cattle relish it before and after frost. Slough grass cures easily. Some difficulty, however, is experienced in harvesting it, owing to its wet habitat. Ditching will be necessary in order to use a mower over much of the natural slough-grass meadows.

Bluegrass succeeds, particularly on the well-drained silt loam soils. It spreads from yard to yard rather rapidly and establishes a good

[1] Moffit, F. H., and Knopf, Adolph. Mineral Resources of the Nabesna-White River District, Alaska: Bul. No. 417, U. S. Geol. Survey, 1910, p. 14.

permanent sod. There is no reason why this grass should not be used in pastures.

Timothy has not given satisfactory results, although volunteer bunches of healthy appearance and good growth are occasionally seen where the seed has been scattered from imported hay. It is possible that on well-drained soil which has been cultivated for some time liberal additions of manure will enable a successful growth of this grass, but it does not do well on new, unfertilized land. Surest results would likely be obtained on the silt loam soils. It might be added that there is no particular need of growing timothy in this region where other valuable grasses give such splendid results.

Excellent grass is said to occur abundantly in various sections outside the area under discussion, as in the Mentasta Pass, upper White River, and Broad Pass regions.

Grass for horses is available in favorable localities in the latter part of May or early in June, and later in the season is abundant, especially on the river bars near Nabesna Glacier, the mouth of Jack Creek, and the head of White River. In many other places, on the contrary, grass is scarce, and it is difficult to keep working stock in good condition.[1]

No great difficulty is experienced in the curing of hay in this region, especially redtop, slough grass, and grain. By use of a tedder the grass or grain can be cut in rain and prevented from decaying through comparatively long wet spells. It is frequently handled satisfactorily by throwing the grass or grain upon some raised object so as to allow the water to run out. (See Pl. XXIX, figs. 1 and 2.) A few hours of sunshine will be sufficient to cure it and make a hay of good greenish color. It can be preserved in stacks in the open without damaging.

Horses relish a number of other grasses and plants in the green state. Among these are joint grass and "nigger-head" grass, the former abundant throughout the region, growing thickly in shady places, even on the cold northerly slopes. After frosts this grass apparently possesses little substance, shriveling to a very chaffy fiber. The "nigger-head" grass grows abundantly over the bottoms of small streams. It is a rather tough sedge and contains a high percentage of fiber (see chemical analyses, p. 86, of this report). Two wild plants, locally called "wild pea," seen in abundance along the Nenana River, were eaten with avidity by our pack horses and those of the survey parties of the Alaska Engineering Commission. The horses would leave oats to graze on these plants, which had been frosted, although many of the leaves were still green. It is said by some that these plants are relished more after they have been frostbitten than before.

[1] Moffit, F. H., and Knopf, Adolph. Mineral Resources of the Nabesna-White River District, Alaska: Bul. No. 417, U. S. Geol. Survey, 1910, p. 14.

Botanically these plants are *Astragalus williamsii* Rydb. and *Hedysarum mackenzii* Richards. They are said to be abundant in the upper part of the Tanana Valley, about the headwaters of White River, and along Delta River. Those who have encountered them on the trail invariably say that they are greatly relished throughout winter by pack animals and are apparently nutritious. There are a number of instances where horses have wintered on these wild peas.

No attempts have been made to domesticate these legumes. If they should be found valuable field crops they would undoubtedly prove of great importance in connection with the development of stock raising, and probably, also, of large value as soil improvers. There is a vast area of land in the Tanana bottoms exactly like that on which these plants were seen growing in profusion. An abundance of seed is produced, especially by *Astragalus williamsii*, and it would seem that there should be no trouble in growing such a crop anywhere on the sandy soils. These are promising winter-grazing plants, at least for horses; in fact, they are reported to have been repeatedly used for winter grazing for horses to good advantage. They may also supply winter pasturage for other stock.

Still other valuable forage crops have been grown by farmers and at the experiment stations. A fine field of mixed vetch (*vicia sativa* L.) and oats was seen on Rickert's farm, at Fairbanks, on the Tanana silt loam. The vetch grows to the height of about 3 feet, and, with the oats of equal height, constitutes a valuable hay, giving heavy yields. In addition to its value for forage, vetch could be used for improving the soil, both in supplying needed vegetable matter and nitrogen.

A rank, dense growth of red clover was seen at the Fairbanks station this year, and several plots of alfalfa showed a fair growth. These crops, however, have not thus far proved safe against the winters. The clovers and alfalfas were winter-killed during the winter of 1913–14. At the Rampart Experiment Station at least one variety of alfalfa (*Medicago falcata*) has proved encouraging. This has produced ripe seed and has successfully withstood winter weather.

A variety of white clover (*Trifolium hybridum*) makes good growth in many volunteer patches throughout the region. This plant promises to be valuable, although, as yet, little attention has been given to its production in fields.

Grain hay can be produced in abundance all through the vast Yukon-Tanana region. Both oat and barley hay are grown, not only on the well-drained, sunny lands, but also on the cool northerly slopes, as well as on the deep sandy bottom soils. (See Pl. XXX and Pl. XXXI, figs. 1 and 2.) From the thin sandy lands or from the cool situations not so heavy yields are obtained as from the heavier textured and more favorably situated silt loams, loams, and very fine

sandy loams. On these better drained soils heavy yields of good oat and barley hay are invariably obtained, even in years of unfavorable seasons. Rye and wheat hay also can be produced, but these grains are not grown nearly so extensively as oats and barley.

The grains are usually cut for hay while the kernels are in the milk or dough stage, farmers saying that such hay is preferred to that of ripened grains. The fact that there is such an immense area of land in this country which is capable of producing large yields of grain hay with little or no fertilization strongly emphasizes the possibility of developing stock raising to an important commercial position.

Oat and barley hay are bringing about $50 to $60 per ton this year (1914). The yield ranges from about 1½ tons per acre on old, unfertilized sandy land to 7 tons or more from unfertilized fields of the better soils. Dairymen say that oat hay is better for milch cows than redtop and that barley hay possesses qualities superior to those of any other hay produced in the region for feeding dairy stock.

Grain.

At both the Fairbanks and Rampart experiment stations several varieties of oats, barley, rye, and wheat have been matured; also some of the farmers of the region have ripened oats and barley. This year (1914) three varieties of spring-sown wheat are reported to have matured at the Rampart station and to have produced plump, hard berries. These were the Chogot, Irkutsk, and "HG." They were sown May 12. Of the nine varieties of oats tried at that station in 1913 not one failed to ripen. A pedigreed variety, Yakutsk No. 498, was sown May 12 and was ripe on August 6. Hybrid No. 25a ripened in 81 days. Finnish Black oats have proved very successful at the Fairbanks station, ripening well before frost. Certain varieties of barley have been ripened easily. This year barley ripened and was cut at the Fairbanks station in early August. Barley and oats are the surest of the grain crops to reach maturity. Some oats are still being imported for stock feed, but there should be no necessity for this. Oats sold this year (1914) on the Fairbanks market for $5 per bushel.

Winter-sown rye appears to give much better results than that seeded in the spring. Rye sown at Rampart July 27, 1913, ripened and was cut during the first week of the following September.

A field of buckwheat at the Fairbanks station matured a portion of its grain this year and produced a heavy growth of straw valuable for supplying humus to the soil.

On northerly slopes grain is not likely to ripen, and in abnormally short seasons any grain, even of the early varieties, may be damaged to some extent by early cold. There has been no difficulty, however,

on southerly slopes, in maturing the grain of oats, rye, barley, and wheat, at least sufficiently for seed. These results obtained at the experiment stations show that the soil and normal climatic conditions are favorable to the production of grain.[1]

Those varieties of grain which have been matured with greatest success at the experiment stations can be grown over much of the region. It may be that the grain necessary for the food of the inhabitants will be produced on those farms of the Yukon-Tanana country that include the well-drained soils occurring in sunny situations, particularly those of the southerly slopes, when the seed of these earliest varieties are distributed among the farmers.

The best wheat land is that occurring on the sunny southward-facing slopes. In the bottoms the crop does not appear to be so promising, owing to the large area of land which does not possess the characteristics of a first-class wheat soil, and to the coolness of the night air. If the crop proves successful in a practical way on the southerly slopes, there is enough of such land to supply bread for a population much larger than that now in the region.

Grain production, further than that required for home consumption, however, is not likely to become an industry of large proportions in the near future; it may even be found that more profitable returns will be had by cutting all grain, except that needed by hogs and poultry, for hay and supplying all necessary breadstuffs by importation. With an all-water route to Seattle and more northerly Pacific ports, such as Prince Rupert, it is by no means certain that it would not be cheaper to import breadstuffs, producing grain only for stock, especially with the establishment of reasonable freight rates, and with an outlet to the coast by rail. At the present time all breadstuffs are imported.

In the matter of establishing successful early varieties of grain, a number of problems which may be found to influence early maturity have not been worked out, such as, for example, the matter of hastening maturity by applications of phosphatic fertilizers. It would seem also that sowing grain in the fall, so it could make the earliest possible start in the spring, would be better than spring sowing.

Fruit.

Strawberries have been grown in a small way by a number of gardeners in the Fairbanks section, but it appears that the berries are not producing abundantly. There seems to be some tendency for the plants to make a too plentiful growth of leaves and vine, with a corresponding tendency toward unfruitfulness. Obviously some work is necessary in the matter of adjusting varieties or hybrids of strawberries to the local conditions.

[1] See annual reports of Alaska Agricultural Experiment Stations, U. S. Department of Agriculture.

A number of wild fruits are found in the region. Low-bush and high-bush cranberry and blueberry grow in the greatest abundance throughout the entire region. Almost unlimited quantities of these berries are easily procurable in any part of the country. They are gathered extensively for use fresh and for making preserves and jelly. The low-bush cranberry makes a preserve quite as good as that of the cultivated cranberry of the "States," and the high-bush cranberry makes very good jelly.

Currants also are plentiful in many sections. Both the red and black varieties were seen. Wild raspberry succeeds on the better drained slopes, particularly those facing southward. Little attempt has been made to improve the raspberry by cultivation.

Stock Raising.

The fact that fine specimens of cattle and hogs are raised in the Yukon-Tanana country and that successful dairies are operated, coupled with the ease with which large quantities of native grass and grain hay, vetch, root crops, and other forms of forage can be produced, removes any doubt as to the possibility of actually raising stock. Cattle and hogs can be raised on the products of the region, and the large extent of land adapted to the production of the necessary feed points to the possibility of successfully establishing important industries in the raising of stock or dairying or both. (See Pl. XXXII and Pl. XXXIII, figs. 1 and 2.) Dairying appears to be the most promising industry, but there seems to be no doubt that sufficient meat for home consumption could be locally produced.

The rigors of the winter climate do not constitute so serious an obstacle to stock raising as might be supposed. In the warm barns, such as have been constructed of spruce logs, well chinked with moss, stock seem to get along comfortably.

It is true that stock must be maintained by feeding 7 or 8 months in the year; that is, where not provided with winter grazing such as the wild peas of the region have afforded in many instances, but this is the only way to make use of the great quantity of valuable forage the country is capable of producing and the crops of native grasses that annually go to absolute waste. This forage can be produced, harvested, and stored without any unusual effort, but it probably can not be exported profitably and to be used at all must be utilized in the production of beef, dairy products, and pork.

It must be understood that this is not a stock-raising region in the sense that cattle can be turned upon vast ranges to care for themselves until ready for the round-up and market. Good grazing is available nearly everywhere during the months of June, July, and August, and ordinarily through part of May and September, while browse consisting of frost-bitten vegetation will be available in many

years through October and perhaps a part of November, but stockmen must be prepared to feed at least 7 months in the year, and they must have efficient means for housing all stock against the severe cold. As already pointed out, the country is fully capable of meeting this demand for feed; it only remains, then, for those entering the business to employ the ordinary means of laying up necessary supplies of feed and providing shelter.

Notwithstanding the fact that the region is capable of producing much more beef than the present population requires—more than a vastly larger population would require—not enough is produced to supply more than a small fraction of the demand, and this is mostly pork and veal raised scatteringly by a few road-house keepers, farmers, and dairymen. Practically all of the cattle in the country are used for dairying purposes. While considerable milk and butter are produced, the output is but a comparatively unimportant part of that used by the present population.

The largest dairy farm seen was that of Mr. C. F. Hinckley, at Fairbanks. In September, 1914, there were on this farm 22 cows, 2 bulls, and several calves. Nineteen of the cows were giving milk. These were Durham, Jersey, Holstein, and grades of these breeds. Milk was being sold at $1 a gallon, cream at $1 a pint, and butter at 75 cents a pound. Three of the best milch cows at this dairy were raised on the farm. Most of the calves were sold for veal.

On Mr. Young's dairy farm near Fairbanks there are 6 cows and 1 bull. The best cows here are said to average about 2 gallons of milk a day.

The Yukon-Tanana region is thus demonstrably one of considerable stock-raising and dairying possibilities. There is opportunity for an immediate extension of these industries to fully meet the demands of the present population for beef and dairy products, and probably for pork. The profitableness of shipping stock or meat to outside markets is somewhat problematical, at least under present conditions of transportation. It may be possible, however, to carry the industry to such a stage of development that such shipments can be made profitably when cheaper transportation is available. Exportation of the more concentrated products, butter and cheese, is even more promising of success.

No information could be secured in regard to the raising of sheep and goats. It is possible that the heavily fleeced breeds would prove successful here. At least some experimental effort should be devoted to the raising of these animals.

Poultry.

Chickens and ducks do well. A considerable number of flocks of the Rhode Island Red and Plymouth Rock breeds are kept. Indian Runner ducks were seen. Ranch eggs were selling at the time this

reconnoissance was made at $1.50 a dozen and cold-storage imported eggs at 75 cents a dozen. Plate XXXIV shows chickens which were raised on a farm near Fairbanks.

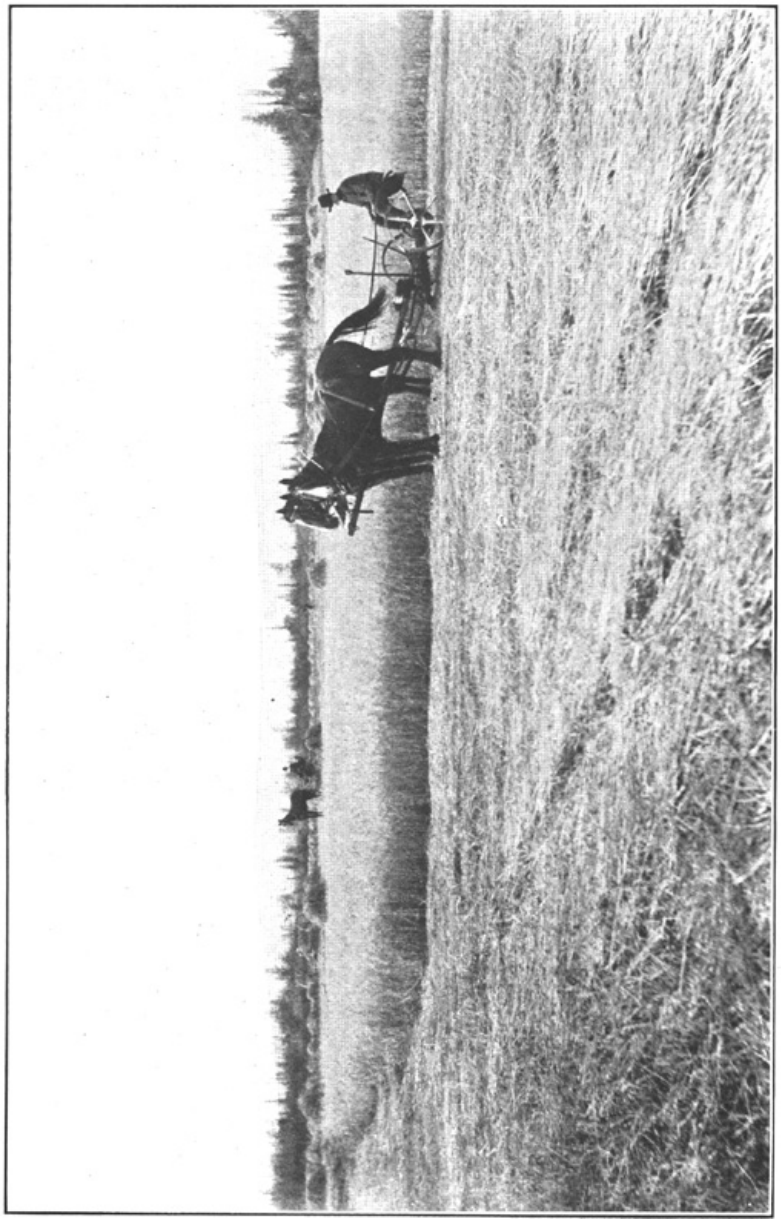
Preparation and Cultivation of Land.

In Alaska generally the first step in the preparation of land for cultivation is to burn it over during the dry season, as a rule in June or July. This is absolutely necessary for clearing those lands which have a heavy covering of moss or other vegetation such as would ordinarily be plowed under at more southerly latitudes. This preliminary burning would be necessary in case of most of the Tanana bottom lands, of practically all of such land along the small streams in the highlands, and of the northerly slopes. Vegetable matter decays slowly here, owing to retardation of oxidation processes by the low temperature, so that any large quantity, especially where of a tough, woody nature, turned under at a single plowing would leave the soil in a rough, loose condition, lacking in that compactness best suited to plant growth. Were such coarse material turned under here it would require long periods for restoration of proper tilth in the soil.

The well-drained southerly slopes mostly do not have a very thick covering of vegetation aside from that which is suitable for plowing in, coarse grass and moss being rather scarce, particularly in case of the burned-over lands. But even here there is generally an undergrowth of shrubs, such as high-bush cranberry and wild rose, which if not removed would impede plowing operations.

Most of the soil of the Yukon-Tanana country contains a fair to good supply of humus, and there is mixed with the surface soil a considerable quantity of finely divided and incompletely decomposed vegetable matter which would not be completely destroyed by fires. Soils naturally deficient in organic matter are the Tanana very fine sand and, to a less extent, the Tanana very fine sandy loam. All the other types encountered are very well supplied with humus.

Taking everything into consideration, it is advisable to burn all lands as a preliminary step to breaking them for cultivation. In addition to the troublesome undergrowth and the thick layer of moss and decaying vegetable matter which will be removed in this way, the burning over will greatly facilitate the work of clearing the land of timber by destroying many of the shallow-growing roots, thus causing a good many trees to fall or to be so weakened in the root system that they can be readily pushed down. Further, the effect of burning invariably is to lower the level of ground ice and to improve the drainage condition of soils. In some places there is such a thick carpet of moss that it is necessary to strip the land of such covering, inasmuch as fires do not always consume such material to a sufficient depth.



CUTTING GRAIN FOR HAY ON THE TANANA BOTTOMS.

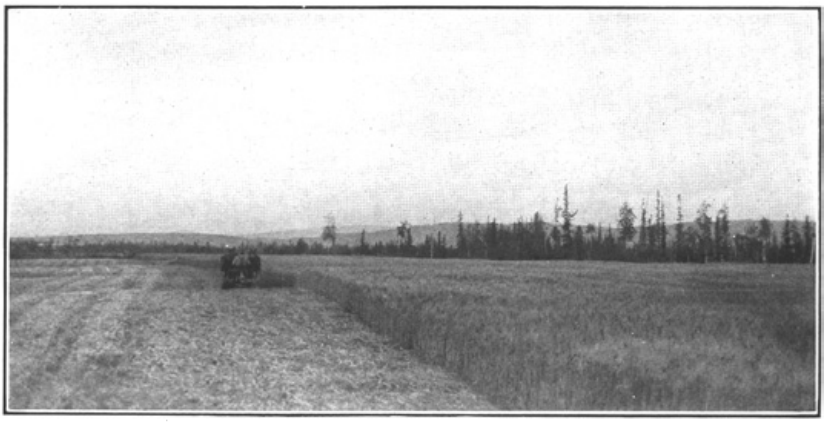
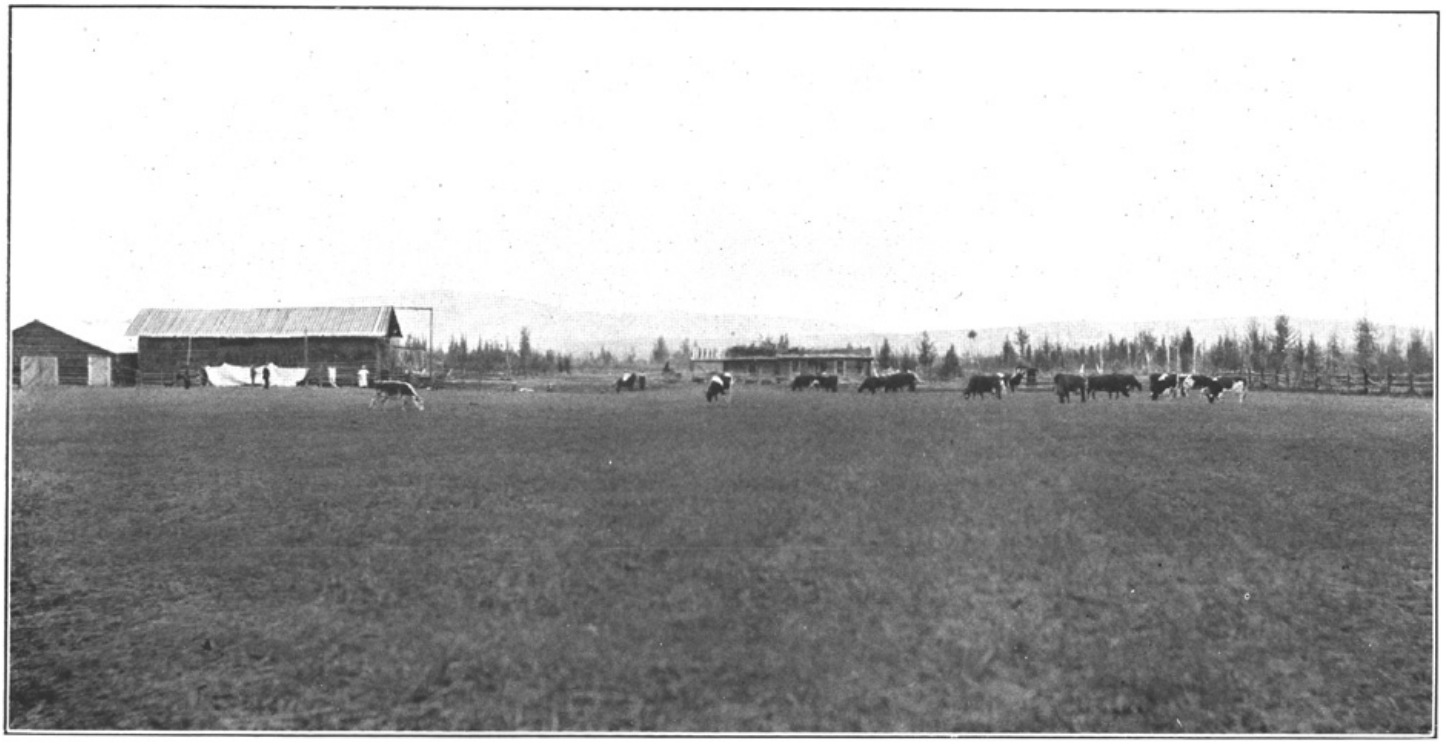


FIG. 1.—FIELD OF BARLEY ON TANANA VERY FINE SANDY LOAM NEAR FAIRBANKS, SEPTEMBER 1, 1914.

FIG. 2.—OATS IN THE SHOCK, SEPTEMBER 2, 1914.

Grown on Tanana bottom soils near Fairbanks.



HINCKLEY'S DAIRY NEAR FAIRBANKS, SEPTEMBER 3, 1914.

Showing herd grazing on grain stubble. The buildings are built of spruce logs.

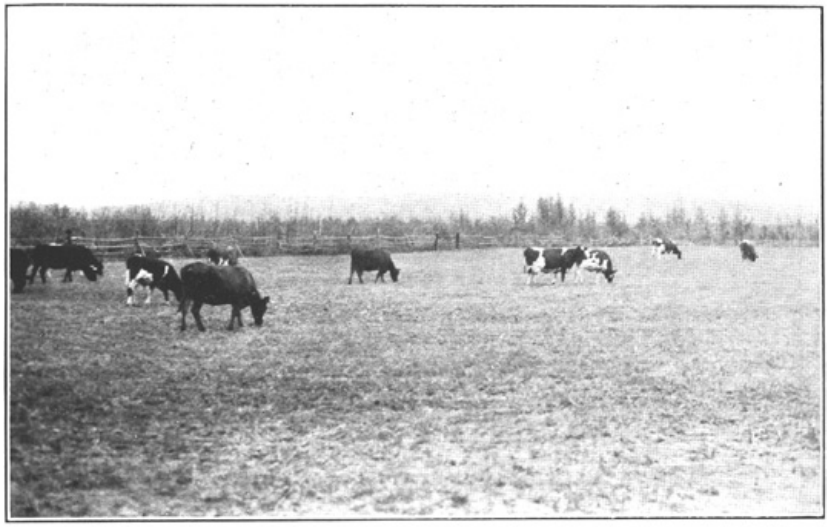


FIG. 1.—CLOSER VIEW OF HINCKLEY'S DAIRY HERD

FIG. 2.—HOGS RAISED ON FARM NEAR FAIRBANKS, AUGUST 31, 1914.

BARNYARD SCENE NEAR FAIRBANKS, SHOWING POULTRY RAISED ON THE FARM.

Much of the moss-covered scrub-spruce lands can be very nearly put into condition for cultivation by burning over, aside from what ditching may be necessary to promote requisite drainage. In fact, much burned-over land was seen, noticeably in the Goldstream Creek Valley, which could be plowed without further clearing, except that which could be accomplished by throwing down by hand the standing spruce poles and piling these along with those already fallen for burning. Most of the root systems here are completely upturned when the trees fall. Through the Tanana bottoms and on the hill slopes there are dense forests of spruce, birch, aspen, cottonwood, and mixtures of these, the clearing of which will entail considerable labor both in cutting the trees and removing the stumps. Owing to the shallow root system of trees prevailing through this region, the result probably of a frozen substratum, the removal of stumps is an easy task as compared to similar work in the prevailing forest lands of the United States. The cost of clearing land in this section of Alaska is variously estimated at about $25 to $150 an acre, according to the density of the growth and size of the trees, but these estimates must not be compared directly with the cost of clearing in the "States." Everything is higher in this country than in the United States; labor is paid more and products of farms bring much higher prices. Potatoes, for example, frequently sell for 6 cents a pound or more and cabbage and carrots from 8 to 10 cents a pound or higher.

After the trees and stumps are removed the land is ready to break, except where ditching is necessary. The amount of ditching required will depend largely upon the topographic character of the land, since all of the soils will lend themselves readily to drainage, in so far as influenced by the character of the soil material. In other words, impervious clay of a kind that retards drainage was not found. Shallow ditches about 2 feet deep at the head will suffice to remove excess moisture from the average land requiring drainage, and these will not need to be placed at very close intervals, except where swales or slight depressions require individual outlets. Generally such wet depressions could be used to better purpose for meadow lands, as could, also, the excessively wet areas of Muck and Peat and flats in which drainage is always poorly established. Some of these areas will have to be ditched to some extent to make possible the use of mowing machines.

It is on such lands as the Goldstream silt loam and the lower areas of Tanana silt loam that ditching can be performed to greatest advantage. It was noticed that oats made an unsatisfactory growth on certain patches of the Tanana silt loam which, upon superficial examination, had the appearance of having good drainage, but which upon closer scrutiny revealed, in dry weather, small spots of soil that were quite moist at the surface, closely associated with other spots

of the same soil which were dry at the surface. It is believed that this condition was due either to the presence of impervious strata in the subsoil or to an underlying stratum of ice, and that ditching would be the remedy for the correction of the unfavorable condition. Owing to the absence of unwieldy clays and to the tractability of the soils in general, the excavation of ditches is easy.

Experience indicates that breaking to a depth of about 5 to 8 inches is generally sufficient for new land. The prevailing contention that land improves with cultivation, crops of better quality and earlier maturity being obtained from the old fields, suggests either that some unsalutary condition obtains in the fresh soil [1] or that time is required to make available necessary plant food. Whatever the cause, aeration evidently has a remedial effect and it, accordingly, seems advisable to break new land some time before planting. It very likely would be a good plan to plow a newly cleared field during the summer preceding its use for a crop, leaving the soil in the rough upturned condition through winter in order to facilitate aeration. Such loose soils as the deep sands of the Tanana bottoms, however, probably would not be benefited as much as the heavier soils by such preliminary cultivation, since the open structure of the former favors better natural aeration.

The heaviest soils of the region, the silt loams, are, where properly drained, susceptible of easy tillage, the material yielding to the plow readily. They are easily reduced to a good pulverulent condition, intractable clods rarely forming, especially if the land is not wet enough to be miry when plowed and has not been allowed to become depleted of organic matter through continuous cropping to clean-cultivated crops.

It appears that yields do diminish, however, on some soils after several years of cropping. One method of overcoming this, as recommended by the Fairbanks and Rampart experiment stations,[2] is to practice summer fallowing. To quote these authorities:

> It has already been demonstrated that by summer plowing the land and letting it rest every other year fairly good crops can be obtained. In this respect Alaska is not materially different from some farming sections of the States, where summer plowing must be resorted to in order to obtain fair crops. The reader should bear in mind the fact that the ground here is frozen for nearly seven months in the year, during which time little or no chemical change can take place to liberate plant food; therefore, to farm the land every other year would be practically the same as farming the land every year in the milder zones. (Fairbanks station.)
>
> Experience here, as elsewhere, has shown that the beneficial effect of summer fallowing is easily traceable for two or three years, both in increase of crops and in the improved physical condition of the soil. (Rampart station.)

Another method for the maintenance of yields is the rotation of crops. At the Fairbanks station beneficial results have followed the

[1] See Farmers' Bul. No. 257, U. S. Dept. of Agriculture. [2] Rept. Alaska Agr. Expt. Sta., 1913, pp. 35-39.

rotation of cultivated crops with grain crops. Even better results should follow the growing of legumes in rotation with plants of other families.

It has been found that the silt loam of the slopes assumes a compact structure at the plowsole with continued cultivation, and that the topsoil itself compacts and crusts with alteration of the humus supply resulting from continuous cropping. This tendency to compact is very common in silt loam soils generally. The most effective remedy is deep plowing in the fall, return of organic matter to the soil, and the application of lime. The maintenance of proper tilth—that mellow condition of the soil which checks loss of moisture by surface evaporation and invites healthy root development—is contingent upon handling the soil in this way.

In general agricultural practice deep fall plowing is done to enable the soil to store moisture and to expose the material to the beneficial action of weathering processes, while frequent shallow cultivation during the growing season is performed in order to destroy weeds and to create a surface mulch which will cut off capillary action between the subsoil moisture and the overlying atmosphere, and thus retain the moisture needed for growing crops. In addition, fall plowing expedites early spring planting, and this assists in taking all possible advantage of the growing season. There seems to be no reason why these methods should not be just as applicable to the soils of interior Alaska as those of any other region.

Manurial Treatment.

The use of barnyard manure in all cases investigated has been followed by increased yields. This at once decides affirmatively the value of manurial treatment in this region.

On the Fairbanks silt loam, very fine sandy loam, and very fine sand, heavy applications of manure have produced marked increases in the yields of both vegetables and grain, while light applications have given proportional increases. One farmer reported 4 tons of oat hay per acre this year on thin Fairbanks very fine sand, which had received a light dressing of manure twice in 4 years of cultivation. Another farmer a short distance away on the same soil this year reported only 1½ tons of barley hay per acre from a field which had been used for barley 7 years without fertilization. Such a yield is not low for a long-used thin soil of this character, but in comparison with the quantity of oat hay secured with manure it is low enough to show that the productiveness of the soil can be materially increased by fertilization.

Commercial fertilizers have not been extensively used and their value on the soils of the region is virtually undetermined. Some of the tests made indicate beneficial effects. Increases in the yield of

hay and potatoes from applications of sodium nitrate are reported by the experiment stations. Indications from some experiments are that nitrates while promoting growth retard maturity. Phosphatic and potassic fertilizers at the Rampart station apparently have had little effect in the trials thus far made. Thorough tests should be conducted with phosphatic fertilizers, such as the common commercial form "acid phosphate," to ascertain whether or not important hastening of crop maturity will follow the use of such material on the soils of the region. Phosphatic fertilizers have been found to have a marked effect in this respect on a number of crops grown at more southerly latitudes.

Reports ascribe beneficial effects to the use of wood ashes in all cases. Whether such good effects are due to the potash or lime in the ashes, or to both, is not known. Most of the soils here are only slightly to moderately acid, according to both the litmus-paper and lime-requirement tests. Slight acidity does not always mean, however, that lime is not needed, since lime frequently gives beneficial results which certainly can not be attributed solely to a correction of soil acidity. It improves the physical condition of soils, making heavy types more friable, and probably has other ameliorative effects. It usually is decidedly efficacious on newly reclaimed mucky lands, particularly in bringing about a condition conducive to healthful plant growth and development where, without lime, crops make imperfect growth. It is very likely that liberal applications of lime to the mucky soils of this region would prove very beneficial, while moderate treatment—1,000 to 2,000 pounds an acre of air-slaked burned lime—would probably benefit the better drained lands, except perhaps the loose sandy types.

In the final consideration of the question of manurial requirements of the soils of interior Alaska, it must be considered that commercial fertilizers will be expensive, and that all available means should be taken advantage of before recourse is had to the commercial forms of fertilizers. This will mean that all barnyard manure should be carefully saved and returned to the land; that nitrogen-gathering crops—the leguminous crops—suitable for supplying vegetable matter and nitrogen to the soil, should be grown in rotation with such crops as grain and grass; and that the soils should be plowed deeply from time to time so that fresh material may be brought up from below and mixed with the surface soil.

Immense quantities of fish scrap are annually wasted at the salmon canneries along the Alaskan coast [1] which could and should be converted into fertilizer material. With the establishment of fertilizer factories to handle this by-product of the canneries a cheap

[1] Utilization of the Fish Waste of the Pacific Coast for the Manufacture of Fertilizer, Bul. No. 150, U. S. Dept. of Agriculture.

fertilizer could be made available for the agricultural land of the Territory. Fish scrap is not only an efficient, highly nitrogenous fertilizer, but it carries in addition some phosphorus, potassium, and lime.

The table below gives the results of lime-requirement tests of several representative samples of the important soils of the Yukon-Tanana region:

Lime requirements of representative soils in the Yukon-Tanana region.[1]

[Quantity of lime required to neutralize soil to a depth of 1 foot.]

Soil type and section.	No. of sample.	Location of sample.	CaO.	$CaCO_3$.
Gilmore silt loam:			*Tons.*	*Tons.*
Soil	590140	Slope just west of Fox	3.8	6.8
Subsoil	590141	.....do	1.9	3.4
Tanana silt loam:				
Soil	590142	Fairbanks	2.2	4
Subsoil	590143	.....do	1.2	2.1
Fairbanks silt loam:				
Soil	590146	Fairbanks experiment station, in timber	2.4	4.3
Subsoil	590147	.....do	2.6	4.6
Soil	590148	Fairbanks experiment station, in field	1.9	3.4
Subsoil	590149	.....do	1.7	3.1
Goldstream silt loam:				
Soil	590153	Lower Goldstream Flats	7.3	13.1
Subsoil	590154	.....do	2.1	3.7
Tanana fine sand, subsurface.	590155	Minto Flats	1.2	2.1
Nenana silt loam:				
Soil	590156	30 miles above mouth of Nenana River	2.6	4.6
Subsoil	590157	.....do	1.9	3.4
Rampart silt loam:				
Soil	590164	Rampart experiment station, on bench	None.	None.
Soil	590166	Rampart experiment station, foot of bench	None.	None.
Yukon silt loam:				
Soil	590168	Rampart experiment station, on river flats	None.	None.
Soil	590169	150 miles above Rampart, on Yukon Flats	None.	None.
Fairbanks silt loam, soil	590173	Slope just northeast of Hot Springs	4.3	7.8
Tanana very fine sandy loam, soil.	590175	Hot Springs	2.6	4.6

[1] These determinations were made by Messrs. R. F. Gardiner and C. F. Miller.

FOX FARMING.

Considerable effort is being devoted to the raising of the valuable fur-bearing foxes which inhabit this region. Large fox ranches have been established at Hot Springs and Fairbanks. So far the sales have been principally of the live animals for breeding purposes. The silver-gray and black varieties bring high prices; it is said $1,500 or more has been paid for a pair of them. The reds and crosses are not nearly so valuable. The industry is rather in its

infancy in this region, and its success as a permanent industry can not be predicted. On the islands of the Alaskan coast fox farming has been practiced for a number of years.[1]

FLOWERS.

In addition to a large number of wild flowers, many domestic flowers are very successfully grown. Most yards have a variety of flowers, and frequently the sides of houses are covered with beautiful masses of tall, heavily flowered nasturtiums and sweet peas. (See Pl. XXXV.) Among the common flowers seen in profusion in yards and gardens are purple, blue, white, and pink asters, white and pink daisies, phlox, petunia, canary vine, verbena, forget-me-nots, China pink, snapdragon, marigold, and pansy.

FOREST PRODUCTS.

The forests of the Yukon-Tanana country include large quantities of valuable timber. In many places spruce trees 2 feet in diameter occur in abundance. Spruce of sufficient size for sawing is likely to be found over most of the Tanana bottoms; it is also present in considerable quantities over the lower slopes of the hills, northward toward the Yukon River.

A number of sawmills are engaged in cutting the lumber necessary to meet the demands of the country for building materials. Spruce logs are well suited to the construction of dwellings and barns. A number of large substantial barns for stock were seen which had been built of long spruce logs, the space between having been effectively chinked with moss. Many substantial and attractive cottages are also constructed of the unsawed logs.

Spruce also supplies the lumber needed in mining. Large areas of the slopes contiguous to those streams along which placer mining has been developed have been partially or entirely denuded, the timber having been used in connection with mining operations and for firewood.

There is much good birch timber, especially on the southerly slopes and in places through the bottoms, the trees frequently attaining a diameter of 16 to 18 inches. Cottonwood of a much larger size is plentiful nearly everywhere along the banks of the larger streams.

A considerable number of woodchoppers are kept busy cutting wood for the Tanana and Yukon River steamers and to supply the needs of those living in towns. The price of firewood at Fairbanks is $6 to $8 a cord. Wood stacked along the banks of the Tanana and Yukon Rivers is bought by the steamship companies at about $6 a cord.

[1] See Report of Alaska Investigations in 1914, by F. Lester Jones, Bureau of Fisheries, Dept. of Commerce, pp. 114-121.

The timber resources of the region, particularly of the broad lowland areas, are sufficient to meet the demands of a very much larger population than that now present, if used economically. Ruthless destruction and waste of the forest is entirely unnecessary, and should not be permitted. There seems to have been little needless waste up to the present time, perhaps because conditions have not favored wholesale deforestation by large sawmill companies In the burning required to clear land properly some timber will necessarily be killed, but even here most of it can be saved for firewood.[1]

SETTLEMENT AND GENERAL DEVELOPMENT.

The agricultural development so far attained has depended upon the growth of the mining industry, which had its beginning in the Fairbanks section about 1902. In the year 1901 Fairbanks began as a trading station. A prospector discovered gold that year about 12 miles from this station, on what is now called Pedro Creek. This marked the beginning of placer mining in this district. In 1903 the output of gold for the Fairbanks district was about $40,000; in 1909 it was $9,650,000. Since this time there has been considerable dropping off in the production, owing to the working out of the better more available deposits, but the output of the district is still of very considerable importance, amounting to several million dollars annually. The most productive areas have been along the following creeks: Cleary, Ester, Fairbanks, Goldstream, Dome, Vault, Pedro, Chatanika, Ready Bullion, Chatham, Treasure, and Fish.[2] Considerable gold is also produced in the Hot Springs placer district. Quartz mines are now being operated and developed in the Fairbanks district.

Population.

Prior to the discovery and development of the placer mines this country was an uninhabited wilderness, except for the settlements of Indians at such places as Nenana and Tanana. Fairbanks had a population in 1910 of 3,541. It was at that time the largest city in Alaska. The present population is probably about the same. Outside of this town there are in the district probably a permanent population of between 2,000 and 3,000, most of whom are connected with the gold-mining industry. Villages of importance outside the Fairbanks district, and located within the Yukon-Tanana region under discussion, are Tanana and Fort Gibbon (a military post), at the confluence of the Tanana and Yukon Rivers; Hot Springs, Tolovana, Nenana, Chena, and Munsons, on the Tanana River; and Rampart on the Yukon River. Rampart, about 69 miles above Tanana, is

[1] See The Forests of Alaska, Bul. No. 81, Forest Service, U. S. Dept. of Agriculture, 1910.
[2] See Bul. U. S. Geol. Survey No. 525.

reported to have had a population of 1,500 in 1898–99,[1] when interest in gold mining ran high in that district. The population of this village is now probably less than 100. Hot Springs, 66 miles above Fort Gibbon, has a permanent population of about 100, and there are perhaps as many more connected with the placer mines out from that town.

The population of the towns and districts fluctuates considerably, owing to changes in the outputs of the placers. In the spring many who have spent the winter in town go out to "the creeks" to engage in gold mining. Also a considerable number "go outside" in the fall, spending the winter in the United States and returning the following spring.

Fairbanks is a city which enjoys the advantages of many modern conveniences. It has good water and electric-lighting systems, hotels, newspapers, schools, churches, and telegraph and postal facilities. The other more important villages also have satisfactory hotels and schools and telephone or telegraph connections. Road houses are maintained throughout the year at convenient places along the main lines of travel; also during the winter along the winter trails, which are not traveled during the summer months. Schools for the natives are maintained by the Episcopal Church at several of the native villages.

Natives are distributed throughout the region in small villages located on the rivers, the most important of which are at Munsons, Nenana, Minto, and Tanana. There are probably more natives in this region than in the Cook Inlet-Susitna region.

The native Indians are chiefly busied in hunting and fishing. They make excursions during both the winter and summer to comparatively remote sections, establishing camps at various points along the Tanana and other streams, from which their hunting and fishing operations are conducted. (See Pl. XXXVI.) Very few of these natives engage in agriculture. In rare instances they cultivate small vegetable patches, but that is about all. Some Indians work occasionally for white men at odd jobs. They also manufacture snowshoes, moccasins, and baskets. Their unique fish wheels for catching salmon are seen at a good many places along the Tanana and Yukon Rivers.

A number of missions along the Tanana and Yukon Rivers are doing effective work in educating the natives. Every effort should be made to improve the conditions of these interesting and docile Indians. They should be instructed in sanitation, in gardening, in the raising of poultry, and in other essentials to healthful living and thrift. There is no necessity to discourage them in continuing their present chief occupations, fishing and the making of simple articles of clothing and outdoor equipment, but helpful encouragement in

[1] See Bul. No. 525, A Geologic Reconnaissance of the Fairbanks Quadrangle, Alaska, U. S. Geol. Survey.

other industries and in the observance of the rules of health should be given them. It is reported that tuberculosis has made inroads upon the population of some villages.

MEANS OF COMMUNICATION.

In the summer passengers and freight reach the Alaskan interior chiefly by river. There are two water routes from Seattle—one up the coast to St. Michael by ocean boat, and from there to Fairbanks and other river points by boat up the Yukon and Tanana Rivers, and another to Skagway, on the southern Alaskan coast, by ocean boat, from there to Whitehorse by the White Pass & Yukon Railroad and thence by river boat down the Yukon. There is some summer travel over the Valdez-Fairbanks Road, but little freight thus far has been handled over this road this season. This road was constructed by the Alaska Road Commission, under the direction of officers of the United States Army.[1] It represents a remarkable piece of work, particularly in view of the obstacles to road construction—the remoteness of the region crossed from points of supply, the large number of swift streams, some of which are dangerous glacial streams, that had to be bridged, and the unfavorable road material and poor drainage conditions encountered in many places. There are long stretches of this road, which extends over 400 miles into the interior, that are so good that automobiles are enabled to make a high rate of speed at any time of the year. The writer went from Chitina to Fairbanks over this trail with a small automobile the latter part of August, 1914, under the most unfavorable conditions that have been known since the road was completed. An abnormally heavy rainfall had caused formidable slides, much damage to causeways and bridges, and had brought about a very soggy condition of the roadbed in places where both topography and character of material have militated against good drainage. It is true some exigencies had to be met on this trip; nevertheless good time was made, some two weeks or more having been saved in reaching the interior by this route. Under normal conditions automobiles make the trip easily. During winter mail for the interior is carried over this trail and some freight is distributed along the road and even carried to Fairbanks. The road houses are nearly all stocked with sufficient supplies during winter for the needs of the following summer.

The road commission, cooperating in some instances with local citizens, has constructed a number of good roads in the mining districts, notably in the Fairbanks district. Good wagon and automobile roads run from Fairbanks to Ester, Fox, Dome, Golden City, Olness, Meehan, Cleary City, Chatanika, and other points along the mining creeks. There is a good road from Hot Springs to Eureka. Trails

[1] The Alaska Road Commission is made up of two line officers and one engineer officer. Col. W. P. Richardson has been president of the commission since its inception.

for dog sleighs, which carry considerable freight during the winter, lead in many directions through this region. Most of them are not much used in the summer.

With the extension of the mining and agricultural interests to other parts of this region, additional wagon roads will have to be built from time to time.

The Tanana Valley Railway operates trains daily throughout the year from Fairbanks to Chena and Chatanika.

YUKON VALLEY.

The Yukon is the largest and longest river in Alaska. It is about 2,300 miles long, ranking in this respect among the most important rivers of the North American Continent. The volume of water discharged is estimated at about two-thirds of that of the Mississippi River.[1] One branch, that followed by the White Pass & Yukon Railroad, heads in the Coast Range at an elevation of about 2,800 feet above sea level and about 20 miles distant from deep tidewater of the Pacific, near the head of Lynn Canal. Whitehorse, at the head of navigation on the Yukon, is about 90 miles north of Skagway. These towns are connected by the White Pass & Yukon, which crosses the range between, through White Pass, at an elevation of 2,888 feet. River boats are operated regularly through the summer season, at which time the stream is not closed by ice, along the entire navigable portion of the Yukon, that is, from Whitehorse to St. Michael, on Bering Sea, a distance of something over 2,000 miles.

The river follows a northwest course through Yukon Territory to the Arctic Circle at Fort Yukon, and there swings southwesterly to the Pacific coast. It crosses the international boundary into Alaska at Eagle, which is 80 or 90 miles below Dawson, the headquarters of the famous Klondike mining industry and the capital of Yukon Territory.

The region from Whitehorse nearly to Circle is mountainous along the banks or at no great distance from the banks of the Yukon River, and only the comparatively narrow benches or terraces, which occur at intervals immediately along the river, appear to be of possible value for cultivation. In the vicinity of Circle the bottoms widen out into the great Yukon Flats. These flats continue downstream to the vicinity of Fort Hamlin. Their greatest width is probably about 100 miles. On the south side of the river, between Circle and Fort Hamlin, it is estimated that the flats comprise an area of about 4,000 square miles. The surface of these Yukon lowlands is comparatively level, and most of the area is forested. The timber growth consists chiefly of spruce. Many of these trees are 20 to 24 inches or more in diameter. They are cut in places along the river for

[1] Brooks, A. H., The Geography and Geology of Alaska: Professional Paper No. 45, U. S. Geol. Survey, pp. 64–66.

steamboat fuel. There is also considerable cottonwood, willow, alder, and birch. Occasional areas are treeless or support only a scrubby growth of willow and alder or grass and dwarf shrubs. Redtop and slough grass, Hudson Bay tea, blueberry, dwarf birch, moss, and other plants of low growth are plentiful over the more open ground.

Soils.

The soils of the Yukon Flats, according to examinations made along the river, predominantly consist of brownish silt loam, fine sand, very fine sand, fine sandy loam, and very fine sandy loam (Yukon soils), and Muck and Peat. The Yukon soils are prevailingly coarser textured in their subsoils than at the surface. The material composing them is of alluvial origin and closely resembles that of the Tanana soils. One difference found in the areas examined is the nonacid nature of the material of the Yukon types.

Below the flats, in the vicinity of Fort Hamlin, mountainous country closes in upon the river and for many miles the stream is flanked by cliffs and precipitous slopes. There are benches farther down the river, beginning between Fort Hamlin and Rampart and extending at least to the junction of the Yukon and Tanana Rivers at Fort Gibbon. These benches are, in part at least, occupied by brown silt loam soil (the Rampart silt loam), which, physically, is practically the same as the Fairbanks silt loam. The material differs from that of the Fairbanks silt loam, in the places examined, in being neutral instead of slightly or moderately acid.

The Rampart and Yukon soils represent the most important agricultural lands seen in the Yukon Valley. The occasional benches above Circle are, to some extent at least, good farming land. The soils of these benches were examined at Eagle [1] and Dawson.

The soil at Eagle is mostly a brown loamy fine sand to very fine sandy loam, underlain at about 15 to 24 inches by grayish to yellowish fine sand. The bench here is somewhat rolling or hillocky, and is about a mile wide. At Dawson the soil of the bench (water-deposited material) on the west side of the river consists of brown fine sandy loam to silt loam overlying yellowish-brown loamy fine sand to silt loam, which at about 18 to 20 inches passes into a mixture of gravel, sand, and silt. In places the texture of the surface soil varies to very fine sandy loam and in other places to loamy fine sand. On the gentler slopes near the river, Muck and brownish loamy fine sand and fine sandy loam were seen, while on the steeper slopes the soil is mostly a grayish to brownish residual stony loam or loam, carrying considerable mica.

The extent of cultivable land above Eagle is rather small in most places, and there are long stretches along the river where the surface

[1] See The Fortymile Quadrangle, Bul. No. 375, U. S. Geol. Survey.

is so steep and rocky or mountainous as to preclude farming operations. The bench lands are not continuous, although some of the strips are several miles long

There are also strips of bottom land at intervals along the river above Circle, as, for example, at the mouth of White River and at Selkirk. The soils of these are the same, apparently, as those of the Yukon Flats, consisting mostly of brownish loamy fine sand and fine sandy loam, overlying fine sand. Between Selkirk and Whitehorse the benches are narrower and gravel appears to come nearer the surface (see Pl. XXXVII, fig. 1). In places there are at least three distinct flat-topped benches occurring in succession above the river.

RAMPART SILT LOAM.

The typical Rampart silt loam, as seen on the benches at the Rampart experiment station, is a brown friable silt loam, which grades at about 8 to 12 inches into yellowish-brown silt loam, showing in places a slight shade of greenish. Texturally the soil and subsoil are the same, both containing over 70 per cent of silt. In its textural, structural, and color characteristics the type is identical with the Fairbanks silt loam, but the samples tested show it to be neutral, whereas the corresponding type of the Fairbanks series is moderately acid. Furthermore, the Rampart silt loam is characteristically a bench or stream terrace soil, while the Fairbanks silt loam is a slope soil.

Along the foot of the bench at the Rampart station there has been some accumulation of colluvial material, and the drainage is not so perfect as on the slopes and benches above. The soil here is a dark-brown to black mucky silt loam about 8 inches deep and the subsoil a brownish silt loam, mottled with bluish, grayish, and yellowish brown.

Under cultivation the soil tends to assume a compact structure. This condition could be prevented by the maintenance of a good supply of organic matter, through the plowing under of manure and probably green vegetation. Like other silt loams, the soil is easily tilled.

Birch and spruce are the characteristic trees. Willow and alder, together with other plants of the region, are present to some extent.

Typically, the surface configuration is flat, but there are places where it is hillocky to somewhat rolling. It is not known that all of the type, as shown on the accompanying reconnoissance map, conforms to the description given above, but it is very probable that much of this same kind of land is included in the areas shown. In addition, there are probably other areas along the Yukon which have not been outlined on the map.

The Rampart silt loam is a valuable agricultural soil, as has been shown by the results of the experiments made on it. It is productive

and will likely be found durable. Crops respond to applications of nitrates, but with other fertilizer ingredients no marked effect has been noted. As yet, experiments with commercial fertilizers have not been carried to the point where definite conclusions as to their merits can be drawn. Additions of manure will meet with ready response in increased yields, probably of all crops.

Potatoes, oats, barley, rye, wheat, and a number of forage crops and vegetables have been and are being successfully grown at the Rampart experiment station.

The tables below give the results and average results of mechanical analyses of samples of the soil and subsoil of the Rampart silt loam.

Mechanical analyses of Rampart silt loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590164	Rampart experiment station, edge of bench back of superintendent's residence.	Soil, brown silt loam, 0 to 12 inches.	0.2	0.4	0.4	1.4	11.2	77.8	8.3
590165	.....do.....	Subsoil, light-brown silt loam, 12 to 36 inches.	.0	.2	.3	.6	17.7	74.0	7.2
590166	Rampart experiment station, foot of bench near superintendent's residence.	Soil, black mucky silt loam, 0 to 8 inches.	.4	1.2	1.3	3.2	7.2	76.6	10.0
590167	.....do.....	Subsoil, brown silt loam, 8 to 36 inches.	.1	.2	.2	.6	5.0	86.3	7.7

Average mechanical analyses of Rampart silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
590164, 590166.....	Soil.....	0.3	0.8	0.8	2.3	9.2	77.2	9.1
590165, 590167.....	Subsoil.....	.1	.2	.2	.6	11.3	80.1	7.4

YUKON SILT LOAM.

The typical Yukon silt loam is a brown to dark-brown mellow silt loam, underlain at about 8 to 12 inches by light-brown loamy fine sand or loamy very fine sand to fine sandy loam. Some fine particles of mica are disseminated through the soil section. In the more poorly drained places back from the stream there is a covering

of black muck or mucky silt loam to a depth of 3 to 5 inches or more. In these places the soil beneath the mucky layer is of a very dark brown to bluish or mottled color, and the subsoil is mottled yellowish brown, greenish brown, gray, and drab. This phase of the type exists on the flats at the Rampart experiment station. On the other hand, the color of the soil inclines to grayish in those places where the drainage is well established, as, for example, at a woodyard on the north side of the Yukon, about 150 miles above Rampart.

The soil resembles the Tanana silt loam closely, but the samples collected are not acid (see lime-requirement determinations, p. 173), whereas the Tanana silt loam is acid to some degree.

Where timbered, ice was commonly found between 24 and 36 inches, in the middle of September, before freezing from the surface had begun.

The timber growth is mainly spruce. Some of this is of large size, 20 to 24 inches or more in diameter. Mixed with this are some alder and willow, and in places cottonwood and birch. Redtop flourishes in the open places and slough grass is abundant in the wet depressions.

The proportion of the Yukon bottoms occupied by this type could not be determined, but it is not improbable that it has an extensive occurrence here. If the Yukon Flats are ever brought into cultivation on an important scale, this soil very likely will be found to be the best type. The mucky phase may require some drainage, but this can be easily accomplished, as natural drainage outlets are close by and the soil material is very easily handled. The lower-lying portions near the streams are subject to overflow.

Grain for hay has been successfully grown on this type at the Rampart station, and potatoes and vegetables are produced in a small way in a number of places. Native grasses do very well.

The table following gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Yukon silt loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590169	Yukon Flats, about 150 miles above Rampart on north side of river.	Soil, grayish silt loam, 0 to 8 inches.	1.2	2.8	2.3	3.4	3.2	67.0	20.0
590170	.....do.....	Subsoil, brown fine sandy loam, 8 to 26 inches.	.2	.6	1.2	25.9	32.2	34.6	5.1

YUKON FINE SAND.

The Yukon fine sand was seen in several places in the Yukon bottoms. It is probably the dominant soil of the numerous islands that have been formed by the splitting of the river into many channels—the prevailing condition of the stream through the Yukon Flats. A considerable part of the type is subject to overflow.

The soil is a dark-brown to grayish-brown loamy fine sand, underlain by grayish fine sand or grayish loamy fine sand. It is mostly covered with willow and alder. Under cultivation the type would probably prove rather droughty. Grain for hay and vegetables would do fairly well with sufficient rainfall.

OTHER SOILS OF THE YUKON BOTTOMS.

Yukon very fine sandy loam, very fine sand, and Muck were seen in small patches. The very fine sandy loam and very fine sand conform with the essential characteristics of the Yukon silt loam and fine sand, except in texture. No estimate as to the relative extent of these types could be made, owing to the restricted nature of the investigations made in this section. The Muck conforms with that of the Tanana bottoms. This material also was seen only in a very small area.

AGRICULTURE.

At the Rampart experiment station, which is situated on both the bench land (Rampart silt loam) and alluvial land (Yukon silt loam), best results have been obtained on the bench soils. Here a number of varieties of grain and forage plants have been tried. Several varieties of oats, barley, rye, and wheat have been repeatedly matured, and seed produced from hardy alfalfa. Also, potatoes and other vegetables are successfully grown. For a more complete account of the excellent work accomplished on this farm, see the annual reports of the Alaska Agricultural Experiment Stations.

Very little farming has been attempted on the Yukon Flats. Some vegetables are grown here and there, and redtop and slough grass are cut for hay. These soils probably have the same crop adaptation as the Tanana soils, although the climate may restrict production here to a narrower range. Grain hay would succeed over most of the bottoms and large quantities of the native grasses—redtop and slough grass—could be harvested. By growing these crops with such legumes as may be adapted to the region and harvesting the native grasses, an abundance of feed could be obtained for the sustenance of stock. The most promising outlook for this region is the type of agriculture which will be centered about stock raising and dairying.

Above the Yukon Flats farming is carried on in a number of places along the river. At Eagle, for example, oats and barley are grown for hay, and the usual Alaskan vegetables, including potatoes, cab-

bage, turnips, carrots, etc., are successfully produced. Hogs, cattle, and chickens are raised on a farm about one-half mile above Eagle. Milk, butter, eggs, and some beef are produced on this farm and sold at the village of Eagle.

At Dawson a dairy farm with about 30 acres of land under cultivation is operated on the bench land on the west side of the river. Cattle (see Pl. XXXVII, fig. 2), hogs, and poultry are raised here, largely upon products grown on the farm, including grain hay from oats, barley, and rye, and root-crop forage, carrots, potatoes, beets, and turnips. There were about 50 hogs, Berkshire and Chester White, 9 cows, 2 bulls, and several calves and yearlings on this farm at the time the writer visited it in September of this year (1914). The chickens were of the Black Minorca, Wyandotte, and Plymouth Rock breeds. All of the live stock and poultry were doing as well as could be expected anywhere. Milk was being sold at Dawson at 25 cents a quart, and eggs at $1.25 a dozen.

SUMMARY.

The region comprising the bottoms of the lower Tanana River, the highlands to the north, and the bottoms of the Yukon River north of this embraces a large area of agricultural land, including considerable areas of the best farming soil seen in Alaska, and very large tracts of fair to good agricultural soil.

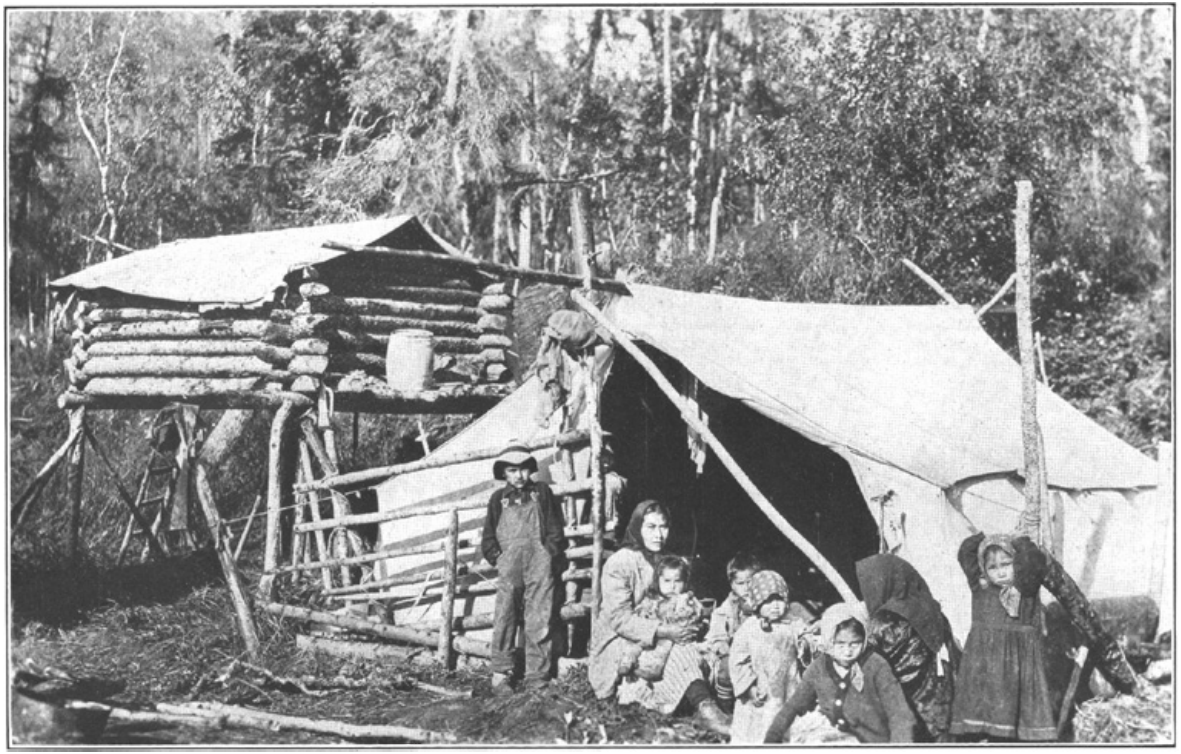
The lowest estimated area of available farming land in this region is 4,500,000 acres. In this estimate only 50 per cent of the 7,000 square miles of the lower Tanana bottoms is included and less than 25 per cent of the uplands lying to the north of the Tanana River. In the sections seen the proportion of farming land was larger than this, and it is probable the figures given fall short of the actual area of arable land. In this estimate the large area in the Yukon bottoms was not taken into account because of its northerly latitude, yet it is recognized that farming is possible in these Yukon Flats.

In the Tanana bottoms the soils are mainly sandy and silty. They are flat, mostly well drained, easy to cultivate, and are easily cleared. It would be a simple matter to drain the wet lands occurring in these bottoms. Those that are not well drained produce much good grass.

On these soils good crops of vegetables and grain hay are produced. Immense quantities of hay and good grazing can be derived from the native grasses which thrive on these soils. In addition, large quantities of grain hay and root-crop forage can be easily grown.

Potatoes from the Tanana bottom soils do not have so good reputation for quality as those grown on the southerly slopes of the hill tcountry to the north, but with proper management the early varieties give a product of at least fairly good quality. All potatoes which do not come up to the desired standard for the table could be used for stock feed.

A RESIDENCE AND YARD, FAIRBANKS.



AN INDIAN FISHING CAMP ON THE TANANA RIVER, AUGUST, 1914.

In summer many of these peaceful natives leave the villages and establish along the navigable streams camps from which they hunt, fish, and gather wild berries.

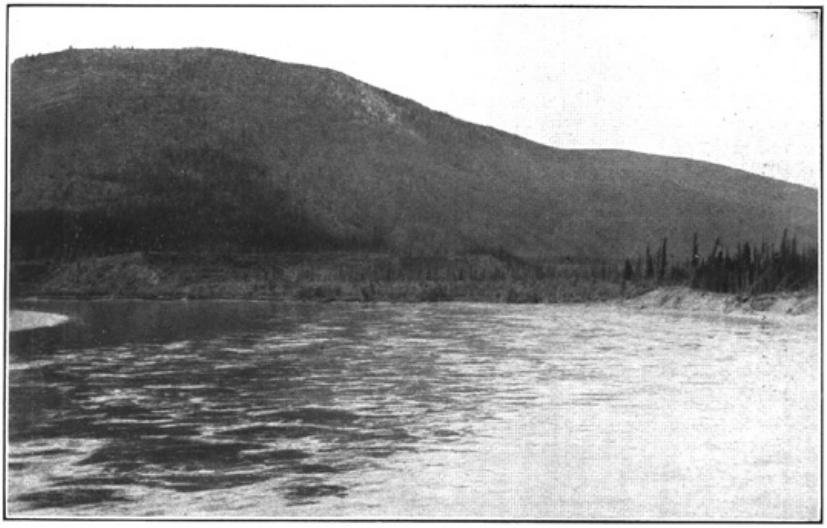


FIG. 1.—TERRACES AND MOUNTAIN SLOPE ALONG UPPER YUKON RIVER IN YUKON TERRITORY, ABOVE SELKIRK.

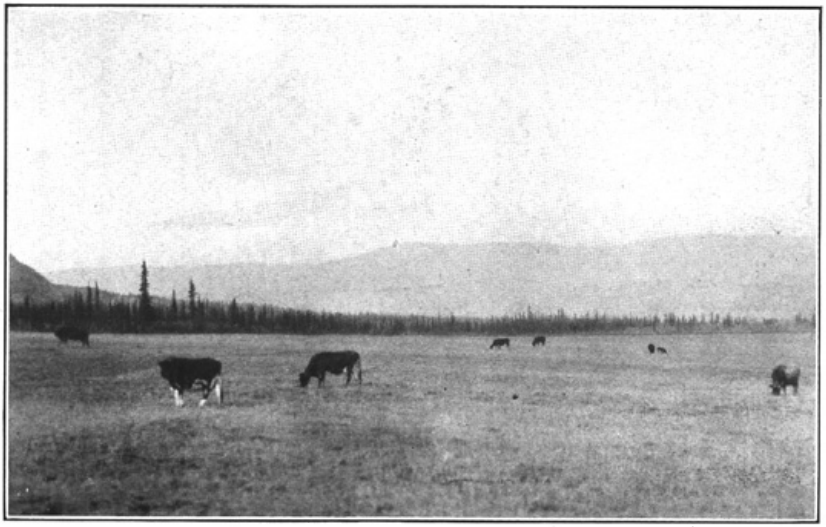
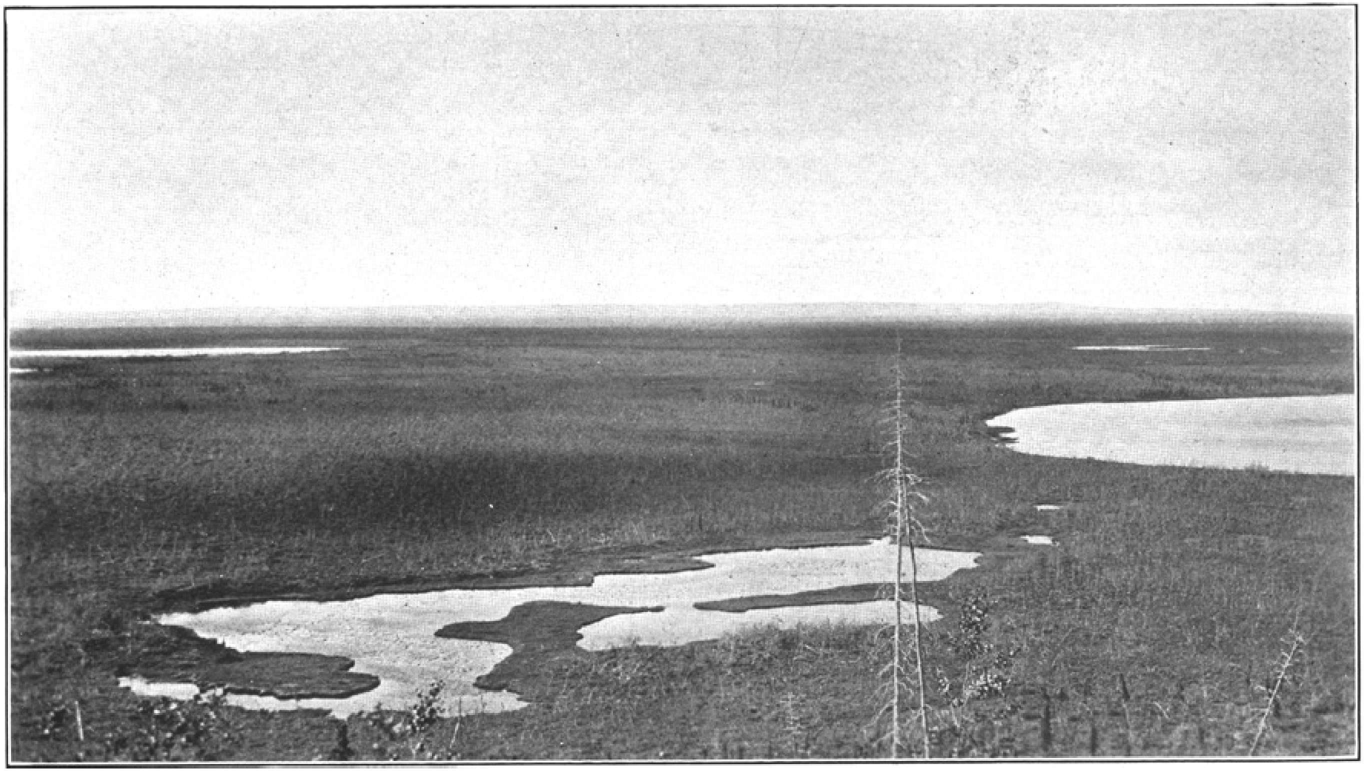


FIG. 2.—CATTLE AT FAULKNER'S DAIRY FARM NEAR DAWSON, YUKON TERRITORY, ON THE WEST SIDE OF THE YUKON RIVER, SEPTEMBER 24, 1914.

This is in the Klondike region.



CHARACTERISTIC SURFACE FEATURES OF THE COPPER RIVER BASIN.

Looking west from hill near Meiers Road House on Valdez-Fairbanks Road.

In the hills north of the Tanana bottoms is found the best soil seen in Alaska. This is a deep, mellow silt loam (Fairbanks silt loam) having good drainage and moisture-holding capacity. It occurs on the lower slopes, and is largely susceptible of easy cultivation. There are approximately a half million acres of this valuable soil. This type of soil is the same as that at the Fairbanks experiment station, where such good results have been had with grains and potatoes. On the southward-facing slopes it yields over 200 bushels of potatoes per acre, without fertilization. Early varieties of oats and barley mature in normal years. Wheat and rye also have matured at the Rampart and Fairbanks stations. All varieties of grain give good yields of hay on this soil, even in years of early frost. Turnips, cabbage, beets, carrots, lettuce, celery, and several other vegetables are grown with unusual success, both as regards quality and yield. Native redtop grass springs up quickly immediately following the removal of timber.

There are still larger areas of other cultivable soils on the slopes of the hill country. These are not so deep as the Fairbanks silt loam, but they produce good crops of excellent potatoes, various vegetables, grain, and grass. Probably 1,500,000 acres of such land exists in the country between the Tanana and Yukon Rivers. Other soils of agricultural possibilities are found in the bottoms of the small streams and on the bench lands of the region.

The winters of this portion of Alaska are colder than those of the Cook Inlet region, while the summers are somewhat warmer. The mean summer temperature at Rampart, according to 7 years' observations, is 58° F. The minimum temperature here is −68° F. and the maximum 96° F. The mean annual rainfall is 10.35 inches, about two-fifths of which falls in the growing season. The snowfall is 53 inches. Evaporation is light and rain falls so slowly that a very large proportion is absorbed by the soil. A large part of the melting snow also is taken up by the soil and conserved for later use by plants. The growing season covers the period from about the last of May to about the first of September. The long duration of summer daylight has the effect of lengthening the growing period considerably.

The occurrence of ice within 1 foot to 3 or 4 feet of the surface is very common in the soils of this region, particularly on northerly slopes and in those places where there is a covering of moss, peat or muck. The presence of this ground frost, however, is of no important consequence, since it melts rapidly when the land is cleared, its level dropping below the zone of root development. Actual benefits have been claimed from its presence, by the moisture supplied crops in dry seasons.

In view of the fact that the early varieties of grain, particularly oats and barley, mature in normal seasons, and that all varieties pro-

duce good yields of hay, coupled with the possibility of a large production of native hay, it is evident the region can support large numbers of cattle and other live stock.

There are several dairies at which cattle have been successfully raised and milk and butter produced in a very satisfactory way. The raising of hogs in a small way has met with success throughout the region. Success has also attended the raising of chickens and ducks. No attempts have been made to raise sheep and goats, but it is possible that some breeds would thrive here.

The past summer a large quantity of native hay was cut for horse and cattle feed. Probably enough potatoes were grown in the Fairbanks district this year (1914) to supply the population there. Considering the crop possibilities of the large extent of farming land, the region is obviously capable of supporting a very much larger population. Already a considerable number of farms are being successfully operated, producing vegetables and potatoes for home use and sale and native grass and grain hay for stock. With cheaper and better transportation facilities and larger market outlets an increased number of homesteaders will take up lands, and it is believed the region will be brought gradually to a place of considerable farming importance. The most promising line of agriculture seems to be the production of grain, hay, and root crops as a basis for dairying and stock raising.

It must be borne in mind, however, that in emigrating to this region without some prior knowledge of the conditions and without sufficient capital to provide the necessary farm equipment and the supplies which will be needed through a period required for getting land into condition for crop production, the prospective farmer runs the risk of meeting with disappointment or failure. If a successful agriculture of important proportions is to be built up here, apparently it will be accomplished slowly and by those who are able and willing to await slow returns beyond the production of those food products required for the sustenance of the family and the live stock. Further development of the mineral industries will mean an enlarged home market for farm products, and upon these local markets the sale of products will depend very largely, at least for the near future. The profitable exportation of farm products will depend upon the cost of production and transportation. With the building of railroads and highways and the establishment of cheaper transportation to outside markets it may be found possible to ship out certain products, as butter and cheese. Before this point is reached there may be a considerably larger home market than at present exists, resulting from railway construction and mining developments.

PART III.—COPPER RIVER REGIONS.

COPPER RIVER BASIN.

Description of the Area.

The Copper River Basin, or Copper River Plateau, is a broad expanse of plainlike country almost completely inclosed by mountains. It is bordered on the north by the Alaska Range, on the west by the Talkeetna Mountains, on the south by the Chugach Mountains, and on the east by the Wrangell Mountains. (See Pls. A and B.)

Copper River and its tributaries, Tazlina, Gulkana, and Gakona Rivers and other streams carry the principal drainage, all that of the eastern and southern portions of the basin; the Susitna and Chulitna Rivers take that of the western portion, while the Delta River receives some of the drainage from the northern part. There are considerable portions of the plainlike floor of the basin which are not traversed by drainage ways, and consequently much of the land is imperfectly drained.

To quote from The Geography and Geology of Alaska, by Prof. A. H. Brooks:

> The basin floor has a monotonous lack of relief, which contrasts strongly with the rugged mountains encircling it. At the escarpment of the eastern margin where it falls off to the Copper River it stands about 2,000 feet above sea level, but it rises gently to the west to an altitude of about 3,000 feet at the divide. This topographic feature is, in fact, a plateau built up largely of Pleistocene deposits, deeply dissected near its margin and called the Copper River Plateau by Mendenhall, who was the first to describe it. While it is usually an almost unbroken plain it is varied in places by hills and small groups of mountains and is dotted with small lakes.[1]

The center of the basin is about half way between Cordova and Fairbanks or about 160 miles north of Cordova. The writer crossed it along the Valdez-Fairbanks wagon road from Chitina. This road follows closely along Copper River by Lower Tonsina and Willow Creek Road Houses and Copper Center to Gulkana; from there along the Gulkana River to Sourdough Road House, where it takes a northerly direction and finally leaves the basin floor near Hogan's telegraph station and continues through mountainous country by

[1] Brooks, A. H., The Geography and Geology of Alaska. Professional Paper No. 45, U. S. Geol. Survey, p. 54. See also Headwater Regions of Gulkana and Susitna Rivers, Alaska: Bul. No. 498, U. S. Geol. Survey; and Mineral Resources of the Kotsina-Chitina Region, Alaska: Bul. No. 374, U. S. Geol. Survey.

Gulkana and Summit Lakes and down Delta River to the Tanana bottoms.

The Copper River Basin embraces a vast extent of land prevailingly of nearly level surface comprising mixed treeless, grassy areas and wooded areas. (See Pl. XXXVIII.) The timber is mostly small or scrubby, and consists of spruce, birch, and aspen, with an undergrowth of Hudson Bay tea, blueberry, dwarf birch, dwarf willow, sphagnum moss, and bunch grass. In some of the lower flats having imperfect drainage there are groves of fair-sized spruce, along with birch, alder, and willow. Small lakes are numerous and there are some of considerable size. The treeless areas, which apparently make up more than half the land area, are covered with bunch and other grasses, sphagnum moss, arctic moss, and a heather growth of Hudson Bay tea, blueberry, dwarf birch, scrub willow, and other shrubs.

Soils.

From the vicinity of Copper Center to Hogan's telegraph station, on the north side of the basin, the soil is predominantly a black muck to mucky loam, underlain by gray or drab stiff silty clay. In many places the clay comes within a few inches of the surface—near enough to be within the limits of ordinary plowing. On the other hand, there are many places where the surface soil consists of silt loam, loam, or muck 6 to 10 inches deep or more. In the imperfectly drained flats and depressions, for example, there is usually 6 to 10 inches of black mucky silt loam or muck overlying the stiff clay. There is very much more clay in the subsoil of this region than was found in either the Cook Inlet-Susitna or the Yukon-Tanana regions.

The extent of stream-bottom soils in this basin is relatively small. There are, however, some strips of considerable local importance, such as in the bottoms of Copper River at Copper Center, for example. The principal type is a brown silt loam to which the name Klutina silt loam is given.

COPPER RIVER CLAY.

The typical Copper River clay is a black mucky loam or mucky silt loam, underlain at about 2 to 5 inches by gray or drab stiff silty clay. In the associated depressions and more poorly drained flats the mucky surface soil averages deeper, in some places extending to a depth of 10 to 15 inches.

The clay subsoil of this type is stiff and intractable and apparently is rather impervious to air and water. Where it comes within reach of the plow it would probably be difficult to keep the soil in a good state of tilth, and heavy teams and tools would be required for its efficient tillage. If plowed when wet, the clay would likely puddle

in such a way that upon drying troublesome clods would be formed by any subsequent cultivation. Heavy clay soils of this character are generally slow to warm up, and on this account the growth of crops upon them is usually retarded.

In a few places gravel and sand were found in the subsoil. About 6 miles east of Gulkana the soil is a black mucky silt loam to an average depth of about 4 or 5 inches, while the subsoil is a drab to gray plastic silty clay, with strata or pockets of fine sand occurring within the 3-foot section. In some places, also, sand occurs at the surface.

Hummocks and slight depressions are not uncommon, but the surface is characteristically nearly level. The streams are fringed by rather narrow bottoms of brownish to black silt loam, loam, sandy loam, and gravelly alluvial soils, the silt loam appearing to be largely predominant. These bottoms are bordered usually by steep escarpments, rising abruptly to the general level of the basin floor, in places approximating 200 feet in height.

The Copper River clay appears to be far more abundant than any other soil in this region, but there are associated bodies of Muck and Copper River silt loam.

The growth consists principally of low scrub spruce, except in some localities where the soil is of rather mucky character, where the trees attain a fairly large size. These timbered areas are interspersed with treeless areas which support a heather growth of Hudson Bay tea, scrub willow, and dwarf birch, mosses, blueberry, and bunch grass. Aspen of rather small size occurs in thick growth in a good many places.

On account of the dense character of the soil the internal circulation of air and moisture is necessarily slow. The drainage of many areas is imperfectly established. Ice is present within less than 3 feet of the surface in many places.

No crops were seen growing on this type. It is not believed that this soil will prove very valuable for agriculture, owing to its unfavorable physical properties. It is probable that grain hay could be produced, but it is doubtful whether even the earliest varieties could be matured in normal seasons. Some farming is done within the limits of the type, but this is confined principally to the associated alluvial soils, such as those at Copper Center. The silt loam can be handled much easier than the clay type, and it has been used for farming to some extent southwest of Copper Center on the Valdez-Fairbanks trail.

The Copper River clay is only moderately acid. Lime-requirement determinations showed that the clay of sample No. 590139 required 4 tons of calcium carbonate to neutralize the material of an acre-foot.

The following tables give the results of chemical and mechanical analyses of samples of the soil and subsoil of the Copper River clay:

Chemical analyses of a representative sample of an important soil of the Copper River basin, Alaska—Fusion analysis.

Soil type and section.	No. of sample.	Location of samples.	K_2O.	P_2O_5.	N.	CaO.	MgO.
Copper River clay:							
Soil	590138	1 mile west Hogan's station.	.26	0.26	0.65	1.38	3.26
Subsoil	590139	do	1.60	.03	.15	1.25	1.93

Mechanical analyses of Copper River clay.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
590136	About 6 miles northeast of Gulkana.	Soil, black mucky loam, 0 to 5 inches.	0.2	1.7	2.2	5.5	20.8	54.4	15.2
590137	do	Subsoil, drab clay, 5 to 15 inches.	1.2	1.6	1.4	7.2	21.0	36.9	31.0
590138	About 1 mile west of Hogan's telegraph station.	Soil, black mucky loam, 0 to 5 inches.	.7	8.2	2.2	7.0	6.3	41.2	34.3
590139	do	Subsoil, drab clay, 5 to 36 inches.	1.2	1.8	1.4	4.6	6.2	51.0	33.9

Average mechanical analyses of Copper River clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
590136, 590138	Soil	0.4	4.9	2.2	6.2	13.5	47.8	24.8
590137, 590139	Subsoil	1.2	1.7	1.4	5.9	13.6	43.9	32.4

COPPER RIVER SILT LOAM.

Beginning on the bench just north of Lower Tonsina Road House and extending to the vicinity of Copper Center along the Valdez-Fairbanks road, the Copper River silt loam is predominantly a brown or dark-brown to black silt loam, which passes at about 6 to 12 inches into brown silt loam, which in turn at about 8 to 24 inches grades into gray or drab stiff silty clay. Ice is present within the 3-foot section of much of the land in late summer. Sand, fine sand, and gravel are found in the subsoil of some areas. Also, spots of Muck and Copper River clay are associated with the type.

Most of the Copper River silt loam to the southwest of Copper Center is forested. The principal growth is spruce and aspen, the forest varying from almost pure spruce through mixed spruce and aspen to pure aspen. Many of the spruce trees are 10 inches or more in diameter. Willow, birch, and alder are present in places.

At Willow Creek Road House the soil of a cultivated field was found to consist of brown silt loam, underlain at about 8 to 10 inches by light-gray to drab stiff silty clay, while in a near-by area covered with small aspen and willow the brown silt loam was underlain at about 8 inches by a grayish mixture of sand, gravel, and clay. In the field here oats were heading out well on the 22d of August of this year (1914). Native hay was being mowed from the margins of the small lakes occurring around this place. Some horses and cows are kept here. Vegetables, including turnips, cabbage, and garden peas, were doing well. At Woodland Road House, between Lower Tonsina and Willow Creek Road Houses, lettuce, turnips, cabbage, beets, radishes, carrots, and other vegetables were being successfully grown on this type. Oats and barley also were reported as having succeeded here.

With the exception of the stream-bottom lands this is the best farming soil in the Copper River Basin, according to the investigations made; but, unfortunately, the type appears to be not nearly so extensive as the Copper River clay. It is an easy soil to work, and its cultivation will not require especially heavy teams or implements.

KLUTINA SILT LOAM.

The Klutina silt loam consists of a brown to dark-brown mellow silt loam about 6 to 10 inches deep, overlying grayish silt loam or silty clay loam, which either changes but little within the 3-foot section or grades into loamy fine sand. Patches of fine sand, loam, and gravelly soil are associated with the type.

The most extensive area seen was at Copper Center. It was on this soil that a considerable part of the Copper Center experiment station was located. Good crops of oats, barley, Canada field peas, and potatoes were seen on this type at this village. A number of vegetables also were doing well. Cows have been successfully kept at this place.

AGRICULTURE.

The predominant soil of the Copper River Basin, as judged by the country seen, is the Copper River clay, which is not believed to represent good farming land, on account of the stiff character and cold nature of the clay which lies so near the surface. This land was nowhere seen under cultivation, and it is therefore impossible to give a positive measure of its agricultural value, but on soils of this character crops generally are inclined to make slow growth, owing to the imperviousness and cold nature of the soil. Furthermore, the

tillage of such land can not be performed satisfactorily, except with strong teams and implements and at a time when the material is not wet enough to be puddled by stirring or dry enough to have a hard, intractable structure.

In looking across the floor of the Copper River Basin there appears to be much wet land. The drainage of these areas necessary to bring them into condition for cultivation probably would be costly, especially in those sections where drainage outlets are scarce.

Owing to the unfavorable physical quality of the dominant soil and the imperfect drainage of many other areas, together with the rather short season at this elevation, the Copper River Basin, at least that portion seen, is not considered so promising for farming as either the Cook Inlet-Susitna or the Yukon-Tanana regions. Crops can be successfully grown here, however, especially on the Copper River silt loam and the alluvial soils. Grain for hay can be produced on such lands, and potatoes and vegetables give fair to good results. Whether the clay land can be economically used in the production of grain hay it is impossible to say, but it is certain that considerably more expense would be attached to the cultivation of such land than of soils possessing a more favorable texture and structure.

Potatoes and various other vegetables are grown, and hay is made from grains and the native grasses on the better soils at several road houses along the Valdez-Fairbanks road between Chitina and the northern edge of the basin. Some poultry and cattle are raised and horses are kept at some of the road houses. There is said to be a good farm ranch at Gulkana, on the Mentasta trail.

Good farm land is said to lie about the headwaters of Copper River and at places along Chitina River. There is said to be especially good pasturage on the upper Copper. Wild pea, valuable for grazing, is reported to grow plentifully in places along Klutina River.

It is believed that the most promising line of agriculture would center about stock raising or dairying. It has been shown by experience that cattle and horses get along very well, and that chickens and ducks can be successfully raised.

An experiment station was operated at Copper Center from 1902 to 1908, and several varieties of grain were matured here, although three crops out of six are said to have been failures on account of unseasonable weather. The results of the work carried on at this station are given in the annual reports of the Alaska Agricultural Experiment Stations for the years 1902 to 1908, inclusive.

Climate.

The table below gives the mean temperature and precipitation and the maximum and minimum temperatures recorded at Copper Center over a period of 9 years. Unseasonable frost seems to be of rather

frequent occurrence here, according to the experience of the experiment station. During the last year the work was carried on, for example, frosts occurred every month in the year. On the 22d of July tender vegetables were killed and grain and the hardy vegetables were injured. The average season of this region, however, will likely prove satisfactory for the production of vegetables and grain, at least for a sufficient growth of grain to make hay.

Normal monthly, seasonal, and annual temperature and precipitation at Copper Center.

[Length of record, 9 years.]

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Mean snowfall, unmelted.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	− 3.3	50	−53	0.54	0.70	0.35	7.7
January	−12.3	49	−74	.66	.45	1.14	7.4
February	− .1	49	−55	.55	.25	.19	3.2
Winter	− 5.2			1.75	1.40	1.68	18.3
March	12.9	48	−48	.26	.05	.69	2.8
April	28.5	59	−26	.09	.10	.36	.8
May	44.1	80	18	.50	.13	.43	Trace.
Spring	28.5			.85	.28	1.48	3.6
June	53.0	96	22	.78	.27	1.19	0
July	55.3	88	22	1.70	1.83	2.14	0
August	52.7	87	20	1.15	.65	.69	0
Summer	53.7			3.63	2.75	4.02	0
September	41.9	80	3	.94	.78	.37	.8
October	27.9	66	−26	1.07	1.15	.84	8.6
November	4.4	49	−46	.60	.10	.99	5.8
Fall	24.7			2.61	2.03	2.20	15.2
Year	25.4	96	−74	8.84	6.46	9.38	37.1

COPPER RIVER DELTA.

Copper River enters the Pacific Ocean a short distance northwest of Controller Bay, through a labyrinth of channels, dividing and reuniting to form an interminable network of passages, "sloughs," with almost countless intervening islands and bars. The low, flat delta through which these numerous distributaries flow is somewhat triangular in shape, with its apex about 30 miles inland, between the fronts of Childs and Miles Glaciers. On the east side there is a great branch, the broad delta plain of Martin River extending to the face of Martin River Glacier. The base of this triangle, fronting upon the

ocean, has a length of approximately 30 miles, stretching from the mouth of Martin River to the mouth of Alaganik Slough. Including the strip of coastal delta, formed by the outwash from the Scott, Sherman, and Sheridan Glaciers, with which it merges and continues, uniformly, practically to Eyak Lake, near Cordova, this great delta fronts upon the ocean with a shore line about 50 miles long.

At intervals the Copper River Delta is inundated in part or largely by the enormous volume of water liberated by the bursting out of impounded water in the great tributary glaciers. The Copper River itself frequently overflows much of the lower delta. This lower delta is in the main virtually a swamp, since most of the land between the water passages is covered with water [1] much of the time and supports a growth of water-loving plants.

The soil, if it can be called such, represents a mixture of the recent glacial outwash, chiefly gravel and sand, with the sand and silt of the Copper River alluvium. During summer the glaciers are continually discharging large quantities of material, while the Copper River rarely ceases at this season to spread out its great burden of sand and silt. There are in places near the banks of the principal channels sand dunes, the shifting of which by wind has necessitated the construction of long sheds to cover threatened portions of the Copper River & Northwestern Railway track.

Practically the entire delta is unsuited to agriculture, owing to the poor drainage, the liability to disastrous floods, and the inferior character of the soil. Near the glacier fronts the glacial plains, covered with freshly discharged glacial débris, are mostly bare of vegetation, but farther away there is much alder and scrub willow and a variety of water-loving grasses.

SUMMARY.

There is a large extent of country in the upper Copper River Basin, northward from the vicinity of Copper Center, which has a quite favorable topography for agricultural operations. The principal soil here, however, is not so favorable, being predominantly of a clayey character, and so stiff and probably cold-natured that it would be difficult to till and crops likely would be slow to reach maturity on it. Heavy teams and tools would be required to work such land. Furthermore, the climate of the region appears to be not so favorable as that of either the Cook Inlet-Susitna or the Yukon-Tanana regions. Vegetables and grain hay, however, are being successfully grown on the bottom-land soils and the more loamy types of the uplands. Some cattle have been raised at various places in the region along the Valdez-Fairbanks road. Stock raising and dairying would likely be found the most remunerative types of farming.

[1] See Reconnoissance map of Chitina Quadrangle, Copper River Region, Alaska, published by the U. S. Geological Survey.

PART IV.—COMPARISON OF ALASKA WITH FINLAND AND PARTS OF SIBERIA.

COMPARISON WITH FINLAND.

The latitude of Finland and Alaska is practically identical; both are largely included between the parallels 58° and 70° of north latitude. The climate at the same latitude appears to be very similar for the two countries; that is, in localities of comparable physiographic situation and location with respect to bodies of water having a modifying influence upon temperatures.

A line drawn from the head of the Gulf of Bothnia to the eastern coast of Lake Ladoga approximately divides Finland into two distinct parts: A southern part, the lake region, and a northern part, or hill region, belonging to the plateau which extends into Archangel toward the White Sea. The northern division is much more sparsely inhabited and is colder than the southern division.

The absolute maximum and minimum temperatures [1] for Helsingfors, in southern Finland, on the Gulf of Finland, at 60° 10′ north latitude, are 87° F. and —25° F.,[2] respectively, while the corresponding temperatures for Seward, Alaska, on Resurrection Bay, at 60° north latitude, are 85° F. and —12° F. The climate of the latter point is moderated by the warm Pacific waters. The minimum temperatures for much of the southern seaboard of Alaska are even higher than that of Seward. The minimum temperature recorded at Sitka, for example, is only 4 degrees below zero. Thousands of miles of the Alaska coast line along the southern mainland coast, the Alaska Peninsula, and the Aleutian Islands are exposed to the warm waters of the Pacific, while the much smaller southern and western seaboards of Finland are contiguous to colder seas, the Gulfs of Bothnia and Finland. The corresponding northern portions of the two countries are climatically much the same.

The higher limit of temperature for the greater part of Finland is about 86° F. to 95° F. It is only on the mainland and in the high-

[1] Unfortunately the basis of recording temperatures in Russia and the United States is different; in the former country the daily mean temperatures represent the "average of three daily observations taken at 7 a. m., 2 p. m., and 9 p. m. (Statistisk Årsbok för Finland, 1912), while in the United States the daily means represent the average of the coldest and highest temperatures recorded during the 24 hours. Notwithstanding this difference of compilation the results are not without value for comparison.

[2] H. Wild, in Petermann's Mittheilungen, 1881, p. 282.

lands that the temperature falls to —40° F. to —49° F. Maximum and minimum temperatures for the northern portion of the country could not be procured. The annual mean temperature ranges from about 28° F. to 41° F., while the monthly means range from 5° F. to 25° F. in February, the coldest month, to 52° to 62.8° F. in July, the hottest month. Killing frosts occasionally occur in June, even in the southern and southwestern parts of the country. July is usually free from frosts, but temperatures of 41° F. to 46° F. are common, and frosts have at rare intervals occurred even in south Finland. On July 14, 1893, a severe frost occurred over central Finland, damaging and destroying rye and potatoes even in situations least exposed to frost. The first fall of snow ranges from September 30 in the northern part to October 30 in the extreme southern part. The snowfall ranges from 6 inches to 59 inches. The total mean annual precipitation ranges from 11.8 inches to 33.4 inches, being irregularly distributed according to latitude. Ice on lakes and sea breaks up from about March 31 in the extreme south to June 16 in the extreme north.[1] The precipitation for Alaska has a much wider range than that of Finland. The amount for the driest year at Copper Center, the driest Alaska station for which there are any considerable records, is 6.46 inches, while that for the wettest year at Fortman Salmon Hatchery, the station of heaviest precipitation, is 169.21 inches.[2]

The table below gives the mean monthly and annual temperatures at Uleaborg, Kuopio, Tammerfors and Helsingfors, for the period 1886–1900. These stations are at low altitudes, in situations apparently favorable to a moderated climate. Uleaborg and Helsingfors are situated on the coast, while Kuopio and Tammerfors are on the shores of lakes in the southern part of the country. Higher temperatures would be expected in less protected localities.

Mean monthly and annual temperatures at Uleaborg, Kuopio, Tammerfors, and Helsingfors for the period 1886–1900.[3]

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Uleaborg	14.4	12.6	18.9	32.9	45.0	56.1	61.3	56.8	46.9	36.1	26.6	18.1	35.6
Kuopio	14.7	13.5	20.3	34.3	46.9	57.0	62.1	57.4	47.6	37.8	28.0	19.2	36.9
Tammerfors	19.2	16.9	23.2	36.3	48.9	58.6	62.2	58.5	49.6	40.3	31.6	23.7	39.2
Helsingfors	21.7	19.0	24.1	36.3	48.9	58.6	62.8	59.9	51.1	41.9	33.8	26.4	40.5

[1] Atlas de Finlande, Société de Géographie de Finlande, 1910.

[2] See Annual Report of the Alaska Agricultural Experiment Stations for 1913.

[3] Statistisk Arsbok for Finland, 1912.

The table below gives the northern limits of production and of general production of the principal crops of Finland:

Approximate northern limits of cultivation and of general cultivation of the principal crops of Finland.[1]

Crop.	Northern limit of cultivation (north latitude).	Northern limit of general cultivation (north latitude).	Crop.	Northern limit of cultivation (north latitude).	Northern limit of general cultivation (north latitude).
	° ′	° ′		° ′	° ′
Rape	69 00	.....	Turnips	[2] 66 30	64 00
Barley	.....	68 30	Hemp	65 00	.....
Timothy	68 00	64 30	Flax	63 10	62 00
Potatoes	67 30	66 50	Peas	62 40	61 45
Rye	67 00	66 25	Cabbage	62 35	.....
Oats	66 45	65 00			

[1] Atlas de Finlande, Société de Geographie de Finlande, 1910. [2] Arctic Circle.

It will be noticed that a number of crops are grown at a considerable distance north of the Arctic Circle (66° 30′). Barley, for example, is generally grown as far north as 68° 30′ or 2° north of the Arctic Circle.

The area of Finland is 144,255 square miles.[1] About 7,000,000 acres were under cultivation and in improved meadow in 1901. There were 271,154 farms in 1901, and of these 106,462 were less than 7.5 acres in size.[2]

The figures given below, relative to crop production, the live-stock and dairy industries, and exports, are taken from a report of the consul general at Moscow, Russia.[3]

The production of the principal crops of the country for the year 1909 is given in the table following:

Production of leading crops in Finland for 1909.

Crop.	Yield.	Crop.	Yield.
Oats.....bushels..	19,759,488	Wheat.....bushels..	133,564
Rye.....do....	12,084,853	Meslin.....do....	536,078
Potatoes.....do....	19,226,108	Peas and beans.....do....	214,811
Turnips, etc.....do....	7,766,203	Flax and hemp.....pounds..	2,895,087
Barley.....do....	4,887,319		

The number of domestic animals for the year 1907 was as follows:

Cows	1,113,633	Swine	221,072
Young cattle	305,886	Horses and colts	327,817
Bulls and oxen	71,745	Goats	6,279
Sheep	904,447	Reindeer	133,749

[1] Stanford's Compendium of Geography and Travel: Europe.

[2] The Statesman's Year Book, 1914.

[3] Snodgrass, John H., Russia; A Handbook on Commercial and Industrial Conditions, Special Consular Report, Dept. of Commerce, No. 61, pp. 203 to 208.

In 1912 there were exported 36,473,993 pounds of butter. Of this, 16,565,221 pounds were shipped to Great Britain and the remainder to other countries. In addition, 2,021,158 pounds of cheese and 3,102,855 gallons of milk and cream were exported.

Other agricultural exports are insignificant in comparison with dairy products. Formerly the exportation of cereals attained notable figures (106,000 tons of oats and rye in 1888). Great attention is devoted to manufacturing and the fisheries are important.

Finland's principal exports in 1912 were: (1) wood, manufactures of wood, wood pulp, and paper, collectively, valued at $46,012,100, and (2) meat, game and dairy products, collectively, valued at $7,898,-500 The total exports of that year amounted to $65,133,100.

At the close of 1911 the population of Finland numbered 3,140,100. The greater part of the population, about 85 per cent, live outside the cities. The population of the chief cities for the year 1911 was as follows: Helsingfors, 147,218; Åbo, 49,691; Tammerfors, 45,442; Viborg, 27,508; Uleaborg, 19,802; Björneborg, 16,990; Nikolaistad, 21,879, and Kuopio, 15,845.[1] Helsingfors, Åbo, Tammerfors, and Viborg are between the parallels 60° and 61° north latitude; Björneborg is between 61° and 62°; Kuopio and Nikolaistad are between 63° and 64°, and Uleaborg is on the sixty-fifth parallel.

The available data bearing on the characteristics of the soils of Finland indicate that there is strong similarity between these soils and those of extensive occurrence in Alaska. Glinka says of the soils of this country:

> The Finland soils belong mainly to the podsol and moor (peaty) groups. The podsol soils are mainly coarse grained in texture and contain an abundance of glacial gravel and bowlders, and fine gravel. Sandy varieties (of podsol) are also very widely distributed.
>
> Of those soils which belong in the group of moor soils, both peat and *wiesenböden* [2] occur. Transition soils, intermediate in character between the podsol and moor soils, are abundant. In addition to these there are imperfectly developed residual soils derived directly from granite and gneiss." [3]

The typical podsol is strikingly similar to the Knik soils of the Cook Inlet-Susitna region. The moor soils are probably the same as or closely related to the Muskeg of the Cook Inlet-Susitna country and the Peat so widely distributed elsewhere in Alaska. The *wiesenböden* soils may be similar to certain dark soils (mucky soils) of the Alaska coast region or to the Goldstream soils of interior Alaska. The residual soils undoubtedly are much like those found in the highland between the Tanana and Yukon Rivers.

The soils of Finland, as judged from published descriptions, are similar to large areas of soils encountered in the regions investigated in this reconnoissance.

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[1] The Statesman's Year Book, 1914.

[2] Probably closely related to the Clyde soils occurring in the Lake region of the United States.

[3] Die Typen der Bodenbildung, pp. 244-245, by K. Glinka, Berlin, 1914.

SUMMARY.

In comparing Alaska with other countries of similar latitude and climate, a close relationship is found to Finland, a country of considerable agricultural importance, and also to portions of Siberia where farming has proved successful.

Finland and Alaska are largely included between the parallels 58° and 70° north latitude. Alaska is bordered on the north by the Arctic Ocean, and Finland nearly touches the Arctic.

The cultivated area in Finland comprises about 7,000,000 acres. In 1909 the country produced 19,759,488 bushels of oats, 12,084,853 bushels of rye, 4,887,319 bushels of barley, 19,226,108 bushels of potatoes, 7,766,203 bushels of turnips, and 2,895,087 pounds of flax and hemp. The number of the principal domestic animals in the country, as reported for the year 1907, is as follows: Cattle, 1,491,264; sheep, 904,447; swine, 221,072, and horses 327,817.

Finland exported in 1912 live animals, meat, game, and butter products, valued at $8,679,400, most of which was derived from butter; and $46,012,100 worth of wood, pulp, paper and manufactures of wood. In 1911 there were exported 36,473,993 pounds of butter and considerable quantities of cheese, milk, and cream.

COMPARISON WITH PARTS OF SIBERIA.

In portions of Siberia having a summer climate approximating that of the regions of Alaska considered in this report, farming operations are successfully carried on. In the Province of Amur, for example, agriculture has advanced to a place of considerable importance. Amur borders Manchuria on the north and is included between the forty-eighth and fifty-seventh parallels, north latitude. Although in a more southerly latitude than the Cook Inlet-Susitna region, there seems to be no great difference in the climate. Blagoveshchensk, a little south of the central part, has a mean summer (June, July, and August) temperature of 65.8° F. and a January mean of −16.6° F.,[1] and the mean annual precipitation is 20 inches, 10 inches of which falls during the summer months.[2]

Much of the country is mountainous, the cultivable lands lying in the valley of the Amur River. In 1911, on 649,574 acres of cultivated land, there were produced in this Province 3,206,566 bushels of wheat, 6,020,312 bushels of oats, 126,606 bushels of potatoes, and smaller quantities of other crops, chiefly rye, barley, buckwheat, and millet. The number of domestic animals in the Province that year was 263,096, including 111,943 horses, 82,701 cattle, 52,425 hogs, and smaller numbers of sheep and deer.[3]

[1] Petermann's Mittheilungen.

[2] The Industries of Siberia, translation by Crawford, v. 5.

[3] Jewell, John F., consul at Vladivostok, in Special Consular Report, Department of Commerce, No. 61: Russia; A Handbook on Commercial and Industrial Conditions.

The population of Blagoveshchensk on January 1, 1912, was 80,102.[1]

The Province of Yakútsk has extremely cold winters, but the summers, even as far north as the central part, are relatively mild, or about the same as at Rampart, Alaska. The production of grain and live stock in this Province is reported as having met with success, although the industries have not yet developed to any great importance.

Jewell says:

> Formerly the Province was regarded as unfit for agriculture, but recent investigations have proved otherwise. In 1912 three expeditions of the colonization department worked in the Province, investigating its capacity as a field for colonization, and their reports have established the fact that agriculture is not only possible but can be carried on with profit.
>
> At present agriculture is pursued in a small way, and wheat forms an important part of the diet of the population, including all of the natives. All Yakuts cultivate it * * *.
>
> Animal raising represents one of the most important occupations of the inhabitants of the Province, especially the natives, many of whom are nomads * * *. In 1911 the number of animals was 486,816, divided as follows: Horses, 113,314; cattle, 333,851 * * *. About 65 per cent of these animals are owned in the Yakútsk district and 20 per cent in the Viliuisk district.[2]

The Province of Yakútsk lies north of the fifty-fifth parallel, extending beyond the seventy-fifth, with a great length of shore line along the Arctic Ocean. Much of the northern part of this Province is tundra and the cold of winter is extreme. Yakútsk, which is in the latitude of Copper Center, Alaska, and the middle Susitna lowlands, has a mean summer temperature of 60° F. and a January mean of −45° F. The mean summer temperature here is milder than that of Copper Center, which is 53.7° F., while the winter is very much colder. Yakútsk had a population of 8,209 on January 1, 1912.[3]

In the Provinces of Irkútsk and Transbaikalia, in north latitude 49° to 62°, an agriculture of considerable importance has been established, but the conditions here probably are much more unlike those in Alaska than the more northerly and easterly Provinces, yet the winters are very cold. The summer and January means at the city of Irkútsk, on the fifty-second parallel, are 61.8° F. and −4.9° F., respectively.[4] Cattle raising and horse breeding represent the most important farm industries of Transbaikalia. In 1911 there were in this Province 570,630 horses, 983,530 cattle, 1,058,817 sheep, 114,105 goats, and 120,784 hogs.

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[1] The Statesman's Year Book, 1914.
[2] Special Consular Report, Department of Commerce, No. 61, p. 225.
[3] The Statesman's Year Book, 1914.
[4] Petermann's Mittheilungen.

The population of Irkútsk, at the end of 1911, was 108,060, while that at Chita, in Transbaikalia, at practically the same latitude, was 68,211.[1]

In recent years there has been a marked advance in the agriculture of Siberia. Increasing numbers of settlers have crossed the Urals into Asiatic Russia. The Imperial Government is encouraging the use of improved farm methods and implements, and land is being granted to settlers. In 1912 the board of emigration established 400,000 persons on land holdings. Expeditions have been made into the remote and thinly inhabited regions for the purpose of ascertaining the character and possibilities of the soils, and it appears that much is being done to promote settlement and to advance development in agriculture and other industries throughout the habitable portion of this vast territory,[2] much of which is as cold as or colder than Alaska.[3]

The most important farming is done in western Siberia in the belt of black land (chernozem) which extends through the Provinces of Transbaikalia, Irkútsk, and Tomsk, across the Province of Tobolsk, to and beyond the Ural Mountains. In this western region wheat is extensively grown and a considerable amount is exported. Also the production and exportation of butter has recently become an important industry.

Although the climate of much of this western portion of Siberia may be similar to that of interior Alaska, the black earth soils and plains topography are different. It is in the more easterly Provinces that the conditions appear to conform closest to those of Alaska.

Eastern Siberia is prevailingly mountainous, and it is only in the smoother valley regions back from the coast that agriculture is being developed extensively. Lumbering, mining, fishing, and trapping are the industries of the maritime Provinces.

The table below gives the monthly and annual means of temperature, with the absolute maximum and minimum, for the cities of Blagoveshchensk, Yakútsk, and Irkútsk. The data conform very closely with the isotherms shown in the late meteorological charts of Barthalomew's Physical Atlas.

Table of monthly and annual means of temperature, with absolute maximum and minimum, at Blagoveshchensk, Yakútsk, and Irkútsk.[4]

City.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Blagoveshchensk	−16.6	− 4.7	13.6	35.1	48.7	64.4	70.0	65.8
Yakútsk	−45.0	−35.1	−10.7	14.7	40.1	56.2	65.8	58.0
Irkútsk	− 4.9	2.1	16.9	36.3	48.6	58.5	65.8	61.2

[1] The Statesman's Year Book, 1914.

[2] The area of Siberia is given (The Statesman's Year Book, 1914) at 4,831,882 square miles, or more than one and one-half times the area of continental United States.

[3] Special Consular Report, Department of Commerce, No. 61, pp. 215–248.

[4] H. Wild, in Petermann's Mittheilungen, 1881, p. 282.

Table of monthly and annual means of temperature, with absolute maximum and minimum, at Blagoveshchensk, Yakútsk, and Irkútsk—Continued.

City.	Sept.	Oct.	Nov.	Dec.	Year.	Absolute maximum.	Absolute minimum.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Blagoveshchensk	52.3	34.5	7.9	−11.7	29.8	.....	.....
Yakútsk	42.1	15.6	−21.6	−40.9	11.8	101.8	−80.0
Irkútsk	49.1	33.8	12.9	.7	31.8	103.1	−45.0

SUMMARY.

The Province of Amur, Siberia, with a mean summer temperature of 65.8° F. and a summer precipitation of 10 inches, near the central part has a large production of wheat, oats, and potatoes, and raises cattle and hogs on an extensive scale. In the Province of Yakútsk wheat is successfully grown and stock raised. Stock raising is said to be successfully carried on in the vicinity of the city of Yakútsk, which is in the latitude of the middle Susitna lowlands of Alaska. Here the January mean is −45° F., the absolute minimum −80° F., and the summer mean 60° F., about that of Rampart, Alaska. These portions of Siberia are in the eastern mountainous belt, where the soils are probably similar to those of much of Alaska and the climate quite like that of the Alaska regions covered in this report, with the exception that the winters are perhaps colder and the summers a little milder than those of the corresponding latitudes of Alaska.

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[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.

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