University of Saskatchewan

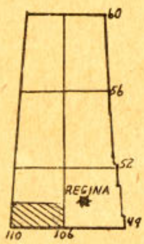
College of Agriculture

SOIL SURVEY

of

SOUTHWESTERN SASKATCHEWAN

FROM THE THIRD MERIDIAN ON THE EAST TO THE ALBERTA BOUNDARY ON THE WEST, AND FROM THE TOP OF TOWNSHIP 16 ON THE NORTH TO THE INTERNATIONAL BOUNDARY ON THE SOUTH



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DEPARTMENT OF SOILS

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SASKATOON, SASKATCHEWAN

June, 1931

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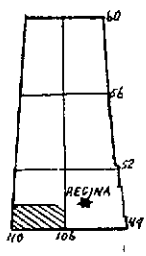

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(The Soil Maps are inserted inside the back cover)

Acknowledgment

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The Legislature of Saskatchewan for a special vote appropriating funds to the University of Saskatchewan for soil survey operations and the publication of reports and maps.

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The Topographical Surveys Branch of the Department of Interior, Ottawa, for supplying topographical base maps and for printing the soil maps.

Various members of the staff of the University of Saskatchewan for useful information regarding matters discussed in the report and related to their respective fields of work.

Farmers and municipality officers in the surveyed area, and the staff of the Dominion Experimental Station at Swift Current, for information regarding agricultural practices in Southwestern Saskatchewan.

PREFACE

THE Saskatchewan Soil Survey is conducted by the Department of Soils, University of Saskatchewan, Saskatoon, in co-operation with the Provincial Department of Agriculture, Regina, and the Dominion Department of Agriculture, Ottawa. The contributions of the various co-operators are stated in the acknowledgment on page V. The project owes its inception to a resolution passed by the Better Farming Conference, held at Swift Current in 1920. This resolution urged that a soil survey be made for the purposes of classifying and mapping the various soil types of the Province in order to assist and encourage the development of these types according to the systems of farming to which they are best adapted.

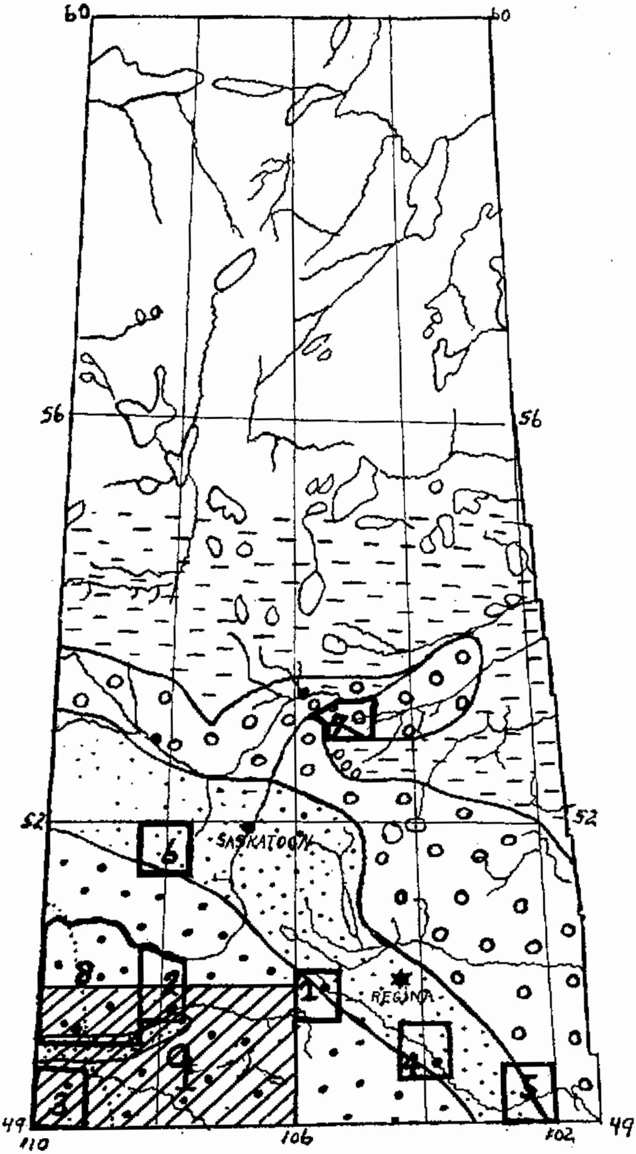
This report, with its accompanying soil maps, is the ninth published to date. The locations of the various areas covered by these publications are shown on the sketch map on page VII. All of the surveys have been of the reconnaissance or broad scale type. The surveys reported by the first eight publications covered widely separated districts comparatively small in extent. The survey represented by the new series of publications, of which this is the first, was conducted on a somewhat broader scale. The principal reason for this change was greater need for soil information for the Province as a whole than for isolated, smaller areas. The experiences of the soil surveyors during the previous eight surveys and the knowledge accumulated thereby have enabled them to conduct the newer survey much more rapidly and without great sacrifice of accuracy and detail. The final outcome of the change will be the publication of reports and maps covering most of the Province within a few years time.

At the time of writing, most of the field work has been completed for about three quarters of the more settled part of the Province. The present plan is to publish the maps and reports of the revised survey in a series of six reports and soil maps.

The present purposes of the soil survey are chiefly to study the character of the soils, to classify them on the basis of such observations and to ascertain problems peculiar to the various soil types. In addition, information is obtained regarding agriculture, climate, community organization, etc., as well as technical information for scientific use.

Many useful applications, both practical and scientific, are being made of the soil survey. Among those who have found the maps and reports useful are prospective settlers and purchasers of farm lands, farmers, scientific investigators, financial institutions of various sorts, highway engineers, public service departments and municipality officials. The surveys should be especially useful as a basis for agricultural experimentation and investigations, and for the organization of agricultural service work.

Fig. 1.—Sketch map locating soil zones and surveyed areas.



Wooded Gray Soil Zone.
Park Dark Brown to Black Soil Zone.
Transitional Dark Brown Soil Zone.
Plains Brown Soil Zone.

Areas for which Soil Survey Reports are Available.

1.—Moose Jaw.
2.—Swift Current.
3.—Robsart.
4.—Weyburn.
5.—Alameda.
6.—Rosetown.
7.—Birch Hills.
8.—Leader-Maple Creek.
9.—Southwestern Saskatchewan.

Soil Survey of South Western Saskatchewan

By A. H. Joel, J. Mitchell, F. H. Edmunds
and H. W. Larson

SUGGESTIONS REGARDING THE USE OF THE MAPS AND REPORT

The publication is in two parts, a set of soil maps and a report. Neither is complete in itself and both should be used together for a worth while interpretation of the information presented.

The Maps.—These are inserted inside the back cover. The scale is five miles to the inch. Township locations may readily be determined by referring to township and range numbers around the borders of the maps. Section and quarter section locations are outlined by the smaller squares. A township diagram is outlined for those not acquainted with the Canadian system of numbering sections.

The classification of lands is outlined at the bottoms of the maps. Soils are classified into Series*(groups) and these groups into their various soil types. Certain lands of special character are grouped separately. As indicated in the legend each soil type is given a special color and letter combination; and the various kinds of topography indicated by diagonal lines or the absence of lines. Special signs are also given for other features such as stoniness and "burnt-outs."

From the map features noted above, together with the soil descriptions given in the report, one can readily ascertain soil conditions in any particular district; and by referring to discussions given for the purpose one can also ascertain the agricultural practices, adaptations and problems associated with the various soil belts.

It is not intended that the maps shall be used in the purchase or sale of land without personal inspection. They are not always sufficiently detailed or accurate for a satisfactory appraisal of particular sections. The survey is of the broad or reconnaissance type and not intended to show detailed variations on individual farms. However, the maps and report, used together, should serve as very useful guides for acquainting

*See pages 2 and 10 for an explanation of Series and Types.

the reader with soil and agricultural conditions in most districts included in the surveyed area. Accuracy and detail are usually greatest in districts readily accessible by roads.

The Report.—The report is divided into two parts. The first is primarily for popular or practical use, and the second for scientific or technical purposes. The table of contents on page III. enables the reader to readily select the sections in which he is most interested.

The popular section describes the area as a whole as to climate, agriculture, general economic development and natural features such as topography and drainage. It also describes each of the various soil types and discusses their agricultural utilization and adaptations.

The technical section gives information of particular interest to scientists. It deals chiefly with soil classification and composition from a scientific standpoint and with surface Geology and Ecology.

Various tables are listed in the Appendix. These give detailed data regarding soil classification and composition, climate, field crop experiments and agricultural and population statistics.

Definitions of Terms.—In writing the popular section of the report the author avoided the use of technical terms and discussions as much as possible. The terms defined below are a few which could not very well be omitted. They are in common use in soil classification literature, but are not clearly understood by most laymen.

Textural Grade.—Used in classification to express the proportions of sands, silt and clay in a soil. The various textural grades are defined in Table II. in the Appendix.

Soil Profile.—A vertical section of a soil such as is exposed in a fresh road cut or hole. The natural arrangement of a soil into "horizons" or layers, from the surface into the deep subsoil.

Soil Type.—A soil which throughout the full extent of its occurrence has relatively uniform texture of the surface soil and relatively uniform profile characteristics. The unit of soil mapping. The name of the type is a combination of its surface texture and the series to which it belongs, *e.g.*, Haverhill loam and Haverhill clay loam.

Soil Series.—A group of soils having the same character of profile, the same general conditions of drainage and usually a common or similar origin and mode of formation. A group of soil types similar in all respects except the texture of the surface soils. The series is usually named after a town near which it occurs.

Glacial.—Surface deposits that owe their origin to the action of ice. Such deposits are called moraines when they consist of stones and bowlders mixed in varying proportions with earthy material. Other deposits, such as outwash and lacustrine (lake) were the result of the grading action of water which formed from the melting ice. It is estimated that the continental ice sheet covered Saskatchewan approximately 25,000 years ago.

Alkaline.—Soils with sufficient soluble salts to interfere with plant growth and usually to form thin surface salt crusts during dry seasons. The term alkaline is used rather than saline because of its established usage by laymen throughout Western Canada. The salts consist, in the most part, of sulphates of sodium and calcium and seldom of the truly alkaline carbonates and bicarbonates of soda.

"Burnt-outs".—A soil condition prevalent on medium and heavy soils over much of the area. It is characterized chiefly by a tough subsurface layer which is frequently exposed as the present surface in numerous shallow pits. This is the result of the removal by some cause, probably by wind, of the natural surface layer of powdery silty soil.

DESCRIPTION OF THE AREA

This section of the report briefly describes the area as a whole. Its general purposes are to provide a background for considering agricultural possibilities and to indicate the present state of development and settlement. The soils are discussed in detail in a later section of the report.

Location and Extent *.—The Southwestern Saskatchewan reconnaissance soil survey covers an area extending from the International boundary on the south, to the top of township 16 on the north; and from the third meridian on the east, to the Alberta boundary on the west. The location is shown on the sketch map on page VII.

The area of the region covered is approximately 17,080 square miles. Comparatively little of this is occupied by water.

Surface Features and Topography.—The more important topographic divisions are shown on the sketch map on the page following.

The area is part of the Third Prairie Steppe or Missouri Plateau. This is the highest of the three great land divisions which lie between the Rocky Mountains to the west and the Ontario Highlands to the east. Within the area itself are two plateaus, the Cypress Hills and Wood Mountains.

The average elevation of the plateaus ranges from about 2,900 to about 3,500 feet above sea level, with the highest point having an elevation of 4,243 feet. The remainder of the area, which will be referred to as the plains division, ranges from about 2,200 to about 2,500 feet above sea level.

In general character the plains division is a country of rolling or hilly belts with level to undulating areas between. There are also areas of sand dunes and marshy alkali flats.

The Cypress Hills plateau is made up of rolling and hilly areas and smooth plateaus. A number of coulee-cut gullies occur along the edges of the plateau and along the borders of several streams, especially along the Frenchman River and Swift Current Creek.

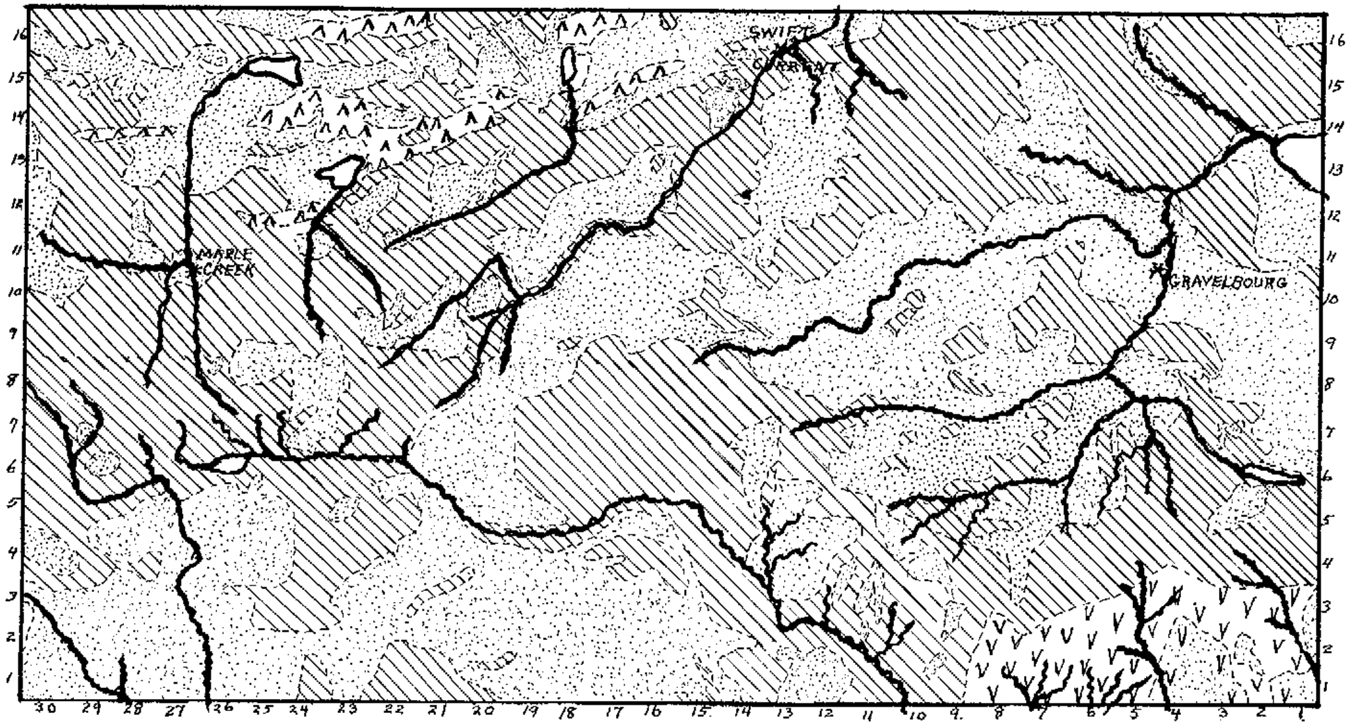
The Wood Mountain plateau is generally similar in topography to the Cypress Hills. It differs from the latter principally in that it has a number of broad plateaus cut up by numerous coulees into many small, smooth plateaus or benches.

Drainage.—The more important rivers, creeks and lakes are indicated on the sketch map on the page following.

There are two general types of drainage systems. The one is

*The following Municipalities and Local Improvement Districts are included in the area: Nos. 13 to 22, 43 to 52, 73 to 82, 103 to 112, 133 to 142, and parts of 163 to 172 (exclusive of 167).

Fig. 2.—Sketch map showing the topography and the principal drainage systems of the area surveyed.



Level and Undulating   Rolling and Steep   Dissected Plateau   Sand Dunes of the interior basin type. Its streams end in or near the area, emptying their waters into alkali lakes which have no outlets. The other, the normal type, has outlets into rivers which finally reach the sea.

The former occurs chiefly in the northwest and eastern parts of the area. Maple Creek and other small streams rise in the Cypress Hills, flow northward, and empty into Bigstick and Crane Lakes on the plains.

In the eastern portion of the area Wood River and several other small streams flow eastward or northeastward and empty into Johnston Lake. The streams are comparatively small and are normally sluggish. Flood plains and terraces, or benches, are in places comparatively extensive. They are usually made up of heavy "gumbo" soil with considerable alkali either in the surface or subsoil.

On the whole the area is well drained, the poorly drained portions being confined largely to the stream flats and to numerous sloughs and small lakes, many of which contain little or no water during dry years. Practically all of these poorly drained areas are alkaline.

Irrigation is not feasible over most of the area. It is confined to a few inextensive flats along several streams, used chiefly for growing forage crops.

Agriculturally the area is normally excessively drained. That is, except in wet years, supplies of good water for stock are limited; and from a soil moisture standpoint the large proportion of strongly sloping land results in excessive run-off of an already deficient rainfall.

Climate.—Consideration of climate is important, not only because of its direct influence on the growth of crops, but also because it largely determines the nature of the soils of a region. This point is discussed in some detail under the section dealing with soils.

Only a brief discussion of the climate is given in this section of the report. Tables of climatic data are given in the Appendix for those who desire more detailed information.

The climate is essentially of the north temperate, continental, semi-arid type. There are local variations of degree, the most marked being associated with the difference in elevation between the plains division and the plateau of the Cypress Hills. There is also a lesser local difference between the eastern and western parts of the plains division. These variations within the area are pointed out in discussions of the different climatic features, in paragraphs following.

Temperatures.—As one would expect in a northern latitude with no nearby large water bodies there is a wide range between summer and winter temperatures. A maximum of 107°F and a minimum of -54°F have been recorded. The temperatures at Swift Current may be considered average for most of the plains division. The higher lands of the Cypress Hills plateau are undoubtedly cooler, and the western part of the area apparently somewhat warmer. Averages of data for Swift Current* indicate a mean annual temperature of about 38.8°F, a winter mean of about 12.1°F, a spring mean of about 39.3°F and a summer mean of about 63.4°F.

The frost free period is about 96 days for the Swift Current or eastern region, about 119 days** for the western, and appreciably less for the higher bench lands of the Cypress Plateau.*** The average dates for last killing spring frosts and first killing fall frost at Swift Current are June 4th and September 10th. When measured by days alone the length of growing season is much shorter than in more southerly latitudes. For a fair comparison, however, one should allow for the long days and high percentage of sunshine hours in Saskatchewan. Damage to grains, hardy vegetables, etc., by frosts, has been serious only in occasional years. On the other hand the cool nights during most of the growing season is a limitation to the growing of a crop such as corn.

Winters are typically long and cold, and the midsummers hot. The dryness of the atmosphere, however, renders extreme temperatures far less uncomfortable than the same temperatures in humid climates.

Precipitation.—The mean annual precipitation for Swift Current is 15.2 inches, the mean for spring 3.38, for summer 7.33, for fall 2.61 and for winter 1.9. The mean annual precipitation for Medicine Hat, Alberta, not far from the western section of the plains division of the area, is 12.8 inches. The seasonal means are also lower than at Swift Current. Figures for Maple Creek, covering a much shorter period, also indicate less precipitation in the western part of the plains area than in the eastern. The mean annual precipitation for Klintonel, in the Cypress Hills, is 17.9 inches. This supports the contention that the plateau division is moister as well as cooler than the plains division.

As is true for Saskatchewan as a whole, a little over 50% of the annual precipitation falls during the growing months, April to July, inclusive.

There is considerable variation in annual and seasonal precipitation over a period of years. Thus, at Swift Current, in the wet-

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*For the period 1885 to 1926.

**Based on data for Medicine Hat, Alta., 1885 to 1914.

***Based on data for Klintonel, 1914 to 1928.

test year, 1891, the annual precipitation was 24.5 inches, and for the driest year, 1894, it was 9.6 inches. Figures for Swift Current over a 29-year period, indicate an average annual snowfall of about 40 inches.

General.—No dependable long-time records of evaporation are available. It is evident, however, that, as is true of most of Saskatchewan, the atmosphere is relatively dry and evaporation relatively rapid during the growing season. It is also no doubt true that the area as a whole has a higher evaporation ratio than the eastern and northern darker soil zones of the Province. Within the surveyed area the evaporation is probably somewhat less on the plateau division than on the plains. Of particular significance are the hot midsummer winds which not infrequently cause serious damage to crops. The western part of the plains division, along the provincial boundary, both north and south of the Cypress Plateau, seems to be especially susceptible. Winds also cause damage from soil drifting, especially in dry springs.

Hail storms occasionally cause damage, but such storms are usually local in character.

Native Vegetation.—A consideration of native plants is important for a number of reasons. The general type of natural vegetation, as a product of climate, largely determines the nature of soil developed in any region; and the particular species of vegetation present are most useful in indicating drainage conditions, alkalinity and many other features of the soils on which they grow. The character of the vegetation is also an important consideration from the standpoint of preparing new land, of selecting home sites, of providing shelter for livestock, and of supplying lumber and fuel, etc.

The dominant type of native vegetation is that of semi-arid plains grasses with associated herbs and shrubs. Three species make up most of the upland grasses. These are June grass (*Kohleria gracilis*), grama grass (*Bouteloua gracilis*) and spear grass (*Stipa comata*). They are especially characteristic of the normal, medium and heavy soils of the steppe or plains division. In the more poorly drained places wheat grasses and salt grasses tend to predominate, while on the plateau division fescue and oat grasses and other subhumid prairie-plains species attain importance.

Sage brush is usually the dominant shrub on the better drained medium and heavy plains soils, and greasewood on the saline, moist lowlands. Wild roses, wild cherry, buck brush and other shrubs prevail in sandy areas and in many of the shallower ravines and coulees.

Trees occur over only a small portion of the area, chiefly in sand dune belts of the plains and in the ravines and near the summit of the Cypress Hills Plateau. Aspen (*Populus tremuloides*) is the dominant species. Some lodgepole pine occurs on the Cypress Hills Plateau, chiefly in the ravines of higher altitude.

A more detailed discussion of native vegetation and its agricultural significance is given under the heading "Ecology", in the technical section of the report.

Population.—The total population * of the whole surveyed area in 1926 was 81,268, of which 80% was rural, 14.8% town and village, and 5.2% city. This made a total population density of about 4.8 people per square mile, and a rural population density of about 3.8 per square mile.

The urban population was distributed in the city of Swift Current (population 4,175) and in five towns and 34 villages. Town populations ranged from 420 to 1,459, and village from 63 to 588. Practically all urban centres of importance are along railway lines. Regina, the provincial capital, is about 60 miles east of the area.

The density of rural population varies greatly by districts, and is determined largely by soil type and distance from railways. The sketch map below indicates the distribution of rural population, and shows the location of railways and urban centres. A comparison of the sketch map with the soil maps will reveal interesting relations between soil type and population number.

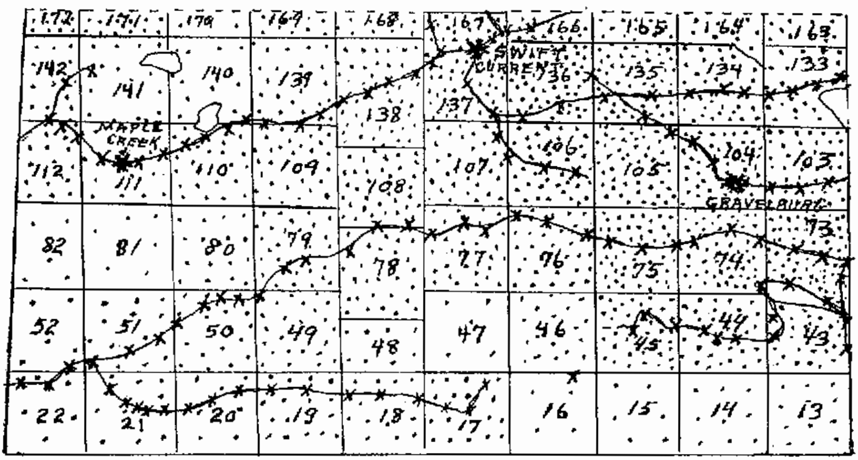

Fig. 3.—Showing railways, urban centres and distribution of rural population. Each dot represents fifty people. Municipalities are indicated by numbers.

*Dominion Census, 1926.

Population has fluctuated considerably since settlement began, both in rural districts and urban centres. In general, growth and decline have been closely linked with the suitability of soil types for grain production. This matter, however, is discussed in some detail in the section dealing with the agricultural history of the area on page 34.

More detailed data as to population are given in tables in the Appendix.

Most of the people are English speaking. The majority have come from Eastern Canada and the United States. A small number, mostly Scotch and English, came from the British Isles.

French settlements are located in and near Gravelbourg, Dollard, Ponteix, and at several other points along the C.P.R. line crossing the south part of the area

Mennonites, a communistic group of Russian-German origin, occupy a fairly large tract south of Swift Current, in the vicinities of Wymark and Blumenhoff. Several settlements of Dunkards, a religious sect, are located near Consul and Vidora.

Markets and Marketing Facilities.—Marketing considerations center chiefly around wheat, as most farmers depend on it for by far the larger part of their income. Rye, livestock and dairy products are also of appreciable importance in a number of districts.

Wheat, as well as other grains, are usually stored in moveable granaries on the farms and delivered to local elevators after threshing time. The bulk of the grain is carried to Fort William on Lake Superior and delivered ultimately to the markets of the world. In the not far distant future it is expected that much of the grain will be shipped over the new Hudson Bay railway and leave Canada from Churchill Harbour.

From a local standpoint, the chief marketing concerns are satisfactory elevator service and shipping facilities at points not far from the farms, and approachable by good roads. About 110 railway shipping points provide elevators and necessary facilities for handling grain. This represents one shipping point for about each 155 square miles. As most of the railways run through the better agricultural districts the majority of farms are located conveniently for grain shipping. Parts of the Cypress Hills and Wood Mountain plateaus are still inadequately served.

Most of the grain shipping points also provide facilities for shipping livestock. Creameries are located at Swift Current, Maple Creek and Shaunavon within the area, and at Moose Jaw not far to the east.

The market for perishable products such as fresh vegetables is very limited.

Roads and road conditions are discussed below.

Markets for the purchase of supplies are generally adequate. Retail businesses in most towns and villages are usually able to supply most of the farmers' needs. Swift Current is the largest of such markets with the variety of retail houses which one would expect in a city of about 4,200 population.

Railways.—The sketch map on page 8 shows the location of railways in the area.

The main transcontinental line of the Canadian Pacific Railway crosses the northern part of the area, providing through fast service, not only to Eastern Canada and to the Pacific Coast, but also to Chicago and intermediate points.

Branch lines of both the Canadian National and Canadian Pacific lines provide passenger, freight and express service to most districts. Such branch line service ranges from daily to weekly.

Roads.—Road allowances have been provided over most of the area, one mile apart for roads running north and south, and two miles apart for roads running east and west. In general the poorest and fewest roads are in the sand dune belts, in the Cypress Hills and rougher parts of the Wood Mountains, along the Frenchman River, in the worst of the burnt-out area, in the hilly and stony lands of the Haverhill series, and in poorly drained alkali belts. Over most of the remainder of the area road allowances have been developed into fair to good roads. These are mostly dirt graded. Some of these roads are sometimes temporarily impassable for automobiles during and shortly following periods of heavy rains. Such roads also become very rough if not properly dragged following the rainy spell. The road difficulties above noted are most serious on medium and heavy soils. The majority of roads are maintained in fairly good condition during years of normal precipitation.

Trunk highways traverse the area both east and west and north and south, most of them following railway routes. Much of highway No. 1, along the main line of the C.P.R., has been gravelled, providing all weather traffic to points east and west of the area. Much road improvement has taken place in the past few years, chiefly in the way of gravelling, grading and providing suitable traffic signs.

Schools, Churches, Telephones, etc.—Much of the area is well supplied with schools. A number of thinly settled districts which are handicapped by poor agricultural land or considerable distance from markets, are inadequately served. High schools are located at Swift Current and in various towns and villages.

Most religious denominations common to Western Canada have churches in the area.

The major portion of the area has fair to good telephone service. However, a number of districts, most of them in thinly settled places noted above in connection with schools, have very poor or no service. Long distance connections may readily be made from most urban centres.

SOILS

The discussion of the soils of the area is essentially from the viewpoint of agricultural utilization. However, the information is so arranged that non-agricultural applications may readily be made of it. Highway engineers, geologists and natural resource departments, for example, should find much of the data valuable.

Soil and Crop Relations.—The paragraphs under this heading are for the purpose of briefly considering the desirable composition and condition of soils for the production of good crops.

It is from the soil that plants receive their mineral plant food and moisture, and directly or indirectly, their nitrogen. Most of the carbon and oxygen are taken from the air as carbon dioxide. Of the mineral foods required by plants the following are most commonly deficient in soils, at least in forms available for use: phosphorus, nitrogen and potassium. Investigations in the area indicate a deficiency of available phosphorus on a number of soils, especially on the heavier types. Due probably to conditions favorable to the activities of bacteria which convert nitrogen into available plant food this element is usually plentiful. It is most likely to be deficient in cold, wet seasons, and is usually most abundant in summerfallows at the end of the fallow season. Potassium seems to be abundant in most soils.

In considering soil fertility it should be borne in mind that soil micro-organisms, chiefly bacteria, are largely responsible for changes taking place in soil composition. This is especially true in relation to available nitrogen. In general the conditions which favor crop growth also favor the development and activities of desirable soil micro-organisms.

The soil is the source not only of plant foods but of moisture. In the prevailing semi-arid climate precipitation is usually not sufficient for maximum crop growth, and the comparative value of soils for cropping is consequently determined largely by their efficiency in storing and supplying moisture. The more important inherent soil conditions favoring this are high percentages of fine soil particles, both in the surface and subsoils, a desirable soil structure, and a slope sufficiently gentle to check rapid run-off of rainfall and of water from melting snow. Gravelly or sandy subsoils are especially undesirable; and heavy textural grades are far preferable to light or medium textural grades for surface soils. High water tables occasionally offset light surface and subsoils in local depressions. Other things being equal, smooth topography is far more economical in moisture conservation than are rougher topographies. Soils of the area vary from high to very low moisture efficiency.

Another important consideration in the soil-crop relationship is the physical condition of the soil under cultivation. It should be such as to permit easy root penetration and to provide for a circulation of moisture and air that is neither excessive nor deficient. Soils which are without hard pans, well drained and neither extremely light or heavy, probably best fit these general requirements. The inferiority of the badly "burnt-out" soils of the Echo Series is due largely to the presence of a tough sub-surface layer. This moderate hardpan not only interferes with cultivation, but also hinders root penetration and lowers the drought resistance of these soils in dry seasons. In the sandy lands moisture penetrates too rapidly, much of it passing to depths beyond the root zone. The heavy clays, on the other hand, usually hold most of their moisture within reach of the absorbing roots. Two disadvantages of clay soils, which are seldom serious in this climate, are the greater tendency to waterlogging, especially in low places, and the colder soil temperature in late wet springs. These minor disadvantages, however, are easily outweighed by the much greater drought resistance.

The physical condition of the surface soil is extremely important from the standpoint of soil drifting, a common and serious difficulty on a number of soil types. The most resistant structure is the lumpy or cloddy type. Medium textured soils, such as loams and clay loams, are most apt to have this. The clays and sands, on the other hand, are most apt to drift, due to the fine granular structure of the former, and sand grain structure of the latter, after a few years of cultivation.

Physical condition of the surface and subsurface are important considerations also from the standpoint of choice of tillage implements and the amount of power required for tillage operations. In general, the soils with the greater amounts of clay and silt particles require the most power for tillage and are most apt to give rise to difficulties with scouring of plows, cultivator shovels, etc. Sandy lands may be worked far more easily, rapidly and cheaply, but the advantage is discounted by their poor resistance to drought. Disc plows are required on most clays and many clay loams. The selection of tillage implements is considered in some detail later in the report.

In addition to the positive factors considered above, a soil, to be productive, must not have harmful constituents in quantities which will seriously retard the development of the growing crop. Alkali and soil born diseases, such as flax wilt and foot rots of grain, are examples of such menaces prevailing in the area, but they are both local in their occurrence.

Soils, to be normally productive, must, therefore, contain the necessary plant foods in proper balance and in an available form; must be in the proper physical condition; and must not contain substances or diseases seriously harmful to plants.

In judging soils as crop producers, one should also give due attention to the environment in which the soil occurs; in this area particularly to climatic conditions. Moisture supply is far more of a limiting factor to crop production than is fertility. Hot summer winds not infrequently seriously damage crops, and occasionally frost damage is serious. Humid, warm conditions when crops are approaching maturity, greatly favor the development of rust, one of the great menaces to wheat production in Western Canada. The influence of these environmental factors varies appreciably with different soil types. In general, Cypress Hills soils are favored by more moist conditions, but are in greater danger of damaging frosts and rust. Other relations of soils, environment and crops are pointed out in the discussions of soil types beginning on page 19

Soil Survey Methods.—Soils of the surveyed areas are investigated both in the field and in the laboratory. The latter investigations are made on carefully selected samples of the various soil types mapped.

Field operations are carried on by parties who systematically traverse the territory and make the necessary observations and notations necessary for the description, classification and mapping of the various soil types.

The first general phase of field operations is the study of the character of the soils. The characteristics which are most commonly observed are color, textural grade,* structure, hardness or ease of penetration, accumulations of lime, alkali and other chemical compounds, and reaction or condition as to acidity. These are observed not only for the natural surface layer but also for the other "horizons" or natural layers below. Color indicates the relative content of organic matter, the drainage conditions, the presence of various chemical compounds and a number of other points. The textural grade is of considerable importance because it largely determines a soil's moisture capacity, the power required in its cultivation and many other qualities. It may be quite accurately determined by feeling moist samples between the thumb and first finger. This field estimation is, however, frequently checked by samples which have been subjected to a mechanical analysis. Structure refers to the arrangement of soil particles. A few common types of structure are single grain, lumpy, cloddy, platy, granular and powdery. Hardness is largely a matter of compactness and degree of cementation as indicated by resistance to a pick or other tool. The more common chemical accumulations in soils of the area are lime carbonate; alkali salts, especially sulphates of sodium and calcium; and brown or red flecks or concretions of iron oxides.

Examinations are made mostly of uncultivated soil in fresh exposures. Road cuts, when properly located, are very handy for such examinations. Otherwise holes are dug. In any case the

*See definition on page 2

aim is to examine the whole soil profile from the surface into the but slightly altered material below. In this way the typical arrangement and thickness of horizons or natural profile layers may be determined for each soil type. Classification is based largely on this profile arrangement. Picks, shovels and trowels are found very suitable for these examinations.

The second general step in field operations is to decide on a suitable classification of the soils examined. This matter, however, is discussed under the next main heading.

The third general step is to systematically map the soils on the basis of the characteristics observed and the soil types established. This is essentially a matter of noting changes from one soil to another and connecting such points on a field map in order to establish the approximate soil boundaries. Many samples are examined for this purpose. The general character of the country also helps greatly in establishing soil boundaries. The native vegetation, the general appearance of cultivated fields and of roadside cuts, the presence or absence of stones, general lay of the land, etc., all indicate soil condition and frequently soil type.

Areas with few passable roads or poorly adapted to agriculture are usually given less attention than other districts; and extensive areas of uniform country were usually not as closely worked as those of mixed character.

Following the study of soil character, the classifying into groups and types, and the mapping of soil type boundaries, the various types are sampled for laboratory investigations, and information is gathered from farmers and others locally informed regarding agricultural methods and problems.

Soil Classification.—The discussion of classification is rather extended, but a full explanation was deemed necessary for an intelligent and worth-while application of the information presented on the maps and in the report. Once understood the classification may also be applied readily to other areas surveyed. Terms which are likely to be unfamiliar to the majority of laymen are defined either in this discussion or on page 2. The classification is not difficult to understand. A simpler system would sacrifice accuracy and valuable details. The reader who is not already familiar with the system is urged to read this section of the report carefully.

In the Saskatchewan soil survey the soils of the Province are classified into zones, Series and types.

Soil Zones.—The zones are broad belts in each of which the soils have certain characteristics peculiar to their particular zone. These great belts are the result of broad differences in climate and native vegetation, two factors which largely determine soil character in any region. Space will not permit of an extended discussion of the nature of such influence, but it will be well to bear in mind that semi-arid and sub-humid soils such as ours differ distinctly from soils of humid areas such as Eastern Canada or along the west coast. It will also be well to bear in mind that soils under grass cover are markedly different from those which have long been covered by timber. Furthermore, soils under thin grass cover are different from those under a luxuriant grass cover, although their differeuces are more of degree than of kind. The above statements may help the reader to better understand why the soils of Saskatchewan may be broadly classified into at least four zones or great groups—zones based on related differences of climate, native vegetation and soils. These zones are as follows: the plains or brown soil zone (semi-arid); the intermediate or dark brown soil zone (transitional); the park* or very dark soil zone (sub-humid); and the wooded or gray soil zone (sub-humid). The sketch map (on page VII.) gives a general outline of the zones and shows the location in relation to them, of the Southwestern Saskatchewan soil survey area.

Soil Series.— **The Series is merely a group of soil types which are alike in the general character of their profiles, that is, in the full depth of soil, from the surface to at least four or five feet. A Series is usually named after some town near which its soils occur. As the various soil types of a given Series may be widespread in distribution they are frequently found far from the town or locality from which they were named. The most satisfactory practical system found has been to give each soil a special name which serves merely as a reference to a full description of its character. Advantages of locality names are that they are more significant and more easily remembered than numbers, letters or other arbitrary designations, and the system is the most common in use in North America. In Saskatchewan, the Series are, in most cases, directly associated with differences in geological origin of soil materials within the same zone. In other words soils in the same zone, and having the same geological origin of materials from which they have developed, will, in most cases, be in the same Series. For example, the Haverhill Series of soils contains soil types on deposits of glacial "till" within the plains or brown soil zoue. Other types of geological deposits in the area are those from lakes, streams, wind action and from certain very old geological formations such as Pierre Shales and Tertiary sandstones.

Soil Types.— **The soils of a Series are classified into individual soil types. This separation is made simply on the basis of differences of surface texture. For example, in the Haverhill Series, there are Haverhill loams, Haverhill clay loams, etc. The name of the type is merely a combination of its Series and textural grade.

*The term park, in Saskatchewan, is applied to a zone of grassland with scattered clumps of poplars, willows, etc., known as "bluffs".

**Note definitions on page 2.

The textural grade,* which determines the soil types within a series, is based on the proportions of clay, silt and sand size particles in the soil. For example, a soil, to be a clay loam, must have between 20 and 30 per cent. of clay, more than 50% combined silt and clay, but less than 50% of total silt. The system is essentially that of the United States Bureau of Chemistry and Soils. It is the one in common use on this continent. Above twelve of these textural grades have been used in classifying most soils mapped by the Saskatchewan soil survey. Loams, clay loams, fine sandy loams, sands, silty clay loams and silt loams are the most prevalent in the area herein described. A table showing the composition of textural grades is given on page 74 of the Appendix. Another table defining the sizes of particles (soil separates) on which the textural grades are based, is given with it.

Topographic Variations.—Soil areas with strongly undulating, rolling or hilly topography are usually far less uniform than those of level to gently undulating topography.

The variability of the soils of uneven topography is chiefly the result of differences in the effect of moisture on knolls and upper slopes as compared to depressions and lower slopes. On the higher lands moisture runs off rapidly and carries fine soil particles and various chemical compounds onto lower slopes and into depressions. As a consequence soils of the higher lands have drier surfaces, much lower water tables, and support much thinner stands of grasses and herbs to supply organic matter to the soils. Some results of this combination of conditions are the frequently drier, coarser, shallower and lighter colored soils on higher lands as compared to those on the lower. In addition, the soils of lower, poorly drained lands, usually have accumulations of alkali salts, sometimes in such large quantities as to seriously interfere with the growth of both native plants and cultivated crops. Furthermore, hardpans, associated with the "solonetz" or "burnt-out" type of soil development are most prevalent where drainage is moderately restricted and water tables moderately high during part of the year.

Mixed Types and General Land Classes.—Some areas were classified and mapped as mixed types and some as mixed Series. The soils of such areas are usually so mixed, even over short distances, that a one-type classification was impossible, at least by a broad survey.

Other lands do not fall well into the Series-type system of classification and are separated into special groups, or land classes. These are mostly lands poorly adapted to agriculture on account of rough topography, sandy character, or poorly drained, alkaline condition.

General Character of the Soils of the Area.—As shown in the sketch map on page VII, the area herein described falls within

*Note definition on page 74.

the plains or brown soil zone. Some of the soils, however, are in a small local zone, so similar to the intermediate or dark brown soil zone of the Province as to be classified with it. This local zone occurs on the Cypress Hills plateau. Its occurrence is the result of the cooler, moister climate and more luxuriant grassland vegetation as compared to that of the plains zone surrounding it at a lower elevation.

Soils of the plains zone have brown, light brown or grayish brown surfaces which are shallower and lower in organic matter and nitrogen than those of the dark brown zone of the Cypress Hills plateau. Also the gray subsoil of lime carbonate concentration is at shallower depths, and there are more and stronger accumulations of alkali salts in low, poorly drained places.

Most soils of Cypress Hills plateau have surfaces which are dark brown or very dark brown in color. An outstanding characteristic of the Cypress soil types is the presence in the surface or lower soils of smoothly worn stones and pebbles, occurring in many places on the plateau and, in certain localities, affecting the agricultural value of the land. They are associated with certain underlying formations in the plateau. Other characteristics are indicated in the comparison with the plains soils in the previous paragraph.

Over the area as a whole surface soils are usually loose, powdery or granular; the subsurfaces hard, cloddy or lumpy, and deep brown or rusty brown in color; and the subsoils gray, high in lime, frequently high in alkali salts, and only moderately hard or compact.

Considering the surveyed area as a whole there is a great range in textural grade, topography, stoniness, drainage conditions, etc. Approximately 14.3% of the area (exclusive of rough, steep land), has light textured soils (sands, sandy loams and light loams), 43.5% medium (loam and silt loam), and 23.6% heavy (clays, light clays and siltyclay loams). About 47.7% of the lands are level to undulating, 25.2% gently to moderately rolling, and 27.1% strongly rolling to steep. About 11.4% of the area has moderately or badly "burnt-out" soils. The "burnt-out" tendency, however, is evident on medium and moderately heavy soils over the area as a whole. Approximately 4.7% of the soils are mapped as poorly drained and usually alkaline. This latter figure, however, does not account for the numerous small areas of this sort which occur around sloughs and along the smaller drainage ways.

SOIL SERIES AND TYPES *

Soil types of the Southwestern Saskatchewan soil survey are classified and mapped in the following Series:—Cypress, Sceptre, Fox Valley, Haverhill, Wood Mountain, Echo and Hatton. The plan followed in discussing these soils is to give a brief statement of the outstanding characteristics of each Series; and to discuss the extent and distribution, the general characteristics and the agriculture of each soil type included in that particular Series. Some soils are mapped as mixed Series. Such areas were composed of numerous small areas of types of two Series, a separation being impractical except by a very detailed survey.

Lands not classified in the regular Series and type grouping (mostly lands not well suited for producing cultivated crops) are classified as general land classes in the next section of the report beginning on page 32.

SOIL TYPES OF THE CYPRESS SERIES **

Soil types of this Series occur on the Cypress plateau in a soil zone very similar to the main intermediate or dark brown soil zone of the Province. The soils are darker, deeper and higher in nitrogen and organic matter than the soils of the other Series mapped in the area, all of which occur in the plains brown soil zone at a lower altitude. These and a number of other differences are the result of the cooler, moister climate of the higher elevation.

Cypress Loam.—This is the most extensive soil type on the Cypress Hills bench. Large areas occur south of Gull Lake and Swift Current. It occupies approximately 3.7% of the surveyed area.

Description.—The color is usually very dark brown when dry, and almost black when moist. Light loams predominate over the eastern part of the plateau and heavy loam to the west. The surface is usually fine granular and small lumpy when cultivated under normal conditions. The layer or horizon below the natural surface soil is usually somewhat heavier, brown in color and made up of rather long, fairly hard clods. The subsoil is usually some shade of gray with a large content of lime carbonate and occasionally some gypsum or sodium sulphate salts. Occasionally gravel or pebble strata occur near enough to the surface to produce a droughty soil in the patches where these occur. However, such condition is not common except in a few local areas.

The topography is usually level to undulating, and occasionally rolling or dissected with coulees. Drainage is normal except in

*The system of classifying soils into Series (groups) and types is explained on pages 15 to 17.

**The mixed Cypress and Haverhill Series is discussed on page 31.

local depressions such as in and around sloughs. Stones and boulders are generally not numerous.

Agricultural Adaptations and Development.—In most agricultural considerations, soil types of the Cypress Series should be considered separately from the majority of other lands in southwestern Saskatchewan. Both from a soils and climatic standpoint they more nearly resemble soils of the intermediate or dark brown soil zone of the Province than soils of the nearby plains. The higher organic matter and nitrogen contents, the deeper surface soils, the longer and moister growing seasons and lesser damage from hot summer winds largely account for this difference.

As a result of such natural differences these lands are, in general, better adapted to both forage and grain production than lands of the plains, except, possibly, the silty clay soils, such as those of the Sceptre Series. The superior moisture conditions would also be reflected in the growing of garden produce and shelter belts. Soil drifting is also apt to be less serious, except in a few areas of light loam.

On the other hand, there is somewhat greater danger from frost, rust and lodging of grain, and a likelihood of a lower protein content in wheat.

Cereal and forage variety adaptations and prevalent weed types would be those of the darker soil zones of the Province, rather than those of the drier plains. For example Reward wheat would likely be more suitable than other wheat varieties over much of this soil type, and French weed, quack grass, wild oats and pig weeds more serious weeds than on the plains soils. Russian thistle prevails, but is usually far less serious than on the plains soil.

The above differences will be most marked in the darkest of the Cypress soils occurring at the higher elevations.

At the time of writing grain production is the chief type of agriculture with spring wheat the leading crop. At the same time there are sufficient successful diversified farms to demonstrate the adaptability of such a type of agriculture to this type of soil.

Cypress Clay Loam.—This type closely resembles the Cypress loam in general character and agricultural adaptations. Being of heavier texture it usually requires a little more power to work, is more drought resistant, and less subject to drifting. It occupies a much smaller area than the loam. The largest belt is located on the bench south of Gull Lake.

SOIL TYPES OF THE SCEPTRE SERIES

These are the heaviest of the upland soils of the plains zone. They are usually free of stones, and level to undulating, or broadly rolling in topography. They contain high percentages of silt and clay and comparatively little sands or gravel. They are apparently developed on Pierre shales * or lake deposits derived mainly from Pierre shales.

Sceptre Silty Clay.—Although this soil type is one of the best grain producing soils in the plains brown soil zone, it occupies only about 0.4% of the area herein discussed. A rather detailed discussion is given below because of the importance of the soil type not far to the north of the area.

Description.—This soil type is largely heavy, silty clay. The surface color is a dull gray, slightly tinged with brown.

Under native grass the soil, when dry, is cloddy and forms deep cracks, sometimes several inches across, the result of great shrinkage. Under cultivation, however, much of the surface soil works readily to fine granules, in fact, so much so that soil drifting becomes a menace in many fields.

The subsurface and subsoil is typically slightly heavier than the surface, cloddy in structure and usually gray to light or bluish gray in color, with a high content of lime. Alkali salts, especially gypsum, frequently occur in the subsoil, especially in or near poorly drained places.

Usually there are few to no stones or boulders, and very little gravel. The topography is generally level to undulating, with fairly frequent shallow depressions which are usually somewhat poorly drained. Some areas are broadly rolling, the hills having a smoothly rounded form and easily worked.

Drainage is not as effective as on most lighter soil types. Under the prevailing dry climate this is an advantage except in occasional years with abnormally moist growing seasons.

This type of soil is probably the most drought resistant of the extensively occurring soils in the drier parts of the Province, due not only to its high moisture-holding capacity and slow percolation of water, but also to the retention of much moisture sufficiently near to the surface to be available to absorbing roots. The native vegetation is short grass with a sprinkling of sage brush (*Artemisia cana*) and other semi-arid shrubs and herbs. June grass (*Koehleria gracilis*) is typically the dominant grass species.

Agricultural Adaptations and Development.—This soil type is one of the best spring wheat lands in the drier parts of the Province. It is highly drought resistant, has a comparatively small percentage

*See discussion of Surface Geology, page 68.

of waste land and is usually well suited to power farming operations. More power is usually required for tillage operations as compared with most of the other plains soil types. Disc plows are usually necessary. Due to the fine granular condition of the surface after a number of years of cultivation, soil drifting occasionally becomes a menace. During the occasional abnormally wet seasons these lands offer more cultivation and seeding difficulties than the areas with lighter soil types. As a rule the growing season of crops is somewhat longer than on the lighter lands. Consequently, during seasons with rust or early frost, grain on these soils is somewhat more subject to damage than on the lighter and earlier plains soils.

French weed, wild and Indian mustards, hares ear mustard, wild sunflowers, wild oats and poverty weed are characteristic weeds in addition to Russian thistle and tumbling mustard which are the most common weeds on most soils of the area.

The agriculture of this type is quite typical of that of the drier parts of Saskatchewan as discussed in the section headed "Agriculture" later in the report. Most farms have been, and still are, devoted almost entirely to grain production. Livestock production in general has been an incidental farm project. This is probably the result of the superior adaptation to spring wheat production, the frequent difficulty of obtaining satisfactory water supplies, the lack of suitable native pastures, and the climatic drawbacks to raising forage crops. Most farms, however, raise a few horses and cows and small flocks of poultry.

During recent years there has been a strong tendency towards power farming and larger farms. There has also been a noticeable tendency to summerfallow the land every second year, and to practise the "ploughless" fallow discussed on page 45.

Land values are usually higher than for most other soil types, and improvements better.

Sceptre Light Silty Clay.—A typical area of this soil surrounds the town of Gravelbourg. The soil is similar in character and agricultural utilization to the Sceptre silty clay. It differs from the latter chiefly in having a somewhat lighter colored, lighter textured, shallower and more variable surface soil. The subsurface and subsoil are usually also lighter, both in color and texture, and somewhat less compact.

The type is consequently somewhat less drought resistant, a little earlier, and requires less power for the various cultivation operations.

SOIL TYPES OF THE FOX VALLEY SERIES

These soils are typically silty, stone-free lands, of intermediate texture, light brown and light grayish brown in color. Most of them are developed from old lake or sluggish stream deposits, now occupying plains and broad valleys which are usually almost surrounded by the rougher and more or less stony lands of glacial origin. A few small areas have developed from silty deposits, known as loess, which owe their origin to wind action. Areas developed from water deposited material are level to undulating, and those from the loessial deposits broadly and smoothly rolling. In general soil character, however, both are essentially the same.

Fox Valley Silty Clay Loam.—Large areas with smooth topography occur in the vicinities of Golden Prairie and Gravelbourg. Several smaller areas of the rolling phase occur north and west of the town of Gull Lake. Soils of this type occupy about 2.5% of the total surveyed area.

Description.—This soil is usually light grayish brown in color with a characteristic thin, gray, silty surface film previous to cultivation. It is characteristically silty, resulting in fineness of textural grade, but in less stickiness than in the clays. The cultivated soil is usually more lumpy in character than the clay types, and therefore less subject to drifting.

The subsurface is heavier and long cloddy in structure. The subsoil is gray and only moderately compact. The soil is variable in the smoother lands, a result of the origin of the land from lake and sluggish stream deposits. However, the surface in most cases, is silty clay or silty clay loam in texture, lighter subsoils occurring usually near stream channels and near outer borders of the belts.

The greater portion of this soil is level to undulating, and quite free of stones.

The percentage of waste land is usually comparatively small.

Agricultural Adaptations and Development.—This is one of the better types of the area for grain production. Agricultural practice is practically identical with that of the lighter silty clays and the medium textured soils of smooth topography. Grain production dominates with spring wheat leading. Soils of this type are less drought-resistant than the clays. This is due largely to their lower water retaining capacity and to the occurrence of fairly open subsoils in places. The rolling areas are less drought-resistant than the smooth.

Most areas are well adapted to power farming.

In general, improvements are above average. The Golden Prairie belt has been handicapped in the past by its long distance from a railway.

Water is usually more easily obtained than on the clays.

Soil drifting is usually not serious.

The eastern areas are somewhat more favored with moisture supply than the western, and less subject to damage from hot summer winds.

Fox Valley Silt Loam and Loam.—These soils were classified and mapped both as separate and mixed types. In the latter case the two were so intimately mixed that a separation was impracticable. The belts occur at the lower elevations along the north side of the surveyed area, usually in association with the silty clay loams.

Description.—The types are described together because they are almost identical in agricultural adaptations and values.

The surface soil is brown or grayish brown in color, and powdery to soft cloddy in structure. The subsurface is heavier, harder, and long cloddy in structure. The subsoil is gray, not very compact, high in lime carbonate, and frequently incoherent.

The loam type is more gritty and open in character than the silt loam.

Having a smaller percentage of clay particles in their makeup as compared with the silty clay loams, these soils are easier worked, but less drought resistant. They are also less uniform and more apt to have stony patches and places with light surfaces or subsoils. This is more especially true of the rolling or strongly undulating phases.

Agricultural Adaptations and Development.—In general these soils are about intermediate between the clays and sandy loams in agricultural adaptations. This is about what one would expect considering their similar position with regard to drought resistance. They may be considered fair to good for wheat production.

In actual practice these lands have been farmed along the same lines as the heavy soils, with spring wheat production the prime object. However, they are far less dependable than the clays for this purpose. Diversification, with a fair number of livestock, and rye for part of the cash crop, as practised on sandier soils, would be preferable on many of these soil types. Belts of these soils in the east part of the area are apparently favored a little more from the standpoint of precipitation and are less subject to hot wind damage than those in the west.

Fig. 4.—Haverhill loam, undulating phase. The lumpy structure of the surface makes this soil type more resistant to soil drifting than the sands and upland clays.

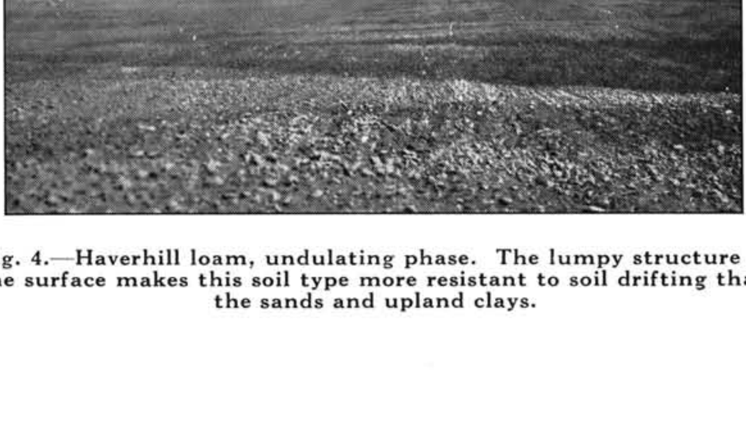

Fig. 5.—View over Haverhill clay loam, moderately rolling phase. Fairly frequent sloughs and moderate to numerous stones are typical of this soil.

SOIL TYPES OF THE HAVERHILL SERIES*

These soils have been developed wholly or partly from glacial till** deposits. The outstanding difference between these and other soils of the area is the presence of a variety of stones and boulders, varying in number from few to numerous. Usually, also, the topography is characteristic; a combination of rounded knolls and rather sharp ridges which frequently have sloughs and pot holes between. Some areas are fairly smooth. The Haverhill soils are usually more gritty and more open in structure than soils of the Sceptre and Fox Valley Series. Subsoils are, in general, much heavier than surfaces.

Sandy types of this Series are developed on sandy, glacial deposits. The sandy types of the Haverhill Series are typically heavier in surface or subsoils than those of the Hatton Series discussed later. The soils vary in texture, especially in areas of rougher topography.

Haverhill Clay Loam.—Soil of this type is scattered over much of the plains brown soil zone. It occupies 7.4% of the total area surveyed.

Description.—The surface soils are usually brown or light brown in color and fine granular and "small cloddy" in structure. Beneath the surface there is usually a heavier, "long cloddy" layer, coffee brown or rusty brown in color, and below this a gray, less compact layer, high in lime carbonate. The surfaces vary considerably in color, depth, and texture according to their position on knolls or slopes, or in depressions. The type might well be considered as a complex of clay loam with smaller areas of loam. Usually the coarser textured shallower and lighter colored soils are on the knolls and higher slopes. There is usually sufficient gravel and coarse, sandy particles in both the surface and subsoils to give them a gritty feel.

The subsoils are usually heavy clay loams or light clays. Topography varies considerably. Few areas are smoother than strongly undulating, and many are strongly rolling to steep. The smooth areas are the most uniform in character. The presence of sloughs between the ridges and knolls is characteristic. The number of stones varies, ranging from few to numerous. Drainage and soil moisture conditions also vary, more moist conditions maintaining in depressions than on knolls.

Agricultural Adaptations and Development.—It is evident from the description that land of this type varies greatly in agricultural value and adaptation.

The usual slight superiority of moisture conditions towards the eastern part of the plains zone holds good for this soil type.

*The mixed Haverhill and Cypress Series is discussed on page 31.

**See page 2 for a definition of glacial till.

Areas of comparatively smooth topography compare well with the silty clay loams of the Fox Valley Series, both in drought resistance and in agricultural utilization. Rolling and hilly belts are less drought resistant and contain more waste land, due to steep slopes, stones, boulders and sloughs. A large percentage of the hilly type is not cultivated, and is used for pasture.

On the better areas of the type the usual wheat- wheat-fallow system of farming prevails, while on the poorer areas livestock and crops other than wheat are grown more extensively in diversified farming systems. A number of very extensive holdings, usually rough in character, are in ranches. Improvements vary greatly, ranging from poor to very good.

Water is usually more readily available than on smooth lands of similar or heavier texture.

Soil drifting is not as frequent as on most other soil types.

Haverhill Loam.—This is the most widespread and most extensive soil type in the plains brown soil zone section of the area. Topography ranges from undulating to hilly. The number of stones ranges from few to many. The level to undulating phases occupy about 8.1% of the whole surveyed area, and the rolling to hilly phases about 21.8%.

Soil of this type is similar in general character and agricultural utilization to the Haverhill clay loam described above. It differs from the latter in averaging somewhat lighter in textural grade, usually containing more of the coarse sand particles in its makeup and less clay and silt. Theese lands are, threfore, on the average, less drought resistant than the clay loams, and more uncertain for crop production in the prevailing dry climate. The type is a complex with loam dominant, and clay loam fairly frequent. Such variation is associated chiefly with differences in relative position, that is, as to occurrence on knolls or slopes or in depressions.

Haverhill Light Loam.—This soil is comparatively inextensive. This is the lightest of the intermediate textural grades of the Haverhill Series of soils. Ordinarily it would be classed with the Haverhill loam above, but, in the prevailing semi-arid climate, the difference in drought resistance was considered sufficient to warrant its separation into a separate type. The type is intermediate between the Haverhill sandy loam and Haverhill loam in general properties and in its susceptibility to drought and soil drifting. Topography is both undulating and rolling.

Agriculturally most of the soil is better suited and "safer" when agricultural practices and systems suited to sandier types, rather than to heavier types, are followed.

Haverhill Sandy Soil Types.—The following sandy types were classified and mapped in the Haverhill Series:—very fine sandy loam, fine sandy loam, sandy loam and gravelly sandy loam. An extensive area occurs northwest of the village of Wood Mountain and a number of smaller areas north of the Cypress Hills, in the vicinities of Maple Creek and Tompkins. About 3.7% of the area is occupied by these types. They are classified and mapped in the Haverhill Series rather than in the Hatton Series because of the occurrence of glacial stones and boulders, of patches of rather heavy glacial till and of frequent heavy subsoils and rolling topography, all of which are more characteristic of the Haverhill Series.

On the whole, agricultural adaptations are those of similar textural grades of the Hatton Series discussed below. However, in small scattered areas, the agriculture of the Haverhill Loam may be practised.

Haverhill Mixed Soil Types.—The following mixed types of Haverhill soils were classified and mapped:—clay loam and loam, silt loam and loam, and light loam and fine sandy loam.

In each mixed area each textural grade occupied a large portion of the belt. Their patchy distribution in small areas, however, made a separation impracticable with the scale of survey followed. Only a most intensive survey could accomplish a thorough separation. This would be very slow and costly, and not always satisfactory. It was felt that these areas could be best classified by naming the two dominant textural grades of each mixed belt.

The character and agriculture of each of these mixed areas can be readily inferred from the information for the individual types in preceding paragraphs. The mixed clay loam and loam and silt loam and loam are usually fair to good wheat lands, while the mixed light loam and fine sandy loam are usually only poor to fair.

SOIL TYPES OF THE WOOD MOUNTAIN SERIES

These soils occur on the Wood Mountain plateau, which is a dissected remnant of a once extensive land elevation. Glaciation has influenced the character of the lands to some extent.

Most of the soil is loam. One comparatively small area of clay loam occurs near Corriander. Both types are described together.

Areas intensely dissected by coulees were mapped as a group of eroded lands.

Wood Mountain Loam and Clay Loam.—These soils occupy about 6.4% of the surveyed area.

Description.—In general character these lands are very much like Haverhill loams and clay loams described on pages 25 and 26.

The chief differences are in topography and uniformity. Wood Mountain soils occur on fairly smooth table lands which are cut into small, separate plateaus by numerous deep coulees, mostly steep sided, while the Haverhill soils, being derived directly from glacial deposits, have a topography of the "knob and kettle" or "ridge and slough" type.

From the standpoint of general character of the soil profile the two groups are very much alike. The Wood Mountain soils contain somewhat more nitrogen and organic matter.

Agricultural Adaptations and Development.—The agricultural adaptations and utilization of these lands are similar to those of the Haverhill loam and clay loam discussed on pages 25 and 26. The Wood Mountain soils offer less difficulties with sloughs, and are more uniform in textural grade (mostly medium loams).

A serious handicap in the development of these soils has been their comparative isolation, most areas being surrounded by rough or strongly dissected lands. This has frequently checked community development in the way of roads, schools, telephones, etc. Marketing conditions have not been very satisfactory, but the recent construction of a branch line railway to the north of these belts promises to improve the situation materially.

THE ECHO SERIES OF SOIL

These soils are of the type known locally in Saskatchewan as the "burnt-out" lands, to some extent in Alberta as "blow-outs", and in Montana as "scab" lands. The soil scientist knows them better as "solonetz" and "solodce". The Echo group includes only the areas which occur in the plains brown soil zone.

The outstanding characteristic of Echo soils is the presence of tough, cloddy soils in numerous shallow depressions which are scattered over the land.

In a more intensive survey a number of soil types could be separated. In the survey of the area herein described, however, these soils are grouped into one type, the Echo clay loam, on the basis of the dominant textural grade.

Echo Clay Loam.—Soils of this Series occur in small scattered patches and areas in medium and heavy soil belts over most of the plains zone. However, the only extensive belts occur in the southwest quarter of the surveyed area, south of the Cypress Hills and the Frenchman River. On the map the "burnt-out" condition is indicated by small circles, and the frequency of the "burnt-out" pits by the frequency of the circles.

About 11.4% of the total surveyed area is occupied by soils mapped as Echo clay loam.

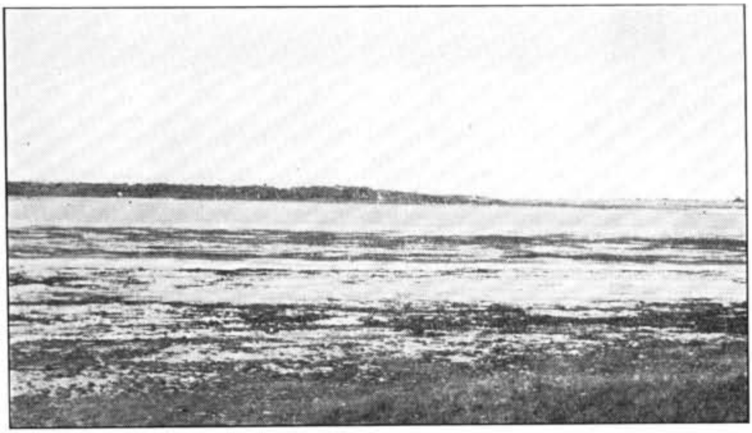

Fig. 6.—High concentrations of alkali commonly occur around lakes and sloughs and along sluggish streams.

Fig. 7.—A belt of Echo clay loam, with Vidora in the background. The sage brush and short grass are typical of the vegetation.

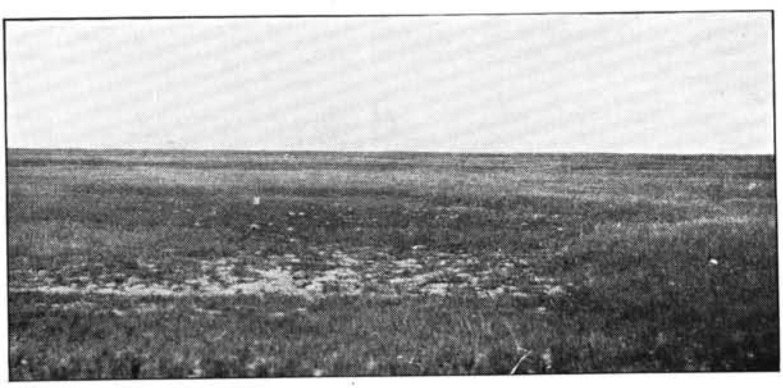

Fig. 8.—"Burnt-outs", or clay spots, typical of the Echo Series of soils.

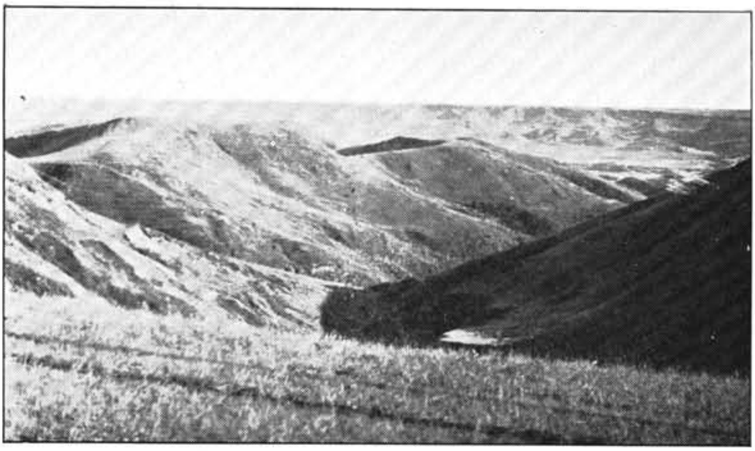

Fig. 9.—Numerous coulees and sharp knolls characterize the rough, eroded lands along the Frenchman River and other streams.

Fig. 10.—A view over a drifted sand belt bordering a sand dune area. Considerable damage is frequently done to nearby farms on superior land by such drifting. The cultivation of sand in this area is seldom warranted.

Description.—The typical natural soil profile consists of a light brown, powdery or soft cloddy surface; a hard, tough, cloddy subsurface, and a gray subsoil with considerable quantities of alkali salts, especially sulphates of calcium and sodium. The so-called "burnt-out" patches are the result of the removal, by some cause, probably wind, of the original silty or fine sandy surface soil, exposing the cloddy subsurface as the present top soil. The result is a surface of very mixed character. The surface soil of the pits is usually clay or heavy clay loam, while that of the undisturbed places is dominantly clay loam, with silty clay loams, loams and fine sandy loams prevalent. The type is a distinct complex and has been classified as clay loam * on the basis of the dominant texture of plow depth soil.

The tough layer of the "burnt-out" pits varies from a few inches to a foot in depth. It shrinks and cracks badly on drying.

The topography is usually undulating.

Stones and boulders are usually present, but seldom in large numbers.

Drainage tends to be restricted in rainy seasons, due to the impervious nature of the tough, cloddy layer. Shallow sloughs and alkali spots are fairly frequent.

Agricultural Adaptations and Development.—Crops on these soils are typically un-uniform, with short, poor stands showing over the fields on the cloddy "burnt-out" patches. Low drought resistance, poor root penetration, alkali salts at shallow depths, cultivation troubles and rather poor drainage in wet seasons are a few of the factors which tend to make most areas of "burnt-out" lands comparatively unprosperous. In years of plentiful moisture, production is usually satisfactory, and with several years of cultivation the cloddy patches improve, especially if not extensive. Unfortunately most soils of this type occur in regions subject to drought and hot summer winds. A large number of grain farms have been abandoned, especially in the areas indicated on the map by numerous circles as being especially affected. Those who have been successful are mostly men of exceptional ability who have studied local conditions and modified their farming methods to suit the situation.

Careful summerfallowing every second year, or at least not less frequently than every third year, seems advisable. A number of farmers report improvement of the "burnt-out" patches by turning under well rotted horse manure during the fallow seasons. Others report good results by turning under an early growth of sweet clover. Experiments are now being conducted on an experimental farm near Radville (east of the surveyed area). This farm is a substation

*In soil survey report, No. 3, covering the Robsart area, this soil was classified as "burnt-out" fine sandy loam. Further investigation showed the desirability of classifying the type as "Echo clay loam."

of the Dominion Experiment Station at Swift Current. A report of the results is given in pamphlet No. 114, Dominion Department of Agriculture.

SOIL TYPES OF THE HATTON SERIES

These soils are distinctly sandy and frequently gravelly. The soils are apparently derived from material deposited by glacial streams (outwash) and from soft sandstones of pre-glacial times. The topography is mostly undulating, and stones are few or absent.

Hatton Very Fine Sandy Loam, Fine Sandy Loam, Sandy Loam and Gravelly Sandy Loam.—These soils are well scattered over the north part of the area. The very fine sandy loam is very inextensive.

Under the prevailing semi-arid climate the general agricultural adaptations and values are similar. The four types are, therefore, discussed together.

Description.—The surface soils are typically light grayish brown in color and contain sufficient clay and silt particles to hold the soils from drifting when unbroken. However, they tend to drift badly under cultivation. Subsoils are usually sandy, open and loose, but subsurfaces are frequently rather hard and compact, the result of cementation by compounds carried from the surface.

The water holding capacity of these soils is very low, and loss of moisture by percolation to lower depths very rapid.

Despite their very sandy character these soils contain sufficient plant food to produce good crops in years of abundant moisture.

Although stones are few or absent, large amounts of gravel occur in the gravelly sandy loam type.

Sloughs and lakes in these areas usually contain much alkali.

Agricultural Adaptations and Development.—On the whole, lands of these types are not well adapted to wheat production. Low drought resistance and soil drifting are the chief handicaps. In addition there is the usual regional difficulty of hot summer winds. Under the prevailing semi-arid conditions even much heavier soils are frequently unable to withstand the drought and hot wind handicaps, so that with their much lower moisture efficiency these soils are very "chancy" for wheat production, to say the least. Much of the land now cultivated should never have been broken, and could be used to better advantage if seeded down permanently.

Judging from past results a system of agriculture far more suitable than wheat production seems to be the growing of fall rye as the chief cash crop, and the raising of appreciable numbers of livestock on more extensive land holdings than are usually farmed for wheat. Such a system should provide for native and cultivated pastures as well as for forage crops for hay. Judging from the results obtained at the Swift Current Experiment Station and by local growers, care should be exercised to sow the rye between about August 15th and September 15th. Earlier or later seedings are apt to give poor results.

Forage crop production is a difficult proposition on these soils as well as on the heavier types.

Most sandy lands of this region must be tilled somewhat differently than the heavier soils if drifting is to be avoided. The aim should be to reduce soil pulverization to a minimum and to produce a lumpy, ridgy surface, especially during late winter and early spring when drifting is most apt to occur. Summerfallowing should be minimized, and, in serious cases it may be advisable to avoid the practice altogether or nearly so.

Late plowing of fallows, less use of disc harrows and other pulverizing implements and more use of such an implement as the duckfoot cultivator to bring up subsurface clods, are practices which have proven advantageous. One-way discs and certain types of cultivator drills, in place of plowing, have proven satisfactory. Further discussion of tillage is given on page 43 in the discussion of the agriculture of the area.

Improvements on these soils are usually fair to poor. Many farms have been abandoned. At the same time there are some farms as prosperous as on heavier soil types. Favorable soil variation and superior management are but two of a number of factors explaining these exceptions.

Water is, as a rule, easily obtained.

Poor drought resistance and soil drifting are the two outstanding handicaps to crop production on these soils.

SOIL TYPES MAPPED AS MIXED CYPRESS AND HAVERHILL SERIES

A number of soil belts are made up of small areas of Haverhill and Cypress soils, usually in parcels too inextensive to warrant separation in a broad soil survey. The typical Cypress soils occupy higher, moister bench lands, usually of smooth topography, while the typical Haverhill soils occupy the lower plain lands. The mixed belts of the two series occupy intermediate elevations usually of mixed topography. In these mixed belts the Cypress soils occupy much of the more level portions and moist depressions, and the Haverhill soils, the slopes, and sharp knolls. Descriptions of the soils of the Cypress Series with a discussion of their agriculture is given on page 19, and of the Haverhill Series on page 25. The following textural grades were mapped in the mixed Series belts: clay loam, loam and light loam.

GENERAL LAND CLASSES

These groups include lands which do not fit well into the regular Series and type system of classification. Most of the areas are of comparatively low agricultural value, each type being seriously handicapped by one or more conditions strongly adverse to farming, such as roughness of topography, excessive moisture or alkali, or susceptibility to extreme drifting.

Hilly, Eroded Lands.—Most of these areas are made up of ridges and hills. The elevations have been formed either by morainic deposits (glacial) or by intense erosion. The former type usually has numerous sloughs between the elevations and the latter type numerous coulees. Both kinds tend to be moderately or very stony. These lands occupy about 12.9% of the surveyed area.

With such topography, constant erosion prevents the development of extensive areas of normal soils, the surface natural to soils of the region frequently being very shallow, or absent. Most of these lands are medium or heavy in texture.

Agriculture is limited almost solely to pasturing, chiefly ranching. Isolated areas of smooth land, suitable for grain farming, occur scattered over the belts. Such areas, however, are usually handicapped by poor roads, distant markets and lack of community development.

The luxuriance and quality of native grass varies greatly. Soils of the Cypress Plateau usually have heavier stands than those of the plains, and depressions and lower slopes heavier stands than knolls and upper slopes. Sloughs, marshes and flood plains of streams, which dry sufficiently in the fall to permit haying operations, provide feed for winter and reserves for dry years.

Dissected Plateau Land.—Areas so classified occur in the Wood Mountain plateau. They occupy about 4.1% of the surveyed area. They represent lands which once occupied a broad, smooth plateau, which is now cut into numerous small plateaus by many coulees, most of which are rather steep sided, narrow and deep. The smooth areas vary greatly in size. Where extensive, they are mapped as Wood Mountain loam.

Isolated farms occur here and there over these dissected areas, but the major portion is not suitable for cultivation except in small areas in connection with ranching. The utilization of these lands is generally similar to that of the hilly, eroded lands above discussed.

Sand Lands.—The texture of the soil of most of these areas is fine or very fine sand. Sand lands occupy about 4.1% of the surveyed area. Such soils are usually formed into dunes of varying shape and height. Many areas are wavy and undulating, and others rolling to hilly. The higher parts of the large dunes are usually loose sand, while the lower dunes and lower slopes of high dunes are usually covered with vegetation. Frequently there is a luxuriant growth of shrubs, herbs and grasses between the dunes, due to the comparatively high water table and ease of root penetration. Aspen and willow scrub also prevail in a number of dune areas, and were doubtless more plentiful in the past before their removal by settlers for fuel.

The sands from many dune areas have shifted sufficiently to seriously damage neighboring farms. In many cases productive soils have been covered with a layer of sand sufficiently deep to greatly lessen their productivity. A fair amount of abandonment has resulted from this cause.

Cultivation, and even close pasturing, have released areas of sand which would no doubt otherwise have been held in check and not drifted badly.

Alkaline marshes and sloughs are fairly numerous between dunes in the sand areas.

Stones are usually very few, or absent.

The dune sands occur chiefly in the northwest quarter of the surveyed area.

Only a small proportion of these lands have been brought under cultivation. Few farms on such land have operated with a profit and the majority have been abandoned. Low drought resistance, and a serious tendency to drift, are the chief reasons for their poor showing.

Extensive belts of dune country are being profitably used for ranching, especially for sheep and cattle. In a number of such areas the necessary water, shelter, pasture and hay, are available or may be conveniently provided.

Alkali Lands.—These lands occur as river, creek, lake and slough flats. Such locations are subject to periodic flooding, and the accumulation of surface drainage from nearby higher lands. They are found scattered over most of the surveyed area, varying in size from a few acres to a number of square miles. Only the larger areas are mapped in this survey. They occupy about 4.7% of the surveyed area.

The soils of most of the alkali lands are heavy, being high in silt and clay. The effect of the alkali is to intensify the heavy, sticky condition, making most of such lands rather difficult to work. Stones, boulders and gravel are seldom present.

The topography is typically level to undulating.

The alkali concentration varies from slight to strong. This is true both within single areas and in comparing different areas. The concentration at various depths also changes with seasonal conditions, and time and degree of cultivation. Tests made on a number of samples from various parts of the area indicate that most of the alkali is of the white type and the predominant salts, sodium and calcium sulphates.

Drainage is usually deficient, at least during part of the growing season. Some lands, especially small sloughs, drain early enough in the spring to permit cultivation for late crops.

Intolerance of crops for the alkali, together with poor drainage and usually heavy "gumbo" soils, make most of the alkali lands generally unsuitable for ordinary grain production. The greater portion of such lands is utilized for wild hay or pasture.

Where the alkali is slight or moderate, and drainage not too poor, many areas are cultivated for grains or grasses or sweet clover. Oats and barley are somewhat more resistant to alkali than wheat, and western rye grass and brome grass are more resistant than the grains. Some difficulty is usually experienced in getting a stand of sweet clover. When established, however, this crop has, in many instances, given good yields, and apparently improved the land for other crops. Manuring and cultivation have improved many mildly alkaline lands sufficiently to permit profitable production of ordinary crops. Drainage, when feasible is desirable, not only to remove excess moisture, but also to hasten the removal of alkali salts by the leaching resulting from the lowered water table.

AGRICULTURE *

History, Development and Present Status.—The agricultural history of the area varies considerably for various soil types. This is true, not only of the degree and manner of agricultural utilization of lands, but also of general community development. On some soil types progress has been such that most of the land is utilized, improvements are generally good, and a rounded community development has been attained. Other soil types, on the other hand, have been only thinly settled and moderately developed. Still other lands have suffered severe setbacks resulting in considerable abandonment. Such areas lack much in settlement improvements and community organization. If present low wheat prices maintain, the divergence of progress by soil types will no doubt become even more marked.

*This discussion is based chiefly on information gathered from field observations of the soil surveyors, from interviews with farmers and from reports of the following:—The Dominion Census of 1926, the Dominion Experimental Station at Swift Current, the Annual Conferences of Saskatchewan Agronomists, and the Saskatchewan Department of Agriculture.

Previous to 1882 most of the country was used as range land, the sparse population consisting almost entirely of ranchers and "squatters". In the above mentioned year the transcontinental line of the Canadian Pacific Railway was built across the area. Settlers soon began to take over the lands under the homestead system, and during the next three decades most of the extensive cattle, horse and sheep ranges were converted into grain farms. Settlement began along the main railway line in the northeast part of the area and spread rapidly westward.

The homestead movement was in full swing over most of the area by 1909, reaching its climax in most places by 1916. The building of the Shaunavon-Govenlock branch line of the C.P.R. in 1911 stimulated the development of regions south of the Cypress Hills Plateau. Other branch lines built in recent years have remedied adverse marketing conditions in various districts and stimulated some further development. By 1926 the total population had attained a density of 4.8 per square mile, and the rural 3.8 per square mile. More detailed population data are given in the Appendix on page 81.

As the result of the homestead movement ranching became restricted mostly to lands decidedly unsuited to grain production. Rough areas, very stony lands, marshy saline flats and the worst of the "burnt-out" soils make up most of this group. The ranch areas were retained as crown lands and reserved for range purposes on a grazing lease arrangement. Recently the natural resources have been acquired by the Province, and these lands will be under provincial control.

With the acquisition of lands by the homestead movement spring wheat production became the dominant farm project, and has remained so on the majority of farms. Probably the chief reasons for this have been the general popularity of wheat farming, the adaptibility of the product to storage and distant marketing, the usually satisfactory prices and the superior adaptation of wheat to the prevailing climate and to many of the soils in comparison to most other crops. Compared to the more moist parts of the Province to the east and north, the protein content of wheat is usually higher, and there is generally less hazard from frost and rust. On the other hand there is far more hazard from drought, hot summer winds and soil drifting.

However, the experiences of this pioneer stage of farm development has proven the unsuitability of a number of soil types to spring wheat production; and the adverse conditions have forced a change, at least partially, to a greater dependence on other agricultural products, especially fall rye and live stock. The Dominion Experimental Station at Swift Current, although less than a decade in operation, has done a great deal to solve agricultural problems peculiar to this semi-arid part of Saskatchewan. The various

Illustration farms under the direction of the Experimental Station are also contributing much to the agriculture of local districts.

Some soil types have failed to support prosperous farming, and there has been considerable abandonment of many farms on such lands. Insufficient drought resistance in the prevailing semi-arid climate has been largely responsible for this movement. Sandy lands have, therefore, been most seriously affected. Alkali salts, "burnt-out" condition of soils, roughness of topography, and other causes have also been responsible.

The adoption of the summerfallow as a regular farm practice in grain production has been the most significant tillage development. Its great value lies in its conservation of moisture, chiefly through weed control. The summerfallow is discussed in detail on page 43. The common practice for many years has been to grow two successive crops of grain, usually wheat, after the summerfallow. The preparation of both the fallow and stubble land is discussed on pages 43 to 47. In recent years a number of farmers have been growing only one crop after fallow, keeping half the land cultivated each season. The practice is confined largely to heavy soils. On the other hand, due chiefly to difficulties with soil drifting, some lands are seldom fallowed or only partially fallowed. In such cases fall rye is usually the chief crop. This practice is most common on sandy lands.

Another outstanding progressive step has been the introduction of Marquis wheat and other superior varieties of both grain and forage crops. These varieties have greatly aided the farmer to combat the various difficulties involved in grain production under the prevailing environment.

A serious handicap to the development of diversified farming systems is the difficulty in growing forage crops, due chiefly to the limited moisture supply in most years, and to the frequent hot summer winds especially over the western part of the plains area. For the same reason it is not easy to grow most garden crops, trees for shelter belts, and flowers and shrubs for beautifying farmsteads.

Crop yields and general prosperity have fluctuated with the amount of annual precipitation more so than with any other factor. The summerfallow has lessened the dependence on rainfall of the current growing season, but the stored moisture of the fallow must usually be supplemented by growing season rains to produce good crops. Several periods of prolonged drought have occurred, one of the most outstanding of recent years being the period 1917 to 1920. These and shorter periods of drought have been responsible for most crop failures or low yields. On the other hand there have been years and periods of abundant rains which have resulted in bumper crops. The years 1915, 1922, 1923 and 1928 are outstanding examples. The yields of the more important crops are given in the discussion of "Crops and Crop Adaptations", beginning on page 38.

Although drought has been the cause of most of the unprofitable yields, other factors have been important. These, however, have been significant only occasionally or locally. Frost and rust have taken heavy tolls in occasional years. There is no doubt, however, that this part of the Province (except for the high bench lands of the Cypress Hills Plateau) has suffered less from both hazards than have the moister regions to the east and north. Soil drifting, hail, grasshoppers, wireworms and other insect pests and hot summer winds have also at times seriously reduced yields, but damage from these causes has usually been local in scope.

In recent years various marked changes in agricultural development have occurred, and a number of definite tendencies become apparent. On the smoother and heavier lands power farming has become increasingly popular and apparently the unit size of farms and farm machinery increased. On these same lands there is also an increasing tendency toward fallowing half the land each year rather than a third as in the past. On light soils the tendency is to reduce or eliminate fallowing by growing fall rye or fall rye and wheat.

On most soil types there is constant effort being made to reduce costs of tillage and other operations. The ploughless fallow, the use of combined tillage and seeding machinery such as plough drills and cultivator drills, and the combined harvester and thresher, are steps in this direction.

Certain farming difficulties have become intensified. This is especially true of the menaces of weeds, soil drifting and insect damage. Each, however, varies greatly in intensity with different soil types.

The farming population has become more stable than in past years. Many of the early settlers came to exploit the land and not to make permanent homes. A large part of these, and of others, unsuited to conditions have been eliminated.

Very recent investigations have demonstrated that phosphate fertilizers benefit grain crops on many soils, but more especially wheat on heavy lands. Not only has there been increased yields, but hastening of maturity, improvement of grades and other benefits usually of lesser importance. Further details regarding these experiments are given on page 53.

A matter which may have far-reaching results on Saskatchewan agriculture is the present low prices for wheat. If these maintain, wheat production on a number of soil types will be a hazardous proposition.

Crops and Crop Adaptations *.—The paragraphs under this heading deal with grain, forage and horticultural crops, discussing them chiefly from the standpoint of relative importance, adaptations, yields and varieties.

Grains.—Grain production, with spring wheat as the principal crop, forms the basis of the agriculture of the area. Other crops are grown almost solely as side lines for special purposes.

Spring wheat, in 1926, occupied about 77% of the total acreage of field crops. Average yields for the area have varied from about 4.7 bushels per acre in 1919, a very dry year, to about 26.5 bushels in 1928, a moist year. Yields on individual farms have ranged from complete failures to as high as 50 bushels per acre. Quality and grade have also had as great a range. Marquis is the best general variety for the plains areas and Reward for many soils of the Cypress Series on the higher bench lands of the Cypress Hills. The cropping system usually followed is fallow, wheat, wheat. The protein content of wheat from the plains areas is usually higher than for the Cypress Plateau and other more moist parts of the Province, but the hazards of production are in general, also greater. Soils of the Cypress and Sceptre Series, and the better lands of the Fox Valley, Haverhill and Wood Mountain Series, are in most cases better suited to wheat than are most other soils of the area. Tillage methods are discussed on pages 43 to 47.

Oats are grown chiefly for feed for livestock. They are usually cut as sheaf oats in the early dough stage, and frequently grown on the more poorly drained later soils of the farm. About 15% of the total field crop acreage was occupied by oats in 1926. The best general varieties for the area are Banner and Victory. Gopher is recommended where an early variety is desired. Average annual yields have varied from about 9.7 bushels per acre in 1919 to about 42.8 bushels in 1928. Oats are not nearly as well adapted to the prevailing semi-arid climate as wheat. The best insurance of a paying crop seems to be to grow them on summerfallow land.

Rye, in 1926, occupied about 2.8% of the total field crop acreage. By far the greater portion of this was fall sown. It is grown largely on soils of low drought resistance, principally the sandy lands of the Hatton and Haverhill Series of soils. Fall rye is especially valuable in checking soil drifting, for the damage from drifting is usually greatest in the early spring. For good yields it is important to sow the rye within the week following or previous to September 1st. On sandy lands during recent years it has been considerably grown in alternate years with wheat, without summerfallowing. Another common practice has been to grow rye continuously for a number of years.

Flax, in 1926, occupied 1.6% of the field crop acreage, and bar-

*The statistical data is from the Dominion Census of 1926.

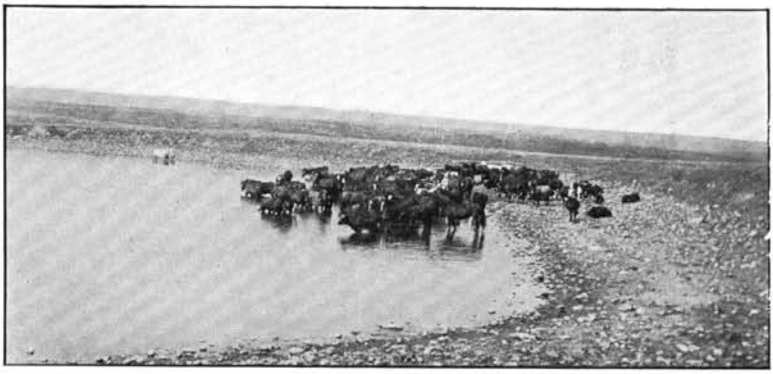

Fig. 11.—The water supply is a very important consideration in the area, to farmers as well as ranchers.

Fig. 12.—Abundant crops are produced on most soil types when the moisture supply is plentiful. Frenchweed is persistent on the heavier soils.

Fig. 13.—Uneven growth of grain resulting from the occurrence of "burnt-outs", or clay spots on soils of the Echo Series.

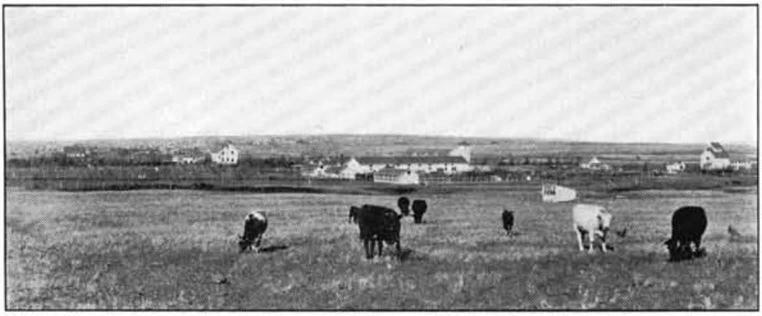

Fig. 14.—Dominion Experiment Station, Swift Current, with the city of Swift Current in the left background. Many worthwhile investigations are being made at this station of matters relating to dry land agriculture.

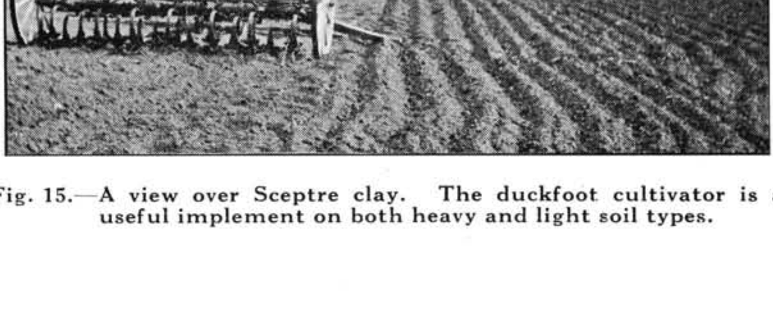

Fig. 15.—A view over Sceptre clay. The duckfoot cultivator is a useful implement on both heavy and light soil types.

ley a little less than 1%. In the past flax has been popular as the first crop on newly broken land. It has been a common practice also to sow it late on poorly prepared land. Average yields are low, ranging from about 2.9 bushels in 1919 to about 11.8 in 1928. A serious objection to the crop is that it tends to leave the land in a weedy condition. It is best adapted to the heavy soils. On the older cultivated lands the flax acreage fluctuates chiefly with prices and seasonal conditions.

Barley is grown to a limited extent chiefly for hog and cattle feed. Its feeding value is high. It is also a useful crop in controlling wild oats when cut early in the season for hay. Average yields have ranged from about 10 bushels per acre in 1919 to about 34.7 in 1927. Trebi is recommended as a feed variety, and Hannchen for malting.

Forage Crops.—One of the greatest handicaps to the development of diversified farming schemes in semi-arid Saskatchewan is the difficulty in growing forage crops. This is due chiefly to frequent insufficient moisture supplies for getting successful stands and satisfactory yields. Hot summer winds not infrequently intensify the difficulty. In 1926 about 1.3% of the total field crop acreage was occupied by forage crops. This included grains cut for hay or summer feeding. Soils of the Cypress Series, and the heavier lands of the various plains Series of soils are better adapted to the majority of the forage crops than are other lands of the area.

Of the perennial and biennial forage crops western rye grass, brome grass, sweet clover and alfalfa are most important. In 1926 brome grass occupied about .2% of the field crop acreage, western rye grass .1%, and sweet clover .08%. Both grasses stand prolonged periods of drought and severe winter conditions. Yields are determined largely by moisture supply. Difficulty is frequently experienced in getting satisfactory stands, owing to dry conditions and hot summer winds. This is especially true when the grasses are seeded with a nurse crop. Both grasses withstand more alkali than do most other field crops commonly grown, and are, therefore, useful for hay in alkali soils.

Sweet clover and alfalfa are the most satisfactory legumes. Arctic is the recommended variety of the former, and Grimm of the latter. As with the grasses, yields are seriously diminished in dry seasons. Alfalfa is very drought resistant. It is probably of greatest value as a crop to occupy the land for a number of years. Sweet clover is a biennial and better suited to the shorter rotations. Difficulty is frequently experienced in securing stands with nurse crops. Recent investigations indicate that for improving soil fertility it is highly desirable to plow the crop under during the early spring of its second season, before much of the nitrogen stored in the roots goes into the new foliage. Sweet clover is useful for utilizing alkali soils. Definite improvement of such land has been noted when this crop is grown.

With moisture the chief limiting factor in the growth of forage crops in this area much dependence must be placed on annual crops for feed for livestock. They are more dependable from year to year as they may be grown on land with reserve moisture. Oats, barley, wheat, millet and spring rye are all grown to some extent for this purpose.

Oats are superior to the others in quality. They are easily damaged by hot summer winds, but are, nevertheless, about equal to the others in yield. The best varieties for grain are also the best for forage. The crop is usually cut in the early dough stage. The beardless varieties of barley should be used rather than the common bearded varieties. About the only justification for growing wheat in place of oats is that it stands hot drying summer winds better. Spring rye also is very inferior to oats in quality, but is sometimes grown in emergencies for early hay, especially on sandy lands. Millet is valuable as a short season catch crop to be sown after the soil is well warmed.

Of the fodder crops sunflowers are probably the most dependable and highest yielding, and are, therefore, the best for silage purposes. They may also be fed green when cut daily.

Corn is better adapted to this area than to other zones of the Province. However, even in this zone it is not very satisfactory as a fodder crop. It holds some promise for pasturing livestock, especially hogs. Early flint varieties such as "Gehu" and "North Dakota" are recommended varieties. They mature in most seasons. Corn leaves the land in better condition for wheat than do either oats or sunflowers.

Horticultural Crops.—A great variety of vegetables, flowers and shrubs may be grown in the area, but great care is required to grow them successfully during seasons of drought or hot winds. Effective shelter belts, the storage of reserve moisture by well prepared summerfallow, comparatively thin spacing of plants and the selection of the most suitable varieties are all important factors in insuring success. Vegetables adapted to hot, dry conditions, will, of course, do better than those adapted to cool, moist conditions. Tree fruits are practically limited to certain varieties of crab apples, certain hardy plums and sand cherries. Of the small fruits raspberries, currants, gooseberries and strawberries are all grown successfully, but as is true of most other crops, it is difficult to get either satisfactory yields or quality in dry years. Frosts are, of course, a greater hazard than with most other crops. As is true of field crops, moisture, rather than fertility, is the important limiting factor.

Cropping Systems.—The prevailing cropping systems exist largely as the result of the following factors and conditions:—

1.—The semi-arid and sub-humid climate, with severe winter temperatures, comparatively short growing seasons, and frequent damaging hot summer winds.

Some outstanding results of this are the necessity of summerfallowing, the great difficulties in growing desirable forage crops and the restriction of the list of adaptable crops by the severe winter temperature. The summerfallow is justified as a means of supplementary growing season moisture supplies, thereby increasing the insurance of satisfactory yields. Crops grown on previously cropped lands do not yield nearly as well on most soils in most years. The fallow conserves moisture chiefly by checking weed growth

The more important climatic restrictions to forage crop production are the difficulties of securing good initial stands; the frequent curtailment of yields and reduction of quality by both drought and hot summer winds; and the winter killing of the less resistant varieties. Successful stands of most forage crops are more apt to be obtained by seeding on summerfallow land without, rather than with, a nurse crop.

2.—Economic restrictions. Distance from large markets curtails the bulk of production to products which may be carried long distances. Wheat, other grains, and livestock, are admirable for this. Farms near local consuming centres and shipping points frequently have the advantage, both in the range and quantity of products which may be in demand.

Present low wheat prices, if not materially improved, will no doubt have far-reaching influences on the whole prevailing agricultural structure of the area.

3.—The influence of soil conditions. Of particular importance are the insufficient drought resistance of many lands; the serious difficulties with soil drifting, or blowing on many of these same lands and on others; and a peculiar prevalent soil condition known locally as "burnt-out" (in soils of the Echo Series). This is discussed in the technical section under the scientific term "solentz".

Most soils are very fertile compared to most soils in more humid regions. Fertility limitations are discussed on page 53 under the heading "Soil Fertility"

4.—The personal element. First, there is the popularity of wheat production as a method of farming. The possibility of large rewards during periods of abundant moisture and high prices have led to many attempts to exploit the land rather than to develop homes and sound farming schemes, and to attempt to grow wheat on lands unsuited to this crop.

The same preference has curtailed the production of other crops and of livestock products on farms where this might be done to advantage, the operator choosing to gamble on seasons favorable to wheat production. The personal factor has also been reflected in the failure of many farm operators to observe and study local natural conditions and to adapt farm practices to them. This is exemplified by exceptional men getting satisfactory returns on soils which have been deserted by most of their former neighbors.

As the result chiefly of the above conditions the usual cropping system is summerfallow followed by two successive crops of wheat. A common modification on the heavier soils is to take only one crop of wheat, fallowing half the crop land each year. The advantages claimed are that the difference in yield on fallow as compared to stubble land more than pays for the extra tillage and smaller crop acreage, and that the problem of weed control becomes much less acute. On the better wheat lands (usually the heavier soils of smoother topography) the nearest usual approach to rotations as practised in the more humid and older agricultural regions of the world is the inclusion of small acreages of forage crops and other grains. Western rye grass, brome grass, sweet clover, alfalfa, sheaf oats, corn and sunflowers seem to be more commonly grown for forage purposes. Flax, fall rye, barley and oats are the usual additional grains. The acreage of forage crops is usually in proportion to the need for stock feed. The acreage of flax and barley fluctuate chiefly with seasonal conditions and prices. The oat acreage is, in addition, determined largely by the supply of stock feed required, especially for horses. Rye is grown only to a minor extent on these heavy soils.

On many of the sandy soils, chiefly fine sandy loams of the Hatton and Haverhill Series, a cropping system which has become popular in recent years is to grow fall rye and spring wheat alternately or fall rye in most years. Under such cropping arrangements there is little or no summerfallow. Soil drifting and low drought resistance are the two principal factors which have forced this change from the fallow, wheat, wheat system. On many of these sandy farms livestock production also is a major farm project. Such farms usually include or have access by lease to a section or more of native pasture land.

A recommended cropping system * for medium and heavy soils of the area, for at least a small part of the farm, where it is desired to modify the usual fallow-grain system, is the following: first year, fallow; second year, wheat seeded down; and third year, hay or pasture. This cropping system may be used to advantage for combating certain weeds, soil drifting, wireworms, sawflys and certain foot rots which attack cereals. At the same time it provides for including livestock in diversified farming systems. In most cases it would likely be more satisfactory to apply it to parts of the farm rather than to the whole. This cropping system may be extended

*See report of Annual Conference of Saskatchewan Agronomists, 1930, published by the Department of Agriculture, Regina.

to four years by including a second grain crop and seeding it down or by taking two seasons of hay or pasture. Sweet clover, western rye grass, brome grass, or any combination of these may be used. Or, the land seeded down may be left four or five years. This latter plan is especially advantageous in combating the sawfly.

Rough lands and other well drained lands may be utilized to advantage for permanent pasture by seeding down to brome grass. For alkali flats rye grass, brome grass or sweet clover, either singly or in combination are far more suitable than grains. They are all superior in alkali tolerance.

Tillage Practices.—The chief aim of tillage of cultivated soils in these semi-arid regions is to conserve soil moisture by checking weed growth, and to do this economically and without seriously promoting such difficulties as soil drifting and damage from wire worms and pale western cutworms. Stubble, dead weeds and other surface trash are either destroyed by burning or worked into the soil to help check drifting.

Tillage practices in the area will be dealt with as related to the two general types of land preparation, viz., the summerfallow and land previously cropped (stubble). Methods of breaking and handling newly broken land will receive little attention as most lands suitable for grain production are already under cultivation.

The Summerfallow.—The importance of this practice in dry farming agriculture has been stressed in previous paragraphs. The chief aim, of course, is moisture conservation through the control of weeds. The particular methods and implements employed should, in most cases, be determined chiefly by prevalent weed species, the seriousness of soil drifting tendency, the ease of working the soil type, economy and the probabilities of wire worm and cut worm infestation.

Of the weeds, Russian thistle is prevalent on all important soil types; tumbling mustard on most of them; stinkweed (Frenchweed) and Wild Mustard on the heavy plains soils; and wild oats, lambs quarters and stinkweed on soils of the Cypress Series. Russian thistle is most troublesome in dry years. Many other weeds occur, and the above grouping is very general.

Soils of the area vary greatly as to ease of working, scouring properties and probability of seriously drifting. In general the Sceptre clays, Fox Valley silty clay loams, Haverhill clay loams, Echo clay loams and poorly drained saline lands require the greatest amount of power and are most apt to give rise to scouring difficulties when moist. Both extremely heavy and extremely sandy soils are far more apt to drift than the medium textured types such as loams and clay loams. The sands drift as the result of their loose, single grain structure, and the upland heavy soils because of their very fine granular structure after a few years of cultivation. Loams and other medium textured soils resist drifting chiefly because of the lumps which are turned up from the naturally cloddy subsurfaces.

Wire worms and pale western cut worms are favored in their development by a loose condition of the soil. Consequently these insects are difficult to control when land is summerfallowed.

There are several strong tendencies in summerfallow practice in the area, viz., on clay soils to fallow in alternative years rather than every third year; on sandy soils to fallow but seldom, if at all; and on all soils to avoid ploughing as much as possible. The chief reasons for alternate fallow on heavy lands is that the higher yields and cleaner land apparently pays for the extra trouble on many farms. The chief reason for minimizing fallowing on sandy lands is to avoid soil drifting and to follow a cropping system of rye and wheat. The so-called "ploughless" fallow is followed to some extent on most soil types. It is far more economical, faster, and, if properly done, apparently about as satisfactory from the standpoint of weed control and yields, as the ordinary ploughed fallows.

Recommendations as to summerfallow methods, given below, aim chiefly at the control of weeds and soil drifting with implements adapted to the various groups of soils discussed. Economy of operations is especially stressed in the discussion of the ploughless fallow. In considering the matter of soil drifting it is well to keep in mind that the various control methods aim either to maintain a lumpy resistant soil surface or to protect the surface by a covering of straw or stubble. Unless necessary for weed control or some other purpose, stubble should not be burned or ploughed under, but should be worked into the upper surface soil by suitable implements. If advisable to burn the stubble, then ridges and surface clods must be depended upon for drift prevention.

The choice of implements for fallow work will be determined by a number of factors. The one way disc has proved well adapted to the ploughless fallow for at least the first operation. It is important to have large discs and close spacing for good work. The duckfoot cultivator and spring tooth harrow are excellent for bringing up moist subsurface soil to bake into clods and check drifting. The former is the more effective implement for weed control. The latter is used when the duckfoot fails to scour. The duckfoot is also excellent for following the one way disc in ploughless fallow. It is necessary to have the shovels sharp and in good condition to scour. The rod weeder has proven useful for uprooting tap rooted weeds, as a complementary implement to the duckfoot or disc. Its use should be confined to smooth land, free of stones, roots and soddy patches.

On light and medium soils late ploughing (July 10 to 20),

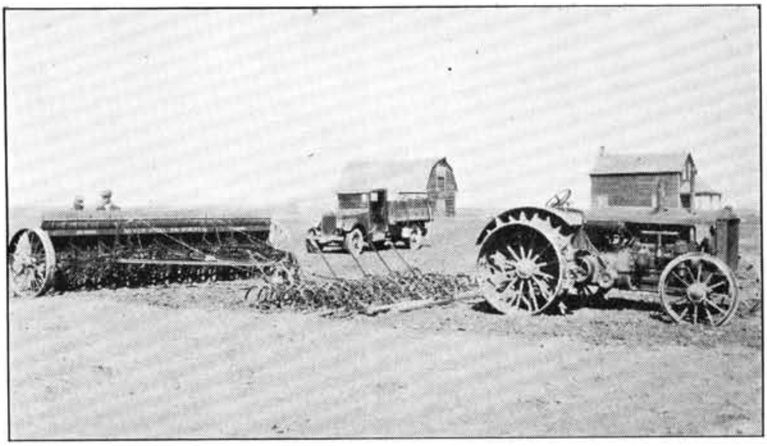

Fig. 16.—The combining of tillage and seeding operations is one of many means employed to reduce production costs.

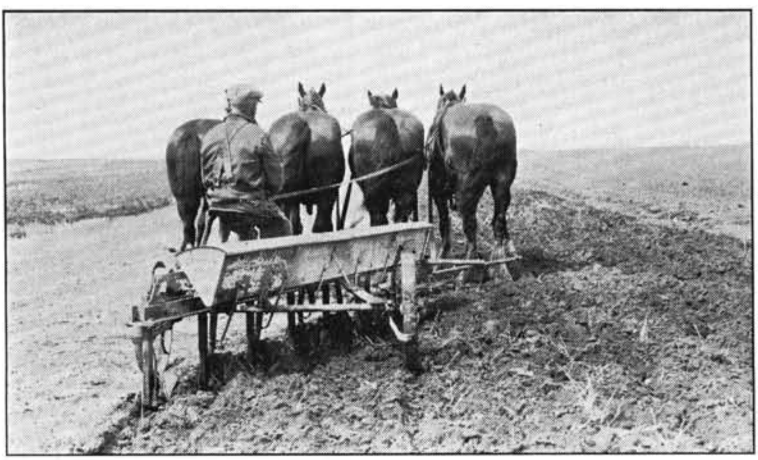

Fig. 17.—The seeder plough has been used to advantage in dry seasons to plough and seed in one operation. It should not be used on heavy, stony or trashy land.

preceded by surface tillage for weed control, is frequently an effective method of fallowing and of checking drifting. Weeds are kept in check during June by the disc and cultivator, and after ploughing there should be the least amount of tillage in order to avoid destroying clods. This method of fallowing is also promising for checking damage from infestations of wire worms and pale western cut worms.

On heavy clay soils the duckfoot cultivator or spring tooth harrow are very useful for bringing moist clods to the surface and checking the damage from wind action. The duckfoot cultivator is usually preferable if the shovels scour. Otherwise the other implement is better for the purpose, but usually not so effective in destroying weeds. It is important after a lumpy condition is obtained to avoid destroying it if possible.

On soils where drifting is extremely serious it may be advisable to only surface work the fallows for weed control, and to plough the following spring just previous to seeding, in order to maintain the most resistant type of surface during the period of drifting damage. This expedient, however, is usually not feasible as it increases spring work and delays seeding.

The so-called ploughless fallow has become increasingly popular. Advantages over the usual ploughed fallow are that it is less costly and may be more quickly done. Apparently weeds may be controlled about as effectively and yields not sacrificed. If the tendency to drift is at all serious, stubble should not be burned. Various implements may be used, but weed control must be effective with each operation. Deep tillage is not advisable except for weed control. For annual weeds the use of the disc or one-way disc is advisable as the early spring operation. When a second growth of weeds appear the cultivator is used, or, if surface trash is still sufficient to clog the cultivator, the discing should be repeated. Subsequent cultivation should be just sufficient to effectively kill weeds. A cloddy condition of the surface should be maintained to check soil drifting. Packing and harrowing after cultivating tend to promote drifting. Packing after seeding, however, tends to lessen wire worm damage, but this is preferably done by a press drill or press drill attachment on the ordinary drill. The ploughless fallow is most apt to be successful in soils which do not drift badly.

The nature of spring work, prior to seeding, on fallowed land, depends largely on prevailing weeds and the condition of soil as regards drifting. A recommended procedure for Russian thistles is to seed early to get the crop established ahead of the thistles. If such weeds as stinkweed, wild mustard or wild oats are also present it is usually advisable to delay seeding sufficiently to let the weeds germinate and destroy them by cultivation. A week's delay is usually sufficient. Long delay may be serious due to too great a loss of soil moisture. To combat damage to the seedling plants by soil drifting in the spring, cultivation with the duckfoot, previous to seeding, is usually worth while, especially on light and medium soils. On heavy soils, if the duckfoot fails to scour the spring tooth harrow is the best substitute for the purpose. In cases of extreme drifting it may be advisable to plough just previous to seeding. This is an exceptional measure, however, and seldom feasible. The purpose of all these spring treatments is to have a lumpy surface soil during the time when the crop seedlings are most apt to be damaged by drifting.

The following quotation from the 1930 Annual Report of the Dominion Experimental Station, Swift Current, indicates the results of their experiments with summerfallow substitutes: "The crops which in ordinary practice are grown in rows; namely, corn, potatoes and sunflowers, have proven to be the best fallow substitutes. Probably the chief reason for this is that weeds have been more easily kept under control in these crops than in small grain crops in rows. With wheat, oats and barley in rows it has been found impossible to keep the rows reasonably free of weeds without hand hoeing. Since hand work of this sort is out of the question on crops of such low value, the failure to control weeds constitutes the greatest objection to small grain crops in rows as fallow substitutes. Moreover, wheat following small grains in rows has not produced any higher yield than wheat after wheat in a three-year rotation. When the production of wheat in rows is added to the following wheat crop the total so obtained is less than the total production of wheat in the three-year rotation".

Experiments* are being conducted at the Swift Current Station to learn the best methods of conserving and utilizing soil moisture.

Preparation of Stubble Land.—Under the prevailing cropping system much grain is grown on stubble land, that is, on land cropped the previous season. The present tendency, as previously discussed, is to lessen this practice by fallowing every other year, especially on heavy soils. The choice of practices will depend largely, of course, on net returns of crops calculated on the basis of yields, grades and costs of production. The alternate fallow is, of course, more expensive in cultivation. Yields, however, are, in some cases, sufficiently higher to counteract this. Probably in the majority of cases weed control is more effective with the alternate fallow system, but not always. The amount of precipitation, of course, largely determines the comparative success of the practices in any given season. In lands infested with wire worms and pale western cut worms, the fallow promotes their growth. This, in many cases, must be seriously considered in choosing between the two systems.

*See Bulletin No. 301, New Series, "Soil Moisture and Crop Production," by S. Barnes and E. S. Hopkins, published by Department of Agriculture, Ottawa.

Another system, with no summerfallow, or only in occasional years, is that of growing fall rye and wheat in succession. This has been followed successfully on a number of farms on sandy lands during the past few years. Greater precipitation than usual has favored the practice during this period. How the system will stand up during dry periods is a question.

The following statement is taken from the 1930 Annual Report of the Dominion Experimental Station at Swift Current:—"Under conditions which produce poor crops of wheat on stubble it may be advisable to fallow half the land, but if the stubble crop is equal to seventy per cent. of the fallow then the three-year system is usually preferable".

At the same station, the average of six years' results on various methods of preparing stubble land, prove that the method of drilling the seed into the stubble without any previous cultivation gave the lowest yields. This so-called "stubbling in" was once a fairly common plan of planting stubble land, but is now seldom practised. In dry seasons fall worked land suffered more from drought than land worked in spring only. Weed control appears to be the factor of chief importance in preparing stubble land for wheat. The preparation must, therefore, be determined largely by the nature of weeds present. Burning of surface trash, and discing and cultivating after weeds have germinated, seems to be equal to more elaborate treatments.

An average for six years showed best results by fall burning, spring discing, harrowing and seeding, giving an average of 21.6 bushels of wheat per acre.

Experiments also indicate that delayed seeding on weedy stubble land for the purpose of killing an extra crop of weeds was not worth while. However, wireworm damage was greater in the plots of delayed seeding, and this must be considered in interpreting the results

Livestock Production.—As a major project livestock production is largely confined to the comparatively small number of ranches which still remain in the area. As pointed out in the agricultural history, ranching was the earliest form of agricultural development. The rapid conversion of most of the ranges into grain farms restricted the ranchers to limited areas, and, in most cases, to the poorer lands.

At the time of writing it seems to be a fair statement that the experiences of the pioneer stage of development through which the area is emerging have shown that, while certain soils have proved to be well adapted to grain production, the major portion of the land of the area is only fairly suitable for grain production, or decidedly unsuitable for this purpose and could be used to better advantage for ranching purposes. This is especially true of areas which are decidedly sandy, rough, stony, alkaline or "burnt-out". Many attempts at grain farming have failed, and numerous farms are either abandoned or in very straitened circumstances and facing a rather hopeless future. At the same time many ranches are in need of more suitable and more extensive range country.

Certain handicaps, however, will have to be overcome in any attempts to convert lands once cultivated into suitable range areas. It will be no easy matter to establish suitable grasses on the weedy abandoned fields and lands which are drifting badly. There are also economic and social problems, such as complication of ownership, financial adjustments and the influence on the social and economic life of municipalities and communities. Successful grain farms scattered through these poor areas would further complicate the conversion of these areas into range land.

Cattle and horse ranches are located chiefly in the rough areas of the Cypress Hills, the Wood Mountain and the strongly eroded area along the Frenchman River. Clydesdale, Percheron and Belgian are the chief horse breeds, and Hereford and Shorthorn of the cattle.

Sheep ranches are confined largely to the Sand Hills areas. Fine wool types, especially the Rambouillet seems to be the best blood for range conditions.

Summer range, water, shelter and winter feed are essential to ranching, and these are not always obtained in the rather limited areas now used for ranching. Streams and valleys are an asset, providing water, shelter, and frequently wild hay or irrigated forage crops for winter feed. They are also usually the most desirable locations for ranch homes and headquarters.

The quality of most of the prevailing upland native grasses is good, but faulty range management, especially overgrazing, have greatly reduced the carrying capacity of stock in many cases.

In very dry years the feed problem is sometimes serious, and occasionally severe winter storms cause appreciable losses in stock. Certain poisonous weeds, especially the loco weeds, are a factor to be considered in some localities. The Dominion Range Experiment Station, Manyberries, Alberta, will no doubt aid greatly in solving many ranch problems for this area.

Aside from ranching proper, livestock is produced both by small scale ranching projects as side lines to grain farming, and by the usual diversified farming arrangements. The former system is most prevalent in districts where grain farming soils border lands more suitable for range purposes. Examples of this would be Haverhill or Wood Mountain loams bordering eroded, rough areas, or Fox Valley silty clay loams bordering sand dune areas.

Diversified farming no doubt accounts for the greater portion of the livestock produced in the area. The numbers on individual farms, however, are usually small, and livestock production is not comparable to grain production in importance. In other words most farms are essentially wheat farms, producing sufficient livestock for farm and home requirements, but placing little dependence on it for cash returns. The farm business investigations * in the Swift Current district in 1927 and 1928 showed that only about 4% of the cash returns on loam soil farms were from livestock and livestock products, and about 8% on sandy land farms. On a number of sandy land farms in the western part of the area much greater dependence is placed on livestock in farming systems with fall rye as the chief cash crop and with appreciable numbers of livestock pastured on a section or two of native grassland.

The following figures from the Dominion Census, 1926, indicate the relative importance of various types of livestock. About 87% of the farms report horses; about 70% cattle; about 46% swine; about 85% poultry; and about 1.8% sheep. These figures cover both ranches and farms, but the ranches are few in number. The farm business studies * referred to above show the following numbers of livestock per farm: on the loam land, 17 horses, 7.9 cattle, 1.9 swine, 0.9 sheep and 59 poultry; and on the sand land farms, 16.5 horses, 9.8 cattle, 0.8 swine, 8.9 sheep and 52 poultry.

The majority of farms still depend largely on horses for working. Tractors, however, have replaced large numbers of them on a number of soil types during the past few years. Clyde, Percheron and Belgian blood seem to predominate.

Hereford and Shorthorn blood are dominant in most of the beef cattle, and Holstein, Ayrshire and Shorthorn, in most dairy stock. Dairying is largely localized near cream shipping points, and near the cities and larger towns.

Hog production is practically restricted to bacon types, with Yorkshire and Tamworth blood generally dominant. As is true with cattle production in diversified farming projects hog production becomes precarious in years of poor crops, due to their dependence on grain feed.

As indicated by the figures given above, poultry is raised chiefly for home needs. In recent years, however, poultry production has increased in importance as a source of cash income.

Sheep are raised on comparatively few farms. Fine wool ewes (especially Rambouillet), mated with suitable mutton breeds, seem to be the desirable type.

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*"Farm Management Research in Saskatchewan," paper by W. Allen, Farm Management Department, University of Saskatchewan, 1929.

Farm Size and Equipment.—A study of figures * from the Dominion Census for 1926 reveals the following as to farm size: approximately 42% were half section * *, about 18% quarter section, about 17% three-quarter section, about 12% section, about 10% larger than a section, and less than 1% smaller than a quarter section. The half section is, therefore, the most popular size, and only a small number of farms contain less than a quarter section or 160 acres. An appreciable number, on the other hand, contain more than a section. It is generally conceded that under the prevailing conditions at least a half section is needed for profitable grain production. When an appreciable number of livestock are kept in a diversified farming system at least an extra section is usually needed for pasture. During recent years there seems to be a definite tendency to increase the size of farms. This trend seems to be going hand in hand with the increase in power farming, and in size of mechanical units for the various farm operations. This whole trend toward larger scale grain farming operations has been most noticeable on the smooth, heavy soils (chiefly those of the Sceptre and Fox Valley Series.) The following statement regarding farm size is quoted from W. Allen * * *: "From these first studies the advantages of a farm decidedly larger than the average were apparent for Saskatchewan conditions."

Farm business studies made in the Swift Current area by the same authority in 1927 and 1928, show an average equipment value per farm of a little over three thousand dollars. The studies were made on 82 rolling loam farms averaging 772 acres in size, and 14 rolling sandy farms averaging 713 acres in size. The value of equipment represented about 9.4% of the total farm capital on the loam lands and about 15.3% on the sand lands. Conditions in this district are quite representative of average grain farm conditions and capitalization over the area.

The equipment on most farms in the surveyed area consists chiefly of implements and machinery used for power and tillage, and for harvesting, storing and carrying grain. The use of tractors has increased greatly in recent years, especially on smooth, heavy soils.

The usual outlay of tillage implements includes ploughs and disc and spike tooth harrows. Spring tooth harrows, stiff shank cultivators and rod weeders would be found on fewer farms, but are not at all uncommon. One way discs and combination cultivators and seeding implements, such as plough drills, seeder ploughs and cultivator drills, have been introduced on a fair number of farms in recent years. For seeding, the double disc drill has become standard. The single disc drill and shoe drills are used to a much less

*Based on Census Divisions Nos. 3, 4, 7 and 8.
* *A section equals 640 acres.
* * *"Farm Management Research in Saskatchewan", by W. Allen, Department of Farm Management, University of Saskatchewan, 1929.

extent. Recent successes with phosphate fertilizers would indicate a near future demand for fertilizer drills on many farms. Most grain is still harvested by horse-drawn binders. The power binder promises largely to replace it. The combine for larger scale harvesting has been adopted by a fair number of farms, though it is not well suited to many types of land.

Tenure and Labor Supply.—Figures from the Dominion Census for 1926 reveal the following as to land tenure: about 64% of the farms are occupied by owners, about 17.6% by renters, and about 18.3% by part owners and part renters.

Most renting is on a crop share agreement basis, the arrangement taking various forms, but usually involving the equal sharing of expenses and crops.

Except during harvest season most of the farm labor is performed by the farmers and their families. A number of the larger farms maintain outside labor during the spring season, and some the year around.

The farm management studies, referred to under the discussion of farm equipment on page 50, show 270 acres of cropland per man on the loam farm, and 247 acres per man on the sand farms; and a charge of labor and board per acre of cropland of $2.39, in the former case, and $2.80 in the latter.

Wages for harvest usually have ranged from four to six dollars per day with board. Wages for other periods, as for spring work, have ranged from forty to fifty dollars per month with board. If present economic conditions maintain these amounts will no doubt be less.

Improvements and Comparative Land Values.—Figures from the Dominion Census of 1926 reveal the following: about 65% of the area was in occupied farms; about 37% of the total surveyed area, or 56% of occupied farms was improved; and about 72% of improved land was in crops.

In general, improvements are best on the smoother medium and heavy lands, especially of the Sceptre, Cypress, Fox Valley and Haverhill Series. These include the more drought resistant farms. This applies not only to buildings, but to machinery, fencing, percentage cultivated, etc. Buildings are not in all cases a safe criterion of relative prosperity of the various types, for in some areas many of the large, well-built barns date back to 1915 and 1916, good crop years. Some of these farms have had comparatively few good crop years since that time. On the lands above mentioned, improvements are generally good, while on the rougher, lighter or stonier lands, improvements range widely, from very poor to very good. Improvements are especially poor on the very sandy and rough soil types.

The farm management studies referred to under the discussion of farm size and equipment place the average value of buildings per farm on loam land at $5,519.00 or $9.26 per acre of farm land, and on the sandy land at $4,289.00 or $7.94 per acre of farm land. Values would no doubt be higher than this on some of the smoother and better wheat lands, such as Sceptre clays, and lower on such soil types as the poorer lands of the Echo Series.

As has been true in other parts of Saskatchewan, land values, and the demand for land, have fluctuated considerably. Such fluctuations have been associated with periods of high and low crop yields more so than with other factors. As one would naturally expect in a region with such a wide range in type and quality of soils there is also a wide range in land values. Suitability for grain production, especially spring wheat, is the chief measuring stick for determining comparative values when the lands are located reasonably close to marketing points.

During the period of soil survey field operations (1927-1929) $20.00 to $40.00 per acre seemed to be a fair range for the improved better soils of the Sceptre and Cypress Series; about $10.00 to $25.00 for the improved lands of the smoother, medium to heavy soils of the Fox Valley and Haverhill Series, and about $3.00 to $15.00 for improved sandier lands. Many exceptions will be found to these ranges, and they are given only to serve as a general index of values. At the time of writing there is little demand for land and values are declining. This is no doubt the result of the exceptionally low wheat prices, and the general economic depression.

The farm business studies * in the Swift Current area, place an average value of $28.99 per acre on 82 rolling loam farms, and $15.03 on 14 rolling sandy farms. The total capital per acre of crop land in the first case was $55.28, and in the second $36.54. The following quotation is taken from this report:—

"The prices of lands in Saskatchewan did not advance as much during the war as in some nearby states, but in many sections of the Province land prices should be considered out of line with their productive capacities

Water Supply —Water supplies vary greatly as to source, quantity and quality on various farms. Wells are depended upon for most of the supply, especially for home use. These vary in depth usually according to soil type and topography. In general, wells are deeper on heavier soils, and with smoother topography. As a rule wells on clays of the Sceptre Series and heavier silty clay loams of the Fox Valley Series are from 100 to 200 feet deep, and the water frequently contains noticeable quantities of lime and com-

*"Farm Management Research in Saskatchewan", by W. Allen, Farm Management. Department, University of Saskatchewan, 1929.

Fig. 18.—One of the better types of farmsteads, of frequent occurrence in areas of Sceptre silty clay and other superior soil types.

Fig. 19.—Ranch headquarters along Middle Creek in the Cypress Hills.

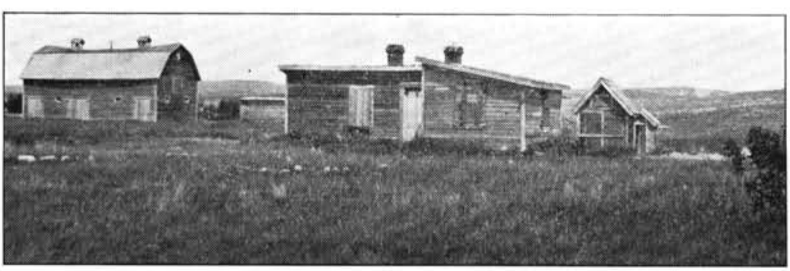


Fig. 20.—One of the poorer types of farmsteads, of frequent occurrence on rough, sandy, alkaline and other inferior soil types.

pounds of iron and other substances. On medium textured lands the more usual depth is from about 50 to 100 feet, and the water very variable in quality. On sandy land wells are usually quite shallow, from about 10 to 25 feet in depth, and the water usually better than on heavier lands.

On the ranches, and, to a lesser extent on mixed farms, dependence is placed to a considerable extent on sloughs, small lakes and streams for supplies for livestock. Frequently the water of sloughs and lakes is too alkaline for this purpose. Water supply is frequently a serious handicap to livestock production on smooth heavy soils of the Sceptre and Fox Valley Series. Artificial dugouts are occasionally resorted to for collecting water in these areas.

Water for irrigation purposes is economically available only in a few, inextensive, local districts bordering some of the streams with low flood plains. In most of such areas, however, the presence of alkali salts restricts the list of suitable crops chiefly to tame and wild grasses, sweet clover and some vegetables.

Soil Fertility.—There are many indications that, at present, moisture is far more important than soil fertility as a limiting factor of crop production in the surveyed area. In years of plentiful moisture most lands produce abundant crops of good quality unless there is serious damage by frost, rust or from other causes. Even very sandy lands have produced excellent crops in moist seasons.

Recent experiments * conducted for several seasons in an extensive investigation over the prairie provinces indicate that a number of soil types will respond profitably to phosphate fertilizing. Results have been most consistent and most marked on the heavier soils such as those of the Sceptre Series. Lighter lands have not responded nearly so well. For best results it is necessary to drill the fertilizer at the time of seeding. Broadcasting has not proven nearly as effective. Small amounts annually (about fifty pounds per acre of triple superphosphate) seems to be more suitable than larger applications. Applications on fallow have generally given better results than on stubble

Some of the more outstanding results of fertilizing have been increased yields, earlier maturity, more uniform growth of grain, improved grades, less difficulty with weeds and heavier tillering of young plants. Soils of the darker, more moist soil zones of the Province have responded better than those of the semi-arid zone in which most of this area occurs.

Under the prevailing system of farming involving the frequent summerfallow there is a considerable amount of cultivation which promotes rapid decomposition of organic matter, especially during the first few years of cultivation. Furthermore, under the pre-

*Data for Saskatchewan to be published by the Department of Agriculture, Regina.

vailing semi-arid climate it is difficult to grow forage crops, and not feasible to return large amounts of organic matter in a single season. Consequently the problem of depleted organic matter is a serious one. It is reflected strikingly in soil drifting which is at least partially a result of the working out of the original "fibre" or soil organic matter

Although the organic matter and nitrogen contents of these soils are much lower than in the darker soils of the more moist parts of the Province there seems to be no serious lack of nitrogen except possibly in cold, wet springs, on heavy soils. Undoubtedly nitrification is intense during the growing season, and much nitrate is stored by this biological process during the fallow year. The supply of nitrogen is at least generally sufficient to produce good growth when moisture is abundant and also a high protein grain. Some soils have given a response to nitrogen fertilizing, but the results have seldom been marked in the mature crop.

Experiments indicate that few soils respond profitably to potash fertilizing, at least for small grain production.

Practically all soils of the area seem to have a plentiful supply of lime carbonate either in the surface or subsurface soils.

A technical discussion of soil composition is given in the Technical Section of the report. Chemical data, from the analysis of soil samples are given in the Appendix.

TECHNICAL SECTION†

SOILS

Natural Environment of the Soil Zones.—The area surveyed lies between the latitudes 49° and 50° 25′ and longitudes 106° and 110°. It is in the northern part of the vast interior plains belt extending from Southern United States northward into Western Canada. The elevation ranges from about 2400 feet above sea level to about 4000 feet.

The larger part of the area lies within the semi-arid plains or brown soil zone of Saskatchewan. The remainder occupies a far less extensive sub-humid zone associated with the Cypress Hills plateau.

Climate.—Tabulated climatic data are given on pages 78 and 79, so that the discussion following is in the nature of a general summary.

The climate is of the north temperate, semi-arid to sub-humid, continental type, with a wide range between summer and winter and between day and night temperatures.

The winters are long and severe, temperatures usually reaching a minimum of at least -35°F. The ground is frozen for about four to five months, usually to a depth of at least three feet. There is a comparatively light snowfall.

Summer temperatures usually reach a maximum of 95°F or greater. The spring and fall seasons are comparatively cool. Nights are usually cool, even in midsummer.

The frost-free growing season averages about 108 days* for the plains zone and is appreciably shorter for the Cypress Hills zone. The comparative shortness of growing seasons is, to a considerable extent, compensated for by the great number of hours of bright sunshine during the long summer days.

Mean annual precipitation averages about 15.2 inches at Swift Current**, and about 12.8 inches at Medicine Hat, Alberta**, two points in the plains zone; and about 17.3 inches at Klintonel** in the Cypress Hills sub-humid zone. A little over 50% of the total precipitation normally falls in the growing season (April to July). Snowfall averages about 40 inches. Rains are both of the general and sudden shower type. Records for a long period of years show a wide variation in total annual precipitation, the low at Swift Current being 9.6 inches in 1894 and the high, 24.5 inches, in 1891. Annual snowfall for the same station has averaged about 40 inches.

†This section is primarily for those desiring information of a scientific rather than popular or practical nature.

*Average of 96 days for Swift Current and 119 days for Medicine Hat, Alberta.

**Swift Current, 1885-1926; Medicine Hat, 1885-1914; and Klintonel, 1910-1921.

Dependable, long time evaporation data are not available. There is no doubt, however, that evaporation is relatively great during most growing seasons, due largely to the warm temperatures, low humidity, winds, and the small amount of wind protection by trees.

Native Vegetation.—The dominant natural vegetation of the plains brown soil zone is an association of short, semi-arid grasses, with a scattering of such shrubs as sage brush (*Artemisia cana*), snowberry (*Symphoricarpus occidentalis*) and wolf willow (*Eleagnus argentia*). The dominant upland grass species are spear grass (*Stipa comata*), buffalo or blue grama grass (*Bouteloua gracilis*) and June grass (*Koeleria gracilis*).

The native vegetation of the cooler, more moist Cypress Hills zone is a mixture of the grasses above mentioned, with several sub-humid species such as oat grass (*Avena Hookerii*) and fescue grass (*Festuca viridula*). The grass stand is more luxuriant than on the plains below. There are scattered clumps of poplars and willows, especially in moist depressions and in ravines along the north slope of the plateau.

More detailed information regarding native vegetation and its significance in indicating soil character, is given in the section on Ecology on page 63.

Zonal Soils and Genetical Soil Types.—Soils of the area fall within two general soil zones which correspond to the natural environment zones mentioned above. The morphological character of soil profiles is apparently identical with or very similar to soils described for similar environments of the Russian Steppes. Russian classification terms are, therefore, freely used in the discussion which follows. Profiles are described chiefly from the standpoint of genetical types; and Series and types are discussed chiefly in their relation to parent materials and to the profiles of genetical types.

Soils of the Plains, Brown Soil Zone.—The environment is that of the semi-arid, short grass type discussed above. As the soils along the east side of the zone are adjacent to the main chestnut brown or transitional soil zone of the Province, these profiles show some of the characteristics of the latter zone. The following genetical types prevail over the area: brown earth soils, alkaline soils, solonetz, solonchak, and solonetz degraded to early stages of soloti. These occur both as small areas or patches in soil complexes and as fairly extensive areas.

In general, the alkaline types and brown earth types occupy locations which are well drained to considerable depths. The well developed solonetz types, for the most part, occupy areas of level to gently undulating topography, with somewhat restricted drainage, due to rather impervious substrata and occasional high water

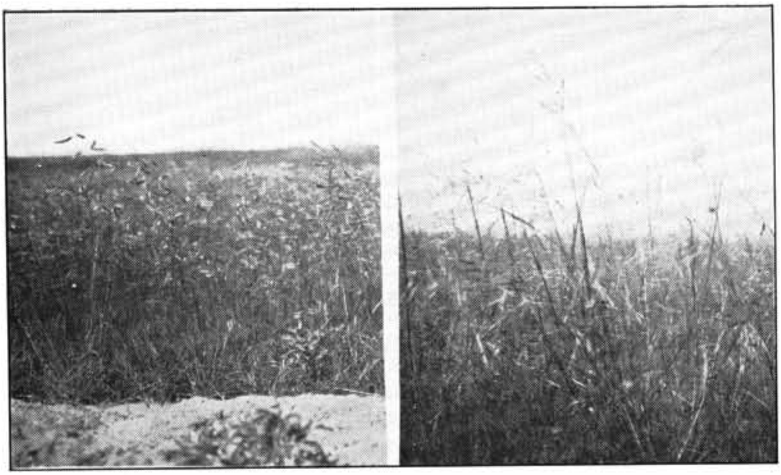


Fig. 21.—Buffalo grass (*Bouteloua gracilis*) **left, Spear grass** (*Stipa comata*) **right, and June grass** (*Koeleria gracilis*), **are the dominant species of the semi-arid grass association.**

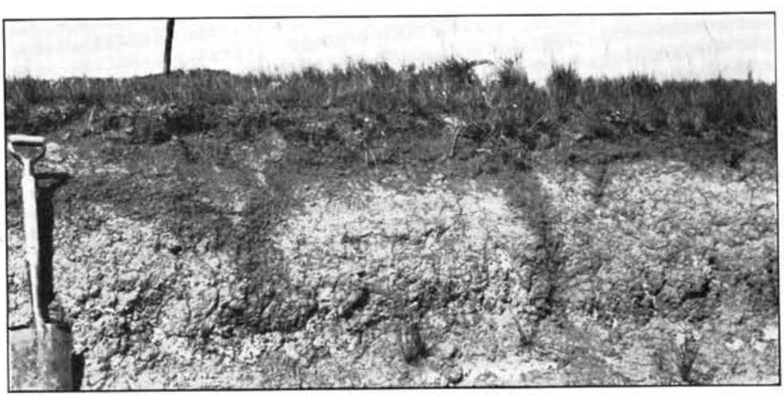
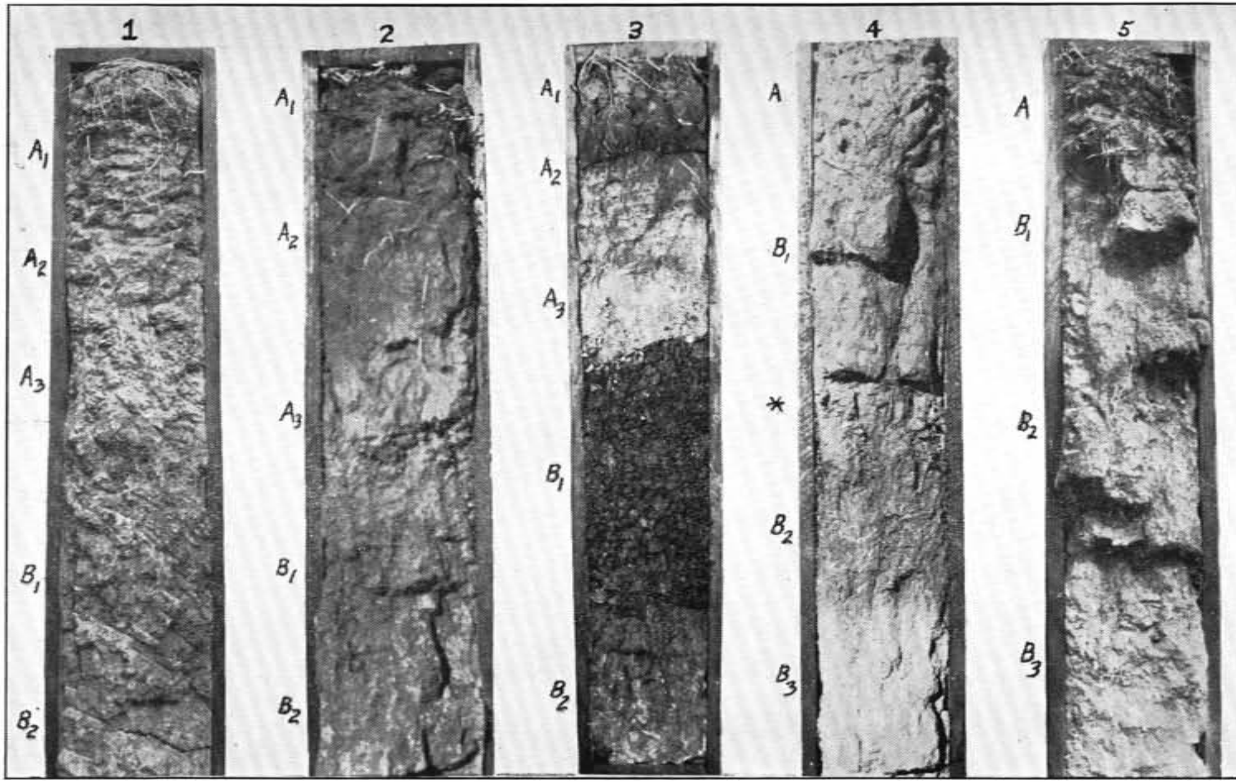


Fig. 22.—Profile of solonetz or "burnt-out" soil type (Echo clay loam). Note the irregular, dark cloddy B_1 horizon, and the large quantity of alkali salts beneath it.

Fig. 23.—Series of "Solonchak", "Solonetz" and Alkaline Profiles.



1.—Early stage of development of solonetz from solonchak. 2.—Moderate solonetz development. 3.—Well developed solonetz degrading to soloti. 4.—Alkaline (prismatic) structure above, and solonetz below. 5.—Normal alkaline (prismatic) structure.
Approximate depth of profiles, 20 inches. The B_1 horizon of No. 3 has been disturbed as the result of breaking and replacing.

*This horizon has the character of a solonetz A_3.

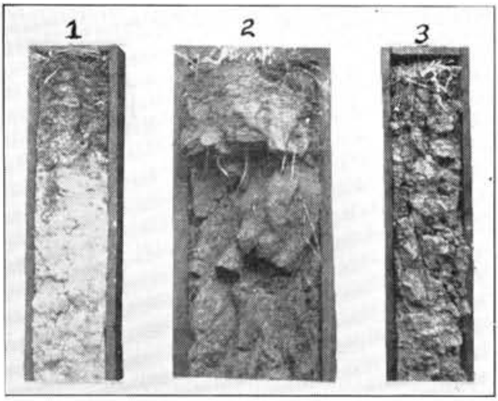


Fig. 24.—1. Solonchak. 2. Brown earth. 3. Cloddy, upland silty clay. Approximate depth of 1 and 3, eighteen inches, and of 2, twelve inches.

Fig. 25.—Illustrating the method of taking monolithic soil profile samples for laboratory studies and exhibition purposes.

tables. The degraded solonetz types are usually closely associated with the normal solonetz. Solonchak types occupy depressions around sloughs and lakes and along sluggish streams.

Features common to all soils of the zone except solonchaks are a film or thin surface covering of brownish gray, silty aeolian drift; a brown, light brown or grayish brown color of the A_1 horizon; one or more horizons of lime carbonate accumulation; more or less alkali salts in the B or C horizons; and flecks or concretions of limonite or ferric oxide in the C_2 horizon.

In the normal brown earth or non-alkaline types, the A_1 horizon is soft cloddy in structure, and one to three inches thick; the A_2 horizon, long cloddy, slightly heavier and more compact and usually grayish brown or yellowish brown, and about two inches thick. The B_1 horizon is of similar structure to the A_2, somewhat heavier and more compact and darker brown in color, and three to six inches thick. The B_2 is gray, grayish brown or yellowish gray, less compact, structureless or slightly long cloddy, and six to twelve inches thick. It contains the lime carbonate accumulation. The C_1 horizon is usually structureless or crumb-like in structure and dark gray in color. The C_2 is of similar structure, and dark gray in color, with reddish brown or yellowish brown flecks of ferric oxide or limonite, and usually contains small accumulations of gypsum.

The above description applies to soils of intermediate texture. Differences in the morphology of clay and sandy profiles are pointed out in the discussion of Series and types in later paragraphs.

The alkaline profiles differ from the brown earth profile described above, chiefly in having a laminated or foliated structure faintly developed in the A_1 horizon, and definite presmatic structure in the B_1, B_2 and upper B_3. The prisms are typically narrower above than below and heavier and are more compact than the surface. They are coated with dark brown or coffee brown staining, and have three to six faces. They usually break easily into flat-topped segments. The prisms are heavier, and of smaller diameter in heavier soils than in the lighter. The B_3 is the zone of lime carbonate accumulation, and is faintly prismatic above, and structureless below. The C horizons are similar to those of the brown earth, but usually with more alkali salts, chiefly sulphates of sodium and calcium. Alkali also frequently occurs in the B_2 and B_3 horizons. The depths of the A and B horizons average about the same as for the brown earths.

In the solonetz profiles the A_1 horizon is grayish brown to light brown, and usually soft cloddy or thinly foliated and easily crushed to single grains and fine granules. The A_2 is grayish light brown, foliated or squamose, and also easily reduced to a powdery or very fine granular state. The A_3 is characteristically light gray, foliated or laminated, and the lightest textured horizon of the profile, and easily crushed to single grain structure. The A_3 is not always present. It apparently indicates the degradation of the upper B_1 in the evolution of the solonetz to soloti. The B_1 is characteristically very heavy, dark brown or deep coffee brown in color, and very hard and compact. The upper part of the horizon frequently has a structure of round topped columns or clods. These columns and the lower part of the horizon break readily into hard, coarse granules. Grass roots usually follow the surfaces of the clods rather than penetrate them. The B_2 horizon is grayish dark brown to grayish brown in color, readily separates into hard granules and contains much alkali, salts and carbonates in the form of concretions, nests, mycelia, etc. The C horizon is dark gray, and usually contains moderate amounts of gypsum. It is only moderately compact, and only moderately heavy as compared to the B.

Except for the presence of alkali salts the solonetz profiles in many ways resemble the podsolic profiles of sub-humid Saskatchewan. This resemblance is even more marked in profiles degraded to soloti or evolving toward this type.

The most characteristic feature of the soloti is the laminated or foliated, light gray, almost white, coarse textured, pulverulent A_2 or A_3 horizon. In soloti profiles the hard, heavy B_1 horizon is thinner than in the solonetz, and the A_2 or A_3 horizon correspondingly thicker.

The thickness of horizons in both solonetz and soloti vary greatly, as shown by the accompanying photograph. The B_1 horizon in cuts takes the form of tongues and waves, its depth from the surface varying greatly even over short distances.

A peculiar feature of some semi-arid areas, with solonetz and soloti profiles, is the removal, probably by wind, of part or all of the A horizons in numerous small patches scattered over the land. These lands are classified in the Echo Series, and further discussed in later paragraphs.

The solonchaks have no characteristic structure except when evolved to a mild development of solonetz. They occupy saline areas, usually of small extent, scattered over the whole area in practically all soil types. The profiles not only possess high concentrations of salts, but have the characteristic mottling of poor drainage conditions in the subsoils.

Soils of the Transitional or Dark Brown Soil Zone.—This zone is comparatively inextensive in its occurrence in the area herein described. It occupies a local elevation, the Cypress Hills plateau. The main dark brown soil zone of the Province lies to the east of the area.

Chestnut brown (dark brown) earth types and alkaline types predominate in this zone. Chernozems occur in very small areas, where moisture conditions are more favorable and sodium salts have not accumulated in the upper soils. A few small areas of subhumid, podsolic soil (with a lime carbonate accumulation at a depth of less than thirty inches) occur on the north slopes of the Cypress Hills under a cover of poplar timber. The total area occupied is less than twenty-five square miles. Solonetz and degraded solonetz are far less prevalent and not as well developed as in the brown plains zone previously described. Prismatic structured B horizons are therefore frequent, but the dense, columnar and coarse granular B_1 horizons are far less frequent. Solonchaks occur in depressions, but the salt concentration is usually much lower than in the brown plains soils at the lower elevations.

The A horizons are darker and deeper and higher in humus in most soils of this zone than in the plains brown soils, and the horizons of lime carbonate accumulation are at greater depths from the surface. The carbonate accumulation is also more distinctly of concretionary form.

The chernozems have a granular structure, the aggregates enlarging with depth. These soils are very local and inextensive.

Parent Materials, Soil Series and Soil Types.—The geological origin of the deposits on which the various soils have developed has influenced profiles markedly, both through differences of topography and composition of parent materials. The topographical differences are reflected indirectly, but none the less strongly, as the result of associated differences in moisture supply, luxuriance of grass growth, erosion and deposition, and the presence and movement of alkali salts. The writer is of the opinion that, under the prevailing semi-arid and subhumid conditions, far greater soil variation results from local differences in topography than in humid regions. Even in areas of very moderate topographic range, variation is so marked as to frequently necessitate classifying the soils as complexes. It is not uncommon to find solonchaks, solonetz, alkaline soils and normal steppe soils within a distance of a tenth of a mile. At the same time there may be marked variation in surface color, depth and texture.

Series differentiation, although based on the character of profiles, corresponds closely with a separation on the basis of parent materials. For this reason the soil Series, types and parent materials are discussed together.

The Cypress Series and Types.—This group includes soils of the subhumid Cypress plateau zone, developed on thin glacial till mixed with Tertiary sediments. Alkaline and chestnut (dark brown) steppe profiles predominate. Profile characteristics may readily be inferred from previous descriptions of the alkaline profile of the plains zone and the profile discussion for the Cypress zone. Beds of water-worn quartzite pebbles of Oligocene age occur in the solum or substrata here and there over the soils of this Series. Two types, loam and clay loam, were mapped.

The Sceptre Series and Types.—This group includes soils of the plains zone derived directly or indirectly (through lacustrine deposits) from Pierre Shale, a Cretaceous formation which weathers into silty clays. The profiles differ appreciably from profiles of intermediate textured soils. There is far less distinct horizon development, the result of less rapid weathering and of immaturity.

The A horizon is steel or blue gray in color, with a faint brown tinge (dry), fine granular to small cloddy in structure, and two to four inches thick. The B horizon is more compact, somewhat heavier, coarse fragmental in structure, and dark gray or bluish gray in color. Where alkalinization has taken place the B horizon has a harder, heavier structure than usual. The C horizon is gray to light gray, large cloddy when dry, and contains gray splotches or concretions of gypsum and calcium carbonate. Effervescence usually occurs within two to six inches of the surface, and usually in the thin aeolian surface film.

The topography ranges from level to broadly rolling. Most areas have few or no stones and very little gravel.

Under cultivation the surfaces assume a fine granular structure which tend to drift badly, especially in late winters or early springs following the summerfallow season.

Light and heavy phases of silty clay were mapped.

Fox Valley Series and Types.—This group includes soils of the plains zone developed on lacustrine deposits, probably of glacial or early post-glacial age. A few small areas developed from loessial deposits are also included in the Series. The profiles are dominantly of the brown steppe and alkaline types. The latter dominates in the silty clay loam which has a heavy substrata, and the former in the lighter types which frequently have very fine sandy substrata. The thin gray aeolian surface covering is characteristic. The A horizon is typically grayish brown, or brown, silty and fine granular, faintly foliated or soft cloddy in structure. The B_1 is brown or dark brown, grading into grayish brown, is more compact, and long cloddy or definitely prismatic in structure. The B_2 horizon is very silty, gray or brownish gray, high in lime carbonate (distributed rather than concretionary), the upper part having a structure similar to the B_1, and the lower structureless or faintly foliated. The C horizon is darker gray and calcareous, and contains moderate amounts of alkali salts.

The topography of the lacustrine areas is typically level to undulating and of the loessial areas broadly rolling. Stones are few or absent in areas of this Series.

Three types and one mixed type were mapped, silty clay loam, silt loam, loam, and mixed silt loam and loam.

Haverhill Series and Types.—This group includes soils of the plains zone, developed on glacial deposits, which occur both as moraines and till plains. Profiles of the smoother phases are generally similar to those of the Fox Valley Series. They differ from the latter chiefly in usually having somewhat darker A horizons, somewhat more compact and more distinctly prismatic B_1 horizons and more lime concretions in the B_2 horizon. They also contain far more fine gravel and coarse sand throughout the profile, and considerably less silt.

Areas with topography stronger than undulating usually occur as complexes rather than as distinct soil types. Solonchaks are frequent in depressions which are marshy for part of the year, the salts frequently forming plainly visible surface crusts. Solonetz profiles commonly occur where water tables are occasionally high or subsoil drainage occasionally somewhat restricted. Alkaline and brown earth phases usually occupy the higher, well drained locations. The thickness, humus content, and textural grade of the surface soils and the depth to the lime horizon also vary greatly according to position on knolls and upper slopes as compared to lower slopes. The strongly undulating and rougher topographies of glacial till areas are, therefore, very mixed in the character of profiles. Such variation is usually reflected in the nature of crop growth and in the yields and quality of grains.

Stones and boulders usually occur on lands of the Haverhill Series in moderate or large numbers. There is also more or less gravel.

The following types, based on dominant textural grade of surface soils were mapped: clay loam, loam, light loam and fine sandy loam. In the following mixed types the textural grades mapped in each case were about evenly distributed: clay loam and loam, silt loam and loam, and light loam and fine sandy loam.

In general, the compact illuvial horizons of prismatic or cloddy structure, of the alkaline and solonetz types, occur more frequently and are better developed in the heavier than in the lighter soil types.

Wood Mountain Series and Types.—These soils are essentially similar to those of the smoother phases of the Haverhill Series. They occur on the dissected plateau of the Wood Mountain elevation, and are developed from slightly to moderately glacial Tertiary sediments. Profiles are dominantly of the alkaline and normal brown soil type. The areas are cut into numerous plateaus by coulees.

The Echo Series and Types.—These soils occur in the plains, brown soil zone.

They are derived from one or two phases only of the Pierre Shale formation (Upper Cretaceous), the geology of which has not been worked out in detail. They may be developed on the outcropping shale or on glacial drift which has been formed by the incorporation of these particular shales with erratic material. In other parts of the Province certain beds of the Belly River, White Mud and Estevan formations serve as parent material for similar soils.

The profiles are dominantly solonetz and degraded solonetz (soloti), with fairly numerous solonchaks. The outstanding surface characteristic is the shallow depressions of varying size, apparently caused by the removal of the A_1, the A_2 and frequently the A_3 horizons, probably by wind, exposing the dark brown, tough cloddy B_1 horizon as the present surface or subsurface. Between these depressions or so-called "burnt-outs", the typical full solonetz profile occurs *.

The topography is typically level to gently undulating. Drainage tends to be restricted in many places in moist periods, due probably to heavy subsoils, smooth topography and to the heavy B_1 horizon.

Glacial stones are thinly scattered over the areas.

The surface texture varies greatly, with clay loam, silt loam, and fine sandy clay, where the A horizon has not been removed, to clay loam and clay in the "burnt-out" pits. The type is a complex, but is classified and mapped in this report as clay loam, on the basis of the dominant surface texture.

The Hatton Series and Types.—These soils occur in the plains brown soil zone and are developed on Belly River, Tertiary and recent alluvial and aeolian sand deposits. The A_1 horizon is usually brown or grayish brown, loose and structureless. The A_2 is typically compact, moderately cemented, rusty brown or dark brown, and of large prismatic or blocky structure. The B_1 horizon is somewhat harder and heavier, and the prisms narrower. The B_2 horizon is gray or brownish gray, moderately compact, calcareous sand. It usually begins at least eighteen inches below the surface, as compared to about 10 inches for intermediate types, and 4 to 6 inches for clay types of similar drainage and topography. Profiles vary considerably from the above, but the one described seems to be the dominant general type.

Four soil types were mapped: very fine sandy loam, fine sandy loam, sandy loam and gravelly sandy loam.

Mixed Series and General Land Classes.—Mixed areas of Haverhill and Cypress Series were mapped due to the impracticability of a separation in a reconnaissance survey. These areas occur along

*Described on page 57.

the moderately eroded border of the Cypress plateau, at elevations intermediate between the plateau and the plains below.

Eroded lands, sands, and extensive areas of saline soils are classified and described as general land classes on pages 32 to 34, in the popular section of the report.

ECOLOGY

Various associations and species of native vegetation have proved to be significant as indicators of soil character and of agricultural adaptations. Such relationships, together with weed distribution according to soil types, are the principal matters discussed in this section of the report.

Native Vegetation Associations.—The dominant associations are the semi-arid grass group of the plains and the sub-humid grass group of the Cypress Hills plateau. Associations of lesser, but appreciable extent, are the saline group, the shrub group of sand lands, and the aspen woods group of high altitudes and escarpment ravines of the Cypress plateau.

The Semi-Arid Grass Association.—This is by far the most extensive group of the area. It is characteristic of the better drained soils (except sands) of the plains. Spear grass (*Stipa comata*), June grass (*Koeleria gracilis*) and blue grama grass (*Bouteloua gracilis*) are the dominant species. On moderately moist soils, not strongly saline, blue joint (*Agropyron Smithii*), wheat grass (*Agropyron dasystachium*) and a number of *Poas* usually predominate.

A number of shrubs and herbaceous plants are commonly associated with these grasses. Sage brush (*Artemisia cana*), mountain sage (*Artemisia frigida*) and various wild legumes are quite common, especially with the *Stipa-Koeleria-Bouteloua* group. Buckbrush (*Symphoricarpus occidentalis*) is frequently found in clumps in somewhat protected places such as runways and shallow ravines along hillsides. Cacti, chiefly *Opuntia polyacantha*, grow in very dry places such as "burnt-out" pits and stony, river escarpments.

There is a variation in the proportion of species with soil types, sometimes very marked. The Sceptre clays usually have almost pure stands of *Koeleria gracilis*, with *Agropyrons* dominant on moderately moist places. The stand of grass is very poor and furnishes only a thin pasture, but these soils under cultivation are highly drought resistant and among the best wheat lands of the plains.

On lands of intermediate texture and well drained, the three dominant grasses are usually well mixed. These lands are about medium in drought resistance and in suitability for grain production. Intermediate textured grades of the Fox Valley, Haverhill and Wood Mountain Series are of this group. A preponderance of

Stipa comata is usually associated with more favorable moisture conditions which occur during moist seasons, in depressed locations and with finer textures of soil.

In observations in Southeastern Alberta and Southwestern Saskatchewan, Clarke* found *Stipa comata* dominant on deep sandy soils, and *Bouteloua gracilis* on shallow soils, especially on southern slopes.

The Sub-humid Grass Association.—This association is characteristic of the Cypress Hills plateau lands, especially on soils of the Cypress Series. The three dominant semi-arid grass species occur, with *Stipa comata* the most prevalent. However, they are supplemented, and, in places replaced, by grasses found in the more moist parts of the Province. Of this supplementary group oat grasses (*Avena Hookeri* and *Danthonia intermedia*) and fescue grasses (*Festuca saximontana, F.viridula,* and *F.scabrella*) are common. There are occasional clumps of aspen (*Populas tremuloides*) and willows (*Salix spp.*) in depressions, and buckbrush is more prevalent than on the plains.

This general association, in most parts of the Province, indicates a higher humus content of soils and cooler and more moist climatic conditions than exist on the plains considered above. Such lands are usually superior to most plains soils for both forage and grains.

The Salt Grass Association.—This occurs on poorly drained saline soils in and around sloughs and along sluggish streams. Salt or alkali grass (*Distichlis stricta*), wild barley (*Hordeum jubatum*), greasewood (*Sarcobatus vermiculatus*), purple samphire (*Salicornia rubra*), gum weed (*Grindelia squarrosa*), and species of *Atriplex* are commonly found in moderately to strongly saline places. Sulphates of sodium and calcium usually are the predominant salts present. Soils are commonly heavy "gumbos". The salts frequently form surface crusts, especially in dry seasons.

Soils with such vegetation are seldom suitable for cultivated crops. Areas less saline are frequently suitable for western rye and brome grasses and sweet clover.

The Sand Land Shrub Association.—Sand lands may usually be detected from a distance by the characteristic clumps and large patches of shrub growth. Wild rose, wolf willow (*Eleagnus argentia*, wild cherry and buckbrush (*Symphoricarpus occidentalis*) are the more common species. Dwarfed aspens and willows are occasionally found between dunes in dune sand country. Most of the sand lands have either a low ridge or billow topography, or occur as a series of dunes.

*Clarke, S. E., Pasture Investigations on the Short Grass Plains of Saskatchewan and Alberta, Scientific Agriculture, Vol. X., No. 11, July. 1930.

Lands with such an association are seldom suitable for cultivation on account of extremely low drought resistance and of soil drifting. Serious damage to neighboring agricultural lands frequently results from the drifting sand. It may be released by close grazing as well as by breaking and cultivating. Seeding down to brome grass would be advisable for many of these sandy areas.

The Aspen Association.—This association occurs in the Cypress Hills, in ravines along the north escarpment and on the plateau at higher altitudes. Aspen (*Populus tremuloides*) is by far the dominant species. Black poplar (*Populus balsamifera*) usually occurs with it. Prevalent shrubs are dogwood (*Svida instolonea*), Saskatoon berry (*Amelanchier alnifolia*), willows, buck-brush, and hazelnut (*Corylus rostrata*).

The association evidences the cooler and moister climate of the north slope and high altitudes of the plateau. Podsolic soils (sub-humid type) occur in a few small areas.

Weeds and Poisonous Plants.—Although weed distribution is greatly influenced by many artificial factors weeds of the area do show a marked adaptation to soil types.

Russian thistle (*Salsola kali L.*) is the dominant weed of the plains zone. It is most prevalent on sandy and medium textured lands and in dry seasons. It occurs on practically all soil types. Although widespread, and able to spread rapidly as the result of its tumbling habit, it is by no means the most difficult weed to control. It is occasionally used as an emergency feed for stock in seasons of hay shortage.

Tumbling mustard (*Sysimbrium altissimum*) is also widespread, especially on medium textured soils.

The silty clays of the Sceptre Series and the soil types of the Cypress Series, in the sub-humid zone, have a number of additional troublesome weeds. French weed (*Thlaspi arvense*), wild mustard (*Brassica arvensis*), wild sunflower (*Helianthus spp.*), hare's ear (*Conringia orientalis*) and poverty weed (*Iva axilaris*) prevail on many of the Sceptre silty clays. Poverty weed is confined chiefly to moderately moist, slightly alkaline locations. It is a most serious weed pest on the Sceptre clays in a number of districts north of the area herein described.

On the Cypress loams and clay loams wild oats (*Avena fatua*), French weed (*Thlaspi arvense*), lambs quarters (*Chenopodium album*), various mustards and other humid weeds are troublesome. Russian thistle is less troublesome than on the plains soils, although it is of appreciable importance on the lighter loams in dry years.

The control of weeds and their relation to tillage practices are discussed in the section on Agriculture.

The following are listed as poisonous plants by Clarke * in his

*See foot note, page 64, for publication reference.

studies of native vegetation in the dry belt of Alberta and Saskatchewan: purple loco (*Aragallus galisides*), yellow loco (*Aragallus gracilis*), dwarf larkspur (*Delphinium bicolor*), horsetail (*Equisetum arvense*), prairie bean (*Thermopsis rhombifolia*), death camas (*Toxicoscordion venenorium*), and water hemlock (*Cicuta maculata*). Some of these pests are serious handicaps to livestock grazing in certain areas. The loco weeds are among the worst, especially on the upland ranges.

CHEMICAL AND PHYSICAL DATA

Only a small part of the data available for soils of this area is presented in this report. Data for a number of soil types herein discussed have already been published in Saskatchewan soil survey reports, numbers two, three and eight *. Although much additional data has been accumulated it is planned to publish most of it in later publications to be devoted to physical and chemical investigations of soils of the Province as a whole.

The discussion in this report is in the nature of summarized statements.

Tabulated data for a few samples of the more important types are given in the Appendix on pages 75 and 76.

Profiles.—The horizons of a number of profiles have been analyzed by the Van Bemmelin-Hissink acid extraction method. * * The data for the upper horizons of two of these profiles are given in Table III. in the Appendix.

The chemical data for these and other profiles analyzed agree in general with the morphological evidence that the majority of soils of the area are solonetz or solonetz-like (of alkali structure) in character, each profile also possessing the general features of the zone in which it occurs.

The zonal differences are evidenced chiefly by the variations in depth of the zone of carbonate accumulation, by the organic content of the A_1 horizon and by pH values. The Cypress Loam is from the transitional or dark brown soil zone, and the Fox Valley silt loam is from the plains brown soil zone.

There has evidently been a downward movement of bases, and a definite accumulation of alkaline earths, sesquioxides and carbonates in the B_1 and B_2 horizons. The insoluble residue is highest in the A_1 and the iron in the heavier, more compact B_1 horizons of prismatic or cloddy structure. Alkali salts occur in the C horizon and upper substrata in most profiles of these and similar soil types, and frequently in the B_2. The phosphorous, both by fusion and acid extraction analysis, is usually highest in the A_1.

*Note locations on sketch map on page VII. The data in reports two and three are for arbitrary depths (old Illinois system).

* *Proceedings and Papers of First International Congress of Soil Science. Vol. I.

In order to assist in studying and interpreting the data the figures for the horizon of lime carbonate accumulation are given in black type, and the high and low figures for each chemical constituent are indicated by the letters "H" and "L".

Morphological characteristics of alkali structure soils occur in the two profiles. Those especially noted are the laminated or squamose structure in the A horizon; heavier, more compact B horizons of prism or column-like structure; and salts at lower depths. Although some of these features are only faintly developed in some cases one or more of them are present in profiles of these and similar types. Soils of such character are widespread over the grassland zones of Saskatchewan, occurring even in the Chernosem belts.

Reaction and Alkali Salts.—Values for pH are given in both chemical tables. The values for surface soils of medium and heavy types are typically 7.0 to 7.2, although occasional samples run 8 and 9. The sandy types normally run 6.8 to 7.2. There is a noticeable increase in pH with depth, indicating the usual presence of carbonate or bicarbonate of sodium. The depth where effervescence with dilute acid begins is normally 8 to 14 inches for medium textured soils of the brown plains zone, and 15 to 18 inches for the dark brown zone. In clays the depth is much shallower (occasionally occurring at the surface) and in sandier soils much deeper.

Saline accumulations occur in most places which collect seepage water or which have high water tables. The quantity of salts on or near the surface varies considerably with seasonal conditions, the movement being directly associated with the movement of soil moisture. Surface crusts frequently form in solonchaks and subsoil accumulations occur in most other soil types. Tests indicate that sodium sulphate composes the bulk of surface and subsurface accumulations, and calcium sulphate the major portion in the B_2 and lower horizons. Effervescence tests with dilute HCl show that $CaCO_3$ is associated with practically all alkali accumulations. Sodium carbonate seems to be confined to lower horizons.

Total Nitrogen, Phosphorous and Potash of Surface Soils*.—Total nitrogen in the surface of the soils of the plains zone ranges from about 0.09% to 0.17% for sand and sandy loam types, and from about 0.20% to 0.35% for medium and heavy types. These figures refer to normal, well drained uplands, and, in most cases, to the first six inches of uncultivated soil. The nitrogen range, on a similar basis, for soils of the dark brown soil zone (Cypress Series) is about 0.37% to 0.5%, with occasional samples at the higher altitudes running as high as 0.6%. These figures are for medium and moderately heavy soils, as few sandy or clay types occur within areas of the Cypress Series.

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*A statement of fertilizer experiments is given on page 53.

The total phosphorous of the surface soils of the plains area ranges from about 0.027% to 0.07%, with the higher percentages usually in the medium and heavy soils, especially in those with the higher contents of nitrogen. The soils of the dark brown soil zone, which are characteristically higher in nitrogen than the plains soils, also average higher in total phosphorous. This observation, however, is based on a comparatively small number of samples. The few samples on which determinations were made run between 0.7% and 0.8%.

Total potash determinations were not made on samples collected for the survey herein reported. However, data for previous soil surveys * within the area show a range from about 1.4% in sands to 1.9% in clays for well drained uplands.

Tabulated data for total nitrogen and total phosphorous determinations are given in Table IV. in the Appendix.

Physical Data.—The results of the mechanical analysis of surface samples of a number of soil types are given in Table V. of the Appendix, and moisture equivalents in Table IV. Additional physical data are given in Saskatchewan soil survey reports ** numbers two, three and eight. It is planned to publish further physical data in later publications which will deal with chemical and physical studies of soils of the Province as a whole.

The mechanical analyses show the silty character of the Sceptre and Fox Valley Series of soils, the high clay content of alkali "gumbos" and Sceptre heavy clay and the higher content of fine gravel and coarser sands in loams and clay loams of the Haverhill Series (glacial till soils) than in similar textural grades of other Series.

Moisture equivalents indicate a concentration of clay in the compact B horizons of prismatic, columnar or cloddy structure in the solonetz and solonetz-like soils so prevalent over the area. They also indicate the relatively higher drought resistance of soils of the Sceptre, Fox Valley and Cypress Series as compared to most other soil types, due either to finer textures or to higher contents of organic matter, or to both combined, as in the Cypress clay loams.

GEOLOGY ***

Relation of Geology to the Soil.—Soil is the most recent of all geologic bodies, and is formed from the weathering or decay of older rocks. Under climatic conditions such as exist in tropical humid countries the type of underlying or parent rock may have left little or no impress on the character of its weathered product, the soil, which may be comparatively uniform, though formed from widely divergent types of rocks. Under temperate climatic condi-

*Saskatchewan Soil Survey Reports, Numbers 2 and 3, for the Swift Current and Robsart areas.

**Note sketch map on page VII. for location of survey areas.

***By F. H. Edmunds, Department of Geology, University of Saskatchewan, co-operating in the Saskatchewan Soil Survey.

tions, however, the parent rock imparts its character to the texture or chemical composition, or both, of the soil.

Much of the surface of Saskatchewan is covered with a veneer of unconsolidated deposits of glacial and post glacial origin; this applies also to the map area under consideration in the report. Where these superficial deposits are absent or have been eroded away sedimentary rocks, mostly unconsolidated, of Upper Cretaceous or Tertiary age are found. Thus there is a wide range in parent material from which the soils within the map area have been found.

Unconsolidated surface material is commonly classified as (a) Residual; (b) Transported. Residual deposits being those formed from the decay of underlying rocks, therefore, soils derived from Tertiary and older sediments are considered as residual. Ice and water are agents of transportation, thus materials of glacial, fluvio-glacial, lacustrine, alluvial and eolian origin give rise to soils that fall under the heading of transported. It should be borne in mind, however, that it is the parent material which has been subject to transportation, not the soil.

The following brief description of the geology of the map sheet area lays emphasis on the glacial and post-glacial phases. The notes given with regard to the subsurface geology are far from complete, but an attempt is made to point out some of the outstanding geological features which have influenced the character of several of the soil types.

Glacial and Post-Glacial History.—It is not possible to discuss the glacial history of the south west quarter of Saskatchewan apart from that of the prairie provinces as a whole, which with the exception of a small area on the Cypress Hills in Alberta, were covered by continental ice in glacial times. The Keewatin sheet which extended over the area of Saskatchewan had its centre in a region to the west of the Hudson's Bay, the Cordilleran sheet with its source of ice in the Rocky Mountain region never advanced as far east as Saskatchewan, its sphere of influence on the prairies being confined to western Alberta.

The Keewatin ice sheet advanced from the north-east carrying a load of Precambrian and Palaeozoic rock debris, and in part, the younger Cretaceous surface rocks of Saskatchewan over which it passed, finally advancing far to the south of the international boundary. With more moderate climatic conditions the ice melted and the enclosed material was left as glacial drift. It should be noted that this drift was made up of debris rich in potash, silica, alumina and magnesia from the Precambrian terrain of the northern part of the Province, magnesia, and lime-rich debris from the Palaeozoic rocks which form a comparatively narrow belt trending a little south of east, south of and bordering the Precambrian and the immediately underlying Cretaceous and Tertiary sediments in Southern Saskatchewan contributing silica and alumina-rich sand and clay.

The heterogenous nature of the soil types of the Haverhill and in part of the Cypress and Echo and Wood Mountain Series which are derived from glacial drift is readily understood in view of the preceding. The variations in composition, texture, topography and stoniness, are due to the heterogenity of the debris making up the drift, and also to the mode of its deposition.

There is evidence of an interglacial period during which time the ice completely retreated from the area, temperate climatic conditions being temporarily established only to be followed by re-advance of the ice. Such evidence is obtained from boring records in the Golden Prairie region where supposedly fossil soils are encountered between glacial deposits, and also to the north of the area under discussion, where, along the South Saskatchewan River valley outwash deposits of gravel and sand are observed to be over and underlain by glacial drift. Since, however, there is no indication that drifts of different ages have given rise to differences in soil types there is no need here to discuss further this interesting phase in the geological history of Saskatchewan.

With the retreat and melting of the ice water, grading of the debris took place, resulting in the formation of outwash deposits of gravel and sand, notable instances of which are mapped in the types of the Hatton Series, and local deposits are to be met with in the Haverhill types. The finer grade material was transported to numerous local lakes where it settled to the bottom, forming lacustrine sediments. With further retreat of the ice towards the north, and the establishment of normal drainage, the lakes became dry, those areas now providing the types of soil mapped in the Sceptre and Fox Valley Series. Wind modification of water deposited sediments has subsequently taken place in some areas, resulting in sand dune and loessial belts, the latter being fine textured silty material mapped as rolling phases of the Fox Valley Series. Comparative uniformity in composition, texture, topography and absence of stones is a characteristic of the above types. The coarser outwash sediments being most variable.

Many deposits in the form of alkaline river or lake flats are met with in the south west quarter of the Province, and are the result of the recent silting and drying up of low lying areas as the drainage becomes more mature. Most of these areas have not been mapped as types belonging to any particular series, but have been included in a general land class.

Erosion, since glacial times, has affected the more elevated parts of the country to a considerable extent. Run off water following heavy showers has been able to cut deep gullies in the unconsolidated sediments of Tertiary and Upper Cretaceous age which underlie the Cypress and Wood Mountain plateaus. The slopes of these hills are strongly dissected, though much variation in the amount of erosion is to be observed from place to place. Certain areas have been rendered useless for agriculture, while others are broken up into Mesas (remnant level plateau land) separated from valley flats by steep slopes. Belts of this type are included in the soil types mapped in the Wood Mountain Series.

Subsurface Geology.—Residual soils have been formed where underlying rock formations come to the surface, and are not overlain by glacial till or other recent deposits. The formations underlying the area, in order of age from the youngest, are as follows:—

Tertiary	Saskatchewan gravel Cypress Hills
Upper Cretaceous	Ravenscrag White Mud Fox Hills Bearpaw (Upper Pierre) Belly River

In general the *Belly River* rocks lie to the north and west of the area, the boundary between these and the *Bearpaw* rocks being covered with drift, and its location not being definitely known. Outside the area the *Belly River* rocks are seen to consist of soft sandstones, clays, shales and coal seams of fresh and brackish water origin. It is probable that much of the sand forming the sane dune belts and the sandy soils of the Hatton Series are indirectly derived from *Belly River* rocks.

The *Bearpaw* formation, commonly known as Upper Pierre in Saskatchewan, overlies the *Belly River* and has wide areal extent. With the exception of the more elevated country occupied by the Cypress Hills, The Old Man on His Back, The Boundary, Wood Mountain, and Wymark Plateaus, the *Bearpaw* rocks underlie the whole of the map area. Occasionally they appear at the surface giving rise to residual soils, but are more usually covered by drift. Rocks in the *Bearpaw* formation are of marine origin, consisting for the most part of dark clay shales, with occasional beds of sandy shale, and a few bands of ironstone nodules. Most of the beds seem to be free from lime in the form of calcium carbonate, so that soils formed from these rocks will not contain an appreciable amount unless the lime has been washed in from the glacial drift. As indicated previously * the lithology of the *Bearpaw* beds has not been fully worked out in Saskatchewan, and it is possible that calcareous phases occur.

*Page 62. Discussion of the Echo Series of soils.

Soils of the Echo Series are derived from *Bearpaw* rocks, either where the rocks come to the surface, are covered by but a thin veneer of drift or where the bulk of the drift is made up of non-calcareous shale containing a small proportion of other debris.

Soils of the Sceptre Series are, for the most part, formed from *Bearpaw* material which has been transported and reworked by ice and water. Since these soils are calcareous they are either derived from limey phases of the *Bearpaw* or else the lime has been derived from glacial debris.

The *Bearpaw* shales grade upwards into brown sands and shales of littoral origin known as *Fox Hills* beds. Exposures of these sands and shales are occasionally seen on the slopes of the plateau areas. It is doubtful if rocks of the *Fox Hills* formation have contributed much soil forming material within the area. Local sandy patches on the lower slopes of some of the hills are the only certain derivatives from these sediments.

Numerous exposures of white weathering clays and sands of freshwater lacustrine origin are to be seen along the Frenchman River valley particularly in the vicinities of Ravenscrag and Eastend. These beds, known as the *Whitemud* formation, though important from an economic standpoint, contributing to the semi-refractory clay resources of the Province, are not important soil producers. Only in limited areas along the Frenchman River valley and its tributaries which have cut down into these clays are derivative soils found.

The *Ravenscrag* formation consists of beds of clay, silt, sand, sandstone and occasional lignite seams. These are of freshwater lacustrine origin and rest upon the *Whitemud* beds in the Cypress Hills region, and in the plateau areas, where not covered by Tertiary rocks (*Cypress Hill* beds) they form the material directly underlying the drift. Since the drift is frequently thin or entirely absent residual soils have been formed from *Ravenscrag* rocks and certain soils in the Cypress and Wood Mountain Series are so derived. Notable examples are found near the north and south edges of the Cypress Hills, the upland country to the south, and, in part, to the north east of Shaunavon, and also in the Wood Mountain region.

The rocks known as the *Cypress Hills* beds consist of conglomerates, sandstones, silts and marls of fluviatile and lacustrine origin. Variation in hardness of the beds is noticeable from place to place, loose gravel and sand, as well as hard resistant conglomerate being present. The pebbles in the conglomerate consist of well rounded, light colored pink or buff weathering fine grained quartzite. These rocks extensively underlie the surface, in the Cypress Hills and in the country south of Swift Current previously referred to as the Wymark Plateau. Where these beds occur at the surface without any drift cover residual soils result, the coarse conglomerate and gravel phases give rise to droughty soils owing to excessive drainage of the surface. For the most part, however, the conglomerates lie 20 to 60 feet below the surface, and provide a suitable reservoir rock for underground water. Silty and sandy members form residual soils in the Wymark area and are mapped as Cypress loams. The heavier textured soil types present on the Cypress Hills are a result weathering of marl and clay members of the *Cypress Hills* formation, and to these materials mixed with glacial drift.

Saskatchewan gravels are most extensively found in the Wood Mountain region between Twelve Mile Lake and Hay Meadow Creek. They consist of pebble beds derived from the *Cypress Hills* conglomerate by erosional forces and were deposited prior to the glacial period. Glacial and post-glacial erosion has caused the formation of similar gravel deposits which may be found scattered in local areas in the Wood Mountain, Cypress, and Echo Series. They are too small in extent to record on the soil maps.

APPENDIX

Table I.—Soil Separates * (Sizes of Soil Particles) on which the Textural Grades in Table II. are based.

Separates	Abbreviations	Diameters in Millimetres
Fine Gravel	f.g.	2.1 –1.0
Coarse Sand	c.s.	1.0 –0.5
Medium Sand	m.s.	0.5 –0.25
Fine Sand	f.s.	0.25–0.10
Very Fine Sand	v.f.s.	0.10–0.05
Silt	si.	0.05–0.005
Clay	c	Less than 0.005

Table II.—Textural Grades * of Soil, Based on the Percentages of Soil Separates.

I.—Soils Containing Less Than 20% Clay:

(A) *Soils Containing Less Than* 15% *Silt and Clay (Sands)*:

1.—Coarse sand..........35% or more of f.g. and c.s., and less than 50% f.s or v.f.s.

2.—Sand..........35% or more of f.g., c.s. and m.s., and less than 50% f.s. or v.f.s.

3.—Fine sand..........50% or more of f.s. and v.f.s.

4.—Very fine sand..........50% or more of v.f.s.

(B)—*Soils Containing from* 20% *to* 50% *Silt and Clay (Sandy Loams)*:

1.—Coarse sandy loam..........45% or more of f.g. and c.s.

2.—Sandy loam..........25% or more of f.g., c.s. and m.s., and less than 35% of v.f.s.

3.—Fine sandy loam..........50% or more of f.s., or less than 25% of f.g., c.s. and m.s.

4.—Very fine sandy loam..........35% or more of v.f.s.

(C)—*Soils Containing* 50% *or More of Silt and Clay (Loam and Silt Loam)*:

1.—Loam..........Less than 20% c., from 30% to 50% si., and from 30% to 50% sand.

2.—Silt loam:..........less than 20% c., 50% or more of si., and less than 50% sand.

II.—Soils Containing from 20% to 30% Clay:

1.—Clay loam..........from 20% to 50% si., and from 20% to 50% sand.

2.—Silty clay loam..........from 50% to 80% si., and less than 30% sand.

III.—Soils Containing 30% or More of Clay:

1.—Sandy clay..........from 30% to 50% of c, less than 20% si., and from 50% to 70% sand.

2.—Clay ....30% or more of c., less than 50% si., and less than 50% sand.

3.—Silty clay..........from 30% to 50% c., from 50% to 70% si., and less than 20% sand.

*System established by the U.S. Bureau of Chemistry and Soils and in common use in North America.

Table III.—Profile Analyses by the Van Bemmelin-Hissink Acid Extraction Method *: and CO_2, Organic Matter, Total Nitrogen, and pH Values.

Sample No. 1.—Fox Valley Silt Loam (From the plains, brown soil zone)

		(Results expressed on moisture (105°C), CO_2 and organic matter free basis)																	
Horizon Depth (Inches)	Moisture (105.°C	Insoluble Residue	Ignition Loss	SiO_2 (Base Soluble)	SiO_2 (Acid Soluble)	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	MnO	P	K_2O	Na_2O	SO_3	CO_2 **	Organic matter **	Total N.	pH **
0-4½	2.60	H 77.45	H 3.68	10.44	L .247	L 3.74	L 2.98	—	L 0.67	L 0.87	.150	.0300	L (1.03) ***		.095	L .12	H 4.34	H .245	L 7.27
4½-8	H 3.14	71.80	2.93	11.34	.283	3.91	H 4.06	—	2.09	1.31	H .153	H .0310	(1.10) ***		H .128	1.30	1.72	.148	8.23
8-20	**2.29**	**L 64.36**	**L 2.08**	**H 12.17**	**H .312**	**4.06**	**3.26**	**.087**	**H 9.57**	**2.60**	**.123**	**.0215**	**.592**	**1.22**	**.113**	**H 7.73**	**1.17**	**.088**	**8.69**
20 +	L 2.19	69.63	2.27	L 10.03	.311	H 4.33	3.56	.086	5.20	H 2.85	L .114	L .0210	.503	H 1.50	L .073	4.83	L 0.57	L .038	H 8.90
Sample No. 2.—Cypress Loam (From the transitional or dark brown soil belt).																			
0-2½	2.58	H 78.00	H 4.44	H 10.79	L .215	3.61	2.70	H .090	0.83	0.71	.090	H .0336	.434	.587	H .154	L .16	H 6.81	H .370	L 7.90
2½-9	2.32	76.43	2.21	9.58	.241	3.94	2.30	L .079	L 0.48	L 0.67	.086	.0238	H .519	.580	.093	.17	2.35	.170	7.96
9-15	H 2.66	76.95	1.91	9.65	.254	H 4.48	H 3.17	.081	0.74	0.96	.093	.0234	.515	.554	.102	.20	L 1.16	.107	8.25
15-25	**1.79**	**L 70.83**	**L 1.34**	**6.07**	**H .289**	**3.22**	**2.50**	**.084**	**H 8.27**	**2.02**	**L .051**	**.0209**	**.416**	**H 1.19**	**L .080**	**4.97**	—	**.081**	**8.65**
25-33	L 1.36	77.11	1.80	L 5.86	.268	L 2.19	L 2.24	.082	5.59	2.02	H .139	L .0200	L .344	L .467	.123	3.51	—	.054	8.75
33-42	1.76	72.29	2.09	8.87	.266	3.19	2.97	.088	6.02	H 2.66	.128	.0246	.374	.643	.101	H 5.93	—	L .029	H 8.91

*As outlined in Proceedings and Papers of First International Congress of Soil Science, Vol. 1., highs and lows for constituents are indicated by "H" and "L". Horizon of carbonate accumulation is in heavy type.

**Organic Matter by the Robinson-McLean method (Jour. Agr. Sc., 1929, Vol. 19), CO_2 by Heck method (Soil Science, Vol. XXVIII., No. 3, Sept., 1929), and pH by the H electrode.

***$K_2O + Na_2O$

Table IV.—Total Nitrogen, Total Phosphorous, pH Values and Moisture Equivalents of Surface Samples of Various Soil Types.

Sample No.	Soil Type	% Total Nitrogen	% Total Phosphorous	pH Values	Moisture Equivalents
M.C. 61	Cypress CL	.342	——	6.8	——
S.C. 1	Cypress L	.404	.071	7.0	30.8
S.C. 14	Cypress L	.456	.08	7.1	33.5
S.C. 2	Cypress LL	.497	——	7.0	37.3
S.C. 16	Fox Valley SiCL	.358	.070	6.9	33.4
M.C. 15	Fox Valley Si.L	.236	——	6.8	21.7
M.C. 46	Fox Valley Si.L	.170	——	——	——
W.M. 2	Haverhill CL	.191	.03	7.0	24.4
W.M. 10	Haverhill CL	.322	——	7.1	30.2
S.C. 20	Haverhill L	.208	.037	7.0	26.7
Cy. 4	Haverhill L	.203	.043	7.0	22.6
Cy. 14	Haverhill LL	.197	.038	7.2	——
M.C. 39	Haverhill FSL	.117	——	7.0	——
W. M. 6	Wood Mountain L	.482	——	6.9	31.9
Cy. 6	Echo CL	.220	.038	7.5	27.0
Cy. 7	Echo CL	.216	——	7.0	25.4
M.C. 38	Hatton SL	.161	——	7.1	——
W.M. 14	Hatton FSL	.168	.027	7.2	15.4
M.C. 32	Sand	.097	——	6.8	8.7
M.C. 37	Sand	.090	——	6.8	——

Table V.—Mechanical Analysis of Surface Samples *

Soil Type	Sample No.	F.G. 2-1 mm.	C.S. 1-.5 mm.	M.S. .5-.25 mm.	F.S. .25-.1 mm.	V.F.S. .1-.05 mm.	Silt .05-.005 mm.	Clay below .005mm.
Cypress Clay Loam	M.C. 61	0.14	0.93	4.38	17.5	24.0	31.0	22.0
Echo Clay Loam	Cy. 7	1.5	0.9	1.75	12.2	30.5	32.03	21.03
Haverhill Clay Loam	W.M. 2	1.8	2.8	3.30	23.0	24.9	23.6	20.6
Hatton Very Fine Sandy Loam	M.C. 65	0.07	0.12	0.18	7.58	50.0	27.0	15.0

*Refer to Soil Survey Reports, Numbers 2, 3 and 8, for data for additional samples.

Table VI.—Summary of Statistical Agricultural Data for the Surveyed Area *

Total acreage of occupied farms	7,073,702
% of farm land improved	55.0
% of farm land unimproved (native pasture, waste land, etc.)	45.0
Acreage of all field crops	2,874,206
Acreage of spring wheat	2,128,369
Acreage of oats	423,627
Acreage of barley	23,093
Acreage of fall rye	61,298
Acreage of spring rye	14,109
Acreage of flax for seed	47,080
Acreage of brome grass	6,175
Acreage of western rye grass	4,926
Acreage of sweet clover	2,098
Acreage of grains for hay	19,182
Acreage of grains cut for summer feed	5,914
Acreage of potatoes	3,524
* * *	
% of farms under 51 acres in size	0.6
% of farms 51 to 160 acres in size	18.6
% of farms 161 to 320 acres in size	42.1
% of farms 321 to 480 acres in size	16.9
% of farms 481 to 640 acres in size	11.9
% of farms 641 to 800 acres in size	4.2
% of farms 801 to 960 acres in size	2.3
% of farms over 961 acres in size	3.5
* * *	
Number of horses	326,637
Number of cattle	253,230
Number of sheep	64,030
Number of swine	87,075
Number of poultry	2,143,068

*From Dominion Census, 1926. The figures in the second part of the table are for Census Divisions Nos. 3, 4, 7 and 8, and, therefore, include territory additional to the surveyed area.

Yields in Bushels Per Acre of Various Crops for the Period 1916-1928, for Crop Districts Nos. 3 and 4 *

Year	Wheat		Oats		Barley		Flax	
	Crop Dis. No. 3	Crop Dis. No. 4	Crop Dis. No. 3	Crop Dis. No. 4	Crop Dis. No. 3	Crop Dis. No. 4	Crop Dis. No. 3	Crop Dis. No. 4
1916	14.3	18.1	40.5	46.4	26.8	33.5	10.5	9.2
1917	12.5	12.2	20.2	21.7	15.9	16.0	5.3	5.2
1918	8.1	4.7	17.9	8.9	14.8	5.4	4.6	3.4
1919	5.8	3.5	13.8	5.6	11.0	9.0	4.2	1.6
1920	11.0	9.9	21.5	20.0	16.2	14.5	4.4	4.8
1921	14.1	8.6	31.7	19.3	21.4	13.7	7.2	5.1
1922	24.2	18.7	41.5	29.0	29.7	22.2	8.5	7.1
1923	19.5	16.7	44.5	34.5	29.5	24.0	11.2	8.5
1924	13.9	6.8	22.2	9.1	19.8	6.0	7.8	4.7
1925	17.7	9.8	29.1	22.5	20.7	12.1	7.3	9.3
1926	16.5	8.8	26.2	14.5	23.8	4.6	6.3	9.0
1927	17.3	26.9	34.6	47.9	30.3	39.0	9.0	10.7
1928	25.8	27.1	41.6	43.9	30.9	34.2	9.8	13.7

*From 1929 Annual Report of Saskatchewan Department of Agriculture, Regina. Crop District No. 3 covers the east part of the area, and No. 4 the west.

CLIMATIC DATA*

Table VII.—Temperature Data for Various Stations in or near the Surveyed Area.

Month and Season	Swift Current	Medicine Hat, Alberta	Nashlyn	Klintonel
December	15.5	21.1	10	12
January	9.3	11.2	7	10
February	11.6	12.8	11	13
Winter	12.1	15.0	9.3	11.6
March	23.3	26.7	22	22
April	41.5	45.1	39	37
May	52.3	54.7	50	48
Spring	39.3	42.2	37	35.6
June	60.5	62.5	59	57
July	66.3	68.4	65	62
August	63.5	66.0	63	60
Summer	63.4	65.6	62.3	59.7
September	53.4	56.5	51.0	49
October	41.6	45.8	40	39
November	26.9	29.3	23	25
Fall	40.6	43.9	38	37.6
Year	38.8	41.7	36.6	36.1

*Data for Swift Current is for the period 1885 to 1926; for Medicine Hat, 1885 to 1914; for Nashlyn, 1910 to 1928; and for Klintonel, 1910 to 1928, for precipitation, and 1914 to 1928 for temperatures.

Table VIII.—Precipitation Data for Various Stations in or near the Surveyed Area.*

Month and Season	Swift Current	Medicine Hat, Alberta	Nashlyn	Klintonel
December	.63	.53	.38	.88
January	.68	.61	.43	.86
February	.60	.61	.55	.86
Winter	1.91	1.75	1.36	2.60
March	.75	.61	.42	1.13
April	.80	.61	.67	1.40
May	1.83	1.75	1.68	2.37
Spring	3.38	2.97	2.77	4.90
June	3.00	2.57	2.14	3.22
July	2.33	1.73	1.66	2.14
August	2.00	1.51	1.20	1.53
Summer	7.33	5.81	5.00	6.89
September	1.24	.92	1.28	1.64
October	.83	.62	.44	1.10
November	.54	.72	.56	.76
Fall	2.61	2.26	2.28	3.50
Year	15.23	12.79	11.41	17.89

*See foot note under Table VII.

Table IX.—Approximate Percentages of the Total Surveyed Area (17,080 Square Miles) Occupied by the Various Soil Types and Land Classes.

Soil Types and Land Classes	% of Total Area
Sceptre Silty Clay	0.42
Sceptre Silty Light Clay	0.37
Fox Valley Silty Clay Loam	2.48
Fox Valley Silt Loam	1.02
Fox Valley Loam	0.71
Fox Valley Silt Loam and Loam (mixed)	0.92
Haverhill Silty Clay Loam	0.24
Haverhill Clay Loam	3.34
Haverhill Clay Loam (Rolling)	3.05
Haverhill Clay Loam (Rolling to Steep)	0.21
Haverhill Loam	7.80
Haverhill Loam (Rolling)	11.75
Haverhill Loam (Rolling to Steep)	8.32
Haverhill Clay Loam and Loam (mixed)	1.51
Haverhill Loam and Silt Loam (mixed)	0.82
Haverhill Light Loam	1.22
Haverhill Loam and Fine Sandy Loam (mixed)	2.02
Haverhill Sandy Loams	3.67
Cypress Clay Loam	0.30
Cypress Loam and Light Loam (mixed)	3.70
Cypress Clay Loam and Loam (mixed)	0.16
Wood Mountain Clay Loam	0.14
Wood Mountain Loam	2.17
Hatton Sandy Loams	4.00
Echo Clay Loam	11.41
Haverhill and Cypress Clay Loam (mixed)	0.60
Haverhill and Cypress Loam and Light Loam (mixed)	1.74
Sands	4.10
Rough and Hilly Lands	12.85
Dissected Plateau Lands	4.10
Lowland, Poorly Drained	4.70
Podsol (Grey Wooded)	0.12

Table X.—Population Figures for the Surveyed Area *

Total	81,268
Rural	65,128
Urban	16,141
Rural per sq. mile	3.8
Total per sq. mile	4.8

Cities—	
Swift Current	4,175
Towns—	
East End	420
Gravelbourg	1,201
Gull Lake	908
Maple Creek	930
Shaunavon	1,459
Villages—	
Admiral	244
Aneroid	336
Bracken	146
Cadillac	230
Carmichael	86
Climax	222
Coderre	190
Consul	63
Dollard	153
Ettington	36
Hatton	122
Hazenmore	254
Villages—*Continued*	
Hodgeville	220
Instow	78
Kincaid	300
La Fleche	555
Limerick	422
Mazenod	180
Meyer	357
Neville	232
Palmer	75
Piapot	230
Ponteix	588
Robsart	96
Scotsguard	161
St. Boswells	162
Tompkins	266
Vanguard	349
Vantage	94
Vidora	63
Waldeck	134
Webb	297
Woodrow	223

*Dominion Census, 1926.

Locations of Dominion Experimental and Illustration Farms Within or Near the Surveyed Area.

Swift Current (*Exp. Farm*)	Parkbeg (*Illus. Farm*)
Fox Valley (*Illus. Farm*)	Piapot (*Illus. Farm*)
Herbert (*Illus. Farm*)	Shaunavon (*Illus. Farm*)
Lisieux (*Illus. Farm*)	