PUBLICATION 600 ISSUED FEBRUARY, 1938
FARMERS' BULLETIN 50 REVISION PAMPHLET 114
DOMINION OF CANADA—DEPARTMENT OF AGRICULTURE

THE IMPROVEMENT OF BURN-OUT LANDS IN SOUTHERN SASKATCHEWAN

BY
E. C. SACKVILLE

DIVISION OF ILLUSTRATION STATIONS
EXPERIMENTAL FARMS BRANCH

ıblished by authority of the Hon. JAMES G. GARDINER, Minister of Agriculture
Ottawa, Canada

TABLE OF CONTENTS

THE IMPROVEMENT OF BURN-OUT LANDS IN SOUTHERN SASKATCHEWAN

According to the Soil Survey Report of the University of Saskatchewan the so-called burn-out soils are classified as the Echo series and occupy an area of approximately 2,300,000 acres of Saskatchewan. A large area occurs in the southwest part of the province, south of the Cypress Hills and extending into southeastern Alberta and northern Montana. Another large area extends from Avonlea southeastward to the International Boundary just west of Estevan and a third occurs near Kerrobert. The area with which this pamphlet deals particularly lies in the region southeast of Avonlea in the vicinity of Radville and Trossachs.

NATURE OF THE SOIL

The most striking feature of these burn-out soils is the presence of shallow depressions scattered over the land and varying in size and numbers. Various terms are used to describe these lands. In Saskatchewan and Alberta they are called "burn-outs" or "blow-outs" and in the United States "scab lands" or "slick spots." The surface soil outside of the burn-out spots consists of a light brown coloured soil, generally clay loam or loam in texture. The subsoil consists of a dark grayish brown clay or heavy clay loam of a tough compact nature. The lower subsoil contains considerable quantities of alkali salts. On account of the impervious nature of the subsoil, water penetration is greatly restricted. The burn-outs are depressions in which the impervious subsoil has been exposed through removal of the natural surface soil and for this reason water which collects in these depressions is largely lost by evaporation. Where this heavy subsoil is exposed or near the surface, the productivity of the soil is low. This is due mainly to its unfavourable physical structure but low fertility, due to relatively low organic matter, nitrogen and phosphorus content, may also be a factor. On lands where the burn-outs are numerous, crop production is poor with short, thin stands in the depressions. The poor physical condition of the soil causes difficulty in tillage and in heavy draft of implements. Where the burn-outs are not so numerous crop yields are higher. On the best of these soils the burn-out spots are small and the subsoil not quite so heavy. Continued cultivation tends to partly fill the depressions with the more fertile surface soil and in this way the productivity is improved.

Wheat production is the chief enterprise on the better areas of the burn-out soils. Where the burn-out spots are very numerous as in the southwest corner of the province, the land is used largely for grazing. In general the areas of these soils lying in the west and southwest districts are under more arid conditions than those found in the districts farther east.

EXPERIENCE OF SETTLERS

The early settlers soon realized the problem they had in breaking up this land to a sufficient depth and working it so as to improve the productivity of the burn-out spots. They used home-made scrubbers or floats for levelling the surface after breaking and in this way moved a portion of the top loam soil from adjacent areas into the depressions. This was found to give good results though adding to the cost of preparing the land for a crop. It was also soon discovered that it required considerable power to pull ploughs and other tillage implements through these hard spots. For these reasons and also due to lack of capital, and in some cases distance from market, many of these early settlers became discouraged and gave up their homesteads. Some stayed with it and in recent

50716—1½

years other settlers have taken up some of these vacant lands and are putting them under cultivation, in a good many cases with the aid of tractors. The advent of the medium sized tractor together with improvements in tillage implements have been two factors which have helped considerably in bringing this land into a good state of cultivation. More initial capital is required to do the breaking with a tractor, yet if one can do it in this way, usually a better job can be accomplished and more progress made.

Those settlers who have persisted have shown that profitable crops can be produced on most of these lands even though the cost of production for the first few years has been greater than on the normal types of soil. Once this land is in a good state of cultivation, however, the cost is approximately the same as on the normal loam and clay loam soils.

ILLUSTRATION STATION WORK

In 1916 an illustration station was established one-half mile east of the town of Radville. This land had been under cultivation for a few years and the burn-out spots were partially levelled. The use of the scrubber was continued after each ploughing to fill in the depressions more fully. Both grain and forage crops were grown, such as wheat, oats, barley, corn, western rye grass, brome, and sweet clover. One system followed was to grow two crops of wheat before summer-fallowing the land, which is the usual practice of most farmers in the district. Wheat was also grown on summer-fallow after two crops of hay. Oats and barley were grown after wheat. The results showed that all these crops could be grown, and in seasons of favourable moisture good yields were obtained, particularly with the grain crops.

Owing to a change in the tenancy of this land in 1923, the location of the station was moved to land three miles north of Radville. This land was right in the burn-out area and had been under cultivation for a number of years. Similar work was continued there. Three rotations of crops were started as follows: (1) the three-year system of two crops of wheat and fallow; (2) a two-year system of wheat and sweet clover hay; (3) a six-year system of wheat, oats, corn, wheat, hay, fallow.

The chief purpose of growing these crops in rotation has been to get information not only on the yields, but also their effect on the land and on the crops following. Western rye grass, sweet clover, alfalfa and corn had not been grown to any extent in this district before, so it was considered advisable to give these a fair trial as well as the ordinary grain crops. So far results have indicated that such crops as sweet clover and grass tend to improve the tilth of this soil. In this respect sweet clover has been more effective than the grasses. Corn has not proved a very suitable crop for the burn-out land and yields of wheat following corn have been very little more than the yields of wheat on stubble land. Wheat on all summer-fallowed land has given favourable yields on the average but on stubble land the yields have been only about one-half as much as on summer-fallow.

Illustration work was started in the Trossachs district on typical burn-out land in 1923 on the farm of Mr. Charles Carlson six miles south of the town. The same general plan of work has been carried on there as at Radville station. The results obtained have been quite similar to those at Radville. The difference between the yield of wheat on fallow and stubble land has been about the same as at Radville.

EXPERIMENTAL WORK

With increasing areas being brought under cultivation there arose a very general demand for more information on the problems of breaking and cultivating burn-out lands. In response to this demand illustration station work was expanded in the year 1926 by acquiring the use of an unbroken quarter section on which to carry on both illustration and experimental work.

Experiments on time and depth of breaking, the value of backsetting, floating, sub-soiling, manuring, liming and other treatments designed to improve the tilth of the soil, were undertaken. Different crops including wheat, oats, barley, flax, rye and sweet clover were sown to learn which would be best adapted to the soil and in case of sweet clover to learn what effect it might have in improving the soil for other crops. In 1929 the work was further increased by the inclusion of some fertilizer trials and other work designed to more clearly indicate the exact nature of the deficiency of the soil.

RECOMMENDED PRACTICES FOR BURN-OUT LANDS

Breaking

From data so far obtained, as well as from a study of the experience of farmers in the district, it is fairly apparent that in breaking the virgin land, the work should be done early in the season to a depth of not less than four inches and preferably deeper. After breaking, the land should be thoroughly disked and then floated with a float of sufficient weight and length to drag the maximum amount of top soil into the burn-out areas. Both disking and floating should be repeated, if possible, later in the season. In the spring the land should be again disked prior to seeding in order to loosen the soil in the burn-out spots and permit ready penetration of the drill.

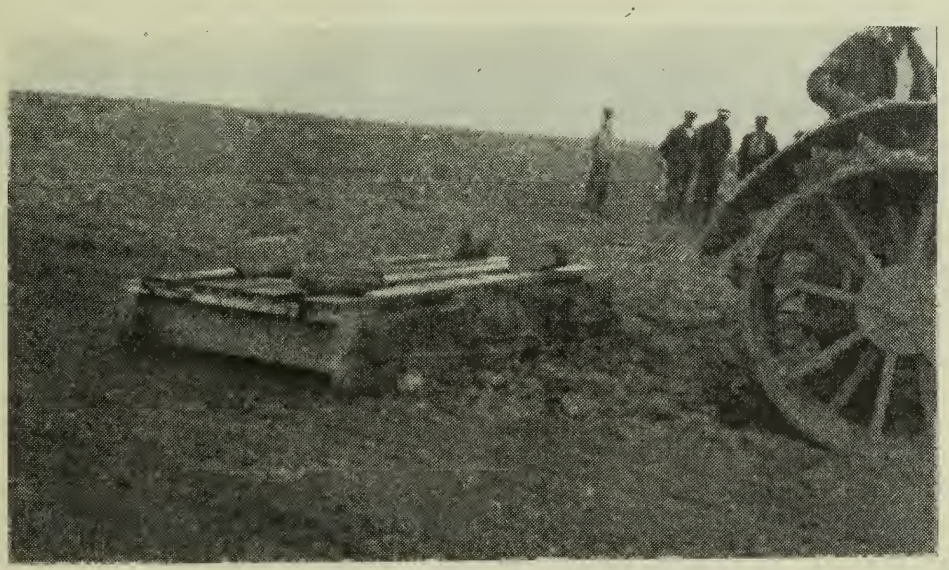

Plate 1—Levelling and filling in the burn-out areas with a planker.

Shallow breaking early in the season, and backsetting to a greater depth later, have given very good results on this land. But the great difficulty of ploughing to any considerable depth late in the season, together with the added cost of this method, make the deep breaking, disking and floating the more economic procedure. Before attempting to break the burn-out land, it is necessary to remove the larger stones. Ploughshares and disks should be kept sharp at all times.

Second Year After Breaking

If the land was well broken and worked down at the time of the first breaking a second crop may be taken before summer-fallowing. Spring ploughing and disking would be the most thorough preparation for this second crop, but under favourable conditions, a good working with the disk may be sufficient. If the land is not in a good state of cultivation or has not a favourable reserve of moisture, it would be advisable to summer-fallow before sowing a second crop.

Summer-Fallow

Results so far obtained with the station work indicate the advisability of frequent and thorough summer-fallowing. At both the Radville and Trossachs stations, over a ten-year period, wheat on summer-fallow has produced practically double the yield of that on stubble land. In view of these results and also the fact that it takes considerable work to put this soil in suitable condition for cropping, it would seem advisable to adopt a two-year rotation of grain and fallow. Under this system all grain crops, at least, would be sown on land which had been summer-fallowed. This system would also have the advantage of a better division of the labour on the farm so that the summer-fallow work could be started early in the season.

In working the summer-fallow, the same general principles should be followed as in preparing new land for crop and, in addition, care should be taken to keep weeds under control.

Early disking followed by ploughing to a fair depth when the soil is in the most suitable condition has been found a satisfactory method of working the summer-fallow. If the land is ploughed when too wet, baking of the furrow slice is likely to occur thus greatly increasing the work required to bring the land into good tilth later. If the land becomes too dry before ploughing is attempted, poor work will result as the plough cannot be kept at a proper depth in the soil. Weeds will not be killed, burn-out spots will not be loosened, and the draft of the plough will be increased.

After ploughing, the stiff-shanked cultivator can be used to good advantage to control weeds and keep the surface in condition to absorb rainfall readily. Surface working of the summer-fallow without ploughing has been tried for two years on land which has been under cultivation for some years. This has given satisfactory results but, when the land is new and particularly if there are many burn-out spots, ploughing is the safest practice to follow.

Prior to seeding in the spring, the use of the disk or cultivator is necessary to loosen the hard spots and permit of seeding to a proper depth.

Preparation for Second Crop

If a second crop is taken before summer-fallowing again, the land can be prepared by one of the following methods: ploughing, disking, one-way disking or cultivating. These methods have all been tried on land which has been under cultivation for a few years. There has not been much difference in the crop yields obtained from the different treatments with the exception of fall ploughing which has not given as good results as the other treatments. When the land is new, and particularly if there are many hard burn-out spots, ploughing will usually give the best results. The time of doing this work is of special importance just as in preparing the summer-fallow. If the soil is worked when too wet or too dry it cannot be put in proper tilth.

Implements and Tillage Methods

In the sections of this pamphlet dealing with the preparation of new land for seeding, fairly deep ploughing and thorough work generally are indicated as being desirable. To accomplish such work two things are essential: first, ample power, and second, well-adapted implements in good condition.

For breaking and heavy work, tractor power is usually more satisfactory than horse-power, even though in wet periods difficulty may be experienced in preventing tractors from becoming mired. Wheel tractors should be equipped with extension rims and six-inch spade lugs. Some method of preventing the accumulation of mud between drive wheel lugs is frequently a necessity.

The most important tillage implements for burn-out lands are the mouldboard plough, the disk harrow and the home-made float or scrubber. The disk plough can often be used to good advantage, but its use is not essential, provided the mouldboards can be made to scour. If difficulties are experienced in getting mouldboards to scour, draft adjustments, different shaped mouldboards and even wider plough bottoms might be tried before abandoning the mouldboard plough in favour of the disk plough.

A special deep tillage implement called the " Killifer Chisel " has been tried for a short time at Radville. It has been used as a subsoiler to stir the soil to a depth of from four to eight inches below the ploughing. While there has been a slight increase in yield of grain from the use of this implement on new land in seasons of favourable moisture supply, it is doubtful if the increase in yield would justify the cost of the extra power required to pull this implement.

PLATE 2—Deep ploughing with a tractor in the depth-of-ploughing experiments at Radville.

A good home-made float or scrubber is almost indispensable on a farm on which much burn-out land is cultivated. No other device has been found so effective in filling depressions and generally improving conditions of the soil. A useful float can be made with 3- by 12-inch planks 12 or 14 feet in length as the main parts. These should be spaced about four feet apart by means of lengths of 2- by 8-inch planks and the whole held in shape by $\frac{5}{8}$-inch iron rods and 4- by 4-inch diagonal bracing. The cutting face of each of the 3-inch planks should be protected from wear by a flat iron bar $\frac{3}{8}$-inch thick, 2 inches wide and of a length equal to that of the planks.

After land has been under cultivation for some years, the stiff-shanked cultivator will be found a very useful implement for summer-fallow work. In many cases the cultivator equipped with two- or four-inch shovels is more effective in loosening hard spots on the summer-fallow just prior to seeding than is the disk. If a choice must be made between cultivator and disk the latter will have a wider range of uses.

The one-way disk has been used a short time only for preparing both summer-fallow and stubble land for a crop. Results so far have been satisfactory and indicate that this implement should have a useful place in working the burn-out soil providing there is sufficient power available so that it can be set to cut sufficiently deep. It has the advantage in being able to cover a considerable acreage in a short time.

Packers would seem to be entirely out of place on burn-out land for the reason that, ordinarily, much effort must be devoted to loosening the soil. However, it has been observed that when the soil has become baked into heavy clods, perhaps as a result of ploughing when too wet, a packer, particularly of the culti-packer type, may somewhat improve conditions by pulverizing the clods.

Manures and Fertilizers

While farmyard manure has been tried on the burn-out lands for many years, it is only in recent years that any experiments in the application of lime and commercial fertilizers have been carried out. Contrary to expectations the application of moderate amounts of lime has not resulted in any marked improvement in the soil tilth or in crop yield. Applications of 15 tons of rotted manure per acre have given variable results but, on the whole, yields and uniformity of stand of crop have been improved by this practice. It should be realized that even though manure is useful on the burn-outs there is not much hope of making an extensive improvement by this means because of the limited amount available on most farms.

A number of the standard commercial fertilizers have been tried for three years but triple superphosphate and ammonium phosphate have been tried for a longer period. The results have not shown any consistent, material increases in yields of grain. The phosphates have shown some increases in seasons of favourable moisture supply. These increases have varied from one to four bushels of wheat per acre. It should be pointed out that these tests have not been carried on for a sufficient length of time to give anything like conclusive results.

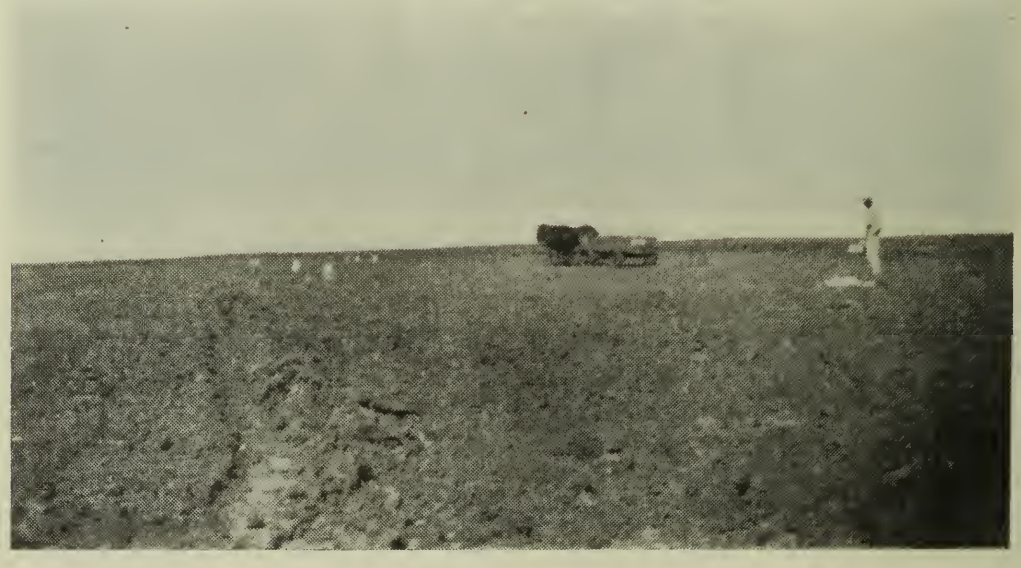

Plate 3—Applying lime in the burnt-out experiments.

Crops and Rotations

Since illustration work was started on the burn-out lands the following crops have been grown: wheat, oats, barley, fall rye, flax, peas, corn, sweet clover, rye grass, brome grass and alfalfa. Concerning each crop two matters of chief importance have been under observation; namely, the value and adaptation of the crop itself and its effect on other crops which might be grown in later years on the same land. While the extent of the work does not permit of anything like final conclusions with respect to all crops, such conclusions as may be drawn are indicated in the following paragraphs.

Wheat

Wheat has been grown as the chief cash crop in this district on both fallow and stubble land. The results on the whole have shown that this crop is well adapted to the district and yields as high as 37 bushels per acre have been obtained on the station fields at Radville. The average yield for a period of 11 years 1924 to 1934 has been 19·3 bushels per acre on summer-fallow and 12 bushels per acre on spring ploughed stubble land. At the Trossachs station the average yield on summer-fallow for a ten-year period covering 1925 to 1934 has been 14·5 bushels per acre and 8 bushels per acre on stubble land.

The chief variety grown in this district is Marquis. On the station fields at Radville and Trossachs it is also the chief variety and on the whole has given the best results.

While such matters as rate, time, and depth of seeding have not been specially studied on burn-out land, the common experience is that fairly early seeding at a rate of $1\frac{1}{4}$ bushels per acre to a depth of from two to three inches is most generally satisfactory.

As already pointed out in the discussion of summer-fallow and tillage methods, the tilth of the soil has a very important bearing on the success of all grain crops.

Oats

Oats (Banner and Victory) have been grown on the station fields principally as a feed crop. The seven-year average yield at Radville following wheat has been 25·4 bushels per acre with the highest yield 47 bushels. In comparison with wheat as a cash crop, where both are grown on stubble land, they have given about equal returns over a six-year period. At Trossachs the highest yield has been 60 bushels but the average yield at this station has been approximately the same as at Radville.

Barley

Barley occupies a comparatively small place on the burn-out lands at present. It has been sufficiently grown however to indicate that it produces about the same relative yield, compared with oats and wheat, as in other districts. There is not any reason why barley cannot be grown regularly if market and other conditions warrant.

Fall Rye

Fall rye has been grown to a limited extent and with fair success on the station at Radville. This crop may have a place as an emergency feed crop for hay or grain in dry seasons. It is also useful for the purpose of weed control.

Flax

Flax has received very little study on the stations and has been tried to only a limited extent by farmers and usually on newly-broken land. The general impression is that flax is not as well adapted to the burn-out conditions as wheat. In any event the returns from wheat are generally higher and this is the deciding factor with respect to the crop to be grown.

Sweet Clover

For some years sweet clover has been grown fairly extensively both in the district and on the stations. On the stations it has, on the whole, produced higher yields than any of the perennial hay crops tested. At Radville the average yield for ten years has been one ton per acre and at Trossachs approximately the same. It has given good stands in favourable seasons with as high as three tons per acre one year from two cuttings, but over a ten-year period

there have been three years when it failed to make a stand. At Trossachs it failed only one year and oats were then substituted. The clover hay has been fed to live stock with good results, especially at Radville where Mr. Stockton, the operator of the station, maintains a herd of dairy cows.

Sweet clover has also proved a good crop for improving the burn-out soils. The roots penetrate deeply and tend to loosen the hard soil so that more moisture and air can be absorbed and the productivity of the burn-out spots increased. There has been some difficulty in securing a good catch in some of the burn-out spots, particularly if they have not been worked well before seeding.

Wheat has been grown directly after sweet clover and also after sweet clover with a year of regular summer-fallow intervening. The yields of wheat directly after sweet clover have been, on the average, about equal to the yield of wheat on spring-ploughed stubble land. Where a fallow intervened before seeding the wheat, the yields were much heavier and the growth of the crop more vigorous.

Emphasis must be given to the fact that when good yields of sweet clover have been secured, yields of wheat on the same land in the following year usually

PLATE 4—Sweet clover on burn-out lands.

have not been good. Experience has shown that in order to derive any considerable benefit to grain crops from the growth of sweet clover it has been necessary to restore the moisture supply by means of a summer-fallow before seeding to wheat.

When wheat is grown directly following a crop of sweet clover the land is usually prepared by ploughing soon after the hay is taken off and giving some cultivation then and also more the next spring. Should land be too dry to make a satisfactory job of ploughing, it is left until the next spring.

This plan of cropping, while it gives some crop every year, has not given profitable returns over a period of four years in this district. In regions of heavier rainfall it has given satisfactory results and also in one very wet season on the Radville sation.

Ploughing under a crop of sweet clover at about the same stage as it is cut for hay has been tried. Wheat has been sown following this treatment. The results so far have shown that there is very little difference in yield of

wheat from this treatment as compared with wheat after sweet clover when the hay is cut and taken off. The difference would not compensate for the loss of the hay crop.

The method followed in sowing sweet clover has been to sow it with the grain crop of wheat, oats or barley at 12 to 15 pounds per acre, the grain being sown at the usual rate. It has usually been sown on summer-fallowed land or after corn, but satisfactory catches have also been secured by sowing with the second crop of grain after fallow. As a rule, however, the stand is better when sown with the first crop after fallow.

In cutting the sweet clover two methods have been tried on the station fields, the mower and the binder. Both do the work satisfactorily, but in curing, the binder method has the advantage, particularly if the weather is unfavourable as is often the case. The sheaves are made fairly small and stooked in small long stooks. Under usual conditions these stooks will cure without being disturbed though it usually takes considerable time. If stacked before being sufficiently cured molding may take place. Before stacking, the stooks are spread out to dry. By this method of curing a better quality of hay can usually be made as more of the leaves are saved than when the curing is done in the windrow or coil.

Western Rye Grass

This crop has been grown on the illustration stations in the burn-out area for a number of years. It has also been grown in a mixture with brome grass. In quality of hay it has been quite satisfactory, but the yield has been low as compared with sweet clover. For a five-year period at Radville it has given three-quarters of a ton per acre average yield. As a soil improver it adds considerable fibre to the soil and thus improves the tilth, yet the yields of grain following the grass crop with a summer-fallow intervening have not been as high as the yield on sweet clover land similarly treated.

Alfalfa

Alfalfa has been grown on the stations at both Radville and Trossachs. In favourable seasons it has made a satisfactory stand and given fair yields when once established. However, in dry seasons it has been difficult to obtain a stand. Alfalfa is a deep rooted crop, even more so than sweet clover, and should help considerably in improving the texture of the soil in the burn-out spots.

Other Crops

Corn and sunflowers have both been grown for silage, the former also for fodder. Sunflowers have given a heavier yield but the grain following this crop has not been so good as after corn. In districts such as this where stands of sweet clover can usually be secured, silage crops are not so essential as in some other districts. The hay crop can usually be grown more cheaply as the labour is much less and it can be handled with the ordinary machines used on every farm.

POSITION OF INVESTIGATIONS

The importance and extent of the problems in connection with farming on the burn-out lands warrant a more complete study than it has been possible to make in the work carried on so far. With the advent of the drought period in 1931 and the serious rust epidemic of 1935, other problems have pressed for solution. While soil drifting was not considered as a problem in the burn-out area in the early years of settlement, experience during the recent dry seasons has shown that unless suitable cultural methods are followed, soil drifting may become a serious problem even on burn-out lands. Work is now being carried

on at the Radville sub-station under the Prairie Farm Rehabilitation Act principally for the purpose of studying the problems in connection with drought and soil drifting. While some of the work in connection with the study of the burn-out soils has had to be abandoned for the present, it is expected that, as a result of the new work now being carried on, considerable information will be obtained on some of the most important problems in connection with crop production on "burn-out lands."

ACKNOWLEDGMENTS

The author wishes to acknowledge assistance given by the staff of the soils department of the University of Saskatchewan, who have supplied the information on the distribution and nature of the burn-out soils and also the help rendered by J. G. Taggart, who assisted with the preparation of the original manuscript. This is a revision of Pamphlet No. 114—New Series, by J. G. Taggart and E. C. Sackville.

Ottawa: Printed by J. O. Patenaude, I.S.O., Printer to the King's Most Excellent Majesty, 1938.