

Agriculture in War Time.

BY

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AGRICULTURE IN WAR-TIME.

BY FRANK T. SHUTT, M.A., D.Sc.
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EDUCATION.

The war has many lessons for those who will learn them, sad lessons many of them certainly, but valuable lessons for the most part for the peoples and the nations involved in this great conflict in which we of the British Empire with our Allies are battling for righteousness, justice and honour. Our view point on many matters has been shifted, but what is perhaps of greater importance I think we have a clearer and better estimate of the things that in the long run really matter in this life, a truer conception and more intense realization of the inherent rightness and wrongness in those qualities and characteristics which determine our attitude and actions towards one another, whether as individuals or as nations.

It is not, however, our purpose to consider these matters, important as they are to us as a people, but what I have said may serve as an introduction, or indeed explanation of the statement that the estimate and conception of the people at large as regards agriculture has greatly changed in these later, latter days of the war. We have I think awakened or at least are awakening to the realization that the food supply, which means agriculture, is playing a vitally important part, not merely in the welfare, but the very existence, of the nations at war. The food supply may be the factor that will turn the scale in the final winning out of the war, certainly it is only second in importance to the supply of ammunition and the successful prosecution of arms on the field of battle. We at least know that it is mainly the shortage of food in Germany that prompted the recent overtures for peace from that country.

And this matter of the importance of agriculture as an industry affecting the welfare of a country has touched us nearer home. In the recent advances in the price of our food stuffs, more especially pronounced since the outbreak of the war, we of the towns and cities—consumers and not producers—are learning the stern lesson of how dependent we are on the output of agriculture. Until a few years ago, living in this land of plenty and of cheap food, we never gave a thought as to how this food was produced or where it came from. The inter-

dependence of town and country was not a subject that entered into our consideration. It is not our purpose to-night to discuss the causes which have led to the present high cost of living, but I may say in passing that the blame, if blame there is, does not altogether lie with the farmer, as many suppose. He suffers with us in the high prices that prevail. All the things that he does not actually produce and which he must buy, even his concentrated cattle foods—the products of milling, etc., have gone up in price and above all the labour that he must hire to help him till his soil, put in his crops and harvest them and feed his cattle, commands to-day a wage unheard of a few years ago. The scarcity and dearness of farm labour is probably to-day the most serious problem in agriculture. If therefore the farmer to-day is getting somewhat more for his own labour and oversight and his capital invested than he did ten years ago, and I think he is, he richly deserves it; compared with other industries, agricultural labor has been but poorly paid in the past.

It has seemed to me that the question of supply and demand is very largely involved in this matter of high prices. For the facts are these, that tremendous quantities of Canadian produced food stuffs are going overseas to feed our troops and we have the distressing fact to acknowledge that our food producing population—our rural population—has decreased while our food consuming population—the population of our cities—has increased. In a word while our food consumption has increased, our food production has decreased. During the last decade there has been a steady exodus from the farm to the city—a most deplorable condition looking to the future stability and progress of our country, which is by nature undoubtedly designed to be a great food producing country.

And you may legitimately ask me why this is so? Why have the young men left the farm and sought employment in the city? Many answers have been given and the subject is worn well-nigh threadbare. Perhaps lack of love for the work has had something to do with it, for many of our farm boys have been brought up with the idea that farming is merely dirty drudgery with no outlook and no prospects. Many of our farmers, with their long experience of toil in reclaiming the forest, have encouraged rather than dissuaded their boys to remain on the farms. Anything that we can do to inculcate a love of the country, of working the soil, a love of plants and animals, will be doing our country good service. Perhaps the glamour of the city life offers opportunities for activities and amusements and mild excitement that are absent in the country. But probably the more immediate cause is the fact that the wages of the various industries and city businesses are con-

siderably higher than can be paid by the farmer. We are an ambitious people, and unfortunately that ambition has largely turned towards dollars and cents; it is not well balanced. The get-rich-quick idea affects our youth as it does that in other countries.

These are digressions, but I have purposely introduced them that you may have a clearer view of what the conditions in agriculture have been and are to-day. My hope is that we are about to enter upon a new era in our agricultural life. The war has shown us many things and with respect to agriculture it is giving us saner, sounder views. It is impressing upon us as a people the dignity and high status of agriculture as an occupation—its vital importance to the stability of the country. We are coming to realize that it is "the source and foundation of our national strength". It may not be a calling that offers great monetary returns, compared with some other occupations, but it is one that will call forth all the intelligence and mental ability that a man has, no matter how clever he may be, and give him a healthy, wholesome life with a fair recompense, provided he applies himself intelligently to its problems. There are problems in soils and crops and livestock that require knowledge and thought as well as labour to solve. I know of no occupation that provides better opportunities, more scope, for study, clear thinking and successful action. Let it not be thought that the farming of the future will consist merely of hard, physical work (though there will always be plenty of that) indeed the most successful farmer to to-day is the one working on advanced and rational lines, and who is using his head more than his hands, proving, adopting and adapting to his own conditions the findings of science and experience. It is all this that the war is bringing home directly or indirectly to the people at large. Further, the war is making very clear the value of scientific research in Agriculture. Our governments are recognizing, as they have never done before, the importance, the vital importance of scientific work if real progress is to be made towards improving farming in all its phases and branches. The British government has been most active during the past two years in enlisting the assistance of the best scientific ability in the land. This is most hopeful; our Government will follow and we may confidently expect that in the next decade great strides will be made in the science of agriculture which must react beneficially on practical farming.

Very early in the history of the war it was foreseen that there would be an extraordinary tax on the supplies of food stuffs at the command of the Empire, and that every effort must be made not only in the home land, but in all the colonies to meet it. There is no necessity I am sure to enlarge on the reasons, the conditions, that led to the urgent and

insistent call issued by the British Government for food and still more food; indeed, it is a matter of daily wonderment how the food requirements of the immense number of those engaged in actual warfare, in the making of ammunition, are met—certainly they must far exceed those that had hitherto satisfied the needs of the Old Country.

Our Federal Government and our several Provincial Governments took up the call promptly and enthusiastically in the autumn of 1914. Throughout the length and breadth of the land it went out that every farmer, if from patriotic motives only, must make an honest effort to increase his crop yields, his live stock, his dairy produce. Every farmer must seriously consider the gravity of the occasion and after a careful survey of his conditions and circumstances see wherein he can do his bit for king and country towards meeting the demands for a larger and still larger output from his farm.

A dominion-wide campaign of education and inspiration was at once inaugurated by the several departments of agriculture and carried forward with earnestness and enthusiasm in every province from the Atlantic to the Pacific. Meetings of farmers were addressed, special bulletins of an educational character were written and widely distributed, articles on timely subjects appeared in the press, correspondence on matters pertaining to better farming was invited. This outlines the principal features of the campaign, in which the officers of the several departments of agriculture took a prominent part. This campaign in certain of its features is still being prosecuted. It has done and is still doing a great deal of effective work and the results are to be seen, I believe, in every province of the Dominion.

The harvest of 1915 was unprecedented in Canadian history. In its truly magnificent abundance it was a record-breaker. This we know was largely due to the exceptionally favourable seasonal conditions that prevailed in that year over the larger part of the Dominion and especially in the great grain-growing areas of the North-Western provinces.

Unfavourable weather conditions prevailed in 1916 over large areas in Canada both in the East and in the West, very materially reducing the agricultural output. It was a very trying year for the farmer in almost every part of the Dominion. In the East, continued and heavy rains prevented the getting in of the crops in good time—and it is seldom that late sown crops give even fair yields no matter how rich the soil may be, though we safely say that crops in a properly prepared and fertile soil will go far towards offsetting the disastrous influence of an untoward season. In certain sections of the prairie provinces, weather conditions induced an outbreak of rust—the most severe since 1904—and this most materially reduced the wheat output.

These two seasons, 1915 and 1916, emphasize the fact that weather, seasonal conditions, constitute a limiting factor in crop production, a factor that will always make agriculture as an industry more or less of a hazard. No matter how well the soil is tilled and cared for, no accurate prediction can be made of what the yield will be; the harvest alone will show the results of the year's labour. It is this consideration that supplies one of the chief reasons for advocating mixed farming, for this obviously must materially reduce the hazard.

But in this matter of results it is well to remember that agriculture compared with other industries is not one that can be readily or quickly "speeded up". In a very real sense it is the methods of the past that largely determine the success of the future, at all events, the immediate future. There are few soils that can be built up to their maximum productiveness in a season. Even with the adoption of the best methods the work of improvement is comparatively slow; soil deterioration, due to poor and irrational methods, unfortunately is much more rapid. We know there are thousands of acres in the Dominion that have not been brought up to their maximum productiveness, not even giving average yields, for the tendency in the past has been towards extensive rather than intensive farming—too many acres to thoroughly till with the labour and capital at the farmer's command. But we shall mend this as the years go by.

With live stock, meat products, dairy produce, the difficulties for immediate increased production are still greater. Many of the reasons for this will be obvious and I need only refer to one, that live stock needs labour—and the labour problem is without doubt the most serious and the most difficult to solve of all agricultural problems to-day. Its solution may be temporarily sought in some degree, by rearrangement of the labour of the country as a whole, by importing labour from the United States, and by the help that to some extent that may be drawn from our towns and cities.

The main purpose of this address is to give you some account of our propaganda, the teachings which, if followed out, might lead to increased production. I must not, of course, attempt to enter into detail which would only be of interest to an agricultural audience. I shall therefore confine myself to an epitome, emphasizing the more important features of the campaign.

In the first place I may point out that the principles of rational, successful farming remain the same, whether we are at war or dwelling in peace. Consequently we had nothing new of a fundamental character to propound, no panacea to advocate that would cure the ills of soils and crops and ensure large yields; no short cuts that would eliminate work

and bring success. We believe that successful farming and maximum production can only be achieved by the application of the teachings of science and practical experience and it was these teachings we wished to bring home to the farmer in the most forceful way possible.

And, secondly, I wish to say that while we urged that every available acre of suitably prepared land be put under crop, we urged still more strongly that the effort be made to obtain a larger yield from the acreage at present under cultivation. There is unfortunately too much room for improvement in this latter regard. Our crop yields in general are much below what is possible and we believed there would be a better result and more profit to the farmer in bringing up his yields than in extending his area under cultivation, although there are places where both may be possible and desirable. To this end we emphasized, primarily, the need of greater attention to methods of increasing soil fertility—drainage, more thorough tillage, more liberal manuring, the growing of leguminous crops, the use of fertilizers. Other matters were the fall preparation of the land, the importance of seed selection, the cultivation of the hoed crops to produce an earth mulch and thus conserve soil moisture for the use of the growing crop—and turning to live stock, their breeding, feeding and care. These then constituted the chief themes of our addresses and writings. To-night we can only rapidly survey those which have to do with the soil, and I have chosen them because of their fundamental character. But many of the other subjects are almost of equal importance.

SOIL CULTIVATIONS.

DRAINAGE.—Speaking generally, drainage is fundamental to the greatest measure of success. There are light and sandy loams underlaid by sand or gravel which need no sub or artificial drainage, but for clay loams it is essential for the best results, not merely to take away water in the spring, and allow early seeding, but to make the soil more moist throughout the season. No amount of surface tillage, no amount of manure or fertilizer can ensure maximum crop production on a poorly drained soil. Surface evaporation is slow in the early months of the season. Tile drainage is needed therefore that the heavier soils may be worked to advantage before the seeding time passes. Poorly drained soils are water-logged soils, and this means a condition absolutely injurious to growing crops, for the root system needs air. Crops can die of suffocation, even after they have got a fair growth. Poorly drained soils are cold and wet.

There are thousands and thousands of acres in the Dominion that need tile drainage before they can be made to do their best. It is

expensive work, but there is no farm operation that pays better in the long run. Wherever needed and funds permit, our farmers have been urged to put in drains.

TILLAGE.—The soil of our fields naturally settles down and runs together into a more or less compact mass, due largely to rains, and it is thus rendered unfavourable for seed germination and the easy extension of the root system of the crop. This condition must be ameliorated by ploughing, sub-soiling, the use of the disc, spring tooth and smoothing harrows and the roller. By these implements the soil is opened up and reduced again to a fine condition; it is aerated and warmed and made capable of holding moisture in a form available for the crop nutrition, known technically as film water. A "fine" seed bed is half the battle and therefore the preparation of the soil is of paramount importance; as the crop grows it needs a due supply of moisture—for all the food that it takes in from the soil must be in the form of a solution—and it is good tillage and subsequent surface cultivation that conserves this necessary moisture.

These observations will have made it clear that the soil, in addition to supplying plant food, must form a comfortable means for the support of the plant, a comfortable home in which the crop can live and thrive. It must be well aerated, moist and warm. Tillage is a generic term to include all those mechanical operations that bring about this comfortable condition, commonly known as good tilth. We are fortunate in this country in having many excellent farm implements for the tilling of the soil, implements specially adapted for their particular work. In this connection we look hopefully in the near future to the perfection of the motor plough, which will enable the farmer not only to cheapen, extend and improve his tillage but to take better advantage of those short periods, altogether too short in some seasons, when the heavier soils are in the right condition for working, neither too wet nor too dry.

Drainage and good tillage mean time, labour and expense, but they are indispensable for maximum crop production; there is nothing we can add to the soil that can take the place of its thorough preparation.

FARM MANURES.

In the whole economy of farming there is no subject of greater, of more vital importance than that of manure and manuring. To-night we can only touch upon some of its more salient features.

Obviously the amount of plant food in the soil which is present in a more or less available form is a prime factor in determining crop yields; therefore in this campaign we are urging our farmers to take every rational, economic means to increase its store. To this end farm manures

stand *facile princeps*. They constitute the basis of fertility for soils under cultivation; they are at once the most effective fertilizers and best "soil improvers" known.

The function of manure in the soil may be said to be threefold: the supplying of the three essential elements of plant food, nitrogen, phosphoric acid and potash: the inoculation of the soil with micro-organisms, bacteria, which give "life" to the soil and which prepare crop food from the store in the soil and are more especially useful in the development of the nitrates, the chief form of nitrogenous food for all crops other than the legumes; and lastly the physical improvement of the soil, making it mellow, warmer, better aerated and increasing its water-holding capacity.

Mixed manures, that is the excreta plus the litter, of average quality will contain approximately per ton, 10 lbs. of nitrogen, 5 lbs. phosphoric acid and 10 lbs. of potash, and such manure would be worth to-day for its plant food about \$2.50 per ton. But from what has been said as to the several functions of manure we must ascribe to it a greater value than that calculated from its plant food content. The chief reason for this lies in the fact that it furnishes a large amount of humus-forming material. Humus is a very important constituent of soils, not merely because of its physical effect in mellowing soils and its large moisture-holding capacity, but because it is the natural storehouse of nitrogen, the most costly of all plant food elements; and because it furnishes the food upon which the soil bacteria thrive and develop. The colloidal properties of humus in holding mineral plant food that would otherwise be leached away to depths below the root system is also an important and valuable function.

Our virgin soils of extraordinary richness and fertility, as found for instance in the prairie provinces, are well supplied with this humus-forming material; soils exhausted by cropping and irrational methods of farming have been depleted of this material and herein lies their poverty, their low productiveness, for as the humus is "burnt" out, so the nitrogen of which it was the storehouse is dissipated. The humus content, we may therefore conclude, is a fair measure of the nitrogen content and of a soil's productiveness. Light soils lose their humus and nitrogen more quickly than strong heavy loams and therefore require more frequent replenishment with manure or other humus furnishing material to maintain their fertility. If time permitted we might well dwell at greater length on the functions of humus, so important is its rôle in maintaining soil fertility. Our campaign has endeavoured to emphasize the necessity of keeping the soil constantly and well supplied with this natural builder of soils.

Our doctrine then is that manure has no substitute—chemical, physical or biological—for maintaining and increasing soil fertility. The more manure the larger the crops, the larger the crops the more live stock that can be kept, the more live stock on the farm the more the manure. This means that rational farming is mixed farming and that mixed farming means increased crop production.

We may very briefly consider one or two of the more important phases of this manure question as emphasized in our campaign. First, the necessity of sufficient litter in the barn, stable, piggery, etc., to absorb and retain all the liquid excreta. This necessity has not been duly recognized on many of our farms, and thousands of tons of plant food in the most valuable form annually have been allowed to go to waste. As regards plant food, especially nitrogen and potash, the liquid is richer than the solid excreta and, further, these elements are present in a soluble and immediately available condition and hence more valuable than those in the solid excreta. If the supply of straw is short, sawdust, or air-dried peat or muck should be employed as supplemental litter. Peat and muck, of which there are many and large deposits in Canada, when air-dried possess a high absorptive capacity and have in themselves a manurial value of no mean importance. Hence their use in the way indicated increases not only the bulk but the value of the resultant manure. They can also be used in the making of valuable composts.

Nearly ninety per cent. of the total potash excreted by the animal is present in the urine. This fact alone would emphasize the value of the liquid excreta to-day, when the product of the Stassfurt mines, practically the world's sole economic supply of potash, is virtually unobtainable. Such small quantities of these potash compounds as remain on this continent are far too high in price to be used for agricultural purposes.

Then we are advocating the application of the manure to the soil while still fresh. This we have proved to be the most economic method in general farming, for the rotting of manure even under the best conditions is inevitably accompanied by some loss of organic matter and nitrogen. If the rotting manure is exposed, as in the barnyard or unprotected heap in the field, there are further losses by the leaching away of the soluble nitrogen and potash and these losses may be enormous. It is a conservative estimate that the losses from the careless management of manure amount to thirty per cent. or more of the initial value of the manure. Undoubtedly these losses throughout the Dominion represent annually many thousand dollars worth of plant food, needed all too badly for our crops.

Weight for weight, fresh manure has given yields almost equal to those obtained from rotted manure, in spite of the fact that the latter contain higher percentages of plant food. This has been proved by careful experiments at Ottawa conducted over a considerable number of years. The reason for this is rather obscure. Possibly it is due in part to the fresh manure inoculating the soil with desirable micro-organisms to a greater extent than does the rotted and in part to the greater warmth set up by the fermentation of the fresh manure in the soil and the heat so developed benefiting the crop in its early stages. Be that as it may, the fact remains that rotting manure in large heaps in the fields—a method which is still quite common—is very wasteful. In general farming manure has no greater value than at the time of its production; indeed we may safely say, for the average farmer its initial value is its maximum value and the quicker it can be got into the land the better.

If it is impracticable by reason of the depth of snow, or the condition of the land, to immediately spread the manure on the fields, the pile should be kept compact and moist, sheltered from the rain and unless heating takes place not turned. Manure made in loose boxes or pens, in which fresh litter as required is added and the manure allowed to accumulate under the cattle, is the best made on the farm, but this plan cannot be adopted for dairy cattle.

In the winter small piles of 500 to 800 lbs. can be made on the fields to be dressed. Over the greater part of the Dominion such piles freeze through solidly and lose but little of their value. They can be spread as soon as the snow disappears.

For teaming the fresh manure from the farm buildings and its distribution on the land a manure spreader should be used. It is an implement that saves labour and in distributing the manure more evenly than can be done by hand, does most effective work. Undoubtedly its employment means a more even crop and larger returns from the manure than were obtainable before its invention.

With the limited amount of manure usually at the command of our farmers it does not seem desirable to plough it under too deeply; if well incorporated with say the first five inches of soil it will by its fermentation warm the surface soil and increase its moisture holding capacity and thus serve to nourish and feed the young crop when it is least able to forage deeply for its food. It is seldom indeed that there is a sufficiency of manure on the farm to allow of more than one application in each rotation. To which crop then shall it be applied? We counsel that manure should be applied for hoed crops in the rotation—potatoes, mangels, corn, etc., for thereby the greater return will be obtained.

The top dressing of impoverished meadows early in the season has also been found a profitable practice.

These then constitute some of the more important features respecting manure in our propaganda.

CLOVER, ALFALFA AND THE LEGUMES GENERALLY.

Though the fact that the growth of clover increased the yields of succeeding crops has been known since the days of the Ancients, the explanation of the fact awaited the discovery of Hellriegel and Wilfarth in 1886. These scientists showed that the leguminosae have the power to appropriate the free nitrogen of the air that is in the interstices of the soil, through the activity of certain bacteria that reside in nodules or tubercles on their roots. Their presence is an example of useful symbiosis. These bacteria pass on the elaborated nitrogen to their host for the development of root and stem and leaf. The immense value of a leguminous crop in the rotation must be at once obvious. The legumes alone of all our crops, leave the soil richer rather than poorer for their growth. Even when the crops are cut and used as fodder—and very rich fodder they make by reason of their high nitrogen content—the soil will be richer for their growth, because of the nitrogen in their root system. Experiments have shown that by the growth and turning under of clover, alfalfa and other legumes from 50 to 150 lbs. of nitrogen can be added to the soil per acre. And this enrichment is not in nitrogen only; it is in humus-forming material and in the mineral plant food therein held and which is set free for crop use as the organic matter further decomposes. Alfalfa with its heavy and deep root system stands first among the legumes in this nitrogen appropriation; red clover comes next. The manurial value of these leguminous crops is easily observable for three or four years, that is, throughout the whole rotation and, at a conservative estimate may be said to be equal to that of an application of five to ten tons of farm manure per acre. This fact has been established by repeated experiments. All grain crops in the rotation should be sown with clover or a mixture of grass seed with clover or alfalfa, for this method not only furnishes an abundant yield in the following season of highly nutritious fodder but manures and improves the land in a way and at a cost not possible by any other means.

It sometimes happens that the soil does not possess the nitrogen-fixing bacteria. In such cases, made known by the absence of nodules on the roots of the crop, inoculation must be resorted to. This is more especially necessary with alfalfa. Cultures for this inoculation may be obtained from the botanical laboratories of the Experimental Farm, or

soil from fields upon which the legume has grown luxuriously can be procured and applied.

The manurial properties of clover and other legumes has been worked out in a long series of experiments and the results have been of inestimable value to Canadian agriculture. In this campaign we are again emphasizing the main facts brought out by this investigational work, with the object of inducing our farmers to grow more clover and alfalfa, both for the production of a highly nitrogenous stock feed and for the enrichment of their soils.

LIMING.

Closely associated with the subject of the successful growth of the legumes is the question of liming. Leguminous crops will not thrive on a sour soil or one deficient in lime. Some soils are naturally deficient in available lime, some have been rendered so by cropping. The presence of lime is an indication of fertility and productiveness. Its functions are many. It promotes nitrification by neutralizing acidity; it improves the tilth of both heavy and light soils and it furnishes plant food. A bulletin has been issued that deals fully with all the important phases of this important question and our farmers are urged to ascertain, as is possible by quite simple means, if their land is in need of this element.

Ground limestone is now being used on many farms as a soil ameliorant with excellent results and we believe its employment in Eastern Canada and British Columbia will very largely increase in the near future. Our experiments in many districts in Ontario, Quebec and the Maritime Provinces have shown that lime or ground limestone is needed and can be profitably employed for increasing crop production.

COMMERCIAL FERTILIZERS.

In all that has been said so far respecting the means of increasing crop production, the call has been, more particularly, for more careful, more thorough methods of farm and soil management and though these entail labour they do not necessarily involve the employment of extra labour, which of course would mean an additional cash outlay. The case with Commercial Fertilizers is different: they must be purchased and unfortunately their cost to-day is higher than in ante-bellum days. Their use involves a distinct and direct cash outlay and the farmer, in their employment, must be fairly confident, not merely of an increased yield but of a profitable return; the increase in yield must be more than sufficient to pay for the fertilizer. The hazard is, of course, always

present, but there should be a reasonable expectation that with a favourable season there will be a profitable return.

Fertilizers are materials that furnish in more or less available forms one or more of the three so-called essential elements of fertility—nitrogen, phosphoric acid and potash. A fertilizer that supplies all three is known as a "complete" fertilizer. They may be chemical compounds, as nitrate of soda, sulphate of ammonia, etc., or they may be of organic origin, such as bone meal, guano, dried blood, tankage, fish scrap, etc. Frequently the compounded fertilizer as manufactured and sold under brand or trade name is made up of or is a mixture of both classes of materials. The Fertilizer Act compels the manufacturers to brand all this class of goods with the percentages of nitrogen, phosphoric acid and potash contained and also stipulates that the amount of available phosphoric acid should be stated.

Due largely to advertising and the activity of fertilizer agents, but also in part to the ignorance of our farmers respecting the nature of the several constituents or ingredients of fertilizers and the fact that these ingredients cannot at all times be readily obtained, the habit in this country has been to purchase the manufactured, compounded fertilizers, the price of which is usually from 15 to 40 per cent. above the cost of the ingredients.

Our campaign in this connection has therefore been one primarily of education; the instruction of the farmer regarding the functions of the several fertilizing elements in the vegetable economy, the special requirements of the several crops and the deficiencies likely to characterize different types of soil. Then we have pointed out the economy of purchasing the ingredients rather than the compounded fertilizer and given simple methods of home mixing and application. To tell all this in detail would be quite impossible to-night, I shall therefore merely bring before you as concisely as possible some of the more important deductions from our investigational work with fertilizers, since these deductions have been given out as a working guide for those employing these aids to increase crop production.

First, we teach that fertilizers have a legitimate, rightful place in a rational system of farming but that profit from their use seldom results if that place is not clearly understood. It seems to us important that the farmers, at the outset, should know our attitude towards fertilizers, for there are many views abroad in the country respecting them. There are those of the old school still in the land who consider fertilizers to be in the same class with quack medicines, that they act merely as stimulants, as a whip to a tired horse, and that no real benefit or profit results from their use. The number of these persons is happily on the decrease.

And there are those—almost as ignorant of the principles of agricultural science as those just referred to—who argue that if fertilizers are a source of available plant food, all that is necessary is to apply them generously and we must obtain increased crop yields. There is an element of truth in both view points, but taken as working hypotheses both are false and wrong. We are endeavouring to give our farmers information respecting the functions, uses and limitations of fertilizers from a sane and scientific standpoint. Fertilizers are no panacea to remedy the evils of poor farming, but they can be so used as to increase the farmer's profits. The advocacy in this war-time campaign, of a large and practically indiscriminate employment as urged by some well meaning persons, would I am sure be fraught with failure and loss.

We begin, then, this study of the profitable use of fertilizers by a consideration of the factors that limit crop growth, other than that of available plant food. First, are the conditions that are under our control so favourable that the fertilizer can perform its function of nourishing the crop? The nature and physical condition of the soil, its moisture-holding capacity (dependent on texture and humus content), its degree of aeration, its drainage, etc., are to be considered. Next, the seasonal conditions of the district likely to prevail are to be taken into account, the distribution of rain, the temperature, the hours of sunshine, etc. The probability is that over the larger part of the Dominion seasonal conditions are the most potent of all the determinative factors in crop yields.

And, lastly, there is the nature of the crop, its special requirements, its inherited capacity for growth and reproduction. All these factors have an important bearing on the scheme of fertilization, profoundly modifying the influence and effect of fertilizers. We cannot now stay to elaborate these factors, but one or two illustrations may be given to emphasize their rôle and importance. Remembering that the soil must be a comfortable habitat for the crop's root system, well aerated, moist and mellow, what opportunity has a fertilizer to play its part successfully in nourishing the crop in a stiff, heavy, plastic, undrained clay? Or, again, if the light and sandy soil, deficient in humus, dries up with a few days' drought, how can fertilizers feed the crop, for plants can only absorb their soil plant food in a soluble form? If there is danger of early autumnal frost, the fertilizing scheme must be towards hastening the ripening of the crop. And, lastly, if we are sowing a variety of oats the prolificness of which is measured by say, forty bushels per acre, can we make it yield sixty bushels by simply feeding the crop? Thus, soil, season and seed must all receive attention if the fertilizer application is to be rational and with a fair expectation of profits.

We may now proceed to some of the more important conclusions reached by us in our fertilizer investigational work during the past twenty-five years.

THE PRAIRIE PROVINCES.—Particular interest attaches itself to possibilities of increasing wheat production in Manitoba, Saskatchewan and Alberta by the use of fertilizers. A study of our results would not justify us in the prediction that this could be profitably brought about by a general application of fertilizer. For ten consecutive years, 1900–1909, we had a series of fertilizer experiments on the Experimental Farms at Brandon, Manitoba, and Indian Head, Saskatchewan. The series contained plots dressed with nitrogen, phosphoric acid and potash, singly and in combinations of twos and threes. The results, taking one year with another, failed to indicate any material increase in the yields of the fertilized over those of the unfertilized plots. Frequently the latter gave the larger crops, but it was seldom that the difference between the plots exceeded the amount that might be attributed to experimental error. Certainly there was no consistent increase due to any fertilizer and in no case was the increase sufficient to cover the cost of the fertilizer. These soils, it must be admitted, were typical wheat soils of high quality, but they were in no way exceptional. Hundreds of thousands of acres equally good are to be found in all three of the Prairie provinces.

Experiments carried on in northern Saskatchewan and northern Alberta likewise failed to indicate any specific deficiency in plant food in the soil, the results being irregular and the increases on the dressed plots (when such occurred) not being of that magnitude to warrant definite conclusions as to the virtue of the fertilizer employed or the expenditure for the purchase and application.

With respect to the future, my opinion is that the time will come when phosphates will be found useful. My reason is that of the three essential elements these western soils are least rich in phosphoric acid and that the extensive grain growing will tend to diminish the store of this element that is more or less available for crop use. Moreover, phosphates may be found of value in inducing an earlier ripening of the crop—a matter of much importance in districts where early autumnal frosts endanger the wheat crop. Our hope for these western provinces is that the abandonment of exclusive grain growing and the adoption of mixed farming and of rotations will serve to maintain fertility and obviate the necessity of relying generally on fertilizers for the up-keep of fertility. At the present time I feel assured that the determinative factors in crop production in these regions are the seasonal conditions. If our northwestern lands are not to be allowed to deteriorate, mixed

farming must be introduced, their fertility cannot be maintained by fertilizers. Above all it is imperative in the highest degree that the large humus content be kept up, be constantly replenished, not only to keep fibre in the soil that will prevent loss from "blowing" and "drifting", but to maintain the present high capacity of the soil for holding moisture.

With respect to British Columbia our investigational work has been carried on chiefly at Agassiz, eighty miles from the coast, and on Vancouver Island—the soils being light and gravelly in nature. The most profitable results have been obtained on potatoes, mangels and corn, and emphatic evidence as to the effectiveness of a complete fertilizer application, in conjunction with manure, for these crops has been accumulated. In the larger number of instances the fertilizer yielded a substantial profit. One of the most profitable formulae was nitrate of soda, 100 to 150 lbs.; superphosphate, 300 to 400 lbs.; and muriate of potash, 100 to 200 lbs. per acre. It would seem from our work that a profitable result from the judicious use of fertilizers may be expected in many parts of this province, especially on hoed crops, and we may look for a large and increasing employment of these aids to production in that part of the Dominion.

As regards Ontario our work has been confined to Ottawa, and therefore is only strictly applicable to the eastern part of the province. Very briefly it has shown that fertility cannot be economically maintained and profitable yields obtained by the exclusive use of fertilizers. The results, however, afford satisfactory evidence that fertilizer may be used to good advantage in conjunction with farm manures in a good system of rotation that furnishes humus to the soil, as in the growing of clover. This is probably true of all Ontario and Eastern Canada generally. The deduction is that when manure is scarce or has to be purchased at a high price it will be profitable to apply fertilizers, not to take the place of manure but to supplement its use. No special deficiency has been noted in the soils, a complete fertilizer, as a rule, giving the largest return.

Basic slag has proven the most useful phosphatic fertilizer on sour soils, heavy clays, on soils naturally deficient in lime and on peat and muck soils, while superphosphate on the lighter soils rich in lime has given the quickest returns, especially for turnips and cereals. Basic slag has frequently proved beneficial to old pastures, increasing the yields and improving the nutritive value of the herbage.

A top-dressing of nitrate of soda, applied in the earlier weeks of growth, has been found beneficial to grass, particularly when intended for hay.

Potash has not proved remunerative on heavy clay soils, but on many light loams it has given a good return, for encouraging the growth of clover, potatoes and leafy crops generally. Muck and peaty soils are improved by this element. No potassic fertilizer has proved more valuable than good hardwood ashes, and this is the chief home source of this element which we can now rely on, as the German potash salts since the war cannot be purchased save at prohibitive prices.

THE MARITIME PROVINCES AND QUEBEC.—By far the larger amount of our experimental work with fertilizers in recent years has been carried on in the Maritime provinces. It is quite evident that there is in these parts of the Dominion a larger and more lucrative field for fertilizers than in Ontario, not simply as we might suspect from poorer soils, but from the fact that the crops upon which they are used in these provinces are more particularly money or cash crops—potatoes, apples, etc. Upon such crops the prospect of a remunerative response is greatly enhanced, for the maximum gross returns are larger than, for instance, in grain growing. It is also probable that taken as a whole the seasonal conditions in the Maritime provinces are more favourable to the fuller use of the fertilizer by the crop, than in Ontario.

It is satisfactory to note that the deductions from our experiments at Ottawa, already stated, hold good in the main for Eastern Canada. Invariably the more lucrative response from fertilizers is on land rich or fairly rich in humus, the fertility of which is kept up by manure and the growing of clover. These means are indispensable for the profitable employment of fertilizers.

The largest profits have not always been obtained by what might be termed excessive applications of fertilizer, say 1,000 lbs. and over, but usually from a combination of manure with a moderate dressing of say 500 to 800 lbs. of a well-balanced complete fertilizer. These results have been confirmed at many points and in different seasons. It is quite true, however, that larger applications can be used with profit in the Maritime provinces and British Columbia than in Ontario. Potatoes are the principal crop to which the fertilizer is applied, the land being under a three or four year rotation.

Summing up this teaching with respect to fertilizers, we conclude that the exclusive use of fertilizers will neither keep up the fertility of the soil nor yield profitable returns; that it is on soils of medium rather than poor quality that a lucrative response from their employment is to be expected; that they can profitably be used to supplement the home source of fertility, farm manures; that the largest returns are not necessarily from the largest applications and, lastly, that it is on the money crop of the rotation, such as potatoes, that their application is most profitable.

The employment of fertilizers in Canada has been to date a very small matter compared with that in some other countries in which the soils are lighter and poorer than ours, but this use will assuredly increase. It cannot be otherwise with the adoption of intensive methods, the larger returns for farm produce, the increase in the price of land and the establishment of larger, better, steadier markets at home and abroad for farm produce.

In this account I have said nothing of that part of our campaign that has dealt with the choice of crops, with live stock—their care and feeding. These matters, of almost equal importance with that of crop production, have received the attention they merit. Practically every phase of farm life and work has been dealt with, but time to-night has only permitted me to bring before you in outline our teachings in this fundamental proposition of increased crop production.

At the outset of this address I said that this campaign to our farmers was one, not only of education, but one in which the men on the land were called upon from patriotic motives, as members of the great British Empire, to do their very best in these troublous times for their King and Country. They have been impressed with the fact that a great responsibility rests upon each one of them to put forth every effort possible towards increasing their farm products. As their lot is no easy one in ordinary times and doubly hard now that labour is so scarce, words of encouragement and inspiration have been spoken. Farmers are a hard working class under ordinary circumstances, now they are called upon to do a little more, work a bit longer and a bit harder. They need our sympathy and encouragement.

But there is no need to dwell at length on this phase of the campaign. I cannot do better in closing than quote from an appeal by Lord Selborne, President of the Board of Agriculture and Fisheries, to English farmers for an increase in the food production from the land. His words were direct and struck the right chord and they are as applicable in the Dominion of Canada as in the old land. He said: "You have something more on your shoulders than your own business to-day. You are no longer individual farmers making your own fortunes or losing them. You are trustees on your own land to do your best for England. You have your duty quite as clear and as definite as the captain of the cruiser or the colonel of a battalion. England has a claim on you farmers, men and women of every class, as clear as she has on our sons and husbands to go and serve in the trenches". These surely are inspiring words and clearly state the imperative duty of every farmer in the British Empire in these days.

