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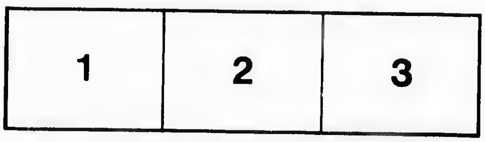

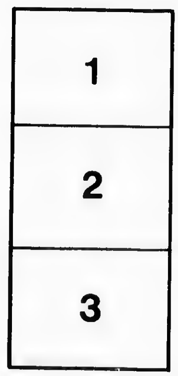

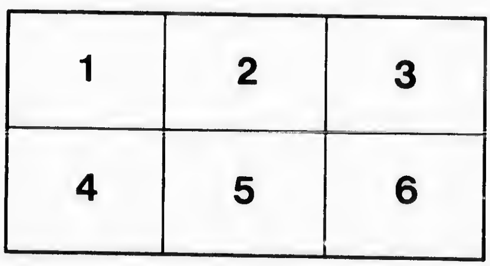

EVIDENCE OF Mr. F. T. SHUTT

CHEMIST, DOMINION EXPERIMENTAL FARMS

BEFORE THE

SELECT STANDING COMMITTEE OF THE HOUSE OF COMMONS

ON

AGRICULTURE AND COLONIZATION

Session of 1894

PRINTED BY ORDER OF PARLIAMENT.

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COMMITTEE ROOM 46,

HOUSE OF COMMONS,

FRIDAY, 18th May, 1894.

The Select Standing Committee on Agriculture and Colonization met this day, at 10.30 a.m. Dr. Sproule, chairman, presiding.

Mr. FRANK T. SHUTT, M.A., chemist of the Dominion experimental farms, was present by citation, and being called, addressed the committee as follows:—

Mr. CHAIRMAN AND GENTLEMEN,—In coming before you again, after an interval of another year, to give an account of the work accomplished by the chemical department of the experimental farms, it will only be possible for me, as on former occasions, to touch very briefly upon some of the more important features of that work. I shall have, of necessity, to pass over, without even mentioning much that is of interest, and for a detailed account of the work of the year, I shall have to refer you to my report which has lately been issued.

INCREASE OF INTEREST BY FARMERS IN AGRICULTURAL CHEMISTRY.

It is not necessary for me here to emphasize the important character of the work in which I am employed, namely, that of investigating agricultural problems by the means which chemistry affords, and of disseminating knowledge respecting agricultural matters, that is to say, respecting soils, fertilizers, cattle, fodder and the like—a knowledge which must necessarily lead our farmers to a clearer understanding of what they are doing, resulting in a more economic and profitable practice on Canadian farms. I say it is unnecessary for me to dwell upon the important character of this class of work, but I feel sure you will be glad to learn that every year marks a keener interest on the part of our farmers throughout the whole country, in our work and experiments. Each succeeding year sees a greater desire evinced by our agriculturists to avail themselves of that knowledge and that assistance which, we, at our experimental farms can offer them.

During the last few years my work has naturally arranged itself into several subdivisions, or classes, and with your permission I shall briefly outline these and speak somewhat of their character and extent.

ANALYTICAL WORK.

This includes the planning and working out of all agricultural problems, the solution of which it is deemed will be of value to the country, or at any rate to a large number of Canadian farmers. As examples of this kind of work, I might mention the chemical and physical examination of typical virgin soils which represent large areas in the Dominion, the question of the amelioration of alkaline soils, the rendering soluble of the mineral phosphates, and the estimation of the nutritive value of the various fodders. These are all questions which are of wide importance, and the results of which would benefit to a large extent the whole country.

VIRGIN SOILS OF CANADA.

I would speak for a moment upon the first of those I mentioned, namely, the virgin soils of Canada. In the examination of typical soils which represent, as I have said, large areas of territory, soils which have neither been manured nor cropped, we can obtain much needful information regarding the amount and the character of the plant food which they contain. Although it is impossible, in the present state of chemical science, to ascertain the exact amount of immediately available plant food in the soil, yet a chemical analysis tells us distinctly the total amount of plant food and its character. We learn therefrom in what essential constituents it is rich, and what elements it is necessary to add to supply deficiencies. Having in our possession data regarding temperature, rainfall, &c., we may use chemical and physical results that have been carefully obtained, to predict the probable fertility of the soil. We can also foretell, in a degree, the suitability of those soils for various farm crops. It would take up too much time on the present occasion to review the work done during the past year in this branch of our investigations, but I should like to say that we are gradually accumulating some very valuable data which will be of use, not only to our own people here, but, I am convinced, will be of great service for immigration purposes in European countries.

I trust that some time in the future we may be able to construct, for certain large areas of Canadian territory, soil maps—maps similar in principle of construction to those that are prepared as weather maps. Such maps would outline more or less accurately, the general character and fertility of the soil of the various areas in Canada. This work, of course, could not be carried out entirely from laboratory data, but would have to be supplemented by an examination of the various soils *in situ.* I mention this matter to show the possibility of a more extended and permanent usefulness in the future, in connection with the examination of virgin soils.

The soils which we have examined comprise specimens from all parts of the Dominion, from every province. Our results show that we possess in Canada soils which compare most favourably in richness of plant food with the best and most fertile soils of other countries. Concerning much of the prairie soil in Manitoba and the North-west Territories, as well as those alluvial soils which have been formed as river deltas and tidal deposits, both on the Pacific and the Atlantic coasts, it is scarcely possible for me to speak in terms of exaggeration, because they possess such a vast store of plant food, a large portion of which is assimilable and ready to be used by crops. With regard to the other provinces, we have analysed many soils which have shown themselves to be excellent. A detailed account of the analytical results in this work, as well as deductions drawn therefrom, will be found in my report for the year.

FODDER GRASSES.

It will now be necessary for me to proceed to the second subject of my branch of research work, namely, the examination of cattle fodders. In fodders, the most important work of the past year has been the preparation of bulletin No. 19, which was issued in September last. It contains a botanical and an agricultural account of many of our native and imported varieties of grasses. It contains, as well, a statement of the chemical composition, and deductions therefrom, as to the relative value of these grasses for feeding purposes. This bulletin is the result of the joint labours of Mr. Fletcher, the botanist of the experimental farm, and myself. The grasses, whose analyses appear in this bulletin, were grown either at our own farm here, in Manitoba or in the North-west Territories. We have, therefore, the composition of the grasses grown under various conditions of climate and on different soils. I should also add that many of the grasses examined were cut and analysed at two stages of growth. This was to ascertain the best period at which they should be cut for making into hay. In this bulletin, a farmer can find an account of all the more common grasses, some of which are illustrated. There were ninety-two in all examined, and the dairymen and stockraisers will here obtain much useful information regarding the general character and suitability of our grasses, either for pasture or for meadow purposes. The figures given show their composition, and, consequently, their relative food value. One of the most important deductions which we were able to make from this work, is in regard to the deterioration which takes place in the food value of grasses as they ripen their seed.

The analyses of these grasses show that the best practice would be to cut the grasses while in bloom, or shortly after, if we wish to preserve the greatest amount of the most valuable of the food constituents, viz., the flesh-formers or albuminoids. Shortly after the time of bloom, the fibre of the grass becomes woody and less digestible; so that there are two important reasons why timothy and other grasses should not be allowed to ripen before cutting for hay. The comparison of the food value of all the grasses examined is a matter of such extreme detail, that I fear it will be impossible for me, this morning, to enter upon it. In conclusion, I may say, that the examination of our Canadian grasses is not yet completed, but during the present summer we hope to do a considerable amount of work to increase our knowledge of this subject, which is of very great importance to farmers and dairymen, and to bring this investigation to a conclusion.

VALUE OF LEGUMINOUS PLANTS FOR GREEN MANURING.

In my report for 1893 will be found the analyses of several leguminous fodder plants. The botanical family, leguminosæ, is one comprising the pea, bean, clover, vetch, and some others of a similar character. I wish to call particular attention to this class of plants, because whether we grow them as fodders or for the purpose of green manuring, they are extremely valuable and important. As fodders, they exceed in food value the ordinary bulky fodders, such as Indian corn and the grasses. They are very much more valuable, weight for weight, than these, and their cultivation improves the soil, not only in tilth, but also in the elements of fertility. A few words in explanation of this may not, here, be out of place. It has long been known that by turning under a crop of growing clover, the soil may be very much enriched, but until quite recently the reason for this has not been rightly understood. It was thought that owing to the fact that clover was a deep-rooted plant, which drew its nourishment largely from the sub-soil, by the turning under of the clover, this nourishment drawn from the sub-soil was added to the surface soil, to be used by subsequent crops. This is but a small part of the truth. We know now that clover and pease, and the rest of the class to which these belong, obtain their nourishment as far as one important constituent is concerned—in a very large measure, from the atmosphere. It is for this very reason that these plants are of so much importance, from an economic standpoint, both as sources of cattle food and for the purpose of green manuring. A further word of explanation may be added to make that clear. We all understand now that the essential elements of plant food, necessary to be returned to the soil if fertility is to be maintained, are three in number, viz., nitrogen, phosphoric acid and potash. Of these three, nitrogen is the most costly. In the form of commercial fertilizers it costs about 15 cents a pound; phosphoric acid and potash cost from 5 to 7 cents a pound. Nitrogen therefore is the most expensive of all plant foods. The same is true when we come to consider animal foods. The most important and the most costly constituent of fodders are the albuminoids, the characteristic element of which is nitrogen. So that whether we feed plants or animals, to do so economically, we have to look for a cheap source of nitrogen. Now the legumes, alone of all classes of plants, are able to appropriate, absorb, assimilate, and convert into their own tissues the free nitrogen of the atmosphere. All other plants have to take their store of nitrogen from the soil. This is one of the greatest and most important of recent discoveries of agricultural science, and it is one that when widely known and practised must certainly prove of the utmost value to our farmers. Plants may, therefore, now be divided into two great class—the NITROGEN COLLECTORS, viz., clover, pease, beans, vetches, lupines; and the NITROGEN CONSUMERS, which class includes all other farm crops.

In many parts of the world where this knowledge has been disseminated, accepted and put into practice by the farmers, agriculture has been revolutionized, and this is more particularly the case where the soils so improved have been originally of a light and sandy character. The growing of the legumes, it is to be understood, then, affords a means of taking a large amount of free nitrogen from the air and converting it within its tissues into a very important and valuable material, which, when turned under, furnishes readily assimilated food for succeeding crops, at the same time the humus or the vegetable matter thus added to the soil very materially improving its tilth. In light and sandy soils it increases the capacity of the soil for moisture, and fermentative changes also take place which not only improve the tilth but finally result in a setting free of mineral plant food. I must not further pursue this interesting and important subject now, but I thought it well, this morning, to draw your attention to this recent discovery in agricultural chemistry, and so, indirectly, to emphasize its importance to our farmers.

By Mr. Carpenter :

Q. At what stage of growth is there the most nitrogen in these plants ?—A. The maximum amount of nitrogen is immediately after flowering—as the seed is forming.

By Mr. McMillan :

Q. The scientific men at one time thought that the assimilation of nitrogen was all by the leaves. Are they still of that opinion ?—A. No. If you take up a clover plant and carefully wash the earth from its roots, you will notice there are little tubercles upon the roots. In these tubercles will be found bacteria, which in some way, not at all clearly understood at present, but by some physiological process, assimilate for the clover plant the free nitrogen of the air. This is proved by the fact that when the clover plant is deprived of the tubercles it is no longer able to make use of or assimilate the free nitrogen in the atmosphere. It has been found that when the clover plant is grown in soil rich in nitrogen, these tubercles do not, develop, showing that their growth is dependent upon a certain "hunger" of the plant for nitrogen. This points to the fact that there is no economy in growing clover for manure upon soils which are already rich in nitrogen, because in that case, they draw nitrogen from the soil and not from the air. But if you supply mineral food in the form of potash and phosphoric acid to a soil deficient in nitrogen, the legumes, by the bacteria in the tubercles, by a process known as *symbiosis*, assimilate and finally convert into albuminoids, within their tissues, the free nitrogen of the air.

By Mr. Roome :

Q. Then the leaves have nothing to do with the assimilation of the free nitrogen ?—A. No.

By Mr. Bain:

Q. Does this apply also to the bean plant ?—A. Yes.

Q. The roots develop in the same way ?—A. Yes, but they have their particular form of bacteria. The tubercles of the lupine contain a different form of bacterium to that of clover, but the function is the same in both cases.

SOILING CROP.

The practice of growing a patch of mixed oats, pease and wheat to be fed to dairy cattle when the pasture runs short, is now becoming common, and wherever it has been tried has been highly spoken of. Sometimes the mixture is of oats and pease only. This green food is succulent, nutritious and palatable, and proves of much value in keeping up the milk flow during the hot dry season. It is a cheap fodder, there being a large yield per acre.

By Mr. McMillan :

Q. Will the development of the tubercles take place most rapidly in a well drained soil, or in a soil well saturated with water?—A. I have no data on that point, but should not suppose the clover would thrive in a soil altogether impermeable to air. I might add, that we can inoculate soil and can induce this assimilation of nitrogen, by transferring to a plot of ground a certain quantity of soil that has had clover or pease grown in it. That will bring the bacteria with it and inoculate the soil. Root tubercles will then be formed on pease or clover subsequently sown.

By Mr. Roome:

Q. What do you include in the term "bacteria"?—A. I include the plants which we ordinarily understand as those which produce fermentative changes, and amongst which are those germs which cause zymotic diseases. There are beneficial and injurious bacteria. They belong to a very low order of plants known as the fungi. They lack green colouring matter and are microscopic in size.

By Mr. Pridham:

Q. Have you ever tried experiments with buckwheat for fertilizers?—A. Buckwheat can only take nitrogen from the soil like other plants, but it is easily grown. A crop of it ploughed under returns to the soil plant food in a condition more or less assimilated for future crops. You have, so to speak, partially digested it. It adds humus-forming material to the soil, which is an important factor in soil fertility. There are several ways in which this green manuring may be done profitably. If the soil is exceedingly sandy the nitrogen-collecting crop, previously manured, if possible, with potash and phosphoric acid fertilizers, may be turned under just after flowering and while yet still green. If clover is used, the first crop may be fed and the second growth ploughed under. However, in the majority of instances, the more economical and profitable method will be to use the legumes as soiling crops, as in this way we obtain highly nutritious food very cheaply—food that will allow us to diminish the grain ration of the cattle, and at the same time to replace on the soil from 75 to 85 per cent of all the plant food in the crop. I think we should draw the attention of our farmers to the importance of this question, and to the necessity of endeavouring to increase the fertility of their soils by growing more of these leguminous crops. In this way, we may cheaply obtain the most costly element in both plant and animal food, and at the same time, permanently improve the condition of our soils.

By Mr. McMillan:

Q. Do you think that they would be of more value acre for acre, where a good crop of corn can be raised? Which crop can we raise the greatest quantity of?—A. We have to look at this matter from several standpoints. In comparing clover with Indian corn, we can obtain a much larger yield from the latter crop. In the case of grasses, however, that ratio is altered. We obtain not only richer food through the legumes, but we also obtain a larger yield per acre. I am advocating a more extensive growth of legumes, but in doing so I am not in any way speaking disparagingly of Indian corn. On former occasions, I have gone into the question of the growing of corn very fully, and pointed out to this committee that it is our chief and most important fodder crop in this country. It is of inestimable value for dairy purposes and the one plant which has made winter dairying possible, but at the same time we have to recognize this fact, that the Indian corn plant takes from the soil those three essentials of plant food which I have already mentioned, in considerable quantities. The growth of Indian corn does by its proper culture, improve the tilth of the soil, still it cannot utilize the free nitrogen of the air to make its albuminoids from, nor can it add plant food to the soil. In the growth of the legumes, we have, on the contrary, a valuable fodder produced cheaply, in addition to the nitrogen stored in the roots, which may be used by the future crops.

By Mr. Carpenter:

Q. Would you recommend the growing of pease in an apple orchard?—A. A a great deal would depend on the character of the soil. If you wish to improve the tilth, that is to say, if the soil is deficient in humus as well as to supply nitrogen; if it were a light porous soil it would be well to turn in a crop of clover or pease, and in that way increase the amount of plant food and the capacity of the soil for moisture. I do not think it is advised, however, by the best authorities, to grow a crop in the orchard if the soil is fairly good, because it is looked upon, generally, that the trees require all the ground available to furnish them their plant food. In the second place, in doing so, you would add nitrogen, which is not the most essential fertilizer for orchards. At the same time that such a crop is grown there should be added some wood ashes or some other form of potash.

By Mr. Semple :

Q. What is your experience as to the best time of cutting hay to get the most good ?—A. While it is in bloom, or shortly afterwards, we find in the majority of instances that the grass gives the largest amount of cattle food. It is then most palatable and nutritious.

By Mr. Roome :

Q. You told us, that with corn the best time to cut it is the glazing stage? How do you account for this difference ?—A. Several questions have to be discussed in that connection. If the corn plant is cut at an earlier stage of growth than "glazing"—say when tasselling—we sustain a considerable loss of real cattle food. This is because the young plant is watery. As it matures it not only increases in weight, but a portion of the water—from 10 to 12 per cent—is replaced by "dry matter." This development of the carbohydrates points to economy in allowing the plant to mature, though it should never be left standing until stalk and ear are ripe, for such would mean a loss in digestibility. From "tasselling" to "glazing" there is an increase of almost 100 per cent in the dry matter, so that if we cut the corn at that early stage we should only get one-half of the cattle food we obtain, if we allow it to go to the glazing condition. Although the dry matter of the corn is richer in albuminoids at the earlier stage, yet, allowing the plant to reach full development, the additional store of food more than balances the slight deterioration in the quality of the dry matter.

Q. I cannot see why in timothy and millet, it should not follow the same rule as with corn ?—A. Another point I should mention in connection with this matter is that as the plants mature, the fibre becomes more and more indigestible. Food is valuable just in accordance as it is digestible. The fibre in ripe grass is therefore less digestible and less valuable than that in grass at a younger stage. Further, as the seeds of grass or Indian corn fill out, there is a migration of food material, including albuminoids, from the stem and leaves to the seeds. This migration of elaborated food leaves the former poorer but enriches the latter. Hence, if the seeds are in a great measure lost, as is sure to result by shedding if the grass is allowed to thoroughly ripen before cutting, a serious loss of cattle food ensues, which might have been avoided by cutting a week or so earlier. Many grasses shed their seed very easily and readily on being harvested when ripe. Indian corn, on the other hand, does not suffer loss this way, but retains its seeds which possess the albuminoids derived from the stem and leaves.

Q. If you use the millet for silo purposes, will there be any loss through shelling of the seed ?—A. Not if it were cut green, i.e., before the stems and seeds were ripe.

Q. If timothy and millet are cut then, when their seed begins to glaze and placed in the silo, we are to understand there is no loss ?—A. There will be no loss, unless subsequent changes occur through a faulty silo.

By Mr. Carpenter :

Q. Have you tried millet for silos ?—A. I cannot say, but there is no reason why it should not make first-class ensilage if cut at the right time and preserved. All grasses may be siloed with success, if proper precautions are taken.

Q. I think Indian corn would be a better crop for silo.—A. Oh, yes, there is no doubt of it. There is no crop from which we can obtain the same yield per acre of cattle fodder. It is, however, to be remembered that corn is not a fodder rich in albuminoids, and must be supplemented either by some of these legumes or a partial meal ration. If we grow and feed more clover, we shall be able to reduce in our cattle rations the number of pounds of meal now necessary to feed. A cheap source of fodder, rich in albuminoids, is necessary for profitable dairying and stock-raising.

By Mr. Semple:

Q. Whether is clover or timothy the most valuable for feeding purposes, weight for weight ?—A. Clover is very much the more valuable.

By Mr. Wilson:

Q. But that would not be so for horses?—A. Yes, for all feeding purposes. There is a mistaken notion in this country with regard to the relative value of grasses and legumes. The analyses and the results of experience show that the feeding value of clover is very much superior to that of the grasses.

Q. Superior to timothy?—A. Yes.

Q. For horses?—A. Yes. I cannot recall at the moment any instance where grass hay has been entirely replaced by clover hay in the feeding of horses, but undoubtedly the latter affords them, weight for weight, much more nutriment than the hay from grasses.

By Mr. McMillan:

Q. I believe that clover is much more nutritious for horses if you get it into the barn without any taste of mould. That is what injures the animal?—A. This erroneous notion with regard to the relative value of timothy and clover (viz., that the former is much more valuable), is very common in this country, but you will not find that it exists in the older countries. Great care, as you have just remarked, as to the proper preservation of the clover, is necessary. It is owing to carelessness in this matter, that makes it possible that any objection can be raised to clover as a nutritious and wholesome feed. It should be free from dust and mould. Our analyses and our feeding experiments combine to show that the clover is much the more valuable of the two.

RELATIVE VALUE PLAN FOR THE PURCHASE OF MILK.

I would now speak briefly with regard to the relative value plan for the purchase and sale of milk. On former occasions I have explained to you the principle of the Babcock process, and the composite test, and I have also dwelt at some length on the advantage that would accrue to our farmers and dairymen from the adoption of this plan in the sale of their milk.

In June last, I issued a bulletin (No. 13), which gives full instructions for manipulating the test, in creameries and cheese factories. It also contains an explantion and illustration of the necessary calculations (which are exceedingly simple), to be undertaken in estimating the dividends due to patrons who use this process. Some idea of the interest taken in this matter, by our people, may be obtained from the fact that the first edition of this bulletin was exhausted a few weeks after it was issued. The bulletin has been incorporated in the Dairy Commissioner's Report for 1893, but to meet the special demand for factory purposes, it is proposed to issue a special edition in the course of a few weeks. It is not at all to be wondered at, that such a method as the "Babcock" should appeal to everybody who gives the matter a moment's thought, as being a more equitable and business-like plan to adopt in creameries, than the old pooling plan. Every one must acknowledge that it exactly measures the qualities of the milk for butter making purposes. The superiority of the test over all others, for creameries, is now universally admitted, but it is not as yet acknowledged by all, that it is the best plan to adopt for cheese factories; and that is why I wish to bring the matter before you this morning. From the work carried on by our Dairy Commissioner, Mr. J.W. Robertson, as well as from a large number of experiments conducted by Dr. Van Slyke of Geneva, New York, and Dr. Babcock, Wisconsin, it has been clearly shown that the fat in milk varies with the casein or curd, so that the ratio between the percentage of fat and the percentage of curd is more or less constant for milks of varying proportions of fat. The ordinary impression is therefore erroneous, that a milk rich in butter fat is necessarily poor in curd. A rich milk will make more and better cheese than a poorer milk. The popular idea that one cow is a butter cow, and another is a cheese cow, is not borne out by science or experience. It has been most conclusively shown that the percentage of butter fat in the milk, gives us all that is necessary to arrive at the value of the milk for cheese making purposes. The following are some statistics to corroborate this: they are from the very highest authorities in this matter, and are well worth careful consideration by all interested in cheese making:—

TABLE prepared by Dr. S. M. Babcock, embodying the results of experiments by Dr. Van Slyke, of the experimental station of Geneva, N. Y., and showing the relation of fat to casein, and yield of cheese in normal milks containing different amounts of fat.

Per cent of fat in milk.	Average per cent of fat.	Average per cent of casein.	Lbs. of casein per lb. of fat.	Fat lost from 100 lbs. of milk.	Per cent of fat in milk lost in whey.	Lbs. of cheese from 100 lbs. of Milk.	Green cheese for lb. of fat in milk.
From 3·0 to 3·5	3·35	2·20	·66	·32	9·55	9·14	2·73
" 3·5 " 4·0	3·72	2·46	·66	·33	8·33	10·04	2·70
" 4·0 " 4·5	4·15	2·70	·65	·32	7·70	11·31	2·73
" 4·5 " 5·0	4·74	3·05	·64	·28	5·90	12·85	2·71
" 5·0 " 5·25	5·13	3·12	·61	·31	6·00	13·62	2·66

The results of the large number of experiments conducted and here epitomized establish this fact, that the fat contents of milk are a true indication of the value of that milk for the purpose of cheese-making. Milk with 4·74 per cent of fat gives a proportionately better yield of cheese per 100 lbs. than milk with 3·74 per cent of fat. In the first instance 12·85 lbs. of cheese, in the latter 10·04 lbs. of cheese.

By Mr. McMillan :

Q. Is it possible to get milk with so much butter-fat that you cannot convert it into cheese?—A. I know that milk of the richness of 5 per cent to 5·25 per cent of butter-fat, can be used without any loss of butter-fat in the whey. In fact, as a matter of experiment, it has been found that there has been a smaller percentage of loss of butter-fat in the whey with the richer milk than with the poorer milk The above table shows over 9 per cent of the fat lost in the whey with milk 3·35 per cent fat, while the loss is reduced to 6·0 per cent in the richer milk of 5·0 per cent butter-fat. I do not know that any extensive experiments have been conducted with milk with 7 or 8 per cent of butter-fat, such as some Jerseys might give. Such milk would make an exceedingly rich cheese, and if the price of the cheese were according to its richness or amount of butter-fat, an exceedingly valuable cheese would result. But milks containing such a high percentage of butter fat are not met with in ordinary practice. All that I have said is quite true with regard to milks which might be supplied to creameries and cheese factories. It is of the greatest importance that this definite knowledge should be widely disseminated, because until a short time ago, the accuracy and reliability of the "Babcock method" for cheese making was a disputed point. This work will lead to the wider adoption of the Babcock test and put the whole question of purchasing and selling of milk on a more business-like and equitable basis.

By Mr. Rowand :

Q. You consider the Babcock a perfectly reliable test?—A. I consider it perfectly reliable in every way.

By Mr. McMillan :

Q. When you spoke of examining soils, you mentioned about the preparation of a soil map. In going over Ontario, would that be possible? Are there not large tracts of country dotted over with drift, with a topping of boulder clay, soils that would make it very difficult to make a proper map?—A. Undoubtedly there are great difficulties in mapping out the areas of this country. Much territory could not be satisfactorily mapped, but I think several of the largest areas could be mapped, as for instance Manitoba, the North-west Territories and British Columbia. There are also some portions of Ontario and Quebec and the Maritime Provinces that might also be worked up in this way, but I recognize the difficulty that there would be in certain portions of the older provinces, in making such maps. The work is one of the future. For many years it would be necessary to accumulate chemical and physical data, as well as information respecting limits of areas, before even a commencement could be made at the maps.

ANALYSES OF SAMPLES OF SOILS AND FERTILIZERS, &c., FOR FARMERS.

I shall now pass on to speak of the second division of my work, namely, the examination and reporting on samples sent in by farmers for analysis. This work is an ever increasing one. I suppose that this branch is becoming popular because our farmers are learning the usefulness of chemical information and also from the fact that no charge is made for our examinations. Of course, it is hardly necessary for me to add that no analyses are made, the results of which would benefit the individual only. Such should rightly be undertaken at private expense. The results of all analyses made, and the deductions from them, are of that character that when published they may serve to benefit a large portion of the farming community. During the past year 153 samples have in this way been received from farmers.

By the Chairman:

Q. 153 samples of soils?—A. No; not altogether. Of that number 36 were natural fertilizers, comprising muds, mucks, peat, wood ashes, marl and gypsum. At previous meetings of this committee I have discussed the value of these different materials for fertilizing purposes, and it will not therefore be necessary to speak as to their composition, on the present occasion. I may remind the committee that the examination of all commercial fertilizers sold in Canada is annually undertaken by the Inland Revenue Department, to which department the work is assigned by statute.

Of soils, 41 samples were sent in. These were not submitted to complete analysis, for such would neither be possible, owing to the very large amount of work it entails, nor, in the second place, would it be desirable or profitable. The history of the soils so sent in, as regards manuring and cropping, is uncertain, and the sampling is not taken with that care that insures the sample forwarded being thoroughly representative. We have therefore no data that would warrant a large expenditure of time on our part, for the results would be of very uncertain value. We, however, make a preliminary physical and chemical examination of such soils, and from the data so obtained, we are able to report to the sender, as to their general character, what crops they are best suited for, and what fertilizers and treatment will probably give the best results. In this way, we have been able, I think, to do a useful work, although it is not of that complete and detailed nature that characterizes the examination of soils, the history of which we know and which are typical examples of large areas. The information we have thus been enabled to give to farmers seems to be of value, and appreciated, since every year a larger number of samples are sent in. I have learned from many farmers that they have materially improved their soil by following out the suggestions given. In one case, as when the soil has been light and sandy, the advice has been to turn under a green crop, such as clover; in another instance, as when the soil has been a stiff clay, draining has been strongly recommended. In others, the treatment of muck soils with lime and wood ashes, the suitability of the soil sent for cereals and root crops, are amongst the more important features of the report. These, briefly, may serve as indicating the nature of the reports sent to farmers regarding their soils.

WELL WATERS.

During the past year, forty samples of farmers' water supplies have been analysed and reported on. The importance of pure water, I am glad to say, is fast becoming recognized by our agricultural population. Many are now seeking to preserve their water supplies from pollution. When all realize the risk in drinking impure water, when all are convinced that for dairy purposes pure water is indispensable to good results, then we may hope for an improvement of the water supplies on Canadian farms. We take every possible opportunity to speak against the pernicious habit of sinking wells in the barnyard and stables. We endeavour to emphasize the equal importance of good water with nutritious food. When farmers learn that there is direct scientific testimony establishing the outbreaks of epidemics, as typhoid, diphtheria, scarlet fever and the like, with contaminated water, they will pay greater attention to this question of pure water.

By Mr. McMillan :

Q. What proportion of water sent in from the farms did you find obnoxious?—A. I have referred to the matter in my annual report. The chemical details are set out there, but I did not calculate the percentage of those unfit for use. There are 34 samples tabulated in the report, and confirmatory of what I have just stated, I might quote some of the conclusions which were reached after an examination of these waters. For instance, the first is classed as "fair; not polluted by sewage." "Of purer quality than No. 1." "Fair, though too much vegetable matter." "Unfit for use; polluted by drainage from stable." "Fair, no indication of sewage pollution." "Unfit for use; polluted by drainage." "Suspicious; previous contamination indicated." "Seriously polluted; unfit for use." "An exceedingly bad water." "A fairly good water, though chlorine too high." "Not safe for drinking purposes; polluted. "Second class; with suspicious features." "Totally unfit for drinking purposes; very bad." "Very bad water; the free ammonia and chloride indicate presence of liquid manure." "Unfit for drinking purposes." "Excellent; perfectly wholesome, and ranking with first class waters." "Polluted, as in No. 15." "A good water; safe for drinking purposes." "Seriously polluted, and unsafe for drinking purposes." "Dangerous to use; a bad water." "A first class water, of excellent quality." "An excellent water." "Not fit for drinking purposes." "A good drinking water." "Probably a good and safe water." "Polluted." "Polluted; not fit for drinking purposes." "A very fair water; safe to drink." "Condemned as a drinking water." "Dangerously contaminated." "Seriously polluted; unsafe for drinking purposes." "Shows previous contamination." These brief reports give a very good indication of the character of the waters forwarded for examination.

Q. What effect would not cleaning out a well for a number of years have?—A. If the well did not act as a cesspool and the top was properly covered in, so that small animals could not find their way in, it might be many years before it would be necessary to clean out the well. The accumulation of injurious matter, however, is very apt to take place. Much would depend upon whether or not the well is located in a barnyard, or near any source of pollution. When a well acts as a cesspit, cleaning is of little use. It must be abandoned, and another source sought for.

By the Chairman ;

Q. What analysis do you make of water?—A. Our analysis of water is a very thorough one. I make a complete report as to the amount of free ammonia, albuminoid ammonia, nitrogen in nitrates and nitrites, chlorine, the total solids, the solids after ignition, the loss on ignition, the oxygen absorbed at 80 degrees Fahrenheit, and the phosphates, if any. You will see from this that we make a thorough analysis of the waters. Deductions from partial or incomplete data are often very misleading. There is no rough and ready way of making a reliable water analysis.

By Mr. Semple :

Q. How is the water supplied by the Ottawa water works classed?—A. It is a pure water, showing no sign of contamination with sewage matter. Nevertheless, it would not rank as a first-class water, owing to the amount of dissolved vegetable matter which its contains and which gives to it its brown colour. It must not, however, be thought that such vegetable matter is of the same dangerous character as that derived from drainage. Its presence, however, prevents Ottawa water from ranking as first-class, although it is a good and wholesome drinking water.

By Mr. Wilmot :

Q. The clearness is not always an indication?—A. No. The very brightest and most sparkling are often the very worst.

To those who are desirous of sending water for analysis, we issue instructions, because it is absolutely necessary that a sample should be carefully taken in a perfectly clean jar. If the instructions are carried out faithfully, and the information supplied regarding the source of the water, the work of analysis is done free of charge. The following is a copy of the instructions:—

" *Instructions for Sending Samples of Water for Analysis.*"

" Procure from a druggist an empty " Winchester Quart " bottle, which, however, must not have held ammonia. If such be not obtainable, a clean, new stoneware gallon jar may be used. In either case, rinse the vessel several times with the water about to be sent, finally filling it up to the neck. Close tightly with a new cork, and tie over the cork and around the neck a piece of new cotton, which will prevent the cork from coming out and dirt from entering the bottle. Pack the bottle in sawdust or other suitable packing material, to prevent it from shifting in the box *en route.* Ship the sample as soon as possible after taking it, prepaying express charges. At the same time, send particulars as to the nature of soil and subsoil or rock, through which the well is sunk, the depth of well, the usual height of water in well, the distance of well from barn, stable or privy, whether the well has been lately cleaned, material and condition of cribwork, and any other information regarding the water, which may assist in drawing conclusions as to the nature of the source and the normal condition of the sample sent for analysis."

" FRANK T. SHUTT, M.A.,

" Chemical Laboratory, " *Chemist.*

" Central Experimental Farm, Ottawa."

By the Chairman:

Q. They send it in bottles by mail?—A. No, by express. The sender must prepay the express charges.

I have already stated there is direct scientific testimony establishing the connection of outbreaks of epidemics, such as typhoid fever and diphtheria, with polluted water supplies. These diseases are often very prevalent in country parts. I am of the opinion that this matter of pure water is just as important for the farmer to study as that of a good and cheap food supply, and perhaps more so, since health is before profit, and indeed without the former the latter is unattainable.

By Mr. Bain:

Q. Don't you think these epidemics often break out when the water is low?—Yes.

Q. That would indicate that the water at one season was not as pure as at others?—A. You will easily understand how that can arise. When the soil is light, the weather hot and the rainfall slight, the water in the wells is consequently reduced in volume; at the same time the climatic conditions are those favourable to the growth of bacteria which produce diseases. These two factors work together, viz., the concentration, or rather diminution in volume of the water containing the bacteria, and the greater development of the bacteria.

Q. They are not produced by the water being concentrated?—A. No, they are not so produced, but there is a larger number. Before the process of evaporation commences, we may assume, for the purpose of illustration, that there were ten bacteria per cubic centimetre; if this water evaporates to one-tenth of its volume, there will be just one hundred bacteria per cubic centimetre.

Q. How will it evaporate under the ground?—A. The evaporation does not so much take place in the well as in the supply flowing into the well. This is much less. The chief reason, however, for the presence of so many bacteria is that the temperature in the dry season is extremely favourable to their growth, and the water already contains nitrogenous organic waste materials for the bacteria to feed on.

By Mr. McGregor:

Q. Have you tried rain water, many use a cistern?—A. When the rain is collected in a perfectly pure condition there is no objection to it; but unfortunately, it often contains the washings from a dirty roof and eaves. The soft water cistern should be constantly examined, in case organic matter, that would decompose and spoil the water, accumulated.

FODDERS.

In fodders we have had twenty-one samples sent us. These comprise specimens of the bulky fodders, such as grass and corn, and also of concentrated fodders, including meals and grains of various kinds. The remaining fifteen samples include a variety of substances of a miscellaneous character connected with agriculture; dairy and food products, insecticides and fungicides. Useful work for the departments of entomology and horticulture has been done, which greatly assists in combating insect and fungous foes to fruit. Many interesting points in the chemistry of Bordeaux mixture and ammoniacal copper carbonate combined with insecticides have been worked out in our laboratories. The conclusions arrived at from our experiments will be of service to fruit growers.

CORRESPONDENCE AND CONVENTIONS.

I should not bring my remarks to a close without mentioning the increase in the number of correspondents that has marked the past year. I spoke at the outset of the increased interest taken in the work of the experimental farms by the farmers in general. Perhaps one of the best indications I can give you of that ever growing interest, is in the matter of correspondence. Inquiries are now received from farmers in all parts of the Dominion, on all matters relating to agriculture, soils, fertilizers, cattle food and so on, so that I suppose nearly one-third of my time is now occupied in answering by letter questions upon such things. It seems to have become widely known that the experimental farm is a sort of bureau of information which can be applied to free of all cost. It is scarcely necessary to add that we are not always able to give definite answers to the questions which are sent to us. That of course would be impossible for any one to do, but the best is done under the circumstances, and I am convinced that in very many instances material help has been afforded by the suggestions made. Several of the large dairymen's convention and farmers' institutes have been addressed. In thus meeting and discussing with farmers, personally, matters of interest to them, we have one of the surest and best methods of disseminating not only agricultural truths in general, but the result of our experiments at the farms. For this reason, I look upon this work as one of considerable importance and value.

CEREALS AT THE WORLD'S COLUMBIAN EXPOSITION.

I would very briefly refer to the fact that last year I acted as expert juror on the cereals at World's Columbian Exposition. This work was undertaken by me at the instigation of the Honourable the Minister of Agriculture, my appointment being made through the nomination of Sir Henry Trueman Wood, secretary to the Royal Commission of Great Britain. At Chicago I assisted in the analyses of over 500 samples of grain, including wheat, oats, barley, buckwheat, rye, pease, &c. Many of these samples came from Canada, but the collection included specimens taken from all over the world. I regret very much that as yet the awards have not been published. The importance of my work, in this connection, will be apparent when you learn that the basis upon which the awards were made took into consideration the composition, as arrived at by chemical analysis, as well as the ordinary physical data, such as colour, weight per bushel, &c. I am very sorry that these results have not yet been made known, but I learnt the other day from Washington, that all our data were being collected, and will soon be published in bulletin form. A certain number of these bulletins will be at my disposal, and when they come to hand, it will be found that the results corroborate the favourable impression we have regarding the value of our Canadian cereals, and more particularly of the wheat of Manitoba and the North-west Territories.

This bulletin will be of great commercial value to us, because it will show that we can compete most favourably with the best grain countries in the world, and it also will be of great scientific value, inasmuch as it will show the effects of climate and soil, throughout the large portion of the known world, upon the composition of cereals.

By Mr. McMillan:

Q. Have you tested wheat in a greenish condition and when it is fully ripe? I will tell you the reason why I have asked that question. We have been under the impression that cutting wheat on the green side was advantageous, but a miller at Seaforth instructed the farmers to allow the wheat to get ripe, because if it were cut on the green side, it would not make strong baker's flour?—A. I have no direct experience in the matter, but from what I have already said, with regard to the cutting of grasses before they were quite ripe, for the purpose of making hay, it will be seen that we have an analogous case to the one you have stated. I have said that as the said seed matures, the material which is stored up in the leaf and stem migrates to the seed. Now, if that plant is cut before the seeds are fully formed—before this migration of material is complete—the migratory action will go on after the grain is cut; but if the grain is cut such a length of time previous to ripening that the vegetable cell dies before all assimilated matter can pass to the seed, then that material remains in the straw and enriches the straw, but to a similar extent the seed is impoverished. The life of a vegetable cell after you sever the plant would depend very greatly on the amount of moisture and temperature.

Q. On the weather?—A. Certainly. In some cases the cells would die comparatively quickly and the progress of migration would soon cease.

By Mr. Semple:

Q. I think it is important that you should test wheat when it is quite ripe and a week earlier, in order to ascertain the value of these different methods?—A. It is possible that we shall do that. The plant is all the time storing up material until the seeds are formed, and then the material so assimilated goes to the seed. If the plant is cut before the requisite time, the seed must necessarily be impoverished.

By Mr. McMillan:

Q. When I put the question about Indian corn, I recognized, of course, that leguminous plants are valuable. But is it not a fact, that all these things are returned back to the soil in the shape of manure, and that corn is after all the more profitable crop?—A. The object of good farming is to keep the plant food on the farm. But plant food in the soil is there to be used. I have no objections to farmers using plants which are exhaustive; such are often the richest in food value and give us the best returns. That, however, does not affect the fact that in the leguminosæ we have a distinct advantage over other plants, because they can appropriate from the air a material, worth at least 15 cents per pound, whether we buy it as a plant food or animal food. This must not be understood, however, as speaking against the Indian corn crop. I wish our farmers could be brought to see there is no necessity to impoverish the land by growing exhaustive crops. I say, exhaust the soil, if necessary, but take good care of the manure. As long as the plant food remains in the soil, it is of no value to anybody. If any profit is to result from it, it must be converted into plant substance and then into animal products. Experiments have shown that from 75 to 95 per cent of the food taken from the soil by the plant, is returned to the soil in the manure.

By the Chairman:

Q. Which is most valuable for enriching the soil, to turn down a crop of clover or buckwheat?—Clover, most decidedly. Buckwheat only returns to the soil what it has taken from the soil, while clover, in addition, returns to the soil that which it has taken from the air, namely, nitrogen.

By Mr. Roome:

Q. If clover and leguminosæ in general take this atmospheric nitrogen by their root tubercles and not by their leaves, how can they appropriate this nitrogen?—

A. In all open or porous soils, there is a very large quantity of air. This consists of oxygen and nitrogen. The bacteria in the tubercles are able to make use of this soil nitrogen. It is possible that the nitrogen must first be dissolved in soil waters.

By Mr. McMillan:

Q. It must be a well pulverised soil that must have the best effect?—A. Certainly, the soil must be sufficiently porous otherwise the clover cannot thrive.

By Mr. Roome:

Q. How are plants affected which grow in water?—A. Some are well adapted to such circumstances, while others cannot live. However, with regard to this assimilation and fixation of free nitrogen, scientists in Germany and England have shown that all other plants save the leguminosæ must have soil nitrogen in order to live, and mature their seed.

By Mr. McMillan:

Q. I think buckwheat has this advantage over clover, that is if it is summer fallowed (and especially if the soil is a stiff heavy clay), and in six or seven weeks you can be ploughing it down. It pulverizes the land, thoroughly?—A. It will undoubtedly give you a soil on which you can grow clover the better. It adds humus to the soil and improves the tilth.

By the Chairman:

Q. Do you consider the oil in the buckwheat of any value?—A. Not as plant food.

FRUIT PRESERVATION.

By Mr. Bain (Wentworth):

Q. When you where on duty at Chicago, did you pay any attention to the preservation of fruit as exhibited in the samples preserved with various materials to keep the fruit fresh?—A. I did not have anything to do with that class of work at Chicago, though I made a number of the fluids that the fruits were preserved in. We have experimented with a very large number of chemical fluids, with varying success. Without the data which I have not with me, it would be difficult for me to give you the exact particulars as regards the success we have met with in the various fluids. We have found different fruits require different fluids, for their successful preservation. Certain fruits are very easy to preserve, as museum specimens, while others are extremely difficult of preservation. Success largely depends on the character of the fruit, whether it is watery or not. With your permission, I will include in my evidence the results obtained by Mr. Craig and myself when preparing the samples for Chicago. We experimented with a large number of fluids, for instance, corrosive sublimate, chloride of zinc, salicylic acid, boracic acid, sulphurous acid, and other chemicals. Without the data, however, which are exceedingly voluminous it would be difficult to give anything like a detailed account of the results which have been arrived at in the several cases. I shall be glad to append a summary of our results.

Q. Have you been able to find any fluids that have been pretty successful in preserving samples?—A. With certain fruits, we have. There are several points that we have to consider in preparing and using these preservative fluids. In the first place, the fluid must be an antiseptic which will prevent fungus growth; in the second place it must be a fluid which will not absorb any of the liquid in the fruit. If the fluid is of the right density, the fruit will neither shrink nor burst. We also desire to obtain a fluid which will not abstract the colour from the fruit. You can well understand that it is very difficult to get a chemical fluid embodying all these three characteristics, an antiseptic, one possessing the right specific gravity, and at the same time having no effect on the colour.

Q. Possibly you noticed some of the United States samples of fruit shown at Chicago were exceedingly fine. Generally the Canadian samples were good, but a few would have been better away?—A. Do you speak with regard to colour alone?

Q. I refer to colour, texture and fulness?—A. With such fruit as the pear, it is extremely easy to keep them in good colour by the use of sulphurous acid. They, however, soon obtain an unnatural whiteness; the acid bleaches them to a certain extent. As a museum object they generally are considered beautiful. In the case with grapes, it is difficult to preserve them with their natural hue; after a few weeks their colour changes and they become somewhat dingy in appearance. Though, as was only natural to expect, there were some failures among the Canadian specimens at Chicago, I thought, that on the whole, our exhibit showed very successful treatment. I fully expect that an equal percentage of failures occurred with others as with us.

Q. A preservative is not a good one, if it does not retain the natural colour of the fruit?—A. No. Many preservatives will act well for a few weeks, but will not preserve the fruit in its pristine beauty, for a very long time.

Q. A few years ago it was thought that salicylic acid was effective?—A. Its use has been successful for raspberries, currants and cherries.

Q. I suppose there is nothing that fills that bill just now?—A. Are you speaking from a museum standpoint?

Q. I mean for both purposes?—A. My remarks must be understood as referring to museum specimens only. No one fluid acts equally well for all fruits.

The following are the results obtained with various fluids, and are the outcome of the joint labours of Mr. Craig and myself, when preparing the fruit specimens for the World's Fair at Chicago.

FRUIT PRESERVATIVES FOR EXHIBITION PURPOSES.

In considering this matter it is necessary to remember that not only must the fruit be preserved from spoiling, but that its colour and form be retained. While a certain solution may serve to retain the form and texture of the fruit, it may be found to discharge or extract the colour. Again, on account of the density of the fruit juice being greater than that of many preservative solutions, osmosis takes place—the fruit bursts and the whole becomes an unsightly mass. To overcome this latter trouble, glycerine has been used. If glycerine is added to the fluid until the fruit remains suspended in the mixture (not floating on the top), the fruit will not be apt to burst or shrink, as the fluid will be of the same density as that of the fruit juice. From five to ten per cent of glycerine is the quantity recommended.

Chloral Hydrate.—Four ounces to one gallon of water, for red currants, cherries, grapes and raspberries. This extracts the colour of high coloured fruits somewhat, but as a rule, not to the same extent as salicylic acid. It is, however, more expensive.

Corrosive Sublimate.—For red and black grapes, dark coloured cherries and currants it is advisable to use two solutions; the one in the proportion of one-quarter ounce to the gallon of water, the other, one-half ounce to the gallon. The latter strength, while preserving most thick-skinned fruits perfectly, is apt to coat them with a thin white film of calomel. It is, however, useful for preserving those varieties of grapes whose general appearance would not be much affected by this deposit, and, according to Prof. P. Piche, may serve to replace the weaker solution, after the fruit has been preserved for some time.

Salicylic Acid.—One quarter ounce to the gallon of water. For tomatoes, red and yellow; raspberries and blackberries. One of the best known and most generally used of the antiseptic fluids. In order to render this acid soluble, it is necessary to treat it with hot water, allowing the solution to cool before using. As already stated, the bleaching tendency of this fluid is its principal objection. With tomatoes and yellow fruits it has given good results.

Sulphurous Acid.—For pears, peaches, and light coloured fruits. This may be prepared by saturating water in a barrel with the fumes of burning sulphur. The barrel being half full of water, a tin or iron vessel holding flour of sulphur is floated on the water and the sulphur set on fire; when the flame goes out and a sufficient time has elaped to allow the sulphurous acid formed to dissolve in the water, fresh air is admitted by taking off the cover and relighting the sulphur. This should be repeated several times.

Coal Oil.—This has been used successfully in the preservation of strawberries and raspberries. A colourless grade of oil should be employed.

In selecting fruit to be preserved, great care should be exercised in picking and handling. Raspberries, strawberries and blackberries should be cut instead of picked, leaving the receptacle and a small portion of the stem attached to the fruit.

Having examined the preceding transcript of my evidence, I find it correct.

FRANK T. SHUTT,

Chemist, Dominion Experimental Farms.

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