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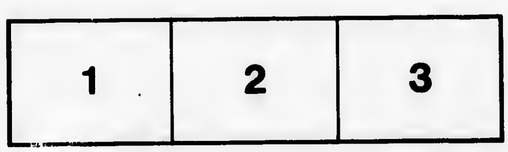
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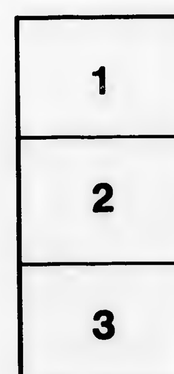
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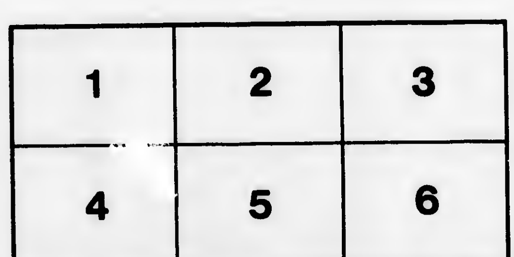
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FERTILIZERS AND FOOD PRODUCTS

EVIDENCE

OF

MR. F. T. SHUTT

CHEMIST, CENTRAL EXPERIMENTAL FARM

BEFORE THE

SELECT STANDING COMMITTEE

ON

AGRICULTURE AND COLONIZATION

1899

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1899

FERTILIZERS AND FOOD PRODUCTS.

COMMITTEE ROOM, No. 47,
HOUSE OF COMMONS,
OTTAWA, 15th June, 1899.

The Committee on Agriculture and Colonization met this morning at 10.45 a.m., Mr. Bain, the chairman, presiding.

At the request of the committee, Mr. FRANK T. SHUTT, M.A., chemist of the Experimental Farms, attended and made the following statement in reference to the work of the chemical division of the Experimental Farms.

MR. CHAIRMAN AND GENTLEMEN,—As I found it difficult on previous occasions, owing to the limited time at our disposal to bring before you all the important features of our work for the past year, I have to-day departed from my usual custom and prepared a statement in writing. I think this will enable me to present the matter more concisely, and at the same time, more fully and need not in any way interfere with the custom of asking questions usual on such occasions. Of course I shall be very pleased to answer, to the best of my ability, any questions that may be asked, as we proceed.

By Mr. Featherson:

Q. In reading your address I suppose you would prefer to have the questions left until afterwards.

A. That is just as the committee chooses. I shall not deem it an interruption if members ask me questions at the time if it is more convenient for them.

It is my pleasure to be able to report that the work of the Chemical Division at the Experimental Farms has during the past year proceeded satisfactorily and afforded results of considerable value to Canadian farmers. This work is necessarily of a varied character, for chemical aid is needed in every branch of agriculture: our purposes, however, will be served to-day if we consider it according to the following classification.

1. Original investigations and research work. This includes experiments instituted by the Chemical Division and chemical work in connection with the experiments conducted by the horticultural, entomological and other divisions of the Central Experimental Farm, as well as at the branch farms. It is scarcely possible to give any typical example of this class of work, but I may cite as of greater importance the determination of the relative fertility of the virgin soils, and of the degree of availability of plant food in certain soils and fertilizers; ascertaining the effect of fermentation upon the elements of fertility in manures and the estimation of the comparative value of certain crops such as clover and of certain naturally occurring fertilizers such as marl, swamp muck, &c., for the improvement and enrichment of soils; the determination of the feeding value of crops and their products. To these classes of research may be added investigations covering the chemistry of insecticides, and fungicides. This is an important matter because the effectiveness and safety with which insecticides and fungicides can be used depend very largely upon their proper preparation; we have numerous instances where much damage has been done to foliage by the use of improperly prepared fungicides and insecticides. Investigations with dairy products, food preservatives, and investigations to ascertain the effect of certain foods on flesh, &c., also receive attention at our hands.

2. The examination of samples of an agricultural nature that have been sent in by farmers and those engaged in one or other of the various special branches of agriculture.

3. Correspondence, writing of reports and bulletins, and the delivery of addresses at agricultural, dairy and horticultural conventions.

1.—Original Investigations and Research Work.

This, as might be supposed, makes the first demand upon our time; other work must be taken up as opportunity permits. I shall endeavour to place before you, briefly, an account of the more important results obtained from investigations of this character during the past year.

The Preservation of Barnyard Manure.

Our report for 1898, recently issued, contains a full account of the results obtained from a somewhat extensive investigation, commenced two years ago, to ascertain: (1) the relative value, weight for weight, of fresh and rotted manure; (2) the losses that occur during rotting under conditions of protection and exposure respectively; (3) the effect of rotting on the availability of the plant food in the manure, and (4) the effect of gypsum as an absorbent of ammonia in the manure heap.

As this work was approaching completion when I addressed the committee last year, I took the opportunity of bringing before you some of the chief results and the deductions that I was able to draw therefrom. It may not therefore be necessary to-day for me to speak of this investigation further than to draw your attention to two tables of data that I have specially prepared, setting forth (1) the weights of fertilizing constituents in the protected and exposed manures at different and stated periods throughout the year of rotting, and (2) the losses, calculated in percentages, of the various fertilizing constituents in the rotting of the manure under the two series of conditions. Table II is calculated from the data furnished in table I.

It will be remembered that the experiment we are now speaking of consisted in the rotting of manure composed of equal parts of horse and cow manure (*a*) in a well built shed with weather-proof sides and roof, and (*b*) in an open bin, the sides and floors of which were double boarded. The former we termed "protected," the latter "exposed." The manures were weighed and analyzed month by month for a year, and the following tables show the results in detail:—

TABLE No. 1.

WEIGHTS OF FERTILIZING CONSTITUENTS IN PROTECTED AND EXPOSED MANURES.

—	Fresh.		At end of 3 mos.		At end of 6 mos.		At end of 9 mos.		At end of 12 mos.	
	Protected.	Exposed	Protected.	Exposed	Protected.	Exposed	Protected.	Exposed	Protected.	Exposed
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Manure.	8,000	8,000	2,980	3,903	2,308	4,124	2,224	4,189	2,185	3,838
Organic matter.	1,938	1,938	880	791	803	652	760	648	770	607
Nitrogen.......	48	48	40	34	39	33	37	29	37	31
Phosphoric acid	25	25	25	23	26	22	25	21	24	21
Potash	62	62	65	48	59	44	60	41	60	40

TABLE No. 2.

LOSS OF FERTILIZING CONSTITUENTS IN THE ROTTING OF MANURE.

—	At end of 3 mos.		At end of 6 mos.		At end of 9 mos.		At end of 12 mos.	
	Pertected.	Exposed	Protected.	Exposed	Protected.	Exposed	Protected.	Exposed
	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.
Loss of organic matter..........	55	60	58	65	60	67	60	69
" nitrogen..................	17	29	19	30	23	40	23	40
" phosphoric acid..........	None.	8	None.	12	None.	16	4	16
" potash.................	None.	22	3	29	3	34	3	36
Loss in value per ton of original manure......................	20c.	64c.	27c.	80c.	36c.	90c.	36c.	95c.

Value of fresh manure $2.61 per ton.

Without reading to you all the data presented in these tables, I think it may suffice if I make mention of some of the more important figures and explain the results that I have deduced from these figures.

Barnyard manure, from its beneficial effect upon the mechanical condition of the soil, and the fact that its application introduces certain bacterial organisms which perform a useful function in setting free inert plant food in the soil, has a value peculiarly its own. But barnyard manure is valued ordinarily according to the percentages of nitrogen, phosphoric acid and potash it contains. That is to say, that if we wish to make a comparative valuation of any pile of manure as contrasted with any quantity of a commercial fertilizer it is usual to estimate the amount of nitrogen, phosphoric acid and potash in that manure and assign to these elements the price which they have in the commercial fertilizer. However, as we know, barnyard manure has an additional value over and above the value of these elements of fertility. To these elements (nitrogen, phosphoric acid and potash) in my opinion we should add organic matter, for it is the constituent which by its decay adds humus to the soil. Humus, as we are aware, is not only the plant's storehouse which prevents undue waste of fertilizing elements, but the constituent that improves the water-holding or moisture-holding capacity of the soil and tends to regulate the soil's temperature, guarding against extremes in both directions.

Now table No. 1 shows the original weights of these constituents when the experiment was started; these are placed in the two first columns. The same amount of manure was experimented with under the protected as under exposed conditions, and as they were alike in composition, the weights of the elements of fertility in both cases were the same.

The first fact that I would draw your attention to is that in the protected manure there was practically no diminution throughout the whole period in the amount of potash and phosphoric acid, showing that there has been no leaching of these elements. The phosphoric acid we started out with practically remained the same—about twenty-five pounds—till the experiment was closed at the end of twelve months.

By Mr. Featherston:

Q. That is the original weight?

A. Yes, twenty-five pounds; this is the original weight of phosphoric acid in these manures. The weights at the end of three months are to be found in the third and fourth columns: it will be noticed that at the end of this period there had practically no diminution in the amount of this element. The nitrogen and organic matter, however, had suffered considerably by fermentation, thus the forty-eight pounds of nitrogen contained in the four tons rotted under protection, had been reduced to forty pounds in the first three months.

Q. How much manure at the outset?

A. We started with four tons in both cases.

Q. That is fresh manure, not rotted?

A. We commenced with fresh manure.

In regard to organic matter the manure at the outset contained 1,938 pounds and this was reduced in the protected manure in three months to 880 pounds, and the nitrogen from 48 pounds to 40 pounds. Now we will contrast that with the result obtained in the exposed manure. The initial amounts were originally the same. In the exposed manure the loss of organic matter and nitrogen was greater than that just cited; that is, the loss of nitrogen and organic matter was greater than in the protected manure. The organic matter, originally 1,938 pounds, was reduced in the exposed manure to 791 pounds; about 90 pounds more organic matter had been destroyed under these conditions than under the conditions of protection. With regard to nitrogen, 48 pounds has been reduced to 34 pounds.

Q. Well, what class of manure was that in the first place?

A. Equal parts of horse and cow manure, taken fresh and put on the pile.

Q. What was the food of the cattle?

A. That is rather hard to say; as we have so many feeding tests going on it would be practically impossible to give the data. Both horses and cattle are liberally fed both as to amount and quality. This was fairly rich manure. This is evident from the chemical analysis of it that we made.

By Mr. McGregor:

Q. It was general feed?

A. General good feed, but I should add that great care is taken to preserve liquid manure from waste by a generous use of litter and absorbents. This is a very important affair, more important than many farmers realize, for the liquid manure is the more valuable of the two.

By Mr. Featherston:

Q. Cattle fed on meal produce stronger manure?

A. Quite true. I presume, however, that if this manure had been of a poorer quality the loss, while it might not have been so great, would have been in the same ratio.

By Mr. McMillan:

Q. Was the manure taken right from the stable to the shed?

A. Yes, though it took us some two or three days to collect the desired amount, namely, eight tons. During that time incipient fermentation had commenced. We should have liked to have avoided that, but it was necessary to work on comparatively speaking, large quantities in order to get results from which to draw safe conclusions.

We have now seen that there was a greater waste of nitrogen and organic matter in the exposed manure than in that which was protected. I have in addition to draw your attention to a very serious loss in potash and a slight one in phosphoric acid in the exposed manure. We commenced with in the neighbourhood of 62 pounds of potash. In the exposed manure at the end of three months we found that that 62 pounds of potash had been reduced to 48 pounds. We also found that there had been some leaching of phosphoric acid; we started with 25 pounds and this had been reduced to 23 pounds, not a very serious loss, but sufficient to show there was a leaching away under these conditions of a certain quantity of this important element of plant food.

By Mr. Featherston:

Q. But you had not practically any phosphoric acid or potash loss in the protected manure?

A. Quite so, that is what I wish to emphasize. This loss of potash in the exposed manure occurred in spite of the fact that the walls and floor of the bin were double boarded. So I think we may conclude it is impossible to prevent loss from leaching of potash, unless we put the manure in concrete pits or in pits containing a thick bed of some absorbents such as air-dried muck.

By Mr. McMillan:

Q. I see that in the exposed manure there was a loss of potash from 62 pounds to 48 pounds, but in the protected manure there was an increase from 62 pounds to 65 pounds; how do you explain that?

A. It was due perhaps to two causes; to errors of analysis and weighing, or perhaps to the fact that the fermentation of this manure had caused a certain quantity of potash, which was before unavailable (insoluble in the acid solvent) to become available, so that the acid brought it more readily into solution than before. I may be allowed to point out that a very small error in analysis when multiplied into four tons makes a considerable difference. This work was done with the greatest care, but the very circumstances of the case and nature of the material worked with prevented us obtaining absolute truth. However, the figures are put down as I obtained them, and they are such, in my opinion, as to carry conviction as to their general correctness and the conclusions that are to be drawn from them.

Q. Then your analysis could not have been correct at first because it should have shown all the potash?

A. Well, not necessarily incorrect. It is quite understandable that using the acid solvent at the strength we did (precisely the same strength as in analyses of soil)—it is quite possible that slightly more potash would be dissolved out of the rotted than out of the fresh manure. Incomplete sampling might also be a cause of this slight difference. However it may not be necessary to enter into a minute account of the factors which would affect the truth of the figure, for I feel sure that a consideration of them will be sufficient to convince you of their general correctness and of the practical lessons they teach.

We found that the loss in organic matter and nitrogen, in both manures, was more severe during the first month than subsequently. After the first three months there was but little further loss of these elements in the protected manure. In the exposed sample however, loss not only of nitrogen and organic matter but also of potash and phosphoric acid continued as long as the experiment lasted. I have already stated that there was practically no loss of potash and phosphoric acid from the protected manure. Tables will be found in my report for 1898 that trace the values of these manures month by month. The points I would at this juncture emphasize are, that there was no loss of potash and phosphoric acid and, after the first two or three months there was but little further loss of organic matter and nitrogen, from the protected sample; but when possible, as in the exposed sample, loss not only of nitrogen and organic matter but also of potash and phosphoric acid continued as long as the manure was exposed.

By Mr. McGregor:

Q. You say to put it on the land as soon as possible. If scattered on the ground would it not lose a great deal of strength before being ploughed in?

A. There might be loss due to several causes, under such conditions as you speak of. Loss from leaching, the floods in the spring carrying it off from the land before it could be absorbed would be the chief loss I imagine. This would occur more particularly on hill sides and poorly drained soils. I do not think, however, there is any material loss when the manure is put upon the field, spread out and ploughed under immediately. There would be a somewhat greater loss from manure in an active state of fermentation than from fresh manure, but from an experiment I made some years ago we found the amount of such loss was very small, equal to about ten cents worth of nitrogen to the ton of manure. When you spread manure out thinly and it is at once dried by the atmosphere, fermentation is arrested and no further loss occurs. The rain that falls will dissolve much of its plant food out, but if the ground is absorbent it will not be lost. If the land is flooded, however, and much surface water is carried off, the loss in plant and food of the most available kind will be considerable.

Table II. gives similar information to Table I. but in different form. It states the losses in percentages; thus comparing the two manures at the end of three months we find that the protected manure had lost 55 per cent of its organic matter and 17 per cent of its nitrogen, equivalent to a loss in value of 20 cents per ton; while the exposed manure during the same period had lost 60 per cent of its organic matter and 29 per cent of its nitrogen and, in addition, 8 per cent of its phosphoric acid and 22 per cent of its potash, equivalent to a loss in value of 64 cents per ton. We valued the manure at the outset at $2.61 per ton; that is assigning to these three substances, nitrogen, phosphoric acid and potash the values which they receive in a commercial fertilizer.

Starting with manures in each case that contained plant food to the value of $10.43, we found at the end of three months that the plant food in the protected manure was worth $9.63 while that in the exposed manure was worth only $7.86. In arriving at these values, it may be remarked, we have not assigned any greater values to those proportions of the phosphoric acid and potash which by fermentation had become more available. We have made it clear by this investigation that one of the beneficial effects of rotting is that certain constituents (and more especially the phosphoric acid) are rendered more available for absorption by growing crops. Were we to assign a greater value to these elements in the fermented manure than in the fresh manure, as I think we should be justified in doing, the difference I have referred to here between the values of the protected and the exposed manures would be greater than that shown by the figures just mentioned, and would be in favour of the protected manure.

I may close the consideration of this interesting subject by stating the deductions of practical value that I have been able to make from this investigation, a complete discussion of which is, as I have already said, to be found in my forthcoming report.

1. That fermentation or rotting of manure necessarily causes a greater or less loss of organic matter and nitrogen. The extent of this loss will depend upon the conditions under which the manure is rotted.

2. That the least loss of these two constituents, organic matter and nitrogen, occurred in the protected manure, the pile being kept moist and compact. The principle involved is that fermentation is controlled and to a great extent retarded by the exclusion of air.

3. That this loss of nitrogen was not altogether as is generally supposed, due to the production and volatilization of ammonia, but must in a large measure be due to the production and escape of gaseous nitrogen. It is commonly held that the loss of nitrogen from manure results, if not principally, very largely from the formation and escape of ammonia (which is a compound of nitrogen) but I have come to the conclusion from our work that there is a very large amount of nitrogen which is lost from manure in a free gaseous condition. The nitrogen which escapes in that way cannot be held or retained by gypsum or any absorbent of that kind, because the action of gypsum is to form a fixed compound with ammonia. It cannot combine with nitrogen but it will with ammonia.

4. That at no time during the rotting did we find in either manures any large or considerable amount of free ammonia, ammonium salts, nitrates or nitrites, forms of nitrogen that are more or less directly usable by crops. Rotting, however, breaks down and disintegrates the litter and coarser parts of the manure making it more uniform, and consequently allowing a more intimate mixing of the manure with the soil. It also no doubt hastens the formation of humus and available nitrogen compounds when the manure is subsequently in the soil. That is to say, it brings about the initial stage in the production of nitrates and nitrites. While there is very little

immediate available nitrogen in fresh manure, there are nitrogen compounds in rotted manure the' readily furnish nitrogen to growing crops.

5. That as regards potash we could not detect any appreciable or beneficial effect upon its availability by rotting the manure. We found in round numbers 85 per cent of the potash in fresh manure to be in an available condition. We cannot look therefore for any beneficial effect upon the potash in the manure by rotting. There is in this a very important and practical lesson, namely, that we have in the fresh manure potash practically as available as in the rotted manure. It teaches the necessity of well looking after the liquid manure. The potash is contained for the most part in the liquid manure.

6. That as regards phosphoric acid, rotting under the best conditions does improve its availability. At the outset 60 per cent of the total phosphoric acid was available and at the close of the experiment the percentage available had been increased to 75 per cent. So that rotting has a beneficial effect upon the condition of phosphoric acid.

By Mr. McMillan:

Q. You have not tried rotting manure in the case where it is kept tramped hard and firm by the animals and kept solid as against where it is left in the shed?

A. No, we have not. But it was not allowed to be kept loose in the shed in either case. After each month's turning we were careful to make it as compact and solid as possible with ordinary means.

Q. Was there any fermentation took place after three months?

A. Yes, but the fermentation practically ceased, that is to say, as far as the evolution of the heat was concerned, about the end of three months, but up to that it kept quite warm.

Q. And didn't it increase the heat when it was turned over?

A. Yes, it did for the first two or three months, not after.

Q. In turning it over you kept it damp?

A. Yes. Of course that outside or exposed was kept more or less always damp by the rain.

Q. But inside you kept it from mould?

A. Yes. It must be kept solid and damp if we are to have the most favourable conditions. I am convinced of that.

7. There was practically no loss of phosphoric acid and potash from the protected manure?

A. Practically no loss of these elements.

8. That the exposed manure lost about one-sixth of its phosphoric acid and somewhat more than one-third of its potash by leaching, in spite of the fact that it was on a fairly well—constructed board floor. That is a very important deduction.

9. That all the benefit to be derived from rotting results from or is caused by the changes during the first two months, practically speaking, of rotting, certainly within three months. The most marked changes are effected in the first month. A longer period than this gives, in my opinion, but little additional value to the manure and may lead to further loss. After a period of three months I cannot detect any appreciable effect upon the availability of the plant food in the manure, and after that period in some particulars certain losses continue to take place.

Upon the ordinary every day farm we find no special provision for or precautions taken in the preservation or rotting of manure. I am therefore led to conclude that the loss ordinarily suffered must be much greater than that from the exposed manure in our experiments, because, as I have said, we constructed a fairly well built bin with a double boarded floor and sides, and in spite of that there was one-third lost in the value of plant food as well as a large amount of organic matter.

If it is desired to rot the manure it seems to me that a concrete bin or cellar should be used, or in default of this a thick layer of air dried muck or earth rich in organic matter placed under the manure to obsorb the liquid portions. It is important that the latter should be well looked after, for it is of more value than the solid portion; it contains not only the larger proportions of nitrogen and potash, but these are present in more available forms for plant use, than contained in the solid portion. I therefore again emphasize that it is important we should pay attention to the preservation of the liquid portion. From what I know of the prevalent practice of this country the farmers preserve and put into the ground the solid portion but take little or no pains whatever to prevent the liquid portion of the manure from running away and wasting.

As far as practicable the manure during rotting should be kept compact and moist. These conditions are frequently obtained by allowing cattle to run over the manure and tramp it.

In this statement I have only set forth the chief results of our experiments; the principles have been enunciated and it remains for the individual farmer to apply them as best he may according to his circumstances and as far as his conditions and circumstances will allow him.

By Mr. McGregor:

Q. Do you think it would be well to put ashes in your compost heap?

A. No, sir, not wood ashes, or indeed ashes of any kind. Wood ashes contain alkali, and that would have the effect of liberating the ammonia which would be lost.

Q. You would rather use it on the land?

A. Yes, I would use wood ashes directly upon the land, but I would not mix them with manure as that might occasion loss of nitrogen.

Q. Lime would have the same effect?

A. Yes.

Q. Nor salt, you would not use that?

A. I see no object in using salt in that way. It would not have the same effect as I have named, but I fancy it would tend to leaching. Salt has not the power to fix escaping ammonia.

Q. Would it make the compost heap of manure more valuable?

A. No, I do not think it would have any effect in that regard either one way or the other. Muriate of potash has, however, been recommended for that purpose, but I don't generally advise it.

Q. These are the losses I see there?

A. Yes, on that table (Table No. 2) are given the losses in percentage of the amounts originally present.

Q. The losses at 3, 6 and 9 months.

A. In table No. 1 the weights of the various elements of fertility are given at the end of 3, 6, 9 and 12 months. From these data the losses in percentage (given in table 2) have been calculated.

By Mr. Erb:

Q. Before leaving this question of manures, have you ever conducted any experiments to show what loss, if any, takes place in fresh manure kept compact and preventing fermentation?

A. No, we have not, chiefly because I do not believe it would be possible or at any rate practicable to preserve manure in such a condition. I do not think you could totally arrest fermentation without the use of some preventive such as formalin.

Q. Generally speaking, a great many farmers allow their cattle to run over the barnyard and they keep the manure compact and solid?

A. I am afraid the majority of farmers do not take pains to keep the manure compact and protected from washing rains though, of course, there are some that do.

By Mr. McGregor:

Q. In barnyards where there is plenty of straw and the manure is kept in the cellar, what my friend says is the larger portion of that manure is thoroughly tramped and solid, and is not taken out until June or July and is then put upon the ground, and in that case it is not mildewed or moulded in any way, and that is the way in which we use it?

A. Such manure would be very rich, because the conditions named would be such as to prevent both excessive fermentation as well as leaching.

Q. You don't think there is any loss from leaching of the liquid manure in such a case?

A. There might be and there might not be. If the floor were water-tight and plenty of bedding used, there would be but little loss from leaching. The losses occur from two causes—fermentation and leaching; the loss of soluble matter by leaching is frequently the most serious. If you can prevent fermentation on the one hand and leaching on the other, you save all the fertilizing constituents of your manure.

By Mr. McMillan:

Q. I have seen a stable constructed so that the mangers at which the animals fed were so arranged that could be raised as the manure rose in the stalls. That building was deep enough to allow it to lie there till spring, and there was no fermentation?

A. There would be some fermentation, but, I believe, under such circumstances, the loss would be exceedingly small compared with that in manure loosely kept in the barnyard.

We know that manure is full of minute living organisms, and that liquid manure is a peculiarly unstable material; it is not surprising, therefore, that these organisms, which live upon the organic matter of the manure, should destroy the more soluble part of the manure (urine), provided conditions are favourable. Fermentation is the effect or result of these organisms living in the manure.

By Mr. Featherston:

Q. Your experiment on fermentation shows a loss along the line of that manure from the first?

A. You speak in regard to the exposed manure?

Q. All?

A. I say in certain elements. I must make a guarded answer, because I have pointed out that in the protected manure the losses were in organic matter and nitrogen and that there were none in phosphoric acid or potash but on the other hand there were losses in potash, phosphoric acid, nitrogen and organic matter in the exposed lot of manure. The extent of the losses will be regulated by the condition under which the rotting takes place.

Q. But can't you do better by using fresh manure at once upon the land rather than rotted?

A. That may be true for most soils but yet for certain soils and crops I think, there are advantages which make it advisable at times to use rotted manure rather than fresh manure. For instance I think that on light soils, it is often preferable. Also for crops which have only a short season of growth and which require their plant food to be supplied to them in a more or less immediately available condition; such is furnished them by rotted manure rather than fresh manure. The relative merits of better fresh and rotted manure is a large question, which I shall be willing to take up, but I feel it should be answered fully if at all, as otherwise it might be misunderstood. We have to take into consideration not only the manure but the soil and the crop. My only endeavour to-day has been to show the nature of the changes which take place under various conditions of rotting. I will say this however, that if a farmer has not the means to carefully preserve his manure it would better to get into the soil as soon as possible. If his land is heavy, one in which clay predominated, and the matter of labour did not prevent him, it would be most economical to get the manure into the soil as soon as it is made. For light soils, producing crops with a short season of growth, partially rotted manure would in all probability be better. Corn and roots might be termed crops of a long season of growth, the cereals those with a short season of growth.

Q. In the event of seeding clover with grain you would be giving the benefit of the manurial content of the clover crop to the soil.

A. Yes.

By Mr. Rogers :

Q. Rotting manure is of benefit in killing bad weeds ?

A. Yes, that is one of the advantages, but unless the rotting is thorough, some of the weed seeds will escape destruction.

Q. Manure supplies a good deal of humus ?

A. Yes. I place great importance on humus. The more I look into the question of virgin soils, the more I find that their fertility is closely associated with the amount of humus present. The fertility of a soil depends largely upon the amount of humus in it. Where there is humus there I find nitrogen ; and, usually, where I find humus, there I find the right physical and mechanical conditions of the soil, conditions that, in times of drought, will bring a full, good crop to harvest.

By Mr. McGregor :

Q. You say that ashes are good in the compost heap ; would it not be good on the soil ?

A. Wood ashes are a very excellent source of potash. You can apply fifty to eighty bushels to the acre. I do not know a more economical way of supplying potash and also phosphoric acid to the soil. They contain about two per cent of phosphoric acid and five to six per cent potash. They make an excellent compost with swamp muck.

By Mr. Erb :

Q. One point is not clear to me. Your table shows that a loss in fertilizing elements took place in the exposed manure that was rotted. Have you any table to show the effect on exposed manure not rotted, because that is the common way of keeping manure in our district ?

A. No, I have no data of my own, but there would be a loss in liquid manure and also by the rain washing through the manure.

Q. Not necessarily, if you use lots of straw.

A. You suppose conditions under which it would be exposed to rain ?

Q. Yes.

A. Well, we understand that if liquid manure has a chance it will drain away and be lost.

Q. With us, all the manure which accumulates is left till a few weeks ago.

A. The loss would be in a large measure proportionate to the rain fall and the lay of the land.

Q. Well, you have no experiments to show the loss in that way, because this is a common practise.

A. No.

By Mr. Gilmour :

Q. How often did you weigh it ; every time you turned it ?

A. Yes.

Q. That is something we do not have ; that manure is changed very often, it is an extraordinary shrinkage in three months, from 8,000 pounds to 2,980.

A. The work was very carefully done, sir, and I can personally vouch for the weights.

By Mr. McMillan :

I will say this, as far as taking manure from the stable to the fields, we have practiced it for years. When we began we took a certain amount of manure rotted in the shed and also some from the heap and we found the same amount of good from both. Besides there was the amount of saving of labour by not having to cart it twice; that is when your land is well drained and not too hilly.

THE CHAIRMAN.—You don't find your manure, where the cattle are on it all the time, is fermented, do you?

MR. MCMILLAN.—No, but when cattle is on it all the time we take it right from the cattle to the field?

By Mr. McGregor:

Q. You advise that in every case possible the straw should be cut?

A. Yes. It increases the absorbent quality.

THE CHAIRMAN.—I think there is one thing we should all remember, and that is that these experiments were carried on with a view of showing the changes that take place in the manure pile and in manure that is under cover.

THE WITNESS.—We have already considered instituting experiments which would include putting manure on the field in a heap and allowing it to remain there untouched until the end of the rotting period. I am afraid, however, there are difficulties in such an experiment that we shall not be able to overcome. Where we can control or measure the conditions we can make an experiment successfully, but where we cannot control conditions the results will not be so definite.

By Mr. McGregor:

Q. Where the experiments are carried on I claim there is more good if the conditions are such as we actually find and are not supposititious ones?

A. The conditions are different on every farm. There is no uniform method or practice through out the country as far as I am aware. It is a somewhat mistaken idea to suppose that no fermentation ensues under such conditions as have been mentioned. In the barnyard, unless the manure in a very thin layer. I am of opinion that considerable fermentation takes place there.

By Mr. McMillan:

Q. In the barnyard?

A. Yes.

Q. We don't keep any in the open barnyard at all.

By Mr. Erb:

Q. That it does not ferment is proved I think by the fact that when you come to move the manure in the spring you sometimes find snow and ice under it.

A. I scarcely think that is sufficient proof, though of course fermentation is much retarded during the winter months.

THE USE OF NITROGEN FOR ENCOURAGING THE GROWTH OF CLOVER.

For some years past, as you are doubtless aware, we have been advocating the more extensive growth of the legumes, clover, beans, peas, etc., and particularly clover, as a means not only of furnishing a rich fodder but also of improving the land by adding to its store of humus and nitrogen.

I shall not refer again in detail to the great importance I place upon humus as a soil constituent nor to the fact that the greater part of the nitrogen supplied to a soil when ploughing under clover (or even the clover roots) is a distinct addition to the soil's fertility, since the clover plant obtains the greater part of its nitrogen from the free nitrogen of the air, a source, as we know that is not utilizable by other farm crops.

In previous years I have explained the underlying principles which are involved in the absorption or assimilation of atmospheric nitrogen by clover. I have also stated the reasons why I consider clover one of the cheapest and best means for improving the condition of our soil. As a soil enricher we have shown both by trials in the field as well as by careful analysis in the laboratory that clover is a fertilizer at once cheap and effective. If we supply the clover with a sufficiency of potash, phosphoric acid and lime, together with a fair condition of the soil, it will by the agency of certain microbes in the soil obtain its own nitrogen from the atmosphere. By furnishing potash and phosphoric acid and growing clover there will be little need to purchase for our soils nitrogen, the most expensive of all the elements of plant food. Moreover the organic matter of the decaying roots and foliage of the clover furnishes humus, mellowing the soil and making it more retentive of moisture and plant food, less subject to sudden changes of temperature and a more comfortable home for the myriads of microscopic organisms which during their life convert inert soil elements into food for growing crops.

It is only been during recent years that investigations have shown that the conversion of the inert plant food of the soil into available forms is due largely to the activity of these micro-organisms which exist in myriads in our soils. We now understand why and how the legumes, clover, peas, beans, etc., become enrichers rather than impoverishers of the soil in nitrogen. This latter is due to the activity of certain bacteria that reside in nodules that are found on the roots and rootlets of the legumes. They, in some way which we do not at present altogether understand enable the clover to appropriate the free nitrogen of the air. These bacteria I repeat appropriate and absorb the free nitrogen of the air which is present between the particles of soil and passing it on the host plant, the clover, the introgen there converted into the tissues of root and stem and leaf. Without the aid of these bacteria, clover like all other farm crops can only use soil nitrogen. In other words without the assistance of these bacteria, the legumes can only take their nitrogen from soil in the form of nitrates in the same way as other farm crops.

NITRAGIN AS A FERTILIZER FOR LEGUMINOUS PLANTS.

With the aid of these bacteria, clover adds to the soils store of nitrogen, not without them. Many soils contain these bacteria in sufficient numbers, but never-the less there are soils that appear to be practically destitute of them. Last year I informed this committee that a preparation of these clover bacteria was being made and sold in Germany, and that we had used this preparation, known as nitragin, with good effect, increasing thereby the crop very considerably. I think last year I brought a bottle of this preparation (nitragin) to this committee and said that there were about seventeen apparently distinct nitragins made in Germany, each one being intended for a special member of the legume family. We have experimented with three, for clover, pease and horse beans.

By Mr. McMillan:

Q. Would it not be too costly for this use?

A. The bottle which I showed last year contained sufficient when diluted for half an acre; it cost laid down here between 70 and 80 cents, There are two plans of using it, one the inoculation of the seed and the other the inoculation of the land. In my evidence of last year the details of these methods are given. We have been using this material under both methods for the last two or three years to ascertain its effect upon the crop of clover. During 1898 the third year's experiments were made, and the results corroborate those hitherto obtained, namely, that treatment of the seed with nitragin caused a marked increase in the weight of crops produced.

I shall only cite one of the experiments which I tried last year and which is still in force, giving you the data of last year's results and exhibiting a photograph which I took yesterday. These show most markedly the difference between the growth of the treated and untreated crops this year. For this experiment we selected a small area of practically pure sand. This soil—if it can be so called, because it was practically destitute of humus and nitrogin—we furnished with phosphoric acid and potash, supplied at the rate of superphosphate, 360 pounds per acre and muriate of potash 120 pounds to the acre. This application was made with the view of furnishing the clover with the mineral constituents which it required. Supplied with these the clover with the aid of the bacteria was to get its own nitrogen. Upon this plot were then sown two rows some eight inches apart of clover seed that had been soaked in nitragin and at a distance of two feet from these two rows of untreated seed were sown. The crop from the inoculated seed was much more luxuriant than that of the untreated seed. In October, the plants in four running feet in each row were carefully taken up, the roots washed and the whole plants weighed. We found that the weight of the plants from the untreated seed was 16 ounces, and those from the inoculated seeds weighed 18½ ounces. This represents a gain of about 15 per cent which we must suppose was due to the fact of theinoculation of the seed and the beneficial action of the nitrigen.

By Mr. Erb:

Q. Did you sprinkle or water that plot or trust to the natural rain fall?

A. I watered it at first; it is situated on a slope and I watered it when necessary, treating both sets of plants alike.

The remaining portions of the rows were left undug. The plants in both series survived the winter and the day before yesterday I photographed them *in situ*. On the left hand of the photograph you see the clover from the inoculated seed, on the right, the clover from the untreated seed. Nothing could give you a better idea of the great luxuriance of the growth from the inoculated seed as compared with that of the untreated seed. (*Vide plate* 1, *p.* 31.) The results are truly remarkable. In a few weeks from the present date the plants in both series will be taken up, weighed and analysed.

It is scarcely possible to exaggerate the importance to agriculture of this modern achievement of science, and it will be to the interest of every farmer to inform himself how clover can be made to improve his soil, and how the growth of clover can be encouraged. All who can should seize this opportunity of seeing this experiment at the Central Farm. The results are of a most convincing nature.

By Mr. McMillan:

Q. But it will be necessary in all such cases that the land should be well underdrained, so that it will be in a proper state of cultivation?—A. You are referring now to the leaching of manure and loss on undrained land, I presume?

Q. No, not so much to that as to the preservation of bacteria which go into the nodules, as they cannot work with the nodules in water?—A. Yes, drainage is important, especially if the soil is of a heavy nature. It is impossible to get a good crop of clover on land which is water soaked, that is, upon which and in which the water lies without draining away readily. From the results of this experiment I judge that with the use of nitragin a good crop of clover can be obtained on the poorest soil, provided phosphoric acid and potash are supplied. Of course moisture is necessary, one must have a favourable season, but I think we are justified in supposing that by providing the necessary mineral constituents, phosphoric acid and potash, as we have in this case, clover will thrive and finally turn out well on exceedingly light and sandy soils.

Q. What will be the cost per acre of treating the seed?

A. About $1.50.

By Mr. McGregor:

Q. Can it be bought readily?

A. It cannot as yet be bought readily in this country. There are one or two difficulties in the way of its coming into general use at present. One is that it has to be used while still freshly made; it won't keep for any length of time. The manufacturers will not guarantee its fertility or rather vitality after some six weeks. Another point is that it must not be exposed to the light, *i. e.* to strong sunlight, or to a temperature above that of the human body, about 100° Fah. If the temperature is above 100 it very much diminishes the activity of the germ.

Q. It could be made here, I suppose?

A. It could be made here. Any farmer, to a certain extent, without making it could obtain the same results by taking soil from a field that has grown a good crop of clover and sowing it over the poorer field. By such means he would inoculate the poorer soil with clover germs and obtain a good crop of clover as the result. The earth which comes from about the roots of the clover contains the germs and would serve to inoculate the poorer soil. Another plan would be to pour cold water over the earth (previously placed in a barrel) containing these germs and after allowing the soil to settle to pour off the supernatant water and soak in it the seed about to be sown.

By Mr. Rogers:

Q. A change of soil instead of a change of seed?

A. Having indicated the nature of our work in this matter, it will only be necessary for me to draw your attention to the following table, which gives the amount of crop (both foliage and roots) and amount of nitrogen therein contained, in the chief experiments since 1894. It gives us information as to the weight of nitrogen we can supply to a soil per acre (1) by ploughing under the whole crop or (2) simply by allowing the roots of the clover to decay, feeding off the clover. I think we may safely say that 75 to 100 lbs. of nitrogen can be furnished per acre simply by sowing eight to ten lbs. of clover seed. This, it appears to me, is the cheapest source of nitrogen known.

In this connection it is important to remember that eight pounds of clover seed can be sown with the grain (oats or barley) without diminishing the yield of the latter, at least, so we have found on the Experimental Farm.

CLOVER AND GREEN MANURES.

A. Mammoth Red. B. Common Red.

Numbers.	Kind.	Sown.	Collected.	Weight of Material (Fresh) per Acre.						Nitrogen, per Acre.		
				Stems and Leaves.		Roots.		Total.		Stems and Leaves.	Roots.	Total.
				Tons.	Lbs.	Tons.	Lbs.	Tons.	Lbs.	Lbs.	Lbs.	Lbs.
1	A	April '94..	May '95..	10	70	5	1,476	15	1,546	101	49	150
2	A	" '93..	" '95..	5	1,235	9	535	14	1,770	52	61	111
3	A	July '96..	Oct. '96..	6	1,310	3	1,260	10	570	82	48	130
4	B	" '96..	" '96..	4	1,779	2	1,445	7	1,224	70	47	117
5	A	May '96..	May '97..	...	......	......	......	2	1,995			81
6	B	" '96..	" '97..	......	......	......	......	3	125	......	......	62
7	A	" '97..	Oct. '97..	4	508	2	1,785	7	293	*62	*35	*97
8	B	" '97..	" '97..	5	209	3	296	8	505	*76	*54	*130

Nos. 1 and 2, roots taken to a depth of four feet. Good spring growth when collected.

Nos. 3 and 4, sown as cover crop in orchard. Roots taken to a depth of two feet.

Nos. 5 and 6, dead stems, leaves and roots. Winter-killed.

*Nos. 7 and 8, nitrogen estimated.

Canadian and Hungarian Flours.

In view of the present increased demand in England for hard wheats to mix with the home grown and softer wheats, it may be of interest if I bring before you the results of a comparative examination between Canadian best patents and the best grades of Hungarian flours, made a few months ago in our laboratories.

All our data point to the superiority of the Canadian flour for bread-making purposes; the percentages of albuminoids or protein—the most important part from a nutritive standpoint—are as follows:—

Canadian, best patents	12·59 per cent.
Hungarian, best grade	11·27 "

By Mr. McGregor:

Q. It makes a good deal of difference where you get that wheat from at first?

A. Undoubtedly. I am now comparing the best grades of Canadian and Hungarian flour. The analyses were made at the direction of the hon. Minister of Agriculture, who himself obtained the samples. It is, I believe, a comparison of the best grade flour from Canadian North-western wheat with what we may suppose to be the best grade Hungarian flour?

Q. That would be wheat from west of Winnipeg?

A. It was.

The determination of gluten, both wet and dry, is also in favour of Canadian flour, as follows:—

	Wet Gluten.	Dry Gluten.
Canadian, best patents	34·22	12·33
Hungarian, best grade	26·17	9·79

From these figures I conclude that, weight for weight, Canadian flour would yield more bread than the Hungarian flour. I dare say you are sufficiently conversant with the manner in which this determination is made, and its value, to understand the great superiority which the above data give to the Canadian flour.

Q. It depends to some extent upon what land this wheat was taken off. If you take land that has been used a long time, it means that the wheat will have more starch and less gluten?

A. We have not any data on record to show that the poorer land makes a wheat which is richer in starch and poorer in gluten; the variety of wheat and the climatic conditions generally undoubtedly are the factors that affect the percentage of gluten. Climatic and seasonal influences are most potent in their effect upon wheat.

By Mr. Semple:

Q. Have you made any comparison with fall wheat compared with the others?

A. We have not. But we are commencing, or rather we have commenced, a very extensive series of experiments to arrive at the relative values of certain of our Canadian wheats, as grown more particularly in the North-west. The work is not sufficiently far advanced at present for me to give any information. Fall wheats, as a class, contain less gluten, than spring wheat.

By Mr. McGregor:

Q. In the North-west they take out more bread to the pound than with the eastern flour?

A. Yes. The wet gluten was 34 per cent in the Canadian North-western flour, as against 26 per cent in the Hungarian. These data make the former more absorbent and more valuable for bread making. In respect to those qualities of gluten which are valuable in bread making, elasticity and firmness, the gluten from the Canadian flour was the more marked of the two.

By Mr. Erb :

Q. Is this Hungarian flour made from wheat grown in Hungary?
A. Yes. The flour was made in Hungary.
Q. Is there much export from there to Britain?
A. I cannot tell you as to quantity, but I know it is largely used in Great Britain for mixing with soft home grown flours.

By Mr. Featherston:

Q. Our wheat is better?
A. Yes, flour from Red Fife wheat grown in our North-west is richer in gluten and will make more bread, weight for weight.

FODDERS AND FEEDING STUFFS.

It is now my wish to bring to your attention some facts about fodders and feeding stuffs. First, in connection with the native grasses of Manitoba and the North-west Territories. During the season of 1898 we procured through the superintendents of the experimental farms of Manitoba and the North-west Territories samples of many native grasses, growing both upon uplands and sloughs, in order to ascertain their relative feeding value. We deemed this investigation of considerable importance, as frequently the native grasses must be depended upon as the chief supply of cattle food. The native hay cut from the uplands proved to consist of a mixture of grasses, comprising at least half a dozen species, together with various weeds, such as artimesia, Canada thistle, stink weed, heliopsis, wild rose, &c. The hay cut from the lowlands and sloughs consisted largely, sometimes wholly, of sedges. These sedges are characterized—they are not true grasses—by having a solid triangular stems and very rough-margined leaves. Sedges are usually considered as decidedly inferior to grasses as regards palatability and digestibility, though we have the testimony of many reliable and practical men in the North-west that animals not only eat such sedge hay with avidity, but keep in good condition throughout the winter. Our analyses go to show that in many particulars this native hay compares favourably with that of many cultivated grasses. We should probably find that the sedges, like grasses, deteriorate in feeding value as they ripen, and that the most nutritious, digestible and palatable hay is that from sedges which have been cut before reaching maturity. We find many of these sedges contain a large amount of nutriment, but not quite as good as native grasses. No doubt as a coarse fodder for cattle they are of value, especially when cut early.

By Mr. Rogers:

Q. I thought they were considered more nutritious than our cultivated grasses?
A. No, I should not like to say that sedge hay was equal to hay from the cultivated grasses.

By the Chairman:

Q. It grows in the sloughs?
A. And on low lands as well as the sloughs.

BROME GRASS.

In regard to Brome grass, a comparatively speaking newly introduced grass—the importance of which, both for meadow and pasture, has been brought before you on several occasions—we made last year a comparative study of its hay with that of Timothy, both having been grown in the same season on the Central Experimental Farm. This was done to make more complete our data respecting nutritive qualities of this grass. The analyses showed that the Brome grass from a feeding standpoint was somewhat the better of the two. I need not give the data in detail, as they will appear in my annual report, but will state that the albuminoids, the most important constituent of fodder, stand thus: Timothy hay 118·8 pounds per ton, and Brome grass hay 132·2 pounds per ton, showing that the Brome grass hay is somewhat the richer of the two.

SOJA BEANS.

In the matter of Soja beans we have made a series of analyses of this fodder plant grown under varying conditions. In common with other legumes it was found to be rich in albuminoids, though in this respect not quite the equal of many other members of this family. The chief object in growing this plant was to obtain a fodder to put in the silo with corn. We have been using horse beans for siloing with corn for some years, but we find that the horse beans will not withstand drought. Unfortunately the Soja beans become hard and woody in the stalk before the corn is ready for the silo. It seems doubtful whether they will be largely grown for silo purposes for this reason. They fairly well withstand heat and drought, but the difficulty is that as the autumn advances the stems get very woody and fibrous.

OAT FEEDS.

We have made some inquiry into the feeding values of certain oat feeds,—milling by-products. In the manufacture of oat meal and the preparation of breakfast foods there result many by-products of the oat. These find a ready sale among farmers and dairymen under various names—oat dust, oat feed, oat shorts, &c., and differ greatly in feeding value, according to the part of the grain which predominates and the presence or absence of mill sweepings. The greater the proportion of oat hulls the less will be the feeding value. The so-called oat dust, consisting chiefly of the hairs of the kernel, is also poor in nutritive qualities. Oat feed or oat shorts, however, may contain but a small proportion of these materials. Feeds under this name are usually prepared, or largely so, from the crushed broken and small grain and the shorts and bran of the oat form a valuable feeding stuff. Our analytical results make it apparent that a careful descrimination is necessary on the part of the purchaser. Only those having a clean, bright appearance and are heavy, close and fine can be considered as comparable in feeding value to our ordinary milling products. I bring this matter before you because I think it is wise to speak a word of warning to farmers and dairymen not to buy without first making a somewhat careful scrutiny of these feeds. It is not necessary to have an analysis in each case to form an opinion but those which consist largely of the hairs of the kernel we must understand do not contain much digestible food material. There are, say, two per cent of digestible albuminoids in oat hulls where there would be 12 per cent in meal prepared from small and broken grain. The several samples which I have brought here this morning illustrate this point. I have here, for instance, one sample containing 17 per cent of protein, and here another containing 11·0 per cent. The first is worth half as much more as the second. Again, in this sample of oat dust there is contained a very small percentage of albuminoids; it cannot be regarded as a concentrated feed at all.

By Mr. McGregor:

Q. When feed is so cheap it does not pay to bother with them?—A. No, unfortunately, though, some people have taken a fancy to these foods and are feeding them very largely without using any discretion as to their quality.

By Mr. Rogers:

Q. It would be an incentive to grow heavy oats?—A. These are by-products in the manufacture of oatmeal. The hulls and hairs of the kernel are very poor and indigestible food.

By Mr. Featherston:

Q. Can you give an analysis of the different feeds as to their digestible matter?—A. Professor Henry, of Wisconsin, states their digestible nutrients, as follows:—

Name of Feed.	Dry Matter in 100 Lbs.	Digestible Nutrients in 100 Lbs.		
		Protein.	Carbo-hydrates.	Fat (Ether Extract).
	Lbs.	Lbs.	Lbs.	Lbs.
Oats	89·0	9·2	47·3	4·2
Oatmeal	92·1	11·5	52·1	5·9
Oat feed or Shorts	92·3	12·5	46·9	2·8
Oat dust	93·5	8·9	38·4	5·1
Oat hulls	90·6	1·3	40·1	·6

Molasses Refuse from Refining.

A product of the nature of molasses is obtained in the refining of sugar (especially that made from beets) from which the further extraction of crystalized sugar is unprofitable owing to the presence of certain saline and nitrogenous, (albuminous) materials. This molasses has been used on the European continent with good results either per se or mixed with various meals and used as a cake. In view of certain inquiries from correspondents who had been using this molasses in the maritime provinces and also from the fact that a company is being formed in Montreal to manufacture a cake from it using cornmeal and bran (intending to sell it to cattle exporters for use on ship board), we submitted to analysis two samples forwarded from Halifax. We found that this material would make a very valuable feed stuff, for it practically contained fifty per cent of sugar, the most assimilable of all the carbo-hydrates found in cattle feeds. Though not destitute of nitrogenous matter its use would have to be supplemented with a due proportion of some meal or concentrated mill product to make a balanced ration as well. A certain amount of coarse fodder also would be necessary. The function of sugar in the animal economy is as a source of energy, to maintain the vital heat and for the production of fat. Being soluble it enters at once the circulatory system and can be utilized. Animals take to this refuse readily and evince a great liking for it. No doubt it stimulates the appetite and probably increases the digestibility of the other constituents of the ration. This crude molasses contains about nine per cent of mineral matter about one half of which is potash. This element is a valuable plant food, and as it is eliminated by the animals through the kidneys, it behooves the farmer using this material to look well after the liquid manure.

By Mr. McGregor:

Q. Did you ever try sorghum? the product of sorghum.
A. No, sir.
Q. They grow a lot of it with us and make molasses from it and I was wondering if you had tried it for feeding.
A. No, sir.

The Preservation of Eggs.

We have recently conducted a series of experiments in connection with preservatives for eggs. You will doubtless have noticed an account of "water glass" or silicate of soda as a preservative for eggs, going the rounds of the press for the past year. To ascertain its efficacy for this purpose as compared with ordinary lime water, Mr. Gilbert and I commenced a series of experiments last October, testing the eggs in March of the present year.

After six months' trial we failed to see that there was any additional benefit due to the water glass over the ordinary lime water, in other words, that the lime water and the solution of "water glass" were equally efficacious. Since the water glass is a caustic fluid and consequently more disagreeable to use than lime water there was nothing to recommend the former in preference to the latter. In both cases all the eggs were good, using the term according to its usual acceptation. We found on poaching the eggs (we think that is the best way to test them) that in all a peculiar flavour had been developed which I can only designate as slightly stale or musty. We came to the opinion that no preservative, at present known, will prevent the loss of that flavour which characterizes the fresh egg. However, we are continuing this work, and we have hope of greater success than in the past, more particularly with certain solutions containing glycerine.

By Mr. McMillan:

Q. I have seen an egg put in the pickle in March and taken out in September and you could not distinguish any smell and you could not detect any flavour.

A. Was that in lime water.

Q. I cannot say what it was. It was in Mr. G. D. Wilson's institution.

A. We used a number of solutions of various strengths. All the treated eggs looked beautifully fresh and even when broken it was exceedingly difficult to notice any difference compared with a fresh egg. Unless the eggs were submerged, a slight shrinkage of the contents had occurred. In those submerged in the lime water and water glass solutions, the air space, however, was not larger than in the fresh egg, showing little or no shrinkage. In the poached eggs from both preserwe detected that slightly musty or stale flavour that I have spoken of.

By Mr. Rogers:

Q. In poaching did the egg flatten or rise up?

A. It flattened more than the fresh egg.

By Mr. McMillan:

Q. Would those eggs boil without cracking?

A. Some did but some did not. Those continuously kept in the lime water and the water glass for the most part did crack. All the eggs were strictly fresh when we started the experiment. This is an essential point. Another essential is that the eggs shall be completely submerged in the preservative liquid. A shrinkage of the contents in those not kept submerged occurred. As far as our experiment went, we believe the best way was to keep them is in lime water all the time.

By Mr. Erb:

Q. Will the eggs sink of their own weight in that liquid—water glass?

A. Yes, sir, eggs sink in a ten per cent solution. That is the strength we used. The following statement gives our results concisely.

EXPERIMENTS WITH EGG PRESERVATIVES.

The liquids employed were (1) a saturated solution of lime-water, and, (2) a ten per cent solution of "water glass" (Sodium silicate).

The eggs were treated during the first week of October, 1898, and tested 22nd March, 1899. Those eggs which were not kept throughout this term in either of the preservatives, together with the untreated eggs, were placed in a rack within a drawer in the laboratory. The eggs in the solutions were also in the laboratory, and consequently all were at a temperature of about 70 degrees F. throughout the winter. The examination consisted of noting the appearance on breaking and the colour, odour, taste, &c., after poaching.

TREATMENT AND RESULTS.

No. 1. *Untreated.*—The yolk was stuck to the side of the shell and was much shrunken, having lost its globular form;

The "white" had taken on a slightly yellow tint, which was more pronounced on boiling.

The "air space" was very large, occupying about one-third of the shell, showing shrinkage from evaporation.

There were no signs of decay and the eggs might be pronounced as free from odour and apparently good.

On boiling, a faint "stale" odour and taste was developed.

No. 2. *Kept under lime-water* 2 *days* and then put in rack in drawer:

The yolk was not stuck to the shell and was more globular than in the untreated, though not so globular as that in a fresh egg.

The "white" was similar to that in the untreated.

The "air space" was only about one-half the size of that in the untreated, showing less shrinkage.

Apparently quite good, but developing a slight "stale" odour and flavour on boiling.

No. 3.—*Kept under lime-water* 7 *days* and then placed in rack:

Apparently quite good; somewhat less shrinkage, perhaps, of the yolk than in No. 2, but in all other particulars giving practically the same results.

No. 4.—*Kept in lime-water continuously* throughout period of testing:

Apparently quite good, but the "white", as before, turning slightly yellow and a faint stale odour developing on boiling.

Yolk almost, or quite, globular. "air space" no larger than in fresh egg.

No. 5.—*Kept in silicate of soda* 24 *hours* and then placed in rack:

Apparently quite good; the "white" had taken on a faint yellow tinge. Yolk, slightly stuck to shell and shrunken; "air space", larger than in Nos. 2 and 3.

On boiling, the "white" became slightly yellower and the "stale" odour before mentioned was developed.

No. 6.—*Kept in silicate of soda* 3 *days* and then placed in rack:

Apparently good, but yolk slightly stuck to shell. In all respects very similar to No. 5.

No. 7.—*Kept in silicate of soda* 7 *days* and then placed in rack:

Apparently good, but yolk stuck to shell. "air space" somewhat similar to Nos. 5 and 6.

On boiling, was similar to Nos. 5 and 6 as to colour and odour. Shell did not break on boiling.

No. 8.—*Kept in silicate of soda continuously* throughout testing period:

Apparently quite good and no shrinkage. "air space" not larger than in fresh eggs. Yolk, globular.

On boiling, the "white", as before, assumed a faint yellowish tinge and the egg had a slight "stale" or musty flavour. Shell broke on boiling, but not so as to allow contents to escape.

CONCLUSIONS.

1. In no instance, either of treated or untreated eggs, were any "bad" eggs found.

2. In all cases where the eggs were not kept covered throughout the period of the test with the preservative solution, shrinkage of the contents had taken place, as shown by the larger air space, the less globular form of the yolk, and in many instances by the adherence of the yolk to the shell. The eggs treated for seven days and less with lime-water showed somewhat less shrinkage than those treated a similar length of time with silicate of soda.

3. It would appear that lime-water and "water glass" used continuously, are equally efficacious in preventing shrinkage. They may also be said to give practically the same results as regards both external and internal appearance, flavour, &c., of the eggs preserved. Since water glass (silicate of soda) is more costly and more disagreeable to use than lime-water, we could not from the present results recommend the former as the better preservative.

4. The albumen or "white" in all the preserved eggs was very faintly yellow (though not to the same degree in all eggs), the tint becoming deeper on boiling.

5. No offensive odour was to be perceived from any of the eggs when broken, but in all instances a faint but peculiar musty or stale odour and flavour developed on poaching.

6. It is probable that no preservative will prevent the loss of flavour possessed by the fresh egg, but those which wholly exclude the air (and thus at the same time prevent shrinkage from evaporation) will be the most successful. Continuous submergence is evidently better than treatment for a few days.

It is, of course, essential that eggs to be preserved should be perfectly fresh when treated.

The experiments are being continued, and further results will be issued as obtained.

AN INVESTIGATION INTO THE CAUSE OF SOFT PORK.

Another branch of our original research was an enquiry into the cause of soft pork. I do not think it is necessary for me to dwell upon the importance of this work, because, as you are doubtless aware, there is a very large quantity of this very undesirable product at the pork packing establishments to-day. It is a low priced material and it does not pay to export it. My "preliminary report" to the Honourable Minister of Agriculture on this subject containing work done in the laboratory since February of the present year is as follows:—

COMPOSITION AND PROPERTIES OF THE FAT IN "FIRM" AND "SOFT" PORK.

"It has become a matter of great importance to Canadian farmers and those directly interested in the bacon export trade, to learn the cause or causes which produce 'soft' or 'tender' pork, since such pork sells at a much lower price than 'firm' pork, both in the home and the English markets. With the view of furnishing useful information to pork producers, and, if possible, of solving this admittedly difficult problem, the chemical composition and physical character of the fat in these two classes of pork have been studied, it being considered that the results of such an examination would form a valuable basis or standard for reference in making further experiments. These latter would consist chiefly of feeding tests under various conditions (age, breed, exercise, etc.), and the analysis, chemical and physical, of the resulting pork.

On 1st February we received from The Wm. Davies Co., Limited, Toronto, two Wiltshire sides; the one marked 'firm,' and reported on as of excellent quality; the other marked 'soft,' and stated as of very inferior quality. The former weighed forty-six pounds and a half; the latter, forty-four pounds.

Both were frozen when received, but, nevertheless, there was a most marked difference in the relative hardness of the two sides. As the sides thawed (at the temperature of the laboratory, about 70° F.) this difference, which was ascertained or measured by the resistance of the fatty portions to pressure by the fingers, became still more pronounced. This was further evidenced (February 2nd), by raising the ham by lifting as the sides lay on the table; the 'firm' remained fairly straight; whereas, the 'soft' doubled over. The relative softness is also shown in the accompanying photographs, taken 2nd February, at 3 p.m., and 3rd February, at 10 a.m. They illustrate the amount of 'drag' caused by the weight of the sides similarly suspended by hooks. The extent of the 'drag' in the 'soft' side is much the greater.

The samples of the fat for examination were obtained by: (1) first cutting the sides (a) immediately in front of the thigh joint (socket of the femur in the pelvic arch), and (b) immediately in front of the first rib, and then taking the fatty tissue at each of these sections. Those taken at (a) are designated in the following tables as "Ham", those at (b) as "Shoulder" (see photo). The precaution of confining the place or area from which the fat was taken was made necessary from the fact that certain authorities stated that the fat varied considerably in composition, etc., according to its position in the animal. Care was exercised in the preparation of the sample for analysis, to dissect out and reject all muscular tissue, blood vessels, etc.

Though the "Soft" side was somewhat the lighter of the two, its proportion of adipose tissue (fat) to muscle (lean) was the greater (*vide Plate II, p.* 32).

In determining the composition of the fat of the two sides, the following estimations were made: water, nitrogen (from which the amount of tissue-other-than-fat was calculated), fat (which was obtained by difference) and the amounts of olein and palmitin and stearin. The amount of salt present was also determined. Table I, sets forth the results obtained:—

TABLE I.

COMPOSITION OF FATTY TISSUE IN "FIRM" AND "SOFT" BACON.

Constituent.	Firm.		Soft.	
	Ham.	Shoulder.	Ham.	Shoulder.
	p. c.	p. c.	p. c.	p. c.
Water	15·56	6·53	12·50	2·67
Salt	2·73	1·12	1·84	·48
Nitrogen, N_2	·504	·285	·243	·142
Fibre, N_2 x 6·25 (tissue other than fat)	3·15	1·78	1·52	·89
Fat by difference	78·56	90·57	84·27	95·96
Olein in bacon	50·05	58·33	66·37	76·94
Palmitin and stearin in bacon	28·51	32·24	17·90	19·02

From the foregoing data we may notice several very important differences in the composition of the bacons. These differences are discussed in the following paragraphs:

1. It is to be observed that the percentage of water in the fatty tissue of the "firm" is greater than in the fatty tissue of the corresponding part of the "soft" bacon.

2. Also, that the percentage of tissue other than fat, that is, of a nitrogenous nature, was also greater in the "firm" than in the "soft." This falls into line with the results stated in the preceding paragraph, since the water for the most part is contained in or held by the nitrogenous tissue. I conclude from this fact that the walls of the cells containing the fat proper are thicker in the "firm" than in the "soft" or "tender" bacon.

3. Further, it is to be noticed that the amounts of salt present are also larger in the "firm" than in the "soft" bacon. This is accounted for by the assumption that the salt, like the water, is held by the nitrogenous tissue to a greater extent than in the fat.

4. The percentages of fat are, from a consideration of the foregoing statements, necessarily greater in the "soft" than in the "firm" bacon.

5. The fat proper consists of olein, fluid at ordinary temperature, and palmitin and stearin, solid at ordinary temperature.

The data show that the percentage of olein is much greater in the "soft" than in the "firm" bacon, while as a natural consequence the percentages of palmitin and stearin are greater in the "firm" than in the "soft" bacon. These facts afford the cause of the greater softness in the "soft" or "tender" bacon.

COMPOSITION OF THE FAT.

In order to obtain a fuller knowledge of the composition of the fat proper in the "firm" and the "soft" bacons, the fatty tissue was rendered and the pure fat filtered off. The analysis of these fats furnished the data in Table II.

TABLE II.

COMPOSITION OF FAT FROM "FIRM" AND "SOFT" BACON.

Constituent.	Firm.		Soft.	
	Ham.	Shoulder.	Ham.	Shoulder.
	p. c.	p. c.	p. c.	p. c.
Olein (calculated)	63·71	64·40	79·95	80·18
Palmitin and stearin	36·29	35·60	20·05	19·82
Ratio of palmitin and stearin to olein	1 : 1·76	1 : 1·80	1 : 3·99	1 : 4·02

These figures show very clearly that the fat of the "soft" bacon contain much larger percentages of olein then that of the "firm" bacon, with a corresponding decrease of palmitin and stearin.

They also make evident that no great differences in the composition of the fat taken from the ham and from the shoulder of the "firm" bacon exist, and that the same statement regarding the fat of the ham and shoulder of the "soft" bacon also holds true.

PHYSICAL AND CHEMICAL CONSTANTS OF FAT FROM "FIRM" AND "SOFT" BACON.

Table III. sets forth certain determinations that were made upon the pure, filtered fat. These are of considerable importance, since, though of a strictly scientific character, they allow us to make deductions easily understood regarding the nature of the fats.

TABLE III.

PHYSICAL AND CHEMICAL CONSTANTS OF FAT FROM "FIRM" AND "SOFT" BACON.

—	Firm.		Soft.	
	Ham.	Shoulder.	Ham.	Shoulder.
Melting point	37·6°C.	37·75°C.	27·4°C.	28·2°C.
Spec. Gravity, at 96°C	·8668	·8659	·8678	·8740
" " 105°F	·9009	·8980	·8970	·8988
Sapon. equivalent	285·3	282·3	287·3	286·0
Reichert No	·408	·714	·408	·663
Iodine absorbed	55·3	55·9	69·4	69·6

1. The melting point of the fat from the "soft" bacon is practically 10° centigrade lower than that of the "firm" bacon.

2. The specific gravities in both series are so close that it is not possible to use this constant as a means of differentiation or for deducing therefrom any information respecting the relative composition of the fats.

3. The saponification equivalent likewise appears to be of little value in the diagnosis.

4. The Reichert number shows the practical absence of volatile fatty acids in both series, though there is an indication of larger traces of the presence of such in the shoulder fat than in that of the ham.

5. The "iodine absorbed" is of great value in this investigation. From it may be calculated the percentage of olein or liquid fat present in a fat. The data here presented clearly demonstrate the larger amount of olein in the "soft" fat, a fact that gives the explanation for the greater softness or tenderness of the "soft" bacon.

We have every reason to be encouraged by the results of this investigation which you will admit has by no means been an easy one. It is a problem which yet requires much careful work before it can be finally solved. Having now the chemical and physical data that allows us to distinguish between the fat of the "firm" and of the "tender pork," it now remains to institute a series of experiments, feeding pigs with various kinds of foods and keeping them under different conditions, such as, with and without exercise, and submitting the pork produced to analysis. These pigs should be killed and analyzed at different periods of growth. In some such way as that the factors causing this "tenderness" will be eliminated; at least, I hope so. Among the facts brought out by this preliminary investigation, the chief is the larger proportion of olein—a fat fluid at ordinary temperatures, in the "soft" pork. Whether this is due, wholly or in part, to the character of the feed, we cannot as yet say. Probably there are several factors. It may be in part an inherited quality. I should not be at all surprised to find that it is. Again it may be caused, in part, by lack of sufficient exercise or too heavy feeding before pigs have attained their growth.

Experiment Rations for Hogs.

Associated with Mr. Grisdale, I am now at work on a much more extensive investigation of a similar character. Mr. Grisdale (Agriculturist of the Farm), is now feeding a large number of pigs, according to a scheme we have drawn up. These pigs will be slaughtered and analyzed from time to time to ascertain what effect the various foods and conditions have had upon the pigs.

By Mr. Featherston :

Q. Do you consider the "firm" pig to be a healthier animal than the other, is not that right?

A. I am not prepared to say that, though it is possible that "soft" fat betokens an abnormal condition.

We have established a basis for reference and we have begun a further investigation of a very extensive character, feeding nearly 200 pigs. When the work is completed I trust we shall be able to give to our farmers and pork raisers such information as will enable them to avoid the production of soft pork.

We start this experiment with weaned pigs. They will be analysed at all stages of growth until they reach maturity, or rather the weight the pork packers desire them. By this means we shall be able to discover if this olein that I have referred to is developed at any particular time in the pigs life or is there from the first. If we find the very young pigs just off the mothers milk with this soft fat, we may conclude that it is an inherited quality. All the pigs to be experimented with are Tamworths or Tamworth grades.

By Mr. McMillan :

Q. Were the pigs that you are experimenting with bought from outside or were they produced on the farm?

A. Some few were littered on the farm, but most of them were bought outside. Some of them came from this district and some of them from Essex and the west, so we have pigs representing both east and west. The reason locality was introduced, was, that some consider soft pork is due more or less to the district in which the pigs are bred and reared. As many factors as possible have been taken into consideration in arranging or settling upon this scheme or this experiment.

By Mr. Featherstone :

Q. You have them ready for slaughtering now, have you?

A. The work has just begun. It cannot be completed for six or eight months yet. We shall slaughter them from time to time.

Q. I thought you said you were going to kill some next week?

A. Yes, we are going to kill four of them only, and analyse them; others will be killed at various stages of growth.

SAMPLES RECEIVED FOR EXAMINATION FROM FARMERS.

Having now brought before you some of the more important results obtained last year in the branch of original research, I wish to say a word or two with regard to the other classes of work I have been engaged on, and more particularly with regard to samples sent in by farmers for examination. In the following tables I have arranged according to their nature and locality the samples received during the years 1898 and 1899, respectively:—

SAMPLES RECEIVED FROM 31ST MAY, 1898, TO 1ST JUNE, 1899.

	B. C.	N.W.T.	Man.	Ont.	Que.	N. B.	N. S.	P. E. I.	Total.
Soils	3	2	3	3	12	1	5	....	29
Mucks, mud and marl...	1	1	1	5	2	8	5	7	30
Manures and fertilizers..	2	....	....	11	2	4	7	1	27
Forage plants and fodders	1	30	19	21	3	2	10	5	91
Well waters	2	6	10	57	10	4	5	6	100
Miscellaneous, including dairy products, fungicides and insecticides..	3	6	1	23	6	1	2	6	48
Total	12	45	34	120	35	20	34	25	325

SAMPLES RECEIVED FROM 31ST MAY, 1897, TO 1ST JUNE, 1898.

	B. C.	N.W.T.	Man.	Ont.	Que.	N. B.	N. S.	P.E.I.	Total.
Soils	5	....	3	9	10	5	3	4	39
Mucks, mud and marl	5	....	1	7	6	9	12	17	57
Manures and fertilizers	4	1	....	3	....	2	7	3	20
Forage plants and fodders	18	1	....	16	....	1	5	2	43
Well waters	2	3	4	34	23	2	3	18	89
Miscellaneous, including dairy products, fungicides and insecticides	2	3	1	6	17	....	7	3	39
Total	36	8	9	75	56	19	37	47	287

Last year, that is to say up to the 1st of June of the present month, we received 325 samples for examination; the year before, for the same period, we received 287 samples. These consist chiefly of soils, naturally recurring fertilizers including muck, mud and marl, manures and fertilizers, forage plants and fodders, well waters, and miscellaneous including dairy products, fungicides and insecticides.

By the Chairman:

Q. You have apparently a little of everything?

A. Yes, we get something of everything relating to agriculture, or nearly so.

It is scarcely necessary to say, perhaps, that only those samples which we consider fall within our province to examine, are analysed.

There is constantly on hand a large number of samples awaiting attention, as of course it is work that can only be taken up as time permits.

Many of the results of these analysis are inserted in the annual report of the Chemical Division for the reason that they furnish useful information to our readers. Thus many of our reports on soils are of sufficient importance to merit publication, for they contain suggestions regarding treatment and improvement which will be of value to those possessing soils similar in character. The data regarding various natural fertilizers occurring in Canada, obtained from samples forwarded to farmers, are also for the most part published since they serve to make known to others the presence of materials of fertilizing value which can often be obtained at little or no expense.

By Mr. McMillan:

Q. Before you leave the matter of soft pork, has a case come under your notice of a lot of hogs, we will suppose a litter of hogs all brought up together and made ready for the market, all being fed together and kept together, and some bacon being soft and other being hard on the same treatment, the same breed and the same feeding?

A. Indeed, no; I must confess I have not. Although I have read a considerable amount on this subject, I have never seen any account of that case. There are many and conflicting theories abroad as to the cause of soft pork. It may be due to the breed or to the feed or to both. I don't wish to be understood as speaking definitely, because we really as yet don't know anything as facts, but I am of the opinion, it is only an opinion, that it is not due to any one cause. Probably it was at first induced by feed, and that after a number of years the quality became such that it was acquired either through the mother's milk or they inherited the soft fat when born. Soft and firm pork are, I understand, to be found in all breeds.

By Mr. Featherston:

Q. The Swine Dealers' Association in the west are conducting experiments now and Mr. ——— and Mr. Hodson, the Secretary of the Association, told me the other day they found there is a good deal in the breed, and they are afraid it is going to be quite a question.

By Mr. McMillan:

Q. As far as I can see there is a good deal in allowing the pigs to get plenty of exercise and to be kept thriving all the time?

A. I certainly think exercise is necessary to keep them in good health, though I could not say that lack of it caused "softness."

Well Waters from Farm Homesteads.

The work on waters from farm wells, creameries and cheese factories has been continued; we analysed in the neighbourhood of 100 samples last year. It will be unnecessary for me to emphasise to-day the value of this part of our work, since on several occasions in past years I have dwelt at some length upon the danger to health, stock and dairy products from a polluted water supply.

All farmers and dairymen can obtain an analysis of their well water free of expense, provided they follow certain instructions as to collection that we issue and prepay express charges.

The examination of samples sent in by farmers has been the means of extending a helping hand to the intelligent farmer. It has gained the sympathy and cooperation of our people in the work of this branch of the experimental farm system, a very important matter and convinced them of the practical aid to be obtained through chemistry.

Correspondence.

The experimental farm is now and has been for some time recognized throughout the Dominion as the bureau from which information can be obtained for the asking on agricultural matters. Letters addressed to us as you know need no postage, but it is not this fact altogether I feel sure that has caused the yearly increase in the number of our correspondents. It is rather due to the fact that it becomes more widely known year by year that information of a helpful and reliable character can be obtained gratis. The letters for the most part contain inquiries respecting fertilizers, cattle foods, soils, the chemistry of dairy products, insecticides and fungicides and allied subjects. Many of them require a certain amount of research and analytical work before they can be answered and it will therefore be obvious that a considerable portion of my time is occupied in this branch of our work. For the year ending last of June, 1899, we received 1,309 letters and dispatched 1,510.

Bulletin on Farm Yard Manure.

A bulletin on farm yard manure (No. 31, Central Farm Series) was written and issued last December and was distributed to those on our mailing lists during the earlier months of the present year. It treats of this important subject from all the practical aspects of the question, and no doubt will be found of value for reference by our farmers. From the tenor of the letters acknowledging its receipt we have every reason to conclude that it is not only filling a long felt want but that it will have a good effect upon the negligent and wasteful practices in connection with the preservation of barn yard manure, practices which, I am sorry to say, have been altogether too common in the past.

Addresses at Conventions.

Addresses have been delivered at some of the more important agricultural conventions in Ontario, New Brunswick, and Nova Scotia since last I appeared before your committee.

Tuberculin.

The tuberculin furnished by the department of agriculture to veterinary surgeons throughout the Dominion is prepared and sent out by us. This necessarily has encroached upon our time, for the quantity now used by the Government Inspectors is over 10,000 doses per annum. It is important work, however, and we are consequently making arrangements to carry it out carefully and at the same time in such a way that the chemical work proper of the farms may not be interfered with.

New Laboratories.

I am glad to report that a new and substantial building, devoted entirely to chemical work, has been constructed at the Central Farm. It comprises two laboratories in addition to offices and weighing rooms on the first floor, storage and sample rooms in the basement, and a suite of three rooms in the attic, two of which will be used for grinding and drying of samples and the third for photographic purposes. The building is now being fitted up and equipped with the necessary laboratory appliances, and we confidently expect to be in a position to move in within a month or two. Since the fire that occurred in 1896 we have been seriously incommoded. The new laboratories will enable us to accomplish more work and with greater convenience than heretofore.

Having read over the preceding transcript of my evidence I find it correct.

FRANK T. SHUTT,
Chemist to the Dominion Experimental Farms.

PLATE I.

PLATE II.