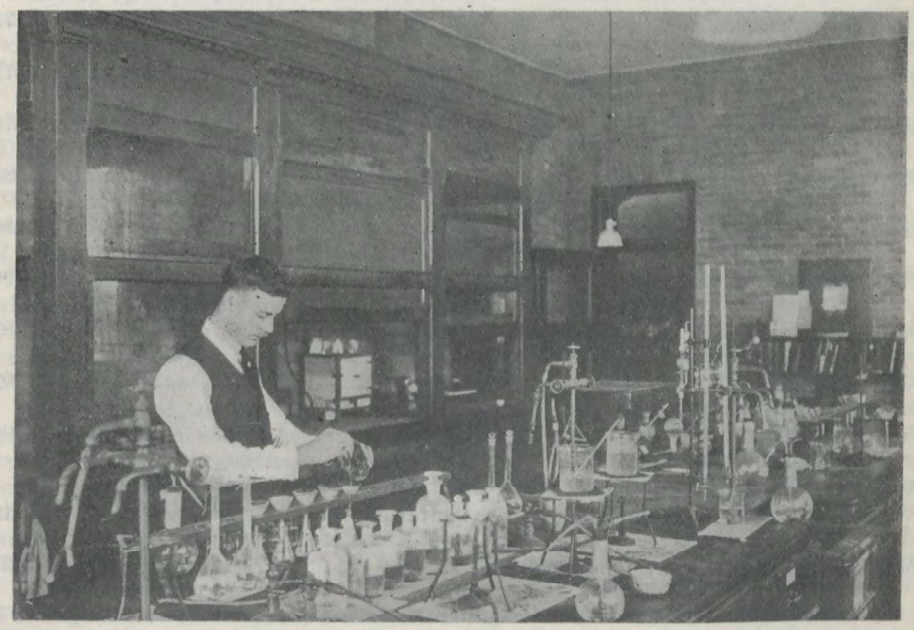
DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

DIVISION OF CHEMISTRY

INTERIM REPORT OF THE DOMINION CHEMIST

FRANK T. SHUTT, M.A., D.Sc., F.I.C.

FOR THE YEAR ENDING MARCH 31, 1922



Feeding Stuff and Fertilizer laboratory, showing fume cupboard. Chemical Building, Ottawa.

Printed by authority of the Hon. W. R. MOTHERWELL, Minister of Agriculture, Ottawa, 1922

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DIVISION OF CHEMISTRY

REPORT OF THE DOMINION CHEMIST

FRANK T. SHUTT, M.A., D.Sc., F.I.C.

During the past year the various phases of chemical work which have characterized the activities of the Division in recent years have been carried forward; in addition, several new and special investigations have been successfully prosecuted. The endeavour has been to make the work cover, in scope and character, as large a portion of the field of agricultural chemistry, as was possible with the staff and equipment available.

Throughout, our object has been to attack those problems which appeared to be of more immediate and practical importance to the man on the land.

Permanent progress in agriculture can only come through the results of research or investigation and therefore it is this phase of work which has received our first attention. This has included investigational work with soils, fertilizers, feeding stuffs, sugar beets, field roots, silage and forage crops, waters, etc., and the results here reported will, we believe, prove of considerable interest and value to the farming public.

From the outset there has been a "chemical service" for farmers. This is carried on chiefly by correspondence, and the analysis of samples submitted for examination and report and may be said to be both educational and advisory in character. This work which puts the division into touch with the individual farmer—increases yearly in volume—an evidence of its appreciation and value.

Mention may be made of the large amount of control and investigatory work undertaken for the Meat and Canned Foods Division; Health of Animals Branch, Department of Agriculture. This work comprises the chemical and microscopical examination of all samples from the packing houses and canneries throughout the Dominion. The primary object of this work is to ensure that the food products of these industries conform to the government standards of purity. During the year 2,190 samples were examined and reported on.

The investigational work on soils for the Reclamation Service of the Department of the Interior, for the purpose of assisting in the classification of the irrigable lands of southern Alberta and southwestern Saskatchewan has been continued. The chief object of this work is the determination of alkali, enabling a report to be made upon the lands examined, as to their suitability or otherwise for cultivation under irrigation.

As required and in as far as circumstances permitted, analytical work and research has been undertaken for the several branches of the Department of Agriculture, Post Office Department, Department of the Interior, Department of Customs and Excise, Department of Marine and Fisheries, Department of Naval Service, and the several commissions and boards in connection with the soldiers' re-establishments and settlement. In a very real sense the division acts as a bureau of chemistry for the Government service.

Two bulletins have been written and issued during the year "Commercial Feeding Stuffs" and "Bran, Shorts, Middlings and Feed Flours." Both make available to the farming public information that will be of service in the economic purchases and rational use of feeding stuffs.

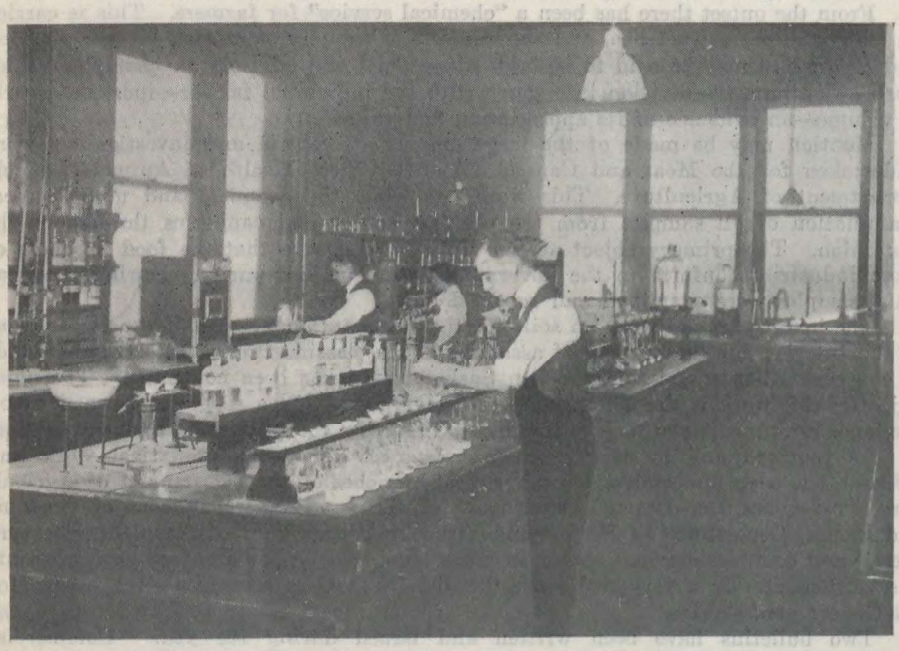
During the fiscal year ending March 31, 1922, a total of 4,122 samples were received at these laboratories for examination. Their classification is given in the following table:—

SAMPLES RECEIVED FOR EXAMINATION AND REPORT FOR TWELVE MONTHS ENDING MARCH 31, 1922.

—	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	New Brunswick	Nova Scotia	Prince Edward Island	Total
Soils	72	345	15	19	69	54	20	22	10	626
Manures and fertilizers	11	4	.....	1	32	36	23	19	20	146
Forage plants, fodders and feeding stuffs	30	29	10	6	466	40	10	8	5	597
Waters, including rains and snows	9	24	13	5	208	20	12	7	2	300
Samples from Meat and Canned Foods Division	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,190
Miscellaneous, including dairy products, insecticides and fungicides	9	83	11	2	73	69	16	10	.....	263
										4,122

INVESTIGATIONAL WORK WITH FERTILIZERS

Of the Farms and Stations in the Experimental Farms system on which investigations with commercial fertilizers are being carried out, systematically and extensively, may be mentioned particularly Charlottetown, P.E.I.; Kentville, N.S.; Nappan, N.S.; Fredericton, N.B.; Cap Rouge, P.Q.; Kapuskasing, Ont.; and Agassiz, B.C.



Soils and Fertilizers laboratory. Chemical Building, Ottawa.

The Interim Report of the Division of Chemistry for the year ending on March 31, 1921, presented in some considerable detail results obtained from investigations approaching the second decade of their course, besides others of shorter duration, and marked a definite stage in the history of this work.

The spring of 1921 saw the commencement of several new schemes, the outgrowth of the basic or primary tests, of specialized and somewhat elaborate design. From these, it is hoped, may be obtained, ultimately, data of considerable interest and value in respect to the relative influence on crop growth of the three "essential plant food elements," furnished in different forms and combinations, and particularly of nitrogen in various compounds and applied at different periods of the year and rotation.

At this juncture in the progress of the new investigations it would be premature to attempt any intimate discussion of the results; yet in so far as they may be found to throw light or have a bearing on earlier investigations, reference to these special features is permissible.

But few data can be added to the records of a year ago and, therefore, experiments discussed in the report of last year will be passed over in the meantime.

The investigational work of, perhaps, minor importance and due to be recorded here, includes tests of new or unusual materials of fertilizing value or soil ameliorants, such as Nitrapo (Charlottetown and Kentville), Malagash Salt (Charlottetown, Nappan, and Kentville), and Soda Nitrogen (Ottawa, Agassiz, and Sidney).

Experiment E-21 at Kentville, N.S.—This experiment, commenced in 1921, embraces 62 plots treated variously in respect to fertilizing and manuring. Since the scheme is in duplicate, there are in all 124 plots exclusive of the checks.

The rotation to be followed consists of (1) Potatoes, (2) Grain, (3) Clover Hay. The fertilizers, for the most part, are applied in the first year (1921), but—an important feature of the scheme—provision is made for supplemental applications of nitrogenous materials (chiefly nitrate of soda) in the second and third years.

The plots in the first section of the scheme receive nitrate of soda (though, for purposes of comparison, in one or two instances sulphate of ammonia is employed) at the rate of either 400 or 200 pounds per acre, in addition to a phosphatic and potassic fertilizer. Of the three plots in each series, A receives all the nitrate in the first year; B, two-thirds in the first and one-third in the second year; and C, one-third in each of the three years.

Other plots in this section have sulphate of ammonia as the nitrogenous fertilizer; and in two series basic slag is substituted for superphosphate as a source of phosphoric acid.

In the second section various minerals and organic sources of nitrogen and phosphoric acid are compared in different quantities per acre, and provision is made for an application of nitrate of soda to the hay crop of the third year.

In the third section the fertilizers, in various combinations, are to be applied at the rate of one-half of the total quantum in the first, and one-quarter in each of the second and third years.

Considering the very dry season which obtained in 1921, the results from the crop of that year are remarkably good.

A plot receiving 10 tons of manure, supplemented by 200 pounds of nitrate of soda, 250 pounds of superphosphate, and 120 pounds of muriate of potash per acre, yielded 208·5 bushels of potatoes; one receiving manure alone yielded 186·5 bushels, while the average yield from the unfertilized check plots was 172·7 bushels.

Fertilizer Experiment, Ka-21, at Kapuskasing, Ont.—This experiment (comprising 50 fertilized plots) is similar to and in its scope only slightly less comprehensive than E-21 at Kentville. There are two principal sections, one in which fertilizers are applied supplementary to 15 tons of barnyard manure per acre; another in which, instead of barnyard manure, a green crop of sweet clover is to be ploughed down in the third year of a five-year rotation. In the first section the rotation consists of (1) O.P.V. for Ensilage, (2) Grain, (3) Red Clover Hay, (4) Timothy Hay, (5) Timothy Hay. In the second the rotation is (1) O.P.V. for Ensilage (2) Grain, (3) Sweet Clover, (4) Oats, (5) Red Clover.

In the "Manure Series," Section 1, consistent results (with a single exception) have followed the application of nitrate of soda (in conjunction with a phosphatic fertilizer) at the respective rates of 330, 220 and 110 pounds per acre. The results (average) from the five (5) three-plot series are given in the following table:—

VARYING THE AMOUNT OF NITRATE OF SODA IN THE FERTILIZER, KAPUSKASING, 1921

—	Plot	Nitrate of Soda	Phosphatic Fertilizer	Yields per Acre of Oats, Peas and Vetches	
		Lbs.		Tons	Lbs.
Average of Five Series.....	A.	330	Superphosphate and basic slag in addition to 15 tons manure.	8	1,020
	B.	220		7	820
	C.	110		6	770
Average of three checks 15 tons of manure alone.....				4	1,950

The experience of the first year alone, indicates the maximum quantity of nitrate applied to have been most profitable.

Experiment E-21 at Agassiz, B.C.—In this experiment which comprises 60 fertilized plots, one of the principal features is represented in the provision for furnishing the nitrogenous fertilizer (nitrate of soda) at different rates and periods. For instance, plot A of the series receives the full quota of nitrate in the first year but none in the next two years; plot B receives one-half the nitrate in the first and one-half in the second year but none in the third, and plot C receives one-quarter of the nitrate in the first and one-half of the remainder in each of the two succeeding years of the rotation. This part of the scheme may be expected to reveal important data relative to the most economic methods of applying nitrate of soda.

With but few exceptions, the yields of mangels from the plots in the first year (1921) correspond in direct ratio to the quantity of nitrate applied.

Another feature meriting more than passing notice is the relative influence of "mineral" and organic sources of nitrogen and phosphoric acid, the results agreeing closely with those obtained in Experiment E-7 at Agassiz, in the years 1918 and 1919, and recorded in the Interim Report of the Superintendent, Experimental Farm, Agassiz, B.C. (pages 52-53), for the year ending on March 31, 1921.

For purposes of comparison, the data obtained in the years 1918 and 1921 are presented herewith in tabulated form.

In both years, and prior to the commencement of the three-year rotation, the areas received an application of barnyard manure.

The tankage used in 1918 was in the nature of a bone tankage, being high in phosphoric acid and relatively low in nitrogen, whereas that used in 1921 was high in nitrogen and very low in phosphoric acid. Because of this dissimilarity in composition, in the fertilizing of plots 18 B and 19 B in 1918, tankage furnished, respectively, half and the whole of the phosphoric acid required, while in 1921 the highly nitrogenous tankage was employed to furnish half (18B) and all (19B) the nitrogen required in the fertilizing of these plots. The results follow:—

MINERAL VERSUS ORGANIC FERTILIZER MATERIALS, AGASSIZ, 1918, 1921

Plot	Treatment	Yields per Acre Mangels (1918)
		Bush.
11B.	All mineral fertilizer (nitrate and superphosphate).....	668·0
18B.	Half phosphoric acid from tankage, half from superphosphate.....	452·8
19B.	All phosphoric acid and most of nitrogen from tankage.....	304·0
20B.	All organic materials (blood, tankage and bone meal).....	152·0
Checks (average) manure alone.....		22·4

MINERAL VERSUS ORGANIC FERTILIZER MATERIALS, AGASSIZ, 1918, 1921.—*Concluded*

Plot	Treatment	Mangels, 1921
		Bush.
11B.	All mineral fertilizer (nitrate and superphosphate)	1,586·4
18B.	Half nitrogen from tankage, half from nitrate of soda	1,448·0
19B.	All nitrogen and part of phosphoric acid from tankage	1,349·6
20B.	All organic materials (blood, tankage and bone meal)	1,243·2
Checks (average) manure alone		876·0

Notwithstanding the difference in the nature of the tankage used, which in 1918 was highly phosphatic and in 1921 highly nitrogenous, and the fact that a more favourable season and more fertile soil contributed to the production of larger yields in 1921 than in 1918, the relative influence of mineral and organic sources of nitrogen and phosphoric acid has been the same in both years, having varied only in degree, that is to say, the change from an all-mineral fertilizer (11 B) to an all-organic fertilizer (20 B) has been accompanied through the intermediate stages (plots 18 B and 19 B) by a gradual decline in the yield of crop.

These results constitute fresh evidence of the greater economy which generally characterizes the judicious use of the more readily available forms of nitrogen and phosphoric acid, as furnished by nitrate of soda and superphosphate.

Sources of Nitrogen Experiment at Charlottetown.—In this experiment four nitrogenous fertilizers—nitrate of soda (15 per cent), sulphate of ammonia (20 per cent), cyanamide (14 per cent), and Nitrapo (15 per cent)—were compared. (The percentage figures represent the nitrogen present in each of these materials.)

The soil is a medium loam of moderate fertility but unmanured for several years, and the experimental crop was turnips. Cyanamide is the product of an electrical process whereby the nitrogen of the atmosphere combines with lime and carbon. When first applied to the soil cyanamide forms, presumably, a small quantity of an intermediate compound, dicyanodiamide, which is poisonous to germinating seeds and young plants. For this reason it cannot be applied with impunity later than two weeks before seeding or planting. The nitrogen of cyanamide becomes available in the soil through its conversion first to ammonia and then to the nitrate form. "Nitrapo" is a by-product of the Chilean Nitrate Industry and consists of a mixture of nitrate of soda and nitrate of potash, so combines the qualities of the former with that of potash in its most readily available form. Since Nitrapo contains 15 per cent of nitrogen and 15 per cent of potash, 100 pounds of this material is equivalent to 100 pounds of nitrate of soda plus 30 pounds of muriate of potash. While the annual production of Nitrapo is not of a volume sufficient to warrant its recognition as a staple article of commerce, its concentrated and soluble form commends it highly as a nitro-potassic fertilizer. The table which follows shows that each nitrogenous fertilizer was applied singly (plots 2, 3, 10), also with superphosphate (6, 8), or with superphosphate and muriate of potash (plots 7, 9). The small quantity of cyanamide available for this experiment did not permit of its inclusion in a mixture.

In whatever form, the amount of nitrogen furnished was the same in each instance, viz., 30 pounds per acre. Phosphoric acid, where furnished, was at the rate of 48 pounds, and potash at the rate of 30 pounds per acre.

SOURCES OF NITROGEN COMPARED AT CHARLOTTETOWN, 1921

Plot No.	Fertilizers Applied	Rate per Acre	Elements Furnished.	Yield of turnips per Acre. Average of Duplicated Plots.
		Lbs.		Bush.
1	Nitrapo	200	Nitrogen and potash	805·6
2	Nitrate of soda	200	Nitrogen	790·8
3	Sulphate of ammonia	150	Nitrogen	492·4
4	Check			646·0
5	Nitrapo	200	Nitrogen and potash, phosphoric acid	899·6
	Superphosphate	300		
6	Nitrate of soda	200	Nitrogen and phosphoric acid	757·2
	Superphosphate	300		
7	Nitrate of soda	200	Nitrogen, phosphoric acid and potash	876·8
	Superphosphate	300		
	Muriate of potash	60		
8	Sulphate of ammonia	150	Nitrogen and phosphoric acid	588·4
	Superphosphate	300		
9	Sulphate of ammonia	150	Nitrogen, phosphoric acid and potash	813·6
	Superphosphate	300		
	Muriate of potash	60		
10	Cyanamide	225	Nitrogen	410·4

Comparing the results from plots 2, 3 and 10 to which nitrogen alone was furnished in the form of nitrate of soda, sulphate of ammonia and cyanamide, respectively, the superiority of nitrate of soda and inferiority of cyanamide are equally remarkable, though, compared with cyanamide, sulphate of ammonia has not much in its favour in point of yield.

Of the cyanamide plots (No. 10) it should be stated that the material, instead of being applied—as usually prescribed—from two to three weeks prior to planting, was applied at seeding time, concurrently with the application of the other fertilizers used in the experiment. This afforded a striking object lesson relative to the harmful influence exerted by cyanamide, freshly applied, on germination and the development of the young seedling. Germination was seriously affected by the cyanamide, and the stand of plants on these plots was, in consequence, far from uniform. A large proportion of the plants remained spindly throughout the season.

Plots 6 and 8 received, besides phosphoric acid, nitrogen in the form of either nitrate of soda (6) or sulphate of ammonia (8). Here again nitrate of soda takes precedence over sulphate of ammonia by a very considerable margin.

When potash is added to complete the mixture (plots 7 and 9) nitrate of soda still maintains a marked advantage, though somewhat less pronounced than in the other instances. Plot 5, with Nitrapo, is comparable with plots 7 and 9—all having received the same amounts of nitrogen, phosphoric acid and potash.

The small margin by which the yield of plot 5 exceeds that of plot 7 may be deemed to be within the limits of experimental error. There is no doubt, however, that Nitrapo, by virtue of the ready availability of its nitrogen and potash, has proved itself a valuable concentrated source of these elements of plant food.

Influence of Potash in the Experiment at Charlottetown.—On plots 1 and 5 the potash was furnished by Nitrapo; on plots 7 and 9 by muriate of potash. On comparing the yields from plots 1 and 2 where Nitrapo and nitrate of soda, respectively, were applied without superphosphate, it will be seen that the increase, which may be attributed to the potash in the Nitrapo, was slight—only 14·8 bushels per acre and within the limits of experimental error. With superphosphate Nitrapo (plot 5) shows more plainly the value of the potash as compared with the no-potash plot (6).

Like results are noticeable when potash is furnished in the form of muriate on plots 7 and 9. On comparing the yields from plots 8 and 9 a very large difference in favour of potash appears. Plot 8 (sulphate of ammonia with superphosphate) produced a very low yield. This, though in less degree, is true also of the behaviour of plot 5 (nitrate of soda with superphosphate) which produced a yield smaller than that from plot 2, with nitrate of soda alone. Despite these apparent inconsistencies, the influence of potash has been unmistakeable throughout and on a crop (turnips) which does not usually respond, in any marked degree, to artificial supplies of potash. This is true more particularly when manure—according to the usual custom—is applied. The omission of manure in this experiment may account in part for the potency of the potash in the fertilizer.

Experiments with "Soda Nitrogen"

Soda Nitrogen, a by-product of the American Nitrogen Products Company, Seattle, Wash., was first brought to our attention in February, 1921, when it was being offered on the Pacific coast markets as a nitrogenous fertilizer.

The examination of a sample received from the manufacturers revealed the fact that of the total nitrogen present, approximately two-thirds existed in the form of sodium nitrite and one-third in the form of sodium nitrate.

While nitrite nitrogen is toxic to plant life, its transition to the more highly oxidised form of nitrate would be supposed to take place fairly rapidly in the soil, so that under ordinary conditions no serious injury might be anticipated from its use. Of course, the conversion of nitrite to nitrate in the soil is dependent on bacterial agencies which, in early spring, would not be active; consequently injury to germinating seeds might result from an application of soda nitrogen under such conditions.

Our practical experience with "soda nitrogen" is limited to the knowledge gained from the results of investigations carried on with oats in the greenhouse at the Central Experimental Farm, with oats and potatoes at the Experimental Farm of Agassiz, B.C., and with potatoes, corn, beans and peas at the Experimental Station of Sidney, Vancouver Island, B.C.

Pot Test with Soda Nitrogen in the Greenhouse.—In this experiment, with oats, soda nitrogen and nitrate of soda, in quantities of each representing applications of 150 and 300 pounds per acre, were compared. In one series of plots the smaller, and in another series the larger application was made at seeding time. In two further series the applications were made after the plants had attained a growth of about one inch in height.

Of course, under greenhouse conditions the activities of the nitrifying bacteria would be favoured, so that the conversion of the nitrite to nitrate nitrogen would have taken place almost immediately. Be this as it may, observations made at the commencement and during the progress of the experiment failed to detect evidence of injury either to the germinating seedling or to the maturer plant at any stage.

The heavier applications, whether of soda nitrogen or of nitrate of soda, gave results superior to those from the lighter applications, while the untreated checks were decidedly inferior.

This experience at Ottawa was repeated in a field test with oats at Agassiz, B.C.

Soda Nitrogen with Potatoes at Agassiz.—The results of this experiment favour nitrate of soda throughout. Besides the nitrogenous material, each fertilized plot received superphosphate and muriate of potash at the rates of 300 pounds and 150 pounds per acre, respectively.

On plots 1 and 2 the two nitrogenous fertilizers are applied at the rate of 200 pounds; on plots 3 and 4 at the rate of 400 pounds per acre, at planting time. On plots

6 and 7 the 400 pounds application is divided, 200 pounds thereof being given at planting time and 200 pounds as a top dressing subsequently. Plot 8 received the superphosphate and muriate of potash but no nitrogen. Plots 5 and 9 were unfertilized checks.

NITRATE OF SODA VERSUS SODA NITROGEN AT AGASSIZ (ON THE POTATO CROP)

Plot No.	Nitrogenous Fertilizers	Rate and Time of Application		Yields and Increases		
		At Planting	As Top-dressing	Yield per Acre	Increase over Check	Greater yield from Nitrate
		Lbs.	Lbs.	Bush.	Bush.	Bush.
1	Nitrate of soda	200	.....	254·3	48·9	23·8
2	Soda nitrogen	200	.....	230·5	25·1	
3	Nitrate of soda	400	.....	246·3	40·9	42·7
4	Soda nitrogen	400	.....	203·6	−1·8	
6	Nitrate of soda	200	200	282·2	76·8	26·6
7	Soda nitrogen	200	200	255·6	50·2	
8	No nitrogen			212·2	6·8	
5 and 9	Average of Checks (205 and 205·8)			205·4		

The tabulated statement shows nitrate of soda to have been consistently superior to soda nitrogen. The larger amounts of both, applied on plots 3 and 4, have proved less profitable than the smaller dressings on plots 1 and 2; indeed, the yield from plot 4, with soda nitrogen, is lower than that of the check.

Where (on plots 6 and 7) the large application was divided into two portions, one being given at planting time, the other as a topdressing later on, very much the best results have been obtained. Plot 8, which received the phosphatic and potassic fertilizer but no nitrogen, has given a yield only 6·8 bushels greater than that from the checks (5 and 9).

The similarity of the yields from the two checks (205·0 and 205·8 bushels) which were situated at some distance apart, may be taken as evidence of uniformity in soil conditions within the area.

Experiments with Soda Nitrogen at Sidney, B.C.—These experiments were carried out on a small scale with potatoes, corn, beans and peas. Of the corn, beans and peas on the plots receiving soda nitrogen, 90 per cent failed to germinate, whereas germination on the nitrate of soda plants was normal. On potatoes there was much less evidence of injury.

EXPERIMENTS WITH MALAGASH SALT

Malagash salt is mined in the neighbourhood of Malagash, N.S. The material is essentially common salt (sodium chloride), but contains varying small amounts of potash.

Since the potash content is so small—seldom exceeding one per cent—and the quantity of salt which might be applied to the soil without risk of injury to vegetation does not exceed 300 pounds per acre, the futility of attempting to measure the influence on crop growth of the almost negligible amount of potash thus supplied may be appreciated.

In the spring of 1921 small quantities of Malagash salt were furnished to the superintendents at Charlottetown, Kentville, and Nappan by Messrs. Chambers & McKay, of New Glasgow, N.S., who desired that the material should be submitted to field tests.

At Charlottetown the salt arrived too late to permit its use that year. However, at Kentville and Nappan experiments were undertaken with Malagash salt on mangels and turnips, respectively.

Experiment with Malagash Salt at Kentville.—The Malagash salt was compared with a like quantity of common salt, each being used supplementary to a dressing of 15 tons of barnyard manure, 200 pounds of nitrate of soda, and 300 pounds of superphosphate per acre.

The results of the experiment may be shown as follows:—

MALAGASH VERSUS COMMON SALT AT KENTVILLE. CROP: MANGELS

Plot	——	Yield per Acre in Bushels
1	Common salt, 300 pounds per acre	480·3
2	Malagash salt, 300 pounds per acre	573·5
3	No salt	609·1

The data show that whereas the Malagash salt plot outyielded the common salt plot, the no-salt plot outyielded both. It should be stated, however, that in the dry season which prevailed in 1921 the somewhat lower location of the no-salt plot in the area favoured that plot.

Experiment with Malagash Salt at Nappan.—Here Malagash salt was applied in different quantities per acre and also in conjunction with muriate of potash, being compared also with common salt.

MALAGASH SALT VERSUS COMMON SALT AT NAPPAN. CROP: TURNIPS

Plot	Treatment	Rate per Acre in Pounds	Yield per Acre in Bushels
1	Malagash salt	300	650·7
2	Malagash salt	600	452·4
3	Malagash salt	900	435·0
4	Check plot	.....	565·5
5	Common salt	500	598·3
6	Malagash salt	300	
	Muriate of potash	100	756·9
7	Common salt	300	
	Muriate of potash	100	722·1
8	Muriate of potash	100	765·6

Comparing the treatment and yields of plots 1, 2, and 3, it will be noted that the latter were smaller as the application of the salt was higher, tending to prove the correctness of the impression that 300 pounds per acre approximates the limit of profitable application for salt.

Where Malagash salt was combined with muriate of potash the yield was larger (slightly) than where common salt was used in the same way. But muriate of potash alone has given a yield higher than that from either plot where salt was applied supplementarily.

That any benefit following the use of Malagash salt in this experiment was due to the potash contained in the material could not be entertained, for a sample of the Malagash salt used in the Nappan tests was found on analysis to contain less than two-fifths of one per cent of potash.

LIMESTONE

The crushing of limestone for agricultural use is already an established (though small) industry in Canada. As evidence respecting the value of this material for soil improvement accumulates, there will undoubtedly be an increasing demand for it, especially in the more humid provinces, and crushing outfits will multiply throughout the country. At the present time the chief factor militating against the wider use of ground limestone appears to be high transportation rates. In the larger number of our agricultural districts in need of lime the prices of farm produce would not economically permit of more than $3 to $4 per ton being paid for finely crushed material of good quality and according to our information such is not easily obtainable, save within comparatively short hauling distances of the source of supply.

The solution of the difficulty would appear to be in the increase of the number and the wider distribution of crushing plants. This, to a large degree, would be possible by reason of the fact that limestone of excellent quality occurs abundantly in many parts of Canada and outcrops readily quarried and covering large areas are to be found in almost all the provinces of the Dominion. Limestones, however, are variable as to composition and while there are many of the highest grade, *i.e.* with a calcium carbonate content of over 95 per cent, there are others with notable amounts of magnesium carbonate, quartz, slate, etc., all of which reduce the value of the rock for agricultural purposes. It is imperative therefore that the deposit should be analysed and its quality as well as its extent ascertained before crushing operations are undertaken.

A number of samples of Canadian limestone have been submitted to this division for analysis; their locality of occurrence and composition are given in the accompanying table.

These limestones, in part received from farmers, but chiefly from agricultural authorities in the various provinces of the Dominion, were, if sufficiently pure, to be used in the preparation of ground limestone.

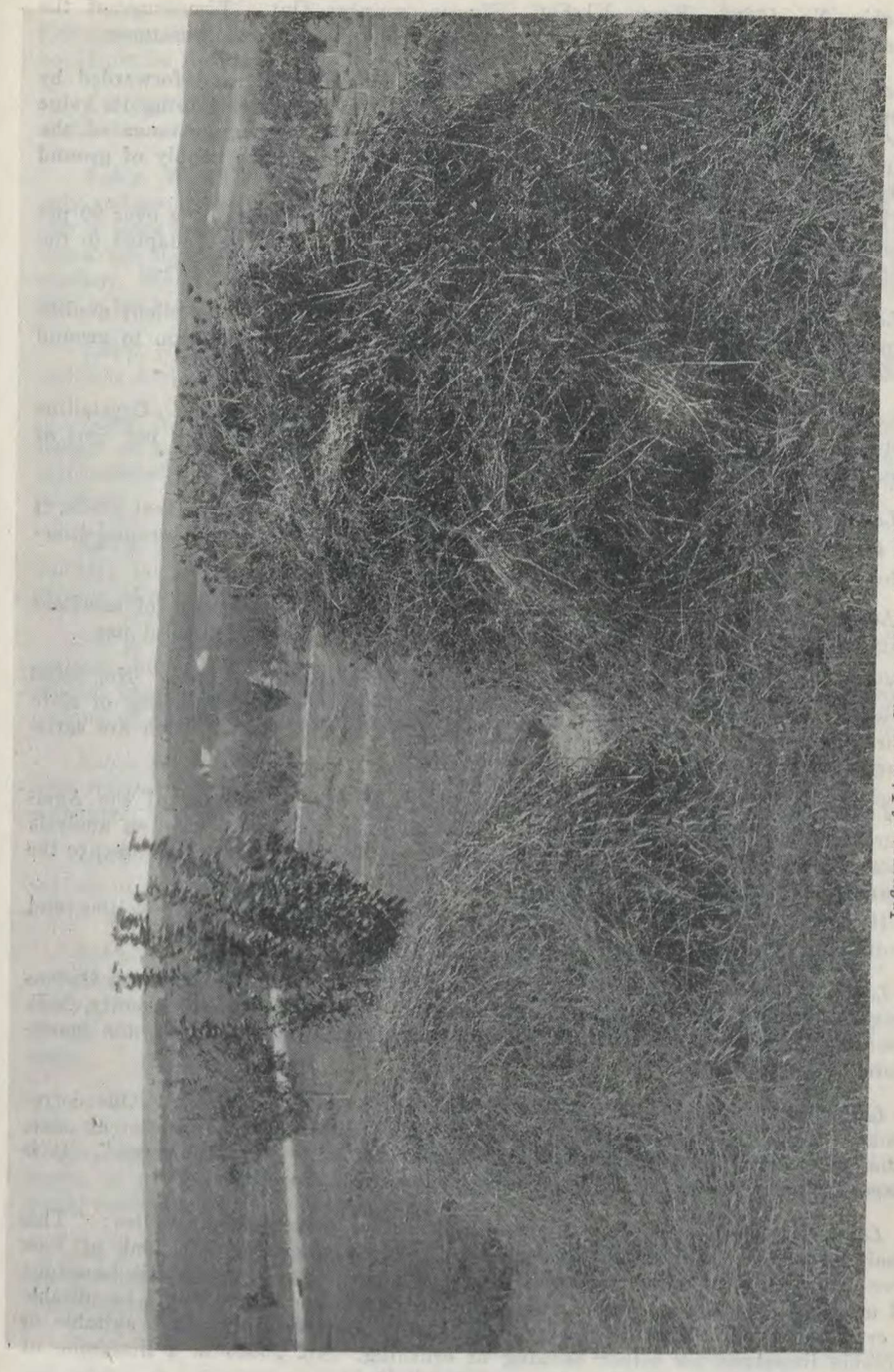
Lab'y. No. 27344.—From Collins Bay, Ont. Though not a limestone of the first quality, it is sufficiently rich in carbonate of lime to possess a distinct value for the purposes of manufacturing a crushed limestone product, if it could be used locally. The selling price of the ground material would be largely determined by the competition it might meet with from limestones of better quality and the demand in the immediate vicinity. It contains too large a percentage of carbonate of magnesia to warrant burning for lime.

Lab'y. No. 28409.—From Erinsville, Ont., and sent in by the district representative at Napanee, Ont. This is a limestone of excellent quality; it would prove eminently satisfactory for the preparation of pulverized limestone.

Lab'y. Nos. 28719-20.—Two samples of limestone from Seaforth, Ont. Both are of the highest grade, containing over 90 per cent of carbonate of lime, and would be quite suitable for grinding.

Lab'y. Nos. 31022-23.—These are dolomitic or magnesian limestones and, consequently, are not suitable for the production of quicklime. It is a matter of very considerable dispute if dolomitic limestones, especially those with such a high percentage of carbonate of magnesia, are desirable for the manufacture of crushed limestone for agricultural purposes, since excess of magnesian salts are injurious to plant growth. For this reason we would not advise the use of these limestones.

Lab'y. Nos. 56163-64.—From Sequin Falls, Ont. No. 1 is a crystalline limestone of good quality; No. 2 is a magnesian limestone of low grade and unsuitable for the manufacture of crushed limestone.



Influence of Lime on Clover, 1921, Kentville, N.S.
Clover Hay per acre
Limed area (to right) .. .. 1,504 pounds
Unlimed area .. .. 762 "

Lab'y. No. 57662.—From Uhthoff, Simcoe county, Ont. Limestone of the highest grade and eminently suitable for the making of pulverized limestone.

Lab'y. No. 26844.—From Port Daniels, Bay Chaleur, Que., and forwarded by the president of the local Agricultural Society with a view to ascertaining its value for crushing, the farmers in the district co-operating with the assistance of the provincial agricultural department for the purpose of obtaining a supply of ground limestone.

This is a mottled (chocolate brown and white) limestone containing over 90 per cent carbonate of lime and hence of the highest quality. It is well adapted to the manufacture of crushed or ground limestone for agricultural purposes.

Lab'y. No. 26853.—From St. Louis de Champlain, Que. An excellent quality of limestone; suitable either for burning to quick lime or for reduction to ground limestone.

Lab'y. No. 30575-6.—From Escuminac, Bonaventure County, Que. Crystalline limestone or calcite, No. 30575 being the better quality, with over 90 per cent of carbonate of lime.

Lab'y. No. 30983.—From St. Fabien, Que. Though not of the highest grade, it is of good quality and would prove satisfactory for the production of ground limestone.

Lab'y. No. 49638.—From Three Rivers, Que. This is a limestone of excellent quality and would make a high grade ground limestone for agricultural use.

Lab'y. Nos. 26603-4.—From St. Charles Settlement, Beresford, N.B. No. 26603 is a white crystalline limestone of high quality. No. 26604 is a dark grey or slate coloured limestone of good quality but not so pure as No. 26603. Both are satisfactory from the standpoint of composition.

Lab'y. No. 26481.—From East Centreville, N.B. The Secretary of the Agricultural Society of that locality writes: "We should be pleased to have an analysis as soon as possible, as, if the limestone is of good quality, the Society will procure the Government crusher at once."

It is of poor quality, containing only 54 per cent of carbonate of lime and cannot, therefore, be recommended for crushing purposes.

Lab'y. Nos. 30837-38-39-40.—Nos. 30837 and 30838 are from Queenstown, Queens County, and 30839 and 30840 are from Carpenter, Rush Hill, Queen's County, N.B. These samples are essentially all of high quality and quite suitable for the manufacture of ground limestone.

Lab'y. No. 26484.—From MacLellan's Brook, Pictou County, N.S. Our correspondent writes: "If this sample is satisfactory we shall start the crusher at once, as there is a large demand for crushed limestone for agricultural purposes". It is of excellent quality and well adapted for the purpose mentioned.

Lab'y. Nos. 26645-6.—From Riverton, N.S. Our correspondent writes: "This deposit, of which there is a large quantity, is situated on the left bank of East River about 2½ miles west from Stellarton. We have been burning this limestone and using the product on our farms and should like to know if it would be suitable for crushing." No. 26645 is of very poor quality and certainly not a suitable or profitable limestone for either burning or crushing. No. 26646 is a limestone of excellent quality, either for burning or for grinding.

Lab'y. No. 28329.—From Amherst, N.S. The analysis indicates a limestone of inferior quality and its employment for the manufacture of pulverized limestone could not be recommended; its percentage of carbonate of lime is too low.

Lab'y. No. 29275 (B).—From Parrsboro, N.S. A limestone of the best quality, admirably suited for grinding purposes.

Lab'y. No. 29426-9.—From Middleton, N.S. This is a limestone of fair quality only and could only be profitably worked if the deposit were easily quarried and there was a large demand for crushed limestone in the immediate vicinity. Material of this grade should not be employed unless it is impossible to secure limestone of better quality. We are of the opinion that the cost of quarrying, crushing and transportation is too high to permit of it being economically used save quite locally.

Lab'y. No. 29707.—From Avondale, N.S. This is a limestone of fair quality only and it is doubtful if it could be profitably used for crushing.

Lab'y. No. 30097.—From Strathlorne, Inverness county, N.S. This is a calcareous deposit of a hard stalactite nature, with a honeycomb structure. It is essentially carbonate of lime and if finely crushed could advantageously be used for agricultural purposes.

Lab'y. No. 30526.—From Kirk Hill, N.S. This is a limestone of very poor quality; the percentage of carbonate of lime is certainly too low to warrant the expense of crushing.

Lab'y. Nos. 33457-58.—From Nappan, N.S. These are fairly similar in composition, being dolomitic or magnesian limestone. Owing to the high magnesian content (approximately 40 per cent), we do not consider the rock as suitable for the making of ground limestone for agricultural purposes.

Lab'y. No. 55460.—From Cross Roads, Colchester county, N.S. This is a very poor quality of limestone and we could not advise its use either for burning or crushing.

Lab'y. No. 58206.—From N.E. Mabou, N.S., and collected from the weathered surface of a limestone bed. Though not comparable to limestone rock of the highest grade, it would prove a useful amendment for soils deficient in, or in need of lime.

Lab'y. No. 54878-9.—From different parts of the quarry at Miminegash, P.E.I. and forwarded by the Director of Agricultural Instruction, Charlottetown, No. 54879 (grey) is much richer in carbonate of lime than No. 54878 (red); it is of good quality, though not of the highest grade, and might well be used as a source of ground limestone.

Lab'y. No. 58229.—From Lot 26, North Tryon, P.E.I., and forwarded by the Secretary of Agriculture, Charlottetown. It is of inferior quality, containing only 60 per cent carbonate of lime. It is doubtful if it could be economically used as a source of ground limestone—especially if freight charges on the crushed material would markedly affect the selling price.

Lab'y. No. 56259.—From Brainard, Alberta. This deposit is of a light grey colour with a honeycomb structure. It is of high quality, containing over 90 per cent carbonate of lime.

Lab'y. No. 55684.—Forwarded from Vancouver, B.C., but locality of occurrence not given. A limestone of very high quality.

Analyses of Limestones, 1921-22

Lab. No.	Locality of Occurrence	Mineral Matter Insoluble in Acid	Oxide of Iron and Alumina (Fe_2O_3+ Al_2O_3)	Carbonate of Lime ($CaCO_3$)	Carbonate of Magnesia, etc. ($MgCO_3$) by difference
		p.c.	p.c.	p.c.	p.c.
	Ontario				
27344	Collins Bay	14·98	1·66	72·19	11·50
28409	Erinsville	1·76	0·76	96·50	0·98
28718	Seaforth	1·91	0·58	96·43	1·08
28719	Seaforth	1·65	0·38	94·68	3·29
31022	Billings Bridge	10·94	1·52	50·50	37·86
31023	Billings Bridge	11·36	1·32	51·00	36·50
56163	Sequin Falls (No. 1)	3·16	0·34	90·01	6·49
56164	Sequin Falls (No. 2)	11·85	1·18	56·00	30·97
57662	Uhthoff	4·10	1·74	92·50	1·66
	Quebec				
26844	Port Daniel, Bay Chaleur	6·27	0·72	91·30	1·71
26853	St. Louis de Champlain	4·65	0·56	93·44	1·35
30575	Escuminac	5·14	1·32	93·12	0·40
30576	Escuminac	11·34	1·52	86·00	1·14
30983	St. Fabien	12·70	1·04	85·00	1·26
49638	Three Rivers	4·35	1·05	93·62	0·98
	New Brunswick				
26603	Beresford, St. Charles Settlement	0·44	0·14	98·25	1·77
26604	Beresford, St. Charles Settlement	3·31	0·39	89·13	7·77
26481	East Centreville	34·83	5·13	54·00	6·58
30837	Queenstown	5·12	0·78	94·00	0·10
30836	Queenstown	6·40	1·40	91·60	0·60
30839	Carpenter (Rush Hill)	5·96	0·64	93·00	0·40
30840	Carpenter (Rush Hill)	5·32	0·70	93·75	0·23
	Nova Scotia				
26484	Maclellan's Brook	4·09	1·00	92·50	2·41
26645	Riverton	35·26	5·65	52·18	6·91
26646	Riverton	5·04	3·22	89·80	1·94
28329	Amherst	13·76	17·98	63·13	5·13
29275	Parrsboro	1·57	0·68	95·81	1·94
29426	Middleton	20·00	6·66	72·60	0·74
29707	Avondale Sta	18·60	2·62	75·00	3·78
30097	Strathlorne	6·22	1·50	90·75	1·53
30526	Kirk Hills	74·60	1·94	22·75	0·71
33457	Nappan	2·72	2·40	55·50	39·60
33458	Nappan	2·82	2·86	53·00	41·54
55460	Cross Roads	51·30	3·16	41·66	3·88
58206	N.E. Mabou	13·22	2·40	81·38	3·00
	Prince Edward Island				
54878	Miminegash	32·36	4·20	62·50	0·94
54879	Miminegash	15·38	2·50	81·00	1·12
56040	Murray Harbour	13·18	2·05	84·07	0·70
58229	North Tryon	33·52	5·67	60·00	0·81
	Alberta				
56259	Brainard	3·18	0·90	91·75	3·45
	British Columbia				
55684	Vancouver	0·56	0·42	97·96	1·06

CRUSHED OR GROUND LIMESTONE

The use of lime and lime compounds for soil improvement—for correcting sourness (acidity), for ameliorating tilth and for adding an important element of plant growth, is constantly on the increase, especially in Eastern Canada and parts of British Columbia. Experiments conducted by this division in Quebec, New Brunswick and Nova Scotia, have demonstrated the beneficial influence of lime compounds on several classes of cultivated soil and more particularly have these been effective when applied in addition to manure and fertilizers. Free carbonate of lime is undoubtedly a factor of very considerable importance among those which go to make a soil productive, and the evidence is rapidly accumulating to prove that liming (using the term in its broadest sense, to include the application of quick-lime, slaked lime, marl and ground limestone), is a profitable practice on many worn soils—soils which have lost their lime by leaching and cropping over long periods of cultivation.

Though quick-lime and slaked (hydrated) lime are forms to be preferred for heavy clay loams, ground or finely crushed limestone and marls are as a rule safer and cheaper forms for light sandy soils and those poor in organic matter. They are milder and somewhat slower in their action but they may be applied in large amounts without any fear of injury or of materially reducing the humus content of the soil.*

The growing demand for crushed limestone has induced certain of the Provincial Departments of Agriculture to purchase portable crushing plants for the use of farmers in localities in which there are outcrops of limestone rock. Samples of the limestone and crushed material from these sources have been received and analysed, in order that money and labour may not be lost on low grade rock. This demand has also led to the establishment of firms for the manufacture or production of crushed limestone and in response to requests from farmers a number of samples of these products have been analysed as to composition and examined mechanically as to degree of fineness. The results of this work are tabulated in the accompanying table.

Composition.—Limestones are variable as to composition; those of good quality will contain not less than 80 per cent carbonate of lime, those of the purest and highest grade, 90 per cent and over. Lower grade limestones contain varying proportion of quartz, slate or other inert rock material, with a carbonate of lime content ranging, say, from 50 to 75 per cent. Owing to cost of grinding and high transportation charges, it is doubtful if it would be worth while to crush a limestone containing less than 50 per cent carbonate of lime. It is obvious, from these considerations that in purchasing ground limestone the percentage of carbonate of lime present be ascertained—it is one of the two important factors determining the agricultural value of a sample.

Certain limestones contain notable amounts of magnesium carbonate; these are known as magnesian limestone or dolomite. A small proportion of carbonate of magnesium, say, not more than 5 per cent, apparently does not affect the agricultural value of a limestone, but a large percentage is certainly undesirable, since excess of magnesium compounds in the soil is more or less injurious to crop growth.

Degree of Fineness.—The degree of fineness is an important factor since it determines in a very large measure the rate of solution of the ground limestone and hence the rate at which the material will neutralize or correct sourness (acidity) in the soil and furnish lime for plant growth. The finer the limestone the greater the surface of the material exposed to the moisture of the soil, the more rapid, up to the point of saturation, will be its solution and hence its effectiveness. Fineness is also a factor in even distribution and in effecting a more perfect mixing with the soil.

* Bulletin No. 80, entitled "Lime in Agriculture," discusses very fully all the more important phases of this question, including an account of the chemical, physical and biological functions of lime in the soil. Copies may be obtained on application.

The proper degree of fineness is still a matter of investigation; it will in part be determined by the price of the material, since grinding to a fine powder is a rather costly operation. And there is this further to be said, that though the coarser material will be the slower in its action, it will, within limits, remain the longer an ameliorating agent in the soil. Generally speaking, if a quick prompt action is desired, a material 60 to 75 per cent of which passes a sieve 80 meshes to the linear inch, will be found very fairly satisfactory. If an immediate and, in a sense, quick decisive action is not a desideratum, a matter of first importance, then a somewhat coarser ground limestone can be successfuly used, say 50 to 75 per cent passing a 60-mesh sieve. In any case all should pass a 10-mesh sieve.

Lab'y. No. 26429.—From St. Marc des Carrières, Que. The analysis shows it to be a limestone of the highest quality.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	96·2
" 20 " "	71·4
" 60 " "	35·8
" 80 " "	28·0
" 100 " "	19·8

This material is fairly satisfactory as regards degree of fineness, though a more finely ground product is desirable if quick, prompt action is a desideratum.

Lab'y. No. 26845.—From Marbleton, Wolfe county, Que., a limestone of high quality.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	100
" 20 " "	99·8
" 60 " "	85·8
" 80 " "	79·0
" 100 " "	72·6

Ground very finely and well adapted to give a quick response on application.

Lab'y. No. 27932.—Forwarded by the Secretary of the Hibernia Agricultural Society, Hibernia, Queens county, N.B., and stated to be the product of the Provincial Chemical Co., St. John, N.B. It is of excellent quality, containing 96·75 per cent of carbonate of lime.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	100·0
" 20 " "	80·3
" 60 " "	37·8
" 80 " "	30·0

The degree of fineness is fairly satisfactory, though finer grinding might be desired in cases calling for an immediate and prompt effect.

Lab'y. No. 28946.—From quarries at Merrivale, Ont. This is the siftings or "fine stuff" resulting from the making of road stone. Though not of the highest quality, its percentage of carbonate of lime is fairly satisfactory for pulverizing.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	74·0
" 20 " "	38·5
" 60 " "	10·5
" 80 " "	6·5

This is too coarse if an immediate effect is desired. To be profitably used its price must be sufficiently low to allow of heavy applications.

Lab'y. Nos. 29273-4.—From Kirks Hill, N.S. Neither are of the highest quality as to composition, but No. 29273 is the superior, both as regards carbonate of lime content and degree of fineness.

MECHANICAL ANALYSIS

	Per cent No. 29273	Per cent No. 29274
Passes 10 mesh sieve	92·3	72·0
" 20 " "	65·0	47·8
" 60 " "	36·5	24·3
" 80 " "	30·3	19·1

No. 29274 is altogether too coarse for prompt action.

Lab'y. No. 29275a.—From Parrsboro, N.S. A limestone of the highest quality; it ranks with the best in the series.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	91·0
" 20 " "	66·9
" 60 " "	32·9
" 80 " "	24·2

Too coarsely crushed if a quick response is essential, otherwise it would be found fairly satisfactory.

Lab'y. No. 29668.—Limestone of excellent quality, of the highest grade.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	94·6
" 20 " "	61·6
" 60 " "	37·2
" 80 " "	32·0

Though not sufficiently finely ground to be fully and very quickly effective, it wil prove quite satisfactory, from the standpoint of fineness and availability, in ordinary farm practice.

Lab'y. No. 30402.—Limestone of excellent quality and no less excellent degree of fineness.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	100·0
" 20 " "	87·0
" 60 " "	65·0
" 80 " "	59·0

Lab'y. No. 30933.—A good quality of limestone, sufficiently finely ground for ordinary or general use, but rather coarse for prompt action.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	100·0
" 20 " "	84·6
" 60 " "	47·4
" 80 " "	35·9

Lab'y. No. 32087.—Limestone of excellent quality and extremely finely ground. It would be quickly effective but possibly from its extreme fineness would offer some difficulty in its distribution or application, especially if there were any breeze.

MECHANICAL ANALYSIS

	Per cent
Passes 20 mesh sieve	100
" 60 " "	99
" 80 " "	96

Lab'y. No. 33435.—Limestone of excellent quality, of a very fairly satisfactory degree of fineness.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	97.2
" 20 " "	80.5
" 60 " "	43.0
" 80 " "	33.3

Lab'y. No. 33436.—Limestone of the highest grade, very well ground.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	99.0
" 20 " "	87.0
" 60 " "	51.0
" 80 " "	38.0

Lab'y. No. 41373.—Limestone of good quality and well ground.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	99.2
" 20 " "	85.9
" 60 " "	52.6
" 80 " "	44.3

Lab'y. No. 44293.—In point of composition this is an excellent agricultural limestone but rather coarsely ground for complete immediate effectiveness; considering immediate results and residual value it is quite satisfactory:

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	96.2
" 20 " "	72.8
" 60 " "	31.0
" 80 " "	20.6

Lab'y. No. 46995.—This is an excellent sample of ground limestone, both as to quality—percentage of carbonate of lime—and degree of fineness:

MECHANICAL ANALYSIS

	Per cent
Passes 20 mesh sieve	100.0
" 60 " "	81.8
" 80 " "	75.9

Lab'y. No. 47000.—This is a limestone of excellent quality. As to degree of fineness it must be considered fairly satisfactory, looking to immediate results and residual value.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	100.0
" 20 " "	78.1
" 60 " "	37.7
" 80 " "	29.2

Lab'y. No. 47093.—A ground limestone of excellent quality and quite satisfactory as to degree of fineness.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	100.0
" 20 " "	97.5
" 60 " "	76.5
" 80 " "	53.0

Lab'y. No. 47094.—From the Deschambault Quarries, Quebec. Limestone of the highest grade; one of the purest of the series now reported on.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	100.0
" 20 " "	100.0
" 60 " "	61.5
" 80 " "	44.0
" 100 " "	19.5

Fairly satisfactory as to degree of fineness.

Lab'y. No. 47589.—From the Deschambault Quarries, Que. An exceedingly pure limestone and ranking with those of the highest grade.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	100.0
" 60 " "	89.5
" 80 " "	78.3

This material is very satisfactory as to degree of fineness.

Lab'y. No. 48248.—An excellent limestone as to carbonate of lime content and very fairly satisfactory as to degree of fineness.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	99.16
" 20 " "	78.0
" 60 " "	41.3
" 80 " "	31.7

Lab'y. No. 51541.—High grade limestone quite finely ground. A very satisfactory sample.

MECHANICAL ANALYSIS

	Per cent
Passes 20 mesh sieve	99.9
" 60 " "	62.0
" 80 " "	43.9

Lab'y. No. 55595.—Contains a larger percentage of carbonate of magnesia than is present in the best grades of limestone but would be found suitable for agricultural use. It is quite satisfactory as to degree of fineness.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	94.4
" 20 " "	81.6
" 60 " "	62.8
" 80 " "	60.0

Lab'y. No. 55845.—This is a low grade limestone, containing only 56 per cent of carbonate of lime. It is only coarsely crushed.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	67.8
" 20 " "	49.9
" 60 " "	31.3
" 80 " "	27.2

Lab'y. No. 56040.—Source unknown but forwarded from Murray Harbour, P.E.I. Though not of the highest grade it is of good quality.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	66.5
" 20 " "	44.5
" 60 " "	26.7
" 80 " "	23.8

Too coarsely ground if an immediate response is essential; it is doubtful if any ground limestone will be found satisfactory which does not meet the following minimum requirements: from 65 to 85 per cent passing an 80-mesh sieve and all passing a 10-mesh sieve.

Lab'y. No. 56231.—This is a magnesian limestone containing only 48 per cent of carbonate of lime. It is not of a quality or grade to be recommended; it is only coarsely crushed.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	79.0
" 20 " "	57.1
" 60 " "	32.6
" 80 " "	26.6

Lab'y. No. 56654.—Limestone of the highest grade and very finely ground.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	100.0
" 20 " "	99.6
" 60 " "	89.6
" 80 " "	79.0

Lab'y. No. 56655.—A limestone of the best quality; rather too coarsely ground to be quickly effective.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	92.2
" 20 " "	71.7
" 60 " "	40.5
" 80 " "	32.7

Lab'y. No. 56768.—A limestone that, as regards composition, is of the highest grade. It contains, however, a much larger proportion of coarse and very coarse material than the brands of ground limestone sold for agricultural use. With fairly heavy applications, however, we think there would be a sufficiency of fine material for marked reduction of soil acidity. To be used economically the price per ton should not be more than one-half that of a brand containing, say, 50 per cent or over of fine material, i.e. passing through 60-mesh sieve.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	53.8
" 20 " "	38.7
" 60 " "	23.0
" 80 " "	19.4

Lab'y. No. 57069.—An excellent sample of ground limestone, both as to carbonate of lime content and degree of fineness.

MECHANICAL ANALYSIS

	Per cent
Passes 10 mesh sieve	100.0
" 20 " "	99.3
" 60 " "	77.6
" 80 " "	66.5

Lab'y. No. 58183.—This is a limestone of poor quality, very coarsely ground. It could not be used advantageously unless procurable at a very low price. say, not more than one-third of that of ordinary brands of good quality as indicated in this series.

It is satisfactory to note that of the twenty-one samples of ground limestone in this series, three only are inferior quality and that in respect to degree of fineness the larger number of the brands are eminently satisfactory.

ANALYSES OF CRUSHED OR GROUND LIMESTONES, 1921-2

Lab. No.	Manufacturer or Source	Mineral Matter Insoluble in Acid	Oxide of Iron and Aluminia (Fe_2O_3+ Al_2O_3)	Carbonate of Lime ($CaCO_3$)	Carbonate of Magnesia, etc. (by difference)
		p.c.	p.c.	p.c.	p.c.
26429	St. Marc des Carrieres, Que.	0·82	0·50	97·75	0·93
26845	Marbleton, Wolfe Co., Que.	4·86	0·54	93·19	1·41
27932	St. John, N.B.	1·06	0·20	96·75	1·99
28946	Merrivale, Ont.	12·34	1·68	81·34	4·64
29273	Windsor, N.S.	14·77	1·80	79·59	3·84
29274	"	16·21	2·10	76·85	4·84
29275	Parrsboro, N.S.	4·30	1·10	92·32	2·28
29668	Missisquoi Marlbes Ltd., Phillipsburg, Que.	3·00	0·20	96·25	0·55
30402	Montreal Crushed Stone, Ltd., St. Vincent de Paul, Que.	4·64	0·36	94·12	0·88
30933	Stinson-Reeb Builders' Supply, Ltd., Montreal	5·10	1·20	87·38	6·32
32087	Deschambault-Quarry Corporation, Quebec	0·64	0·62	98·50	0·24
33435	Gaudy & Ellison, St. John, N.B.	3·66	0·56	90·17	5·61
33436	Clairmont Brand, C. H. Peters & Sons, St. John	4·24	0·70	95·50	
41373	Canada Cement Co., Ltd., Montreal	11·46	1·32	86·40	0·82
44293	Penitentiary Quarry, Kingston, Ont.	5·70	2·27	89·02	3·01
46995	Dominion Lime Co., Sherbrooke, Que.	3·42	0·36	94·79	1·41
47000	Deschambault Quarry Corporation, Quebec	0·76	0·84	98·01	0·39
47093	F. Carnac-Marquis, Quebec, Que.	1·14	1·10	97·32	0·44
47094	Deschambault Quarry Corporation, Quebec	0·88	1·00	98·21	
47589	" " "	0·64	0·72	98·18	0·46
48248	" " "	0·92	0·78	97·21	1·09
51541	Shediac, N.B.	6·78	1·38	88·00	3·84
55595	Tyndall Quarries on C.P.R. east of Winnipeg	2·66	0·34	80·35	16·97
55845	Montreal Crushed Stone, Ltd., St. Vincent de Paul, Que.	28·94	4·02	56·80	9·12
56040	Murray Harbour, P.E.I.	13·18	2·05	84·07	0·70
56231	Kemptville, Ont.	18·48	1·76	48·25	29·16
56654	Deschambault Quarry Corporation, Quebec	1·14	1·00	98·50	
56655	" " "	1·52	1·44	97·50	
56768	Wright & Co., Hull, Que.	7·20	1·00	90·50	1·30
57069	Source unknown, sent from Hampshire, P.E.I.	6·22	2·47	89·16	2·15
58183	Montreal Crushed Stone, Ltd., St. Vincent de Paul, Que.	29·88	1·50	65·75	2·87

MARL

Marl, or shell marl, is a naturally-occurring carbonate of lime deposit, being found in nearly all the provinces of the Dominion. It usually occurs in beds of a few inches to several feet in thickness on old lake bottoms, frequently overlaid by swamp muck or peaty deposit.

Though essentially carbonate of lime, it is of variable quality, some samples containing notable percentages of clay, sand, vegetable matter, etc. An analysis is therefore necessary to determine the value of any particular sample, though it may be identified and distinguished from other earthy deposits by giving a copious effervescence on the addition of a little strong vinegar or other acid.

When freshly dug it is usually a greyish, pasty mass; on drying it becomes lighter in colour, forming lumps which may be easily crushed. Its generally soft and friable nature when air-dried renders it readily prepared and easily and uniformly applied to the land.

Lab'y. No. 28398-28401.—From Lake Mayo, Yukon Territory. These four samples were submitted by the Directing Geologist of the Geological Survey, Ottawa, to whom they had been sent by Dr. D. D. Cairns, who writes respecting them as follows: While waiting at Mayo last September for a steamer, I was told of a lake in the vicinity, around which there is a peculiar deposit that is reported to have the property of wonderfully stimulating plant growth. I accordingly visited the locality, taking four samples of marl and soil from the vicinity of this lake, and it seems quite possible that an examination and analysis of these samples may prove of considerable importance. The lake around which the samples were taken lies along the wagon road running from Mayo to Minto bridge and commences 2 or 2½ miles from Mayo, so that it is quite accessible.

"The lake in question lies in a broad valley several miles wide. The surface of this valley represents an old glacial floor and is irregularly strewn with morainal and other glacial and glaci-fluvial deposits. The level of the lake is being gradually lowered, as the drainage of the area becomes integrated, and there is now exposed all around the lake and over the islands within it, a greyish deposit of shell marl—the area covered by the water and marl rim being apparently between one and two miles. The marl deposit is very soft, so that I was able, without trouble, to push a stick about 10 feet down into it, showing the deposit to be at least of that thickness. Undoubtedly the entire lake is underlaid by a considerable thickness of this marl which may also persist further from the water's edge than appears. In fact it may extend over the benches back from the water's edge. If the deposit is of economic importance, it is quite extensive and readily accessible."

Sample A. (Lab'y. No. 28398)—Surface sample of the marl.
" B. (" 28399)—Upper 3 feet of deposit.
" C. (" 28400)—Reddish, sticky soil taken a few feet from the water's edge and grey marl rim.
" D. (" 28401)—Lighter, reddish soil higher up and less closely associated with the marl.

A. (Lab'y No. 28398). This in the air-dried condition consists of small masses and coarse powder of a greyish colour and of an earthy or calcareous appearance, with a considerable number of small shells.

B. (Lab'y. No. 28399). A little darker in colour and somewhat finer than A, but otherwise quite similar: an earthy marl with many small shells.

C. (Lab'y. No. 28400). Air-dried, this is of a light reddish, earthy appearance, in rather soft masses, and apparently with no shells.

D. (Lab'y. No. 28401). Air-dried, this is a reddish earthy powder with some root fibres. No shells present.

ANALYSIS OF AIR-DRIED SAMPLES

—	A	B	C	D
	p.c.	p.c.	p.c.	p.c.
Moisture	16·00	9·04	5·66	4·75
Organic and volatile matter	23·51	24·03	1·66	1·34
Mineral matter insoluble in acid	6·55	6·75	24·91	36·60
Carbonate of lime	49·90	54·39	53·14	45·91
Undetermined	4·04	5·79	14·63	11·40
	100·00	100·00	100·00	100·00
Nitrogen, in organic matter	0·84	0·75	0·16	0·20

Phosphoric acid was detected, in traces only, in all samples.

All four samples are marl of fair quality, the carbonate of lime content approximating 50 per cent.

Samples A and B in addition to their carbonate of lime contain notable amounts of organic matter and nitrogen.

The agricultural value of this deposit as already indicated is measured chiefly by its carbonate of lime content; it should prove a useful amendment for all soils likely to be benefited by lime. Its use upon such soils would undoubtedly stimulate crop growth.

It is also worthy of remark that the deposit proper (A and B) is rich in nitrogenous organic matter—a fact which would undoubtedly enhance its value for thin light sandy loams as well as for heavy clays deficient in humus.

In the following table we present the analytical data from the examination of a number of marls sent in for a report as to quality.

Lab'y. No. 28686.—From Stouffville, Ont., occurring under a deposit of black muck two feet in thickness. The extent and depth of the deposit is not known. While not of the highest grade, it is of excellent quality and quite suitable for agricultural purposes.

Lab'y. No. 29471-2.—From a lake near Querry, Que. No. 29471 is a true marl, showing many shells of a grey colour. It is of excellent quality and could be advantageously used on sour soils, muck soils and others naturally poor in available lime.

No. 29472, of a brown colour, contains only traces of carbonate of lime and, in consequence, is not marl. It possesses no agricultural value.

Lab'y. No. 29477.—From Strathlorne, Cape Breton, N.S. Taken from the outcrop of a deposit at the foot of a hill.

The sample consisted of pale yellow, fine grained and rather soft rock-like masses, readily crushed. The structure is very uniform and has the appearance of being deposited from water.

This calcareous deposit scarcely answers to the description of marl, as the term is generally understood, but as regards composition it may be regarded as marl of good quality. It is comparatively soft and therefore its crushing or grinding should not prove expensive. The product should be a valuable amendment for sour soils and indeed all soils deficient in available lime.

Lab'y. No. 29536.—From St. Mary's, Ont. Taken from an outcrop along the banks of a creek.

This is a "clayey" marl, containing about one-third of its weight of carbonate of lime.

If easily obtained and the haul short, this deposit might be advantageously used on soils in need of lime, but its low quality would preclude the possibility of profitably transporting it any considerable distance.

Lab'y. No. 29624.—From Daniels Centre, Que. Taken from the bed of a river at this place; the sample has all the characteristics of clay.

This is not a marl, as supposed, for it contains little more than traces of carbonate of lime. By reason of its organic matter and nitrogen content, this material (which for practical purposes may be considered a river mud) might prove a useful amendment for very light soils. We should counsel trying it out on a small area—preferably on a sandy or gravelly loam and noting results—before going to any great expense in procuring it.

Lab'y. No. 29627.—From Sayabec, Que. Collected from the bed of a small lake. This is an excellent sample of marl and well adapted to agricultural purposes.

Lab'y. No. 29750.—From a deposit on the Humber river, near Toronto. A marl of excellent quality, rich in carbonate of lime and well adapted for use in agriculture.

Lab'y. No. 30339.—From the bank of a creek near Stanstead, Que. This deposit has no special value; its percentage of carbonate of lime is too small to allow the material to be used economically—unless quite locally—as a source of agricultural lime, i.e., for treatment of land in need of lime.

Lab'y. No. 30496.—From near Peterborough, Ont. This marl is of fair quality. For local use and for certain soils its value is perhaps somewhat enhanced by its notable percentage of organic matter, viz., 18·43 per cent.

Lab'y. No. 30569.—From Salmon Arm, B.C., occurring in the banks of a creek in N.E. ¼ S. 33, T. 19, R. 9, W. of the 6th mer. This is a marl of excellent quality, rich in carbonate of lime, and when air dried readily crushing to a coarse powder. It would make a very suitable amendment for soils in need of lime.

The sample as received contained 18 per cent of water; dried out by exposure to a moisture content of, say, 10 per cent, the percentage of carbonate of lime in this marl would be approximately 85.

Lab'y. No. 30885.—From Mount Forest, Ont. A shell marl of very fair quality and one well adapted for agricultural use.

Lab'y. No. 31801, 31806.—From South Maitland, N.S. Are rather of the nature of disintegrated or weathered limestone than true marl. No. 31806 is much the better of the two, with 81 per cent carbonate of lime and if finely crushed could be advantageously used for soils in need of lime. No. 31801 contains too high a percentage of inert (insoluble) rock matter to make it of much value.

Lab'y. No. 31891.—From Riverside Corners, N.S. Disintegrated or weathered limestone rock. This material would prove a valuable amendment for soils deficient in lime; it is satisfactory from the standpoint of composition and readily breaks down to a coarse powder.

Lab'y. No. 32385.—From Campbellton, N.B. One of the purest marls in the series and one eminently suitable for agricultural purposes.

Lab'y. No. 35985.—From Perth, Ont. Shell marl of very good quality and well adapted for agricultural use.

Lab'y. No. 40747-8.—From Okanagan Mission, B.C. No. 40747 consists of hard and brittle masses with a honeycomb structure and greyish yellow colour. It would appear to be the result of deposition from spring or creek water heavily charged with carbonate of lime. No. 40748 is comparatively soft, in soft lumps and powder; it has evidently resulted from the disintegration by weathering of the honey comb carbonate just referred to. Both samples are rich in carbonate of lime. Though No. 40748 is the poorer it may be found more economic to use it, by reason of the fact that it would require less labour to reduce it to a condition suitable for distribution on the land.

Lab'y. No. 40919.—From South Crosby, Leeds County, Ont. Shell marl of good quality, well adapted to agricultural use.

Lab'y. No. 41175.—From Ashcroft, B.C. This may be described as "indurated marl", formed no doubt by deposition from water highly charged with carbonate of lime. It is almost pure carbonate of lime and crushed would undoubtedly prove eminently valuable for soils in need of lime.

Lab'y. No. 41792.—From Okanagan Mission, B.C. Similar in character to Nos. 40747-48, and practically identical with the latter sample of good quality.

Lab'y. No. 41932.—From Boswell, B.C. Essentially carbonate of lime and a marl of good quality.

Lab'y. No. 46230.—From Okanagan Mission, B.C. This is a sample of "indurated" marl of honey comb structure; evidently a deposit from water surcharged with carbonate of lime. Of very high grade and, crushed, would form an admirable dressing for soils in need of lime.

Lab'y. No. 46288.—From Kalso, B.C. This sample of "calcareous deposit" or "indurated" marl as received was in dry, hard lumps or masses with a porous or honey combed structure. Of excellent quality, with very small percentage of foreign matter. Very suitable for crushing for agricultural purposes.

Lab'y. No. 51799.—From Campbellton, B.C. Shell marl of excellent quality, easily crushed when air-dried and very suitable for agricultural use.

Lab'y. No. 53941.—From Simcoe, Ont. Shell marl of excellent quality; soft, and readily crushed to a coarse powder when air-dried—well adapted to agricultural use.

Lab'y. No. 54738.—From Lumby, B.C. A sample of indurated marl, a specie of marl found as a deposit in many of the valleys in the dry belt of British Columbia and resulting from the deposition of carbonate of lime from water surcharged with that mineral. Of good quality and crushed would from an excellent amendment for soils in need of lime.

Lab'y. No. 55857.—From Tatla Lake, B.C. Sample collected from bed or deposit occurring near lake and consisting of earthy white lumps and powder. Analysis shows that it consists essentially of carbonate of magnesium with only a small percentage of carbonate of lime. This material could not be recommended for soil treatment, as magnesian compounds in excess are harmful to vegetation and depress the productiveness of soils.

Lab'y. No. 55955.—From St. Antoine, Que. A marl of high quality, well adapted for agricultural use.

Lab'y. No. 56162.—From St. Joseph's Island, Ont. A shell marl of good quality.

Lab'y. No. 56180.—From Lumby, B.C. Marl of high quality and quite suitable as source of lime for soil treatment.

Lab'y. No. 56260.—From Centreville, Carleton County, N.B. Shell marl from very large deposit of light grey colour and excellent appearance. Analysis shows it to be of the highest grade. Eminently suitable for agricultural purposes.

Lab'y. No. 56607-09.—From Marlbank, Ont. These two samples are practically identical and to be considered as marl of good quality.

Lab'y. Nos. 56739-40-41.—From Cranbrook, B.C., Nos. 56739 and 56740 are from a marly deposit, associated with fragments of hard, inert rock. Considered as marl they are of poor quality, containing from 40 to 44 per cent only of carbonate of lime. No. 56741 is a hard rock-like material with a honey comb structure. It is known as indurated marl and results by deposition from waters rich in carbonate of lime. As regards composition it is a marl of excellent quality and if finely crushed would prove a useful source of lime for soils deficient in that element.

Lab'y. No. 57116.—From Solsqua, near Sicamous Junction, B.C. An excellent sample of marl, practically free from foreign matter; would prove a valuable amendment for soils deficient in lime.

Lab'y. No. 57117.—From Fernie, B.C. A marl of the highest grade with nearly 92 per cent of carbonate of lime. Ranks with the best samples of the series.

Lab'y. No. 57247.—From Balmoral, Restigouche, N.B. Taken from the bed of a pond or lake about five miles from the Bay of Chaleur. A light yellowish grey deposit of marly appearance, showing presence of many small shells. A marl of very high quality; an amendment of very considerable value for soils needing liming.

Lab'y. No. 57336.—From Mackay's Lake, near Ottawa, Ont. A marl of excellent quality, comparing very favourably with the best grades of marl as analysed in these laboratories.

We feel the importance of the matter warrants us in again calling attention to the value of marl as a cheap and excellent amendment for soils in need of lime. As yet, farmers in Canada have not fully realized its worth. In many districts it is procurable at a minimum of expenditure—possibly at the cost of digging and hauling —making it by far the cheapest form of lime for agricultural purposes.

On light and sandy soils the application may be from 2 to 5 tons per acre; on heavy clay loams and mucks from 10 to 30 tons but no reasonable excess of these amounts is likely to prove harmful. The application may be made in spring or fall, scattering on the ploughed land and harrowing in. Broadcasted on pastures and meadows its influence is to encourage more particularly the growth of clovers.

ANALYSES OF MARLS (AIR-DRIED)—1921-22

Lab. No.	Locality of Occurrence	Mineral Matter insoluble in Acid	Oxide of Iron and Alumina (Fe_2O_3+ Al_2O_3)	Carbonate of Lime ($CaCO_3$)	Moisture Organic Matter, etc. (Undetermined)
		p.c.	p.c.	p.c.	p.c.
28686	Stouffville, Ont.	14·97	1·18	80·46	3·39
29471	From Lake near Querry, Que.	1·96	0·60	90·32	7·12
29472	" "	80·26	10·92	trace	8·82
29477	Strathlorne, N.S.	14·90	2·40	80·34	2·36
29536	St. Marys, Ont.	44·88	4·34	36·50	14·69
29624	Port Daniel Centre, Que.	73·50	8·31	traces	
29627	Sayabec, Que.	1·96	0·20	90·50	7·34
29750	Humber River, near Toronto, Ont.	0·78	0·75	91·75	6·72
30339	Stanstead, Que.	72·23	12·08	5·54	10·15
30496	Peterboro, Ont.	7·10	1·74	66·50	24·66
30569	Salmon Arm, B.C.	0·50	0·10	76·25	23·15
30885	Mount Forest, Ont.	2·40	0·46	72·00	25·14
31801	South Maitland, N.S.	36·94	4·50	54·00	4·56
31806	" "	12·38	2·90	81·63	3·09
31891	Riverside Corners, N.S.	13·20	2·78	79·50	4·52
32385	Campbellton, N.B.	0·44	0·12	94·00	5·44
35985	Perth, Ont.	1·90	.....	84·30	13·80
40747	Okanagan Mission, B.C.	0·34	0·28	94·41	4·97
40748	" "	4·24	0·44	83·32	12·00
40919	South Crosby, Leeds Co., Ont.	3·00	1·00	88·61	7·39
41175	Ashcroft, B.C.	0·26	0·26	99·12	0·36
41792	Okanagan Mission, B.C.	0·90	0·28	86·43	12·39
41932	Boswell, B.C.	3·22	1·60	88·74	6·44
46230	Okanagan Mission, B.C.	0·30	0·10	94·05	5·55
46288	Kaslo, B.C.	3·08	0·90	93·68	2·34
51799	Campbellton, N.B.	0·58	0·15	90·80	8·47
53941	Simcoe, Ont.	2·04	0·58	96·50	0·88
54738	Lumby, B.C.	2·90	0·58	88·50	8·02
55857	Tatla Lake, B.C.	3·60	0·45	2·97	92·98
55955	St. Antoine, Que.	0·46	0·94	85·56	11·82
56162	St. Joseph's Island, Ont.	1·15	0·44	81·75	13·94
56180	Lumby, B.C.	12·34	.....	82·37	5·29
56260	Centreville, N.S.	0·90	0·50	90·75	6·63
56607	Marlbank, Ont.	1·07	0·35	86·63	11·95
56609	"	1·04	0·36	86·25	12·35
56739	Cranbrook, B.C.	46·38	3·80	44·00	5·82
56740	"	40·40	4·80	40·37	15·11
56741	"	0·84	0·41	96·75	2·00
57116	Solsqua, B.C.	2·63	2·14	91·75	3·48
57117	Fernie, B.C.	0·87	0·32	91·62	7·19
57247	Balmoral, Restigouche Co., N.B.	0·89	0·65	93·00	5·46
57336	Mackay's Lake, Ottawa, Ont.	3·30	1·96	91·00	3·74

MUCKS, MUDS AND SIMILAR DEPOSITS

Among naturally-occurring materials of value for the improvement of soils, may be numbered swamp or black muck, river, pond and marsh muds and similar deposits from both fresh and salt water. Many of these possess a distinct manurial value and applied liberally can frequently be used to advantage in the upkeep of fertility. They are not however to be regarded as in the same class as "fertilizers"—materials furnishing notable and well marked percentages of available nitrogen, phosphoric acid and potash, but rather as amendments, furnishing chiefly semi-decomposed vegetable (organic) matter or carbonate of lime, as the case may be, with small percentages of nitrogen and mineral plant food matter for the physical and chemical improvement of the soil. As a supplier of humus-forming material and nitrogen (largely inert) swamp muck finds its chief functions and value, while the several classes of "muds" are perhaps more particularly useful for their mineral content and their influence on the texture or tilth of the soil to which they may be applied.

Past reports of this division contain many analyses of these "amendments," sent in by farmers and agricultural representatives from many widely distant points in the Dominion. Reference to these accounts will show the varied character of these materials and the great differences which exist between them in agricultural value. For this reason it is practically impossible to arrange them in a satisfactory classification. Undoubtedly many of these deposits, judiciously used, have gone a long way, especially in Eastern Canada and more particularly the Maritime Provinces, towards the economic upkeep of soil fertility, while on the other hand our laboratory examination has shown in many instances that their digging and application has been largely a waste of time and labour. Specific consideration of each deposit seems therefore necessary if reliable information and advice is to be given.

In the following paragraphs the analysis with report as to agricultural value is furnished of a number of these materials submitted since the publication of the detailed Annual Report of the Division in 1916; these accounts will be found interesting reading by all farmers possessing deposits of one or other of these amendments on their farms or in their neighbourhood.

Lab'y. No. 28480.—"Salt mud" from the harbour of Chester, N.S. It was reported as having been used with excellent results at the rate of 25 to 35 tons per acre for turnips, beans, cabbage, barley and hay by farmers in the vicinity. The use however had been limited or restricted, being taken advantage of by a few only, who dug the mud at low tide and hauled it to their farms. It was thought that if the analysis showed that it possessed a notable fertilizing value the farmers might be induced to club together in purchasing a mud-digging outfit at a cost of about $300 and thus extend the employment of this material.

As received, this mud was a black, pasty, semi-fluid mass with some free fluid separating on standing. Evidently rich in organic matter that is well decomposed, with some eel grass and small shells. The sample had a strong smell of rotting seaweed.

Air-dried by simple exposure to the air it forms a fairly hard mass, but not extremely refractory, with a rather heavy coating or efflorescence of common salt.

The analysis of the air-dried mud afforded the following results:—

	Per cent
Moisture	1·81
Organic matter*	11·07
Clay and sand	74·30
Carbonate of lime	3·96
Common salt	3·19
Oxide of iron and alumina	5·10
Phosphoric acid	traces
*Containing nitrogen	0·41

This mud is fairly rich in organic matter and nitrogen and its chief fertilizing value is undoubtedly due to this fact. The nitrogen is most probably present in

forms that would more or less readily become converted in the soil into assimilable nitrogenous food for crops under favourable conditions of moisture and warmth. It also contains nearly 4 per cent of carbonate of lime and this would enhance the value of the mud for many types of soils.

Our opinion is that this mud would possess a very considerable manurial value, more especially on sandy and gravelly soils and prove more particularly of benefit for vegetable and leafy crops generally.

Possibly for certain crops the salt present might be found more or less detrimental if heavy applications of the mud are made. But if the land has fair drainage the result from this cause would not be appreciable after the first year. For some crops, as for instance, mangels, beets and barley, the salt present might be specially serviceable—the salt acting as a liberator of soil potash and in part acting as a substitute for it in plant nutrition.

Lab'y. No. 29600.—A river mud and taken from the Little Pierre Jacques river, P.E.I. This had been used locally, but information of a definite character was desired as to its fertilizing value.

As received this mud was a dark coloured pasty mass containing some fragments of shells. On being air-dried it formed somewhat hard masses of a light grey colour, essentially sand with some clay and a few shells.

Analysis of the air-dried sample gave the following result:—

	Per cent
Moisture	1·08
Sand and clay	80·48
Oxide of iron and alumina	5·20
Organic matter*	5·15
Carbonate of lime	1·86
Phosphate of lime	0·73
*Containing nitrogen	0·20

The percentage of plant food constituents in this mud do not exceed those found in good soils and consequently, as a fertilizer, it must be considered as of low value.

Though undoubtedly an amendment of some value for certain classes of soils, we should not counsel going to any great expense in procuring this mud until from practical field trials it had been found beneficial.

Lab'y. No. 28986.—Marsh mud, from Black Cape, P.Q.

The examination of this sample which is largely of the nature of swamp muck was made principally with the view of ascertaining if the area involved could be advantageously cultivated. The partial analysis of the air-dried sample afforded the following data:—

	Per cent
Moisture	3·55
Clay and sand	73·66
Organic matter*	22·79
*Containing nitrogen	0·79

If drained and thoroughly cultivated this area should prove very productive especially if at the outset it were dressed with manure and lime.

As an amendment it possesses considerable fertilizing value by reason of its high organic and nitrogen content. It would be most advantageously used on soils poor in humus.

Lab'y. No. 25928.—Black mud, described as a bog deposit, from Rothesay, N.B. The deposit is of some acres in extent and about three feet in depth.

The sample forwarded for examination consisted of peaty matter with a considerable admixture of the underlying silt and clay.

The air-dried material on being submitted to analysis furnished the following data:—

	Per cent
Moisture	11·78
Organic matter (peaty)	49·02
Clay, sand, etc	39 02
	100 00
Nitrogen in organic matter	1·35

This material, it will be observed, contains about 50 per cent of organic (peaty) matter, holding nitrogen to the extent of about 1⅓ per cent. These two constituents practically comprise the manurial value of the material.

The nitrogen however is not present in an available form, but on composting with manure a fair proportion no doubt would be rendered assimilable. This is the treatment we would suggest, rather than applying the crude and untreated muck to the soil. It might also be used as an absorbent in the pig pen, cow house and about the farm buildings where there may be liquid manure going to waste. The resultant compost should have a comparatively high manurial value.

As an area, it could be brought in time into successful cultivation for several classes of crops, by drainage and the application of manure and thorough tillage. Wood ashes and basic slag are mineral fertilizers that might prove valuable in its enrichment.

Lab'y. No. 29480.—Lake mud. This sample, it was stated, was of a composite and representative nature, having been collected to a depth of 20 feet, from Moose Lake, township of Firstbrook, Lake Temiscaming district, at about 50 feet from shore.

It was stated to hold 16 per cent of potash, as calculated on the dry matter basis, and therefore a very valuable fertilizing material at the present time when potash salts are at such exhorbitant prices as to be beyond the reach of farmers. It was further said to contain valuable oils.

As received, the sample was a semi-fluid, practically homogenous, mass of peculiar gelatinous consistency, odourless, and of a dark brown colour. From its appearance it would be adjudged to be composed essentially of vegetable débris, the result of the partial decay and breaking down of fresh water algae, etc.

ANALYSIS

	As Received	Water-free Substance
Water	91·05	....
Organic matter	2·75	30·70
Mineral matter insoluble in acid	5·32	59·45
Oxide or iron and alumina	0·45	4·98
Lime	0·14	1 55
Potash	0·02	0·22
Phosphoric acid	0·04	0·50
Undetermined	0·23	2·67
	100·00	100·00
Nitrogen	0·14	1·61

This "mud" dries on exposure with great shrinkage to a light grey very hard cement-like mass.

A microscopical examination of the fresh mud by the Dominion Botanist revealed the presence of diatoms, desmids, remains of fresh water sponges and to some slight extent the fragmentary remains of higher plants, such as Juncus. An abundance of pollen grains of Pinus sp. was also observed. Low animal life was almost entirely absent. No oil globules could be detected.

The analysis shows that the percentages of plant food present are practically negligible. The material has no value as a manure or fertilizer and is apparently of no economic importance.

Lab'y. No. 29721.—Mussel mud, from Escuminac, Bonaventure County, Que. The sample, as received, consisted of dark grey, clay-like lumps with many large shells embedded.

ANALYSIS OF AIR-DRIED MUD

Moisture	2·88
Organic and volatile matter	6·10
Mineral matter insoluble in acid	54·24
" " soluble in acid	36·78
	100·00
Nitrogen	0·23
Phosphoric acid	0·29
Carbonate of lime	26·38

Though possibly this mud has a certain slight value for its nitrogen and phosphoric acid, it is essentially, as an amendment furnishing lime that it should be considered. In all probability it would be found to give the best response on light, sandy or gravelly loams deficient in lime. It would not be advisable to go to any great expense in obtaining this mud before trying it out on a small scale.

Lab'y. No. 30449.—Lake or bog mud, from Whitney Pier, Sydney, N.S. Our correspondent writes: "The area from which the sample was taken was a lake that has become filled up. There is at least a deposit of 20 feet in thickness and 25 acres in extent."

As received, this was a brown pasty mass, showing little vegetable fibre and distinctly acid. On air-drying it becomes extremely hard.

ANALYSIS OF AIR-DRIED MUD

Moisture	12·75
Organic and volatile matter	72·65
Mineral matter insoluble in acid	8·85
" " soluble in acid	5·75
	100·00
Nitrogen	1·10
Carbonate of lime	1·52

Used in its crude, raw condition this mud would yield slowly its nitrogen in available form for crop growth, though it should prove valuable as a dressing for both clays and sands poor in vegetable matter by improving their texture and increasing their moisture holding capacity. By composting, as with manure, its plant food—and more especially its nitrogen—would be rendered more readily available. Further, it could doubtless be used to advantage after air-drying—as a supplemental absorbent litter about the farm buildings. By this means valuable liquid manure might be saved and in the subsequent fermentation the peaty matter of the deposit would be broken down and its plant food elements set free in available form.

Lab'y. No. 30719.—Swamp muck, from Hampton, Kings county, N.B. As received, damp, dark brown, fibrous, very acid.

ANALYSIS OF AIR-DRIED MUCK

Moisture	18·50
Organic and volatile matter	75·70
Mineral matter insoluble in acid	·75
" " soluble in acid	5·05
	100·00
Nitrogen	1·76
Carbonate of lime	2·90

Of value as a source of humus-forming material and, after composting (as with manure), or after its use as a stable absorbent, for its nitrogen. The direct application of the crude raw muck would probably not give any return save as it might improve the tilth.

Lab'y. No. 30797.—Creek mud, from bed of stream running into Cowhead Bay P.E.I. As received, a hard clay-like mass containing some small shells.

ANALYSIS OF AIR-DRIED MUD

Moisture	6·95
Organic and volatile matter	11·75
Mineral matter insoluble in acid	63·70
" " soluble in acid	17·60
	100·00
Carbonate of lime	4·03
Nitrogen	·54

While not so rich either in vegetable matter or carbonate of lime as many deposits of a similar character examined in these laboratories, it has some value as an amendment. It would not be advisable, however, to go to any great expense in procuring it before proving its influence in a small way.

Lab'y. No. 30856.—Lake deposit, from Dawson, Y.T. This is described as a sediment from the bed of a small lake near Dawson. As received a dark grey, easily powdered mass containing a large number of small shells.

ANALYSIS OF AIR-DRIED DEPOSIT

Moisture	9·12
Organic and volatile matter	26·15
Mineral matter insoluble in acid	14·68
" " soluble in acid	50·05
	100·00
Carbonate of lime	33·75
Nitrogen	1·44

This mud or deposit is rich in organic (vegetable) matter and in carbonate of lime. It contains a notable percentage of nitrogen. It, no doubt, could be used advantageously on soils deficient in lime and on those which could be improved by the addition of organic matter.

Lab'y. No. 30884.—Pond mud, from North Hatley, Que. As received, dark grey, powdery, containing a small proportion of vegetable matter.

ANALYSIS OF AIR-DRIED MUDS

	No .1 surface	No. 2. At a depth of 18"
Moisture	4·90	6·50
Organic and volatile matter	11·55	11·93
Mineral matter insoluble in acid	72·50	70·17
" " soluble in acid	11·05	11·40
	100·00	100·00
Carbonate of lime	0·95	0·87
Nitrogen	0·36	0·36

The samples are essentially the same in point of composition. Though possessing no appreciable fertilizing value, the application of this deposit to soils poor in humus may be advised, provided that the cost of procuring and application is not too high.

Lab'y. No. 30892.—Swamp muck, from Guysboro, N.S. As received, this sample of muck was moist, strongly acid and of a dark brown colour. Its organic matter, of which evidently there was a fair percentage, was well broken down, with a small proportion only of root or woody fibre.

ANALYSIS OF AIR-DRIED MUCK

Moisture	6·04
Organic and volatile matter	57·17
Mineral matter insoluble in acid	33·17
" " soluble in acid	3·62
	100·00
Nitrogen	1·00

Though not a muck of the best quality, it would prove a useful amendment after composting. It could also be employed to advantage, after air-drying, as an absorbent in the gutter of the cowbarn and in the pigpen. The value of an application of the raw muck is doubtful, chiefly by reason of the high acidity of the deposit.

Lab'y. No. 30988.—Pond mud, from Matapedia, Que. Consists largely of sand and silt with a little clay and some woody fibre.

ANALYSIS OF AIR-DRIED MUD

Moisture	1·53
Organic and volatile matter	5·36
Mineral matter insoluble in acid	80·78
" " soluble in acid	12·33
	100·00
Nitrogen	·26
Carbonate of lime	traces

The fertilizing value of this deposit does not exceed that of the average productive soil; we doubt the advisability of going to any great expense in applying it before its usefulness has been established on an experimental area. It is difficult to predict with precision what response might result from its application; much would depend on the character of the soil to which it was applied, as its influence would be due to effect upon tilth rather than from the amount of plant food supplied.

Lab'y. No. 31182.—Lake deposit, from Kleena Kleene, Tatla Lake, B.C. As received, a wet jelly-like mass of brownish colour, of somewhat granular appearance. It dries on exposure to a hard, brownish grey mass, which strongly effervesces on the addition of acid.

ANALYSIS OF AIR-DRIED DEPOSIT

Moisture	4·40
Organic and volatile matter	36·40
Mineral matter insoluble in acid	8·92
" " soluble in acid	50·28
	100·00
Carbonate of lime	42·31
Sulphate of lime	2·62
Nitrogen	1·84

This deposit is essentially vegetable matter and carbonate of lime—a species of marl. It would have a distinct value for sour soils and those in need of lime and also prove useful as a source of humus and nitrogen for many classes of soils.

Lab'y. No. 31611.—Mussel mud, from Chatham, N.B. As received, it consisted essentially of very large shells and fragments of shells embedded in a matrix of clay, the shells being largely in the preponderance.

ANALYSIS OF AIR-DRIED MUD

Moisture	1·76
Organic and volatile matter	2·41
Mineral matter insoluble in acid	29·00
" " soluble in acid	66·83
	100·00
Carbonate of lime	60·03
Phosphoric acid	traces
Potash	traces
Nitrogen	·13

This mud would be chiefly useful for soils in need of lime; in organic matter and nitrogen it is decidedly poor. Its agricultural value, no doubt, is measured by its percentage of carbonate of lime.

Lab'y. Nos. 31827-28.—Peat, from Dalhousie, N.B. As received, these samples consist of spongy, fibrous, brown peat, showing no appreciable degree of disintegration and decidedly acid.

ANALYSIS OF AIR-DRIED PEAT

	No. 1	No. 2
Moisture	7·14	7·08
Organic and volatile matter	88·28	88·54
Ash	4·58	4·38
	100·00	100·00
Nitrogen	1·50	2·17
Absorptive capacity	3·35	3·36

No. 2 is the richer in nitrogen, but otherwise the samples, both chemically and physically, are identical.

This peat would have no fertilizing value as applied directly to this soil, but could be used to advantage as an absorbent litter for which it is well adapted. It is free from sand and clay and might find uses as a fuel and as a packing material.

Lab'y. No. 31998.—Deposit, from Keremeos, B.C. Received as a light grey earthy powder, with lumps.

ANALYSIS OF AIR-DRIED DEPOSIT

Organic and volatile matter	1·50
Mineral matter insoluble in acid	14·16
Oxide of iron and alumina	2·88
Carbonate of lime	16·14
Sulphate of lime (gypsum)	63·38
Carbonate of magnesia	2·04
	100·00

This is an impure gypsum, containing a notable percentage of carbonate of lime. It could be used to advantage on soils in need of lime. It is doubtful if it has any economic value for industrial or manufacturing purposes.

Lab'y. No. 33150.—Mussel mud, from Mitchell River, P.E.I. As received, a mixture of large mussel shells embedded in clay.

ANALYSIS OF AIR-DRIED MUD

Moisture	2·09
Organic and volatile matter	5·29
Mineral matter insoluble in acid	60·31
" " soluble in acid	32·31
	100·00
Carbonate of lime	19·62
Phosphoric acid	trace
Potash	0·64
Nitrogen	0·31

Its chief constituent is carbonate of lime, of which it contains approximately 20 per cent. It might therefore be expected to give its best returns on soils in need of lime. The percentages of nitrogen and potash are not such as to give the material any special value, nor is the organic matter content of any significance.

Lab'y. No. 33943.—River mud, from bed of Cardigan River, P.E.I. As received, a grey, powdery, earthy deposit, containing a large number of small shells.

ANALYSIS OF AIR-DRIED MUD

Moisture	0·49
Organic and volatile matter	6·02
Mineral matter insoluble in acid	84·34
" " soluble in acid	9·15
	100·00
Carbonate of lime	4·00
Phosphoric acid	traces
Potash	0·32
Nitrogen	0·19

This mud is essentially a fine grey sand with a small proportion of organic matter and broken shells.

The percentages of plant food present are very small, but it has some small value as an amendment for soils deficient in lime.

Lab'y. No. 38203.—Harbour mud, from Louisburg, C.B., N.S. As received, dark brown sandy deposit, showing an appreciable amount of root fibre, small shells, eel grass and fragments of charcoal and coal.

ANALYSIS OF AIR-DRIED MUD

Moisture	2·47
Organic and volatile matter	19·22
Mineral matter insoluble in acid	63·44
" " soluble in acid	14·17
	100·00
Carbonate of lime	2·00
Phosphoric acid	0·30
Nitrogen	0·42

The percentages of plant food are small and in consequence this deposit can only be regarded as an amendment useful for worn and poor soils, which it might improve by furnishing organic (humus-forming) matter and lime.

Lab'y. Nos. 42539-40.—Lake deposit, from Glassville, Carleton county, N.B. As received, No. 1, quite wet, black, apparently rich in well decayed organic (vegetable) matter, very little fibre, soft and putty-like but not sticky, very little clay, if any, present. Reaction: slightly alkaline. No. 2 very wet, brown, of jelly like consistency with granular appearance, labelled "vegetable ooze." Analysis indicates 92 per cent water present.

ANALYSIS OF AIR-DRIED DEPOSIT

	No. 1	No. 2
Water	5·30	5·47
Organic and volatile matter	40·90	56·19
Mineral matter (sand, clay, etc.)	53·80	38·34
	100·00	100·00

The inquiry accompanying these samples was with respect to their value as a fertilizer if dried and ground. As the plant food content is extremely small, the dried, ground material would only be serviceable as a "filler" and "conditioner," and we very much doubt if its use in this way would be found profitable.

Lab'y. Nos. 45250-51.—River mud, from Tabusintac river, Northumberland county, N.B. These are described by the Agricultural Representative who sent them as samples of two grades of mud from an extensive deposit which the farmers are anxious to use if the mud proves to be of any agricultural value. No. 1. Air-dried: dark grey compact masses, with considerable vegetable matter throughout. No. 2. Air-dried: light, porous material, largely dark brown decayed vegetable matter, to some degree resembling moss.

ANALYSIS OF AIR-DRIED MUD

	No. 1	No. 2
Moisture	6·53	11·38
Organic and volatile matter	15·95	59·00
Mineral matter, insoluble in acid	51·56	17·28
" " soluble in acid	15·96	12·34
	100·00	100·00
Nitrogen	0·64	2·05

No. 2 is much the more valuable of the two, by reason of its higher percentage of nitrogen. It should prove a useful amendment, after composting, for soils deficient in humus and nitrogen, both clays and sands. Neither sample contains any appreciable amount of lime.

Lab'y No. 49507.—Mussel mud, from the Buctouche river, Kent county, N.B. The Secretary of Agriculture for New Brunswick writes that "there is a large amount of this material available, if the analysis proves satisfactory." The major portion of this mud consists of mussel shells, varying as to size, more or less broken up and embedded or encrusted with clay. There is also present a certain amount of loose clay.

ANALYSIS OF AIR-DRIED MUD

Moisture	1·30
Organic and volatile matter	5·05
Mineral matter insoluble in acid	23·75
" " soluble in acid	69·90
	100·00
Carbonate of lime	66·58
Phosphoric acid	traces

Carbonate of lime is the chief, practically the only constituent of agricultural value. This mud would prove a useful amendment for soils deficient in lime, but would be of little value for furnishing other elements of plant food.

Lab'y. No. 54096.—Deposit from Port Howe, N.S. As received, a light grey powder, consisting largely of sand with small shell fragments.

ANALYSIS OF AIR-DRIED DEPOSIT

Moisture Organic and volatile matter	3·95
Mineral matter insoluble in acid	72·55
" " soluble in acid	23·55
	100·00
Carbonate of lime	19·38
Phosphoric acid	0·32

The only agricultural value this deposit would possess is its carbonate of lime content; this would make it a useful amendment for soils deficient in lime. The percentages of nitrogen and phosphoric acid are much too small to be of practical value. We do not think that it is sufficiently valuable to bear transportation charges to any distance.

Lab'y. No. 54700.—Pond mud, from Mira Road, Sydney, N.S. As received, greyish-brown mud, rich in organic matter, a little clay but considerable amount of fine sand.

ANALYSIS OF AIR-DRIED MUD

Moisture	2·58
Organic and volatile matter	33·72
Mineral matter insoluble in acid	57·80
" " soluble in acid	5·90
	100·00
Nitrogen	0·89
Carbonate of lime	traces
Phosphoric acid	"

This mud is rich in organic matter and nitrogen and as the material is well broken down and decomposed it should prove valuable as a top-dressing. Further, it no doubt could be used to advantage after composting with lime or wood ashes.

Lab'y. No. 55166.—Lake deposit, from near Ashcroft, B.C. As received, has the appearance of an impure marl. Effervesces strongly on the addition of acid.

ANALYSIS OF AIR-DRIED DEPOSIT

Moisture, Organic and volatile matter	25·80
Mineral matter insoluble in acid	21·00
" " soluble in acid	53·20
	100·00
Carbonate of lime	40·67
Sulphate of soda, " " magnesia	1·00

This material should prove of value for soils deficient in lime. The organic matter also present enhances its value for certain classes of soil. No harmful influence would be experienced from the comparatively small percentage of sodium and magnesium sulphate present.

Lab'y. No. 55294.—Swamp muck, from Clear Spring, P.E.I. As received a dark brown muck with a large proportion of root fibre, some woody fragments and a small proportion of clay and sand.

In the air-dried condition this material contains 60·20 per cent of organic matter. It unquestionably would improve the physical condition of soils deficient in organic matter, furnishing a notable amount of nitrogen on its further decay. It could be used to best advantage after composting.

Lab'y. No. 56221.—Deposit, from Wroxeter, Ont. This proved on examination to be clay with a very small proportion of fine sand. Though possibly suitable for brick or tile making, it has no fertilizing value.

Lab'y. No. 56577.—Black muck, Carleton, Bonaventure county, Quebec. This is a greyish brown muck, containing, in the air dried condition, approximately 85 per cent of organic matter. It is of excellent quality and could be used to advantage on soils deficient in humus. It could also, air-dried, be employed as an absorbent litter about the farm buildings; its subsequent composting would yield a valuable manure.

MISCELLANEOUS FERTILIZER MATERIALS

ASHES

The fertilizing value of wood ashes has been long and generally recognized, more particularly as a source of potash but also for the notable amounts of phosphoric acid and lime they contain. Naturally, the composition of wood ashes is variable; woods differ widely in their ash and potash content and subsequent exposure and leaching of the ash, admixture with sand, etc., may very materially lessen their value. In the subjoined table we present the composition of a number of samples submitted by farmers and in the notes which follow information is given as to their source or origin and their respective value for fertilizing purposes.

From 25 to 50 bushels of wood ashes per acre will furnish from 60 to 120 pounds of potash, the latter an ample dressing for even very light soils including both sandy and peaty loams. They are not needed on heavy clay loams. Their application is best deferred till spring, broadcasting, preferably on a quiet, damp day, on the ploughed land and incorporating with a thorough harrowing.

For clover, corn and mangels, they will be found very valuable, especially are they beneficial for orchards and for grapes on sandy loam: for turnips, mixed with one-third to one-half their weight of bone meal, they have similarly proved advantageous. But indeed there are few crops on light and gravelly soils, as also on vegetable loams inclined to be sour, for which wood ashes cannot be employed with profit. It is not however desirable to use them directly for the potato crop, as their alkaline character favours the development of "scab."

In addition to wood ashes proper a number of ashes from incinerators, mills, etc., have been sent in for analysis and report as to fertilizing value. These are included in the table and it will be found that several of these by-products contain notable amounts of plant food and in consequence have a distinct value for soil improvement.

Lab'y. No. 26263.—Incinerator ashes, from Fort William, Ont. Our correspondent explains: "This is not the ordinary garbage ashes from the incinerator but the residue or ashes from the incineration, in a separate chamber, of dead animals and offal. There may of course be a small percentage of ordinary ashes present, but it would seem that this product should have some fertilizing value and, if so, it could be used here to advantage."

This product possesses a very considerable fertilizing value, not only by reason of its notable amounts of phosphoric acid, potash and lime but for its nitrogen, of which it contains 1·66 per cent. It would undoubtedly prove valuable for farm and garden crops generally.

Lab'y. No. 29716.—Wood ashes, from Rivière Verte, N.B. These ashes are of good quality; they are free from excessive moisture, sand, etc., and their percentages of potash and phosphoric acid indicate that they have not suffered by leaching.

Lab'y. Nos. 30567, 31550 A and B.—Incinerator ashes, from Ottawa, Ont. These three samples are from the city incinerator; No. 30567 from the "Big Combustion Chamber" is distinctly poorer in plant food constituents than average incinerator ashes and their value as a fertilizer is consequently very small; No. 31550 A from "Back of Arch" and No. 31550 B "combustion chamber" do not differ markedly (though A is somewhat richer in phosphoric acid) and are to be regarded as of low fertilizing value.

Lab'y. No. 32992.—From furnace of saw-mill burning fir, pine and cedar, at Robson, B.C. As received the sample had the appearance of cinder, a coarse black gritty powder.

The percentage of potash is unusually high and if the sample is representative, these ashes possess an exceptional value as a potash fertilizer.

Lab'y. No. 33953.—Wood ashes, stated to be from saw-mills in province of Quebec and purchased for use in tanneries.

These ashes have been excessively leached and as a fertilizer are not to be valued at more than one-fourth the price of good, unleached ashes.

Lab'y. No. 35659.—From Richelieu, Que. These wood ashes are of good quality, free from inert foreign matter and unleached.

Lab'y. No. 35668.—Ashes from a tannery burning coal and spent tan bark (hemlock), at Millerton, N.B.

Of low fertilizing value compared with good quality wood ashes, but if cheaply obtained might be used to advantage on sandy, gravelly loams and muck soils; might be considered of chief value as an amendment for soils needing lime.

Lab'y. Nos. 35674-75.—From Cap Chat, Que. Two samples of birch ash—unleached and leached. No. 35674 is of excellent quality, with a potash content considerably higher than that usually found in wood ashes of commerce.

No. 35675. The analysis clearly shows that these ashes have been strongly leached and lost all but a very small proportion of their potash.

Lab'y. No. 35852.—From Peterborough, Ont., as offered for sale. Genuine unleached hardwood ashes as found on the market usually fall within the following limits: potash 5·50 to 6·5 per cent, phosphoric acid 1·5 to 2·0 per cent. The present sample is therefore of good commercial quality.

Lab'y. No. 36321.—This ash "is the fine droppings" from the flue of a large boiler which burns Nova Scotia bituminous coal.

These ashes possess but a very small, practically negligible, fertilizing value and they could only be recommended for heavy clay soils, which they might improve as to physical condition or tilth.

Lab'y. No. 36954.—Purchased in Montreal by a farmer in Rimouski, Que. The analysis indicates that these are leached ashes, with an exceedingly low fertilizing value. They are certainly not worth the cost of freightage from Montreal to Rimouski, even if they were obtained gratis.

Lab'y. No. 37799.—From St. Eugene, Que. These ashes have been seriously leached and are of very poor quality They contain nearly 20 per cent water. In reporting to our correspondent we advised against the purchase of these ashes.

Lab'y. No. 40319.—From Millerton, N.B. Spent tan bark (hemlock) ashes. These ashes contain very small percentages of potash and phosphoric acid and consequently have but little fertilizing value. If very cheaply obtained, however, they might find a use as an amendment for soils in need of liming.

Lab'y. No. 40320.—From New Denver, B.C. Saw-mill incinerator ashes, subjected to leaching by exposure. Though below the average of commercial wood ashes in potash, these ashes have a distinct fertilizing value. The percentage of phosphoric acid is high and is notable for this class of material. The lime content (33 per cent) enhances the value of the ashes as a mineral fertilizer.

Lab'y. No. 40432.—From Millerton, N.B. Ashes from mill refuse, chiefly spruce. Somewhat lower in potash than average grade of unleached ashes, but of fair quality.

Lab'y. No. 41158.—Wood ashes from incinerator of saw-mill burning cedar, at Eburne, B.C. The logs used had been in salt water.

Though possessing fertilizing qualities, it is of very low value compared with good grades of hardwood ashes. In addition to its small percentages of potash and phosphoric acid it contains about 30 per cent of carbonate of lime, making it more especially useful as an amendment for soil in need of liming.

Lab'y. No. 41255.—From Wotton, Que., but purchased in Montreal. Very seriously leached and of little value.

Lab'y. Nos. 41447-48.—From Wotton, Que. No. 41447, wood ashes from the house furnace; exceedingly high in potash, one of the best samples submitted to these laboratories. No. 41448, wood ashes purchased in Montreal; of very poor quality and evidently severely leached.

Lab'y. No. 43489.—Coal ashes from Tignish, P.E.I. The fertilizing value of these ashes is practically nil, but they might be of service for their mellowing influence on heavy clay soils.

Lab'y. No. 44152.—From Ottawa, Ont. Low grade wood ashes and of inferior value.

Lab'y. No. 46568.—Wood ashes from incinerator of saw-mill near Woodstock, N.B.

This sample was of the nature of a brittle clinker, with some fine powder. These ashes contain about one-third the potash found in average wood ashes of commerce. Their carbonate of lime content (35 per cent) would make them of value for sour soils and soils deficient in lime.

Lab'y. No. 46871.—Ashes from saw-mill burning, chiefly, tamarac and pine refuse at Waldo, S.E. Kootenay, B.C.

These ashes are of excellent quality, the percentage of potash and phosphoric acid being equal to those of high commercial grade.

Lab'y. No. 52220.—From Richelieu, Que. Ashes produced by the burning of whitewood (poplar). Of excellent quality, fully equal to the best grade of commercial wood ashes.

Lab'y. Nos. 53879-80.—From Langley Fort, B.C. Household wood ashes, chiefly from the burning of alder but a little maple, hazel, birch, etc. No. 53879 was from the open grate. No. 53880 was in the form of clinker from furnace.

Both these samples are of excellent quality, the percentage of potash being exceptionally high.

Lab'y. No. 55671.—From Kemptville, Ont. As received these wood ashes were quite moist, containing 27·75 per cent of water. The analysis shows that they are quite seriously leached, with about one-fourth the potash content of good quality, dry unleached ashes.

Lab'y. No. 55700.—From Smiths Falls, Ont. This sample of wood ashes, as received, was quite wet (18·61 per cent water), and evidently, by exposure or intentionally, partially leached, as it is distinctly low in potash. Their value would be approximately one-half that of good quality unleached ashes.

Ashes

Lab'y No.	——	Moisture	Loss on Ignition	Insoluble Residue	Oxide of Iron and Alumina (Fe_2O_3+ Al_2O_3)	Lime (CaO)	Magnesia (MgO)	Phosphoric Acid (P_2O_5)	Potash (K_2O)	Undetermined
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
26263	Incinerator ashes, Fort William, Ont.	1·08	18·51	38·31	14·45	10·83	2·10	7·34	2·87	
29716	Wood ashes	11·00	4·24	14·78	.....	32·48	.....	2·47	5·68	
30567	Incinerator ashes, Ottawa	0·21	0·34	74·13	12·35	7·26	1·23	0·73	1·27	
31550*a*	" "	0·05	0·60	70·55	12·22	7·25	.....	1·98	1·61	
31550*b*	" "	0·06	1·32	70·33	12·39	6·65	.....	0·86	1·75	
32992	Sawmill ashes, Robson, B.C.	0·07	0·06	8·01	.....	37·80	.....	3·85	16·73	3·78
33953	Wood ashes, Millerton, N.B.	1·07	1·91	30·85	.....	34·51	.....	0·45	1·15	
35659	" Richelieu, Que.	5·35	9·00	13·78	.....	32·57	2·90	1·95	5·61	38·84
35668	Tannery ashes, Millerton, N.B.	8·32	8·19	21·50	.....	22·36	1·19	0·77	1·00	36·67
35674	Wood ashes, No. 1, Cap Chat, Que.	5·18	5·20	16·38	.....	28·57	4·89	2·39	8·26	29·13
35675	" No. 2, "	2·66	3·09	5·04	.....	43·88	4·35	2·62	0·93	37·43
35852	Hardwood ashes	5·00	3·93	7·36	.....	40·16	2·50	1·63	5·95	33·47
36321	Boiler flue ash, Amherst, N.S.	3·61	13·55	50·13	.....	5·93	1·74	.....	0·53	24·51
36954	Wood ashes, Montreal, Que.	1·78	13·68	66·45	.....	4·42	0·62	0·44	0·76	11·85
37799	" St. Eugene, Que.	1·09	7·10	64·80	11·14	6·28	.....	0·86	1·27	7·46
40319	Spent tan bark, Millerton, N.B.	1·62	1·93	31·98	23·50	21·39	.....	0·77	0·58	
40320	Sawmill (incinerator), New Denver, B.C.	12·64	3·42	6·74	9·57	33·46	.....	4·47	3·69	26·10
40432	Sawmill ashes, Millerton, N.B.	8·86	3·79	35·31	11·96	22·46	.....	1·13	4·67	11·82
41158	Incinerator ashes (cedar mill), Eburne, B.C.	1·17	3·20	44·03	12·58	16·76	.....	0·62	1·14	
41255	Wood ashes, purchased in Montreal, Que.	0·86	4·93	64·90	10·82	6·02	.....	1·43	1·52	
41447	Wood ashes from house furnace, Wotton, Que.	1·87	1·46	9·67	3·22	34·21	.....	2·38	12·68	
41448	Wood ashes purchased in Montreal, Que.	0·88	6·98	53·78	13·13	11·08	.....	1·42	1·68	
43489	Coal ashes, Tignish, P.E.I.	0·89	11·26	54·02	23·48	2·56	.....	0·22	0·30	
44152	Wood ashes, Ottawa, Ont.	0·69	2·45	26·81	.....	28·98	.....	1·50	3·52	14·68
46568	Incinerator ashes (sawmill), Woodstock, N.B.	0·10	0·70	50·52	.....	20·77	.....	1·12	2·48	9·04
46871	Sawmill ashes, Waldo, B.C.	2·35	10·26	22·62	.....	25·86	.....	2·01	5·60	12·86
52220	Ashes of "White wood," Richelieu, Que.	0·21	.....	37·22	9·26	34·19	.....	1·41	6·44	
53879	Ashes of Alder, Langley Fort, B.C.	1·33	6·22	5·08	.....	27·78	.....	6·19	14·45	31·63
53880	Ashes (clinker), Langley Fort, B.C.	0·25	7·46	6·73	.....	33·40	.....	6·54	13·81	24·07
55671	Wood ashes, Kemptville, Ont.	27·75	3·46	23·51	.....	22·53	.....	1·03	1·36	19·14
55700	Wood ashes, Smiths Falls, Ont.	18·61	3·08	5·79	.....	34·54	.....	2·23	3·03	30·08

LIME REFUSE AND MINING BY-PRODUCTS

Lab'y. No. 29658.—This is a sample of refuse from lime-kilns of Missisquoi Marbles, Ltd., and forwarded from Phillipsburg, Que. As received it was in the form of a very wet paste, containing approximately 44 per cent of water.

Air-dried it readily reduces to a fine powder which was found to have the following composition:—

ANALYSIS

Moisture, organic matter, etc.	3.81
Mineral matter insoluble in acid	1.85
Carbonate of lime	24.69
Slaked lime ($Ca(OH)_2$)	66.76
Oxide of iron and alumina	.61
Carbonate of magnesia	2.28
	100.00

This is essentially a mixture of carbonate of lime and slaked lime. It would prove excellent for agricultural purposes, i.e., for treatment of soils in need of liming, and considering it may be obtained for the hauling its use may be strongly urged. The application may be from 1 to 3 tons per acre.

Lab'y. No. 29710.—Refuse lime from tannery, sent from Bath Road, Ont.

ANALYSIS

Water, organic matter, etc.	29.90
Lime (CaO)	63.56
Magnesia (MgO)	1.34
Mineral matter insoluble in acid	3.13
Oxide of iron and alumina	.96
Undetermined	1.11
	100.00

This waste or refuse material contains about 84 per cent of slaked lime. It is well adapted for agricultural use and would be found specially valuable for heavy clay and muck loams. No charge was made for this material.

Lab'y. No. 29953.—Refuse lime from tannery, Dunham, Que. Greyish-white, marly appearance, with considerable amount of hair present.

ANALYSIS

Moisture and organic matter	6.15
Mineral matter insoluble in acid	3.20
Oxide of iron and alumina	1.42
Slaked lime ($Ca(OH)_2$)	56.09
Carbonate of lime	28.32
Carbonate of magnesia	4.18
Undetermined	.64
	100.00

Practically 85 per cent of this refuse consists of lime compounds suitable for agricultural use. It would prove a cheap and valuable amendment for all classes of soils in need of lime. No charge was made for the refuse at the tannery.

Lab'y. No. 30009.—Crushed rock, refuse from Graphite Works at Port Emsley, Lanark county, Ont. This by-product, offered for sale as a fertilizer, was in the form of a coarse powder of a grey colour and showing small scales of mica.

ANALYSIS

	Per cent
Mineral matter insoluble in acid	34.64
Oxide of iron and alumina	8.50
Carbonate of lime	46.60
Carbonate of magnesia	11.62
Phosphoric acid	1.60

MECHANICAL ANALYSIS

Passes 80 mesh sieve	45
" 60 " "	66
" 20 " "	100

Agriculturally, this may be considered as crushed limestone of rather poor quality. It could be used for dressing soils in need of lime. The magnesia content is rather high but probably not such as to render the material harmful for most soils. The percentage of phosphoric acid, equivalent to 3·49 per cent phosphate of lime, is notable for limestone, but is not present in a form directly available for crop use. The product is very coarsely ground and consequently a quick, immediate action from its carbonate of lime content could not be expected; if such is not a desideratum the material is fairly satisfactory.

Lab'y. No. 30296.—Crushed rock, refuse from graphite mines from the Globe Graphite and Mining Co., Buckingham, Que. A fine light grey powder resembling ground limestone and showing some particles of graphite and mica.

ANALYSIS

Mineral matter insoluble in acid	27.61
Oxide of iron and alumina	5.67
Carbonate of lime	52.59
Carbonate of magnesia	13.51
Phosphate of lime	.94
	100.00

MECHANICAL ANALYSIS

	Per cent
Passes 80 mesh sieve	44
" 60 " "	58
" 20 " "	100

This is equivalent to crushed limestone of medium quality. The magnesia content is decidedly high and this detracts from the value of the material for agricultural purposes; it approaches the limit of safety, as excess of magnesia is harmful to most farm crops. It is fairly satisfactory as to fineness, unless an immediate quick action is essential.

Lab'y. Nos. 48634-5-6.—Tailings from Graphite Works, Buckingham, Que.

ANALYSIS

	No. 1	No. 2
Mineral matter insoluble in acid	59.95	49.82
Oxide of iron and alumina	11·35	19·00
Carbonate of lime	16.25	17.86
Phosphate of lime	1.64	1.02
Undetermined	10.81	12.10
	100.00	100.00

MECHANICAL ANALYSIS

	No. 1	No. 2	No. 3
Passes 10 mesh sieve	100·0	100·0	100·0
" 20 " "	99.4	99.9	99.7
" 60 " "	77·7	84.5	86·0
" 80 " "	63·9	66.5	69·9

The only constituents of agricultural value present in sufficient quantity to make it worthy of note is carbonate of lime. This would make these "tailings" of some value as an amendment for soils in need of, or likely to be benefited by, liming. The percentage of phosphate of lime, from the commercial point of view, is negligible.

CALCAREOUS AND PHOSPHATIC DEPOSITS

Lab'y. No. 30575.—Calcite, from Escuminac, Bonaventure county, Que. This is a crystalline form of carbonate of lime.

ANALYSIS

Carbonate of lime	93·12
Mineral matter insoluble in acid	5.16
Oxide of iron and alumina	1.32
Undetermined	·40
	100.00

Of excellent quality and if reduced to a fine powder would form a high grade material for the treatment of soils in need of lime.

Lab'y. No. 31348.—Gypsum. This was forwarded from Steveston, B.C., as a "lime deposit" of probable fertilizing value.

ANALYSIS

Water	16·58
Organic matter	1·15
Mineral matter insoluble in acid	·38
Sulphate of lime	77·44
Carbonate of lime	3·73
Undetermined	·72
	100·00

This material is essentially sulphate of lime (gypsum), containing a small percentage of carbonate of lime. While of very little value for correcting the acidity of soils, it would be found useful for improving the tilth of heavy clay loams and as a top dressing for clover.

Lab'y. No. 47165.—Gypsum, forwarded from Halifax, N.S.

ANALYSIS

Mineral matter insoluble in acid	1·34
Sulphate of lime	96·68
Oxide of iron and alumina	·20
Undetermined	1·78
	100·00

This sample of fibrous gypsum is of excellent quality. Its use after grinding (land plaster) may be recommended for heavy clay loams, which it improves in tilth and as a top dressing for clover. It, of course, would have no value for correcting the acidity of sour soils.

Lab'y. No. 53943.—Volcanic Ash from Grand Forks, B.C. This was forwarded as marl, with a request for information as to its value as an amendment for soils in need of lime. It is a fine, greyish powder, giving no effervescence with acids. Microscopical examination shows it to be volcanic ash.

ANALYSIS

	Per cent
Mineral matter insoluble in acid	89·24
Oxide of iron and alumina	5·89
Lime	very slight traces
Magnesia	" " "
Phosphoric acid	" " "
Potash	
Nitrogen	·03

The percentages of plant food constituents are negligible and the deposit has no agricultural or fertilizing value.

Lab'y. No. 31557.—Shells, from bed or deposit of considerable magnitude at Beauport, Que. These small shells (Saxicava rugosa) were forwarded for a report as to their probable agricultural value.

ANALYSIS

Moisture	·27
Organic and volatile matter	2·66
Mineral matter insoluble in acid	1·42
Carbonate of lime	95·25
Oxide of iron and alumina	·40
Phosphoric acid	traces
Magnesia	"
	100·00

These shells are essentially carbonate of lime. Ground or finely crushed they would make an excellent material for the improvement of lands in need of lime.

Lab'y. No. 26277.—Deposit from St. Thomas de Joliette, Que. This is a reddisn coloured "natural deposit", thought to be of fertilizing value. As received it was reddish brown pasty mass, containing some small stones, root fibres, etc. On air-drying it formed a golden brown mass which was easily pulverized.

ANALYSIS

Mineral matter insoluble in acid	49·52
Oxide of iron and alumina	43·25
Carbonate of lime	traces
Organic matter, etc. (undetermined)	7·23
	100·00

Of no fertilizing value, but might find a use as a low grade mineral paint.

Lab'y. No. 30225.—Hydrated oxide of iron. This is the "spent oxide" from the gas works at Charlottetown, P.E.I., and forwarded to ascertain if it had any fertilizing value. A reddish brown material, powdery, with small lumps, with a rather disagreeable (bituminous?) odour.

ANALYSIS

Moisture	6·73
Volatile (tarry) matter	8·77
Mineral matter insoluble in acid	3·98
Oxide of iron	20·70
Sulphur (total)	50·26
Carbonate of lime	6·75
Undetermined	2·81
	100·00
Nitrogen	·55

This by-product has no value as a fertilizer but might be found useful in the control of certain classes of noxious insects, that is, used as a soil fumigant. Experimental work would be necessary to determine what practical value it might have in this connection and to what extent it could be so employed without proving harmful to vegetation.

Lab'y. No. 54780.—Deposit, from Cardigan, P.E.I., and forwarded for a report as to its fertilizing value. This sample as received had the appearance of a red soil, consisting of clay and fine sand with an admixture of oxide of iron.

ANALYSIS

Water and organic matter	4·84
Mineral matter, insoluble in acid (clay and sand)	78·70
Oxide of iron and alumina	13·84
Lime	traces
Undetermined	2·62
	100·00

This deposit does not possess any fertilizing or agricultural value and is not rich enough in iron to make it an economic ore of that element.

Lab'y. No. 30980.—Deposit, from about four miles north of Kingston and alleged to have fertilizing value. This sample as received has the appearance of very poor sandy loam. It is evidently essentially sand, with some vegetable debris and root fibre.

ANALYSIS

	Per cent
Moisture	1·55
Organic and volatile matter	2·35
Mineral matter, insoluble in acid	91·34
Oxide of iron and alumina	3·13
Lime	·21
Phosphoric acid	·25
Nitrogen	·06

The amounts of plant food constituents present are so small as to be negligible; the "deposit" has no fertilizing value.

Lab'y. No. 28717.—Phosphate rock. This is a sample of the recently discovered and extensive beds of phosphate bearing rock occurring in the neighbourhood of Banff, Alberta, a report upon which has been published by the Mines Branch, Department of Mines, which kindly supplied the present sample.

ANALYSIS

	Per cent
Mineral matter insoluble in acid	26·70
Phosphoric acid	27·58
" " calculated as tricalcic phosphate	60·23

Although this deposit is decidedly inferior to Canadian apatite in phosphoric acid content and in the fact that it would require a larger amount of sulphuric acid in its treatment in the manufacture of superphosphate, it is quite possible that this discovery may in the future become a source of phosphoric acid for fertilizing purposes. It could not, at present, be worked profitably but this fact does not, as we have said, preclude the possibility of utilizing these beds to advantage at some time and we must therefore consider the discovery not only as an interesting one geologically but as a valuable and important one. The mean phosphoric acid content of the deposit is estimated at 20 per cent, or slightly higher, a somewhat lower figure than obtained on the sample analysed.

Lab'y. No. 42919.—Phosphatic deposit, from Emerson, Manitoba. As received, in white or greyish-white lumps, rather soft, with portions quite hard, slight effervescence on the addition of acid.

ANALYSIS

Loss on ignition	5·40
Mineral matter, insoluble in acid	8·50
Oxide of iron and alumina	3·80
Phosphate of lime	65·67
Carbonate of lime	11·20
" " magnesia	1·45
Potash	traces
Soda	"
Undetermined	3·98
	100·00

This deposit contains a notable percentage of phosphate of lime, and therefore if found in sufficient quantity might have a commercial value.

It is stated, by our correspondent, to "occur in small deposits, cropping up in places almost to the surface of the soil and continuing more or less to a depth of approximately 5 feet, when one reaches gravel. It probably does not exist in any very large quantity."

TOBACCO BY-PRODUCTS

Lab'y. No. 27427.—Tobacco stems. This is a sample of tobacco stems, a waste product, from a tobacco factory in the province of Quebec and may be considered as fairly representative of a large quantity produced annually at the tobacco and cigar factories in the Dominion.

ANALYSIS

	Per cent	Pounds per Ton
Water	8·51	....
Mineral matter (ash)	21·55	....
Organic matter	69·94	....
	100·00	
Nitrogen	1·64	32·8
Phosphoric acid	0·54	10·8
Potash	4·43	88·6

As pointed out in previous reports, this waste product has a high fertilizing value and ought to be carefully conserved for agricultural use. Especially is it valuable for its potash, the larger proportion of which is undoubtedly in readily available forms. That this material is also rich in nitrogen must not be overlooked. If the "stems" are composted this nitrogen is conserved and converted into available plant food, but if they are reduced to ash this element is lost and the mineral constituents potash, lime and phosphoric acid—alone remain. As nitrogen is the most costly of all fertilizing elements, the economy of composting the stems, protecting the compost from leaching rains, will be obvious.

Lab'y. No. 51006.—Tobacco dust, from Port Dover, Ont. This dust is used in greenhouses for the control of the rose midge. As it is procurable at a reasonable price, the enquiry was: Can it be regarded as a fertilizer?

ANALYSIS

Moisture	3·54
Organic matter	26·61
Mineral matter insoluble in acid (largely sand)	64·16
" " matter soluble in acid	5·69
	100·00
Fertilizing Constituents—	
Nitrogen	0·65
Phosphoric acid	0·19
Potash	0·75

One ton would furnish: 13 pounds nitrogen, 3·8 pounds phosphoric acid and 15 pounds potash. It is evident that while possessing some fertilizing properties, its value from this point of view would be too small to allow it a place among commercial fertilizers.

Lab'y. No. 35070.—Tobacco ashes, sold by Carnac-Marquis, Quebec, as a high-grade potassic fertilizer.

ANALYSIS

	Per cent
Potash (K_2O) total	24·78
" soluble in water	23·24

These ashes are of excellent quality and very rich in potash, which is almost entirely soluble in water and immediately available; they constitute a potassic fertilizer of very considerable value.

EEL-GRASS, SEAWEED, BRACKEN FERN

Lab'y. No. 28365.—Eel-grass and algæ from St. John, N.B. This material, a green spongy mass, consisting of marine algæ and fragments of eel-grass, occurs in large quantities on the shores of the lower part of the St. John river, thrown up by the tide. Our correspondent writes: "Farmers in this vicinity gather up quantities of the vegetable material and compost it with barnyard manure. Some claim that when rotted it is a valuable fertilizer in itself; others contend that it is only good as an absorbent of liquid manure. We shall be glad to learn which of these views is correct."

This material air-dries on exposure to a felt-like, green, spongy mass. Its analysis afforded the following data:—

ANALYSIS

Water	5·13
Organic matter	42·66
Mineral matter (ash and sand)	52·21
	100·00
Nitrogen	1·36
Potash	1·46

To determine its absorbtive capacity it was soaked over night, being entirely immersed in water.

Drained 15 minutes 1 part holds 6·6 parts water.
Drained 1¼ hours 1 part holds 6·5 parts water.

The percentages of nitrogen and potash present give this material a distinct though not large fertilizing value. Provided it rots readily in the soil it could be advantageously used both directly as a manure, and in the making of composts.

The air dried material was found to possess a high absorptive capacity and in this condition it should prove useful as a supplementary bedding for stock and for use about the farm buildings where there may be liquid manure likely to go to waste. The subsequent fermentation of the whole should bring about the liberation of the plant food in this material in more or less available forms.

Lab'y. No. 28985.—Eel-grass from Black Cape, Que. This sample as received consisted of small fragments (¼-inch) of eel-grass, quite soft and moist and slightly decomposed.

ANALYSIS

	As Received	Air-dried
Water	32·14	8.84
Organic matter	41·63	55·91
Mineral matter*	26·23	35.25
	100·00	100·00
Nitrogen	1·04	1·39
Phosphoric acid	0·24	0·32
Potash	0·51	0·69
*Containing sand	6·86	9·22

This sample is not quite as rich in plant food as one of eel-grass analysed in these laboratories some years ago, but it might be used to advantage in making composts and possibly in the air-dried condition as a bedding material, though its absorbent capacity is not high. The resultant manure would be more suitable for heavy than for light soils, but would be more or less valuable for all types. The application of the crude, raw material without composting is not to be advised save perhaps to very heavy soils as eel-grass rots but very slowly unless in the presence of readily fermentable matter, such as manure.

Lab'y. No. 42924.—Eel-grass, semi-decayed, from Summerside, P.E.I. As received, a wet stratified mass of semi-decayed eel-grass, quite soft and short, with apparently little clay or sand. The material was slightly acid. It occurs " deposited in bed of creek and along the shore and the quantity must amount to hundreds of tons".

ANALYSIS

Water	75·55
Organic matter	11·05
Mineral matter (containing 7·99 per cent clay)	13·40
	100·00
Nitrogen	0·26

This deposit might find a use as an amendment for poor and worn soils, supplying organic matter to increase their store of humus. Its only element of plant food in appreciable quantities is nitrogen but the amount present is so small that the material cannot be regarded as receiving much fertilizing value therefrom. It would be desirable to use lime in connection with this material, to correct acidity and hasten its further decay.

Lab'y. No. 30801.—Algal growth, described as "moss" from surface of creek running into Cowhead Bay, P.E.I. This vegetable growth is essentially composed of algæ, chiefly of the form, Alva latissima, a common fresh water alga. As received this material was comparatively dry and consisted of very thin, paper-like layers welted into a pad of from one-quarter to one-eighth inch in thickness, the uppermost layer was quite green, the underlying dead layers, yellowish white.

ANALYSIS

Moisture	16·21
Organic and volatile matter	58·68
Mineral matter, including adherent sand	25·11
	100·00
Nitrogen	1·78

Absorptive Capacity: immersed in water over night:—

After draining 15 minutes, 1 gram retains 7·0 grams water.
After draining 1 hour, 1 gram retains 5·8 grams water.

This material possesses some fertilizing value, but owing to its leathery condition and high resistance to decay, its plant food would not readily become available. Air-dried it has a fairly high absortive capacity indicating that it might be advantageously used as a litter in the farm buildings.

Lab'y. No. 52087.—Seaweed, dried and ground. Forwarded from Beaver Harbour, N.B.

ANALYSIS

Moisture	3·55
Organic matter	66·16
Mineral matter or ash	30·29
	100·00
Nitrogen	2·37
Phosphoric acid	2·75
Potash	1·98

This product would furnish, per ton, 47.4 pounds nitrogen, 55 pounds phosphoric acid and 39.6 pounds potash.

While these fertilizer elements could not be classed as immediately available, they would undoubtedly become soluble and assimilable in a moist, warm soil. Seaweeds generally readily decay in the soil and this material must assuredly be regarded as possessing distinct and notable fertilizing value, especially as a supplier of nitrogen and potash.

Bracken Fern

Lab'y. No. 35856.—Bracken fern. Numerous inquiries have been received—more particularly from British Columbia—respecting the manurial value of bracken; the following account presents the results of our analysis of this fern as to plant food content and also furnishes information as to manner of use—as litter or for composting purposes.

The common bracken or brake (*Pteris aquilina* L.) is a fern of very wide distribution and in certain parts of Canada and more particularly on the Pacific coast, British Columbia, it grows most luxuriantly. The officer in charge of the Experimental Farm at Agassiz, situated on the Fraser Valley, B.C., to whom we have written in the matter, says in a letter dated June 26:—

> "Bracken grows most profusely in this district on logged or burned over land. On this kind of land the labour entailed in harvesting it would be considerable, as most of the work would have to be done with a scythe and labour at present is very scarce and high priced. The plant may be found in patches of almost all sizes throughout the Fraser valley. I would say that the approximate tonnage per acre would be two tons, after the plant had been cured."

In 1903 we first directed attention to the manurial value of bracken, used as a litter or as rotted in the compost heap with manure. It is particularly as a bedding material that the fern, in the air-dried condition, can be employed to advantage, since it possesses a well marked absorptive capacity for liquids and ammonia. When thus used the subsequent fermentation in the manure pile rots the fern and sets free its plant food, which as will be seen by the analyses, is present in notable quantities. Manure made with bracken as a litter is fully equal to that from straw and is more particularly useful on heavy clay loams from the fact that it takes somewhat longer to rot in the soils and thus acts in opening up the soil and improving its tilth. Our analysis at that date (1903), obtained on a sample of the air-dried fern sent from Loch Errock, B.C., afforded the following data:—

	Per cent	Pounds per ton
Mineral matter or ash	6.78	135.6
Nitrogen	1.29	25.8
Phosphoric acid	.43	8.6
Potash	1.52	30.4

Last June a sample forwarded by the officer in charge of the Experimental Farm, Agassiz, B.C., was submitted to analysis. The plant at the time of cutting was about 6 feet high, consisting approximately of 3 feet of bare stalk and 3 feet of leafy frond. The relative proportion by weight of stalk and leaf is shown as follows:—

	Grammes
Stalk	82.7
Frond (leaf)	135.8
Whole plant	218.5

Analysis of Air-dried Bracken

—	Stalk	Leaf	Whole Plant	
			Per cent	Pounds per ton
	p.c.	p.c.		
Moisture	6·25	5·99	6·09	
Ash	6·35	8·79	7·84	156·8
Nitrogen	0·85	2·45	1·84	36·8
Phosphoric acid	0· 7	0·81	0·68	13·6
Potash	2·81	2·72	2·75	55·0

Analyses made in England indicate that the ash of very young bracken contains over 50 per cent potash; that of the fully grown fern from 30 per cent to 40 per cent However, owing to the larger yield the fully grown plant will furnish more potash per acre than the fern cut in the earlier stages of growth.

Since in many localities bracken may be obtained at the cost of cutting and hauling, it is evident that its harvesting and use, especially in seasons when straw is scarce, may be advantageous. Its notable percentages of potash and nitrogen, not to speak of its other fertilizing elements and its organic matter content, give it a manurial value of no mean order.

Bracken may be cut, dried and stored in the autumn, but if climatic conditions permit, it might be cut throughout the winter. In connection with the harvesting, it should be noted that dried bracken rapidly loses its potash on exposure to rainy weather, and when left out all winter is found to be very poor in that element.

Recent investigatory work carried out by the pathologist of the Health of Animals Branch, Department of Agriculture, has shown that dried bracken as present in poor hays may act as a poison to horses.*

It is, however, well established that no animal will readily eat withered green or dry bracken; indeed it is only under conditions which practically preclude all other food that they can be induced to take it. Further, it has been shown that small amounts may be eaten with impunity and this is especially true as regards cattle. We therefore are of the opinion that while the use of ferny hay as a fodder is to be deprecated, the employment of dried bracken as a bedding material for cows and swine, on farms where the live stock is rationally and generously fed, is a perfectly safe practice.

On farms which cannot use bracken as a litter, or if this employment of it is objected to, the green material may be composted with manure. Or the cured form may be burnt and the ash preserved, but in this case, of course, the organic matter and the nitrogen are necessarily lost.

Lab'y. No. 42654.—Bracken fern. This sample, forwarded from West Point Grey, B.C., as received was a wet, soft mass containing 77.0 per cent water and consisting of the fern in a partially decayed condition. It was slightly acid. Our correspondent writing in February says: "This bracken was cut and piled last July."

ANALYSIS OF AIR-DRIED BRACKEN

Moisture	5.49
Organic matter*	86.80
Ash or mineral matter**	7.71
	100.00
*Containing nitrogen	1.96
** " phosphoric acid	0.23
" potash	1.21

This should prove a useful and cheap source of humus, both for heavy and light loams. It contains notable amounts of nitrogen and potash. Its use might well be supplemented by basic slag, which would correct its acidity and add phosphoric acid.

STREET SWEEPINGS

Lab'y. No. 29629.—From Fredericton, N.B. As received this sample was in the form of a dry powdery mass of a dark brown colour, and which on examination was found to be made up largely of quartz sand, fragments of undecomposed woody

* The poisoning of horses by the Common Bracken, by S. Hadwen, D.Vs., and E. A. Bruce, V.S., Bulletin No. 26, Scientific Series, Health of Animals Branch, Department of Agriculture.

fibre and oat hulls—the latter evidently from horse manure. There was no appearance of oil or tar, though the sweepings were said to be from a "tarvia" road. The sample was odourless.

ANALYSIS

Moisture	1·16
Organic and volatile matter	9·51
Mineral matter, insoluble in acid (sand, etc.)	74·66
Oxide of iron and alumina	10·20
Lime	1·08
Magnesia	traces
Potash	slight "
Phosphoric acid	·77
Undetermined	2·62
	100·00
Nitrogen, in organic matter	·28

The amounts of plant food present are very small, so that agriculturally these sweepings are to be considered as an amendment rather than a fertilizer.

Street sweepings must necessarily be very variable as to composition and fertilizing value, dependent upon the nature of the roadbed, the amount of horse traffic, weather conditions, time of year of collection and several other factors. But it is seldom that the analysis supports the impression widely held that the material has great merit as a fertilizer. The present analysis is fairly in accord with published data of road sweepings and we are of the opinion that in the larger number of cases in which marked benefit has been reported from this application that the benefit has been due to an improvement of the texture of the soil rather than any large increase in the available food supply of the crop. Thus it is that peaty and muck soils have frequently been improved by street sweepings, which have had the effect of "firming" the land and giving it a more compact texture.

Before going to any large expense in procuring street or road sweepings, indeed before reaching a decision as to the desirability of their application, consideration should be given not only to the probable proportion of manure that may be present but also to the effect the sweepings may be likely to have on the texture of the soil. Much harm might result from a heavy application of sweepings from a clay road to a mellow loam, for such material—necessarily largely clay—may have been puddled by traffic and drying after a rain may "set" like cement. In such a case the benefit from the small amount of plant food furnished would be outweighed by the injury to the texture of the soil.

Lab'y. No. 30493.—Street sweepings from the city of Quebec. As received, this sample was decidedly moist and clayey, with a large proportion of organic matter. It contained a considerable amount of oat hull and appeared to be a mixture of fine earth and horse manure.

ANALYSIS OF AIR-DRIED SWEEPINGS

Moisture	1·51
Organic and volatile matter	14·78
Mineral matter, insoluble in acid	42·95
Carbonate of lime	30·16
" " magnesia	2·25
Phosphate of lime	·66
Potash	·35
Undetermined	7·34
	100·00
Nitrogen	·25

These sweepings possess some fertilizing value and may be regarded as a useful amendment. They may be considered as consisting of approximately 40 per cent sand and clay, 30 per cent carbonate of lime and 30 per cent manure, more or less leached.

Lab'y. Nos. 25388-89.—Apple pomace, from Norwich, Ont. "Of these two samples of old apple pomace, No. 1 (25388) is taken from the top two feet, No. 2 (25389) represents the remainder of the heap below two feet. Weeds grow very rank on this pomace, and we should like to know what value it may have as a fertilizer."

No. 25388, as received: almost black; very moist; fibrous and somewhat woody; very acid.

No. 25389, as received: yellowish green; very moist and pasty; very acid.

ANALYSIS

	No. 25388	No. 25389
Water	64·74	81·21
Organic matter	29·83	18·27
Ash or mineral matter	5·43	·52
	100·00	100·00
Nitrogen	1·18	·26

Calculated to a water-free basis, we have:—

Nitrogen	3·36	1·38
Ash	15·41	2·80

Analyses of apple pomace are to be found in the report of this division for 1906 and that for 1909. They indicate that the fertilizing value of this by-product is very small and the present data for sample No. 25389 are in accord with this finding. The percentages of ash (mineral matter) and nitrogen for No. 25388 are very much higher than any hitherto obtained for pomace and denote a marked, though not high, manurial value. This would seem to be exceptional, as we cannot find in such records as are available data approaching those of the present analysis.

The acid character of pomace suggests the advisability of adding lime or ground limestone to the compost or an application of one of these lime compounds to the soil when the pomace is used directly on the land.

Lab'y. Nos. 47113-14.—Tomato slush, from Colborne, Ont., and a waste product of the tomato canning industry, consisting chiefly of tomato skins and seeds. This waste very readily ferments and develops acidity.

ANALYSIS

	A	B
Water	90·38	94·62
Organic matter	7·85	4·65
Ash	1·77	·73
	100·00	100·00
Nitrogen	·35	·16
Phosphoric acid	·15	·06
Potash	·26	·18

Unless dried to a water content of, say, 10 per cent, this by-product could not be considered as possessing any material fertilizing value; its percentages of plant food are very small.

In the condition, as produced, it might be used on soils poor in humus in the more or less immediate vicinity of the cannery, directly, or after composting. In either case a certain amount of lime or ground limestone would be desirable to check acidity

GUANO, FISH REFUSE, TANKAGE

Lab'y. No. 46524.—Guano, from Porto Rico, in the form of a coarse yellowish-red powder, effervescing strongly on addition of acid.

ANALYSIS

Moisture	7·30
Loss on ignition (organic matter, etc.)	5·10
Mineral matter insoluble in acid	3·21
Total phosphoric acid	24·42
Available phosphoric acid (citrate soluble)	4·24
Water-soluble phosphoric acid	trace
Nitrogen	0·17

This is a phosphatic guano of fair quality. It could not be expected to give the immediate results on many soils and for many crops, obtainable from superphosphate, but if bought sufficiently cheaply it might profitably be used on soils poor in lime and rich in humus, if any immediate response is not of prime importance. The amount of nitrogen present is practically negligible.

Lab'y. No. 58861.—Bat Guano, from deposits in Colombia, South America. It is stated that it can be purchased at $35 per ton C.I.F. New York, and further that the deposit of which this is a sample contains 200,000 tons.

As received it was quite moist, of a dark brown colour and granular.

ANALYSIS

Moisture	40·00
Organic matter	34·53
Mineral matter	25·47
	100·00
Nitrogen	4·22
Phosphoric acid	4·66

This guano is a valuable fertilizer, being specially rich in nitrogen. If the percentage of moisture could be reduced, by exposure to the air and sun or by means of a rotary dryer or similar apparatus, its value would be much enhanced and a saving in transportation charges effected.

Lab'y. No. 49243.—Fish refuse, forwarded from Berwick, N.S., with the statement that large quantities of this waste product could be purchased at a reasonable price along the coast of Nova Scotia.

The sample consisted of the back bones, fins and tails—probably largely of cod—approximately 1 foot in length; sound and clean with no discoloration. The bone is damp, soft and pliable, with an efflorescence of salt showing in many spots; no disagreeable or offensive odour. There is a fair amount of muscle tissue (meat) on the bones.

Analysis was made of this refuse and the following data obtained:—

ANALYSIS (As Received)

Water	46·40
Organic matter*	24·75
Phosphate of lime**	9·67
Potash	0·43
Common salt	18·71
Insoluble mineral matter	0·12
*Containing nitrogen	3·87
**Containing phosphoric acid	4·43

The essential elements of agricultural significance in this product are nitrogen and phosphoric acid and the percentages of these constituents present, unquestionably place the refuse in the class of raw materials of very considerable value. It will be

observed that, as forwarded, it contained 46 per cent of water; if it were dried to, say, 10 per cent of water, the percentage of nitrogen would be, approximately, 6·5 and that of phosphoric acid, 7·4.

As received, this refuse contained 18·71 per cent common salt. This amount would not, in our opinion, prove injurious, unless very heavy and frequent applications of the material were made. A dressing of 800 pounds per acre would mean approximately 150 pounds of common salt per acre, and that would not be considered excessive, if applied once in the rotation, say, every fourth or fifth year.

For convenience of application and also to enhance the availability of the plant food of the product it would be well to compost it, as with manure. This would start decay and bring the material into a condition more easily and evenly distributed; it would at the same time tend to bring the nitrogen and phosphoric acid into more readily assimilable forms.

If the material were to be put on the market it would, I think, be desirable to soak the refuse in water to dissolve away the larger part of the salt and then to dry and grind. This would present a material in a convenient form for application.

Lab'y. No. 53085.—Tankage, from slaughter-house refuse, forwarded from Charlottetown, P.E.I.

A damp, pasty, sticky mass of a light grey colour, containing some fragments of bone. Its analysis afforded the following data:—

Water	65·34
Organic matter	31·26
Mineral matter insoluble in acid	0·30
" " soluble in acid, including phosphates	3·10
	100·00
Phosphoric acid	1·13
Nitrogen, in organic matter	1·78

If this material were dried to a basis of, say, 10 per cent water content it would contain approximately 3 per cent phosphoric acid and 4·5 per cent nitrogen. Such material, *if sound and wholesome* might presumably be used as a feed, but in its present moist condition it could not be kept for any length of time without spoiling and its use as a food would then become dangerous.

The value as a fertilizer is indicated by its percentages of phosphoric acid and nitrogen, and here, again, it would have to be further dried to allow of proper distribution and in order that it should not become offensive in storage. Properly prepared the product would have a distinct value both as a feed and as a fertilizer.

STOCK YARD MANURE

Lab'y. No. 52888.—Stockyard manure from the Alberta Stockyards, Calgary, Alta.

It was stated to be thoroughly representative of the manure produced at the yards, having been collected in accordance with directions issued by us to that end and with all necessary care. It weighed about 30 pounds and was sent in a tight container which prevented absorption or evaporation of liquid en route.

On examination of the mass, preparatory to obtaining a laboratory sample for analysis, it was found to be quite moist, of a dark brown colour and "short." The mass was quite fairly uniform throughout, the litter which was well distributed and not excessive in amount, being apparently hay. The manure, presumably from cattle only, would be regarded as "fresh," decomposition changes or rotting not having taken place to any marked degree. The analysis of the sample yielded the following data:—

ANALYSIS

Water	75.20
Organic matter	19.38
Mineral matter, soluble in acid	2.06
Mineral matter insoluble in acid	3.56
	100.00

	Per cent	Pounds per ton
Nitrogen	0.48	9.6
Phosphoric acid	0.14	2.8
Potash	0.47	9.4

For the purpose of comparison we append a number of "averages" obtained from several sources, the figures giving the percentages of the essential elements of fertility, nitrogen, phosphoric acid and potash, in fresh cow manure (with litter), not including results from leached or imperfectly preserved manure.

AVERAGE COMPOSITION OF COW MANURE

Authority	Nitrogen		Phosphoric Acid		Potash	
	Per cent	Lbs. per ton	Per cent	Lbs. per ton	Per cent	Lbs. per ton
Cornell Experiment Station, N.Y.	0·42	8·0	0·29	5·8	0·44	8·8
Heiden (German)	0·39	7·8	0·15	3·0	0·70	14·0
Experimental Farm, Ottawa (many analyses)	0·39	7·8	0·18	3·6	0·45	9·0
Well preserved, Experimental Farm	0·67	11·4	0·14	2·8	0·49	9·8

No farm product is so variable as manure, the composition and value of which depend on a great many factors—kind, function and food of the animal producing it, quantity and nature of the litter employed and the care taken in its production and preservation. We conclude, however, from our own results and those of others that fresh cow manure from well-fed animals fairly liberally bedded with straw will contain, per ton, approximately, nitrogen 10 pounds, phosphoric acid 3 pounds, and potash 9·5 pounds.

In view of the foregoing data and considerations we are of the opinion that the sample of manure here reported on may be regarded as of good average quality, comparing very favourably with fresh cow manure that has been well made without appreciable loss of urine.

POTASH LIQUOR

Lab'y. No. 31633.—Potash Liquor, known as "Mother Liquor," a by-product from the extraction of beet root sugar—submitted by the Dominion Sugar Co., Ltd., Chatham, Ont. As received, a dark brown syrupy liquid, with a very disagreeable odour,

ANALYSIS

Water	35.82
Organic matter*	45.40
Ash or mineral matter**	18.78
	100.00
*Containing nitrogen	3·21
**Containing potash (K_2O)	12·04

This refuse liquor contains approximately 12 per cent of potash, the greater part of which exists as carbonate with a small proportion as sulphate, but no chloride. It is undoubtedly a very valuable source of potash for fertilizing purposes, but its employment directly or in the manufacture of commercial fertilizers may be more or less troublesome owing to the viscous character of the fluid.

FELDSPAR FERTILIZER

Lab'y. No. 41687.—Feldspar Fertilizer. This product is the result of experimental work by Professor C. W. Drury of Queen's University, Kingston, Ont., in which ground feldspar, coke, iron ore and limestone are heated in an electric furnace, the object being to render the potash of the feldspar soluble and available.

ANALYSIS

	Per cent
Potash, soluble in water	.26
" in 1 p.c. citric acid solution	5.75
" hydrochloric acid sp. gr. 1.115	5.96
" hydrochloric strong	5.98

This product contains about 6 per cent potash of which more than 90 per cent is soluble in 1 per cent citric acid and hence may be considered available.

LIGNAITE

Lab'y. No. 50843.—Lignaite. This product, manufactured by the Canadian Lignaite Co., Ltd., Victoria, B.C., is described in the pamphlet advertising it as a compound for "radiumizing the soil" and from the same literature it is learned that "Lignaite is a radio-active fertilizer" and is prepared by treating "fine coal dust and coal ashes with certain chemicals in solution."

This material is a black powder resembling coal dust, showing a few minute whitish-grey specks—which on analysis proved to be carbonate of lime—throughout the mass. Its analysis has afforded the following data:—

ANALYSIS OF LIGNAITE

Moisture	2.50
Organic matter	45.79
Mineral matter, soluble in acid	7.39
Mineral matter, insoluble in acid	44.32
	100.00

FERTILIZING CONSTITUENTS

Constituent	Total (soluble in strong acid)	Available (soluble in water)
	per cent	per cent
Phosphoric acid	0·07	0·013
Potash	0·29	0·030
Nitrogen	0·60	—

These results clearly show that from the standpoint of supplying plant food the material has no value—the percentages of the essential elements of fertility and more especially those of phosphoric acid and potash being so small as to be negligible. The nitrogen—the only element present in an appreciable amount—exists in the organic matter of the coal and must be regarded as in a form peculiarly resistant to those changes which convert organic nitrogen into available plant food. It must therefore be concluded that according to the ordinary accepted views regarding fertilizers this product is worthless.

As regards radio-active properties, a portion of the sample was examined at our request by the Department of Mines, who report as follows:—

"The sample of lignaite submitted by you has been examined for radio-activity by the usual methods applied to supposedly radio-active minerals, ores and similar substances.

"Fifty grammes of the material showed no trace of radio-active properties."

Extended comment on this report is unnecessary; in a very clear and concise statement it absolutely and finally disposes of all claims that may be made for the recognition and value of this material as a fertilizer by reason of radio-active properties.

However, if it could be shown that this product possessed radio-active properties, its value as a fertilizer would not be enhanced; for it has been observed that while radio-active substances may exercise at first certain stimulating or physiological effects, they later have no notable or permanent influence on plant growth. There is no evidence that stimulation is kept up throughout the life of the plant or that it results in the formation of new and increased tissue. The opinion of the highest agricultural authorities is: that radio-active substances considered in connection with their possible use in agriculture are of scientific interest only; they have no commercial or practical value for increasing crop growth or yields.

NITRO PHOSPHATE FERTILIZER

Lab'y. No. 51964.—Nitro-Phosphate Fertilizer, manufactured by the Canadian Explosives, Ltd., Victoria, B.C., and stated to be bone char treated with nitric and sulphuric acid.

Analysis

	Per cent
Nitrogen	4.97
Total phosphoric acid	17.17
Water-soluble phosphoric acid	14.29

The nitrogen is essentially in the form of nitrate and water soluble, the amount of nitrogen exclusive of nitrates, and presumably organic, being ·075 per cent.

It will be observed that 83 per cent of the phosphoric acid present is in the water soluble form.

The large percentages of nitrogen and phosphoric acid and the fact that these elements are almost entirely present in readily available forms would indicate a very high fertilizing value for this product. Its mechanical condition appears to be good and we would judge that the material could be readily and equally distributed by hand or drill.

BROKEN EGG SHELL

Lab'y. No. 30582.—Dried and broken egg shell, forwarded from the Valcartier Camp, Que.

Analysis

Moisture	1·17
Organic matter (largely albumen)	6·56
Carbonate of lime	87·63
Carbonate of magnesia	1·66
Phosphate of lime	0·52
Oxide of iron and alumina	0·45
Mineral matter insoluble in acid (sand)	0·16
Undetermined	1·85
	100·00
Fertilizing elements—	
Nitrogen	1·05
Phosphoric acid	0·24

The mineral content of this material is essentially carbonate of lime and considered as an amendment it would be useful for soils deficient in lime. Its more profitable use however would undoubtedly be found in poultry feeding, since its protein content (6·56 per cent), in large part from the white or albumen of the eggs, enhances its nutritive value for this purpose. Crushed to a coarse powder it should prove a valuable adjunct to the ration of laying stock, taking the place of oyster shell for egg shell formation and to some extent acting as a substitute for green bone and meat scrap.

SLUDGE FROM SEPTIC TANK

Lab'y. No. 30905.—Sludge from septic tank at Oakville, Ont. This deposit as received was quite moist (18·81 per cent water), of a dark greyish colour with a somewhat earthy but not disagreeable odour. It effervesced strongly on the addition of acid.

Analysis of Air-dried Deposit

Moisture	2·39
Organic and volatile matter	9·00
Mineral matter insoluble in acid (sand, etc.)	72·20
Oxide of iron and alumina	5·05
Lime	5·25
Potash	0·37
Phosphoric acid	0·37
Undetermined (carbonic acid, etc.)	5·37
	100·00
Nitrogen	0·48

This material by reason of its plant food content, and more especially its nitrogen, has a manurial value; this value, however, is small and does not approach that of commercial fertilizers. Its notable percentage of carbonate of lime (9·37) would make it useful for correcting soil acidity. It undoubtedly could be used to advantage as an amendment on soils for garden crops.

FLAX STRAW EXTRACT

Lab'y. No. 31002.—Flax straw extract obtained as a by-product in a new process of treating flax. Submitted by Department of Trade and Commerce for analysis and report as to possible fertilizer or feeding value. As received: a dark coloured fluid, neutral to litmus and with an odour of musty hay.

Analysis

Specific gravity	1,037.0
	Per cent
Organic matter in solution	4·617
Mineral matter in solution	4·586
Total solids	9·203
Nitrogen	0·139
Phosphoric acid	0·029
Potash	0·386

This fluid possesses a slight fertilizing value, but the percentages of plant food constituents present are not such as to give the fluid any commercial value.

The nutritive properties of this fluid are practically negligible, and further, it is not likely to be found palatable to stock. It cannot be said to have any material value, either as a cattle feed or stock medicine.

FURNACE SLAG

Lab'y. No. 32422.—Furnace slag, a by-product of the Lloyd Manufacturing Co., Kentville, N.S., accompanied by a request from a correspondent as to its fertilizing value.

ANALYSIS

Phosphoric acid, total	0·78
Phosphoric acid, available	0·42

This slag is essentially a silicate of iron and alumina and contains a very small amount of phosphoric acid. Though this slag, if finely ground, would supply a certain proportion of available phosphoric acid, the percentage is too small to make the material of any commercial value.

ROTTED SAWDUST

Lab'y. No. 31888.—Rotted sawdust, from Blenheim, Ont. As received, moist (51·55 per cent water) dark coloured, well decomposed, with slight effervescence on addition of acid.

ANALYSIS OF AIR-DRIED MATERIAL

Moisture	4·45
Organic matter	49·00
Mineral matter insoluble in acid	33·05
Oxide of iron and alumina	5·43
Carbonate of lime	7·25
Undetermined	0·82
	100·00
Nitrogen	1·04

By reason of the fact that this material contains approximately 50 per cent of well decayed vegetable matter and 1 per cent of nitrogen, it should prove a useful amendment for all soils and especially heavy loams, deficient in organic matter.

THE FERTILIZING VALUE OF RAIN AND SNOW

It has been demonstrated, beyond dispute, that nitrogen is the dominant element of plant food, the soil factor, which, other conditions being favourable, determines in a very large measure crop growth.

In the free, gaseous condition in which it occurs in abundance in the atmosphere, it is only available to the legumes (clover, peas, beans, etc.) and this through the agency of certain nitrogen-fixing bacteria residing in nodules on their roots. All other crops can utilize only combined nitrogen, e.g., nitrates. Nitrogen therefore as nitrates, or in forms readily converted into nitrates, plays a most important part in crop production. We have further to remember that not only does crop growth remove nitrogen from the soil but that there are inevitable losses of this valuable element in soil cultivation, consequent upon bacterial activity and drainage. Lastly, nitrogen is the most expensive of all plant food elements when fertilizers must be purchased to increase the soil's fertility. The economic up-keep of the soil's store of nitrogen forms probably the most important of the many problems which science is called upon to solve for modern agriculture.

Rain and snow have a fertilizing value by reason of the soluble nitrogen compounds they contain and this investigation, in which every fall of rain and snow at Ottawa is analysed, has for its object the determination of this value. The data

obtained permit us to calculate the amount of nitrogen so furnished annually per acre. The data for the fifteenth year of the investigation, closing February 28, 1922, are now recorded and discussed.

The total precipitation (rain and snow), for the year March, 1921, to February, 1922, inclusive, was at Ottawa 35·05 inches, an amount somewhat in excess of the average for the past 15 years, viz. 33·499 inches. The distribution was fairly even throughout the year with the exception of the month of September, when the rain fall was only 1·71 inches.

In table I particulars are given of the monthly totals of precipitation, and data for the monthly average nitrogen content of the precipitation, present as free and albuminoid ammonia and as nitrates and nitrites. The calculations for the pounds of nitrogen furnished monthly per acre are also added.

TABLE I.—RAIN AND SNOW AT OTTAWA, ONT., FOR THE YEAR ENDING FEBRUARY 28, 1922

Month and Year	Precipitation in Inches			Nitrogen			Total	Pounds of Nitrogen per Acre
	Rain	Snow	Total in Inches of Rain	In Free Ammonia	In Albuminoid Ammonia	In Nitrates and Nitrites		
				p..p.m.	p.p.m.	p.p.m.	p.p.m.	
1921								
March	4·18	5·00	4·68	0·365	0·030	0·104	0·499	0·529
April	2·18	2·50	2·43	0·881	0·049	0·327	1·258	0·693
May	2·73	–	2·73	0·825	0·148	0·198	1·171	0·725
June	3·82	–	3·82	0·931	0·108	0·117	1·155	1·000
July	2·50	–	2·50	0·610	0·096	0·707	1·410	0·799
August	2·69	–	2·69	0·513	0·032	0·106	0·651	0·397
September	1·71	–	1·71	1·314	0·068	0·747	2·129	0·825
October	4·57	–	4·57	0·695	0·038	0·144	0·877	0·908
November	0·84	22·25	3·07	0·408	0·047	0·083	0·538	0·374
December	1·47	12·50	2·72	0·357	0·056	0·163	0·576	0·355
1922								
January	0·06	16·25	1·69	0·224	0·085	0·150	0·457	0·175
February	3·6	20·75	2·44	0·277	0·105	0·219	0·602	0·331
Total for 12 months	27·11	79·25	35·05	.....	.....	.....	.....	7·111

The rainfall was 27·11 inches, one-tenth of an inch less than that of the previous experimental year and approximately three inches more than that of the average for the past fifteen years. The highest records are for March and September, with precipitations slightly exceeding 4 inches each month. June followed closely with 3·82 inches.

The snowfall was 79·25 inches (equivalent to 7·92 inches in rain), exceeding the preceding season by approximately 12 inches but approximately 14 inches less than the average for the fifteen years ending February 28, 1922.

The total nitrogen for the year amounted to 7·111 pounds per acre, the amount for the preceding year being 6·525 pounds per acre and the average for the fifteen years of the investigation, 6·579 pounds.

TABLE II.—PRECIPITATION AND AMOUNT OF NITROGEN PER ACRE, OTTAWA, ONT., 1908-1922

——	Rain in Inches	Snow in Inches	Total Precipitation in Inches of Rain	Pounds of Nitrogen per Acre
Year ending February 29, 1908	24·05	133·0	37·35	4·322
" 28, 1909	22·99	96·05	32·63	8·364
" 28, 1910	28·79	80·75	36·87	6·869
" 28, 1911	19·67	73·00	26·97	5·271
" 29, 1912	20·33	104·25	30·76	6·100
" 28, 1913	30·34	96·25	39·96	6·144
" 28, 1914	23·31	84·75	31·78	6·208
" 28, 1915	16·70	86·25	25·34	4·905
" 29, 1916	23·13	105·25	33·65	9·765
" 28, 1917	24·62	118·25	36·44	7·877
" 28, 1918	19·99	128·75	32·86	6·259
" 28, 1919	27·77	77·97	35·59	5·845
" 29, 1920	23·39	98·50	33·23	7·117
" 28, 1921	27·21	66·90	33·90	6·525
" 28, 1922	27·11	79·25	35·05	7·111
Average for 31 years	24·456	92·827	33·730	
" 15 years	24·177	93·228	33·499	6·579

Table II permits a comparison of the annual precipitation and the amounts of nitrogen furnished per acre for the fifteen years of this investigation.

As already pointed out the past year shows a decidedly higher rainfall with a lower snowfall, when compared with the averages for 31 years and 14 years, the total precipitation exceeding the average of the past 31-year period by 1·33 inches and that of the 14-year period by 1·55 inches.

In the amount of nitrogen furnished per acre, 7·111 pounds, the results exceed the average of the 15-year period (6·579 pounds) by ·532 pounds. It is significant to note that the average of 6·579 pounds is equivalent to the nitrogen contained in approximately 42 pounds of nitrate of soda, the most important of nitrogenous fertilizers.

TABLE III.—AMOUNTS OF NITROGEN, FURNISHED BY RAIN AND SNOW, 1908-1922

Year Ending	Total	By Rain		By Snow	
		Pounds	Proportion	Pounds	Proportion
	lbs.		p.c.		p.c.
February 29, 1908	4·322	3·243	75	1·080	25
" 28, 1909	8·364	7·528	90	0·836	10
" 28, 1910	6·869	5·830	85	1·040	15
" 28, 1911	5·271	4·424	84	0·847	16
" 29, 1912	6·100	5·075	83	1·025	17
" 28, 1913	6·144	5·113	83	1·031	17
" 28, 1914	6·208	5·192	84	1·016	16
" 28, 1915	4·905	3·976	81	0·929	19
" 29, 1916	9·756	8·065	83	1·700	17
" 28, 1917	7·877	6·226	79	1·651	21
" 28, 1918	6·259	4·719	75	1·540	25
" 28, 1919	5·845	4·929	84	0·916	16
" 29, 1920	7·117	5·909	83	1·208	17
" 28, 1921	6·525	5·195	80	1·330	20
" 28, 1922	7·111	6·118	86	0·993	14

Table III presents the total nitrogen and the amount and proportion furnished respectively by rain and snow, throughout the fifteen years of the investigation. In the past year, following higher rainfall, the proportion of nitrogen furnished by the

rain somewhat exceeds the average and similarly, with the lower snowfall, the proportion from snow is less than usual; the figures are 86 and 14. The rain furnished 6·118 pounds and the snow ·993 pounds, making the total of 7·111 pounds.

TABLE IV.—AVERAGE NITROGEN-CONTENT OF RAIN AND SNOW—AMOUNT OF NITROGEN PER ACRE AS FREE AND ALBUMINOID AMMONIA AND AS NITRATES AND NITRITES, 1921-22

—	Number of Samples Analysed	Precipitation in Inches	Nitrogen								
			Parts per Million				Percentage of Total			Pounds per Acre	
			In Free Ammonia	In Albuminoid Ammonia	In Nitrates and Nitrites	Total	In Free Ammonia	In Albuminoid Ammonia	In Nitrates and Nitrites	As Free and Albuminoid Ammonia	As Nitrates and Nitrites
Rain.....	82	27·11	0·693	0·056	0·246	0·996	69	6	25	4·581	1·527
Snow.....	28	79·25	0·291	0·086	0·175	0·553	53	15	32	0·675	0·318

The distribution or proportion of the various nitrogen compounds in the rain and snow is shown in table IV. It will be seen that rain is much the richer, especially in free ammonia. These results are closely in accord with those of past years, though an exception is to be noted for the previous year, 1920-21, when, considered weight for weight, the rain and snow were almost of equal value in respect to nitrogen content.

Of the total nitrogen, 7·111 pounds per acre, 5·256 pounds occurred as free and organic ammonia and 1·855 pounds as nitrates and nitrites.

During the twelve months a total of 110 samples were analysed: 82 of rain and 28 of snow.

INVESTIGATIONAL WORK ON SOILS FOR THE RECLAMATION SERVICE

This work is undertaken for and reported to the Reclamation Service of the Department of the Interior; it was entrusted to our care in 1913 and has been carried on continuously in these laboratories since that time. During the year closing March 31, 1922, 89 soil groups comprising about 356 samples have been submitted to analysis.

This work is entirely of an investigational character and may be regarded as falling into two main subdivisions:—

(1) The chemical and physical examination of soils from districts in southern Alberta and southwestern Saskatchewan suspected of containing alkali in quantities deleterious to crop growth and undertaken with the view of assisting in the classification of such lands into irrigable and non-irrigable areas, and (2) the analysis and examination of soils in connection with the Government drainage projects in the northwestern provinces, with the object of determining the suitability and probable agricultural value of the reclaimed areas for cultivation. This latter class calls occasionally for the determination of alkali but is more particularly examined as to the nature and quality of the soil from the farming standpoint.

In connection with the irrigation phase of the work 27 groups, comprising about 108 samples have been analysed. These included groups from the following projects: Rolling Hills, Cypress Lake, Lethbridge Southeastern and Maple Creek.

From Drainage Reclamation projects 62 groups comprising about 248 samples have been examined and reported on, the projects or schemes being as follows: Chip Lake, White Water Lake, Sounding Lake, Manatago, Winigami, Kimiwan. Moose Range, Sullivan Lake, Big Lake, Majean Lake.

Satisfactory progress has been made towards the solution of certain problems incidental to irrigation in the semi-arid belt. The results of this work have been presented to the Royal Society of Canada in two papers entitled "The Vertical Movement of Alkali under Irrigation in Heavy Clay Soils" and "The Alkali content of Soils as related to Crop Growth."

These papers contain the results of the past year's work and a summary to date of the accumulated evidence in these important questions. Conclusions are drawn in respect to the conditions under which heavy clay soils may be safely irrigated, and the limits of tolerance of ordinary farm crops towards the "alkali" characteristic of certain areas in the dry belt of the Canadian Northwest are tentatively given.

During the month of September an inspection trip was made to Alberta and Saskatchewan, primarily to review soil and alkali conditions of the Cypress Hills and Maple Creek Projects. The following extracts from our report upon the visit are of interest: "Our opinion is that the soil and alkali conditions of the "*Maple Creek Project* emphasize very strongly the desirability of instituting plot tests on this area, before reaching a decision in respect to the prosecution of this irrigation scheme."

"*Cypress Lake Project.*—Thirty-four groups were collected, their character noted and their alkali content determined by the electrical bridge. Twenty-seven of these groups furnished data which would permit the classification of the areas involved as safely irrigable, applying the limits for zones A and B provisionally used in the latest classification of the lands of the St. Julien Colony. . . . ." Of the remaining seven groups it is possible that chemical analysis may permit two to be classified as irrigable. According to "bridge results" five groups would be distinctly classed as non-irrigable."

SUGAR BEETS FOR FACTORY PURPOSES

The question is frequently asked, could Canada produce the sugar she requires? Recognizing that there are many important factors of an economic nature which must receive consideration before this inquiry can be fully and satisfactorily answered, there remains one which scientific, systematic investigation in field and laboratory must be called upon to furnish evidence—the quality, i.e., the richness and purity—of sugar beets as grown in various parts of the Dominion.

The present investigation, begun in 1902, has afforded data respecting the richness and purity of leading varieties of factory beets as grown at a number of points from Prince Edward Island in the East to Vancouver island in the West; its results therefore serve to indicate, in a general way, throughout the Dominion the districts in which climatic and soil conditions have proven favorable to the growth of suitable beets for sugar extraction.

For the past six years Canadian-grown seed, supplied through the courtesy of the Dominion Sugar Co., Wallaceburg, Ont., has been very largely used in this experimental work and found eminently satisfactory; the four stocks of seed employed in 1921 were similarly obtained and are designated in the table of results simply by the name of the province or locality in which they were grown, thus, British Columbia, Chatham, Waterloo and Kitchener. The name of the specific variety could not be ascertained, but presumably the parent seed was originally imported from Russia. This seed has been satisfactorily used by the Dominion Sugar Co. in connection with operations of their beet sugar factories at Wallaceburg, Chatham and Kitchener, in southwestern Ontario.

During the past year this inquiry was conducted at eighteen farms, stations and sub-stations of the system as follows: Prince Edward Island: Charlottetown; Nova Scotia: Kentville and Nappan; New Brunswick: Fredericton; Quebec: Lennoxville, Cap Rouge and Ste. Anne de la Pocatière; Ontario: Ottawa; Manitoba: Brandon; Saskatchewan: Rosthern and Scott; Alberta: Lacombe, Lethbridge, Fort Vermilion and Beaverlodge; British Columbia: Agassiz, Invermere and Summerland.

Sugar Beets Grown on the Dominion Experimental Farms, 1921

Variety	Locality where Grown	Percentage of Sugar in Juice	Percentage of Solids in Juice	Coefficient of Purity	Average Weight of one Root		Yield per Acre	
				p.c.	Lbs.	Ozs.	Tons	Lbs.
British Columbia	Charlottetown, P.E.I	16·62	19·34	85·92	1	8	14	500
	Kentville, N.S	18·89	22·17	85·21	..	14	11	
	Nappan, N.S	18·27	20·86	87·56	..	13	..	
	Fredericton, N.B	17·99	21·14	85·11	1	3	..	
	Lennoxville, Que	15·75	19·40	81·19	1	10	10	734
	Cap Rouge, Que	17·49	20·03	87·32	1	2	10	1,240
	Ste. Anne de la Pocatiere, Que	16·51	19·57	84·37	1	5	11	1,876
	Ottawa, Ont	16·21	18·74	86·52	1	2	..	
	Brandon, Man	17·15	20·20	84·87	2	5	10	520
	Rosthern, Sask	14·07	17·34	81·12	..	12	..	
	Scott, Sask	15·61	19·26	81·06	..	10	7	512
	Lacombe, Alta	15·06	20·17	74·66	..	15	5	1,220
	Lethbridge, Alta. (irrigated)	18·27	22·06	82·81	1	..	5	500
	" " (non-irrigated)	15·92	20·06	79·38	..	14	1	1,900
	Agassiz, B.C	17·15	18·68	91·79	1	9	15	1,150
	Invermere, B.C	16·44	19·17	85·76	1	8	10	675
	Summerland, B.C	18·72	21·83	85·74	3	6	10	1,840
Chatham	Charlottetown, P.E.I	16·19	18·94	85·47	1	14	14	
	Kentville, N.S	16·75	20·17	83·05	1	..	15	1,500
	Nappan, N.S	17·21	18·86	91·22	1	..	..	
	Fredericton, N.B	17·26	21·00	82·19	1	2	..	
	Lennoxville, Que	15·78	19·83	79·56	1	6	11	912
	Cap Rouge, Que	16·78	19·20	87·40	1	4	8	1,818
	Ste. Anne de la Pocatiere, Que	18·12	21·57	84·03	1	6	12	1,652
	Ottawa, Ont	14·37	17·57	81·79	1	1	..	
	Brandon, Man	16·06	19·23	83·51	3	1	..	
	Rosthern, Sask	13·59	16·77	81·04	1	3	..	
	Scott, Sask	16·44	20·03	82·10	..	13	6	408
	Fort Vermilion, Alta	14·37	17·34	82·90	2	2	17	200
	Beaverlodge, Alta	16·29	21·26	76·63	..	10	7	1,785
	" " (home grown)	16·35	20·66	79·12	..	13	8	830
	Lacombe, Alta	11·71	15·97	73·31	1	5	6	1,332
	Lethbridge, Alta. (irrigated)	17·35	21·33	81·32	1	1	9	1,000
	" " (non-irrigated)	17·56	21·46	81·83	..	13	2	1,000
	Agassiz, B.C	14·57	16·80	82·83	1	12	14	1,890
	Invermere, B.C	13·32	17·17	77·56	1	12	10	1,888
	Summerland, B.C	21·36	23·83	89·62	2	1	12	1,340

Waterloo	Kentville, N.S.	18·27	21·57	84·70	..	15	9	500
	Nappan, N.S.	17·48	20·46	85·43	..	8	..	
	Fredericton, N.B.	18·35	21·34	86·00	..	15	..	
	Lennoxville, Que.	17·20	20·63	83·37	1	2	8	411
	Cap Rouge, Que.	16·84	20·03	84·10	1	1	8	756
	Ottawa, Ont.	15·93	18·90	84·28	1	1	..	
	Brandon, Man.	17·26	20·43	84·47	1	14	12	840
	Rosthern, Sask.	13·02	16·57	78·56	1	3	..	
	Scott, Sask.	15·32	19·03	80·50	..	12	5	1,784
	Fort Vermilion, Alta.	14·85	17·54	84·67	2	3	16	1,320
	Beaverlodge, Alta.	14·67	19·06	76·98	..	11	8	1,160
	Lacombe, Alta.	14·75	19·27	76·54	1	4	5	164
	Lethbridge, Alta. (irrigated)	18·34	22·06	83·14	1	2	14	1,000
	" " (non-irrigated)	16·41	20·86	78·65	..	10	5	1,100
	Agassiz, B.C.	15·88	18·00	88·22	1	9	14	910
	Invermere, B.C.	17·57	20·20	86·96	1	8	11	813
	Summerland, B.C.	20·90	23·20	90·07	2	15	13	320
Klein Wanzleben (Rimpau)	Kentville, N.S.	18·34	20·97	87·46	1	2	4	360
	Nappan, N.S.	19·36	21·66	89·37	..	14	..	
	Fredericton, N.B.	18·75	22·17	84·57	1	3	..	
	Lennoxville, Que.	15·31	18·63	82·19	1	10	..	
	Ottawa, Ont.	16·30	19·94	81·74	1	4	..	
Kitchener	Rosthern, Sask.	13·54	16·74	80·87	..	7	..	
	Fort Vermilion, Alta.	14·18	17·14	82·73	1	13	18	15
	Summerland, B.C.	19·16	21·80	87·86	3	10	..	
Lot 56, Vilmorin's Improved B	Ottawa, Ont.	14·72	18·57	79·27	1	4	..	
Lot 57, Vilmorin's Improved B	Ottawa, Ont.	16·14	19·50	82·77	..	15	..	

Table I records the results of the analysis and certain other data and information of interest in this inquiry. In the larger number of instances the beets were found to be eminently satisfactory, both as to sugar content and purity. At a few points, however, the roots fell below the standard required for factory purposes. Too much importance should not be attached to the "yields per acre" as recorded in the last column of the table, as these were calculated from the yields of small experimental plots—a method open to objection but the only one in this work which could be adopted.

The nature of soil, manuring, character of season, etc., as obtaining at the several Farms and Stations at which the beets were grown, are briefly reported from the notes of the several superintendents in the following paragraphs. To this account a summarized interpretation of the data in respect to the quality of beets is added.

Charlottetown, P.E.I.—Soil: sandy loam, 6 inches to 10 inches deep, manured 13 tons, autumn 1920, 12 tons, spring, 1921. Subsoil: heavy clay. Previous crop, barley. Sown June 7; pulled October 25. Spring, dry and hot; precipitation, light; summer, very hot and dry, but roots did fairly well; autumn, mild, open, fine growing weather for roots.

While not equal in quality to the beets that have been grown at this Station in certain past seasons, the results indicate beets of good average quality, quite suitable for sugar production. Two varieties only were grown, both showing a sugar content between 16 and 17 per cent and a coefficient of purity of between 85 and 86.

Kentville, N.S.—Soil: sandy loam. Clover the previous season. Spring, 1921, manured 15 tons per acre and nitrate of soda 200 pounds, superphosphate 300 pounds, per acre. Subsoil, gravelly. Sown May 5; pulled October 17. May and June, precipitation 3·84 inches; mean temperature 54·98° F. July and August, precipitation 2·97 inches; mean temperature 65·8° F. September, precipitation 1·82 inches; mean temperature 59·06° F.

The beets are of superior quality and the yields very good. Excellent results have almost invariably been obtained at this Station.

Nappan, N.S.—Soil: medium clay loam about 5 inches deep. Manured 20 tons per acre in spring of 1920 and 15 tons in spring of 1921—present season. In garden (vegetable) crops in 1920. Subsoil: heavy clay. Sown May 20; pulled October 18. May and June, precipitation 2·32 inches. Poor germination and growth. July and August, precipitation 3·13 inches, continued dry weather and abnormal heat, very poor growth, slightly improved in latter part of August. September, precipitation 2·99 inches. October, precipitation 2·07 inches; good growth made in these months. Season was fairly normal as regards temperature, but precipitation for growing period only 65 per cent of average.

The results both as to sugar content and purity are excellent. Our record since 1902 has almost invariably shown the beets grown at this Farm to be of the highest quality. Yields per acre were not calculated.

Fredericton, N.B.—Soil: medium clay loam. Manured 15 tons per acre in spring of 1920 and similar dressing in present season. Subsoil: clay. Sown June 7; pulled October 22. Previous crop: peas, oats and vetch. Spring, very early, dry and warm; summer, hot with little rainfall; autumn, sufficient rainfall in August, September, and October to produce a good crop of beets.

Excellent results both as to sugar content and purity were obtained.

Lennoxville, Que.—Soil: sandy loam about 7 inches deep. No manure in 1920; present season 20 tons to the acre. Previous crops: timothy hay. Subsoil: sand and gravel. Sown May 16; pulled September 29. Spring: May, unusually dry with occasional frosts; precipitation 0·84 inches; mean temperature 53·36° F. June, very dry with wide fluctuations in temperature; precipitation 1·78 inches; mean temperature

60·14° F. July, high temperatures, with mean of 72·94° F.; precipitation 3·62 inches. August, fine and fairly warm; mean temperature 62·09 F.; precipitation 1·87 inches. September, very dry; precipitation 1·49 inches; mean temperature 58·23° F.

The data as to sugar content are fairly satisfactory, distinctly superior to those of 1920, and practically equal to those of 1918 and 1919. Results from this Station have as a rule been below rather than above the average. The coefficient of purity is decidedly low, indicating that seasonable weather conditions were not favourable at this point to the proper ripening of the roots.

Cap Rouge, Que.—Soil: sandy loam. No manure in 1920; present season 20 tons per acre. Previous crop: clover hay. Subsoil: shale. Sown May 6; pulled October 6. Spring, warm, dry and bright; summer, warm with fair precipitation; autumn, warm and rather wet.

The results, both as to quality and yield, are satisfactory.

Ste. Anne de la Pocatière, Que.—Soil: heavy clay. No manure in 1920; present season 20 tons per acre. Previous crop: timothy, preceded by clover. Subsoil: blue clay. Sown May 19; pulled October 19. Spring, very early and fine; precipitation 5·12 inches; mean temperature 57·7° F. Summer, very dry and warm; precipitation 8·80 inches; mean temperature 63·7° F. Autumn temperature about normal; precipitation was light in September but fair (3·69 inches) in October.

Two stocks of seed (British Columbia and Chatham) only were tried at this Station. The sugar content in both was good (16·51 and 18·12 per cent), with satisfactory coefficients of purity.

Ottawa, Ont.—Soil: medium to light sandy loam, in excellent state of fertility. Manured, 15-20 tons in 1920. Subsoil: sand. Spring: the early spring was exceptionally fine, with very welcome rains in late May and early June. Later it became very warm and very dry and vegetation suffered considerably from drought—broken by a heavy rainfall on June 28. Summer: July was exceptionally hot and dry, temperatures registering higher than for any month during the past 31 years. August was dry and warm, with heavy showers from 11th to 14th and again from 18th to 20th. Autumn: September, warm, bright and dry; October, cool and wet.

The results do not rank with the best, though the beets may be considered of average quality and quite suitable for factory purposes.

Brandon, Man.—Soil: deep, rich black loam. No manuring; in summer-fallow 1920. Subsoil: clay. Sown May 18; pulled October 4.. Spring: ample rains in May; good growing conditions in May and early June. Summer: wet to end of June, drought in July; August, hot with fair amount of rain. Autumn: heavy precipitation and no killing frosts in September.

The data indicate richer beets than have usually been grown at this point. In previous reports it has been remarked that only occasionally have beets of high quality been obtained. Seasonal conditions, as a rule, are conducive to a heavy growth but unfavourable to ripening of the beet. The beets are large and the yields very good.

Rosthern, Sask.—Soil: sandy loam, rich; summer-fallowed 1921, no manuring 1922. Subsoil: clay. Sown May 10, pulled September 23. Spring: rather late, but after May 10, warm with plenty of moisture. Summer: moderately warm, rather dry in July. August very dry. Autumn: September, cool and wet.

The beets were of inferior quality, the sugar content being very low and the coefficient of purity much below that required for profitable sugar extraction. The beets grown at this Station since 1911, when this work was begun there, have invariably been of poor quality and we may conclude that seasonal conditions at the northern point are not conducive to a satisfactory beet for factory purposes.

Scott, Sask.—Soil: chocolate clay loam summer-fallowed the previous season; no manuring 1921. Subsoil, reddish clay. Sown June 2 pulled October 6. Spring: late and backward, with ample moisture in May. Summer. very dry through June, July and August. Autumn: heavy rains in September.

The results as to sugar content and purity are fair only; the record indicates that conditions in this district are not favourable to the growth of high quality beets.

Lacombe, Alta.—Soil: rich, chocolate loam summer-fallowed the previous season, no manuring 1922. Subsoil, clay. Sown May 9, pulled October 7.

Spring—						
April	Mean temperature		37·5°F.	Precipitation	2·61	inches
May	"	"	48·7°	"	1·69	"
Summer—						
June	"	"	58·9°	"	1·85	"
July	"	"	60·5°	"	3·62	"
Autumn—						
August	"	"	57·8°	"	0.98	"
September	"	"	46·4°	"	1·49	"

The hottest weather was in June and July; the late summer and autumn months were cool.

The quality of the beets was very poor, both as to sugar content and purity: in no year of this inquiry have the results been good, evidently due to the seasonal conditions being unfavourable to a proper ripening of the crop.

Lethbridge, Alta.—Soil: deep silt-sandy loam, summer-fallowed the previous season, no manuring 1921. Subsoil, chocolate clay. Sown May 18, pulled October 20. Spring, temperature normal; precipitation, slightly above normal. Summer, temperature normal; precipitation low. Autumn: temperature, normal. Precipitation very light—no extremes in temperature. At this Station beets were grown on both irrigated and non-irrigated land.

Irrigated: the quality was excellent, the sugar content (average 17·99 per cent) and purity both being high.

Non-irrigated: these beets, though of good quality were inferior to those from the irrigated plot; the data both for sugar content and purity are lower.

Fort Vermilion, Alta.—Soil: heavy dark loam, manured at the rate of 15 tons in 1920, no manure in 1921. Subsoil, sand or sandy loam. Crop of previous season: oats and barley. Sown May 7, pulled September 13. Spring, cool and dry. Summer, moderately warm with abundant precipitation. Autumn: cool with frequent showers.

The results as to sugar content and purity are decidedly low; while the yields, were very large the quality was too poor for profitable sugar extraction.

Beaverlodge, Alta.—Soil: deep, black loam summer-fallowed the previous season, no manuring 1921. Subsoil: heavy clay. Sown April 30, pulled October 6. Spring: dry and not very favourable to growth. Summer: very dry until midsummer. Autumn: heavy precipitation.

The sugar content of the variety "Chatham" was very fair but that of "Waterloo" was quite low. In both instances the quality as denoted by the coefficient of purity was quite poor. It is of interest to note that beets of the Chatham variety from seed grown at Beaverlodge fully equalled in sugar content those from Ontario grown seed.

Agassiz, B.C.—Soil: deep sandy loam, manured at the rate of 20 tons per acre in 1920 and fertilized in 1921 as follows: superphosphate 350 pounds, nitrate of soda 150 pounds per acre. In pasture the previous season. Subsoil: gravel. Sown May 5, pulled October 10.

Spring—						
May	Mean temperature		54·08°F.	Precipitation	3·58	inches
June	"	"	59·46°	"	5·20	"
Summer—						
July	"	"	62·65°F.	"	2·18	"
August	"	"	63·09°	"	1·81	"
Autumn—						
September	"	"	52·84°F.	"	2·67	"

The British Columbian grown seed gave most excellent results, over 17 per cent sugar with a coefficient of purity exceeding 91. The beets from the other two stocks of seeds were only fair, bringing the average of sugar content down to 15.87 per cent. As a rule the results from this Farm are among the best in the series.

Invermere, B.C.—Soil: light, sandy, silty loam, no manure in 1920, manured at the rate of 12 tons per acre in 1921. Previous crop: wheat. Subsoil: gravel. Sown May 18, pulled September 26.

Spring—					
March, April, May.. ..	Mean temperature	40·94°F.	Precipitation	1·45	inches
Summer—					
June, July, August.. ..	"	57·47°F.	"	3·05	"
Autumn—					
September..	"	47·03°	"	2·56	"

The sugar beet plot was irrigated on June 29 and July 25, the two irrigations furnishing approximately 10 acre-inches of water.

Two of the stocks (British Columbia and Waterloo) furnished excellent data, the beets being rich in sugar and of good quality; for some unexplained reason the results from the Chatham seed indicated a poor beet, both as to sugar content and purity.

Summerland, B.C.—Soil: sandy loam, manured 1920 at the rate of 20 tons per acre and similarly in 1921. Subsoil: sand. Crop of previous season: oats and peas. Sown March 30, pulled October 4.

Spring—					
March..	Mean temperature	38·97°F.	Precipitation	·75	inches
April..	"	44·87°	"	1·13	"
May..	"	56·15°	"	1·30	"
Summer—					
June..	"	63·60°F.	"	1·90	"
July..	"	68·45°	"	·34	"
August..	"	67·92°	"	·98	"
Autumn—					
September..	"	55·21°	"	·39	"
October..	"	48·95°	"	·25	"

The sugar beet plots were irrigated as follows:—

May, 1·29; June, 3·98; July, 26·98; August, 3.83. Total, 36.08 acre inches.

The results are the best in the series and exceptionally high, the average sugar content for the three stocks of seed being 20.03 per cent. The coefficient of purity is practically 90 for two of the samples, while the yields in all three cases rank with the best.

Summary.—Three stocks of seed were grown at eighteen Farms and Stations of the System. From eleven of these the beets were of excellent quality, rich in sugar and with a high coefficient of purity; from four points the beets were of medium quality only but could be satisfactorily used; from three districts—all in the extreme northern parts of Saskatchewan and Alberta—the beets were too poor for profitable sugar extraction.

Averages of "sugar in juice" and of "coefficient of purity" for the three stocks of seed, obtained from the data from eighteen Farms and Stations, may be tabulated as follows:—

TABLE II.—AVERAGES: SUGAR IN JUICE AND COEFFICIENT OF PURITY, 1921

Origin of Seed	Sugar in Juice	Coefficient of Purity
	p.c.	p.c.
British Columbia	16·83	84·14
Chatham, Ont.	16·07	81·91
Waterloo, Ont.	16·65	83·01

These results are slightly better than those of the previous season and indicate a very fairly satisfactory beet for factory purposes.

KLEIN WANZLEBEN (Rimpau).—This is a well-known factory variety and the seed used in this experiment was imported from Germany and obtained through the courtesy of Messrs. Roeker & Son, New York. It was grown at five Stations in Eastern Canada and, as will be seen from table I, excellent results both as to sugar content and purity were obtained at four of the points. In Nova Scotia and New Brunswick the data denote particularly good beets.

VILMORIN'S IMPROVED B.—The seed of this variety was imported from the well-known sugar beet breeders, Vilmorin, Andrieux et Cie, Paris, France. The results obtained at the Central Farm, Ottawa, from the two strains of this variety, designated No. 56 and No. 57 in table I, are not very satisfactory, but as all the varieties grown at Ottawa last season (1921) furnished data somewhat below the average, it would seem that unfavourable seasonal conditions at this point are responsible for the poor results noted.

TABLE *III*—AVERAGE PERCENTAGE OF SUGAR IN JUICE IN SUGAR BEETS GROWN ON DOMINION EXPERIMENTAL FARMS, 1902-1921

Locality	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911
Charlottetown, P.E.I.	.....	.....	.....	.....	.....	.....	.....	.....	14·25	17·23
Kentville, N.S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nappan, N.S.	15·87	15·33	14·41	16·52	17·08	.....	17·53	16·74	16·43	17·56
Fredericton, N.B.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lennoxville, Que.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cap Rouge, Que.	.....	.....	.....	.....	.....	.....	.....	.....	.....	16·16
Ste. Anne de la Pocatière, Que.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
La Ferme, Que.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ottawa, Ont.	16·77	15·34	16·91	12·45	14·37	15·44	16·30	14·84	16·44	.....
Brandon, Man.	.....	11·36	16·62	11·09	15·50	16·99	15·82	18·83	18·40	13·50
Rosthern, Sask.	.....	.....	.....	.....	.....	.....	.....	.....	.....	13·30
Scott, Sask.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Indian Head, Sask.	15·15	16·54	15·24	14·94	14·91	15·92	15·66	17·16	.....	14·48
Fort Vermilion, Alta.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Beaverlodge, Alta.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lacombe, Alta.	.....	.....	.....	.....	.....	13·34	11·21	12·72	12·69	.....
Lethbridge, Alta. (irrigated)	.....	.....	.....	.....	.....	.....	16·09	17·91	.....	17·02
Lethbridge, Alta. (non-irrigated)	.....	.....	.....	.....	.....	.....	16·73	18·36	.....	14·05
Agassiz, B.C.	.....	17·44	8·10	17·32	14·28	17·65	17·15	18·30	19·18	19·95
Sidney, B.C.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Invermere, B.C.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Summerland, B.C.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Locality	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921
Charlottetown, P.E.I.	15·31	15·68	17·94	21·05	18·51	19·09	16·74	18·38	15·44	16·40
Kentville, N.S.	.....	17·17	17·07	18·00	18·51	19·48	19·83	19·25	18·36	18·06
Nappan, N.S.	16·68	19·17	17·79	16·45	18·49	20·20	20·10	17·83	18·01	18·03
Fredericton, N.B.	.....	.....	15·98	17·15	18·90	17·93	17·99	20·94	18·84	18·09
Lennoxville, Que.	.....	.....	.....	18·90	.....	.....	15·98	15·91	14·55	16·01
Cap Rouge, Que.	14·92	19·94	14·38	17·33	16·48	11·87	18·47	16·88	16·69	17·04
Ste. Anne de la Pocatière, Que.	.....	.....	.....	18·00	16·98	12·82	10·93	18·89	13·24	17·31
La Ferme, Que.	.....	.....	.....	.....	.....	.....	.....	16·05	.....	.....
Ottawa, Ont.	17·59	16·48	19·84	17·30	13·82	16·37	16·86	17·79	15·09	15·61
Brandon, Man.	13·40	13·92	12·06	15·90	14·09	16·08	15·91	.....	15·24	16·82
Rosthern, Sask.	14·63	15·61	12·69	10·06	12·99	15·51	15·25	.....	14·15	13·56
Scott, Sask.	.....	.....	14·67	13·96	13·84	18·12	15·26	14·39	15·74	15·79
Indian Head, Sask.	15·78	20·73	16·54	18·93	19·86	19·42	14·11	15·68	20·24	.....
Fort Vermilion, Alta.	.....	.....	.....	.....	.....	17·31	9·96	17·35	.....	14·47
Beaverlodge, Alta.	.....	.....	.....	.....	.....	.....	.....	.....	.....	15·77
Lacombe, Alta.	.....	12·67	.....	9·56	15·78	.....	.....	.....	12·86	13·84
Lethbridge, Alta. (irrigated)	17·41	19·54	12·95	18·33	18·70	18·99	15·94	14·31	18·34	17·99
Lethbridge, Alta. (non-irrigated)	17·68	19·33	14·23	18·43	17·64	18·54	.....	.....	19·35	16·63
Agassiz, B.C.	11·53	18·08	17·07	17·76	19·03	16·96	17·20	17·02	16·46	15·87
Sidney, B.C.	.....	.....	15·20	19·03	21·06	17·20	.....	17·98	14·29	.....
Invermere, B.C.	.....	.....	19·04	18·90	21·54	.....	15·14	14·72	19·26	15·78
Summerland, B.C.	.....	.....	.....	.....	18·91	18·35	18·07	.....	16·85	20·03

In table III averages as regards the sugar content in juice for the period 1902-1921 inclusive, are presented.

In the larger number of instances the results are quite satisfactory, supporting the conclusion that beets suitable for sugar extraction may be grown at many widely distant points in the Dominion.

The average sugar in juice content of the beets from one Station was over 20 per cent, from three of the eighteen localities was between 18 and 19 per cent; at three, between 17 and 18 per cent; at four, between 16 and 17 per cent; at five, between 15 and 16 per cent; thus, at 16 points the sugar in juice was over 15 per cent. The average for the entire series was 16.48 per cent.

FIELD ROOTS

As a succulent winter forage there is no doubt that corn silage has very largely displaced field roots in many parts of the Dominion, especially in those districts devoted more particularly to dairying. In digestible dry matter per acre, corn is assuredly the more economical crop—and it has other excellent features to commend it. The place of corn, as silage, among the most important Canadian forages, is firmly and permanently established.

Nevertheless, it is well not to overlook the importance of field roots in the scheme of feeding, for though they cannot compete with corn on the ground of economy it can be shown that it is highly advantageous to use them as a part of the succulent ration. Field roots have a dual value, nutritive and medicinal, in the ration of farm stock. They are palatable, appetizing, wholesome and digestible. They have an appreciable feeding value, for though low in protein and practically destitute of fat, they contain notable amounts of readily assimilable sugar and pectin-carbohydrates capable of furnishing much heat and energy to the system. Their particular value, however, chiefly lies in the fact that they are most useful in maintaining the health and thrift of the animal. This is generally considered as largely due to their potash compounds, in which they are fairly rich.

As already remarked, the nutritive value of roots depends largely on their percentage of dry matter and the richness of this dry matter in sugar. This investigation, dating from 1904, has shown that large differences in composition between varieties or strains of the same class of farm roots, exist and therefore that the determination of the relative feeding values, as measured by dry matter and sugar of the more common varieties on the market, is a matter worthy of attention. It has further been demonstrated by work carried on for almost twenty years with the Gate Post and Giant Yellow Globe varieties of mangels that heredity may markedly influence the composition of field roots—a study of scientific interest and practical value.

The work to be recorded for the season of 1921 includes the analysis of the several varieties and strains of mangels and carrots grown by the Division of Forage Plants at the Central Experimental Farm, Ottawa. The turnip crop was a complete failure owing to rot—hence the absence of chemical data from this class of field root in the series.

MANGELS

This series comprises forty-one varieties, a number of which were grown this past season for the first time at Ottawa. The varieties have been arranged in table I in the order of their richness in dry matter. It will be observed that in a general way, but not invariably, the sugar content follows the dry matter. The size of the roots analysed (each sample consisted of twelve roots) is indicated by the "average weight of one root," recorded in the last column of the table.

TABLE 1—ANALYSIS OF MANGELS, C.E.F., OTTAWA, ONT., 1921

Variety	Source of Seed	Dry Matter	Sugar in Juice	Average Weight of One Root	
		p.c.	p.c.	Lbs.	Oz.
McKee	Ottawa	13·20	7·73	1	12
Dagg	"	13·10	7·54	2	3
Prize Mammoth Long Red	Macdonald Bros.	13·00	5·75	2	10
Lazenby	Ottawa	12·60	7·05	2	4
Mammoth Long Red	Steele Briggs	11·67	5·05	2	9
Rose Giant	Scandinavian & R. Wibolt	10·75	4·54	3	1
Giant Yellow Intermediate	Wm. Ewing	10·57	4·87	3	2
Yellow Intermediate	Ottawa	10·57	4·06	2	15
Giant Half Sugar White	Macdonald Bros.	10·51	4·16	2	8
Improved Giant Sugar Beet	Rennie	10·44	3·85	2	10
Yellow Intermediate	Ottawa, check	10·35	3·36	3	2
Giant White Green Top	Scandinavian and R. Wibolt	10·31	4·06	3	0
Selected Long Red Mammoth	Wm. Ewing	10·26	4·16	3	2
Perfection Mammoth Long Red	Rennie	10·18	4·16	2	8
Improved Danish Sugar Beet	Macdonald Bros.	10·04	4·56	2	11
Selected Giant Rose Intermediate Sugar Beet	Wm. Ewing	9·96	4·34	3	1
Sludstrup	Scandinavian & R. Wibolt	9·90	4·35	2	13
Rose Feeding Sugar Beet	Weibull	9·81	4·05	3	17
Royal Giant Sugar Beet	Steele Briggs	9·77	4·16	2	13
Giant Yellow Intermediate	Macdonald Bros.	9·71	4·25	2	16
Danish Sludstrup	"	9·57	3·53	3	1
Giant White Sugar	Rennie	9·47	3·74	2	15
Giant Half Sugar	Steele Briggs	9·43	3·46	3	6
Giant Yellow Globe	Wm. Ewing	9·32	4·06	2	11
Giant Yellow Half Long Intermediate	Rennie	9·16	3·33	3	5
Golden Tankard	Macdonald Bros.	9·11	3·77	2	1
No. 4	Svalof	9·02	3·75	3	9
Sarrimer	Weibull	8·93	3·55	3	4
Giant White Half Sugar Mangel	Wm. Ewing	8·81	3·24	3	3
Yellow Oval Giant	Scandinavian & R. Wibolt	8·75	3·86	3	10
Jumbo Sugar Beet	Rennie	8·70	3·55	2	15
Danish Sludstrup	Wm. Ewing	8·61	2·84	3	10
No. 2	Svalof	8·57	2·65	3	10
No. 3	"	8·46	3·46	4	2
Eckendorffer Red	Macdonald Bros.	8·44	2·13	3	1
No. 1	Svalof	8·43	3·14	3	5
Cylinder Barres	Weibull	8·24	3·05	3	4
Eckendorffer Red	"	8·08	3·15	3	6
Selected Yellow Globe	Steele Briggs	7·86	2·44	2	8
White Sugar	"	7·71	1·74	3	0
Yellow Globe	Macdonald Bros.	7·55	2·77	2	11

The range or "spread" in dry matter content is fully equal to that found in past years; it indicates wide differences in nutritive value among the varieties examined.

The richest root contains 13.20 per cent dry matter and 7.73 per cent sugar, while the poorest in the series contains 7.55 per cent dry matter and 2.77 per cent sugar. The former is worth, weight for weight, almost twice as much as the latter. From a study of this table the value of this inquiry, as an aid to the farmer in the selection of varieties to grow, will be obvious.

From the yield per acre and the percentage of dry matter, the amount of dry matter per acre can be calculated. This has been done for the twelve varieties in the series giving the highest yields, and the results are recorded in table II. (Yields per acre were not obtainable for a number of the varieties recorded in table I.)

TABLE II.—MANGELS: DRY MATTER PER ACRE, 1921

Variety	Source of Seed	Dry Matter		
		Per Cent	Per Acre	
			Tons	Lbs.
Prize Mammoth Long Red	Macdonald Bros.	13·00	3	815
Yellow Intermediate	C.E.F., Ottawa	10·35	3	379
"	"	10·57	3	138
Danish Sludstrup	Macdonald Bros.	9·57	3	43
Giant Yellow Intermediate	Wm. Ewing	10·57	2	1,953
Selected Long Red Mammoth	"	10·26	2	1,913
Rose Giant	Scandinavian & R. Wibolt Ltd.	10·75	2	1,804
Sludstrup	"	9·90	2	1,762
Danish Sludstrup	Wm. Ewing	8·61	2	1,632
Giant White Green Top	Scandinavian & R. Wibolt Ltd.	10·31	2	1,518
Yellow Ovid Giant	"	8·75	2	1,403
Mammoth Long Red	Steele Briggs	11·67	2	1,314
Royal Giant Sugar Beet	"	9·77	2	1,301
Improved Danish Sugar Beet	Macdonald Bros.	10·04	2	1,233
Selected Giant Rose Intermediate Sugar Beet	Wm. Ewing	9·96	2	1,218
Giant White Half Sugar	Macdonald Bros.	10·51	2	1,215
Giant Yellow Intermediate	"	9·71	2	1,184
Giant White Half Sugar Mangel	Wm. Ewing	8·81	2	1,135
Improved Giant Sugar Beet	Wm. Rennie	10·44	2	1,048
Eckendorffer Red	Macdonald Bros.	8·44	2	1,036
Giant Yellow Globe	Wm. Ewing	9·32	2	953
Perfection Mammoth Long Red	Wm. Rennie	10·18	2	942
White Sugar	Steele Briggs	7·71	2	930
Giant White Sugar	Wm. Rennie	9·47	2	781
Jumbo Sugar Beet	"	8·70	2	571
Giant Yellow Half Long Intermediate	"	9·16	2	534
Giant Half Sugar	Steele Briggs	9·43	2	323
Yellow Globe	Macdonald Bros.	7·55	2	185
Selected Yellow Globe	Steele Briggs	7·86	1	1,876
Golden Tankard	Macdonald Bros.	9·11	1	1,863

It is significant and of considerable interest to note that of the twelve best yielders, seven are among the best twelve rated according to dry matter content.

TABLE III.—MANGELS—YIELD AND AVERAGE COMPOSITION, 1904-1921

Year	Number of Varieties Analysed	Average Weight of One Root		Dry Matter	Sugar
		Lbs.	Oz.	p.c.	p.c.
1904	10	2	11	11·69	6·62
1905	17	3	9	10·04	4·67
1906	16	2	7	11·63	5·93
1907	10	2	11	12·64	7·46
1908	12	2	2	11·87	5·33
1909	14	3	5	11·21	6·21
1910	8	5	10	10·04	4·46
1912	23	2	9	9·51	6·43
1913	13	2	14	10·51	5·63
1914	24	2	1	12·79	7·75
1915	36	3	9	9·25	4·27
1916	26	2	–	8·86	2·66
1917	31	1	15	12·64	6·72
1918	13	2	4	11·78	6·13
1919	80	–	14	12·58	6·26
1920	42	3	8	9·18	4·07
1921	41	3	0	9·73	4·00
Average for 17 years		2	12	10·93	5·56

The averages obtained in this investigation since 1904 are presented in table III. The results for 1921 are higher than those of the preceding year but somewhat lower than the averages for the past seventeen years. This is largely accounted for in the trying out in recent years of a number of newly introduced varieties and strains which have proved of low feeding value.

CARROTS

Thirteen varieties of carrots were submitted to analysis, the larger number of which are to be found in the lists of preceding years.

As with mangels, a very considerable range in dry matter content is to be observed from 12·09 per cent to 7·95 per cent. This denotes a large difference in feeding value.

TABLE IV.—ANALYSIS OF CARROTS, CENTRAL EXPERIMENTAL FARM, OTTAWA, ONT.

Variety	Source of Seed	Percentage of Dry Matter	Percentage of Sugar in Juice	Weight per Root	
				Lbs.	Oz.
Danvers Half Long	Macdonald Bros.	12·09	2·62	–	14
Improved Inter. White	Wm. Ewing	11·62	2·02	1	–
Improved White Vosges	Macdonald Bros.	11·25	1·82	1	2
Danish Champion	Ottawa	11·06	3·43	1	–
Improved Short White	Macdonald Bros.	10·59	2·73	1	6
Yellow Belgian	Wm. Ewing	9·96	3·01	–	13
White Belgian	Scandinavian & Wibolt Co.	9·74	1·93	–	14
Danish Champion	Macdonald Bros.	8·95	1·93	1	1
Improved White Belgian	"	8·82	1·82	1	–
Improved White Belgian	Steele Briggs	8·56	1·62	1	–
Danish Yellow Champion	Scandinavian & Wibolt Co.	8·37	2·62	1	2
Mammoth White Interm	Rennie	8·29	2·02	1	4
Large White Belgian	Steele Briggs	7·95	1·42	–	12

The averages for the past sixteen years are presented in table V. The results show an improvement over those of 1920 but the carrots are poorer as regards both dry matter and sugar than indicated by the averages for the experimental period.

TABLE V.—CARROTS, YIELD AND AVERAGE COMPOSITION, 1905-1921

Year	Number of Varieties Analysed	Average Weight of one Root		Dry Matter	Sugar
		Lbs.	Ozs.	p.c.	p.c.
1905	11	1	3	10·25	2·52
1906	10	1	2	10·59	3·36
1907	6	1	1	10·30	3·02
1908	6	1	3	10·89	3·34
1909	6	1	..	10·40	2·30
1910	5	1	..	10·17	3·23
1912	6	1	1	10·50	2·54
1913	6	1	8	9·11	2·11
1914	8	..	10	11·42	2·62
1915	10	..	6	10·08	1·86
1916	10	..	7	11·40	2·87
1917	13	..	10	12·69	2·92
1918	3	..	6	12·13	5·30
1919	36	..	7	12·04	2·79
1920	15	1	7	9·48	2·25
1921	13	1	4	9·78	2·23
Average for 16 years	.....	..	15	10·70	2·83

Table VI permits a comparison of the averages of these three classes of field roots for the experimental period.

TABLE VI.—AVERAGE COMPOSITION OF MANGELS, TURNIPS AND CARROTS

Class of Root	Average for Period of	Dry Matter	Sugar
		p.c.	p.c.
Mangels	17 years	10·93	5·56
Turnips	15 "	10·63	1·27
Carrots	16 "	10·70	2·83

THE DEVELOPMENT OF THE WHEAT KERNEL

During the summer of 1917 the Dominion Cerealist, Dr. Charles E. Saunders, in a study of the development of the wheat kernel with the view to determine the effects of premature harvesting, collected and examined several series of heads of Marquis wheat grown at Ottawa and cut at intervals of two or three days between July 21 and August 15. The Division of Chemistry co-operated in this work, with the object of obtaining information as to the influence of maturity on the protein content of the kernel. To this end the kernels of two of the series, that cut with 3 inches of straw, and that cut with full length straw were submitted to analysis.

The results of this examination were presented in detail in the report of this Division for last year (year ending March 31, 1921) and need not be inserted here, but in view of the repetition of the work during the summer of 1921, it will be desirable to repeat the main conclusions reached on the 1917 series.

The results showed "(*a*) that protein is deposited throughout the whole period of development of the kernel and that (*b*) the rate of deposition is most rapid at about the time when the kernel is gaining most rapidly in weight, and that (*c*) during the first few days of the experiment the deposition of other material was relatively more rapid than that of protein, so that the percentage of protein actually decreased. However, as the period of greatest physiological activity approached, the proportion of protein rose again. The percentage of protein did not change materially during the last ten days of the experiment."

Although the results of 1917 were considered as fairly satisfactory, the Dominion Cerealist deemed it desirable to repeat the experiment with some additional precautions, in 1921, and this Division has again co-operated to the extent of determining the protein content of the kernels of three series, the particulars of which are as follows:—

Prelude Wheat, (*a*) kernels removed at once from the head, (*b*) kernels from heads with 6 inches of straw attached, and (*c*) kernels from heads with full length straw attached. The heads of (*a*) and (*b*) were allowed to dry out under room (office) conditions, series (*c*) with full length straw was left in the field to ripen under stook conditions.

The first collection was made June 27 and the last July 13, so that the period of investigation covered sixteen days. The intervals between collections were usually two days, but in one or two instances, three days. In all, six collections were made. It was expected that at least ten collections would be made, but owing to continuous hot dry weather the wheat ripened with unusual rapidity.

The accompanying table gives the dates of cutting, the weight of 1,000 kernels and the percentage of protein calculated to the dry matter basis.

It will be observed (1) that in all three series there is a constant increase in the weight of kernel from the date of the earliest cutting (June 27) to that of the latest cutting (July 13).

(2) That in all three series the increase in the weight of kernel is most marked in the intervals from June 27 to July 4, reaching a maximum in the interval July 1-4; subsequent to this latter date and to the date of the final collection, this increase diminishes.

(3) One apparent exception occurs in respect to this continuous increase in the weight of kernel. There is a very slight loss in weight in the series ("Heads with six inches of straw") in the interval July 8-11. This, it is to be noted, is the period characterized by slackened physiological activity, as measured by reduced increases of weight in both the other series.

(4) Comparing the weights of kernel of the several series at the same date, it is to be noted that from June 27 to July 6, the weight of the kernel in the third series—heads with full length straw—is decidedly heavier than that of the other two series, clearly indicating that the kernel continues to develop after cutting, at this stage, when the heads are left with full length of straw—field or harvesting conditions.

(5) In all three series the percentage of protein in the kernel decreases slightly from the first collection (June 27) to the third collection (July 1). It then steadily rises to the close of the experiment, though very slowly during the interval July 8-13, a period very largely of drying out.

The decrease in the *percentage* of protein, marked in the earlier intervals, is to be accounted for by the relatively more rapid deposition of carbohydrates at this period of development.

(6) The data for "grams of protein per 1,000 kernels" clearly prove, as in the previous experiment, that the deposition of protein continues throughout the period of the development of the kernel. This is observable in all three series, the increase in weight of this constituent per 1,000 kernels, from one period of collection to the next being most marked until about July 6.

The results confirm those of the previous experiment and are in entire agreement with those obtained by the writer some years ago in studies relating to the development and ripening of the wheat kernel.

PRELUDE WHEAT: PROTEIN AND WEIGHT OF KERNEL

Laboratory Nos. 57368-57391 (Protein calculated to dry matter basis).

Date of Cutting	Kernels Removed at Once			Heads with 6-inch Straw			Heads with Full Length Straw		
		Protein			Protein			Protein	
	Weight of 1,000 Kernels	Per cent	Grams per 1,000 Kernels	Weight of 1,000 Kernels	Per cent	Grams per 1,000 Kernels	Weight of 1,000 Kernels	Per cent	Grams per 1,000 Kernels
	Grams.			Grams.			Grams.		
27-6-21.....	11·24	18·64	1·93	11·27	18·70	1·93	13·17	19·73	2·37
29-6-21.....	15·26	17·24	2·41	15·20	18·43	2·57	18·31	19·48	3·25
1-7-21.....	18·73	17·26	2·97	18·71	17·31	2·94	19·91	18·25	3·29
4-7-21.....	24·29	18·07	3·99	25·14	18·40	4·18	25·17	18·88	4·33
6-7-21.....	27·60	18·64	4·65	28·29	18·80	4·83	29·16	18·80	4·97
8-7-21.....	30·21	19·28	5·25	30·37	19·07	5·24	29·18	19·21	5·09
11-7-21.....	30·55	19·58	5·29	30·35	19·00	5·22	29·62	19·38	5·24
13-7-21.....	30·92	19·51	5·47	30·79	19·53	5·44	30·59	19·70	5·41

WESTERN RYE GRASS

In Bulletin No. 19, "Grasses: Their Uses and Composition," September, 1893, we wrote concerning western rye grass (*Agropyrum tenerum*): "This grass has succeeded remarkably well under cultivation and is one of the best western hay grasses, producing a large number of leaves and straight slender stems. It is an early grass, and does well on heavy soil, even when impregnated slightly with alkali. Judging from its composition, it compares very favourably with the other members of the family, being of good quality and nutritive."

The statements and opinions expressed in the foregoing paragraph have received wide confirmation during the past twenty-nine years and the value and importance of this grass are now well and widely recognized throughout the western Prairie Provinces.

In a study of the many wild forms of this grass in their natural habitat, Dr. M. O. Malte, Dominion Agrostologist, observed that "Western rye grass forms were normally self-fertilized." This was a discovery of more than scientific interest. This mode of fertilization, Dr. Malte argued, would permit of the development of a vast number of distinct varieties from which improved strains might be selected.

With the view of testing the soundness of this conclusion—that the seed would breed true to type—and of developing if possible varieties superior in yield, seed-producing capacity, etc., to those now grown, the Dominion Agrostologist collected seed from a large number of wild forms chiefly in Western Canada. These were grown at Ottawa in 1919, 1920 and 1921, in which latter year the plants had reached full development, permitting a study of their relative agricultural value. In this investigation the Division of Forage Plants harvested in 1921 some 130 varieties for comparison of hay and seed yield. A number (34) of the more desirable and promising of these, as judged by field results, were submitted to this division in the hope that the additional chemical data so obtained would be of assistance in a further selection of plants from which to carry on tests at Ottawa and the western farms and stations. These thirty-four, therefore, constitute an important series, selected by virtue of their yields, seed production and characteristics; their analytical data, now presented in the accompanying table, allows a comparison on the basis of composition and will permit of a further selection according to nutritive value.

The samples submitted for analysis were all collected when the plants were approximately at one and the same stage of growth—full bloom—placing the results on a strictly comparable basis.

DISCUSSION OF DATA

The dry matter content of the plants as cut varies greatly. This is significant when we remember that all the members of the series were approximately at the same stage of growth when collected for analysis. These differences may be accounted for in large part by varying proportions of leaf and stem. They may, we consider, be largely attributed to distinct typal or varietal characteristics, denoting from the practical standpoint a real difference in yield of nutritive matter. Probably this explanation or consideration may not fully account for the wide differences to be observed throughout the series, but we believe that no other possible factor has had the same influence. These results may be taken as exemplifying the value of chemical analyses in an investigation of this character and serve to emphasize the fallacy of depending solely on the gross weight of green material to determine the relative yields of nutritive matter per acre.

The range of dry matter is from 27·87 to 69·33 per cent, and the average in this datum for the series 44·89 per cent. If the results of this examination may

Laboratory Number	Variety Number	Date of Cutting	Fresh Material						Dry Matter				
			Moisture	Protein	Fat	Carbo-hydrates	Fibre	Ash	Protein	Fat	Carbo-hydrates	Fibre	Ash
55439	5	23–6–21	55·01	3·41	1·12	20·85	17·60	2·01	7·57	2·49	46·36	39·11	4·47
55440	17	23–6–21	30·67	5·02	1·56	32·61	26·83	3·31	7·23	2·26	47·03	38·71	4·77
55441	18	23–6–21	46·52	4·18	1·10	25·19	20·49	2·52	7·81	2·06	47·09	38·32	4·72
55442	19	23–6–21	55·90	4·55	1·09	20·53	15·51	2·42	10·31	2·49	46·55	35·16	5·49
55443	20	23–6–21	51·56	5·26	1·23	22·90	16·46	2·59	10·85	2·53	47·28	33·99	5·35
55444	21	23–6–21	54·65	5·58	1·04	20·76	15·19	2·79	12·30	2·30	45·76	33·49	6·15
55446	82	23–6–21	55·83	4·28	0·90	20·50	16·25	2·24	9·65	2·04	46·43	36·80	5·08
55447	83	23–6–21	68·06	2·75	0·69	14·93	12·00	1·57	8·64	2·15	46·73	37·58	4·90
55448	84	23–6–21	57·81	3·97	0·97	19·85	15·09	2·31	9·41	2·29	47·05	35·77	5·48
55449	86	23–6–21	59·23	3·99	0·75	18·53	15·28	2·22	9·80	1·83	45·43	37·47	5·45
55450	91	23–6–21	64·87	4·20	0·61	15·23	12·93	2·16	11·95	1·77	43·33	36·81	5·14
55451	98	23–6–21	55·59	4·40	1·16	20·27	16·50	2·07	9·90	2·62	45·64	37·17	4·67
55513	93	27–6–21	61·63	3·89	0·73	16·30	15·16	2·29	10·13	1·89	42·52	39·51	5·95
55567	64	30–6–21	61·01	4·48	0·71	16·91	14·06	2·83	11·51	1·83	43·35	36·84	7·27
55570	89	30–6–21	48·21	5·59	1·06	22·23	19·10	3·81	10·80	2·05	42·92	36·88	7·35
55568	65	30–6–21	72·13	3·79	0·38	11·19	10·40	2·11	13·59	1·34	40·17	37·33	7·57
55569	85	30–6–21	38·07	6·70	1·22	27·26	22·91	3·84	10·82	1·97	44·01	36·99	6·21
55571	92	30–6–21	68·93	3·37	0·60	12·63	12·33	2·14	10·85	1·85	40·64	39·78	6·88
55573	109	30–6–21	53·17	5·47	0·71	19·02	17·84	3·79	11·67	1·52	40·60	38·10	8·11
55574	118	30–6–21	61·48	3·81	0·70	17·44	13·80	2·77	9·89	1·81	45·27	35·82	7·21
55579	3	30–6–21	57·68	4·16	0·69	17·64	17·66	2·17	9·82	1·62	41·69	41·74	5·13
55580	6	30–6–21	57·20	3·47	0·69	20·18	15·58	2·88	8·10	1·61	47·18	36·41	6·70
55581	7	30–6–21	49·56	4·29	1·10	21·77	20·52	2·76	8·49	2·18	43·17	40·68	5·48
55582	8	30–6–21	57·62	3·87	0·89	19·76	15·68	2·18	9·13	2·10	46·63	37·00	5·14
55583	9	30–6–21	53·11	3·79	1·04	20·26	17·94	3·86	8·09	2·22	43·20	38·20	8·25
55584	10	30–6–21	54·31	4·04	0·97	21·14	17·35	2·18	8·85	2·13	46·28	37·96	4·78
55585	11	30–6–21	60·00	3·44	0·67	17·67	15·81	2·41	8·60	1·68	44·16	39·54	6·02
55586	14	30–6–21	.....	.....	.....	.....	.....	.....	10·30	1·71	42·75	38·90	6·34
55588	16	30–6–21	51·81	4·67	0·98	20·73	18·06	3·75	9·68	2·04	43·03	37·49	7·76
55589	51	30–6–21	64·18	3·39	0·76	15·31	13·95	2·40	9·48	2·14	42·72	38·94	6·72
55590	56	30–6–21	63·74	4·69	0·69	14·64	13·45	2·79	12·95	1·90	40·37	37·10	7·68
55591	60	30–6–21	65·27	4·03	0·71	13·55	13·80	2·63	11·60	2·05	39·04	39·75	7·56
55593	63	30–6–21	60·20	4·63	0·80	17·59	14·25	2·53	11·62	2·01	44·20	35·81	6·36
55594	70	30–6–21	58·68	4·89	0·72	16·82	16·45	2·44	11·83	1·75	40·70	39·81	5·91

be depended on, and there seems no reason to doubt them, analysis has shown wide differences per plant among the several types in food value, i.e., presuming they are all equally digestible, a fair presumption under the circumstances.

Discussing the composition of the dry matter of the several types as revealed by the data set forth in the table, we may note, first, that the range in protein is from 7·23 to 13·59 per cent, the average of the thirty-four samples for this nutrient being 9·87 per cent.

Protein constitutes by far the most important and valuable of all the nutrients and hence the significance to be attached to the results under this caption. The difference between the extremes is almost 100 per cent—a very long range for a series of plants of the same family, of the same age, and cut at the same stage of growth. When considered in conjunction with "yield" and other desirable field characteristics, it would appear that the protein content might be of notable assistance in the work of selection.

Secondly, the fibre content of the dry matter may be briefly considered. Fibre is the least valuable of the constituents of a fodder or forage crop; in the fully matured or ripened plant it becomes of little real food value because of its low digestibility.

The range in fibre in this series is from 33·49 to 41·74 per cent, the average being 37·64 per cent. Other things being equal, a low fibre content must be considered a desirable feature. The difference here accorded are not of the same magnitude as those in protein content, but they are appreciable. It is therefore probable that while not of the same diagnostic value or importance as the protein data, those for the fibre may serve in differentiating the varieties, and in the selection of those types most worthy of further study.

CLOVER HAY

An experiment conducted at the Experimental Station at Cap Rouge, Quebec, had for its object the determination of the value of the clover crop from an area from which both first and second cuttings were cured as hay, as compared with that from an adjacent area yielding a first cutting as hay, the second growth or aftermath being allowed to seed before cutting and then threshed. A third plot was cut but once—after seeding—and then threshed.

The analysis of these several cuttings being necessary to determine their nutritive value, samples were forwarded as harvested and their composition ascertained. In the accompanying table the essential particulars of the experiment and the analytical data, are presented.

DISCUSSION OF DATA

A cursory examination of these results reveals the fact that wide differences in composition—especially in protein, the most valuable nutrient, and in fibre, the least valuable—exist between the several cuttings. These differences are not merely of scientific interest; they must be regarded as denoting real and large differences in nutritive value of the several cuttings, and hence of practical economic importance to all farmers, but especially to those contemplating clover seed production. The results, calculated to a water-free basis, permit a strict comparison of the dry matter of the several cuttings, and the reader would do well to study them closely.

(1) First, a comparison may be made of the hay from the first cutting of Plot A with that of the first cutting from Plot B. These cuttings were made ten days apart, that from Plot B having had the longer period of growth. There is a slight difference in the moisture content of these two hays, but it is not such as to markedly affect

the comparison. The results on the water-free basis, however, allow a comparison on an absolutely equitable basis and quite free from any disturbing factor, and, therefore, are those to which attention is specially called.

It will be observed that the earlier cut hay (Plot A) contains approximately 3 per cent more protein than that cut ten days later (Plot B). This means that the former possesses much the higher feeding value.

Further, comparing the fibre content of the two hays, that of the earlier cutting (Plot A) contains about 6 per cent less fibre than that cut later (Plot B). This may be interpreted that not only is the earlier cutting richer in nutrients more valuable than fibre—the constituent of least feeding value—but it is the more digestible.

(2) Comparing now the composition of the two cuttings from plot B, both cured as hay, very marked differences are to be observed.

The first cutting, made July 16 (ten days after plot A had been harvested, and therefore more mature), was decidedly inferior to that cut October 5, containing 4 per cent less protein in its dry matter. The fibre content of the two cuttings, on the water-free basis, is the same, so that as regards digestibility it may be presumed they are virtually identical. The inference from these results is that the second cutting is, physiologically speaking, the younger, and undoubtedly is the more nutritive fodder. It must not, however, be concluded from these results that the second cutting of hay is always richer in protein. The character of the season, the stage of growth at which the first cutting is made, and the period elapsing between the first and second cutting are all factors which affect the composition and the relative feeding values of the two hays.

(3) The two cuttings from plot A afford most instructive data. The first cutting was made comparatively early in the season and cured as hay, the second was allowed to seed and threshed.

On the dry matter basis, the hay of the first cutting contains approximately 6.5 per cent more protein, and, further, more than 80 per cent of this protein exists in the more valuable true albuminoid form, whereas only 50 per cent of the protein in the threshed hay is present in this form.

Further accentuating the higher nutritive value of the first cutting hay, it has a lower fibre content—the threshed clover hay contains, on the dry matter basis approximately 16.5 per cent more fibre. All the data point unmistakably to the inferior character of the threshed clover hay as a fodder.

(4) Comparing the threshed hay of the second cutting of plot A, harvested October 5, with the product of plot C, also threshed hay, but cut August 8. there being no earlier cutting, it may be observed that the former (second cutting plot A) is much the superior hay, since it contains approximately 5 per cent more protein and almost 6 per cent less fibre. The product of plot C was coarse, harsh and woody. It may safely be concluded, we think, from these results that, weight for weight, the threshed hay from a second cutting will be a more valuable—richer and more digestible—fodder than that from a crop grown exclusively for seed and cut but once, comparatively late in the season, the plant having become more or less ripe, harsh and fibrous.

It may be pointed out that all these comparisons are made simply on composition of the several hays, weight for weight. To obtain the nutritive values of the products per acre the yields would have to be considered and the necessary calculations made. The experiment, however, has very satisfactorily furnished data on an important and oft-disputed matter—the relative nutritive value of (1) the first and second cuttings of clover hay and (2) of the clover hay, both first and second cutting, with that of the threshed hay from the aftermath and the crop as grown and cut for seed.

Analyses of Clover Hay—Cap Rouge, Que., 1921

Plot	Laboratory Number	Cutting	Date of Cutting	Crop	As Received						Dry Matter					
					Moisture	Protein	Fat	Carbohydrates	Fibre	Ash	Protein		Fat	Carbohydrates	Fibre	Ash
											Albuminoid	Non-Albuminoid				
First cutting, hay																
A. Second cutting for seed.	55670	1st	July 6	Hay....	12·95	16·05	6·90	38·41	18·41	7·28	15·50	2·95	7·93	44·13	21·13	8·36
	56550	2nd	Oct. 5	Threshed hay	6·00	11·25	4·25	36·83	35·48	6·19	5·90	6·07	4·52	39·18	37·78	6·58
B. Two cuttings of hay.	55738	1st	July 16	Hay....	13·50	12·98	5·53	37·12	23·86	7·01	13·79	1·23	6·39	42·91	27·59	8·09
	56549	2nd	Oct. 5	Hay....	7·15	18·03	5·18	37·15	25·42	7·07	17·97	1·44	5·57	40·02	27·38	7·62
C. One cutting, grown for seed.	55952	.....	Aug. 8	Threshed hay	6·58	7·00	2·81	37·87	41·15	4·59	7·54	·05	3·02	40·54	44·04	4·91

SILAGE

OAT: PEASE AND OAT: OAT, PEASE AND VETCH: CORN: SUNFLOWER: CLOVER: SWEET CLOVER: TOMATO WASTE: PEASE WASTE: CORN WASTE

Eighteen samples of silage have been analysed since the issue of the last report: their analysis is given in the accompanying table. With the exception of the silages from the wastes of the canning factory the larger number were representative of silages used in feeding trials at one or other of the farms or stations of the Experimental Farm System.

SUNFLOWER SILAGE

Lab'y. No. 54896.—From Experimental Station, Rosthern, Sask. The plants were not frosted when cut but the silage had been frozen for three months when the sample was forwarded.

The sample was very dark in colour and particularly soft, with a large proportion of leaf and very little head. It was taken from the centre of the silo. The dry matter content was 25.35 per cent and the acidity 3.69 per cent, which is decidedly higher than is desirable, probably due to immaturity of the crop. From the standpoint of chemical composition this sample ranks with corn silage of good quality; it is probably higher in crude protein and lower in fibre—two very good points—than this forage.

Lab'y. No. 57918.—From Experimental Station, Lacombe, Alta. The superintendent writes: "This sample is, I believe, fairly representative of the sunflower silage as produced at this Station." As received this silage was brownish green in colour and fairly finely cut, with a good mixture of stem and leaf. It had a rather pleasant aromatic odour and was sound and in good condition.

The results show a dry matter content of 22.16 per cent and an acidity of 2.38 per cent. From our results to date we should judge this silage below the average in dry matter but the composition of the latter fully equal to that of the better quality of sunflower silage.

Lab'y. No. 58201.—From Animal Husbandry Division, C.E.F., Ottawa. Of a dark brown colour, finely cut, sound, in good condition. As received, dry matter, 25.62 per cent, acidity 2.35 per cent. This silage while of average quality as regards dry matter is distinctly low in protein and high in fibre, two undesirable features. It is interesting to note, however, that of the crude protein the major part exists as the true albuminoid. It would seem probable from the high fibre content that this crop was cut when somewhat too mature to give the largest yield per acre of digestible dry matter.

Lab'y. No. 58252.—From Experimental Station, Lethbridge, Alta. Grown on irrigated land and cut for the silo when on the larger part of the crop "the seeds were just forming on the outside edge of the heads." Sound and in good condition. Dry matter 22·50 per cent, acidity 1·43 per cent. This sample is somewhat low in dry matter and protein content and high in fibre. Like the preceding sample, however, the crude protein consists chiefly of true albuminoids.

CORN SILAGE

Lab'y. No. 32477.—From Experimental Farm, Agassiz, B.C. This silage, used in a feeding trial to ascertain its value as compared with clover silage and oat and pea silage, was of good colour, sound and free from mould. The kernels were well glazed when the crop was cut for the silo—October 2 to 16.

Dry matter, 24.04 per cent, acidity 2.33 per cent. The analytical data, generally—and those for protein and fibre more especially, are satisfactory and indicate this to be a corn silage of good average quality.

Laby'y. No. 58200.—Submitted by Animal Husbandry Division, C.E.F., Ottawa. This sample was of a yellowish-green colour, with leaf predominating: sound and in good condition. The dry matter content was 23·83 per cent, indicating that the corn, when cut, was less mature than is usually considered desirable for the best quality of silage. The acidity, 3·68 per cent, is high, confirming the conclusion that the corn had not been sufficiently matured for the best results.

Lab'y. No. 58253.—From Experimental Station, Lethbridge, Alta. Grown on irrigated land and fed in a competitive trial with sunflower silage. The sample was sound and in good condition. The dry matter content was 25.01 per cent—a good average—and the acidity 1·32 per cent. The data throughout indicate a much higher feeding value than that of the preceding samples, containing more protein and less fibre.

OAT SILAGE

Lab'y. No. 57919.—From Experimental Station, Lacombe, Alta. The superintendent writes: "This oat ensilage is representative of this year's crop, which owing to a heavy growth of ball mustard we cut some three weeks earlier than would otherwise have been the case, in order to prevent the mustard from ripening. The oats are therefore much greener than usually cut for ensilage and there is present probably 15 per cent ball mustard." "Seeded on barley stubble, May 21-23, cut August 1 and 2. Ensiled August 1 to 4. No surplus moisture ran from silo."

As received it was of a greenish-brown colour, rather pleasant odour and the oat kernels were fairly well formed; it was sound and in good condition. It contained 31·25 per cent dry matter and had an acidity of 2·74 per cent.

With the exception of the data for fibre, which are rather high, these results are in fair accord with those for good oat silage. The dry matter content, exceeding that usually found in corn silage, and the comparatively high percentage of crude protein (half of which is in the true albuminoid form) would indicate that it possesses excellent feeding value; it may be regarded as more than the equal, weight for weight, of average corn silage.

PEASE AND OAT SILAGE

Lab'y. No. 32479.—From Experimental Farm, Agassiz, B.C. The superintendent writes: "The crop of peas and oats was ensiled between July 23 and 30 and at that time the peas were fairly well formed and the oat straw was turning colour, half way up the stems." Sample as received, showed the silage to be in excellent condition.

Dry matter 27·67 per cent; acidity, traces only. The analysis indicates a rather dry silage, a feature that we have previously noted as characteristic of this type of ensilage. In point of nutritive value, the analytical data would place this silage about midway between that of clover and of corn.

Lab'y. No. 58384.—Submitted by Animal Husbandry Division, C.E.F., Ottawa. The sample was finely cut, succulent, green in colour with a slightly unpleasant odour. Oats appeared to preponderate. The dry matter content was 29·97 per cent and the acidity 1·96 per cent.

Though containing somewhat less dry matter than the oat silage this is a distinctly richer forage, possessing a much higher percentage of protein, due to the presence of the pease. Judging from the analytical data this should prove a highly nutritive silage.

PEASE, OAT AND VETCH SILAGE

Lab'y. No. 50061.—From a correspondent in Central Bedique P.E.I., who writes: "The mixture—13 pounds vetch, 30 pounds peas, 85 pounds oats and 10 pounds wheat—was sown May 20 and cut the first week in September. The yield of 3½ acres filled 15 feet in a cylindrical silo 12 feet in diameter. The silage is very palatable; the cattle prefer it to clover hay. The crop got fairly ripe before it was cut for the silo, but in this condition, in my opinion, it makes better silage than if cut greener. We packed it thoroughly, running in a small stream of water.

Dry matter, 37·78 per cent; acidity, 1·44 per cent.

As received, this silage was decidedly dry, somewhat brown in colour and apparently fibrous—as if the crop had been cut when fairly ripe.

The data indicate a much richer silage than that of corn, partly due to its dryness and partly because it is made up largely of legumes, vetch and peas, which are characterized by higher percentages of protein than corn. It should prove a valuable forage.

CLOVER SILAGE

Lab'y. No. 32478.—From Experimental Farm, Agassiz, B.C. Sound and free from mould. The crop was in full bloom at the time of cutting, June 12-22.

Dry matter, 25·11 per cent; acidity, 1·67 per cent. The data throughout indicate average quality for this class of silage, which, as might be expected, has a much higher protein value than that of corn silage.

SWEET CLOVER SILAGE

Lab'y. No. 49603.—Submitted by a correspondent in Mount Albert, Ont., who writes: "This silage is thought to be the cause of the death of three cattle, a cow and a bull each 5 years old and cow 13 years old. They were part of a herd of seven head which had been fed this silage almost entirely for at least two months, with a little straw and no grain or roots. The crop was cut while still quite green and immediately put into the silo. It was not old nor fibrous."

As received this silage was dark in colour, very dry and stalky and possessed a strong and somewhat offensive smell.

The analytical data are in fair agreement with those of sweet clover silage calculated to the same dry matter content and do not indicate any marked or abnormal feature. It is evident however that this silage is very dry and very acid. This extreme dryness has probably accentuated the stalky fibrous character of this forage and aggravated the effect of such on the digestive organs. It has no doubt been fed heavily, practically exclusively and if the material is answerable for the death of the cattle, the fault would seem to lie rather in improper and injudicious feeding than in any directly poisoning property or quality of the silage. Such a feeding practice as has been followed in this case is most undesirable and probably dangerous.

Lab'y. No. 57011.—This sample forwarded from the Agricultural School, Kemptville, Ont., as received was of a dark green or greenish-brown colour, finely cut and well mixed, sound and in good condition and apparently a desirable silage. It possessed the characteristic odour of sweet clover. "It was cut and ensiled between June 9 and 15, 1921, from a crop seeded with oats in 1920 at the rate of 18 to 20 pounds of seed per acre. None of it had commenced to bloom, although it would have done so if left a few days longer. It was a heavy crop, yielding approximately 10 tons per acre of green material. It was cut with a binder, being from 9 to 12 inches high. and put directly into the silo."

Dry matter, 24.92 per cent, acidity, 1.12 per cent. This silage, of approximately the same dry matter content as that of corn, is much richer in protein than the latter, as might be expected—the legumes being characterized by a high protein content. Its percentage of fibre does not exceed that of corn, so that other things being equal we might expect that, weight for weight, it would possess a higher feeding value. About two-thirds of its crude protein consists of the true albuminoids; in corn silage slightly more than one half of the crude protein exists in this more valuable form.

PRAIRIE HAY SILAGE

Lab'y. No. 29978.—Forwarded from Chilliwack, B.C. Our correspondent writes: "From all appearances this silage seems to be very good and if analysis shows it to have any considerable feeding value it would be a boon to the dairy industry in this and other similarly located settlements."

Dry matter, 37.77 per cent; acidity, 0.17 per cent.

This is a very dry silage with practically no acidity. In point of composition the analytical data indicate a silage of very fair feeding value. In protein it compares very well with corn silage, with somewhat less fibre. It would appear to be a useful, nutritious forage.

CANNING FACTORY WASTES

Lab'y. No. 50092.—Pea Waste Silage. "This silage, forwarded by the Lakeside Canning Company, Ltd., Wellington, Ont., consists of the green vines and the pods after the crop has been put through the viners and the green peas threshed out."

As received, this sample was moderately moist, green, free from mould and quite sound. It consisted of the pea vine and empty pods—though some of the pods contained small, immature peas.

Dry matter, 67.98 per cent; acidity, 2.17 per cent. This silage, it will be observed, is particularly dry, a feature that necessarily raises its percentages of the several nutrients. The legumes, of which the pea is a member, are characterized by richness in protein and it is this fact that makes this silage so much higher in this valuable nutrient than ordinary corn silage. It appears to be succulent and palatable and notwithstanding its high fibre content it should prove a nutritious forage, useful for cattle and sheep.

Lab'y. No. 50093—Corn Waste Silage. Forwarded by the Lakeside Canning Company, Ltd., Wellington, Ont. This is the waste product from the canning of corn and is composed of the almost colourless corn husks, corn silk and pieces of crushed cob without kernels. This silage as received was quite sound and free from mould; no acid odour.

Dry matter, 76.11 per cent; acidity, 0.93 per cent. This material is unusually dry for silage, containing less than one third the amount of water found in ordinary corn silage. This fact obviously gives it a higher dry matter content than the latter product. In respect to the composition of its dry matter, it is poorer in protein and decidedly higher in fibre than that of ordinary corn silage—due no doubt to the large proportion of cob present. However, the fibre is perhaps not objectionably high for a green forage and we should judge it would prove palatable and of some feeding value for cattle.

Lab'y. No. 57047.—Tomato Waste Silage. This silage was submitted by the Lakeside Canning Company, Wellington, Ont., who write: "This silage consists of the peelings and seeds from tomato canning. It has been kept in a hole in the ground for the past two months, using the hole instead of a silo. It has been fed to hogs with other feed and is stated to give good results."

Lab'y No.	Particulars	As Received							Water-free					
									Protein					
		Moisture	Protein	Fat	Carbohydrates	Fibre	Ash	Acidity	Albuminoid	Non-Albuminoid	Fat	Carbohydrates	Fibre	Ash
	SUNFLOWER	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
54896	Experimental Station, Rosthern, Sask.	74·65	3·82	1·10	10·73	5·19	4·51	3·69	8·33	6·73	4·35	42·30	20·49	17·80
57918	Experimental Station, Lacombe, Alta.	77·84	2·65	0·34	10·63	5·53	3·01	2·38	9·26	2·69	1·57	47·94	24·96	13·58
58201	Animal Husbandry Div., C.E.F., Ottawa	74·38	1·95	1·60	11·26	8·69	2·12	2·35	6·87	0·71	6·23	43·95	33·95	8·29
58252	Experimental Station, Lethbridge, Alta.	77·50	2·04	0·97	9·46	7·46	2·57	1·43	8·17	0·89	4·31	42·08	33·14	11·41
	CORN													
32477	Experimental Farm, Agassiz, B.C.	75·96	2·00	0·60	14·36	5·97	1·11	2·33	5·32	2·98	2·49	59·81	24·80	4·60
58200	Animal Husbandry Div., C.E.F., Ottawa	76·17	1·93	2·57	10·70	7·22	1·41	3·68	4·83	3·28	10·81	44·89	30·29	5·90
58253	Experimental Station, Lethbridge, Alta.	74·99	2·69	1·14	12·87	6·85	1·46	1·32	7·77	2·97	4·54	51·46	27·43	5·83
	OAT													
57919	Experimental Station, Lacombe, Alta.	68·75	3·18	0·87	14·09	10·74	2·37	2·74	5·15	5·05	2·78	45·09	34·36	7·57
	PEASE AND OAT													
32479	Experimental Farm, Agassiz, B.C.	72·33	2·20	0·64	12·95	10·12	1·76	.....	7·42	0·52	2·30	46·81	36·60	6·35
58384	Animal Husbandry Div., C.E.F., Ottawa	70·03	4·07	1·71	12·64	8·73	2·82	1·96	7·35	6·26	5·72	42·16	29·10	9·41
	PEASE, OATS AND VETCH													
50061	Central Bedique, P.E.I.	62·22	4·62	1·48	18·79	10·74	2·15	1·44	7·73	4·49	3·92	49·74	28·44	5·68
	CLOVER													
32478	Experimental Farm, Agassiz, B.C.	74·89	3·62	0·60	10·14	9·14	1·61	1·67	11·79	2·62	2·41	40·36	36·39	6·43
	SWEET CLOVER													
49603	Mount Albert, Ont.	42·56	12·52	3·87	20·23	14·72	6·10	2·66	21·79		6·74	35·22	25·62	10·63
57011	Agricultural School, Kemptville, Ont.	75·08	4·74	0·54	10·74	6·70	2·20	1·12	12·95	6·08	2·16	43·10	26·89	8·82

	Prairie Hay													
28978	Chilliwack, B.C.	62·23	4·00	0·62	18·35	8·83	5·97	0·17	7·38	3·20	1·64	48·57	23·40	15·81
	Canning Factory Wastes from Lakeside Canning Co., Wellington, Ont.													
50092	Pea waste	32·02	11·36	3·54	28·89	17·83	6·36	2·17	8·09	8·64	5·23	42·47	26·22	9·35
50093	Corn waste	23·89	5·52	3·31	42·61	23·47	1·20	0·93	4·27	2·83	4·35	56·06	30·90	1·59
57047	Tomato waste	78·83	4·56	1·56	3·38	10·68	0·99	2·17	21·58		7·31	15·96	50·54	4·61

As received, this waste product possessed an exceedingly rank and offensive odour and had the appearance of having undergone strong fermentation—probably subsequent to having been sampled. Its condition, as received, would preclude its safe feeding to swine, but if fresh or preserved that there was no decay the material, judiciously fed, would no doubt be found wholesome.

Dry matter, 21.17 per cent; acidity, 2.17 per cent. Considering it as fresh or as not having undergone any putrefactive change, the material while probably wholesome, cannot be regarded as possessing any high feeding value, nor very nutritious, for the large proportion of "skins" leads to a very high fibre content and, secondly, the seeds (of which there is a large amount) have such a hard integument or seed coat, that the larger number would pass through the animal undigested.

CHEMISTRY OF THE SUNFLOWER PLANT

The past three or four years have witnessed an ever-increasing interest in the sunflower as a silage crop; season by season its growth has extended and the acreage planted, more especially in the northwestern provinces, and particularly in southern Alberta, has become larger.

From the practical point of view the sunflower crop has won recognition and a permanent place in the agriculture of semi-arid districts. As a substitute for corn silage, the value and importance of sunflower silage may be said to be well established. There is good reason to conclude that this newly introduced silage crop has solved the problem of furnishing succulent, palatable forage for those parts of northwestern Canada in which the climatic conditions—sparse rainfall, cool summer nights and short growing season, preclude the possibility of successfully growing corn.

Though, as stated, the position of sunflower silage may be regarded as fairly well established, there are still several important phases, both in respect to the culture of the crop and the making of its silage, requiring scientific investigation. The larger part of the evidence to date is from the field and feeding trials—practical in character and extremely valuable; for the several problems yet unsolved—the best stage of growth at which to cut for ensiling, the influence of cultural methods on the nutritive value of the crop, the effect of irrigation on the quantity and wholesomeness of the silage, the draft that the crop makes on the fertility of the soil—these and a number of allied questions need chemical data for their elucidation.

We have accordingly during the past year, taken a first step in the study of the chemistry of the sunflower plant, the results of which, dealing chiefly with composition as related to the stage of growth, may now be briefly presented.*

Series I.—Crop grown at Experimental Station, Summerland, B.C., under irrigation. All the samples, ten in number, were from the same plot and cut at weekly intervals from June 20 to August 29 1921, representing the crop from "before flowering" to "full bloom."

Series II.—Crop grown at C.E.F., Ottawa, by Field Husbandry Division. The samples analyzed—five in number—were all cut on August 23, 1921, but were representative of crops sown at three dates, May 12, 19 and 26, from areas thinned to plants 3, 6 and 10 inches apart. At the date of harvesting (August 23) the plants of all three crops were approximately 50 per cent in bloom.

Series III.—Crop grown at C.E.F., Ottawa, by Division of Forage Plants. The samples collected consisting of plants in different stages of growth as indicated by their inflorescence. This series consisted of six samples.

* The analysis of nine samples of sunflower silage produced in 1919 and 1920 on the branch farms and stations of the Experimental Farm System in the Western Prairie provinces will be found on pages 37-39 of the Annual Report of this Division for the year ending March 31, 1921.

SERIES I.

The procedure followed in respect to these samples was as follows: Each sample consisted of three plants, the superintendent at Summerland weighing the sample as closely as possible in pounds and ounces immediately on cutting. It was then allowed to dry by simple exposure until danger of moulding in transit was eliminated, parcelled in paper and mailed to the laboratories at Ottawa. On arrival it was weighed, further dried and prepared for analysis. From the several weights and the analytical data, the composition of the fresh material was calculated.

Table I presents the calculated results representing the composition of the plants (fresh material) at the time of the several collections.

The results of table I must not be too closely interpreted, for although the analytical work was done with all care the plan of procedure with respect to the collection and shipment of the samples introduced a possible source of error which might markedly affect the final results of the calculation. Nevertheless the results from this series do allow certain broad deductions to be made in respect to the relation of age to composition.

This series represents for the most part young and immature plants; it did not carry the crop through to that stage of maturity—seed development—that has been commonly recognized as that most desirable at which to cut for the silo, consequently the data more particularly have significance with respect to the composition and nutritive value of the very young plant.

Dry Matter.—Omitting any consideration of the data of sample No. 55739, with respect to which, owing to their exceptional character, there appears to be considerable doubt, the dry matter content increases throughout the period of experimentation, the limit being 9·80 to 17·76 per cent. The increase in dry matter as the plant develops no doubt is more or less steady and uniform; that the data do not more closely support this statement is due, we believe, very largely to the difficulty—the impractibility—of collecting a series of samples which truly represent a fixed and regular advance in growth.

Protein.—Though not regularly—possibly for reasons already advanced—the percentage of protein decreases with the age of the plant. This decrease in crude protein may be said to be a feature common to crops in general. Undoubtedly the nitrogen is absorbed and protein elaborated throughout the whole growing period of the plant, but it is during the earlier stages of growth that this absorption and synthesis are most active. As a result and the further fact that the carbohydrates are built up in the tissues more quickly, proportionately, in the latter stages of growth, we find, speaking within reasonable limits, that the younger the plant the richer in protein.

Fat.—This datum is rather to be considered as "ether extract" consisting largely of chlorophyll, gums, etc., and containing, in the tissues of the very young plant and before seed formation, very little true fat. No very marked difference in this constituent" occurs as the plant advances throughout the experimental period.

Carbohydrates.—An increase in the carbohydrate content is to be observed—the percentage practically doubling during the period June 20-August 29. This of course means a large increase in the food value of the crop, the carbohydrates being the chief nutrients in forage crops for the production of heat and energy in the animal economy.

Fibre.—As the plant grows and increases in dry matter content the percentage of fibre also increases. In this series the fresh material shows a range from 1·73 to 5·72 per cent. Though excessive fibre, especially in the mature plant, is undesirable, we cannot consider that digestibility or palatability has been impaired due to high fibre content, even in the later samples of the series.

TABLE I.—Series I.—Composition of Sunflower Plants (Fresh Material), grown under Irrigation at Summerland, B.C.
(Results obtained by calculation from field weights and analytical data.)

Lab'y No.	Date of Cutting	Water	Protein	Fat	Carbo-hydrates	Fibre	Ash	Remarks
	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	
55589	June 20	89·86	1·72	0·14	4·52	1·93	1·83	Average length, 3 ft. 6 in. No sign of inflorescence.
55605	June 27	89·45	1·84	0·14	4·03	2·44	2·10	Average length, 4 ft 6 in. No sign of inflorescence.
55680	July 4	90·20	1·07	0·14	4·75	2·34	1·50	Average length, 6 ft. 3 in. No sign of inflorescence.
55739	" 11	93·61	0·50	0·08	3·16	1·73	0·92	Average length, 7 ft. No sign of inflorescence.
55811	" 18	85·78	0·80	0·21	7·02	4·42	1·77	Average length, 7 ft. 3 in. No sign of inflorescence.
55850	" 25	84·92	0·99	0·20	7·97	4·08	1·84	Average length, 7 ft. 6 in. One plant in flower, two in bud.
55928	Aug. 1	86·90	0·65	0·15	6·59	4·13	1·58	Average length, 7 ft. 6 in. One flower with immature seed, two plants in bud.
55965	" 8	87·26	0·57	0·14	6·39	4·08	1·56	Average length, 9 ft. One mature bud. two plants with immature buds.
56078	" 14	82·24	0·71	0·20	9·29	5·72	1·84	In full bloom.
56195	" 29	84·18	0·72	0·20	7·99	5·18	1·73	All plants in flower; no material development of seed.

In table II, presenting the composition of the dry matter, the evidence for the foregoing conclusions is clear and convincing. The variable factor—water—is eliminated and the data permit a strict and close comparison of the dry matter (water-free substance) of the crop at the several dates of collection. Further, in these data the disturbing factors referred to as arising from the crude weighing, etc., of the samples—the indirect method of arriving at the composition of the plants at the several cuttings—cannot exert any influence; the data are strictly comparable.

TABLE II.—SERIES I.—COMPOSITION OF DRY MATTER OF SUNFLOWER PLANTS, SUMMERLAND, B.C.

Lab'y. No.	Date of Cutting	Protein		Fat	Carbo-hydrates	Fibre	Ash
		Albu-minoid	Non-albu-minoid				
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
55559	June 20	12·57	4·34	1·43	44·50	18·97	18·20
55605	" 27	12·56	4·85	1·31	38·22	23·16	19·88
55680	July 4	8·45	1·67	1·42	48·47	23·93	15·27
55739	" 11	6·77	1·01	1·35	49·30	27·16	14·41
55811	" 18	4·87	0·69	1·46	49·37	31·17	12·44
55850	" 25	5·76	0·73	1·30	52·93	27·05	12·18
55928	Aug. 1	4·66	0·53	1·15	50·26	31·52	12·06
55965	" 8	3·99	0·47	1·05	50·14	32·07	12·28
56078	" 14	3·64	0·44	1·15	52·23	32·19	10·35
56195	" 29	4·38	0·16	1·32	50·47	32·75	10·92

CRUDE PROTEIN.—There is a marked falling-off in the crude protein content as growth proceeds; from 16·91 to 4·54 per cent during the experimental period. There is a very distinct and large fall between the second and third cuttings; after the second collection, June 27, the decrease in this nutrient between the intervals of sampling is more gradual. This is quite in accord with our findings from other crops—the larger and more rapid absorption of nitrogen during the earlier stages of growth, the dilution, as it were, of this protein later on with the non-nitrogenous nutrients, which as the plant matures are more especially stored up.

The crude protein may be said to consist of the true albuminoids or flesh formers and non-albuminoids—nitrogenous compounds of lesser feeding value and comparable as far as nutritive properties are concerned to the non-nitrogenous part of the dry matter. As the plant matures the proportion of true albuminoids to non-albuminoids increases and therefore the crude protein in the mature plant (provided the digestibility of the fodder has not been affected) has a higher nutritive value than that of the young and immature plant.

That the percentage of crude protein decreases as the plant develops, but that this protein becomes more valuable as a nutrient as the plant advances towards maturity, is shown by the data presented in table III.

FAT.—The data do not call for any special comment—they remain fairly constant throughout the whole period of experiment, indicating that until seed formation the development of true fat or oil in the plant is very slight. The sunflower plant before seed formation, or after seed production but minus the head is very poor in fat.

In this connection it may again be remarked (1) that even in the final collection of the series seed formation had scarcely begun, and (2) that the "fat" is impure fat and really to be regarded as "ether extract," consisting largely of green colouring matter, gums, etc., extracted in the process of analysis.

CARBOHYDRATES.—The nutrients grouped under this heading are starch and allied compounds. The dry matter as the plant develops becomes richer in these useful nutrients—the increase during the period of experiment of the present series being about 12 per cent, i.e., calculated on the dry matter.

TABLE III.—COMPOSITION OF CRUDE PROTEIN

Laboratory No.	Crude Protein in Dry Matter	Composition of Crude Protein	
		Albuminoids	Non-albuminoids
	p.c.	p.c.	p.c.
55559	16·91	74·33	25·67
55605	17·41	72·14	27·86
55680	10·12	83·50	16·50
55739	7·78	87·02	12·98
55811	5·56	87·59	12·41
55850	6·49	88·75	11·25
55928	5·19	89·40	10·60
55965	4·46	89·32	10·68
56078	4·08	89·21	10·79
56195	4·54	96·40	3·60

FIBRE.—This is the least valuable of the nutrients. As the plant matures it becomes hard and woody and less and less digestible. When present in excessive proportions in the ripened plant, fibre is not only in itself largely indigestible but its presence depresses the digestibility of the other nutrients.

The percentage of fibre in the dry matter, it will be observed, increases in the series under consideration from, roughly, 19 to 33 per cent. It is evident that during this period of growth there is a large and rapid development of fibre and it would seem most probable that this development is regulated or determined largely by the method of culture—the more room, i.e., the wider spacing of the plants, the more air and sunshine they receive, the more robust the plant and the greater development of fibre.

Since the plants in this series in the final collection were still immature, soft and succulent, we may conclude that the comparatively large fibre content of their dry matter had not materially impaired their digestibility.

ASH.—The percentage of ash or mineral matter, according to these results, in the dry matter of sunflower plant is very large. It decreases as the plant develops, falling off during the period of this experiment from approximately 18 to 10 per cent, indicating that the heaviest draft on the mineral constituents of the soil is during the earlier stages of growth.

Very probably the amount of "ash," i.e., lime, potash, phosphoric acid, etc., absorbed by the plant is determined to some appreciable extent by the nature and richness of the soil and the soil's water supply but it is evident that the sunflower crop is to be regarded as a more or less exhaustive one, making a large draft on the mineral plant food in the soil. Successive cropping of the same area with sunflower, without any concomitant return of mineral fertilizer, must appreciably diminish the soil's store of available plant food. When the crop is grown for seed the ash produced by the burning of the dry stalks returned to the soil suggests itself as a valuable means of maintaining soil fertility in respect of the mineral plant food constituents. Under irrigation it would seem very probable that the draft on the soil, especially in regard to these minerals, is much greater than when the crop is grown under dry land conditions.

SERIES II.

The field particulars of the five samples constituting this series, as furnished by the Dominion Field Husbandman, may be tabulated as follows:—

Lab'y. No. 56149.—Sown May 12. Plants thinned to 6 inches apart in row. About 60 per cent in bloom when cut. Yield, 27,360 pounds.

Lab'y. No. 56109.—Sown May 19. Plants thinned to 3 inches apart in row. About 50 per cent in bloom when cut. Yield, 31,025 pounds.

Lab'y No. 56111.—Sown May 19. Plants thinned to 6 inches apart in row. About 50 per cent in bloom when cut. Yield, 36,400 pounds.

Lab'y. No. 56112.—Sown May 19. Plants thinned to 10 inches apart in row. About 50 per cent in bloom when cut. Yield, 35,200 pounds.

Lab'y. No. 56113.—Sown May 26. Plants thinned to 6 inches apart in row. About 40 per cent in bloom when cut. Yield, 34,968 pounds.

All were cutivated and hoed thoroughly during summer. Cut on August 23 with corn harvester.

The analytical data in this series would show the composition of the crop as cut at approximately the same stage of growth as indicated by inflorescence but with varying periods of growth as determined by dates of sowing and under varying cultural conditions as regulated by the extent of thinning. The crop on all five plots at the time of cutting, August 23, was approximately from 40 to 60 per cent in bloom and considered to be at about the right stage or condition for ensiling.

Table IV presents the data. The oldest plants—those sown on May 12 possesses the least dry matter, viz., 16.04 per cent, the increase in this constituent being steady with the advance in seeding date until it reaches 24.88 per cent in the crop planted May 26.

This would seem contrary to what might be expected, for it would naturally be concluded that with advance in age (if such be determined by time of seeding) there would be an increase in dry matter content. The only conclusion to be drawn from these results in respect to this matter is that the date of sowing in a series of this nature in which the intervals between seeding are comparatively short, does not determine what may be designated as vegetative age. It is evident that some other factor than this has affected the composition of the plant as shown by the analytical data. It is significant in this consideration, to note that the lowest yields were those from the earlier planted crops and vice versa. This apparent anomaly in respect to dry matter content and yields cannot be explained by "distance of thinning," nor in the proportion of the crop in bloom. It is to be noted however that there is an apparent relationship between dry matter and yield and this might be regarded as indicating a more rapid growth with a concomitant gain in dry matter in the plants from the later sown crops.

With respect to the protein and ash data, the results furnish confirmatory evidence in favour of the conclusion that the "vegetative age" of the crops under investigation has not been materially influenced by the date of seeding. The protein results, if they show anything, might be taken as indicating but little difference in stage of growth throughout the series; the percentage of ash in the dry matter decreases from the first to the last of the series and this gives some additional support to the conclusion from the dry matter data, viz., that the crop from the later seeding is in reality the older—measuring age by increase of dry matter content.

Though the data for fibre show but little variation, they do afford some slight confirmation of the conclusion already arrived at respecting the relative "ages" of the crops of this series.

While it would be unwise to interpret the results of this series too closely, we may fairly safe say that they prove that age as measured by period of growth, i.e., length of time, does not necessarily determine stage of growth. Further, from these results it would seem probable that there is a period in the history of the plant during which the dry matter content increases without any very marked change in its composition. This period appears to be approximately between appearance of bloom and development of seed. Possibly very little change takes place in the composition of the dry matter over a considerable period of time—the period in which the crop advances from first coming into bloom until, say, fifty to sixty per cent of the plants are in full bloom.

TABLE IV.—SERIES II.—Composition of Sunflower Plants, grown by Division of Field Husbandry, C.E.F., Ottawa, 1921.

Lab'y No.	Date of Sowing	Date of Cutting	Fresh Material						Water-free Substance				
			Water	Protein	Fat	Carbo-hydrates	Fibre	Ash	Protein	Fat	Carbo-hydrates	Fibre	Ash
	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
56149	12-5-21	23-8-21	83·96	1·02	0·99	7·07	5·37	1·58	6·38	6·19	44·13	33·46	9·84
56109	19-5-21	23-8-21	81 87	1·20	0·95	8·41	6·08	1·49	6·62	5·20	46·35	33·56	8·27
56111	19-5-21	23-8-21	81·44	1·49	0·85	8·41	5·99	1·82	8·08	4·57	45·28	32·27	9·80
56112	19-5-21	23-8-21	78·02	1·38	1·12	10·08	7·43	1·97	6·29	5·12	45·82	33·81	8·96
56113	26-5-21	23-8-21	75·12	1·59	1·14	11·48	8·77	1·90	6·38	4·61	46·13	35·23	7·65

TABLE V.—SERIES III.—Composition of Sunflower Plants of Several Stages of Growth. Grown by Division of Forage Plants, C.E.F., Ottawa, Ont.

Lab'y No.	Stage of Growth	Fresh Material						Water-free Substance					
								Protein					
		Water	Protein	Fat	Carbo-hydrates	Fibre	Ash	Albu-minoid	Non-Albu-minoid	Fat	Carbo-hydrates	Fibre	Ash
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
56057	Buds unopened	80·72	1·94	0·46	10·99	4·07	1·82	8·96	1·11	2·40	56·99	21·12	9·42
56058	Buds opening	81·83	1·77	0·40	10·40	3·87	1·73	8·75	1·00	2·27	57·12	21·30	9·56
56059	Florets open half way to centre	82·99	1·84	0·37	9·22	3·69	1·89	8·81	1·99	2·20	54·18	21·72	11·10
56244	Full bloom	79·43	1·57	0·50	12·51	4·38	1·61	6·99	0·65	2·42	60·80	21·32	7·82
56245	Seeds half developed	80·98	1·36	0·54	10·74	4·68	1·70	6·77	0·36	2·84	56·43	24·63	8·97
56246	Seeds fully developed but not ripe	82·10	1·67	0·40	9·25	4·94	1·64	8·12	1·20	2·20	51·74	24·57	9·17

SERIES III.

This series, furnished by the Division of Forage Plants, C.E.F., Ottawa, comprised six samples, each sample consisting of four complete plants and each sample representative of a different and distinct stage of growth.

The field particulars are as follows:—

Lab'y. No.	Date of Cutting	Weight of four Plants		Stage of Growth
		Lbs.	Oz.	
56057	19-8-21	3	12	Buds formed but not opened.
56058	19-8-21	3	7	Buds opening, stamens beginning to appear.
56059	19-8-21	3	8	Flowers fully open, stamens and pistils showing half way to centre of flower.
56244	13-9-21	4	12	In full bloom, flowerets open to centre.
56245	13-9-21	4	4	Pistils wilted, seeds half developed.
56246	13-9-21	4	3	Seeds fully developed but not ripe.

Throughout this series there is no indication of an increase in the dry matter content as the plant progresses from the stage "buds formed but unopened" to that of "seeds developed but not ripe."

Examining the data in more detail it will be observed that the three samples (of four plants each) collected on 19th August differed but slightly in weight, viz., from 3 pounds 7 ounces to 3 pounds 12 ounces, and the same is true of the samples collected on September 13, the weights varying from 4 pounds 3 ounces to 4 pounds 12 ounces. The weights at both dates might be regarded as indicating young and immature plants and also that between the stages of growth, as measured by inflorescence, there had been but little development.

The results from this series in respect to certain phases of the question are not altogether satisfactory. After closely studying them we hesitate to interpret them specifically and in detail, but the inference may be perhaps safely made that between the stages denoted in this series the composition of the crop, i.e., the ratio of water to dry matter and the composition of the dry matter, suffer but little change.

PLANT FOOD CONSTITUENTS IN SUNFLOWER CROP

There is one phase of sunflower culture that has not yet received due consideration, namely, the draft that the crop makes on soil fertility. Looking to the upkeep of the soil it is highly important to know to what extent the sunflower plant depletes the soil of its stores of nitrogen, phosphoric acid and potash. The amounts of these constituents taken out of the soil must be returned if the fertility of the soil is to be maintained.

Our analyses show that the sunflower crop as usually cut for the silo contains, approximately, the following percentages of the essential elements of fertility.

Fertilizer Constituents in Sunflower Crop

(Fresh material as cut for the silo)

	Per cent.
Nitrogen	0.23
Phosphoric acid	0.14
Potash	0.82
Lime	0.52

Taking the average yield of fresh material at 15 tons per acre we find that the amounts of the above constituents withdrawn from the soil per acre are, approximately, as follows:—

TABLE No. 1.—SUNFLOWER SEED, 1921

Lab'y No.	Source	Description	Weight of 1,000 Seeds	Percentage by Weight		Remarks
				Kernels	Hulls	
			Grams.			
56233	Cereal Division, C.E.F.	"Early Ottawa" No. 76. Large striped light-coloured seeds—brown and white.	127·9	48·8	51·2	Grown at Ottawa, 1921, selected.
56234	" "	Large striped dark seeds—grey and white.	123·9	49·1	50·9	Grown at Ottawa, 1921, "Friesen".
56235	" "	Large striped long angular dark seeds—grey and white.	131·7	50·5	49·5	Grown at Ottawa, 1921, "Rosthern".
56313	Division of Forage Plants, C.E.F.	No. 30. Large seeds—brown with white stripes.	89·3	60·1	39·9	Grown at Ottawa, 1921, "Selected No. 30".
56315	" "	No. 22. Long seeds—brown with faint striping.	83·1	67·7	32·3	Grown at Ottawa, 1921, "Selected No. 22".
56316	" "	No. 19. Large seeds—grey with narrow white stripes.	100·1	48·2	51·8	Grown at Ottawa, 1921, "Selected No. 19".
58020	*A. Griffin*, Brooks, Alta.	Hulled seed				Hulled accidentally in threshing. Mixed seed of several varieties.
58193	" "	Short, plump, white smooth seed	82·94	54·1	45·9	Mixture of Manteca and Prolific White Burbank varieties.
58194	" "	Black seed, large	130·8	51·1	48·9	From "Brooks' Dwarf": dwarf with very large heads.
58195	" "	Large seed, chiefly greyish-brown with thin white stripes.	84·2	54·3	45·7	Mixture of two varieties, a dwarf 6 ft. to 7 ft. high, and a taller variety 10 ft. high.

Table No. 2.—Analysis of Sunflower Seed, 1921

Lab'y No.	Whole Seeds						Kernel						Hulls and Husks					
	Moisture	Protein	Oil or Fat	Carbohydrates	Fibre	Ash	Moisture	Protein	Oil or Fat	Carbohydrates	Fibre	Ash	Moisture	Protein	Oil or Fat	Carbohydrates	Fibre	Ash
	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
56233	4·55	20·59	21·42	17·96	31·95	3·53	4·42	38·14	43·06	7·70	2·02	4·66	4·67	3·85	0·73	27·77	60·54	2·44
56234	3·63	16·04	26·02	18·63	32·61	3·07	3·54	29·58	52·25	8·18	2·19	4·26	3·70	2·97	0·72	28·71	62·00	1·90
56235	4·34	18·43	23·63	15·47	35·10	3·03	4·15	33·22	46·36	8·04	3·24	4·39	4·53	3·33	0·41	22·46	67·63	1·64
56313	5·06	26·63	20·20	20·81	23·22	4·08	5·56	41·66	33·34	11·20	2·95	5·29	4·29	3·90	0·40	35·34	53·82	2·25
56315	4·95	26·17	29·74	17·83	17·18	4·13	4·96	35·88	43·47	9·60	2·05	4·04	4·95	5·78	0·94	35·07	48·93	4·33
56316	4·29	16·74	22·62	20·79	32·58	2·98	4·50	31·76	46·65	10·05	2·22	4·82	4·11	2·78	0·30	30·79	60·73	1·29
58020	.....	.....	.....	.....	.....	.....	3·74	27·52	54·21	8·91	2·08	3·54	.....	.....	.....	.....	.....	.....
58193	5·01	19·76	24·94	17·39	29·01	3·88	4·67	32·54	45·67	9·79	2·78	4·55	5·41	4·73	0·58	26·33	59·91	3·04
58194	5·45	19·09	23·70	16·51	31·49	3·76	5·10	34·50	45·66	6·10	4·24	4·40	5·82	3·02	0·77	27·36	59·93	3·10
58195	4·89	17·15	28·04	18·94	27·55	3·43	4·03	29·50	51·06	9·04	2·49	3·88	5·90	2·49	0·53	30·77	57·43	2·88

WHOLE SEEDS

The range and average of the three most important constituents may be given as follows:—

—	Maximum	Minimum	Average
Protein	26·63	16·04	20·06
Oil or fat	29·74	20·20	24·50
Fibre	35·10	17·18	28·96

It is evident that sunflower seed is very variable; while degree of maturity at time of harvesting may influence its composition it would seem probable from this preliminary study that heredity is a more potent factor. In the present state of our knowledge it is quite clear that chemical analysis is necessary to determine the value of any particular sample as regards either its oil or protein content.

KERNELS

The essential data are as follows:—

—	Maximum	Minimum	Average
Protein	41·66	27·52	33·40
Oil or fat	54·21	33·34	46·17
Fibre	4·24	2·02	2·62

Throughout the series a high oil content is associated with low protein and vice versa. The fact of the wide range in composition indicates the possibility of breeding and selecting in special directions, e.g., for high oil content.

Seven of the ten samples contain more than 45 per cent of oil; three contain over 50 per cent.

HULL OR HUSKS

As might be expected, these are of little or no economic value; the fibre is usually over 50 per cent and the protein and fat are present only in negligible amounts. Withal, they must be practically indigestible.

The range and average for protein, oil and fibre are as follows:—

—	Maximum	Minimum	Average
Protein	5·78	2·49	3·66
Oil	0·94	0·30	0·60
Fibre	67·63	48·93	58·99

FLAXSEED

The value of flaxseed (linseed) lies essentially in its oil content, though secondarily the percentage of protein present is of very considerable importance as influencing the nutritive value of "oil-cake", the product resulting from the expression of the oil and a feeding stuff with a deservedly high reputation.

Flaxseed may vary very considerably in composition, especially in oil content, so that as ordinarily found on the market it cannot be said to have any fixed value for oil production. The analysis of twenty samples in 1910 representing as many distinct strains grown on the Experimental Farm, Ottawa, furnished data from which the following interesting results are taken:—

	Per cent
Oil—	
Highest	42.20
Lowest	34.50
Average	37.10
Protein—	
Highest	27.56
Lowest	19.06
Average	24.77
Weight of 1,000 kernels—	Grammes
Highest	8.8538
Lowest	3.9044
Average	4.9151

During the earlier months of the present year inquiries were received from flax growers and linseed oil mills relative to the oil and protein content of flaxseed as produced by varieties grown (*a*) for fibre and (*b*) for the seed, *i.e.*, for oil content, the contention of certain authorities being that the seed of flax grown for fibre is poorer in oil than that of seed grown specially for the oil mills. Further, information was asked for as to the relative richness in oil of "Western" and Ontario-grown seed, and how "Canadian-grown seed compared with that of Ireland, Belgium and France in point of oil content."

There being no data on record which would permit us to satisfactorily answer these inquiries, an attempt was made to obtain samples of flaxseed the analysis of which would yield reliable data on the several points at issue.

The Chief of the Division of Economic Fibre Production kindly furnished the following:—

Lab'y. No. 54383.—Imported from Japan; seed fully ripened when crop was harvested.

Lab'y. No. 54466.—Imported from Ireland; pure line No. 3; ripe when harvested. Fibre variety.

Lab'y. No. 54467.—Imported from Ireland; pure line No. 5; ripe when harvested. Fibre variety.

Lab'y. No. 54492.—Grown in Western Canada for oil production, 1921. Crop had been subjected to frost; poor sample.

Lab'y. No. 54493.—Grown in Ontario; "Dutch Child," 1921; crop fully matured.

Lab'y. No. 54494.—Imported from France; 1921 crop; fully matured.

Lab'y. No. 54495.—Imported from Holland; 1921 crop; fully matured.

The Dominion Cerealist furnished four samples, from flaxseed grown on the C.E.F., Ottawa, as follows:—

Lab'y. No. 54167.—Longstem, grown for fibre.

Lab'y. No. 54168.—Kostroma, grown for fibre purposes.

Lab'y. No. 54169.—Novelty, grown for seed (oil) purposes.

Lab'y. No. 54170.—Premost Reselected, grown for seed (oil) purposes.

These four varieties were all allowed to mature properly, *i.e.*, ripen, in the field before being pulled.

The accompanying table presents the analytical data of this series of eleven samples.

The range in protein is from 20·57 to 25·64 per cent.

In fat or oil the variation is from 30·07 to 40·55 per cent.

The "weight of 1,000 seeds" exhibits the following limits: 3·5716 to 6·1854 grams.

Analysis of Flax Seed, 1921

Lab'y No.	Source of Variety	Purpose	Weight of 1,000 Seeds	Moisture	Protein	Fat or Oil	Carbohydrates	Fibre	Ash	Remarks
			Grams.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	
54167	Longstem, Ottawa	Fibre	5·2096	5·88	24·39	32·48	21·31	11·85	4·09	Weight per bush., 54·1 lbs.
54168	Kostroma, Ottawa	"	4·9457	6·31	25·17	30·07	25·77	8·40	4·28	Weight per bush.. 56·2 lbs.
54169	Novelty, Ottawa	Oil	6·1854	6·76	20·57	39·60	20·32	8·85	3·90	Weight per bush., 55 lbs.
54170	Premost, Reselected Ottawa.	"	5·4272	6·54	23·30	36·27	22·41	7·20	4·28	Weight per bush., 56·3 lbs.
54383	Imported from Japan		4·2665	7·43	24·63	33·40	22·61	7·98	3·95	Seed fully ripened when harvested.
54466	Imported from Ireland	Fibre	4·5534	7·52	21·90	34·52	24·50	7·60	3·96	Pure line No. 3. Ripe when harvested.
54467	" "		5·1428	7·76	24·03	34·85	20·44	9·12	3·80	Pure line No. 5. Ripe when harvested.
54492	Western Canada	Oil	3·5716	6·84	25·64	36·65	17·67	8·92	4·28	Very poor sample—subjected to frost.
54493	Ontario Dutch Child		5·5043	9·83	22·30	34·72	21·23	8·38	3·54	Fully matured.
54494	Imported French		4·7028	9·14	22·74	40·55	16·54	7·10	3·93	"
54495	Imported Dutch		4·8317	9·34	21·29	37·70	21·39	6·90	3·38	"

It is significant to note that of the four samples from varieties grown by the Cereal Divisions specifically for fibre and for seed, the two Longstem and Kostroma, fibre strains or varieties, possess a lower oil content than Novelty and Premost Reselected, seed varieties. Novelty in oil falls but a little below the French imported flax which heads the list in this respect. Kostroma, a fibre variety is the lowest in the series in oil content.

No information was available with respect to the "purpose" *i.e.*, fibre or oil, of samples, Lab'y. Nos. 54383, 54493-4-5, but the two samples of Irish seed (Nos. 54466-7), presumably grown for fibre, contained 34.52 and 34.85 per cent of oil, an amount slightly below the average for the series (35·53 per cent) and markedly lower than the oil content of the seed or oil varieties examined.

It is further to be noted in this connection that the flaxseed grown in Western Canada has a comparatively high oil content, viz., 36·65 per cent, the average for the eleven samples of the series being 35·53 per cent.

A sample (Lab'y. No. 58192) of very fine flaxseed, plump, large, heavy and of a light yellow colour, was furnished by Mr. A. Griffin, of Brooks, Alta. It was seed of a variety selected by Mr. Griffin and developed by him for a number of years and submitted to this division for examination and report as to oil value for the past two seasons. The 1921 crop, grown on irrigated lands at Brooks, yielded seed containing oil 47·47 per cent and protein 23·44 per cent, with a weight for 1,000 seeds off 9·178 grammes. This is evidently an exceptionally fine variety or strain which would be particularly of value for oil production.

While these results are altogether too few for the purpose of a final conclusion in the matter, they furnish some data towards supporting the correctness of the belief that flaxseed from varieties grown for oil expression is richer in oil than that from varieties specially bred for fibre production. They further may serve in some small measure to support the contention that flaxseed grown in Western Canada has a higher oil content than that grown in Ontario. However, this work is merely a beginning and these results are to be considered simply as indicative and the inferences therefrom as tentative only. Further and more extensive work is necessary and will be undertaken, as opportunity permits, towards the solution of these flax problems.

Though the percentages of protein and oil throughout the series are not inversely proportional, it may be noted that those varieties characterized by a high oil content are in a large number of instances those with a low protein, and *vice versa*.

This series furnishes but little evidence of any direct relationship of "weight of 1,000 seeds" to either the protein or oil content. In this consideration probably the thickness and weight of the integument or seed coat is an interfering factor. It would seem evident that this "weight" cannot be used alone as a determinative factor of composition."

We have as yet taken but the first step towards accumulating the data which would definitely answer the questions which instigated this inquiry. The oil content may prove to be a resultant of several factors, among which the following may be found to play an important part: heredity, seasonal conditions during growth and ripening and the stage of maturity of the crop when harvested.

FEEDING STUFFS

Within the fiscal year March 31, 1921-April 1, 1922, two bulletins on feeding stuffs have been issued: "Commercial Feeding Stuffs," Bulletin No. 47, and "Bran, Shorts, Middlings and Feed Flours," Bulletin No. 2, New Series.

War conditions were answerable for the appearance on the market of a considerable number of worthless, and in some cases, dangerous feeds. Many complaints were received (with samples) of gross adulteration by admixture with mill refuse, noxious

weed seeds and other foreign material, rendering the feeds unpalatable, of low feeding value and not infrequently fatal to stock. The evidence at hand pointed to the desirability of an investigation as to the purity and quality of the feeding stuffs on the Canadian market and to this end some 400 samples were collected throughout the Dominion and submitted to chemical analysis and microscopical examination. The results were published in the bulletin "Commercial Feeding Stuffs" and the series includes a very large number of our milling by-product and compounded feeds. In addition to the composition of the feeds the bulletin contains a considerable amount of matter of educational value respecting the nature and uses of feeds in general, so that the publication will be found useful for reference and as a guide in the purchase of feeding stuffs.

The work included in the bulletin "Bran, Shorts, Middlings and Feed Flour" was undertaken (1) to ascertain how far the present standards in respect to percentages of protein, fat and fibre were strictly applicable and to propose revised standards if such were found to be desirable or, necessary, and (2) to determine the cause or causes of the complaints constantly being received respecting the unsuitability of much of the shorts or middlings, more especially for the feeding of swine and young stock. As the dissatisfaction in respect to these important and basal milling by-products was widespread, the value of this inquiry will be obvious. Fifty-seven samples of bran, eighty-four of shorts and middlings and twenty samples of feed flour were submitted to analysis; the bulletin also contains the analyses of "bran with screenings," "shorts with screenings" and ground and unground screenings.

As a result of this investigation revised standards were proposed and these have since been adopted. A comparison of the old and revised standards may be made as follow:—

BRAN STANDARDS

	Old	Revised
	p.c.	p.c.
Protein, not less than	14.0	15.0
Fat, not less than	3.0	3.5
Fibre, not more than	10.0	11.5

The changes are that the protein and fat requirements have been slightly raised and that a somewhat higher percentage of fibre will be allowed. Modern milling practice, which separates more thoroughly the floury particles than formerly, very largely accounts for these differences, but undoubtedly the wide introduction throughout the grain-growing provinces of Marquis wheat, a hard spring variety of the highest milling quality plays some part in raising the protein and fat content of this feeding stuff.

SHORTS STANDARDS

	Old	Revised
	p.c.	p.c.
Protein, not less than	15	16
Fat, not less than	4	5
Fibre, not more than	8	8

The protein and fat requirements have been increased by one per cent in each nutrient. The facts warranted this change, which will have a decided influence in improving the quality of this important feeding stuff.

MIDDLINGS STANDARDS

	Old	Revised
	p.c.	p.c.
Protein, not less than	—	16.5
Fat, not less than	—	3.5
Fibre, not more than	—	4.5

Hitherto, as far as the Feeding Stuffs Act was concerned, the terms "shorts" and "middlings" were synonymous and interchangeable, consequently there was no

separate standard for middlings. It has been thought necessary however in the interest of the feeder, and especially to provide a feed more suitable for young pigs and calves, to distinguish between these two products—the more mealy, floury feed with a decidedly lower fibre content to be known as "middlings".

In addition to the work on feeding stuffs appearing in the aforementioned bulletins, examination has been made of a considerable number of feeds submitted by farmers, agricultural representatives and Provincial Departments of Agriculture. These may now be briefly considered.

BRAN

Three samples of this staple feeding stuff were received for analysis and report:—

Lab'y. No. 55674.—"Wheat bran with government screenings not exceeding mill run," Lake of the Woods Milling Co.

Lab'y. No. 55961.—"Bran, with ground screenings," Lake of the Woods Milling Co.

Lab'y. No. 57761.—"Bran." Ogilvie Flour Mills Co., Winnipeg, Man.

ANALYSIS

	No. 55674	No. 55961	No. 57661
Moisture	9·20	12·12	8·19
Protein	16·07	15·48	15·99
Fat	4·60	4·51	3·95
Carbohydrates	52·58	51·84	53·83
Fibre	12·20	10·70	11·75
Ash	5·35	5·35	6·40
	100·00	100·00	100·00

As regards protein and fat, all three samples conform to the proposed revised standards, but all are high in fibre, judged by the standards that have hitherto been in force. No. 55674 markedly exceeds in this constituent the higher fibre content allowed by the revised standard.

SHORTS AND MIDDLINGS

It seems desirable to consider the samples forwarded as "shorts" and "middlings" under the one caption, since, as already remarked, the official classification of feeding stuffs has not hitherto differentiated these products.

In respect to protein and fat, all the samples (with the exception of No. 55085 in fat) may be considered as satisfactory and meeting requirements. Two of the samples forwarded as "shorts" (Nos. 55389 and 57717) have an excessive fibre content and it is significant that they were alleged to have an injurious effect when fed to young pigs. Microscopical examination of these samples showed they contained ground weed seeds, but those which might be considered noxious or poisonous were not present in sufficient quantity to make the feed toxic. It was concluded therefore that the high fibre content was responsible for the trouble.

Of the samples labelled "middlings," all are quite satisfactory in respect to protein and fat but one only (No. 58751) will meet the new standard for middlings in regard to fibre. As an indication that standardization of this valuable feeding stuff was necessary, it will be observed that the four samples in the series so branded contain respectively 4·19, 5·26, 6·22, and 7·08 per cent of fibre—a very wide range with

the larger number of the samples containing too high a percentage of this constituent for safe feeding to young stock.

SHORTS AND MIDDLINGS, 1921-22

Laby. No.	Particulars	Moisture	Protein	Fat	Carbohydrates	Fibre	Ash
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
54884	"Middlings," Empire Flour Mills, St. Thomas, Ont.	11·03	17·48	6·70	53·51	7·08	4·20
55085	"Shorts," Hedley Shaw Mfg. Co., Rossland B.C.	10·55	18·08	3·10	55·79	8·13	4·35
55389	"Wheat Shorts," Ogilvie Flour Mills Co., Fort William, Ont.	7·01	18·36	5·70	55·78	9·00	4·15
55962	"Shorts with Mill-run Screenings" Wolverton Milling Co. Ltd.	10·73	18·11	6·03	54·93	6·05	4·15
57717	"Shorts with Mill-run Screenings" Ogilvie Flour Mills Co.	7·50	17·64	5·58	55·27	9·62	4·39
58483	"Laurentia Middlings," St. Lawrence Flour Mills Co., Montreal.	11·77	18·68	5·70	53·94	6·22	3·69
58537	"Shorts", Interprovincial Flour Mills Co., Renfrew, Ont.	11·93	18·13	5·24	52·52	8·16	4·02
58706	"Laurentia Middlings," St. Lawrence Flour Mills Co., Montreal.	9·65	17·83	5·70	57·89	5·26	3·67
58751	"Premier Middlings," St. Lawrence Flour Mills Co., Montreal.	11·17	18·16	5·21	58·10	4,19	3·17

To obtain some data in respect to a desirable degree of fineness in middlings, Nos. 58483, 58706, and 58751 were subjected to a mechanical separation using two sieves, of 44 and 34 mesh, respectively. The following interesting results were obtained:—

—	No. 58483	No. 58706	No. 58751
	per cent	per cent	per cent
Through sieve of 44 mesh	63	71	75
" 34 "	90	98	99
Over sieve of 34 mesh	10	2	1

All three are the product of the sample mill and Nos. 58483 and 58706 are of the same brand. The data show that greater uniformity in milling is desirable, for two samples of the same brand differ by 8 per cent in the finest quotient (passing 44-mesh wire). We may consider No. 58751 as an excellent sample, chemically and mechanically, of the type of middlings desired by stock raisers, and one fully meeting in all respects the requirements of the new standards for this feed.

WHEAT GERM

To obtain information as to the nutritive value of wheat germ a typical sample of the commercial product, kindly furnished by the Maple Leaf Milling Company, Port Colborne, Ont., was submitted to analysis.

ANALYSIS

Moisture	**7·16**
Protein	**29·90**
Fat	**11·37**
Carbohydrates	**44·76**
Fibre	**2·91**
Ash	**3·90**
	100·00

This product is not commonly found on the market as a feeding stuff. The analysis indicates a very high nutritive value, especially in respect to oil or fat. It presents itself as a material particularly adapted to raising the protein and fat content of a ration without adding to its fibre. It is sweet and very palatable, but its high oil content undoubtedly renders it liable to become rancid in warm weather.

DAMAGED WHEAT

Lab'y. No. 58212.—This sample, submitted by a correspondent at Ormond, Ont., was ground wheat stated to have been salvaged from a sunken barge, kiln dried and ground.

ANALYSIS

Moisture	9·33
Protein	14·22
Fat	2·60
Carbohydrates	70·07
Fibre	2·81
Ash	·97
	100·00
Acidity (as acetic and lactic acid)	3·4 per cent
Water soluble extract	8·66 " "

The sample was decidedly dark in colour and possessed a strong, very disagreeable smell.

In point of general composition, no difference of note exists between this sample and sound wheat, but this sample is unsound, as made evident by its high acidity and water extract. The wheat has undoubtedly fermented and become sour. It is an undesirable feed and one that would most probably prove unwholesome.

BARLEY PRODUCTS

Lab'y. No. 57865.—Barley chop. This sample was forwarded from Vallican, B.C. The inquiry was as to its purity as ground barley and its suitability as a feed for stock.

ANALYSIS

Moisture	10·07
Protein	12·60
Fat	2·88
Carbohydrates	64·19
Fibre	6·22
Ash	4·04
	100·00

This sample consists of ground barley with screenings containing a little wheat, oats, and flax with some weed seeds and chaff. A small amount of stinkweed, hare's ear mustard and tumbling mustard occurs ground, while whole seeds of the latter mustard are present at the rate of two whole seeds to the ounce. The presence of the tumbling mustard seed would in all probability render the feed unpalatable and on this account undesirable and unsuitable, especially for young pigs.

OAT PRODUCTS

Lab'y. Nos. 54783 and 54885.—Oat hull—whole and ground. Received from the Quaker Oats Company, Peterborough, Ont.

ANALYSIS

Moisture	2·68	5·10
Protein	2·85	7·31
Fat	1·02	1·47
Carbohydrates	56·15	55·09
Fibre	31·75	25·68
Ash	5·55	5·35
	100·00	100·00

Oat hulls, as has been repeatedly pointed out in previous reports, must be regarded as practically worthless, considered as a feed. The percentage of the more valuable nutrients is very low and the content of indigestible fibre very high.

The inquiry has reached us as to whether ground hulls might find use as a diluent or "filler" mixed with high grade concentrates. We strongly deprecate their employment for this purpose; they would add nothing of value and by their presence would materially depress the digestibility of the compounded feed. There has been altogether too many low grade and worthless feeds on the market, the result of this practice, and practical experience has amply shown their doubtful value. Too often these compounded feeds, which necessarily contain an excess of fibre, have not only proved useless but dangerous.

SCREENINGS

Lab'y. Nos. 57925-26.—Two samples of screenings (unground) forwarded from Brantford, Ont., with an enquiry as to value as chick feed. Their examination may be reported as follows:—

SCREENINGS

	Per cent
Seeds: Wheat	79·0
Wild oats	2·2
Cheat	0·6
Wild buckwheat	14·2
*Cow cockle	0·7
*Ball mustard	0·1
Flax seed	0·2
Great ragweed	0·1
Miscellaneous seeds	0·3
Chaff	2·6

Seeds marked thus * are considered injurious to the health of live stock and poultry.

The Poultry Husbandman says: "This would make a very satisfactory chick feed from the time the chicks were about one month old, but I would not care to feed it prior to that age."

SIFTINGS FROM SCREENINGS

	Per cent
Seeds: Wheat	5·4
*False flax	48·9
Kentucky blue grass	8·3
Cheat	5·3
Timothy	6·4
Corn cromwell	5·1
Canada thistle	0·3
Lady's thumb	0·1
Corn flower	0·2
Buttercup	0·5
Curled dock	4·0
Miscellaneous seeds	1·8
Chaff	13·6

"This would not prove satisfactory for chick feeding at any time and I would not recommend it for that purpose." (Dominion Poultry Husbandman.)

Lab'y. No. 58079.—Ground Screenings sold by Geo. Tanquay, Quebec.

ANALYSIS

Moisture	9·03
Protein	13·90
Fat	2·14
Carbohydrates	65·52
Fibre	7·01
Ash	2·40
	100·00

Guaranteed to contain 13 per cent protein, 3.0 per cent fat and not more than 11 per cent fibre.

The micro-analyst of the department to whom the sample was submitted, reports as follows:—

> "This sample of ground wheat screenings composed mainly of wild buckwheat with a considerable quantity of ground wheat and bran. A trace of hare's ear and ball mustard and traces of other sorts of non-injurious character, with a little chaff and a slight trace of ergot, constitute all other materials found in this feed."

From the analytical data and the microscopical findings, we may expect this to prove a very fairly good feed, if found palatable.

Lab'y. No. 58232.—Ground screenings, forwarded from Dublin, Ont.

ANALYSIS

Moisture	9·29
Protein	13·34
Fat	3·81
Carbohydrates	62·44
Fibre	8·26
Ash	2·86
	100·00

This sample of ground screenings consists of a mixture of cracked wheat and wild buckwheat with some weed seeds and chaff. The vital weed seed content (8 per ounce) is in excess of Regulation No. 2 of the Feeding Stuffs Act. Traces of injurious weed seeds—hare's ear mustard, stinkweed and ergot are present.

Though fairly satisfactory from the standpoint of the percentage of nutrients present, this feed should be carefully tested, noting results, before making any large purchase.

Lab'y. No. 58481.—Ground screenings sent from Galiano, B.C., and suspected to be the cause of the death of several pigs.

ANALYSIS

Moisture	14·09
Protein	11·74
Fat	5·92
Carbohydrates	55·89
Fibre	9·15
Ash	3·21
	100·00

The only feature in this analysis to which exception could be taken, considering the material as a feed for pigs, is the comparatively high fibre content.

Microscopical examination shows that there is very little weed seeds present of a distinctly injurious character but there is an abundance of small, hard coated and unpalatable weed seeds which would be difficult of digestion. The feed, from appearance, consists largely of mill sweepings and refuse.

LINSEED OIL-CAKE MEAL

Lab'y. No. 56508.—Linseed oil meal, American Grain and Feed Corporation, Buffalo, N.Y.

Lab'y. No. 57660.—Oil-cake meal, old process, Canada Linseed Oil Mills, Maple Leaf Brand.

ANALYSIS

	No. 56508	No. 57660
Moisture	9·22	7·08
Protein	35·98	40.14
Fat	6·03	5·96
Carbohydrates	36·18	34·55
Fibre	7·57	7·38
Ash	5·02	4·59
	100·00	100·00

No. 56508.—Genuine oil-cake meal, with traces only of ground weed seed and chaff.

No. 57660.—Sold under a guarantee of protein 35 per cent, fat 6 per cent and fibre 7 per cent. It exceeds the guarantee in protein and is to be considered of excellent quality.

POULTRY AND CHICK FEEDS

The composition of a number of proprietary feed mixtures prepared for poultry and chick feeding was given in the report of this Division for last year, together with some information respecting the nature of this class of feeds in general and the features or characters to be considered as desirable.

During the year three further brands of poultry feed have been examined and are now reported on.

Lab'y. Nos. 54633 and 58385.—Two brands of "Laying Mash," forwarded by J. E. Love, Calgary, Alta.

ANALYSIS

	No. 54633	No. 58385
Moisture	10·00	7·38
Protein	16·22	21·42
Fat	5·11	5·62
Carbohydrates	55·47	52·54
Fibre	8·15	6·38
Ash	5·05	6·66
	100·00	100·00

No. 54633 contains barley chop, oat chop, bran, shorts, corn meal, meat meal and charcoal. No. 58385 contains oat chop, corn meal, bran, shorts, feed flour, meat meal and charcoal.

Both of these are of good composition but No. 58385 is the better by reason of its higher protein content and lower fibre.

Lab'y. No. 57665.—"Peerless" Laying Mash, manufactured by P. P. Products Ltd., Red Deer, Alta.

ANALYSIS

Moisture	8·50
Protein	16·19
Fat	4·52
Carbohydrates	53·45
Fibre	9·92
Ash	7·42
	100·00

This product is made of bran, shorts, oat middlings, barley chop, cornmeal, meat meal, bone meal, alfalfa meal and charcoal.

In protein and fat this "laying mash" is of good average quality; the fibre is somewhat high and probably approaches the limit for feeds of this type.

FOX BISCUIT

Lab'y. No. 58182.—"Imperial Cod Oil Fox Biscuit." Manufactured by the Imperial Fox Biscuit Co., Charlottetown, P.E.I. It is a brown crusted porous biscuit, hard and brittle, with a distinct, though not strong, fishy taste and smell.

ANALYSIS

Moisture	6·67
Protein	18·35
Fat	6·93
Carbohydrates	64·58
Fibre	0·77
Ash	2·70
	100·00

Compared with the analyses previously made in these laboratories of various brands of fox biscuit, the protein and fat content of this sample must be considered satisfactory. The biscuit is sound and apparently palatable and wholesome.

Lab'y. No. 58406.—Fox Biscuit manufactured by the P.E.I. Fox Biscuit Co., Charlottetown, P.E.I.

Hard, very dry, brittle, open texture; stated to be made up of flour, cod liver oil, oil-cake, middlings and meat scrap.

ANALYSIS

Moisture	5·11
Protein	21·30
Fat	12·59
Carbohydrates	58·48
Fibre	0·91
Ash	1·61
	100·00

The percentages of protein, and fat—the more valuable nutrients—are decidedly high and the biscuit would appear to be of one of excellent quality.

FLAX AND FLAX PRODUCTS

Lab'y. No. 58192.—Flaxseed, grown in 1921 by Mr. A. Griffin, Brooks, Alta. (Sown May 24, harvested August 20) from seed raised at Brooks in 1920 and reported on last year (Annual Report Division of Chemistry, 1921).

ANALYSIS

Moisture	7.42
Protein	23.44
Fat	47.47
Carbohydrates	12.33
Fibre	5.54
Ash	3.80
	100·00
Weight of 1,000 kernels	9.178 grams.

This is seed of a new variety, introduced by Mr. Griffin. It is large and heavy and of a light yellow colour. It is exceptionally rich in oil and would appear to be a valuable variety. The essential data for the two seasons are:—

	Oil p.c.	Protein p.c.	Weight of 1,000 seeds grams
1920	43.40	20·79	10.38
1921	47.47	23.44	9·17

Lab'y. No. 58423.—Flax Meal or Flax Feed, forwarded by a correspondent in Listowel, Ont., who writes: "This is simply ground flax seed with a few flax "bolls." If the fibre is not too high it should make an excellent feed."

ANALYSIS

Moisture	6.18
Protein	17.74
Fat	22.32
Carbohydrates	31.70
Fibre	16.80
Ash	5.26
	100.00

In respect to protein and fat there can be no doubt of its high standing but the fibre content is such that its usefulness may be interfered with as a feed, especially for calves.

Our correspondent was advised to make trials with this feed, with small amounts at first and note results. He writes some three months later: "I have made trials with this feed as you suggested and have had good results in every case. With ten calves at first feeding with 4 quarts of whole milk and am now feeding 2 quarts of milk and 1 pint of the meal and getting better results. With milch cows I use a quart of meal with their chop and find an average increase of 4 pounds of milk per day." This is but a single experience and until its real value is established, it should be employed with some caution.

MISCELLANEOUS FEEDS

Under this caption we give the results of our analysis of a number of feeding stuffs of varied character, submitted and examined during the past year. The analytical data will be found in the subjoined table.

MISCELLANEOUS FEEDS, 1921-2

Lab'y. No.	Particulars	Moisture	Protein	Fat	Carbohydrates	Fibre	Ash
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
54361	Feed, largely screenings	9·19	12·87	2·74	60·91	6·74	7·55
54650	Gluten Feed, Can. Starch Co., Fort William, Ont.	9·65	26·64	2·28	50·23	6·45	4·75
54777	Stock Food (Calf Meal) Listowel Flax Mills	7·98	20·09	7·00	48·43	11·72	4·78
55386	Burmah Bean Meal, Victory Mfg. Co., Vancouver, B.C	7·91	19·45	3·30	60·09	5·20	4·05
55556	Feed, Wm. Scott & Co., Deschenes, Que.	8·65	18·68	4·90	58·80	5·42	3·55
55929	Marsh Hay, Institut Agricole d'Oka, La Trappe, Que	6·82	7·16	1·60	41·29	29·62	13·51
56083	Apple pomace, Kentville, N.S	11·76	7·11	2·03	60·95	16·14	2·01
56178	Tulis, Silver Valley, B.C	71·85	4·21	0·92	11·73	7·55	3·74
57071	Sugar Beet Meal, Dominion Sugar Co	6·37	9·42	0·24	59·67	21·15	3·15
57658	Hominy Feed, Ont. Corn Products Co	6·91	11·38	8·03	65·71	5·17	2·80
57659	Malt Sprouts and Brewers' Grains, Molsons Breweries, Montreal	7·34	22·81	5·38	45·64	15·40	3·43
57778	Feed, largely screenings	10·53	14·28	4·01	52·18	13·75	5·25
58084	Beef Meal, Gunns Ltd., Toronto	8·43	51·92	7·36	1·94	3·39	26·96
58100	Distillers' Grains, Melchers Distillery, Montreal	6·77	24·72	10·23	38·76	17·20	2·32
58163	Meal with ground screenings	8·39	12·07	4·42	55·67	13·77	5·68
58538	Cottonseed Meal, Dept. of Customs, Ottawa	.....	37·50	7·24	.....	8·63	7·17

Lab'y. No. 54361.—Feed, forwarded by a correspondent at Rockland, Ont., who could give no information as to its source—it had been purchased locally and the manufacturer's name was not obtainable—but who wished to know if it was a suitable feeding stuff for cattle.

It would appear to be a feed of fair quality, but as it contained ground weed seeds there is some doubt as to its palatability and therefore a trial was advised before purchasing any large quantity.

Lab'y. No. 54650.—Gluten Feed, the product of the Canada Starch Co., Fort William, Ont. It carried a guarantee of protein 25 per cent, fat 3 per cent and fibre 8 per cent.

As regards protein and fibre this feed fully meets its guarantee; in respect to fat it is somewhat low. It has a considerably higher "ash" than gluten feed in general, but this may not betoken any appreciable adulteration. Gluten feed is generally recognized as an excellent concentrate, but this sample possesses a bitterish, scorched taste which may make it more or less unpalatable to stock.

Lab'y. No. 54777.—Stock or Calf Meal from Listowel, Ont., and stated to be made from flaxseed 50 per cent, wheat middlings 25 per cent, clover seed 20 per cent and salt 5 per cent. The manufacture of this feed was owing to an accumulation of flax and clover seed following a slump in the prices of these feeds.

From the standpoint of composition the percentages of protein and fat are quite satisfactory for a concentrate but if the feed is to be used as a calf meal the fibre is somewhat high—probably due to poor flaxseed or the presence of refuse. No information is at hand respecting the palatability of this feed.

Lab'y. No. 55386.—Burmah Bean Meal, manufactured by the Victory Milling Co., Vancouver, B.C.

This meal was of a creamy colour, fine and floury, and possessed a slightly bitter taste.

Very little information is available regarding the practical feeding value of this bean meal, but its protein content would place it with concentrates of considerable value.

Lab'y. No. 55556.—Wheat Feed, manufactured by Wm. Scott & Co., Deschenes, Que.

Microscopical examination shows that it is entirely a wheat product with a large proportion of germ. There is practically no weed seed content.

It appears to be an excellent feeding stuff, high in protein and fat and low in fibre. It should prove a valuable concentrate in a ration of coarser feeds.

Lab'y. No. 55929.—Marsh Hay, submitted by Institut Agricole d'Oka, La Trappe, Que.

This hay is entirely composed of a plant known, botanically, as *Leersia Oryzoides*, a marsh plant the stem and leaves of which are covered with fine barbs. The harshness of this hay considered in conjunction with its low nutritive value would seem to preclude the possibility of its economic use.

Lab'y. No. 56083.—Dried Apple Pomace, the product of the United Fruit Co., Kentville, N.S.

It is stated that there are about 400 tons of the pomace from cider manufacture available annually in the Annapolis Valley and the question has arisen as to the possibilities of making a cattle feed therefrom. The pomace of which a sample was forwarded for examination had been artificially dried and contained 11.76 per cent water, at which moisture content it appeared to have good keeping qualities. Two methods of utilization seemed possible: (1) ground and mixed with other meals and (2) soaked and used as a succulent feed.

The analysis would indicate a very low nutritive value; the percentages of protein and fat are very small and the fibre content is high. Even granting palatability and a fair degree of digestibility, it would not appear to be a product that would, from the economic point of view, stand transportation.

To obtain information as to its possible value as a succulent fodder—as a substitute, say, for corn silage or roots—certain tests were made, as follows: on standing 24 hours with water, the pomace increased in volume to about 2½ times its original bulk, becoming quite soft and pulpy. A 10-gramme sample, allowed to stand over night in water, absorbed 33·7 grammes of water. On this basis, i.e., that in becoming succulent 10 parts become 44·7, the softened material would have the composition as stated in the following tables, in which, for the purposes of comparison the composition of corn silage and mangels is also given.

—	Apple Pomace (soaked)	Corn Silage	Mangels.
Moisture	80·3	76·9	90·6
Protein	1·6	1·9	1·4
Fat	0·4	0·9	0·1
Carbohydrates	13·7	12·7	6·1
Fibre	3·6	6·2	0·8
Ash	0·4	1·4	1·0
	100·00	100·00	100·00

Apart from the economic aspect of the matter, the palatability of the pomace, both dried and soaked, should be ascertained with various classes of stock. Presumably the dried ground material, used judiciously as a part of the ration, could be fed without difficulty. Some experimental work would be necessary to determine how it could be most advantageously and conveniently used.

Lab'y. No. 56178.—Tulis or Swamp Horsetail (*Equisetum limosum*) sent from Silver Valley, B.C., for analysis as to feeding value. This is a hollow-stemmed, reed-like plant. The sample was green, with stalks from 2 to 2½ feet in length; a few flowering stalks.

The analytical data indicate a very low (if any) feeding value. The high fibre and ash (largely silica) content indicate that it would be found unpalatable and indigestible. It is very doubtful if animals could subsist upon it for any length of time, even if it possessed no toxic qualities. It certainly has no value as a forage.

The Division of Botany, to which the sample was submitted for a botanical report, stated "Swamp horsetail *(Equisetum limosum)* has no food value; it contains much silica in its tissues. While we have little or no definite information regarding this plant, some allied species, such as field horsetail, are poisonous."

Lab'y. No. 57071.—Sugar beet meal manufactured by the Dominion Sugar Co., Ltd., Chatham, Ont. This is sold under a guarantee of protein 8·7 per cent, fat 0·5 per cent, fibre 20 per cent.

This by-product, also known as dried beet pulp, can be used for cattle and sheep as a component of the meal ration or, moistened (soaked) as a succulent feed for taking the place of ensilage and roots. It is palatable and wholesome but its nutritive value is low and its use would entail enrichment of the ration with concentrates high in protein and fat. It has proved a useful feed for dairy cattle and sheep when purchased at a price commensurate with its composition.

Lab'y. No. 57303.—Molasses, manufactured by the Atlantic Sugar Refineries, St. John, N.B. A cane product.

Water	25.34
Dry matter	74.66
	100.00
Sucrose (cane sugar)	27.42
Reducing sugars	23.82
Total sugars	51.24
Albuminoids (N x 6·25)	1.92
Ash	6.98

This is a sample of cane molasses of good quality.

The nutritive value of molasses is almost entirely dependent on its sugar content. It is a palatable and appetizing material and though it supplies little or no protein and fat it can be used advantageously, especially in conjunction with roughages that might otherwise be unpalatable. Used in moderation it assists in keeping the animal in a healthy thrifty condition.

Lab'y. No. 57658.—Hominy feed, manufactured by the Ontario Corn Products Co. Sold under guarantee of protein 10 per cent, fat 8 per cent and fibre 5·10 per cent. It fully meets its guarantee.

Hominy feed (a corn product) is a palatable, wholesome feed, fairly rich in protein with a high fat content. It is much relished by stock.

Lab'y. No. 57659.—"Malt Sprouts and Brewers' Grains," manufactured by Molson's Breweries, Montreal.

This is a concentrate with many desirable qualities and one that has been chiefly used to advantage in the ration of dairy cows. The range in composition of this by-product may be stated as follows: protein, 20 to 25 per cent, fat 4 to 5·5 per cent and fibre 11 to 13 per cent.

Lab'y. No. 57778.—Feed, sent from L'Assomption, Que. No information could be given as to the name of the miller or manufacturer.

Though of a fair composition in respect to protein and fat, the presence of a large proportion of objectionable weed seeds would render the feed unpalatable. It would appear to be largely screenings.

Lab'y. No. 58084.—Meat meal, manufactured by Gunn's, Ltd., Toronto.

This sample, as received, was light brown, fairly finely ground meal showing small fragments of bone, sound and without any unpleasant odour.

The analysis and examination indicate that this meat meal is of good quality. In addition to its protein and fat it contains approximately 21 per cent of bone phosphate.

Lab'y. No. 58100.—Distillers' Dried Grains, from The Melcher Gin and Spirits Distillery Co., Ltd., Berthierville, Que.

This by-product is a high protein and fat concentrate. It has proved a satisfactory feeding stuff in the ration of milch cows. It should always be bought on guaranteed analysis, as in common with other by-products of this character, it is likely to vary in composition.

Lab'y. No. 58163.—Meal, forwarded from Charlesbourg, W., Que. This is an inferior feed and one of doubtful value. It contains bran and indian corn meal but, also, oat hulls, mill sweepings and many noxious weed seeds.

Lab'y. No. 58538.—Cottonseed meal, Department of Customs, Ottawa. Though not of the highest grade, this meal is of good quality, without any admixture of foreign material.

Cottonseed meal ranks with the higher protein concentrates and is a valuable feeding stuff when carefully and somewhat sparingly used.

ANALYTICAL AND EXAMINATIONAL WORK ON SAMPLES SUBMITTED BY HEALTH OF ANIMALS BRANCH, DEPARTMENT OF AGRICULTURE

The work involved in this branch is increasing yearly; a total of 2,084 samples have been examined and reported on. It has not been our custom to publish details of examination; we propose, however, to give a short and critical summary of each class of product.

The appended table gives a classified list of samples examined during year 1921-22.

Condensed milks	596
Evaporated apples	729
Colours and inks	6
Spices and condiments	59
Denaturing oils	20
Butters and oleomargarines	31
Salts and preservatives	20
Meat and vegetable extracts	2
Lards, lard compounds and edible oils	104
Canned and preserved fruits	240
Sausages, potted and preserved meats	133
Canned vegetables, tomato products	61
Miscellaneous	129
	2,084

CONDENSED AND EVAPORATED MILK

A total of 596 samples were examined during the past year. This work while of a heavy nature is despatched with expediency and accuracy with the Mojonnier apparatus.

The determination of the net weight, in view of the extent of the trade, is still one of vital importance.

The average net weight on 270 samples of condensed milk in cannisters labelled "14 ounces net weight" was 14·01 ounces.

The average fat content of the same number of condensed milks was 8·23 per cent.

The average net weights of 9 samples of condensed milk in cannisters labelled "12½ ounces," and 12 samples labelled "7 ounces" were 12·47 ounces and 7·00 ounces, respectively.

The average fat content of the same number of condensed milks was 8·09 per cent and 8·84 per cent.

The average net weight of 170 samples of evaporated milk in cannisters labelled "16 ounces net weight" was 16·01 ounces.

The average fat content of the same number of evaporated milks was 7·94 per cent and the total solids 26·05 per cent.

The average net weight of 14 samples of evaporated milk in cannisters labelled "12 ounces net weight," and 121 samples in cannisters labelled "6 ounces net weight," were 12·10 ounces and 6·02 ounces respectively.

The average fat content of the same number of evaporated milks was 7·75 per cent and 7.84 per cent, and the solids content 26.18 and 26.54 per cent.

An appreciable improvement is apparent in the output of the product. Only three leaky cans were received and one with bumped head, known as "hardswell," in this case due to gaseous fermentation. This indicates that less than one per cent of the cans received were unfit for use.

Only eight cans were received that did not show a normal consistency, the contents of two cans being too fluid, and contents of the remaining six cans too thick to pour. These defects are in appearance only and due to the operator not "striking" the batch at the proper time and in no way affects the food value, i.e., butter fat and milk solids.

Eleven cans showed separation of butter fat and sixty-four cans showed an excess of condition known as "sugar down," precipitation and deposition of lactose in bottom of tin; this also is a defect in appearance. All samples were free from mould and harmful defects. Progress in improvement of the manufactured articles is apparent and supports our viewpoint that co-operation of manufacturers combined with chemical control ensures a product of the finest quality passing to the consuming public.

SKIM-MILK AND WHOLE MILK POWDER

A total of twenty-seven samples of milk powder were examined under this heading the past year, chiefly for water content. The average per cent water was 3·79. The maxmium water content was 7·59 per cent the minimum 0·92 per cent. Six samples exceeded the allowable limit of moisture, i.e., 5 per cent.

In view of the increasing output of this valuable food product it is desirable that the moisture content be kept as low as possible in order to minimize unnecessary loss due to fermentation.

All samples submitted were found to be free from preservatives, carbonate and bicarbonate of soda and borates. Microscopical examination showed the samples to be free from adulteration.

CONDENSED MILKS

Mention has been made of the fact that a Mojonnier apparatus has been used in the examination of milk products. During the year some question arose as to the accuracy of results obtained with this machine as compared with A.O.A.C. methods.

At the request of Mojonnier Brothers, co-operative work was carried out on a sample of condensed milk. Our results were as follows:—

Determination	Analyst 1		Analyst 2		Average
	1	2	1	2	—
Total solids—A.O.A.C.	72·49	72·67	72·69	72·85	72·68
" Mojonnier (Hot plate 170°–180°C)	72·94	72·91	72·86	72·93	72·91
" Mojonnier (Hot plate 150°–160°C)	73·21	73·14	73·25	73·27	73·22
Fat—A.O.A.C.	8·26	8·30	8·37	8·22	8·29
Mojonnier	8·26	8·27	8·26	8·26	8·26

The results fully confirm the accuracy of the Mojonnier method.

EVAPORATED APPLES

Seven hundred and twenty-nine samples of evaporated apples were examined for water-content during the year.

The average water content was 20·57 per cent: 450 samples last year had an average water content of 21·39 per cent. Six per cent of samples contained water in excess of 25 per cent:—

The maximum water content was 29.9 per cent.
The minimum water content was 5·1 per cent.

The value of systematic control of evaporated products is well illustrated by our annual results. So far as water content is concerned, evaporated products are at present in an exceedingly satisfactory position.

INKS AND COLOURS

Six samples only of this class were examined during the past year. The use of artificial colouring in food-stuffs has decreased yearly. To-day practically one class of food, only, contains artificial colour, viz., fruit products. The extremely limited period of the Canadian small fruit season is the only reason for sanction of the use of artificial colouring.

All six samples examined conformed to the standards set by Order in Council.

SPICES AND CONDIMENTS

A total of fifty-nine samples were examined in the past year; time permitted of a rather more exhaustive examination than in previous years.

Seven per cent of samples showed excess of foreign starch; four per cent of the samples showed presence of excessive ash, both total and acid insoluble, indicative of the presence of earth or sand.

Five per cent of samples showed the presence of foreign materials or substitutes. This form of adulteration was almost entirely confined to mace. Bombay mace is a very frequent adulterant.

One sample showed the presence of insect infestation.

DENATURING OILS

Specifications for denaturing oils and the reason for setting the limits of such specifications were outlined on page 60 of the report for year 1920-21; there is no necessity for repetition this year.

Twenty-one samples only were examined this year. The packers are appreciating the fact that no useful purpose is served by submitting highly refined paraffin oils, and in no case has such a sample been found to answer the taste requirement, the most deciding factor in the case of a denaturant.

Forty per cent of samples examined fulfilled all requirements and were permitted for use. Ninety-five per cent of the samples answered gravity test; ninety per cent of samples the flash point test. Slightly under fifty per cent of samples satisfactorily met the taste test.

BUTTERS AND OLEOMARGARINES

Thirty-one samples were examined during the year, chiefly for the presence of artificial colouring. Two samples only showed the presence of coal tar colour.

SALTS AND PRESERVATIVES

Twenty samples were examined during the year. All samples were correctly named, and no evidence of fraudulent practice was revealed.

A preservative preparation, the use of which we were not aware was brought to our attention by one of our conscientious manufacturers, requesting to know if such preservative was permissible for use in fruit products. We are not certain of the manufacturers of this product but have been informed by the trade that the makers have assured them by circular that the said preservative cannot be detected by chemical means. This product is sold under a trade name and is essentially a dilute solution of formic acid containing slightly over 20 per cent formic acid.

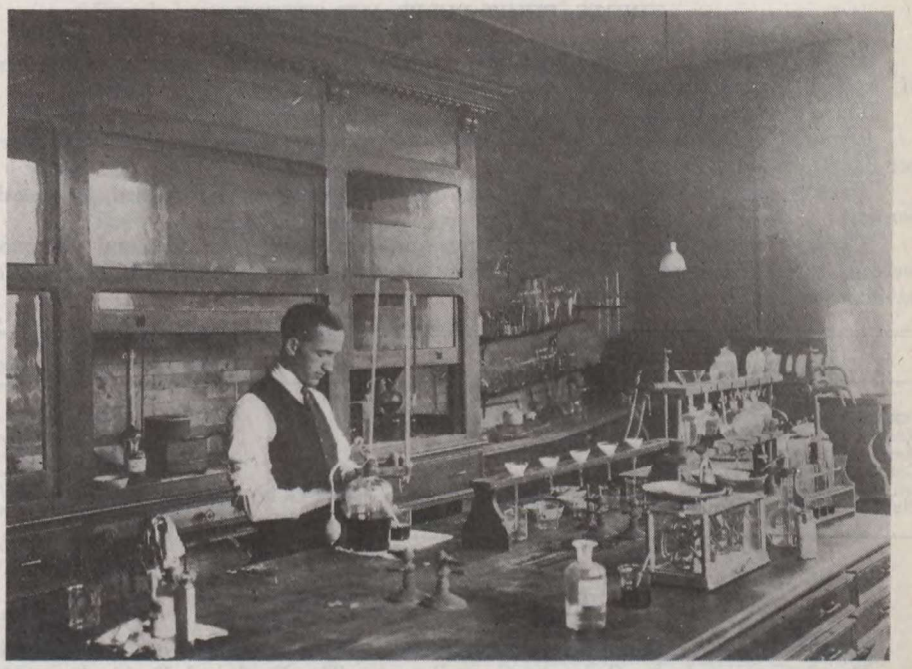
Formic acid is described in "Squire's Companion to the British Pharmacopœia as a powerful stimulant very similar in action to kola, coca and caffeine." To say the least, its use as a food preservative should be carefully guarded, and if used as such in food products, should readily be detected by chemical means.

LARDS, LARD COMPOUNDS AND EDIBLE OILS

One hundred and four samples were examined during the year; the larger percentage of samples were labelled "Pure Lard."

Four samples of pure lard all from the same establishment contained water in excess of that allowed by regulation. In view of the very unusual nature of this adulteration it is desired to draw special attention to these samples. The amounts of water present were as follows: 5·66 per cent, 7·23 per cent, 4·39 per cent, 3·03 per cent.

In our report for last year, page 61, special attention was drawn to a method for the detection of fatty adulterants of lard depending upon the melting point of the solid glycerides separated from ether. One of the samples mentioned above as containing excess moisture showed by this test unmistakable evidence of the presence of foreign fatty matter. We consider the facts outlined above worthy of special attention; it is the first time that we have found definite evidence of adulteration in "Canadian Pure Lard."



Food Products Laboratory, Chemical Building, Ottawa.

MEAT AND VEGETABLE EXTRACTS

Under this heading two samples only, Bovril and Bovril Extract, were examined during the year. Both preparations were found free from preservatives not permitted by regulation under the Food and Drugs Act of 1920.

JAMS AND JELLIES

One hundred and nine samples of pure Canadian jams and 24 samples of compound Canadian jams were examined for artificial colour, glucose and preservatives (benzoates and salicylates).

Twenty-six samples, 24 per cent, of pure jams contained artificial colour.

Four samples, 4 per cent, of pure jams contained glucose.

Eight samples, 33 per cent, of compound jams contained artificial colour.

Twelve samples, 50 per cent, of compound jams contained glucose.

Of the total 133 samples, 23 samples, of 17 per cent, contained salicylates in excess of limit allowed and eight samples, or 6 per cent, contained salicylates in amounts below limit allowed by Food and Drugs Act. None contained benzoates in excess of limit allowed and 2 per cent and three samples, or 2 per cent, contained benzoates in amounts below limit allowed by Food and Drugs Act.

Thirty-six samples of pure imported jams and three samples of compound imported jams were examined as above.

Two samples, 5 per cent, of pure jams contained artificial colour.

Nine samples, 25 per cent, of pure jams contained glucose.

Of the total thirty-nine samples, two samples, 5 per cent, contained salicylic acid in excess of limit allowed.

FRUITS, FRUIT PULPS AND JUICES

Sixteen samples were examined, two were found to contain benzoates in excess of limit allowed, two contained less than limit allowed.

Three contained coal tar colours, amaranth and ponceau 3 R, both permissible.

(Sample of Maraschino cherries contained a very excessive amount (10 parts per 2,000), of sulphite as SO_2).

Twenty samples of apple juices and pectin syrups were examined for pectin content.

Twenty-six samples of pure and compound jams, both Canadian and imported, were examined for percentage of water content. The percentage of water found for various jams were as follows:—

—	Highest	Lowest	Average
Strawberry—6 samples	32·19	21·21	27·01
Raspberry—4 samples	30·35	20·22	24·63
Marmalade—4 samples	27·73	26·52	27·02
Compound Jams—6 samples	38·48	22·41	29·02
Jellies—2 samples	30·93	24·48	27·70
Plum—2 samples	30·67	29·90	30·28

SAUSAGES, POTTED AND PRESERVED MEATS

A total of ninety samples were examined under this heading in the past year.

Regulations made by Order in Council under The Food and Drugs Act, 1920, contain the following definition of sausage (XIV B, p. 22):—

> "Sausage, sausage meat, is a cominuted meat from swine or neat cattle, or a mixture of such meats, either fresh, salted or pickled or smoked, with added salt and spices, and with or without the addition of edible animal fats, cereals, blood and sugar, or subsequent smoking. It contains no larger amount of water than the meats from which it is prepared contain when in their fresh condition, and this must not exceed sixty (60) per cent, and not more than (5) five per cent, of its weight of cereals, and if it bears a name descriptive of kind, composition or origin, it corresponds to such descriptive name. All animal tissues used as containers, such as casings, stomachs, etc., are clean and sound and impart to the contents no other substance than salt. Sausage shall not contain any added colouring matter."

These comments on adulterations of sausages with starchy materials and water, by a well-known authority* are of interest.

"Lean meat carefully chopped has an enormous combining power and can be made to take up a great quantity of water. Frankfurts, bologna, and pork sausage have been found to be adulterated with from 0·5 to 5 per cent of starch, indicating an addition of approximately 1 to 10 per cent of so-called cereal (chiefly corn flour), and from 5 to 40 per cent of water in addition to that contained in the meats when in their fresh condition. The main excuse for the use of water is that it renders the meat of such a consistency that it may be easily stuffed into thin cases, such as are usually used for sausages that are eaten without removing the casing. As a matter of fact, this addition is not necessary where fresh meats are used, nor with those cuts of meat which the American public is in the habit of using in the manufacture of sausages in the home. Without doubt, in sausages composed of ox hearts, ears, snouts, lips, etc., in considerable quantities the addition of water may facilitate the stuffing into thin casings.

"Starch hastens and increases the absorbing or combining power of lean meat. In many instances where inferior products, such as ears, etc. are used, virtually, it is the only absorbing agent present in the product. It then serves a two-fold purpose, first, giving an absorbing power to a meat which naturally is deficient in this respect, and second, acting as a skeleton or framework, thereby disguising shrinkage during the process of cooking. Generally, added water and cereal are evidences of inferiority, and they are by no means infrequently added with the very purpose of concealing such inferiority.

"The evidence of adulteration with water is the discrepancy in the ratio of the water to the protein in the sausage. This ratio in sausage made from fresh carcass varies from 3:1 to 3·6:1, being on an average about 3·35:1."

EXAMINATION OF SEVENTY-FOUR SAMPLES OF SAUSAGE

	Water	Starch	Protein	Water-protein ratio
	p.c.	p.c.	p.c.	p.c.
Maximum	69.40	9.49	19.90	6.69
Minimum	41.50	0.21	8.10	2.90
Average	57.48	3.77	12.68	4.69

Twenty-three per cent of samples contained starch in excess of 5 per cent.

Thirty-six per cent of samples contained water in excess of 60 per cent.

Seven per cent of samples had water-protein ratio in excess of 6·0 per cent.

Thirty-eight per cent of samples had water-protein ratio in excess of 5·0 per cent.

Sixty-one per cent of samples had water-protein ratio in excess of 4·5 per cent.

Seventy-five per cent of samples had water-protein ratio in excess of 4·0 per cent.

Eighty-five per cent of samples had water-protein ratio in excess of 3·6 per cent.

Fifteen per cent of samples had water-protein ratio equal or less than 3·6 per cent.

The results obtained this year show a certain improvement in the quality of sausage. The average percentage of water and starch are somewhat lower than last year, viz., 57·8 and 3·77, against 60·90 and 6·22 respectively. It cannot however be maintained in consideration of our results on water-protein ratio that our present product is satisfactory. Only a small percentage of sausage examined contain a smaller amount of water than the fresh meats used in their preparation; a very large percentage contain water greatly in excess.

* Robinson, Michigan Dairy and Food Department.

For the purpose of explaining to the public and the trade generally the functions of a chemical laboratory in the administration of food laws, it is desirable to draw attention to a sample of canned dried fried fish imported from China and labelled "Fried Pangolin in Lard." We were assured by the Chinese importer that "Lard" in China was universally applied to olive oil and that this product was not, as indicated by the label, packed in lard or hog fat but in a vegetable, probably, olive oil. The results of our examination proved to our satisfaction that this product was packed in lard or hog fat and not in a vegetable oil, as claimed.

CANNED VEGETABLES AND TOMATO PRODUCTS

Sixty samples were examined under this heading.

NINETEEN SAMPLES OF TOMATO PASTE EXAMINED FOR TOTAL SOLIDS CONTENT

	Per cent
Maximum	43·5
Minimum	20·3
Average	32·4

TWENTY-EIGHT SAMPLES OF CANNED PUMPKIN EXAMINED FOR TOTAL SOLIDS CONTENT

	Per cent
Maximum	11·92
Minimum	4·79
Average	8·10

Based on these results the product has been standardized.

One sample of imported peas contained copper.

MISCELLANEOUS

One hundred and twenty-nine samples were examined under this heading.

These samples consisted chiefly of baking powders, flours and starches used in the manufacture of sausage, custard powders and cleaning compounds.

Special mention should be made of custard powders. Several imported samples have been found not to conform to regulations respecting artificial colour. Others purporting to contain dried egg have been found to consist entirely of coloured cereal products.

WELL WATERS FROM FARM HOMESTEADS

During the year ending March 31, 1922, 119 samples of well waters from farm homesteads have been analyzed and reported on. Every province in the Dominion has contributed to this series.

The analytical data are omitted from this report, as they are very voluminous, but, a detailed analysis with report is sent to each forwarder, commenting on the wholesomeness of the supply or explaining the nature and probable source of the contamination—where such has been found. Information is also given as to the possibilities and methods of purification, where such is necessary and possible.

These reports may be summarized as follows:—

	Per cent
Pure and wholesome	24
Suspicious and probably dangerous	18
Seriously polluted	35
Saline	22

In the majority of instances the pollution is drainage matter of an excretal character and is due to the well being improperly located—as in the barnyard or under the stable or barn, or not far from the privy. Sooner or later such wells must become contaminated and their water a menace to health.

Preferably a spring or pure stream at some distance from the farm buildings, is to be selected, from which the water can be piped to the house and farm buildings by gravity or the aid of a windmill or gasolene engine.

Failing this, the choice of a site for the well is of the utmost importance—a matter of primary consideration. The location should be one beyond reproach from the sanitary standpoint—at least 50 yards from any possible source of contamination. The surrounding area, say, for a radius of 50 yards should be kept free from manure and all filth and preferably maintained in sod.

Many farm houses equipped with a piped water supply have installed the septic tank system for the disposal of household sewage. This movement, which involves the putting in of a bathroom, is to be highly commended, not only on sanitary grounds but those of comfort and convenience. But a word of caution must be added. Do not sink the well near the absorption bed carrying the distributing tile. During the past few years our analyses have afforded evidence in a number of instances of pollution due to proximity of the well to the septic tank system. The soil is an effective filter but as it becomes, in the course of time, more and more impregnated with the effluent from the tank the danger of drainage matter but partially purified finding its way into the well increases.

The shallow well is not to be advised; unless properly located and very carefully guarded it may become at any time a menace. The safest supply is the bored or drilled well, passing through a layer of impervious rock and tapping a deep-seated source.

The protection of the well against local pollution should not be overlooked. It will be found of very considerable value to line the well to a depth of 10 to 12 feet and to a thickness, say, of 6 inches, with concrete or puddled clay, continuing this wall or lining for, say, a foot above ground to prevent the entrance of surface water from the immediate surroundings. The well should be furnished with a sound, tight well-fitting cover.

Garbage and dirty water should never be thrown out near the well. In a word, the area of land surrounding the well should be kept clean.

If there are reasons to doubt the purity of a supply, an analysis is desirable. Well waters from farm homesteads, creameries and cheese factories are analyzed, free of charge, in the laboratories of the Experimental Farms, provided that the samples are collected in accordance with instructions which may be obtained, in application, from the Division of Chemistry, Central Experimental Farm, Ottawa.

In conclusion, certain safeguards or precautionary measures may be given, one or other of which it will be well to adopt if contamination is suspected.

1. Boiling for ten or fifteen minutes all water required for drinking and culinary use. The boiled water may be aerated, and thus freed from insipidity by cooling in the open air.

2. Cnlorination. A level teaspoonful of chloride of lime is rubbed up with a little water to the consistency of cream. This thin paste is diluted and thoroughly mixed with water to the volume of approximately one pint, bottled and securely corked. This stock solution will keep for at least a week. A teaspoonful of this solution should be added with stirring to each two gallons of the water to be treated. After fifteen minutes all disease germs present will be destroyed.

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OTTAWA: Printed by F. A. ACLAND, printer to the King's Most Excellent Majesty, 1922.