DOMINION OF CANADA

DEPARTMENT OF AGRICULTURE

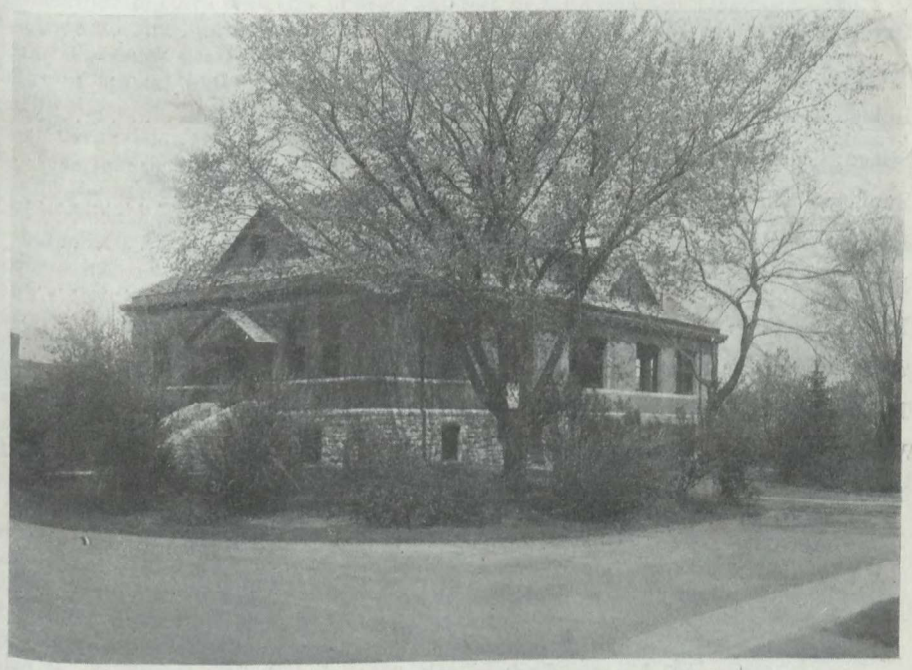
DOMINION EXPERIMENTAL FARMS

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, 1921



Chemical Laboratory, Experimental Farm, Ottawa.

Printed by authority of the Hon. S. F. TOLMIE, Minister of Agriculture, Ottawa, 1912
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DIVISION OF CHEMISTRY

REPORT OF THE DOMINION CHEMIST

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

The work of the Division of Chemistry is varied and covers a wide field, the greater part, however, may be considered as falling within the following classification: Agricultural investigation or research; Chemical service for farmers; Control work and chemical work for other departments of the Government Service.

In accordance with the object for which the division was instituted as a part of the Experimental Farm system, investigation or research of an agricultural character—the endeavour to solve problems of wide interest to the Canadian farming public—is considered of first importance and receives, as far as may be practicable, first attention. For some years past, owing to conditions brought about by the late war—the influx of special work and loss of staff—much of this research work has been necessarily deferred. As conditions again approach the normal we trust that this branch of the division's activities may again take its rightful place, for it is unquestionably true that is furnishes the only satisfactory basis for economic and permanent progress in the practice of farming.

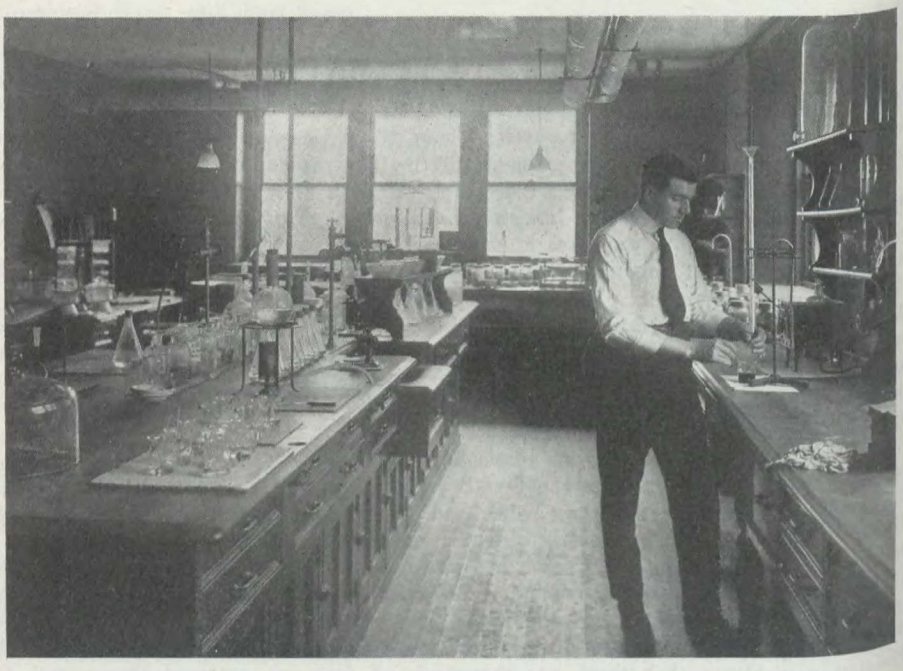
The division has acted as an educational and advisory centre for the assistance of the individual farmer since the first days of its establishment. Chemical service for farmers has always been regarded and treated as an important phase of the division's activities. It necessarily consumes much time but there is good evidence to believe that it has not only proved very helpful to the individual farmer but has also been of value in the general advance of the agriculture of the Dominion. The correspondence with farmers in this connection has greatly increased of recent years—in itself a good sign that this work is appreciated and helpful—and the register of the division now shows that there are thousands of farmers scattered throughout the several provinces who are from time to time incommunication with this Division inquiring as to soils, manures, fertilizers, liming, cattle feeds, insecticides and fungicides, well waters, etc., etc. This phase of work also necessitates a considerable amount of examinational and analytical work, so that a considerable portion of the time and energy of the division must be devoted to its prosecution. We believe, however, that it is time and energy well spent, since it directly helps to make the occupation of farming more intelligent and more profitable.

The chief control work has consisted in the examination and reporting on samples submitted in connection with the administration of the Meat and Canned Foods Act and the Oleomargarine Act, for the Health of Animals Branch of the Department of Agriculture. During the year over 1,200 samples, chiefly products of the packing houses and canneries have been reported on and a summarized discussion of our findings is given elsewhere in this report.

A further feature of control work during the past five years has been in the examination of flour samples, representative of flour shipments for overseas consump-

tion. This work was first undertaken for the British War Office in 1915, continued in 1917 for the Wheat Export Company, the official agents of the Allied Governments, and still more recently for the Canadian Wheat Board. In all 11,513 samples have been examined. This control work was brought to a close in August, 1920, the number of samples analysed during the year to that date being 773. This examination has been the means of saving to the Empire very large sums of money and further, in controlling the moisture content of flours, has ensured the arrival of the flour overseas in excellent condition. It has undoubtedly done much to maintain and further establish the high reputation in Europe of Canadian flour for quality and strength.

With respect to chemical work for other departments of the Government service it will be obvious that no detailed report can here be given. It may however, be stated that for a number of years the division has acted as a bureau of chemistry for several



Interior: Soils Laboratory.

of the departments having no chemical staff or equipment. The more important work in this connection undertaken during the past year has been for the Department of the Interior, The Post Office Department, the Department of Marine and Fisheries, the Customs Department and the Soldiers' Settlement Board and the Soldiers' Civil Re-establishment Commission.

SAMPLES RECEIVED FOR ANALYSIS

The register of the division shows that 3,734 samples were received for analysis or examination during the year ending March 31, 1921. These include samples collected in connection with investigations carried on by the division, samples sent in by farmers for analysis and report (soils, naturally-occurring fertilizers, waters, cattle feeds, etc.), samples submitted by the Meat and Canned Foods Division and the Live Stock Branch of the Department of Agriculture and Canadian Wheat Board.

A more detailed classification will be found in the following table:—

SAMPLES RECEIVED FOR EXAMINATION AND REPORT FOR TWELVE MONTHS ENDING MARCH 31, 1921

	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	New Brunswick	Nova Scotia	Prince Edward I.	Total
Soils	53	386	22	7	39	39	6	5	3	560
Manures and fertilizers	16	2	.....	.....	16	40	34	7	6	121
Forage plants, fodders and feeding stuffs	22	38	12	6	223	45	5	10	4	365
Waters, including rains and snows	11	16	11	6	190	8	5	3	1	251
Samples from Meat and Canned Foods Division	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,279
Miscellaneous: including dairy products, wools, insecticides and fungicides	28	7	8	4	285	43	3	6	1	385
Flours (Can. Wheat Board)	.....	.....	.....	.....	.....	.....	.....	.....	.....	773
										3,734

INVESTIGATIONAL WORK WITH FERTILIZERS

Investigational work with fertilizers has been conducted during the season of 1920 on the Farms and Stations of the system as follows: Charlottetown, P.E.I.; Nappan and Kentville, N.S.; Fredericton, N.B.; Cap Rouge, Que.; Ottawa, Ont.; Brandon, Man.; Rosthern, Scott and Indian Head, Sask., and Agassiz, Invermere and Summerland, B.C.

The detailed data of these experiments are necessarily voluminous and it has therefore been thought advisable to include in this report only such results and conclusions as by their definiteness and completeness warranted at this time their publicity.

ORCHARD FERTILIZER EXPERIMENT

Experiment No. 4 at Kentville, N.S.—The ultimate object of this experiment is to ascertain the influence of various fertilizer treatments on the development and yields of apple trees. Data thereon are not available yet, but records of the returns from the "interval" crops grown in rotation on the area not occupied by the young trees are presented in tables 1 and 2.

A three-year rotation, consisting of potatoes, grain, clover hay, is followed. The fertilizers are applied to the first and second crops of each rotation, or twice in three years. No manure is employed. The soil is a light sandy loam.

The crop (wheat) of 1920 was the eighth since the commencement of the experiment, in 1913. Table 1 presents the yields from three crops of potatoes, three of grain and two of clover hay, with the average for each group.

TABLE No. 1—Experiment No. 4—Orchard Fertilizer Experiment (No Manure Series) To ascertain the Influence of Various Fertilizers applied to the first and second crops of a three-year Rotation: 1st year, Potatoes; 2nd Year, Grain; 3rd Year, Clover Hay. Commenced 1913. Experimental Station, Kentville, N.S.

Record of the returns from the Eight Crops (3 Potatoes, 3 Grains, 2 Hay) of the Rotation (1913-20).

Plot No.	Fertilizers (in lbs. per acre) applied in 1913, 1914, 1916, 1917, 1919, 1920.				Yields Per Acre											
					Potatoes			Average of 3 Potato Crops	Grain			Average of 3 Crop of Grain	Average of 2 Crop of Wheat Straw	Clover Hay		
	Nitrate of Soda 15 % N	Acid Phosphate 16% P_2O_5	Basic Slag 11·2% P_2O_5	Muriate of Potash 50% K_2O	1913	1916	1919		Oats 1914	Wheat 1917	Wheat 1920			1915	1918	Average of 2 Hay Crops
					Bush.	Bush.	Bush.	Bush.	Bush.	Bush.	Bush.	Bush.	lbs.	lbs.	lbs.	lbs.
1 (15)	.....	.....	.....	150	136·5	153·0	184·2	157·9	27·6	8·0	10·3	15·3	650	5300	900	3100
2 (17)	.....	350	.....	.....	150·5	167·5	169·2	162·4	30·6	14·0	13·0	19·2	1290	1350	1350	2425
3 (10)	150	.....	.....	.....	183·0	185·0	198·7	185·9	39·5	9·5	12·3	20·1	970	3040	885	1965
4 (21)	.....	.....	500	.....	160·0	183·0	188·5	177·2	33·5	19·0	17·7	23·4	1700	6987	2730	4860
5 (22)	150	.....	500	.....	196·5	198·0	233·0	209·2	54·1	26·5	22·7	34·8	2490	9520	3660	6590
6 (24)	150	350	.....	.....	165·5	173·5	225·2	188·1	58·8	17·0	18·7	31·5	1580	4900	1485	3190
7 (23)	150	.....	.....	150	195·0	127·5	229·0	183·8	54·7	16·5	17·0	29·4	1430	5320	1155	3240
8 (20)	.....	350	.....	150	162·0	181·5	196·2	179·9	45·6	11·5	12·3	23·1	890	4400	900	2650
9 (1–16)	150	350	.....	150	208·2	205·2	258·5	224·0	61·8	19·0	19·6	33·5	1870	3950	1125	2540
*10 (7)	92½	215	.....	92½	221·5	198·5	240·7	220·2	48·2	13·5	17·3	26·3	1560	3920	660	2290
*11 (8)	138½	323	.....	138½	237·5	229·0	258·0	241·5	61·2	18·0	20·3	33·2	1590	4900	495	2700
*12 (12)	185	430	.....	185	252·5	240·0	280·5	257·7	61·7	15·0	25·7	34·1	1960	5600	975	3290
Four (4)	Check Plots (Average) No Fertilizers				132·0	154·7	159·4	148·7	29·4	8·0	10·3	15·9	860	2105	880	1490

*The same mixture applied at the respective rates of 400, 600, and 800 lbs. per Acre.

Discussion of the Data in Table 1.—Of the materials applied singly (furnishing only one element of plant food) basic slag has been most effective, though, on the potato crops, somewhat less so than nitrate of soda. The most pronounced influence of basic slag is noted in the clover hay crops, while the increases, throughout the eight-year period, from the addition of nitrate of soda to the basic slag are no less remarkable.

Though potash alone gave practically no increase, its influence when added to nitrogen and phosphoric acid is quite distinct, as will be noted on comparing the results from plots 6 and 9.

Worthy of note is the behaviour of plots 10, 11 and 12, which throughout the eight-year period have produced yields in ratio corresponding approximately to the quantity of the fertilizer mixture applied.

The degree of response to superphosphate in these experiments would seem, at first, to indicate that amounts smaller than those used might have sufficed to satisfy the crop requirements for phosphoric acid. But the influence of basic slag, either alone or in combination with nitrate of soda, has been so remarkable that one must ascribe to basic slag virtues not revealed by its analysis. True, it furnishes lime in addition to phosphoric acid, but even on soils plentifully supplied with lime (e.g., in experiment 5 at Kentville) basic slag has maintained an advantage over superphosphate.

A financial record of the returns for the eight years (1913 to 1920) is given in table 2. In each instance the statement shows the total cost of the fertilizers (six applications), the total and average values of the increase (over the checks) from three crops of potatoes (1913, 1916, 1919), from three crops of grain (1914, 1917, 1920), and from two crops of hay (1915, 1918).

The column third from the right gives the total values of the increases from the eight crops of the period, while the two last columns present, respectively, the total and average annual profits after the cost of the fertilizers has been deducted.

The prices taken in computing the values of the fertilizers (except potash) and of produce were approximately those ruling during the different periods involved, between 1913 and 1920. After the first rotation the muriate of potash used was valued at $150 a ton—a figure considerably lower than war-time prices of this commodity, but representing probably the limit for profitable application ordinarily.

Discussion of the Data in Table 2.—Since much of the comment made in reference to the data presented in table 1 is applicable to those in table 2, it is necessary only to make brief further reference to the results. It will be observed that the complete fertilizers, compounded of nitrate of soda, superphosphate and muriate of potash, applied to plots 9, 10, 11 and 12, were responsible for the largest profits with potatoes, but that the remarkable influence of the nitrate and slag (plot 5) on the hay crop gives the latter combination a position but slightly inferior to that of the maximum quantity of the "complete" fertilizer (plot 12) at the close of the eight-year period. The hay crop of 1921, completing the third rotation, may be expected to give the nitrate and slag plot precedence by a considerable margin; indeed, the appearance of the clover on the plots in the fall of 1920 warranted this prediction.

FERTILIZER WITH AND WITHOUT LIME

Experiment No. 5 at Kentville.—The rotation here is the same as that followed in experiment No. 4—potatoes, grain, clover hay. The soil, prior to the commencement (in 1914) of the experiment, was described as a light sandy loam, low in fertility and deficient in lime. The object of the experiment was, primarily, to test the influence of ground limestone when used in conjunction with commercial fertilizers and, incidentally, to compare nitrate of soda with sulphate of ammonia as a source of nitrogen, and basic slag with superphosphate and with bone meal as a source of phosphoric acid. The plan of the experiment is detailed in table 3, which presents also the yields from the three potato crops grown in the years 1914, 1917 and 1920, each marking the opening of a new rotation.

TABLE No. 2—EXPERIMENT No. 4.—Record of the Financial Returns from the Eight Crops (3 Potatoes, 3 Grain, 2 Hay) of the Rotations (1913-20)

EXPERIMENTAL STATION, KENTVILLE, N.S.

Plot No.	Fertilizers (in lbs. per acre) Applied in 1913, 1914, 1916, 1917, 1919, 1920				Total Cost of Fertilizers per Acre (6 applications)	Total and Average Values of Increases (Over Check Plots) Per Acre								
	Nitrate of Soda (15% N)	Acid Phosphate (16% P_2O_5)	Basic Slag (11·2% P_2O_5)	Muriate of Potash (50% K_2O)		Potatoes 1913 1916 1919	Average of 3 Potato Crops	Grain 1914 1917 1920 Total	Average of 3 Grain Crops	Hay 1915 1918 Total	Average of 2 Hay Crops	Grand Total Eight Crops	Profits After Deducting Cost of Fertilizers	
													Total (8 years)	Annual Average
					$	$	$	$	$	$	$	$	$	$
1				150	37·50	36·20	12·05	−2·15	− ·70	24·10	12·05	58·15	20·65	2·60
2		350			23·10	27·95	9·30	13·50	4·50	14·00	7·00	55·45	32·35	4·05
3	150				34·80	83·70	27·90	10·25	3·40	7·05	3·50	101·00	66·20	8·30
4			500		27·00	69·40	23·10	31·55	10·50	50·45	25·25	151·40	124·40	15·55
5	150		500		61·00	161·90	53·95	62·75	20·90	76·45	38·20	301·10	240·10	30·00
6	150	350			57·10	122·45	40·80	43·50	14·50	25·50	12·75	191·45	134·35	16·80
7	150			150	71·50	119·90	39·95	36·90	12·30	26·15	13·10	182·95	111·45	13·95
8		350		150	60·60	81·20	29·10	15·45	5·15	17·35	8·60	114·00	53·40	6·70
9	150	350		150	94·60	209·65	69·90	50·20	16·70	15·65	7·80	275·50	180·90	22·60
*0	92½	215		92½	58·25	186·20	62·05	31·95	10·65	11·95	6·00	230·10	171·85	21·50
*1	138½	323		138½	87·40	235·40	78·45	48·90	16·30	18·05	9·00	302·35	214·95	26·90
*2	185	430		185	116·50	290·65	96·90	66·80	22·30	27·70	13·85	385·15	268·65	33·60

* The same mixture applied at the respective rates of 400, 600 and 800 lbs. per acre.

TABLE No. 3—EXPERIMENT No. 5.—Fertilizers and Lime Experiment

To Ascertain the Relative Values of Various Sources of Nitrogen and Phosphoric Acid in a "Complete Fertilizer," with and without Lime

Three-Year Crop Rotation: 1st year, Potatoes; 2nd year, Grain; 3rd year, Hay. Experimental Station, Kentville, N.S.

Plot No.	Ground Limestone in lbs. per Acre in Fall of 1913, 1916, 1919	Nitrate of Soda (15% N)	Sulphate of Ammonia (20% N)	Acid Phosphate (16% P_2O_5)	Basic Slag (16% P_2O_5)	Bone Meal (2½% N 22% P_2O_5)	Muriate of Potash (50% K_2O)	Yields and Increases (over Check Plots) per Acre						Average Increase of three years.	Increase Due to Lime		
								Yield 1914	Increase 1914	Yield 1917	Increase 1917	Yield 1920	Increase 1920		1914	1917	1920
								Bush.	Bush.	Bush.	Bush.	Bush.	Bush.	Bush.	Bush.	Bush.	Bush.
1A		140		150	150		100	73·6	17·7	291·3	39·5	216·5	62·4		12·3	34·7	−21·0
1B	4000	140		150	150		100	85·9	18·3	326·0	12·6	195·5	45·5				
						Average	Increase		18·0		26·05		54·45	32·85			
2A			105	150	150		100	69·7	13·8	295·7	43·9	203·6	49·5				
2B	4000		105	150	150		100	86·3	18·7	321·1	7·7	181·1	31·0		16·6	25·4	−22·5
						Average	Increase		16·2		25·8		40·25	27·45			
3A		70	52½	300			100	83·7	27·8	294·5	42·7	205·6	51·5				
3B	4000	70	52½	300			100	90·6	23·0	326·0	12·6	202·5	52·5		6,9	31·5	− 3·1
						Average	Increase		25·4		27·65		52·0	35·00			
4A		70	52½		300		100	84·9	20·9	297·5	45·7	203·3	49·2				
4B	4000	70	52½		300		100	92·5	24·9	338·3	24·9	207·6	57·6		7·6	40·8	4·3
						Average	Increase		26·9		35·3		53·4	38·55			
5A		50	52½			240	100	69·3	13·4	283·0	31·2	184·8	30·7				
5B	4000	50	52½			240	100	78·7	11·1	335·1	21·7	200·5	50·5		9·4	52·1	15·7
						Average	Increase		12·2		26·45		40·6	26·45			
6A								55·9		251·8		154·1					
6B	4000	Check						67·6		313·4		150·0			11·7	61·6	−4·1

15 Tons per Acre of Barnyard Manure applied to whole are in Fall of 1916

Discussion of the Data in Table 3.—It will be noted that the B plot of each pair received, in the fall preceding the potato crop (the first) of each rotation, ground limestone at the rate of two tons per acre; further, that a 15-ton per acre application of manure was given the whole area at the close of the first rotation (in 1916). The influence of the manure is evident on comparing the yields in 1914 with those in 1917 and 1920.

Throughout, nitrate of soda proved superior to sulphate of ammonia as a source of nitrogen, while basic slag proved the most effective source of phosphoric acid, its superior influence being most pronounced on the hay crop in the third year of the rotation.

The results with the potato crop of 1920 are specially noteworthy because, for the first time in the seven-years' course of the experiment, ground limestone has failed to promote increased yields; indeed, except in series 4 and 5, it has had a depressing action. In explanation, the Superintendent observed that the potatoes on the limed areas appeared to ripen earlier and that, in consequence, they derived less benefit from the late rains which caused a resumption of growth on the unlimed plots.

FERTILIZERS WITH AND WITHOUT LIME

Experiment No. 1 at Kapuskasing, Ont.—The object of this experiment is to ascertain the influence of basic slag and of lime in various forms, also superphosphates in conjunction with nitrate of soda and, sometimes, potash, on crop yields in a four-year rotation consisting of potatoes, grain, clover hay and timothy hay. The soil is a silty clay.

In the fall of 1919 the whole area received manure at the rate of 20 tons per acre. The plots, in respect to individual treatment, are in duplicate. Basic slag was applied alone at the rates of 500, 750, and 1,000 pounds per acre and the series repeated with 3,000 pounds of quick lime in each instance. Two series received equivalent quantities of lime in the forms, respectively, of quick lime, slaked lime and ground limestone. In another section of the experiment nitrate of soda is used in conjunction with superphosphate or with a mixture of superphosphate and slag, the latter treatment being repeated with muriate of potash and again with quick lime. The area was somewhat irregular in respect to soil conditions, so was divided into groups, each containing a check plot.

Some of the data furnished by the first crop (potatoes, 1920) are presented in table 4.

TABLE No. 4.—Experiment No. 1 Lime and Fertilizer Application, Potatoes 1920. Kapuskasing, Ont.

Plot	Ground Lime-stone	Slaked Lime	Quick Lime	Nitrate of Soda	Super-Phos-phate	Basic Slag	Mur. of Potash	Yield per Acre	Increase over Check
	Lbs.	Lbs.	Lbs.					Bush.	Bush.
1	Check	Check	.....	.....	.....	.....	.....	120·0	.....
2	.....	.....	.....	.....	.....	500	.....	133·3	13·3
3	.....	.....	.....	.....	.....	750	.....	158·3	38·3
4	.....	.....	.....	.....	.....	1,000	.....	160·0	40·0
5-16	Check	Check	.....	.....	.....	.....	.....	152·5	.....
6-17	.....	.....	3,000	.....	.....	.....	.....	151·1	.....
7-18	.....	4,500	.....	.....	.....	.....	.....	150·1	.....
8-19	6,000	.....	.....	.....	.....	.....	.....	170·8	18·3
28	Check	Check	.....	.....	.....	.....	.....	85·0	.....
29	.....	.....	.....	100	200	200	.....	137·0	52·0
31-33	.....	.....	.....	100	200	200	100	168·8	83·8
30	.....	.....	.....	100	400	.....	.....	146·0	61·0
34	.....	.....	1,000	100	400	.....	.....	164·0	79·0

Discussion of the Data in Table 4.—The yields from the plots in the first section show that basic slag produced notable increases and that, judged by the returns from the potato crop, the medium quantity (750 pounds) proved most profitable. The slag, however, may be expected to exert a still greater influence on the crops of the next two or three seasons, so that the largest application (1,000 pounds) may prove most profitable before the close of the rotation.

In the next section it will be seen that, of the three forms of lime, ground limestone only has produced an increased yield. It is not unusual for the caustic forms of lime to have a depressing effect on crop yields, in the year of their application.

Greater increases in yield are recorded in the third section, all the fertilized plots of which have received a small quantity (100 pounds) of nitrate of soda. The favourable influence of potash—seen in the difference between the yields of plot 29 and the average of plots 31 and 33—is remarkable and rather unexpected on this silty clay soil. A comparison of the yields from plots 30 and 34 shows the moderate application of 1,000 pounds of quick lime to have been distinctly beneficial when used in conjunction with a nitro-phosphatic fertilizer.

THE INFLUENCE OF PHOSPHORIC ACID IN PROMOTING MATURITY

There exists a widespread belief that certain crops when furnished with phosphoric acid in soluble form will attain maturity earlier than they otherwise would. The belief, if well founded, would indicate a means for advancing the date of ripening and thus permitting the successful growth of crop varieties which in certain regions, because of climatic conditions, may have failed to reach the stage of maturity desired.

In order to test the theory, investigations were conducted with corn at Cap Rouge, Que.; Brandon, Man.; and Indian Head, Sask., in 1919, and with wheat (oats also at Rosthern) at the Experimental Farms and Stations of Brandon, Man.; Indian Head, Sask.; Rosthern, Sask.; and Scott, Sask., in 1920. At each Station the fertilized plot received superphosphate at the rate of 300 pounds per acre, the adjoining unfertilized plot being treated otherwise similarly.

In no single instance, either with corn in 1919 or with cereals in 1920, was the maturity of the crop advanced perceptibly or, stranger still, the yield increased appreciably by the use of the superphosphate. At two Stations the wheat on the treated plot headed out from one to three days earlier than the wheat on the check plot, but in neither case was any difference in maturity noticeable at harvest time. At one Station the fertilized plots of wheat and of oats produced one and two bushels increase per acre, respectively—differences too slight to be considered of any particular significance. The degree of consistency exhibited in the data from these eight experiments proves undoubtedly that superphosphates alone cannot be depended on to promote the maturity or increase the yields of corn or cereals.

NITRATE OF SODA ON THE OAT CROP

Experiment E at Agassiz, B.C.—The feature most prominent in the results from this experiment (concluded in 1920), is represented in the remarkable increases in yield following the application of nitrate of soda at the time of seeding the oat crop of the second year.

Twelve plots, all of which had been fertilized liberally for the mangel crop of the first year, were subdivided and one-half each plot was treated to an application of nitrate of soda at the rate of 133, 200 or 266 pounds per acre.

A cold, wet spring followed by a hot, dry summer produced conditions ideal for demonstrating the influence of nitrate of soda.

The oats were seeded on April 30—the nitrate being applied to the twelve plots the same day—and harvested on July 5.

TABLE No. 5.—Experiment E—Results from the Use of Nitrate of Soda on the Oat Crop of 1919, Agassiz, B.C.

Plot	Nitrate of Soda Applied April 30, 1919	Cost of Nitrate of Soda per Acre	Yields per Acre		Increase per Acre		Value of Increase due to Nitrate	Profit after deducting cost of Nitrate
			Grain	Straw	Grain	Straw		
	Lbs.	$	Bush.	Lbs.	Bush.	Lbs.	$	$
2A	none		22·4	1,720				
2AA	266	15·30	51·8	4,000	29·4	2,280	35·10	19·80
2B	none		28·2	1,360		2,400	34·30	22·80
2BB	200	11·50	56·6	3,760	28·3			
2C	none		22·4	1,320				
2CC	133	7·65	41·2	3,400	18·8	2,080	24·00	16·35
4A	none		25·9	1,760				
4AA	266	15·30	64·7	4,360	38·8	2,600	45·30	30·00
4B	none		23·5	1,360				
4BB	200	11·50	56·5	3,600	33·0	2,240	38·60	27·10
4C	none		16·5	1,360				
4CC	133	7·65	33·0	3,040	16·5	1,680	20·70	13·05
6A	none		20·0	1,800				
6AA	266	15·30	72·9	4,240	52·9	2,440	59·00	43·70
6B	none		20·0	1,560				
6BB	200	11·50	54·1	4,480	34·1	2,920	41·40	29·90
6C	none		23·5	1,680				
6CC	133	7·65	36·5	3,880	13·0	2,200	18·50	10·85
12B	none		10·6	1,320				
12BB	266	15·30	40·0	4,480	29·4	3,160	37·30	22·00
12C	none		12·9	1,640				
12CC	200	11·50	40·0	4,080	27·1	2,440	33·20	21·70
13A	none		15·3	1,240				
13AA	133	7·65	41·8	3,520	26·5	2,280	32·20	24·55
AVERAGES								
4 Plots	none		19·7	1,650				
4 Plots	266	15·30	57·3	4,270	37·6	2,620	44·15	28·85
4 Plots	none		21·1	1,480				
4 Plots	200	11·50	51·8	3,980	30·7	2,500	36·75	25·25
4 Plots	none		19·4	1,400				
4 Plots	133	7·65	38·1	3,460	18·7	2,060	23·85	16·20

Discussion of Data in Table 5.—The results indicate very clearly that to lack of soluble nitrogen in the soil is due the small yields on the plots which received no nitrate of soda. In nearly every instance the yields were doubled and in three more than trebled by the nitrate. A point of further significance is noted in the fact that, without a single exception, 266 pounds of nitrate produced the greatest, 200 pounds somewhat less, and 133 pounds the least increase in each individual series.

The lower yields generally in the fourth series may be attributed to the omission of potash from the fertilizer applied to these plots in the former year.

In these experiments nitrate of soda stimulated crop production in a degree which is undoubtedly exceptional. Under more favourable seasonal and soil conditions probably 150 pounds of nitrate of soda per acre would represent the maximum quantity which might be applied profitably for a grain crop. In a practical demonstration of this nature results more consistent and more conclusive than these from Agassiz could not be hoped for.

THE FERTILIZING VALUE OF RAIN AND SNOW

Apart from other and, undoubtedly, more important agricultural functions, rain and snow contribute notable amounts of nitrogenous plant food and hence may rightly be considered as possessing a distinct and direct fertilizing value. In 1907 we began the determination of these nitrogen compounds, measuring and analysing each fall of snow and rain and computing from the data obtained the enrichment per acre per annum. The average from the first ten years' work (completed February, 1917) was 6·58 pounds of nitrogen, furnished in the form of ammonia and nitrates, per acre, per annum—an amount equivalent to an application of, approximately, 40 pounds of nitrate of soda.

The samples for analysis are collected at the Central Experimental Farm, on the outskirts of Ottawa, so that the results are more particularly applicable to the Ottawa Valley district, though no doubt they are in a very large measure applicable to districts enjoying a similar precipitation.

The data for the fourteenth year of the inquiry (March 1, 1920, to February 28, 1921) are now recorded and discussed.

The determinations in the laboratory are free ammonia, albuminoid ammonia and nitrogen in nitrates and nitrites, these three forms constituting the nitrogenous compounds in the precipitation capable of furnishing food for crops.

During the year ending February 28, 1921, 78 samples of rain and 29 of snow were analysed.

The total precipitation was 33·90 inches, an amount slightly exceeding the average at Ottawa for the past fourteen years, viz., 33·39 inches, and the average for the past thirty years, viz., 33·69.

The rainfall was 27·21 inches, nearly four inches more than in the previous experimental year and approximately three inches higher than the average for the past fourteen years. The precipitation was fairly uniform throughout the year, with the exception of the month of May, which was unusually dry, the rainfall being only ·33 inches. The highest records for rain are in April and September, with precipitations slightly more than 4 inches each month.

The snowfall was 66·9 inches (equivalent to 6·69 inches in rain), 31·6 inches less than in the preceding season and 27·3 inches less than the average for the previous fourteen years.

During the twelve-month experimental period, one hundred and seven samples were analysed: seventy-eight of rain and twenty-nine of snow.

Table I presents the monthly totals of precipitation, the monthly average nitrogen-content of the precipitation in parts per million and the pounds of nitrogen per acre furnished monthly by the precipitation.

TABLE I.—RAIN AND SNOW AT OTTAWA, ONT., FOR THE YEAR ENDING FEBRUARY 28, 1921

Month and Year	Precipitation in Inches			Nitrogen				Pounds of Nitrogen per Acre
	Rain	Snow	Total in Inches of Rain	In Free Ammonia	In Albuminoid Ammonia	In Nitrates and Nitrites	Total	
1920				p.p.m.	p.p.m.	p.p.m.	p.p.m.	
March	1·42	9·75	2·395	1·003	0·062	0·110	1·175	0·638
April	4·02	2·00	4·22	1·098	0·081	0·322	1·502	1·436
May	0·33	.....	0·33	1·111	0·174	0·480	1·765	0·132
June	3·25	.....	3·25	0·577	0·079	0·187	0·843	0·621
July	3·61	.....	3·61	0·150	0·062	0·543	0·755	0·618
August	2·81	.....	2·81	0·674	0·032	0·240	0·947	0·603
September	4·10	.....	4·10	0·641	0·040	0·124	0·805	0·748
October	2·82	.....	2·82	0·355	0·026	0·103	0·484	0·309
November	1·36	14·00	2·76	0·405	0·024	0·119	0·539	0·337
December	2·68	15·15	4·195	0·273	0·069	0·244	0·586	0·556
1921								
January	0·55	12·75	1·825	0·277	0·210	0·187	0·674	0·278
February	0·26	13·25	1·585	0·369	0·126	0·200	0·695	0·249
Total for 12 mths.	27·21	66·9	33·9	.....	.....	.....	.....	6·525

Attention may be called to the exceptionally high nitrogen recorded for the month of April. The high rainfall for that month may in part account for the figure obtained, 1·436 pounds per acre, but cannot wholly do so since as will be seen from the records of September and December, a similar precipitation may not yield more than one-third or one-half that amount. Reviewing the results in this work for the first ten year period of the investigation, it is observed that the largest monthly amounts of nitrogen usually appear in April and May and that these amounts are not directly proportionate to the rainfall. We have at present no explanation or reason to offer for this but it is interesting to note that since the greater part of this nitrogen is present in the forms of free ammonia and nitrates, compounds which are practically immediately available for crop use, the rain becomes a direct fertilizer at a most opportune season.

The total amount of nitrogen for the year amounted to 6·525 pounds per acre—the average for the fourteen years during which this investigation has been carried on being 6·541 pounds.

TABLE II.—PRECIPITATION AND AMOUNT OF NITROGEN PER ACRE, OTTAWA, ONT., 1908-21

	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	96·25	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	36·445	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
Average for 30 years	24·368	93·280	33·687	.....
" 14 years	23·968	94·227	33·388	6·541

The more important data of the investigation are summarized in table II which is of interest in permitting a ready comparison of the chief results since 1908. Comment has already been made on the precipitation; compared with the average for 30 years and 14 years, the results of the past year show a decidedly higher rainfall with less snow. In the amount of nitrogen furnished per acre, the figures for the past year appear to be fairly normal, or perhaps more correctly stated, they very closely approach the average for the past fourteen years. It would seem that the precipitation in the neighbourhood of Ottawa furnishes approximately 6·5 pounds of nitrogen per acre usable as crop food.

TABLE III.—AMOUNTS OF NITROGEN, FURNISHED BY RAIN AND SNOW, 1908-1921

Year Ending	Total Pounds.	By Rain		By Snow	
		Pounds	Proportion	Pounds	Proportion
			p.c.		p.c.
February 29, 1908	4·322	3·243	75	1·080	25
" 28, 1909	8·364	7·528	90	·836	10
" 28, 1910	6·869	5·830	85	1·040	15
" 28, 1911	5·271	4·424	84	·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	·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	·916	16
" 29, 1920	7·117	5·909	83	1·208	17
" 28, 1921	6·525	5·195	80	1·330	20

Table III is of interest in showing the proportion of nitrogen furnished by the rain and snow, respectively, throughout the whole period of the investigation.

Though the rainfall of the year ending February 28, 1921, was higher and the snowfall for the same period lower, than the average, the results show that in the proportion of nitrogen furnished by the rain and snow respectively there is a fairly close agreement with preceding data. Approximately 80 per cent was found in the rain and 20 per cent in the snow. The rain furnished 5·195 pounds and the snow 1·33 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, 1920-21

	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.....	78	27·21	0·587	0·050	0·205	0·842	70	6	24	3·931	1·263
Snow.....	29	66·90	0·493	0·129	0·256	0·877	56	15	29	0·943	0·386

The relative richness of the rain and snow in the several nitrogen compounds is shown in table IV; the amounts of these compounds in pounds per acre are also included.

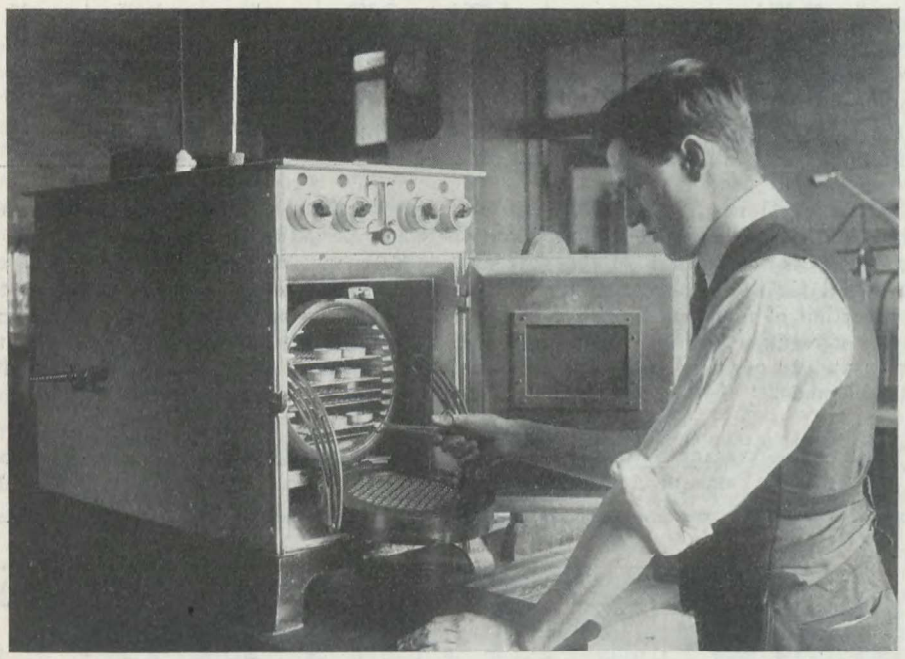
The results for the past year differ from preceding data in showing that the rain and snow, considered weight for weight, are almost of equal value in respect to nitrogen content. In previous years our findings have shown that rain was decidedly richer than snow in all the nitrogen compounds and especially in free ammonia.

Of the total nitrogen, 6·523 pounds per acre, 4·874 pounds occurred as free and organic ammonia and 1·649 pounds as nitrates and nitrites.

Considering the rain and snow simply as suppliers of plant food, their value per acre per annum, in the Ottawa Valley district, may be conservatively placed at $1.75.

INVESTIGATIONAL WORK FOR THE RECLAMATION SERVICE

This work falls into two large sub-classes: (1) the chemical and physical examination of soils from districts in southern Alberta and southwestern Saskatchewan suspected of containing alkali and undertaken with the view of assisting in the classification of such lands into irrigable and non-irrigable areas, and (2) the analysis and



Vacuum oven, for moisture determinations.

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 only occasionally for the determination of the alkali and is more particularly concerned with the nature and quality of the soil from the farming standpoint.

This investigatory work is undertaken for and reported to the Reclamation Service (formerly the Irrigation Branch) of the Department of the Interior, and has

been carried on continuously since 1913 in these laboratories. During the year closing March 31, 1921, 35 groups, comprising 140 samples, of soil have been analysed and reported on as to suitability for cultivation under irrigation, and 48 groups, comprising 189 samples have been similarly examined and reported on in connection with drainage reclamation projects. Among the more important irrigation projects from which samples were examined are the Lethbridge South Eastern Project and the Canada Land and Irrigation Company. Of the drainage projects examined and reported on the following may be cited: Beaverhill Lake, Bittern Lake, Broken Head River, Ponass Lake, Flat Lake, Hastings Lake, West Moose Range, and Cypress Lake.

Considerable study has been given to the review of the voluminous data which have been accumulated during the past five years in connection with the area known as the St. Julien Colony at Tilley, Alberta, and to the completion of the classification of the irrigable lands in the Canadian Pacific Railway eastern section. With respect to the St. Julien Colony the following pronouncement has been made: "The evidence would justify us in releasing as reasonably safe for irrigation such lands as show in "A" (0'.0-0'.5) a corrected resistance of not less than 190 ohms, and in "B" (0'.5-1'.5) a resistance of not less than 130 ohms, provided that:—

> "1. Surface drains or ditches be constructed throughout the involved areas which would permit of the adequate drainage of the lands in question to a depth of 18 inches.
>
> "2. The use of irrigation water be kept within the lowest possible limits necessary to successful crop growth and in no case exceed 1½ acre foot."

In investigational work proper, considerable progress has been made in the study of two important problems more or less closely related to the classification of irrigable lands and alkali soils: The vertical movement of alkali under irrigation in heavy clay soils, and the alkali content of soils as related to crop growth. A study of the chemical and physical nature of "burn-outs," peculiar depressions or pockets characterizing the prairie surface over large areas in southern Alberta and southern Saskatchewan, has been made. Papers incorporating the results of these researches appear in the transactions of the Royal Society of Canada.

LOSS ON SCOURING OF VARIOUS GRADES OF WOOL

At the request of the Live Stock Branch of the Department of Agriculture this division undertook the estimation of th e"loss on scouring" of a number of samples representative of different grades of wool as produced in the several provinces of the Dominion.

The scouring of the wool was carried out at Smith's Falls, Ont., under the direction of experts of the Sheep and Goat Division, Live Stock Branch, and the necessary moisture determination made in the laboratories of the Division of Chemistry. In all one hundred and two samples were examined and reported on. After certain preliminary work of an investigational character it was decided to make the moisture determinations by drying the wool for three hours at a temperature of 100° C. From these results, the moisture in the greasy and scoured wool, respectively, were obtained and the loss on scouring, using the weights of the samples of greasy and scoured wool, was calculated. The loss on scouring, as calculated on the "bone dry" greasy wool, ranged from 27 to 62 per cent, with the larger number of the samples falling between 35 and 45 per cent. The detailed data are too voluminous for insertion in this report.

The information gained by this investigation must be regarded as preliminary in character. Further work will be necessary, having regard to care in scouring,

grading and sampling, before final figures are obtained for the scouring loss for the several grades of wool from the different localities in the Dominion. It is obvious that standards should be established only from averages of thoroughly representative samples from large stocks, carefully scoured.

In this work there was no opportunity to establish a standard "regain" for clean wool; the process of drying to determine moisture content of the wool destroys the hygroscopicity of the fibre. From work done in the United States it has been concluded that standard regain of 15 per cent is a fair figure, somewhat lower than the practice at Bradford, England. The data recorded from the present work permit the calculation of the regain weight of the scoured wool if this figure—or that of Bradford—is tentatively adopted.

In acknowledging the detailed report of this work the Live Stock Commissioner writes: "This is the first work of its kind that has been performed with Canadian wools and it will undoubtedly prove of great value to the industry."

SUGAR BEETS FOR FACTORY PURPOSES

Among the more important factors contributing to the success of the beet sugar industry are cheap labour, fuel and limestone, and an adequate supply, within a reasonable distance, of high quality beets. It is with respect to the quality—the richness and purity—of Canadian-grown sugar beets and the influence thereon of soil and climatic conditions as occurring and prevailing in various parts of the Dominion, that this investigation has chiefly concerned itself, systematic work thereon having been inaugurated in 1902 and continued to date.

The plan in outline has consisted in growing beets of approved and leading varieties for factory purposes at a number of widely distant points throughout the Dominion—the Experimental Farms, Stations and Sub-stations—and analyzing as to richness and purity a representative sample of the harvested crop.

For many years the seed used in this investigation was imported from Messrs. Vilmorin, Andrieux et Cie, Paris, France, noted breeders of sugar beets, the varieties being Vilmorin's Improved A, Vilmorin's Improved B, and Klein Wenzleben. The results showed that excellent beets for factory purposes could be grown at a number of points throughout the Dominion. For the past five years Canadian-grown seed has been largely, and occasionally, exclusively used, with most satisfactory and gratifying results. This latter (Canadian-grown seed) was all obtained through the courtesy of the Dominion Sugar Beet Company, Wallaceburg, Ont., the only beet sugar company operating in Canada, with factories located at Wallaceburg, Kitchener, and Chatham. The three stocks of seed used by us in 1920 are designated simply by the name of the province or locality in which they were grown, thus British Columbia, Chatham, Kitchener—the name of the specific variety not being known. Presumably it is originally from imported Russian seed, subsequently grown and reproduced in Canada, as noted.

The locations of the Experimental Farms and Stations at which this inquiry was conducted are as follows: Charlottetown, P.E.I.; Kentville, N.S.; Nappan, N.S.; Fredericton, N.B.; Lennoxville, Que.; Cap Rouge, Que.; St. Anne de la Pocatière, Que.; Ottawa, Ont.; Brandon, Man.; Rosthern, Sask.; Scott, Sask.; Indian Head, Sask.; Lacombe, Alta.; Lethbridge, Alta.; Agassiz, B.C.; Invermere, B.C.; Summerland, B.C.; Sidney, B.C.

Detailed results of analysis together with certain other data of interest in forming an opinion as to the value of the crop for sugar production, are given in table I.

TABLE 1.—SUGAR BEETS GROWN ON THE DOMINION EXPERIMENTAL FARMS, 1920.

	Percentage of Sugar in Juice	Percentage of Solids in Juice	Coefficient of Purity	Average Weight of One Root		Yield per Acre	
			p.c.	lbs.	oz.	Tons	lbs.
BRITISH COLUMBIA							
Charlottetown, P.E.I	17·39	19·77	87·92	1	11	10	1,000
Kentville, N.S	18·80	20·97	89·66	1		14	336
Nappan, N.S	19·58	21·90	89·41		11	11	80
Fredericton, N.B	18·05	20·63	87·50	1	5	15	1,080
Lennoxville, Que	13·80	16·24	85·00	1	9	10	734
Cap Rouge, Que	17·06	19·40	87·96	1		9	400
Ste. Anne de la Pocatière, Que	14·08	16·97	82·99		13	6	420
Ottawa, Ont	14·48	16·97	85·33	1	12		
Brandon, Man	15·47	19·69	78·57	2	8	13	1,690
Rosthern, Sask	14·19	19·00	74·67		13	6	834
Scott, Sask	16·41	20·89	78·54		9	7	1,312
Indian Head, Sask	20·79	23·89	87·02	1	2	12	1,300
Lacombe, Alta	9·14	13·63	67·07	1		5	1,154
Lethbridge, Alta. (Irrigated)	18·37	21·57	85·17	1	3	4	1,000
Lethbridge, Alta. (Non-irrigated)	19·39	22·17	87·48		5	1	400
Agassiz, B.C	16·34	19·28	84·76	2	7	12	500
Invermere, B.C	17·53	21·17	82·81	1	12	6	1,252
Summerland, B.C	17·22	21·17	81·34	1			
Sidney, B.C	14·01	16·37	85·57	1	4	7	695
CHATHAM							
Charlottetown, P.E.I	15·59	19·69	79·14	1	10	7	
Kentville, N.S	18·30	20·40	89·73	1	1	13	1,016
Nappan, N.S	16·67	19·11	87·26		12	11	1,184
Fredericton, N.B	18·64	20·63	90·35	1	5	13	1,280
Lennoxville, Que	15·24	18·06	84·53	1	8	11	1,870
Cap Rouge, Que	16·50	19·37	85·17	1	3	11	200
Ste. Anne de la Pocatière, Que	10·84	14·00	77·45		12	8	1,700
Ottawa, Ont	15·22	17·91	84·94	1	13		
Brandon, Man	14·81	18·49	80·09	4	8	17	80
Rosthern, Sask	13·81	18·80	73·47		13	4	370
Scott, Sask	16·10	19·77	81·41		14	5	32
Indian Head, Sask	20·44	23·29	87·74	1	6	14	500
Lacombe, Alta	15·24	18·97	80·34	1	2	5	758
Lethbridge, Alta. (Irrigated)	18·41	21·17	86·98	1	4	5	800
Lethbridge, Alta. (Non-irrigated)	19·32	22·77	84·82		7	1	600
Agassiz, B.C	16·62	19·46	85·41	1	13	10	1,000
Invermere, B.C	20·46	23·50	87·06	1	14	5	1,352
Summerland, B.C							
Sidney, B.C	14·58	16·57	88·00	1	2	7	520
KITCHENER							
Kentville, N.S	18·08	20·30	89·08	1		12	640
Nappan, N.S	17·79	20·11	88·47		7	10	640
Lennoxville, Que	14·61	17·41	83·90	1	6	12	219
Cap Rouge, Que	16·52	18·77	88·02	1	1	6	1,000
Ste. Anne de la Pocatière, Que	14·81	17·57	84·29		12	9	300
Ottawa, Ont	15·58	18·11	86·02	1	4		
Brandon, Man	15·45	19·09	80·91	3	15	16	1,370
Rosthern, Sask	14·45	19·80	72·97		12	7	672
Scott, Sask	14·72	18·69	78·75		10	6	1,200
Indian Head, Sask	19·50	22·29	87·50	1	1	11	1,300
Lacombe, Alta	14·20	18·32	77·52	1	4	6	738
Agassiz, B.C	16·43	19·34	84·84	1	15	9	500
Invermere, B.C	19·79	22·70	87·20	1	10	8	1,952
Summerland, B.C	16·51	20·63	80·04	1	2		

The following notes, compiled from reports furnished by the several superintendents, will be of interest as indicating the nature of the soil and season at the several Farms and Stations at which the beets were grown; a summarized interpretation of the data in respect to the quality of the beets is added.

Charlottetown, P.E.I.—Soil: deep, sandy loam, well manured and in good condition. Subsoil: gravelly clay. Season: spring, exceptionally dry; summer, favour-

able growing weather with hot dry spell during early part of August, followed by rainy period; autumn, exceptionally fine growing weather, but probably not conducive to the ripening of the beets.

Two varieties only were grown at this Station. In neither sugar content nor purity were the roots equal to those of certain past seasons; the results, however, indicate beets of good average quality, quite suitable for factory purposes.

Kentville, N.S.—Soil: sandy loam, well manured and 150 pounds nitrate of soda and 450 pounds superphosphate, per acre. Subsoil: gravelly. Season: spring precipitation, light and germination irregular; summer and autumn, good growing conditions.

The results are very good, the beets being of excellent quality and the yields above the average. Sugar beets at this Station have almost invariably shown high sugar content and a high co-efficient of purity.

Nappan, N.S.—Soil: medium clay loam; subsoil, heavy clay. Well manured and aftermath of clover ploughed under. Season: spring, cool with a sufficiency of rain; summer, fine in July, very wet in August; autumn, unsettled in September but fine in October. The beets were pulled October 25th.

The yields were good; the sugar content and purity, excellent.

Fredericton, N.B.—Soil: heavy sandy loam, well manured; subsoil, stiff clay. Season: spring, dry and cold; summer, moderately dry and cool till August, then rather hot; autumn, very wet the first 15 days of September, then dry and warm. Beets pulled October 16.

Two varieties only were grown; both gave very good yields of high quality roots.

Lennoxville, Que.—Soil: gravelly loam, manured on sod; subsoil, gravel. Season: spring, first half of May was cold, the last two weeks, fine; June, dry and warm, July, a good deal of rain and dull weather, August, fine and warm; September, fine and mild.

The results are decidedly poor as regards quality, when compared with those of previous seasons at this Station; they are distinctly lower than the average from all the 1921 data. The yields, however, are quite satisfactory.

Cap Rouge, Que.—Soil: deep sandy loam; previous crop, hay; manured at the rate of 20 tons per acre; subsoil, shale. Season: May, warm and dry; June, warm and wet, July, cool and wet, August, warm, dry, bright; September, warm, dry.

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

Ste. Anne de la Pocatière, Que.—Soil: clay loam, manured in 1915 and again in spring of present season, previous crop, hay; subsoil, heavy clay rather wet. Season: April, wet and cold; May, cold and backward; June, dry and cool; July, cool and rainy; August, warm, and September rainy with cool nights.

The data, both as to sugar content and co-efficient of purity, are decidedly low and the beets were of inferior quality. The season throughout was recorded as unfavourable for roots generally and corn, due chiefly to rather low mean temperatures.

Ottawa, Ont.—Soil: medium sandy loam in a high state of fertility. Subsoil: sand. Season: early spring began with a great deal of rain and little sunshine but changed in May to high temperature with little rainfall. Although early in June heavy rains fell and the weather was very warm, for the greater part of the month there was no precipitation and drought ensued. The early summer (July) was at first cool with rain, later it became fine and warm with numerous rains in September. October had fine mild days with very little frost even at night.

In both sugar content and purity the results are distinctly inferior to those usually obtained at this Farm, apparently due to the excessively wet weather in the autumn a time when for sugar production it should be fine and warm.

Brandon, Man.—Soil: heavy black, rich loam, summer-fallowed previous season, no manuring. Subsoil, clay. Season: spring, late and cool; summer, rainfall during June and July 5·37 inches moderate temperature; autumn, very hot in August with precipitation of 4·34 inches, September, warm.

The sugar content is below the average, in all three varieties and the co-efficient of purity is also decidedly low. Our records show that it is only occasionally that beets of high quality can be grown in this district, the chief reason being that climatic conditions are unfavourable to the satisfactory ripening of the beet, which when harvested are more or less immature. The yields are very high, due to excessive growth in the early summer.

Rosthern, Sask.—Soil: rich sandy soil, summer-fallowed the previous season, no manuring. Season: spring, fairly good growing weather and a good stand secured. Summer: the crop suffered from drought; autumn, crop grew late, harvested without frost on October 7.

The yields were very small. As in past years, the sugar content was very low and the quality poor. At this northern Station, the seasonal conditions since 1911, when the work was begun there, have never been conducive to a satisfactory beet for sugar production i.e., for factory purposes.

Scott, Sask.—Soil: chocolate clay loam, summer-fallowed the previous season; no manuring. Subsoil, clay. Season: spring opened up late with light rains in late May; summer, light rain in June unusually hot in July; autumn, heavy rains in August and again in late September. The crop was somewhat damaged by web-worm in early June. The crop was harvested October 12.

Two of the varieties gave fair results as to sugar content, the third was decidedly below the average. The co-efficient of purity was very low in all three. It is only occasionally that seasonal conditions in this district are favourable to the production of high quality beets.

Indian Head, Sask.—Soil: black heavy, rich clay loam previous crops: potatoes, manured. Subsoil, clay. Season: spring, late but with good moisture; summer very dry in early part succeeded by good rains, moderately warm; autumn, good growing weather, with plenty of moisture and moderate temperature.

The yields are very good, as usual, and the quality of the beets, both as regards sugar content and purity, excellent.

Lacombe, Alta.—Soil: black, rich clay loam unmanured, previous season in pasture. Subsoil: clay. Season: the spring was late, cool and rather wet, the summer hot and very dry, and the autumn very dry. Frost occurred on October 3, the beets being pulled on October 5.

The results from the British Columbian seed were very poor, both as to sugar content and purity. The data from the other two, Chatham and Kitchener, are only fair, so that the average is much the poorest in the series. Evidently conditions in this district are adverse to the production of a high quality beet, for only once since 1907, when the investigation began, have the beets been even of average quality and suitable for sugar production.

Lethbridge, Alta.—Soil: silty sand loam, unmanured. Subsoil: chocolate clay. Season: spring was very late with a light precipitation in March and April, June was hot and dry with only 0·40 inches of rain. July had 2·59 inches, August 0·20 inch, and September was very dry with only 0·05 inches of rain.

Irrigated: The quality was excellent, the sugar content and purity both being high. The yields however were only medium.

Non-irrigated: In quality these beets were somewhat superior to those of the irrigated crop, but the roots were very small and the yield insignificant.

Agassiz, B.C.—Soil: sandy loam, with 20 tons manure, 350 pounds superphosphate and 150 pounds nitrate of soda, per acre; crop of previous season, pasture. Subsoil, gravel. The whole growing season was very wet.

Spring	Mean temperature	54°	precipitation	4·56	inches
Summer	"	"	60°	"	8·39	"
Autumn	"	"	56°	"	12·42	"

The yields were good and the quality fair to good. Much higher results have been obtained in previous seasons at this Farm and we must conclude that the cool and wet summer and autumn recorded for 1921, while inducing growth, prevented the proper ripening of the crop.

Invermere, B.C.—Soil: light, silty sand loam, with 12 tons of manure per acre; previous crop: wheat. Subsoil, gravel and silt.

Season:

Spring..	Mean temperature		37·5°	precipitation	3·12	inches
Summer	"	"	60·2°	"	2·5	"
Autumn	"	"	44·9°	"	1·25	"

In sugar content and purity these beets were excellent but the yields were poor.

Summerland, B.C.—Soil: sandy loam; manured; previous crop, clover; subsoil, gravelly loam. Season: very hot and dry, until late autumn. The beets were seeded three times and on the third seeding a few plants grew where water was available, but the crop was a failure on account of lack of irrigation water. No yields were obtained.

The data indicate a fairly rich and pure beet and one that would be satisfactory for factory purposes.

Sidney, B.C.—Soil: sandy loam, manured at the rate of 20 tons per acre; previous crop, oats and peas. Subsoil clay with gravel. Season: spring, cold and late; summer, warm and very dry; autumn, very wet.

The results are decidedly low; in both sugar content and purity the roots are of poor to medium quality only. Previous data obtained at this station have indicated a very satisfactory crop and we must therefore conclude that the present poor returns both as to the quality and yield, are due to unfavourable seasonal conditions.

Averages of "Sugar in Juice" and of "Coefficient of Purity" for the beets from the three classes of seed and obtained from the data from eighteen farms and stations may be tabulated as follows:—

TABLE II.—VARIETIES OF SUGAR BEETS, 1920

Source of Seed	Sugar in Juice (Average)	Coefficient of Purity (Average)
	p.c.	p.c.
British Columbia	16·42	83·61
Chatham, Ontario	16·48	84·11
Kitchener, Ontario	16·31	83·54

The averages for "Sugar in Juice" are slightly lower than those of the two preceding seasons, no doubt due to unfavourable seasonal conditions at a number of the locations, as already recorded. They however indicate a fairly satisfactory beet for sugar production. The "Coefficient of Purity" is also, from the same cause, somewhat lower than usual.

In table III we present the averages as regards the sugar content of the juice for the period 1902-20 inclusive, obtained at the several localities included in this investigation. The data are of considerable scientific value and are exceedingly interesting from an economic point of view. Among other matters, they indicate the possibilities of successful beet culture, as regards quality, at a considerable number of points from the Atlantic to the Pacific, and also furnish evidence useful in the study of the influence of seasonal and other conditions on the sugar content.

TABLE III.—Average Percentage of Sugar in Juice in Sugar Beets grown on Dominion Experimental Farms and Stations, 1902-1920

Locality	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
Charlottetown, P.E.I.	.....	.....	.....	.....	.....	.....	.....	.....	14·25	17·23	15·31	15·63	17·94	21·05	18·51	19·09	16·74	18·33	16·44
Kentville, N.S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17·17	17·07	18·00	18·51	19·48	19·83	19·25	18·36
Nappan, N.S.	15·87	15·33	14·41	16·52	17·08	.....	17·53	16·74	16·43	17·56	16·68	19·17	17·79	16·45	18·49	20·20	20·10	18·83	18·01
Fredericton, N.B.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15·98	17·15	18·90	17·93	17·99	20·94	18·34
Lennoxville, Que.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18·90	.....	.....	15·98	15·91	14·55
Cap Rouge, Que.	.....	.....	.....	.....	.....	.....	.....	.....	.....	16·16	14·92	19·94	14·38	17·33	16·48	11·87	18·47	16·88	16·69
Ste. Anne de la Pocatière, Que.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18·00	16·98	12·82	10·93	18·89	13·24
La Ferme, Que.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16·05	.....
Ottawa, Ont.	16·77	15·34	16·91	12·45	14·37	15·44	16·30	14·84	16·44	.....	17·59	16·48	19·84	17·30	13·82	16·37	16·86	17·79	15·09
Brandon, Man.	.....	11·36	16·62	11·09	15·50	16·99	15·82	18·83	18·40	13·50	13·40	13·92	12·06	15·90	14·09	16·08	15·91	.....	15·24
Rosthern, Sask.	.....	.....	.....	.....	.....	.....	.....	.....	.....	13·30	14·63	15·61	12·69	10·06	12·99	15·51	15·25	.....	14·15
Scott, Sask.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14·67	13·96	13,84	18·12	15·26	14·39	15·74
Indian Head, Sask.	15·15	16·54	15·24	14·94	14·91	15·92	15·66	17·16	.....	14·48	15·78	20·73	16·54	18·93	19·86	19·42	14·11	15·68	20·24
Lacombe, Alta.	.....	.....	.....	.....	.....	13·34	11·21	12·72	12·69	.....	.....	12·67	.....	9·56	15·78	.....	.....	.....	12·86
Lethbridge, Alta., (irrigated)	.....	.....	.....	.....	.....	.....	16·09	17·91	.....	17·02	17·41	19·54	12·95	18·33	18·70	18·99	15·94	14·31	18·34
Lethbridge, Alta., (non-irrigated)	.....	.....	.....	.....	.....	.....	16·73	18·36	.....	14·05	17,68	19·33	14·23	18·43	17·64	18·54	.....	.....	19·35
Fort Vermilion, Alta.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17·31	9·96	17·35	.....
Agassiz, B.C.	.....	17·44	8·10	17·32	14·28	17·65	17·15	18·30	19·18	19·95	11·53	18·08	17·07	17·76	19·03	16·96	17·20	17·02	16·46
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
Summerland, B.C.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18·91	18·35	18·07	.....	16·85

Ronalane, Alta.—As for a number of seasons past, the Canada Land and Irrigation Company, Limited, forwarded for analysis a sample of sugar beets grown on the Ronalane Irrigated Farm. The particulars are as follows:—

Variety: Klein Wanzleben. Sown May 18. Harvested October 8. Yield 15·1 tons per acre. Soil: silt loam, heavily manured.

Percentage of sugar in juice	17·59
Coefficient of purity	86·34

The roots were of good size, well formed with no forking, sound.

The data as to sugar content and purity are eminently satisfactory and the beets would be regarded as excellent for sugar production.

Influence of Climate on the Yield and Quality of Sugar Beets in Canada.—Through the kind permission of Sir Frederick Stupart, Director of the Meteorological Service of Canada, Mr. E. G. McDougall, M.A., of the Meteorological Service, Toronto, has made a careful and exhaustive study of the chemical and field data obtained in this investigation since 1902 with the view of correlating experimental results with weather factors during the growing season, or, in other words, of determining the influence of seasonal conditions on the quality and yield of this crop.

Mr. McDougall's paper as a result of this study appears in full in the "Monthly Bulletin of Agricultural Statistics," volume 13, No. 146, October, 1920, and constitutes a valuable contribution not only to the science of agriculture in Canada, but also in furnishing reliable information useful in the consideration of the economic production of beet sugar in the Dominion. Among other important conclusions, Mr. McDougall says: "The quality of the beets depends chiefly on the right temperatures. The sugar content and purity decline when the mean minimum for the season falls below 45° F. Yield is closely related with mean temperature. Conditions are favourable when the mean temperature exceeds 60° F., unfavourable when the temperature falls below 55° F.

"The best yields are obtained in the warmer parts of Ontario; the highest quality, in British Columbia, southern Alberta and the Maritime Provinces. In semi-arid regions, irrigation increases the yield without impairment of the quality."

FIELD ROOTS

This investigation, now in its sixteenth year, has had for its object the determination of the relative feeding value of the several varieties of farm roots—mangels, turnips and carrots—obtainable from seedsmen, the percentage of dry matter, primarily, and of sugar, secondarily, being considered a good measure of their feeding qualities. The data accumulated in this work, year by year, have clearly shown that large differences in this respect exist, not only between the several classes of farm roots, but also between varieties, or more properly speaking, reputed varieties of the same class. This will be evident by reference to the results of any and every year in the investigation. On this basis of valuation, one variety or strain of mangels, for example, may be worth, weight for weight, twice as much as another. This is an important fact and worthy of consideration by the farmer in his selection of varieties to grow. Other factors must of course be taken into account, such as yield per acre, cost of harvesting and keeping qualities, but the relative nutritive value should not be overlooked.

The roots now reported on were grown during the season of 1920 on the Central Farm, Ottawa, under the direction of the Forage Plant Division.

The series comprised forty-two varieties, several 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. The table also gives the percentage of sugar—the most important nutrient in farm roots, and the average weight of root.

The bracketed name which frequently follows that of the variety indicates the place of growth of the seed.

TABLE I.—ANALYSIS OF MANGELS, CENTRAL EXPERIMENTAL FARM, OTTAWA, ONT.

Variety	—	Dry Matter	Sugar in Juice	Average Weight of One Root	
		p.c.	p.c.	lbs.	oz.
Selected Giant Rose Intermediate Sugar	Ewings	12·40	6·02	4	5
Giant Yellow Intermediate	Macdonald Bros.	11·87	5·39	3	6
Eckendorffer	Weibull (Ste. Anne de la Pocatiere)	11·38	6·48	1	9
Danish Sugar Beet	Steele Briggs	11·16	5·50	4	4
Danish Sludstrup	Macdonald Bros.	10·97	5·59	4	6
Half Sugar White	"	10·70	5·48	3	10
Barres Red	Weibull (Ste. Anne de la Pocatiere)	10·70	6·99	2	4
Golden Tankard	Macdonald Bros.	10·54	5·29	3	0
Improved Giant Sugar	Rennie	10·42	6·09	3	5
Selected Yellow Intermediate	Charlottetown	10·23	4·21	1	9
Royal Giant Sugar	Steele Briggs	10·20	5·41	3	10
Prize Mammoth Long Red	"	9·93	5·11	2	9
Yellow Intermediate	Charlottetown	9·92	4·41	2	7
Giant White Sugar	Rennie	9·92	4·70	3	5
Cylinder Barres	Weibull (Ste. Anne de la Pocatiere)	9·86	7·17	1	10
Long Red Mammoth	Ewing	9·74	4·50	3	14
Perfection Mammoth Long Red	Rennie	9·70	3·69	3	15
Sugar Mangel	Sutton	9·64	4·28	4	0
Mammoth Long Red	"	9·52	4·21	3	2
Half Sugar White	Charlottetown	9·36	4·81	2	7
Yellow Intermediate	Ottawa	9·10	4·80	3	9
Sarrimer	Weibull	9·04	3·49	4	3
Golden Tankard	Sutton	8·96	4·30	2	12
Danish Sludstrup	Ewings	8·84	4·19	4	4
Yellow Leviathan	Agassiz	8·83	5·02	2	12
Golden Globe	Sutton	8·67	4·30	3	3
Rose Feeding Sugar	Weibull	8·55	5·02	5	14
Yellow Intermediate	Sutton	8·54	3·48	3	10
Danish Sludstrup	Kentville	8·35	3·06	4	2
Mammoth Long Red	Macdonald Bros.	8·30	3·59	4	8
Danish Sludstrup	Summerland	8·12	3·47	3	15
Cylinder Barres	Weibull	8·04	3·78	3	11
Giant Half Long Intermediate	Rennie	8·03	3·07	4	3
Red Intermediate	Sutton	7·95	3·80	3	7
Eckendorffer Red	Macdonald Bros.	7·90	3·28	3	13
"	Weibull	7·72	4·81	3	12
Prize Winner Yellow Globe	Sutton	7·40	2·87	4	3
Devon Yellow Intermediate	"	7·34	3·40	4	4
" Globe	"	7·14	3·09	4	11
Yellow Globe	"	7·02	4·21	3	15
"	Macdonald Bros.	6·90	4·01	2	5
"	Ewing	6·64	2·46	4	4

The range in dry matter is from 12·40 to 6·64 per cent and in sugar from 7·17 to 2·46 per cent. This wide range represents large and important differences in feeding value and is in full accord with the results of the past seasons. It will be observed that, generally though not strictly, the sugar content follows the dry matter content—a feature similarly brought out and confirmed by previous work.

These roots for the past season both for dry matter and sugar are distinctly low, due undoubtedly in a very large measure to the wet and cool autumn which interfered with the ripening of the roots.

The conditions responsible for the low dry matter and sugar content in this season's crop were conducive to rather exceptional growth, so that in weight of root and yield per acre of crop the figures are much higher than usual. The yields were practically twice those ordinarily obtained and ranged from 36 to 60 tons per acre. In the following table we have arranged the twelve best varieties according to dry matter per acre. Of these, five are among the best roots according to dry matter content.

TABLE II.—MANGELS: DRY MATTER PER ACRE

Variety	Source of Seed	Dry Matter		
		Per Cent	Per Acre	
			Tons	Lbs.
Select Giant Rose Sugar	Ewing	12·42	6	1,148
Danish Sludstrup	Macdonald Bros.	10·97	5	388
Danish Sugar Beet	Steele Briggs	11·16	5	295
Perfection Mammoth Long Red	Rennie	9·70	5	262
Sugar Mangels	Sutton	9·64	5	256
Giant Yellow Intermediate	Macdonald Bros.	11·87	5	208
Rose Feeding Sugar	Weibull	8·55	4	1,886
Giant Yellow Half Long Intermediate	Rennie	8·03	4	1,621
Yellow Intermediate	Ottawa	9·10	4	1,334
Sarrimer	Weibull	9·04	4	1,256
Long Red Mammoth	Ewing	9·74	4	1,203
Half Sugar White	Macdonald Bros.	10·70	4	1,112

In table III the averages for the sixteen years of the investigation are given. Those for 1921 are distinctly lower than usual, from the cause already mentioned. It is probable also that the series contains certain new varieties of low feeding value which also disadvantageously affected these averages.

TABLE III.—MANGELS—YIELD AND AVERAGE COMPOSITION 1904-1920

Year	Number of Varieties Analysed	Average Weight of One Root		Yield per Acre		Dry Matter	Sugar
		Lbs.	Oz.	Tons	Lbs.	p.c.	p.c.
1904	10	2	11	30	1,277	11·69	6·62
1905	17	3	9	39	369	10·04	4·67
1906	16	2	7	31	159	11·63	5·93
1907	10	2	11	27	680	12·64	7·46
1908	12	2	2	23	690	11·87	5·33
1909	14	3	5	28	920	11·21	6·21
1910	8	5	10	56	57	10·04	4·46
1912	23	2	9	29	61	9·51	6·43
1913	13	2	14	23	50	10·51	5·63
1914	24	2	1	36	1,157	12·79	7·75
1915	36	3	9	17	428	9·25	4·27
1916	26	2	0	.....		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
Average for 16 years	.....	2	12	.....		11·01	5·66

TURNIPS

The series comprises twenty-two varieties, a few of which were grown for the first time at Ottawa in 1920. The results are excellent, indicating not only that the larger number of the varieties represented are of good quality and high feeding value but

that, unlike the mangels, they were not adversely affected by the character of the autumn weather which, as already remarked, was cool and wet. In this respect turnips differ markedly from mangels, which like sugar beets, require a fine, warm autumn for their best results. Another feature worthy of note and one which has been observed in previous years is that the differences in dry matter between varieties of turnips are not of the same magnitude as in mangels, so that between the richest and the poorest the "spread" in dry matter content is much less.

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

Variety	Source of Seed	Dry Matter	Sugar in Juice	Average Weight of One Root	
		p.c.	p.c.	Lbs.	Oz.
Hardy White	Sutton	14·00	1·83	1	15
Champion	"	13·91	1·72	–	14
Bangholm	Weibull	13·88	1·83	1	2
Caledonian	Sutton	13·68	1·73	1	5
Improved Lord Derby	"	13·34	1·92	–	15
Swedish Smooth	Weibull	13·31	2·23	2	13
Canadian Gem	Rennie	13·27	2·03	1	1
Green Top	Sutton	13·15	1·72	1	13
Champion	Charlottetown	12·98	1·94	1	3
Derby Bronze Green Top	Rennie	12·97	1·83	1	–
Canadian Gem	Kentville	12·90	2·11	2	–
Good Luck	Fredericton	12·72	2·04	1	5
Ditmars	Kentville	12·43	1·91	1	13
Canadian Gem	Kentville	12·39	1·83	1	7
Crimson King	Sutton	12·31	1·71	1	14
Prize Purple Top	Rennie	12·02	1·93	2	9
Magnum Bonum	Sutton	11·98	1·71	2	3
Good Luck		11·91	1·62	1	9
Kangaroo	Rennie	11·90	1·92	3	1
Up to Date	Sutton	11·28	1·51	2	7
Hall Westbury	Ewing	10·70	1·73	2	7
Monarch		10·09	1·73	2	1

Averages for the fifteen year period 1905-20, are given in Table IV. A general improvement during the past five years will be observed and the turnips of last season are the best in the series—the average dry matter content exceeding that for the 15 years by practically 2 per cent.

TABLE V.—TURNIPS, YIELD AND AVERAGE COMPOSITION, 1905-1920

Year	Number of Varieties Analysed	Average Weight of One Root		Yield per Acre		Dry Matter	Sugar
		Lbs.	Oz.	Tons	Lbs.	p.c.	p.c.
1905	20	2	13	30	1,060	10·09	1·10
1906	20	1	10	15	1,890	12·18	1·78
1907	14	3	5	33	142	10·14	1·11
1908	13	3	12	27	1,033	9·87	1·52
1909	13	2	10	29	542	11·30	1·43
1910	10	3	11	31	565	10·87	1·07
1912	19	3	12	33	155	8·65	1·10
1913	19	2	14	24	1,271	9·58	1·54
1914	30	2	–	22	130	9·68	·76
1915	33	2	6	19	1,522	9·60	1·29
1916	33	1	13	16	681	10·67	·92
1917	58	1	13	–	–	11·04	1·41
1918	16	1	–	10	869	11·18	1·06
1919	95	–	13	–	–	12·10	1·11
1920	22	1	12	–	–	12·60	1·84
Average for 15 years		1	16			10·63	1·27

CARROTS

Fifteen varieties of carrots were submitted to analysis. References to Table VI will show that the range in dry matter content is from 11·22 per cent to 7·53 per cent, in sugar, from 2·65 to 1·23 per cent.

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

Variety	Source of Seed	Dry Matter	Sugar in Juice	Average Weight of One Root	
		p.c.	p.c.	Lbs.	Oz.
Improved Red Intermediate	Sutton	11·22	2·65		12
Short White	Macdonald Bros.	10·37	2·45	1	4
Danvers Half Long	Macdonald Bros.	10·26	2·35		11
Yellow Intermediate	Sutton, F.C.	9·84	2·75		14
Magnum Bonum	Sutton	9·82	2·04		14
Danish Champion	Ottawa	9·73	3·05	1	–
White Intermediate	F. S. Cumberland	9·67	2·25	1	3
Danish Champion	Macdonald Bros.	9·53	2·86		14
Improved White Belgian	Macdonald Bros.	9·49	2·04	1	3
Giant White Belgian	Sutton	9·20	2·04	1	6
Matchless White	Sutton F.C.	9·10	1·63	1	3
Mammoth White Intermediate	Rennie	8·99	2·35	1	7
Improved White Vosges	Steele Briggs	8·83	2·04		15
Improved White Vosges	Macdonald Bros.	8·69	2·04	1	5
Improved Intermediate White	Ewing	7·53	1·23	1	1

Averages for the past fifteen seasons are given in Table VII. The carrots of 1920 are among the lowest in dry matter content in the whole series, with an average considerably less than that for the experimental period.

TABLE VII.—CARROTS, YIELD AND AVERAGE COMPOSITION, 1905-1920

Year	Number of Varieties Analysed	Average Weight of One Root		Yield per Acre		Dry Matter	Sugar
		Lb.	Oz.	Tons	Lbs.	p.c.	p.c.
1905	11	1	3	25	1,510	10·25	2·52
1906	10	1	2	19	1,605	10·59	3·36
1907	6	1	1	24	1,517	10·30	3·02
1908	6	1	3	22	133	10·89	3·34
1909	6	1	–	17	1,680	10·40	2·30
1910	5	1	–	13	1,640	10·17	3·23
1912	6	1	1	18	545	10·50	2·54
1913	6	1	8	24	1,100	9·11	2·11
1914	8		10	21	1,359	11·42	2·62
1915	10		6	16	1,500	10·08	1·86
1916	10		7	11	1,140	11·40	2·87
1917	13		10	–	–	12·69	2·92
1918	3		6	31	266	12·13	5·30
1919	36		7	–	–	12·04	2·79
1920	15	1	7	–	–	9·48	2·25
Average for 15 years	.....	1	14	.....		10·76	2·86

Summarized data are presented in the following table. The fact that they represent the analysis of several hundreds of varieties in the several classes of field roots—mangels, turnips and carrots, examined annually over a long experimental period, gives the results a special interest and value.

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

Class of Roots	Average for Period of	Dry Matter	Sugar
		p.c.	p.c.
Mangels	16 years	11·01	5·66
Turnips	15 "	10·63	1·27
Carrots	15 "	10·76	2·88

The season of 1920 at Ottawa, according to the results of this investigation was more favourable to the development of turnips than of mangels and carrots—the quality of the two latter classes of root judging from previous results being distinctly low.

DEVELOPMENT OF THE WHEAT KERNEL

In a study of the development of the wheat kernel, with the view to determine the effects of premature harvesting, the Dominion Cerealist (Dr. Charles E. Saunders) collected and examined a series of heads of Marquis wheat grown at Ottawa. Four series were collected: heads with 3 inches of straw; heads with half length straw; heads with full length straw and heads with full length straw with roots. The collections were made from some 1,100 plants, the stage of inflorescence of which had been the same on the same date. Collection of 100 heads were made on each date of cutting, the intervals between collections being of a two or three day period. The first cutting was made July 21, when the wheat was perfectly green and the eleventh and last on August 15, when ripening was far advanced but the kernels not entirely hard.*

The co-operation of the Division of Chemistry was enlisted to obtain 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 taken with 3 inches of straw and that cut with full length straw, were submitted to analysis. The following table gives the dates of cutting, the weights of 1,000 kernels and the percentage of protein calculated to the dry matter basis.

MARQUIS WHEAT: PROTEIN AND WEIGHT OF KERNEL

Laboratory Nos. 52811-52832 (Protein calculated to dry matter basis).

Date of Cutting	Heads with 3-inch Straw			Heads with Full Length Straw		
		Protein			Protein	
	Weight of 1,000 Kernels	Per cent	Grammes per 1,000 Kernels	Weight of 1,000 Kernels	Per cent	Grammes per 1,000 Kernels
	Grams.			Grams.		
21-7-17	3·650	21·58	0·787	5·136	22·92	1·177
24-7-17	8·176	18·00	1·472	8·114	18·49	1·500
27-7-17	13·624	15·37	2·093	13·688	15·96	2·184
30-7-17	19·122	15·74	3·009	18·940	16·75	3·173
2-8-17	25·152	16·81	4·230	25·391	16·73	4·247
4-8-17	27·546	17·36	4·779	28·082	16·90	4·745
6-8-17	29·963	17·24	5·165	29·260	17·35	5·076
8-8-17	30·770	17·91	5·511	30·859	17·35	5·352
11-8-17	31·707	17·61	5·582	30·477	17·70	5·394
13-8-17	31·707	17·77	5·633	31·242	17·85	5·577
15-8-17	31·956	18·07	5·773	32·167	17·31	5·665

*The results of this investigation were given in a paper entitled "The Effects of Premature Harvesting on the Wheat Kernel," by Chas. E. Saunders, Ph.D., Dominion Cerealist, read before the Western Canadian Society of Agronomy, Winnipeg, January, 1921. Published in "Scientific Agriculture," Vol. 1, No. 2, February, 1921.

1. In both series a constant increase in weight of kernel will be observed from the earliest date of cutting—when the plant was quite green—until the last date of collection—when presumably the crop was fully ripe—a period of 25 days.

2. In both series, the percentage of protein, as calculated to the dry matter basis, steadily and markedly decreases from the date of the first to that of the third cutting —July 21 to July 27. From the date of the third cutting until the end of the experiment—July 27 to August 15—the percentage of protein in both series slowly increases, the total increase however, as measured at the time of the last collection, not being such as to bring the percentage of protein to that of the first cutting.

The grammes of protein in 1,000 kernels

$$\frac{(\text{per cent protein} \times \text{weight of 1,000 kernels})}{100}$$

is undoubtedly a measure, at the dates specified, of the total weight of protein of the crop. This it will be observed increases throughout the whole period of the investigation, at first very rapidly, subsequently and during the later stages of the ripening process, more slowly. These results are in entire agreement with those previously obtained by the writer in studies relating to the development and ripening of the wheat kernels.

This phase of the investigation has been well discussed by Dr. Saunders in the paper already referred to; with his conclusions I entirely agree.

He says:—

> "It is noteworthy that the percentage of protein rapidly decreased from July 21 to July 27, then slowly increased until August 13. The actual amount of protein present, however, increased rapidly from July 21 to August 6, and then increased more slowly until the end of the test.
>
> "Evidently, therefore, in the earliest stages of the formation of the kernel, protein is added with much greater relative speed than later on. Between the 21st and 30th of July, although the amount of protein added was very great, the addition of other constituents (chiefly carbohydrates of course) was even more rapid.
>
> "The period during which carbohydrates were deposited most rapidly is also the period during which protein was deposited most rapidly. Towards the end, both processes became much slower but the deposition of both protein and carbohydrates did not cease in this case until after August 15th, by which time the grain was fit to cut and was well advanced towards ripeness.
>
> "The process of ripening has been described as merely a drying out of the kernel. This is evidently not the case if we used the word "ripening" in the sense it usually bears in Canada. Simple drying out may be the final stage, but up to a very late date protein and other materials are being deposited in the kernel. The amount of such deposition is, however, so small that farmers are fully justified in cutting their grain quite early whenever they have good reasons for doing so."

THE NUTRITIVE VALUE OF THE STRAW OF WHEAT AND OATS AS AFFECTED BY THE STAGE OF RIPENING AT HARVESTING

This investigation was planned and carried out by the Superintendent of the Experimental Station for the Grande Prairie District at Beaverlodge, Alberta, who writes: "If early cutting could be shown to yield straw of superior feeding value the case for early harvesting—cutting on the green side—in this district, characterized by a short and tardy season, would be greatly strengthened. By deferring harvesting until grain is fully ripe, greatdanger of damage by frost is run, particularly to the germ of oats and barley and to the milling samples of wheat. There is also the risk of considerable loss by wind, birds and the operations of harvesting." The object of the work, therefore, was to determine the relative nutritive value of the straws of early and late cut cereal crops, oats and wheat, and the details of the field test in so far as the present discussion is concerned may be briefly outlined as follows:—

Marquis Wheat:—

Series A, sown April 26, harvested August 23, September 6, 13, 18 and 30.

Series B, sown April 17; harvested September 1, 6, 12 and 17.

At the date of the first cutting "the wheat plots were quite green and immature, as judged by appearances, and the crops in question were not considered really ripe until the middle of September, and then by no means dead ripe." Mr. Albright adds: "I have been greatly surprised at the comparatively good showing of the early-cut samples in yield of grain; this furnishes support for the practice of cutting on the green side."

TABLE I.—STRAW OF MARQUIS WHEAT—EXPERIMENTAL STATION, BEAVERLODGE, ALTA. Received: 5/5/20.

Laboratory No.	Plot	Date of Harvesting	As Received						Water-free				
			Moisture	Protein	Ether Extract	Carbohydrates	Fibre	Ash	Protein	Ether Extract	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.
50967	A	23·8·19	6·52	5·34	6·10	44·74	33·40	3·90	5·72	6·52	47·86	35·73	4·17
50968	A	6·9·19	5·06	5·11	6·50	41·01	36·67	5·65	5·38	6·85	43·20	38·62	5·95
50969	A	13·9·19	4·37	4·56	2·25	44·97	38·75	5·10	4·77	2·36	47·02	40·52	5·33
50975	A	18·9·19	6·73	4·06	3·00	44·16	37·60	4·45	4·35	3·22	47·35	40·32	4·76
50971	A	30·9·19	4·84	4·38	4·90	42·98	37·45	5·45	4·68	5·22	45·04	39·27	5·79
50972	B	1·9·19	5·26	4·38	6·30	44·64	35·80	4·02	4·62	6·65	47·12	37·79	4·24
50973	B	6·9·19	5·40	4·47	3·70	43·56	33·40	4·52	4·72	3·92	51·28	35·31	4·77
50974	B	12·9·19	5·41	4·36	3·67	47·18	35·40	4·65	4·61	3·88	49·87	37·43	4·92
50970	B	17·9·19	4·53	4·44	2·10	46·84	37·17	4·92	4·66	2·20	49·04	39·04	5·06

STRAW OF MARQUIS WHEAT

The composition of the five samples of series A and the four of series B, is given in detail in table I. In addition to the date on the straws "as received," the results as calculated to the water-free basis are given for the purpose of a more ready and closer comparison. Comment on the data may be made as follows:—

Series A.—While admitting that many of the differences between the several members of this series might be accounted for by unavoidable experimental error, it

may be noted that the protein content decreases in a general way with the "date of harvesting." This gradation is not regular or uniform throughout the series but the general trend of the results undoubtedly indicates a falling off in protein as the plant matures. There is therefore in these data some support for the generally accepted belief with respect to the higher nutritive value of the straw of the immature plant, and that of course means that as the crop ripens the straw becomes less and less valuable as fodder.

The ether-extract contains chlorophyll, gum, etc., in addition to true fat. In straw very little importance need be attached to this determination, as the percentage of true fat in this material is almost insignificant, but the higher values for the first two members of the series plainly indicate the green and immature state of the straws on the dates of their collection.

As the cereals ripen the fibre in their straw increases in amount and becomes less digestible. The fibre content of the series under discussion increases more or less regularly as the crop advances towards maturity, the trend furnishing additional and supporting evidence to the conclusion from the protein determinations, viz., that marked if not notable changes had taken place in the composition of the straws between the first and the last dates of the collections.

Viewing the series as a whole undoubtedly the greater change in composition occurred between its first two members: after the date of the second cutting the effects of the ripening processes though noticeable, are not so marked.

The sample collected 30·9·19—the last of the series—shows certain apparent inconsistencies, as viewed from its position in the series. From its protein, ether extract and fibre content, it might rightly occupy a higher place in the series. We are unable to offer any satisfactory explanation for its position, but possibly it may be accounted for by a retardation of the ripening process due to a moisture content of the soil higher than that of the neighbouring drills.

Series B.—A review of the protein and fibre data fails to reveal any marked difference in composition between the several members of this series. There is, in consequence, no evidence of material change in nutritive value between the first and last dates of collection, viz., 1st and 17th September.

These results—as compared with those of series A—may possibly be accounted for by the fact that the crop B was much older (9 days) than A at the date of its first collection and, in consequence, nearer maturity; indeed it is possible that the ripening processes in this series had so advanced by September 1 (first cutting) that subsequent changes were not of that magnitude which would be measured by the ordinary methods of analysis. If such is the case, the experiment was started too late in the history of the crop to furnish any information on the point at issue.

Another point of difference between the two series is that in A there is a period of 38 days between the first and last collection, whereas in B this period is only 16 days. This may have a significant bearing on the results, especially as the crop B was considerably further advanced on the date of its first collection and hence had reached a stage in development at which changes had so slowed down as to render their successive measurements a difficult matter.

Ligowo Oats, sown April 25; harvested September 1, 6, 12, 17 and 19.

"The oats were decidedly green-looking on September 1, the date of the first cutting, the upper portion of the heads were beginning to whiten but the straw was still quite green and fresh looking."

The analytical data, similar in character to those obtained in the wheat series, are presented in table II.

TABLE II.—LIGOWO OAT STRAW—EXPERIMENTAL STATION, BEAVERLODGE, ALTA.

Laboratory No.	Date of Harvesting	As Received						Water-free				
		Moisture	Protein	Ether Extract	Carbo-hydrates	Fibre	Ash	Protein	Ether Extract	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.
50976	1·9·19	5·52	3·98	3·65	45·58	33·45	7·55	4·22	3·86	48·54	35·39	7·99
50977	6·9·19	6·07	4·07	3·40	42·68	36·65	7·13	4·30	3·58	45·50	39·06	7·56
50978	13·9·19	6·80	4·31	3·00	43·19	36·00	6·70	4·62	3·22	46·34	38·64	7·18
50979	17·9·19	7·82	3·86	3·42	43·80	35·40	5·70	4·19	3·72	47·51	38·40	6·18
50980	19·9·19	6·65	4·07	3·45	45·01	35·25	5·57	4·36	3·69	48·21	37·77	5·97

STRAWS OF LIGOWO OATS

The protein content throughout the series is fairly uniform; certainly the data for this nutrient exhibits no trend which could be construed as indicative of appreciable change towards a further ripening of the crop.

With respect to fibre, there is a marked difference between the first and second cutting, which might be taken as evidence of considerable progress of the crop towards maturity during the period, 1st to 6th September. From the second cutting onward, however, the percentage of fibre remains fairly constant, which probably means that the crop at this date (September 6) had reached a fairly mature or ripe condition.

The ether-extract figures furnish no evidence as to change in maturity during the period of collection.

The data of this series therefore would indicate that the crop was too far advanced towards maturity at the date of the first collection to permit of obtaining any emphatic evidence towards the solution of the problem in hand.

INFLUENCE OF EARLY PLANTING ON THE QUALITY AND YIELD OF POTATOES

An interesting experiment, and one of considerable importance to the locality in which it was made, has been carried on with potatoes at the Experimental Station for the Grande Prairie District, Alberta, under the direction of the superintendent, Mr. W. D. Albright. The object of the work was to ascertain the effect of early planting on the yield and quality of the crop. To supplement the results from the cooking test used to determine quality, it was thought desirable to ascertain the dry matter content of the tubers and for that purpose representative samples of the harvested crop from each of the several plantings were forwarded to the laboratories.

The particulars as to dates of planting, yields, etc., as furnished by the Superintendent, are as follows:—

VARIETY: EARLY ROSE. DATE OF DIGGING: SEPTEMBER 28

Lot	Date of Planting	Yield per Acre	
		Bush.	Lbs.
1	April 27	412	20
2	May 4	332	45
3	" 10	317	37
4	" 17	208	43
5	" 23	231	35
6	" 31	173	53
7	June 7	176	47

The yields decline steadily with advance of the date of planting; in other words, the highest yields were obtained from the earliest plantings. The only exception to this conclusion in the series is lot No. 4, the yield of which is somewhat lower than No. 5. This has been accounted for by the superintendent by the inclement weather conditions—cold, snow-flurries—at the time of planting.

POTATOES: DATE OF PLANTING AND DRY MATTER

Laboratory No.	Lot	Date of Planting	Dry Matter		
			Per cent	Per Acre	
				Tons	Lbs.
38916	1	April 27	20·57	2	1,091
38917	2	May 4	19·64	1	1,921
38918	3	" 10	18·42	1	1,510
38919	4	" 17	18·49	1	315
38920	5	" 23	18·28	1	538
38921	6	" 31	17·16		1,790
38922	7	June 7	17·01		1,804

These results clearly indicate that under the weather or climatic conditions prevailing, the earlier the planting, within certain limits, the higher the percentage of dry matter in the tubers; the difference between the first and last of this series, covering a planting period of six weeks, was no less than 3·5 per cent.

In the last column of the table the pounds of dry matter per acre are given. The general trend in respect to yields as has been noted, is very marked—the yields steadily decreasing with the advance in the date of planting. Since such is the case, and the percentage of dry matter similarly declines, it follows that the yield of dry matter per acre decreases as planting is delayed. The earlier-planted potatoes yielded tubers of higher nutritive value and also a larger amount of nutritive matter per acre. In this latter regard, between the first and last of the series there is a difference of 3,301 pounds or nearly 200 per cent in favour of the early planting.

SILAGE

CLOVER: OAT, VETCH AND RYE: OAT AND VETCH: OAT, WHEAT, PEA AND VETCH: JAPANESE MILLET: CORN

In the accompanying table we present the analytical data of a number of silages of rather uncommon occurrence. The larger number of these were sent in from the Experimental Station at Lennoxville, Que., and contain a legume, which would naturally result in a product richer in protein than corn silage.

Clover, Lab'y No. 48649.—From Experimental Station, Lennoxville, Que. First cut, 1919. Collected December, 1919, near outer edge of silo. As received: rather dry; sound; in good condition.

This silage contains 32·4 per cent dry matter and a very high percentage (6·03) of crude protein. The acidity is moderately high. The data throughout and especially those for the true albuminoids indicate high nutritive qualities.

Lab'y No. 48650.—This sample, also from first cut, forwarded at the same time as the preceding, was collected near the centre of the silo. It was decidedly the more moist of the two, containing only 23·1 per cent dry matter. As received, it was lower in the percentages of the nutrients but calculated on the water-free basis these two samples of clover silage were quite similar in composition; the difference between the two evidently is simply one of water content.

Lab'y No. 48779.—This clover silage, also from the Experimental Station at Lennoxville, Que., was from the second cut (September 10, 1919), the plants being in bloom. As received: sound, rather dry, in good condition.

The analysis shows 33·1 per cent dry matter, with a high protein content 5·63 per cent. It is undoubtedly a very rich silage. The data agree fairly closely with those of No. 48649 and calculated to a water-free basis all three samples are very similar.

Oat, Vetch and Rye: Lab'y No. 48651.—From Experimental Station, Lennoxville, Que. A composite sample from outer part of silo, December, 1919. As received: very dry; sound; in god condition.

The dry matter content amounted to 41·7 per cent, which is exceedingly high for a silage. While not as rich in nitrogenous matter as clover silage, it is succulent and nutritious and is undoubtedly a material of very high feeding quality.

Lab'y No. 48652.—Collected and forwarded at the same time as No. 48651, but is a composite from the centre of the silo. As received: rather dry; sound; in good condition.

It contained 33·1 per cent of dry matter, 8·6 per cent less than that from the outer part of the silo. It is an excellent silage, well preserved and of good feeding qualities.

As in the case of the clover silages, these two samples from oat, vetch and rye (Nos. 48651, 48652), taken from the outer and inner parts of the silo, are very similar in composition when made comparable by calculation to a common dry matter basis.

Oat and Vetch, Lab'y No. 48780.—From Experimental Station, Lennoxville, Que. Sown: oats 2½ bushels, vetch ½ bushel, per acre. Sample collected and forwarded, December, 1919. As received: dry; sound; in good condition.

It contained 41·7 per cent of dry matter, the same figure as that obtained for the oats, vetch and rye sample No. 48651—with which, in other features, save acidity, it is practically identical. It is a silage of high nutritive value.

Oat, Wheat, Pea and Vetch: Lab'y No. 54888.—From Howard Schurman, Central Bedique, P.E.I.

Crop sown May 15; cut September 5, 1920, when the crop was nearly ripe. Mixture sown: oats 2 bushels, wheat half bushel, peas half bushel, vetch quarter bushel, per acre. Owing to very dry season "only about half the mixture grew and the crop was very light." Water was run into silo at the time of filling and in consequence the silage packed well and came out without any waste."

As received: the silage was brown and rather dry, quite homogeneous with a rather strong acrid odour; sound.

It contained 34·64 per cent dry matter and a fair percentage of crude protein. An excellent silage but not quite so rich as that from clover, but richer than that from oat and vetch, and oat, vetch and rye, of this series, evidently due to a larger proportion of legume.

Japanese Millet, Lab'y No. 49241.—From Experimental Station, Lennoxville, Que. As received: very moist; sound and soft; in good condition.

The analysis reveals a high percentage of water and a low crude protein content. The percentage of fibre is considerably higher than that of corn silage with an equal water content. The exceptionally high ash may in part be due to the presence of sand. It was of medium acidity. From the chemical data we should judge it to be decidedly poorer than corn silage, and materially inferior to the other silages of this series.

Corn, Lab'y No. 54099.—From Experimental Farm, Brandon, Man. As received firm and sound; largely leaf, but cob and kernels were present in the same, mild odour and low acidity.

This sample contains a decidedly high water content, which necessarily reduces the percentages of the dry matter and nutrients. It is, however, of fair feeding quality. The crop, evidently, was somewhat immature when cut (September 7 to 12), the kernels being in the "early dough" stage. The yields on the several fields from which the crop was harvested varied from 9 to 11 tons per acre.

Silage: Clover, Oat, Vetch and Rye; Oat and Vetch; Oat, Wheat, Pea and Vetch; Japanese Millet; Corn

Lab'y. No.	Variety	Locality	As Received							Water-free					
										Protein					
			Moisture	Crude Protein	Crude Fat	Carbo-hydrates	Fibre	Ash	Acidity	Albu-minoid	Non-albu-minoid	Fat	Carbo-hydrate	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.
48649	Clover (outer)	Lennoxvill, Que	67·60	6·03	2·22	12·96	8·73	2·46	2·10	14·53	4·08	6·84	40·01	26·95	7·59
48650	Clover (centre)	"	76·90	4·26	1·17	9·15	6·38	2·14	1·15	15·26	3·19	5·06	39|62	27·60	9·27
48779	Clover	"	66·90	5·63	2·00	14·99	8·08	2·40	2·87	13·10	4·58	6·24	43·43	25·16	7·49
48651	Oats, vetch and rye (outer)	"	58·30	4·08	1·84	20·46	12·68	2·64	1·58	7·04	2·76	4·43	49·10	30·34	6·33
48652	Oat, vetch and rye, (centre)	"	66·90	3·22	1·40	16·93	9·35	2·20	1·36	5·96	3·77	4·24	51·17	28·62	6·60
48780	Oat and vetch	"	58·30	3·79	1·99	20·71	12·37	2·84	2·13	6·00	3·05	4·76	49·77	29·64	6·78
54388	Oat, pea and vetch	Central Bedique, P.E.I.	65·36	3·59	1·71	18·85	8·27	2·22	1·74	8·14	4·30	4·06	47·14	28·65	7·71
49241	Japanese millet	Lennoxville, Que	78·20	1·87	·61	8·68	7·53	3·11	1·27	5·17	3·39	2·82	39·83	34·13	14·86
54099	Corn	Brandon, Man	79·55	2·32	1·03	10·44	4·82	1·84	·93	6·39	4·46	4·99	51·05	23·60	9·06

SUNFLOWER SILAGE

During the past two seasons sunflowers (Giant or Mammoth Russian) have been grown and ensiled at a number of the farms and stations of the Experimental Farms System. Samples of the silage so obtained on the larger number of the western farms and stations have been submitted to analysis. The results of this investigation are given in the accompanying table.

Lab'y No. 49240.—Scott, Sask. Sown May 17-24, 1919. Distance between rows 36 to 42 inches; cultivated at frequent intervals. Land fallowed in 1918. Rate of seeding, approximately 5½ pounds per acre. Cut on September 3, when about 50 per cent of the plants were in flower. Yield from 4 tons 1,190 pounds to 6 tons 1,110 pounds per acre.

Precipitation, April 1 to July 31, was 3·33 inches. August rains, which helped the crop considerably, amounted to 2·56 inches.

Lab'y No. 49756.—Kapuskasing, Ont. Three plots sown June 4 to June 11, 1919. Distance between rows 24 to 42 inches and there was no noticeable difference in height due to varying distance between rows. Harvested October 1 to 4. Yield: 24 tons per acre. Owing to extreme drought, seed did not germinate till July. Crop had made very rapid growth but was frosted before date of cutting, when it was still immature.

The silage consisted largely of stalks, very woody, with no heads.

Lab'y No. 49757.—Indian Head, Sask. Sown May 21, harvested September 12, 1919. Stage of growth when cut: past blossoming but seeds not ripe.

The silage was very dark in colour, almost black; leaves predominating.

Lab'y No. 49901.—Brandon, Man. (1919). Sown May 26, cut September 3, in full bloom. Distance between rows, 42 inches; yield, 7 tons per acre. The silage had a very fresh, green appearance and was in excellent condition. It contained a good admixture of stalks, leaves and heads.

Lab'y No. 54100.—Brandon, Man. (1920). Sown May 25 to 30, harvested September 7 to 12, in bloom; yield, 14 tons per acre after wilting four or five days in field

The silage contained a comparatively small proportion of leaf; evidence of fair proportion of heads but seeds not formed. Strong pungent odour, indicating advanced fermentation in the silo.

Lab'y No. 50063.—Morden, Man. Sown June 3, cut August 22, 1919. Distance between rows, 2, 2½, 3 and 4 feet. Crop was coming into bloom at time of harvesting. Estimated yield, 30 tons per acre.

Silage was of fresh, green appearance and consisted of a good mixture of stalk and leaf.

Lab'y No. 50822.—Lacombe, Alta. Crop was frosted before more than 50 per cent of the plants had formed heads.

Silage decidedly moist and soft but quite sound; brownish green colour, showing large proportion of leaf.

Lab'y No. 53986.—Rosthern, Sask. Sown May 25, harvested August 28, 1920, "when plants were coming into bloom but no seed formed." Yield, 6 tons 473 pounds per acre.

Silage appeared rather dry, with stems woody; some heads present but no seeds had formed.

Lab'y No. 54896.—Rosthern, Sask. Sown May 10, harvested September 13, 1920, " when about half the seeds were in the dough stage." Yield, 8 tons 1,581 pounds per acre. Period of growth was 32 days longer than for crop No. 53986. Silage had been frozen for at least three months when sample for analysis was taken.

The silage was very dark in colour and particularly soft, with a large proportion of leaf.

A study of the analytical data reveals great variation in composition. It is not possible, with the information at hand, to satisfactorily account for this variation in all its details, but undoubtedly it is essentially due to differences in the stage of growth at the time the crop was cut for the silo at the several stations, and secondarily to changes in the silo due to degree of fermentation, action of frost, etc. Further work is planned which it is hoped will throw light on the changes in composition due to growth and ripening processes.

It is, however, safe to conclude that speaking generally the young and immature plant, as before blossoming, will furnish silage more watery and less fibrous than plants cut and ensiled when the seeds are fully formed. This is exemplified by the samples from Morden and Indian Head. In the former the crop had been cut before the plants were in bloom and the silage contained 24·33 per cent dry matter and 6·22 per cent of fibre, whereas in the latter, from crop which had been cut after the seeds had been fully formed, the dry matter was 47·69 per cent and the fibre 10·16 per cent. Again in the two samples from Rosthern, the first cutting gave 23·41 per cent dry matter and 4·75 per cent fibre, the second, with a longer growth period, 25·35 per cent dry matter and 5·19 per cent fibre.

The exact stage at which to obtain the largest amount of digestible dry matter per acre is not as yet known but would appear to be when from 10 to 20 per cent of the plants are in bloom. If left much later it would appear that the increase in dry matter is more than offset by the marked increase in woody fibre, leading to a decided falling off in the digestibility of the silage.

As to palatability, reports from the several stations feeding sunflower silage differ markedly. In certain instances, great difficulty was experienced in inducing the cattle to eat it—at first they practically refused it, and the milk flow fell off; in other cases, the silage being more succulent, was more readily consumed, but even in such instances it was not at first eaten with the same relish or in the same amounts as corn silage. It is stated that once cattle have acquired the taste for sunflower silage they will eat it as readily as that from corn and that no material difference in nutritive value is to be observed, but the evidence in support of these statements is by no means conclusive. The matter is still in the experimental stage, but there is a sufficiency of satisfactory evidence to indicate that sunflower silage will be found a valuable substitute for that of corn in districts in which climatic conditions prevent the successful growth of the latter crop. In this connection it may be well to quote the opinion of the Montana Experiment Station, at which the pioneer work towards utilizing the sunflower as a forage crop was conducted. They say that from four years' results it is concluded that sunflowers make a satisfactory, acceptable soiling and silo crop in districts in which the season is too short, the nights too cool and the rainfall insufficient for the best results with corn.

Analyses of Sunflower Silage

Lab'y No.	Locality	As Received							Water-free					
									Protein					
		Moisture	Protein	Fat	Carbo-hydrates	Fibre	Ash	Acidity	Albuminoid	Non-albuminoid	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.
49240	Scott, Sask.	71·10	5·38	1·55	11·68	5·68	4·61	2·15	8·58	9·77	5·37	40·43	19·64	16·21
49756	Kapuskasing, Ont.	73·11	2·41	1·30	10·24	9·49	3·45	1·68	7·45	1·44	4·86	38·10	35·30	12·75
49757	Indian Head, Sask.	52·31	5·06	2·42	24·75	10·16	5·30	1·64	7·45	3·16	5·08	51·88	21·29	11·14
49901	Brandon, Man. (1919)	72·04	4·06	1·19	13·89	5·64	3·18	1·24	11·02	3·59	4·36	49·69	19·89	11·45
50063	Morden, Man.	76·67	3·43	1·24	10·17	6·22	3·27	1·44	10·32	3·80	5·08	41·83	25·58	13·39
50822	Lacombe, Alta.	79·70	2·30	1·36	9·33	4·91	2·40	1·60	9·45	1·89	6·70	45·96	24·18	11·82
53986	Rosthern, Sask.	76·59	2·57	1·93	11·72	4·75	2·44	1·14	6·95	3·81	8·27	50·10	20·37	10·50
54100	Brandon, Man. (1920)	76·60	2·62	1·91	9·54	6·53	2·80	2·43	6·73	4·59	8·33	39·96	28·15	12·24
54896	Rosthern, Sask. (1920)	74·65	3·82	1·10	10·73	5·19	4·51	3·69	7·60	6·14	4·35	42·30	20·49	17·80

FEEDING STUFFS

The chief work in connection with the examination of commercial feeding stuffs has been the analysis of a series comprising some 400 samples collected throughout the Dominion. This series contained representative examples of all of the more important feeds as found in the Canadian markets. The results of this investigation have been compiled and prepared for issue in bulletin form. This publication will be available very shortly for general distribution and undoubtedly will prove of considerable interest and value to the farming community throughout the Dominion.

In addition to the foregoing there has, as usual, been received a considerable number of samples of feeding stuffs from farmers, agricultural representatives, Provincial Departments of Agriculture, etc., for examination and report. These will now be briefly considered.

BRAN

Two samples only of the staple feed were submitted, the particulars of which are as follows:—

Lab'y. No. 51519: Wm. Scott Co., Ottawa, millers.
" 53934: Renfrew Flour Mills, millers.

ANALYSIS

	No. 51519	No. 53934
Moisture	9·90	7·25
Protein	15·50	16·48
Fat	6·28	4·75
Carbohydrates	50·72	54·57
Fibre	11·90	11·75
Ash	5·70	5·20
	100·00	100·00

The legal standard for bran is protein not less than 14 per cent, fat not less than 3 per cent, and fibre not to exceed 10 per cent.

The above samples are well above the requirements in regards to protein and fat, but distinctly higher in fibre. This latter feature is the direction that has been noted for some time past, due to the more complete extraction of the floury particles in milling, a modification which also increases somewhat the percentage of protein and fat.

SHORTS OR MIDDLINGS

These terms are at present practically synonymous, though "middlings" is very widely understood to designate a floury, mealy product, whereas "shorts" as generally found on the market to-day is of the nature of fine bran.

Lab'y No. 51022: S. J. Cherry & Sons, Preston, Ont., millers.
" 51023: Ogilvie Milling Co., Montreal, millers.
" 51521: Wm. Scott Co., Ltd., Ottawa, millers.
" 51920: Wm. Scott Co., Ltd., Ottawa, millers.
" 52101: Comptoir Co-operative, Montreal.
" 53536: Toronto Milling Co., Toronto, millers.
" 54093: Interprovincial Flour Mills Co., Saskatoon, Sask., millers.

ANALYSIS

—	No. 51022	No. 51023	No. 51521	No. 51920	No. 52101	No. 53536	No. 54093
Moisture	10·61	9·28	10·83	10·90	12·15	9·40	9·52
Protein	17·88	14·33	16·82	16·90	17·52	18·71	18·31
Fat	4·35	3·45	6·15	5·08	4·10	7·22	4·55
Carbohydrates	55·21	55·74	52·37	53·02	57·08	52·63	54·85
Fibre	8·35	11·95	9·20	9·42	6·15	7·57	7·87
Ash	4·60	5·25	4·63	4·70	3·00	4·47	4·90

The standard of quality fixed for shorts requires: protein not less than 15 per cent, fat not less than 4 per cent, and fibre not more than 8 per cent.

Averages for the above series of seven samples are: protein 17·21 per cent, fat 4·98 per cent, and fibre 8·64 per cent.

Four of these samples (Nos. 51022, 52101, 53536 and 54093) fully meet the requirements of the Act and regarded as shorts are of excellent quality. Not one of them, however, is of the character of floury middlings, though No. 52101 approaches this type of feed.

Three samples (Nos. 51023, 51521 and 51920) exceed the limit in fibre; only one sample is below the standard in fat.

No. 51023 cannot be rightly classed as shorts or middlings. The analysis clearly proves its nature as bran; it does not meet the requirements of shorts in protein, fat or fibre.

BARLEY PRODUCTS

Under this caption we include six samples, all milling by-products of barley and called, apparently, indiscriminately, barley feed, barley flour and barley meal. The terms used in designating the samples considered in this report are those under which they were received:—

Lab'y No. 50846: Barley Feed, Peerless Cereal Mills Co., Woodstock, Ont.
" 50847: Barley Flour, Peerless Cereal Mills Co., Woodstock, Ont.
" 51354: Barley Meal, Benoit et Cie, St. Bonaventure, Que.
" 51433: Barley Flour, Canadian Cereal and Flour Mills Co., Ltd.
" 51542: Barley Meal: purchased from Vernon Fruit Union, Vernon, B.C.
" 52200: Barley Feed, source unknown.

ANALYSIS

—	No. 50846	No. 50847	No. 51354	No. 51433	No. 51542	No. 52200
Moisture	8·28	8·73	5·60	11·68	8·25	10·55
Protein	14·55	14·37	12·65	10·75	14·31	12·77
Fat	3·45	3·70	3·67	1·73	1·83	3·15
Carbohydrates	60·17	68·45	68·05	74·33	60·93	56·78
Fibre	9·85	2·70	6·75	·48	10·28	10·55
Ash	3·70	2·05	3·28	1·03	4·40	6·20
	100·00	100·00	100·00	100·00	100·00	100·00

Very considerable variation in composition will be observed; thus in protein the range is 10·75 to 14·55 per cent, in fat 1·73 to 3·70 per cent, and in fibre 0·48 to 10·55 per cent.

The term barley meal ought to be applied only to the product obtained from the grinding of barley grain, without any removal or addition. No. 51354 is the only one of the series which can rightly be called barley meal, according to this definition, though it is to be remarked that its fibre content is above the average for this product, denoting the manufacture from a poor grade of barley.

No. 50847 is a rich and valuable product and would be found especially of value in pig feeding, owing to the excellent percentages of protein and fat and to its low fibre content. It is not, however, a barley flour of the finest grade.

No. 51433. This is a genuine or typical barley flour, being characterized by a very low fibre content. It is decidedly lower in protein than barley meal and not so generally useful as this feeding stuff. It, however, could be advantageously used, if judiciously mixed with some coarser meal. By itself it forms a paste in the mouth, an undesirable feature and one which may lead to absolute refusal by the animal.

Nos. 50846, 51542 and 52200 may be properly termed barley feeds, i.e., they are by-products obtained in the milling of barley, as in the manufacture of pot barley, barley flour, etc.

No. 51542 is a feed reported to have been "refused by pigs after a week's feeding, resulting in wasting away and death."

The percentage of fibre is too high for a feed for very young pigs. Further, microscopical examination showed that there was present an excessive amount of finely ground barley hulls, which undoubtedly accounts for the fibre content and its serious effects when used.

No. 52200. This barley feed is also characterized by a high fibre content, due in this instance to the presence of screenings, consisting of chaff, stems, oat hulls and a considerable amount of weed seeds. It must be regarded as a feed of inferior quality.

OAT PRODUCTS

Pulverized Oat Feed

Lab'y No. 53028.—Robin Hood Mills, Limited, millers, submitted by L. D. McClintock, Agronomist for Brome county, Que. Guarantee: "Protein 7 per cent, fat 3 per cent, fibre not over 30 per cent.

ANALYSIS . . . . . .

Moisture	10·67
Protein	7·59
Fat	1·95
Carbohydrates	51·24
Fibre	22·95
Ash	5·60
	100·00

Though meeting its guarantee as regards protein and fat, this is an exceedingly poor feed. It evidently contains a very large percentage of oat hull. It ought not to be worth the while of any farmer to purchase feed of this character, no matter how low the price; the home-grown feeds and fodders are more nutritious and more digestible than material of this character and it should be the object of the farmer, in purchasing feeds, to supplement them by products richer in protein and fat.

Oat Flour

Lab'y No. 53421.—Peerless Cereal Mills Co., Woodstock, Ont.

ANALYSIS

Moisture	6·12
Protein	16·29
Fat	7·10
Carbohydrates	55·09
Fibre	12·05
Ash	3·35
	100·00

In protein and fat this sample is in accord with the better samples of oat flour examined in this laboratory. It is however somewhat high in fibre. It is a high-grade feed, though not suitable by reason of its large fibre content, for young pigs.

Oat flour appears to be a very variable product and for this reason should always be purchased on guaranteed analysis. Our records show the following range: protein, 13 to 17·5 per cent, fat 2·6 to 7·8 per cent, and fibre 3.4 to 11.1 per cent.

CORN PRODUCTS

Corn Feed

Lab'y No. 52750.—The Ogilvie Flour Mills Co., Limited, Winnipeg.
Lab'y No. 53653.—

ANALYSIS

—	No. 52750	No. 53653
Moisture	7·77	7·87
Protein	10·56	10·36
Fat	7·80	5·40
Carbohydrates	63·10	70·39
Fibre	8·52	4·25
Ash	2·25	1·73
	100·00	100·00

This by-product is of the nature of corn or hominy feed and presumably is made up of the corn bran, germ and part of the starch portions of the kernel resulting from the manufacture of hominy grits. It is palatable, wholesome feed and in common with other corn products very attractive to stock. It has been found a very satisfactory constituent in the ration of dairy cows and swine.

No. 52750 by reason of its fibre content would be classed with hominy feeds of low or average grade. No. 53653 differs from the preceding sample in having a lower fat content and decidedly less fibre. Though low in fat this sample might be ranked with the higher grades of hominy feed, the fibre content of which is less than 5 per cent.

Corn Flour

Lab'y No. 53715.—Imported from southern Illinois.
53716.—Purchased in Ontario; a Canadian product.

ANALYSIS

—	No. 53715	No. 53716
Moisture	11·80	12·35
Protein	6·88	8·34
Fat	1·27	1·62
Carbohydrates	79·18	76·37
Fibre	·37	·50
Ash	·50	·82
	100·00	100·00

Corn flour is the grain minus bran and germ, finely ground. It is a product that as a rule is too expensive to use in stock feeding. It is very starchy in nature and owing to its low protein and fat content, could not rank with feeding stuff concentrates, which are purchased to supplement home grown feeds and fodders in these nutrients.

OIL CAKE MEAL

Twelve samples of oil cake meal (linseed meal, oil meal) were sent in and have been submitted to analysis. These for the most part represent the product of the large and reputable Canadian firms manufacturing linseed oil.

Oil Cake Meal, 1920-21

Lab'y. No.	Particulars	Moisture	Protein	Fat	Carbohydrates	Fibre	Ash
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
50704	Oil Cake Meal	7·78	17·88	9·55	42·74	14·20	7·85
50712	Oil Cake Meal, Dominion Linseed Oil Co	12·23	35·75	4·55	35·64	6·78	5·05
50917	Pure Linseed Oil Meal	9·43	29·38	4·15	41·14	9·30	6·60
50988	Oil Cake Meal, Sherwin-Williams Co., Montreal	7·11	35·08	7·75	35·01	10·10	4·95
51376	Oil Cake Meal, Canada Paint Company, Montreal	5·17	33·16	6·10	41·43	8·07	6·07
51414	Oil Cake Meal, Maple Leaf Brand, Canada Linseed Oil Mills	9·90	31·02	6·75	37·13	9·20	6·00
51795	Old Process Oil Cake Meal, Maple Leaf Brand, Canada Linseed Oil Mills	10·92	32·28	6·10	36·13	8·62	5·95
53041	Pure Old Process, Linseed Oil Meal, Spencer Kellog & Sons, Buffalo, N.Y.	.....	32·43	.....	.....	.....	.....
53256	Old Process Meal, Maple Leaf Brand, Can. Linseed Oil Mills, Montreal	10·66	34·02	6·25	35·52	7·55	6·00
53565	Old Process Meal, American Linseed Oil Co., N.Y.	7·83	30·86	7·20	40·65	7·13	6·33
53566	Oil Cake Meal, Maple Leaf Brand, Can. Linseed Oil Mills, Montreal	9·00	39·00	7·87	31·01	8·15	4·97
53877	" " " " " " " "	8·25	35·36	6·90	36·44	7·70	5·35

ANALYSIS

Lab'y. No. 50712.—Sent in from Marshville, Ontario, and stated to be offered for sale in flour bags bearing the brand of a flour milling company, with no guarantee. This is a reprehensible practice, feeds ought to be sold only in bags stamped with the name and address of the milling firm and carrying the guarantee.

This is a genuine oil cake meal with a good percentage of protein but low in fat or oil. Brands containing a higher percentage of oil would be more suitable for calf feeding.

Lab'y. No. 50988.—The data are in fair agreement with those of previous analyses of cakes or meals from the screw process, with the exception of fibre, which is above the average. It is somewhat high in fibre but in protein and oil it is a very satisfactory sample.

Lab'y. No. 53176.—A genuine meal of average quality.

Lab'y. Nos. 51414, 51795, 53256, 53566 and 53877.—These five samples are all of the same brand, Maple Leaf, and the product of the Canada Linseed Oil Mills, Limited, Montreal.

The three samples Nos. 51795, 53256 and 53566 all bear the guarantee: protein 36·5 per cent, fat 6·8 per cent, fibre 7·4 per cent.

No. 51745 does not meet the requirements of its guarantee in protein and fibre and it is significant that its fat content is distinctly lower than the percentage guaranteed.

No. 53256, similarly, does not quite meet the guarantee as regards protein and oil.

Lab'y. No. 53566.—This sample very satisfactorily meets its guarantee in respect to protein and oil, though a little high in fibre.

All three samples are genuine and of good quality.

No guarantee was submitted in the case of No. 51414; it is genuine though not of the highest quality, being rather low in protein and decidedly high in fibre.

Lab'y. No. 53877 carried the guarantee of protein, 35.0 per cent, fat 6.0 per cent, fibre 7.0 per cent. This is a genuine meal and meets its guarantee satisfactorily.

The following results from the analysis of the five samples of Maple Leaf brand oil cake meal are of interest:—

	Maximum	Minimum	Average
	p.c.	p.c.	p.c.
Protein	39·00	31·02	34·33
Fat	7·87	6·10	6·77
Fibre	9·20	7·55	8·24

No. 53565.—An American Old Process meal bearing the guarantee: protein 32·0 per cent, fat 5 per cent, fibre 8 per cent. It is a genuine meal but does not meet its guarantee in protein. The results in regard to fat and fibre are, however, satisfactory.

The nine samples of genuine oil cake meal, of which we have a complete analysis in the foregoing table, have given the following data:—

	Maximum	Minimum	Average
	p.c.	p.c.	p.c.
Protein	39·00	31·02	34·06
Fat	7·87	4·55	6·61
Fibre	10·00	6·78	8·14

Lab'y. Nos. 50704 and 50917:—These two samples are both seriously adulterated with ground cocoa shells and are products of very inferior quality.

The results of No. 50704 are in close accord with those of ground cocoa shells, which the sample strongly resembles, in appearance, taste and odour. Microscopical examination showed it to consist mainly of ground cocoa shells, with a little linseed oil cake and a trace of flour, possibly barley.

The data of No. 50917 also prove adulteration, with ground cocoa shells but not to the same degree as in No. 50704. This conclusion was confirmed by microscopical examination.

These worthless meals were offered for sale in bags marked pure linseed oil meal. The fraud was not only detected but traced to its source, with the result that the product was withdrawn from the market and destroyed and the victims reimbursed.

COTTONSEED MEAL

Cottonseed meal ranks with the higher protein concentrates and is a valuable feeding stuff when carefully and somewhat sparingly used. Its chief use has been in the feeding of dairy cows and fattening steers but cannot in ordinary farm practice be safely fed to calves, pigs and poultry.

Three distinct grades are found on the market, carrying from 42 to 36 per cent of protein. Cottonseed feed is a mixture of cottonseed meal and cottonseed hulls, containing less than 36 per cent of protein. Since cottonseed meal varies so greatly in composition and quality, chiefly consequent upon the degree of thoroughness with which the hulls have been removed before the seed is crushed for the extraction of oil, it should only be purchased on guarantee.

Five samples of this feeding stuff were submitted during the year, the particulars of which are as follows:—

COTTONSEED MEALS, 1920-21

Laby. No.	——	Moisture	Protein	Fat	Carbo-hydrates	Fibre	Ash
		p.c.	p.c.	p.c.	p.c.	p.c	p.c.
50839	"Forfat Brand," Humphreys Godwin Co., Memphis, Tenn.	7·58	37·84	8·95	23·88	15·30	6·45
50910	Sold without brand or guarantee	8·48	31·64	8·13	31·95	12·50	7·30
53526	"Prime" cottonseed meal, Cottonseed Products Co., Louisville, K.	6·12	39·92	8·10	29·76	8·65	7·45
53564	"Puritan" brand, J. E. Soper & Co., Boston, Mass.	6·82	35·76	8·55	32·43	9·67	6·77
53935	"Danish Brand," Humphreys Godwin Co., Memphis, Tenn.	7·56	35·68	6·25	32·41	10·90	7·20

Lab'y. No. 50839.—This meal was sold under a guarantee of protein, 38.55 per cent, fat 5.00 per cent, fibre 12 per cent. It is a little low in protein, fully meets the guarantee as to fat but is decidedly high in fibre. This last is the most undesirable feature, indicating the presence of a considerable amount of hull. It would be classed with meals of the third or lowest grade.

Lab'y. No. 50910.—No particulars could be gained regarding the brand name of this meal nor of the firm manufacturing it.

From its low percentage of protein and its high fibre content, this meal is of rather inferior quality and would rank according to American classification, as cottonseed feed.

Lab'y. No. 53526.—Sold under guarantee of protein 41 per cent, fat 7 per cent, fibre 11 per cent. In protein, this meal is slightly below its guarantee but as regards fat and fibre it meets the warranty very satisfactorily. It would be classed as "prime," the second grade of cottonseed meal.

Lab'y. No. 53564.—Sold under guarantee of protein 36 per cent, fat 5 per cent, fibre 15 per cent. This meal fully meets its guarantee: it would be classed as "good," the third grade of cottonseed meal.

Lab'y. No. 53935.—Sold under guarantee of protein 36 per cent, fat 5 per cent, and fibre 15 per cent. This meal meets its guarantee satisfactorily and would rank as "good," the third grade.

FISH MEALS

Lab'y. No. 51062.—Prepared by the Canada Feed and Oil Co., Lockport, N.S. It is a dry, finely granular feed, consisting of fragments of meat (fish) and bone. It has a strong odour of fish and is apparently quite sound and wholesome.

ANALYSIS

	Per cent
Moisture	10·58
Protein	58·24
Fat	1·18
*Mineral matter or ash	26·44
*Containing phosphate of lime	22·78

This meal would appear to be of excellent quality; it ranks with the best grades of fish meal in protein and phosphate of lime content. It is exceptionally low in fat, a feature which probably enhances the keeping qualities of the meal and makes it one especially desirable in poultry feeding.

Lab'y. No. 51797-98.—These two fish products, submitted by the Department of Agriculture, Fredericton, N.B., are the manufacture of the Beaver Harbour Trading Co., Limited, Beaver Harbour, N..B. "The fish and fish waste is cooked in retorts by steam, until the bones are soft. The digested mass is allowed to thoroughly drain and put through the rotary drier, from which it issues quite dry. It is then conveyed to the grinder, in which it is reduced to the form of a coarse, dark, almost black powder."

ANALYSIS

—	No. 51797 "L"	No. 51798 "D"
	p.c.	p.c.
Moisture	13·07	8·56
Protein*	42·88	58·66
Fat	5·70	8·80
Mineral matter or ash**	38·40	24·27
*Containing nitrogen	6·86	9·38
**Containing phosphate of lime	22·80	17·41

Though very fairly satisfactory as fish meals from the standpoint of protein content and soundness, these products by reason of their physical conditions (rather too severely charred in the drier) and high mineral content appear to be better suited for use as a fertilizer. "L" differs from "D" in containing less nitrogen (protein) and more phosphate of lime.

PIG MEALS

Various feed mixtures sold with the claim of being specially suitable for feeding of pigs, have been placed upon the market in recent years. Some of these are excellent preparations, rich, nutritious and digestible; others have no particular merits for this special purpose, while again there are others which are worthless or dangerous through the presence of objectionable and poisonous weed seeds or of coarse feeding stuffs high in fibre.

The samples here reported on comprise a series used in the Animal Husbandry Division, Experimental Farm, Ottawa, in a feeding experiment with swine.

PIG MEALS, 1920-21

Laby. No.	Particulars	Moisture	Protein	Fat	Carbo-hydrates	Fibre	Ash
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
53944	Pig Meal, Gardiner Bros., Sarnia, Ont.	12·20	19·92	3·85	52·05	7·53	4·45
53945	Pig Meal, Schumacher, Quaker Oats Co., Peterboro, Ont.	10·16	11·63	4·05	59·66	11·00	3·50
53946	Pig Meal, Blatchford's Calf Meal Co., Toronto	10·95	21·36	4·75	49·24	7·10	6·60
53947	Bar-none Pig Meal, Blatchford's Calf Meal Co., Toronto	9·63	17·16	5·22	53·94	7·30	6·75
53948	Monarch Pig Meal, Maple Leaf Mlg. Co., Toronto	11·68	17·45	7·15	52·87	6·00	4·85
53949	Purina Pig Meal, Chisholm Mfg. Co., Toronto	9·72	15·59	5·70	52·39	9·75	6·85
55108	Home Mixture, C. E. F., Ottawa	7·75	14·83	6·02	61·33	6·97	3·10
55109	Pioneer Hog Feed, Pioneer Feed Mfg. Co., Fort William, Ont.	9·13	16·19	5·70	50·78	11·00	7·20

Lab'y. No. 53944.—A finely ground rather dense meal, of pleasant taste and odor, contains ground corn, fine bran or shorts, oil cake meal and blood meal, with traces of oats and weed seeds. It is rich is protein but rather low in fat. It is satisfactory as to fibre content.

Lab'y. No. 53945.—This feed does not compare favourably with many in the series. Though probably good value at the price asked it is not a high grade pig feed, by reason of its low protein and high fibre content. It would not prove a suitable feed for very young pigs.

Lab'y. No. 53946.—This is a high class feed, rich in protein, moderately rich in fat and comparatively low in fibre. It has proved a palatable, nourishing pig feed.

Lab'y. No. 53947.—A somewhat coarser feed than the preceding and containing 4 per cent less protein. Though not equal in quality to the highest grades of pig meal, it is quite satisfactory in all essential features.

Lab'y. No. 53948.—An excellent feed and quite satisfactory in respect to protein, fat and fibre.

Lab'y. No. 53949.—A rather coarse feed for young pigs; of average quality only in regard to protein and fat with a somewhat high fibre content.

Lab'y. No. 55108.—" Compounded of middlings 4 parts, ground oats 2 parts, corn 1 part, barley 1 part, to which has been added 10 per cent of oil cake meal." Though not a high protein product it is a satisfactory pig feed. In its comparatively high fat and low fibre it presents very desirable features, especially for the feeding of young stock.

Lab'y. No. 55109.—This feed is too high in fibre for use with young pigs; otherwise the data are satisfactory. The percentages of protein and fat are fairly well balanced; they are those of feeds well adapted to the growth and fattening of swine.

As very great differences in composition and in prices exist among the various pig meals on the market, the purchaser should make a study of the analyses with the comparative prices, before placing his order.

POULTRY AND CHICK FEEDS

In recent years a number of feed mixtures have been prepared and put on the market as specially adapted for poultry and chick feeding. These naturally have been found more useful by the town and suburban poultry keeper and to some extent by the poultry raisers on a large scale, the so-called chicken farmer, than to the ordinary farmer who has home-grown grains for his flock. In general, these feeds should be characterized by a moderately high protein content, a fair percentage of fat and little fibre. For laying stock, excessive fat in the ration should be especially avoided and variety of grain and meals is a most desirable feature for all classes of poultry. Meat, milk and animal products in general have been found particularly valuable for furnishing a part of the protein of the ration, alike for growing chicks as for egg production.

Five poultry feeds have been submitted during the year and are now reported on.

POULTRY FEEDS 1920-21

Lab'y. No.	Particulars	Moisture	Protein	Fat	Carbo-hydrates	Fibre	Ash
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
52218	Scratch Feed, Elevator Waste, Montreal	10·00	10·60	2·35	48·95	17·55	10·55
53079	Dry Mash, No. 1, Victoria, B.C.	7·71	17·56	6·70	50·91	10·07	7·05
53080	Dry Mash, No. 2, Victoria, B.C.	8·85	20·88	5·55	41·52	10·50	12·70
53322	Egg Mash, Blatchford's "Fill the Basket"	7·30	18·91	5·17	45·52	10·20	12·90
53714	Egg Mash, Wm. Rennie Co. Ltd., Toronto	6·70	17·80	4·35	58·72	7·18	5·25

Lab'y No. 52218.—This sample is described and sold as "a first-class scratch feed for chickens—cleanings and sweepings from grain elevators." This is a feed of exceedingly poor quality, very low in protein and fat. It is excessively high in fibre and ash—the former due to chaff, hulls, fragments of straw—the latter denoting the presence of sand.

Lab'y Nos. 53079-80.—These two samples of "dry mash" were forwarded by a poultry keeper in British Columbia who had had them prepared as follows:—

	No. 53079 lbs.	No. 53080 lbs.
Wheat bran	600	600
Wheat shorts	300	300
Ground oats	450	450
Oil cake meal	150	–
Soya bean meal	–	150
Feed corn meal	150	150
Fish meal	300	–
Beef scrap	–	300
Charcoal	60	60
Salt	4½	4½

No. 53080 is decidedly the richer in protein, but No. 53079 has a somewhat higher percentage of fat. The fibre content is practically identical in both samples. The higher ash in No. 53080 may be due to phosphate of lime (bone phosphate) introduced by the beef scrap.

Judged from the chemical analyses, as well as from the formulæ, these feeds are of excellent quality and should prove useful for laying stock.

Lab'y No. 53322.—This is sold under guarantee of protein 19 per cent, fat 4 per cent, fibre 10 per cent. This is a widely advertised and well known mash for laying stock. Its nutrients are in good proportions for the purpose intended and the feed very satisfactorily meets its guarantee.

Lab'y No. 53714.—This "mash" has a very satisfactory analysis, the protein and fat being present in good proportions and the fibre particularly low. The chief ingredients as ascertained from miscroscopical examination, are bran, ground corn, oats with smaller proportions of bean meal and blood meal.

MISCELLANEOUS FEEDS

In the accompanying table the analysis are given of a number of miscellaneous feeds submitted during the past year. They vary greatly in character—their composition, purposes and nutritive values and must therefore be considered individually.

Lab'y No. 50686.—Alberta Mixed Chop. Manufactured by the Ogilvie Flour Mills Co. Consists essentially of coarsely crushed, greenish oats with bran or shorts. This should prove a fairly nutritious feed; it has a good percentage of protein and is not excessively high in fibre. It is distinctly low in fat. The feed appears to be a finely pulverized mixture of shorts or middlings with oat feed.

Lab'y No. 50696 and 50986.—Semi-solid buttermilk, manufactured by Bowes Limited, Toronto. It was recommended for use in poultry feeding. It is a thick cream-coloured liquid.

The two samples differ markedly in dry matter content—No. 50696 contains 21·04 per cent and No. 50986, 33·61 per cent total solids—giving evidence of the superiority of No. 50986 and of lack of uniformity in manufacture. Calculated to the water-free basis we obtain the following figures for the two samples; the composition of the dry matter of fresh buttermilk is added for comparison.

COMPOSITION OF DRY MATTER

—	No. 50696	No. 50986	Fresh Buttermilk
Protein	37·41	33·36	40·31
Fat	14·41	14·29	13·32
Milk sugar	34·25	43·22	36·03
Lactic acid	4·28	·68	3·41
Ash	9·65	8·48	6·94
	100·00	100·00	100·00

The price of the "Semi-solid Buttermilk" in Toronto is 8 cents per pound. Diluted to the same "solids" content as that of fresh buttermilk the cost of No. 50696 would be $3.75 per 100 pounds and that of No. 50986, $2.85 per 100 pounds. Fresh buttermilk we understand can be purchased at the creamery at 50 cents per 100 pounds.

Lab'y No. 50851.—Feed purchased in Beauharnois and stated to be a mixture of bran, shorts, buckwheat, oat feed. The correspondent claimed that his cows were falling off in milk yield following its use.

This is a product of low feeding value by reason of its small percentage of protein and its high fibre content. Its use would necessitate the supplemental employment of feeds much richer in protein and less fibrous, if satisfactory results are to be obtained.

Lab'y No. 50896.—Fox biscuit, manufactured by J. A. Marven, Limited, Moncton, N.B. A hard, open-textured, light brown biscuit, giving evidence of containing bran and fragments of meat. It was sound, wholesome and apparently palatable.

As compared with a number of brands analysed some years ago this biscuit is decidedly low in protein, rich in fat and low in fibre and ash. The limits of the series referred to (Farm Feeds, page 37) were protein 23·75 to 17·36 per cent; fat 7.06 to 1·37 per cent, and fibre 2·94 to ·90 per cent.

Lab'y No. 50916.—"Stag Feed" manufactured by the Mile End Milling Co., Mile End, Que. It is an oat feed with a certain admixture of ground barley and a small proportion of wheat bran. From the standpoint of nutritive value, it is of medium quality only and distinctly inferior to bran or shorts.

Lab'y No. 51067.—This "feed" was purchased as ground barley but its percentages of fibre, fat and ash are too high for this grain. Microscopical examination showed that barley was its essential constituent but that ground oats, hulls and certain objectionable weed seeds were also present. While not true to name, it is a product that would be classed with feeds of moderate value.

Lab'y No 51821.—"Mixed Concentrates," alleged to contain bran, shorts and oil cake meal, forwarded from Sardis, B.C. but manufacturer's name not given. The sender had used it as a chicken feed and considered it might be poisonous or otherwise injurious, as certain of his chickens had died. The *Seed Microscopist* reports: "I can find nothing of a poisonous nature. The sample appears to consist of ground peanut skins, corn, bran and a very slight trace of oat hulls. No weed seeds, other than a trace of ground wild buckwheat, could be found."

This must be considered an unsatisfactory, unsuitable feed for chicks; the fibre content is too high and the feed too rich in fat or oil. Peanut products on general principles are not regarded by poultry authorities as suitable or desirable in mixtures for either laying stock or young chickens.

Lab'y No. 51974.—Sampson's Feed Flour, forwarded by the Live Stock Branch, Department of Agriculture, New Westminster, B.C. The data are in agreement with those of good samples of feed flour previously analysed in these laboratories.

Feed flour of good quality is a rich and valuable concentrate and particularly useful in the ration of young stock, especially of young pigs, chiefly by reason of its high protein and low fibre. It must however be fed judiciously and with discretion, i.e. not too liberally, as part of the ration and thoroughly mixed with a due proportion of coarser feeds, to prevent clogging or massing in the digestive tract. No doubt a number of the fatalities reported from using many feeds of high nutritive value are due to the lack of recognition of their special character—physical or chemical; intelligently and rationally employed they may give excellent results, ignorantly employed they may prove fatal.

Laby No. 52748.—Feed stated to be a mixture of ground oats and barley, from Creston, B.C. It was accompanied by an inquiry as to genuineness and comparative value with shorts for pig feeding.

The data indicate that the feed is a mixture of oats and barley, with a preponderance of the former. It is good feed but floury shorts or middlings would be better for pigs, especially young ones—the shorts are richer in protein and lower in fibre.

Lab'y No. 52749.—Feed forwarded by the Scotia Flour and Feed Co., Truro, N.S. It consists of ground refuse screenings containing a high proportion of weed seeds, some ground wheat and corn, traces of oats and trace each of beans, barley and flax.

This is a low grade feed containing a large proportion of mill refuse as indicated by the high percentages of fibre and ash. It is not improbable that with such a large weed seed content this feed would be distasteful or unpalatable to stock.

Lab'y No. 53259.—Flax bran, a flax refuse product, consisting essentially of small and shrivelled flax seed, flax seed hulls, fragments of flax straw and a few weed seeds. From the United Farmers Co-operative Co. of Toronto.

This feed is not correctly named—as already stated, it is a flax refuse product. The fact that it contains such a large proportion of sharp and harsh fragments of flax straw would make the feed, in spite of its high protein and fat content, most undesirable—and, very possibly, dangerous. Even if this unfavourable feature could be removed and the feed made safe as by boiling, soaking or fine grinding, the high fibre content would still militate against its usefulness.

Lab'y. No. 53938:—Flax seed. This is seed of a new variety, sent by A. Griffin, of Brooks, Alta.

It is unusually large and heavy seed (weight of 1,000 kernels—10.38 grams) of a light yellow colour. It may be considered as exceptionally rich in oil, the amount of this constituent, 43.44 per cent, exceeding the oil content of average flax seed by about 5 per cent. It would appear to be a very valuable variety.

Lab'y. No. 53336:—This preparation "Zool," advertised as a "perfect food for horses and cattle," and manufactured at Puteaux (Seine), France. In the directions for use it is stated to be a powder easy to handle and transport which can be administered without any of the inconveniences that occur in the use of liquid phosphoric acid.

As received, it was a brown coarsely granular somewhat sticky powder with a rather pleasant odour indicative of the presence of some ingredient of the nature of raisins or other form of dried fruit. Under the mircroscope the material appears to be largely crystalline. It is strongly acid and possesses a very sour taste.

Chemical examination of this product afforded the following data and information:—

Moisture	14·21
Matter, insoluble in water, essentially organic	44·00
Mineral matter or ash	15·33
By difference, essentially organic in character	26·46
	100·00
Containing phosphoric acid, soluble in water	13·71
Nitrogen	1·39
Soda and potash, in aqueous extract	2·35

Traces or negligible amounts only of lime, magnesia, chlorides, sulphate and carbonates.

This preparation appears to be essentially a mixture of soluble phosphoric acid and some organic material—the latter chiefly present, presumably, to render less objectionable or mask the strongly sour taste of the phosphoric acid. Unquestionably if Zool has any value in the practice of stock feeding, such value is to be attributed to its medicinal value (i.e., phosphoric acid) rather than to any food value. Presumably the claims for this preparation would be based on the properties of phosphoric acid as a tonic and diuretic. It cannot be regarded as a food; its value in practical stock raising must depend upon its merit as a medicine.

Lab'y. No. 53987.—Barley hay from Experimental Station at Invermere, B.C. This is from "Success" barley, an early ripening barley, cut at an early stage. The stubble was immediately irrigated with the view of encouraging a second growth which might give a crop of grain. The question arose as to the nutritive value of this early cut hay.

As received this barley hay was a greyish-green, yellowish towards the base of the stems. It was well headed out but the kernels were very small and immature. Length of stems about 40 inches.

The fibre content is somewhat higher than that quoted from American sources, but from the condition and appearance of the sample it may be concluded that in palatability and digestibility it is not inferior to hay as ordinarily made from young barley. The protein is somewhat higher than is usually given in the text books for this forage, a feature of considerable interest and indicating a distinctly higher nutritive value. It would appear to be an excellent forage, and distinctly more valuable than many of the hays from grasses.

Lab'y. No. 54097.—"Mixed Grain Feed," submitted by H. Crossley Sherwood, Esq. This was found to consist of—

Wheat	31·4
Oats	33·2
Barley	24·0
Weed seeds, etc.	11·4
	100·00

The above particulars and the analytical data would indicate that this grain mixture would yield a chop or meal feed of good quality.

Lab'y. No. 54098.—"Screenings from Wheat." This had the following composition:—

Wheat	58·7
Oats	23·1
Barley	5·0
Weed seeds, etc.	13·2
	100·00

This sample is somewhat superior to the preceding (No. 54097) in possessing a larger proportion of wheat, which increases the percentage of protein and reduces the fibre content. The analytical data indicate an excellent meal and one suitable for many classes of stock.

Lab'y. No. 54247.—"Peanut Hearts," submitted by B. G. Conner and Associates, Calgary, Alta.

Lab'y. No. 54353.—"Peanut Kernels," submitted by Percy C. Deeble, Toronto.

These two feeds are of the same nature, consisting essentially of the germ or embryo of the peanut with a certain proportion of fragments of broken peanut. It is probably a by-product in the manufacture of "peanut butter." It is high in protein—approximately 30 per cent and exceedingly rich in oil or fat—from 43 to 45 per cent. The fibre is very low, from 2·4 to 2·6 per cent.

Lab'y. No. 54248.—"Peanut Skins," from B. G. Conner and Associates, Calgary, Alta.

Lab'y. No. 54354.—"Peanut Skins," from Percy C. Deeble, Toronto.

This feed consists essentially of the skin of the peanut, with a small proportion of broken kernel. It is most probably a by-product in the manufacture of "peanut butter."

It has a protein content from 18 to 20 per cent, oil 31 to 33 per cent, and fibre 7 to 9 per cent. No special reference has been found as to the practical nutritive value or the digestibility of peanut skins. It would seem, however, from the data that they should possess notable feeding value.

These peanut products—kernels and skins—are very rich in protein and oil and low in fibre. Used judiciously, and as a part of the ration with feeds rich in carbohydrates they no doubt could be employed to advantage as they appear to be very palatable to stock. It should be noted, however, that these products when largely fed to swine cause a softness or oiliness in the fat of the resulting pork—a very undesirable feature.

Lab'y. No. 54358.—"Pea Bran." Vendors: H. Murton, Limited, Guelph, Ont. Pea bran or hulls is an extremely poor feed, containing less than 6 per cent of protein and more than 50 per cent of fibre. The present sample, however, by reason of a certain proportion of broken pea fragments, is raised from a feed of practical worthlessness to one possessing a small feeding value.

Lab'y. No. 54368.—"Calf Meal." Manufactured by Lee Deeks, Morrisburg, Ont., and was stated to contain red dog flour, hominy, oil cake meal, blood meal, sulphur, calcium carbonate, fenugreek and salt.

This is a calf meal of the type or class containing mild drugs for the purpose of acting as appetizers, correctives or tonics. From the standpoint of nutritive value we might conclude that it would prove satisfactory; in protein and fat it ranks with the best calf meals on the market and its fibre is particularly low.

MISCELLANEOUS FEEDS, 1920-21

Lab'y. No.	Particulars	Moisture	Protein	Fat	Carbohydrates	Fibre	Ash
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
50686	Alberta Mixed Chop (Ogilvie Flour Mills, Co.)	7·57	14·33	2·80	61·75	9·80	3·75
50696	Semi-solid buttermilk, (Bowes Ltd,, Toronto.)	78·96	7·87	3·04	8·10	.....	2·03
50851	Feed, purchased in Beauharnois, Que	8·12	10·21	3·75	56·90	16·67	4·35
50896	Fox Biscuit (J. A. Marven, Ltd., Moncton, N.B.)	9·23	13·74	9·05	66·06	0·25	1·67
50916	Stag Feed (Mile End Milling Co.)	9·43	12·27	3·23	58·52	12·95	3·60
50986	Semi-solid Buttermilk, (Bowes Ltd., Toronto)	66·39	11·21	4·80	14·75	.....	2·85
51067	Feed, Thibeault Grain Co., Montreal	7·77	11·84	3·37	63·92	8·95	4·15
51821	Mixed Concentrates, (Sardis, B.C)	8·00	14·25	14·25	49·78	7·92	5·80
51974	Feed Flour (Sampson)	10·25	19·36	3·33	60·84	3·45	2·77
52748	Feed from oats and barley, Creston, B.C	9·74	12·66	4·20	61·18	9·35	2·87
52749	Feed, Scotia Flour and Feed, Co., Truro. N.S	8·90	11·19	3·53	55·42	13·37	7·59
53259	Flax Bran(United Farmers' Co-operative Soc., Toronto)	5·70	15·82	16·60	38·16	16·37	7·35
53336	Zool, mfg. in Puteaux, France	14·21	8·66	1·00	59·38	1·42	15·33
53938	Flax Seed, A. Griffin, Brooks, Alta	.....	20·79	43·40	.....	.....	.....
53987	Barley Hay (Success Barley)	4·87	10·35	3·98	44·63	26·87	9·30
54097	Mixed Grain Feed	9·22	12·09	4·75	64·22	6·97	2·75
54098	Screenings from wheat	8·16	14·19	4·05	65·13	5·77	2·70
54247	Peanut Hearts	1·92	29·94	43·17	19·74	2·63	2·60
54248	" Skins	3·46	18·36	31·27	36·11	8·70	2·10
54353	" Kernels	2·61	30·06	45·40	17·03	2·40	2·50
54354	" Skins	4·70	19·93	32·77	31·77	7·83	3·00
54358	Pea Bran, (H. Murton Ltd., Guelph)	8·00	10·53	0 58	37·19	41·12	2·58
54368	Calf Meal, (Lee Deek, Morrisburg, Ont.)	9·83	33·70	10·05	37·58	2·89	5·95

LIMESTONE

Soils containing free carbonate of lime have for many years been recognized and classed as among the most productive; the presence of this basic material not only furnishes an element required in crop nutrition but in other ways, chemical, physical and biological, enhances soil fertility. Similarly, it has been long known that the application of lime in some form—as quick-lime, slaked lime, ground limestone (essentially carbonate of lime), marl (a naturally occurring carbonate of lime)—increases soil fertility, and especially is this true in the case of so-called sour soils.

Of late years there has been a renewed interest, from both practical and scientific points of view, of this question. Much study has been devoted and a large amount of careful investigation has been carried on towards determining the nature and cause of "sourness" in soils and the manner in which basic lime compounds correct this unfavourable quality. As a result many theories have been put forward to account for soil acidity and its correction. Many attempts, based on these theories, have been made to devise a reliable, accurate laboratory method for determining the "lime requirement" of a soil, but as yet all are more or less empirical and approximate. The fact however remains, that these lime compounds have a beneficial influence on many soils and that they can be profitably employed to increase crop yields. We further know that there are laboratory methods which can be applied to ascertain if a soil is in need of lime and to indicate, within certain limits, the amounts per acre desirable and economic to apply.

For the non-scientific reader the outstanding functions of lime (including the forms slaked lime, ground limestone and marl) may be briefly stated as follows: the correction or neutralization of soil acidity, commonly known as sourness—a property more or less injurious to the growth of most farm crops; the furnishing of an important element of plant food; the improvement of the tilth and structure of many types of soils and especially of heavy clay loams, making them more retentive of moisture, better aerated, more easily drained and more easily worked and better adapted to the extension of the crop's root system; the promotion of conditions favourable to the development of those microscopic organisms within the soil which play so important a part in the preparation of crop food from inert soil material—especially in the production of nitrates—and by encouraging the growth of clover which may add available nitrogen to the soil from the free and otherwise unavailable store of that element in the atmosphere.

Attention has been directed to this matter of soil improvement by "liming" for some years past by this Division and it is encouraging to note the ever increasing interest in it by Canadian farmers. The practice of applying lime in one or other of the forms mentioned is extending and a considerable amount of satisfactory evidence is accumulating, especially from the eastern provinces and British Columbia, to show that it has proved beneficial and profitable; especially is this true in districts under humid conditions and in which cultivation and cropping have long been carried on on soils naturally poor in carbonate of lime.

Our analytical work in this connection has been chiefly in the examination of soils as to "lime requirements" and in the determination of the carbonate of lime content in a number of limestones sent in by provincial agricultural authorities for a report as to quality. These limestones, if sufficiently pure, were to be used in the preparation of ground limestone.

ANALYSES OF LIMESTONES, 1920-21

Lab'y. 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. (by difference)
		p.c.	p.c.	p.c.	p.c.
50812	Nova Scotia	13·10	2·82	78·75	5·33
50838	St. Jean Baptiste, Que	3·02	1·10	95·37	0·51
50850	Upper Dorchester, N.B	18·19	1·91	77·50	1·68
51055	Niminigash, P.E.I	11·22	1·46	85·13	2·19
51087	Point Edward, near Sydney, N.S	6·12	1·76	89·75	2·37
52018	South West of Salmon Arm, B.C	4·66	0·18	95·00	.....
52019	" " "	98·10	1·07	.....	0·83
52020	" " "	82·32	10·42	3·20	4·06
52210	North West of Miramichi River N.B	24·60	3·26	71·25	0·89
52475	Val Brillant, Matane Co., Que	28·20	2·58	65·75	3·47
53718	Quarry at Brookville, St. John, N.B	7·03	2·47	86·25	4·25
54023	Lawlor Quarry, Brookfield, N.B	8·00	1·50	90·00	0·50
54094	On East River, West of Stellarton, N.S	3·82	0·68	94·00	1·50
54346	Knowlton, Que	1·83	0·37	97·00	0·80

The indications are that for many districts ground limestone will become the most popular form of lime to use. As a rule it is the cheaper and more economic form and, for light loams it is undoubtedly the safer. The application usually lies between one and three tons per acre, broadcasted on the surface of the ploughed land and harrowed in. Great variation is found in the quality of the ground limestones on the market and no purchase should be made without considering the carbonate of lime content and the degree of fineness of the sample submitted. There are a number of brands on the market containing over 90 per cent carbonate of lime and again there are others of inferior quality containing little more than 50 per cent. With respect to degree of fineness, a brand will generally be found satisfactory if from 65 to 85 per cent passes an 80-mesh screen, all passing a 10-mesh screen.

MARL

The attention of farmers may again be directed to the agricultural value of this naturally-occurring carbonate of lime, for as an amendment for soils in need of liming its value has not yet been fully recognized in Canada.

Marl is found in the larger number of the provinces of the Dominion, but more especially in Eastern Canada. It more commonly occurs as a deposit, varying from a few inches to several feet in thickness, on old lake bottoms and is frequently overlaid by muck—a material also useful as a soil amendment and more especially for loams deficient in organic matter.

ANALYSES OF MARLS (AIR DRIED) 1920-21

Lab'y 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.
53103	Halifax, N.S	20·48	1·75	66·10	11·67
53260	Tyndall, Man	1·53	·48	64·35	33·64
53461	Marksville, Ont	1·89	·61	69·00	28·50

Previous reports have given the analysis of many samples of marl from widely distant parts of the Dominion. During the past year only three samples have been submitted and all were of fair quality.

Its preparation and application will, as a rule, be simple and comparatively cheap. Frequently it can be obtained at the cost of digging and hauling from a deposit on the farm or in the neighbourhood. Its soft and friable nature when air dried permits it being easily and uniformly applied to the land and when of the best quality its results will be found fully equal to those of ground limestone. Naturally it is variable in composition, due to the association of or admixture with clay, organic matter and foreign matter. Marls have been examined in these laboratories containing in the air-dried condition over 90 per cent carbonate of lime but there are many others of poorer quality and hence the value of a chemical analysis when considering the opening up of a deposit which would first require the removal of any great thickness of superencumbent material—in other words when the deposit of marl lies at a considerable depth below the surface.

MISCELLANEOUS FERTILIZER MATERIALS

PEAT

Two samples forwarded from Northumberland county, Ontario, with a request for information as to their use and value as a fertilizer, afforded the following data:—

	Lab'y No. 52448 No. 1.	Lab'y No. 52449 No. 2
Organic matter	94·08	64·02
Mineral matter, soluble in acid	5·27	5·75
" " insoluble in acid (sand)	0·65	30·23
	100·00	100·00

No. 1. Dark brown fibrous peat: 1 to 3 feet.
No. 2. Dark brown compact peat: 3 to 5 feet containing much fine sand.

The area is 15 to 20 acres in extent, covered with huckleberry bushes and fringed with willow.

No. 1 is practically pure peat and might be used, when thoroughly air-dried, as a fuel.

The application to the land of the crude raw peat would not be of any appreciable fertilizing value, but it might be used to advantage as a supplementary litter in the cow stable, pig pen, etc., a s it has very considerable absorbent qualities. By this means it can be employed to save much liquid manure, and would be especially useful when there is a shortage of straw.

No. 2 contains about one-third of its weight of fine sand and further, owing to its compact nature, would not prove so valuable as No. 1 as an absorbent, It also could be used as a fuel, though its large proportion of sand reduces its value for this purpose.

The reclamation of the area would probably involve, as an initial step, the burning off of a considerable depth of the surface peat.

BLOOD

This sample, from a large slaughter-house near Charlottetown, P.E.I., yielded an analysis of the following data:—

Laboratory No. 53084

Water	81·39
Organic matter	17·37
Mineral matter or ash	1·24
	100·00
Phosphoric acid	·10
Nitrogen	2·72

This material, in spite of its high percentage of water, is very rich in nitrogen and hence must be regarded as of very considerable fertilizing value. This product would very readily set free its nitrogen in the soil, if conditions of warmth and moisture were favourable. Dried blood is a highly-esteemed nitrogenous fertilizer and when perfectly sound can be used to a limited extent as a feeding stuff.

This material would not keep for any length of time in its present condition. If dried to a 10 per cent water content it would contain about 13 per cent nitrogen and if properly stored, could be kept without spoiling for a considerable time.

TANKAGE

Lab'y No. 53085.—This sample of tankage, prepared at a large slaughter-house, Charlottetown, P.E.I., is chiefly from waste parts of sheep and pigs' heads, cooked by steam for about ten hours.

As received it was a moist sticky mass of a light grey colour, containing some masses of bone. Its analysis afforded the following data:—

Water	65·34
*Organic matter	31·26
†Mineral matter soluble in acid	3·10
Mineral matter insoluble in acid	·30
	100·00
*Containing nitrogen	1·78
†Containing phosphoric acid	1·13

In the moist condition, as received, this product could not be conveniently used either as a feeding stuff or fertilizer, and further it would very rapidly spoil and become offensive. If 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, and become a much more valuable fertilizer than the fresh material, one that would keep fairly well and one that could be readily applied to the land. Further, if made from a sound material, it would then form a wholesome, high-grade concentrate and could be used in the feeding ration, especially for fattening pigs.

CUTTLE FISH BONE

Lab'y No. 53878.—This sample was sent from Vancouver, B.C., with a request for information as to value for poultry and for gardening purposes.

ANALYSIS

Carbonate of lime	89·30
Insoluble mineral matter	0·23
Organic matter	9·44
Oxide of iron and alumina	0·33
Phosphoric acid	traces
Undetermined	0·70
	100·00
Nitrogen, in organic matter	0·72

As a poultry "grit" it should prove an excellent material, furnishing an abrasive for assisting in the comminuting of the grain, etc., in the gizzard and also for supplying carbonate of lime for egg-shell production.

It could be used advantageously, if price permitted, as an amendment for soils in need of lime, as it possesses a very high carbonate of lime content. Its notable nitrogen content adds to its value as a fertilizer or amendment. For this purpose it would require to be coarsely ground.

KENDEX SANDING DUST

Lab'y No. 52293.—This material also designated "K Dust," is a by-product composed chiefly of charred and pulverized cotton and wool fibres which have been treated with oils. It is from a felt manufactory at St. Johns, Que., and was thought to have some value as a fertilizer.

The results of our analysis are as follows:—

Moisture	1·37
Organic matter	53·07
Mineral matter or ash	45·56
	100·00
Nitrogen in organic matter	3·20

This material possesses a notable amount of nitrogen, the degree of availability of this nitrogen by actual trials in the soil would have to be determined before its fertilizing value could be established. It appears, however, to be a by-product well worthy of investigation, both in the laboratory and in the field.

ANALYTICAL AND EXAMINATIONAL WORK ON SAMPLES SUBMITTED BY HEALTH OF ANIMALS BRANCH, DEPARTMENT OF AGRICULTURE

The object of the examination of samples submitted by this branch of the department is to assist in the control of "The Meat and Canned Foods Act" and the "Oleomargarine Act."

The appended table gives a classified list of samples received and reported on during the year 1920-21:—

Nature of sample	No. received
Colours and inks	19
Evaporated apples	449
Spices and condiments	131
Denaturing oils	63
Butters and oleomargarines	84
Salts and preservatives	39
Meats and vegetable extracts	8
Lards, lard compounds, edible oils	73
Canned and preserved fruits	85
Sausages, potted and preserved meats	47
Canned vegetables and tomato products	48
Condensed milk	208
Miscellaneous	25
Total	1,279

COMMENTS ON ANALYSIS

Inks and Colours.—Total colours and inks examined during the year numbered nineteen. The quality of dyestuffs examined shows a distinct improvement over that

of a few years ago. This is possibly explained by the fact that departmental regulations have practically done away with the use of colours in the packing houses, artificial colours at the present time seem to be used in jam factories only. Fourteen coal tar colours were examined, one sample only consisted of a non-approved colour and all showed freedom from arsenic. It is desirable that dyes used in edible products should not only consist of approved dyes free from arsenic but should show reasonable freedom from inorganic salts notably sulphates and chlorides. It is hoped to include this determination in the present year's work.

Evaporated Apples.—A total of 449 samples of apples were examined during the year for moisture content.

In the absence of an official method, the following process has been tentatively adopted in this laboratory with eminently satisfactory results. The apples are finely ground by passing through a motor-driven meat chopper, approximately five grams weighed into flat-bottomed aluminum dishes and dried in a vacuum of 29 or more inches for a period of 18 hours at a temperature of 80°C.

The average water content of 449 samples was 21·39 per cent. The average water content of these samples containing water in excess of 25 per cent, the limit fixed by regulation, was 27·07 per cent. Nine and one half per cent of samples showed water content in excess of 25 per cent. The maximum water content was 33·5 per cent. The minimum water content was 8·55 per cent.

These results indicate a fairly satisfactory condition of this product as regards water content, a very considerable improvement over the condition at the time this examination was commenced a few years ago. It is believed that this work has been of considerable value to the consuming public and the manufacturers in improving the quality of their product.

Spices and Condiments.—A total of 131 samples examined during the year very largely consisted of ground spices. There were no evidences of gross adulteration but no particular attention has been paid to quality of spice.

Denaturing Oils.—In order to ensure that all fats rendered from diseased carcasses, or otherwise unfit for edible purposes should be used for other purposes, departmental regulations require the addition of a denaturing agent to answer the following specifications: Boiling point not lower than 205°C. Flash point (open cup) not lower than 75°C. Taste easily recognized when present in fat in proportion of 1 part of denaturing agent to 1,000 parts of fat. Specific gravity not lower than 0·819. The reasons for these specifications are briefly: A fat heated higher than 205°C. darkens but not under that temperature. It would be quite feasible to remove an agent with lower boiling point.

The flash point specification is simply a protection against fire hazard. The taste test is the most important from the consumer's standpoint, it is his only practical method of recognizing the presence of a denatured fat in an edible product.

The gravity test ensures a permanent and complete mixture of fat and denaturant.

Sixty-three samples were examined during the year. Eighty-one per cent of samples answered all requirements except taste test. Thirty-six per cent of samples answered taste requirements. Twenty-seven per cent of samples answered all requirements.

Butters and Oleomargarines.—In all 84 samples were examined during the year, chiefly for the presence of artificial colouring, to determine whether samples conformed with the regulations of the Oleomargarine Act. Only 3·5 per cent of samples examined showed the presence of artificial colouring. This result shows an immense improvement over results obtained during the first year of the operation of the Oleomargarine Act when possibly forty to fifty per cent of samples of butter submitted for examination were refused on account of presence of artificial colouring.

Salts and Preservatives.—A total of 39 samples were examined under this heading during the year. All samples were found to be correctly named and in no case was any suspicion of fraudulent practice revealed by analysis.

Meat and Vegetable Extracts.—Eight samples examined under this heading showed freedom from preservatives.

One sample showed the presence of a relatively enormous quantity of zinc, unmistakeable proof of serious corrosion of tank in which the extract was stored. Zinc may be considered one of the most deleterious of the heavy metals; this result shows that extreme care is necessary in the preparation of products so highly saline as meat extract.

One product, imported in the form of cubes showed the presence of approximately fifty per cent starch and twenty per cent salt. Such results show the necessity of examination of products which, while extremely high in price, offer relatively little food value.

Lards, Lard Compounds and Edible Oils.—Of the total 73 samples examined under this heading during the year two showed the presence of excess moisture. No case of mislabelling was revealed by analysis.

It is desirable in this connection to point out the importance we attach to one determination pronouncing upon the purity of a lard sample. The method referred to depends upon the melting point of the solid glycerides separated from ether. Lard has been found to be free from the glyceride tri-stearin. All commonly used adulterants, beef fat, vegetable stearin and hydrogenated oils contain tri-stearin and this determination has been found of much greater diagnostic value than the time honoured iodine number, butyrometer reading, etc., which show such great variations depending on such factors as food of animal, position of fat in body, etc.

During the year the laboratory was asked to pronounce upon the purity of a sample of beef tallow with special reference to the presence of mutton tallow. Our conclusions only may be stated: mutton fat and beef fat are on the average identical in chemical composition. Any known method of analysis is powerless to detect the presence of an admixture of the two fats. Inspection and perhaps certain organoleptic tests must be relied upon for such determinations.

Canned and Preserved Fruits.—Eighty-five samples under this heading were examined during the year. Twenty-one or 25 per cent of these samples showed the presence of commercial glucose. The average percent of glucose in these twenty-one samples was 15.61 per cent. The maximum percent of glucose was 50, the minimum 6.6.

Twenty-five samples, or thirty-four per cent of total samples showed the presence of artificial colour. During the past year time did not permit of the identification of colours present, it is hoped to include this identification in the present year's work.

This work may be considered in the nature of a preliminary examination and simply demonstrates the need of continued analysis of jams and preserves to ensure the best Canadian product.

Sausages, Potted and Preserved Meats.—A total of 47 samples were examined under this heading during the past year, chiefly for water and cereal, also a certain percentage for preservatives and artificial colour. The average per cent water was 60.90. The average per cent cereal was 6.22.

A few determinations only were made of total protein but the results obtained would seem to show that the ratio of water to total protein is exceedingly high indicating the addition of water greatly in excess of that present in the original meat.

Fifteen per cent of samples analyzed showed cereal in excess of 10 per cent starch. It has been customary to consider the term cereal and starch synonymous, a practice we consider in the majority of cases unjustifiable. We are of the opinion that the

present standard of 10 per cent cereal is unnecessarily high and the results of this year's work seem to show no necessity for such a high standard from the manufacturing standpoint.

It is hoped in the present year to conduct a systematic examination of this class of products including determination of water-total protein ratio in an endeavour to improve the nutritive value of this class of product.

Canned Vegetables and Tomato Products.—A total of 48 samples were examined under this heading during the past year. The average solids content of tomato pastes examined was 30.8 per cent.

One sample only was appreciably below standard value in solids content; this was an imported sample and showed the remarkably low figures of 7.5 per cent total solids. It is very desirable that the examination of tomato products be extended to include microscopical and mycological examination for the presence of moulds, bacteria and yeasts, which examination would necessitate an enlarged staff and equipment.

Some fifteen samples of canned peas and beans were examined for the presence of excess copper salts, present as artificial colouring. A relatively small percentage of these samples showed copper in excess of the standards permitted by regulation and these were entirely of foreign origin.

Considerable work is being done at the present time in an effort to explain the darkening which sometimes occurs in canned corn even when no sulphite is added for bleaching purposes. We believe in the majority of cases this discoloration is due to the contamination of the product with a small amount of copper due to the use of incompletely tinned apparatus in the processing but from the series of determinations being carried on at the present time a more intelligent opinion may be rendered.

Condensed and Evaporated Milk.—A total of 204 samples were examined during the past year.

This work is a continuation of that instituted during the period of the war, when a very large amount of condensed milk was exported. In order to cope with the large amount of work involved at that time a Mojonnier apparatus was installed and the results obtained with the apparatus have been exceedingly satisfactory, especially in reference to fat determinations. The time and cost of analysis have been very considerably reduced by this installation, with no decrease in accuracy of results.

All samples of milk examined were previously incubated at a temperature of approximately 37°C., for a period of ten days, which may be considered a very severe test on the keeping qualities of the product.

A very simple test, but at the same time important determination in view of the extent of the trade, is the determination of net weight.

The average net weight on 175 samples of condensed milk in cannisters labelled 14 ounces net weight was 13.99 ounces.

The average fat content of the same number of condensed milks was 8.15 per cent.

The average net weights of thirty samples of evaporated milk in cannisters labelled 16 ounces net weight was 15.98 ounces.

The average fat content of the same number of evaporated milks was 7.90 per cent.

Every sample without exception was in good condition after incubation though some samples showed an excess of condition known as sugar down, i.e., precipitation and deposition of lactose in bottom of tin. All samples examined this year showed remarkable freedom from mould and mould buttons, which condition was quite prevalent when inspection of this product was initiated in 1918. There is good reason to believe that this inspection has had beneficial effects in correcting certain deficiencies in this product noticed when the inspection was first started.

WATERS FROM FARM HOMESTEADS

The analysis of waters from farm homesteads is a useful phase of the division's work that has been in force since the earliest days of its history. Unquestionably it has been the means, directly and indirectly of improving the farm water supply throughout the country generally. There is, however, much yet to be done towards the general realization of the facts that impure water is a menace to health and that an ample supply of pure water is one of the most valuable assets a farm can possess. Our propaganda in this matter will therefore be continued.

The unfortunate location of the farm well, in the barnyard or in the vicinity of some similar source of contamination, is undoubtedly the chief cause of polluted water on the farm. Our data have shown this to be the case. Safety has too often been sacrificed to convenience. It is pollution of an excretal character that has most to be feared and it is this that our farmers are urged to recognize when selecting a site for a new well.

During the year 102 samples of water have been analysed and reported on. They have been received from every province of the Dominion. The results show they may be approximately classified as follows:—

Pure and wholesome	30 per cent
Suspicious and probably dangerous	20 " "
Seriously polluted	30 " "
Saline	20 " "

Farmers desirous of an analysis are requested to apply to the Division for an application form giving necessary directions as to the correct collection and shipment of the sample. No fee is charged for the analysis but the express charges must be prepaid.

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