DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

DIVISION OF CHEMISTRY

REPORT OF THE DOMINION CHEMIST

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

FOR THE YEAR ENDING MARCH 31, 1925

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CORRESPONDENCE AND CHEMICAL WORK FOR FARMERS

One important and very practical phase of the work of the division is the assistance rendered the individual farmer through correspondence and analysis. It has been the aim of the division since its first days to establish a Bureau of Information to which farmers throughout the Dominion could freely turn for information and advice on matters pertaining to their every day work and which required the aid of chemistry for their elucidation or their successful prosecution. The inquiries sent in cover a wide field, information being sought for respecting soils, manures, fertilizers, liming, cattle feeds, insecticides and fungicides, well waters and many other related matters. A very considerable proportion of these inquiries incidentally necessitate a certain amount of examinational and analytical work, and this, whenever practicable and leading to useful results of more or less wide significance, is undertaken.

The volume of work in this connection continues to increase and every year enlarges our list of correspondents. It may therefore be concluded that this service is widely appreciated and proving helpful. Though dealing with the individual it is undoubtedly an educational work which tends to the general advance of the agriculture of the Dominion.

SAMPLES RECEIVED FOR ANALYSIS

During the year ending March 31, 1925, 7,872 samples were received for examination or analysis. These included (1) samples collected in connection with investigations carried on by the division, (2) samples sent by farmers for analysis and report (soils, naturally-occurring fertilizers, waters, cattle feeds, fodders, etc.) and (3) samples submitted by the Health of Animals Branch of the Department of Agriculture and other branches and departments of the Government service.

These samples are roughly classified in the following table, which may serve in some degree to measure the volume as well as to indicate the character of the work of the division.

SAMPLES RECEIVED FOR EXAMINATION AND REPORT FOR TWELVE MONTHS ENDING MARCH 31, 1925

—	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	New Brunswick	Nova Scotia	Prince Edward Island	Total
Soils	63	3	10	.....	68	43	1	12	1	201
Manures and fertilizers	13	.....	2	.....	27	13	11	22	1	89
Forage plants, fodders and feeding stuffs	32	43	82	14	2,416	736	576	378	15	4,292
Waters	15	8	5	2	89	23	13	8	3	166
Samples from Meat and Canned Foods Division	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,502
Miscellaneous, including dairy products, insecticides and fungicides	25	29	21	5	434	43	7	44	14	622
										7,872

SOILS

A very considerable number of soils have been examined and reported on during the past year but lack of space prevents the complete presentation here of the results. Many of these soils have been sent in by farmers and the work done upon them has been such as to furnish the desired information, e.g., necessity for liming, special deficiencies, etc. No account of these samples will be included here.

From the investigational work with soils which the division now has in course, two examples may be presented illustrative of this phase of work—one from Prince Edward Island, the other from British Columbia.

PRINCE EDWARD ISLAND, CHARLOTTETOWN DISTRICT

The analytical and physical work here recorded on Prince Edward Island soils was undertaken at the instance of the provincial Department of Agriculture. The soil samples were collected by the Superintendent of the Experimental Station at Charlottetown and may be considered as representative of the soils in the vicinity of that city.

Lab'y No. 64029, A. & B: From Lot 45, Southport.

Surface soil, 0" to 7", subsoil, 7" to 14", both composites. Surface soil; brownish-red sandy loam, cultivated for 80 years. Crops for past five years: 1917, roots; 1918, oats; 1919, hay; 1920, hay; 1921, hay; 1922, oats. Manuring in past 5 years: 35 cartloads of about 1,800 pounds each, per acre, of barnyard manure. Not tile drained: stated to have efficient natural drainage.

Lab'y No. 64198-99: From lot 32, York Point.

Surface soil, 0" to 7", subsoil 7" to 14". Surface soil brownish-red sandy loam, cultivated 80 to 90 years. Crops for past nine years: 1914, roots; 1915, grain; 1916, hay; 1917, hay; 1918, pasture; 1919, pasture; 1920, pasture; 1921, oats; 1922, oats. Manured in 1914 at the rate of about 45 cartloads (of about 1,300 pounds each) per acre, of stable manure. "Mudded" 43 years ago and partly mudded a second time in 1922. Not tile drained, stated to have efficient natural drainage.

Lab'y No. 64200-01: From Lot 34, Marshfield.

Surface soil, 0" to 7"; subsoil, 7" to 14". Surface soil, brownish-red sandy loam, cultivated about 100 years. Crops for past seven years: 1916, roots; 1917, wheat; 1918, pasture; 1919, pasture, 1920, oats; 1921, oats and barley; 1922, oats. Manured in 1916, with about 20 tons per acre. Not tile drained, stated to have efficient natural drainage.

Lab'y No. 64202-3: From Lot 32, York Point.

Surface soil, 0" to 7", subsoil 7" to 14". Surface soil brownish-red sandy loam, cultivated, apparently, for 100 years. Crops for the past five years: 1919, hay; 1920, pasture; 1921, pasture; 1922, oats; 1923, oats. Barnyard manure applied as a top dressing at the rate of 12 tons per acre in 1923. No tile drainage, stated to have efficient natural drainage.

Chemical Analysis.—The chemical analysis was made on the air-dried, prepared sample, rejecting the portion which did not pass 0·5 mm. mesh sieve.

The tabulated data comprise the "total" constituents as obtained from digestion with 1·115 sp. gr. hydrochloric acid and "available" phosphoric acid and potash from digestion with 1 per cent citric acid solution. Nitrogen determinations were made by the Kjeldahl process and the "Lime requirement" by the Jones method.

Physical Analysis.—The method of analysis employed was that of the Bureau of Soils, United States Department of Agriculture, and furnished seven separates from fine gravel to clay.

Interpretation of Data.—In interpreting the results of soil analysis it must be pointed out that in the present state of our knowledge there is no possibility of directly and definitely correlating the chemical data with degree of fertility. Chemical analysis in itself does not furnish the evidence for the exact classification of soils as to productiveness. Soil analysis, however, has a practical usefulness in indicating marked characteristics and deficiencies, where such exist, and in suggesting appropriate fertilizers and rational methods of soil management; such data have a greater significance in the case of virgin areas than when obtained from cultivated—manured and cropped—soils. Predictions from analyses as to productiveness cannot be of a positive nature—they can only be suggestive and tentative for the plant food content though fundamental and all important, is only one of a large number of ever-changing factors—chemical, biological and physical—influencing and controlling plant growth.

From the statements in the preceding paragraph, it is obvious that rigid "standards of fertility" which could be used in reporting on the relative productiveness of soils cannot be established. Nevertheless, the large number of analyses of Canadian soils made in these laboratories during the past thirty years permit us to make the following statements in respect to the significance to be attached to the essential plant food percentages.

Nitrogen.—The larger number of our good soils contain between ·1 and ·2 per cent, though many reach ·5 per cent and some—the richest soils of the western prairies—may exceed 1·0 per cent of nitrogen. Soils containing less than ·1 per cent may prove, under favourable conditions for nitrification, fairly productive, but such generally show a remunerative response to nitrogenous fertilizers. Richness in nitrogen is determined to a large degree by the organic or humus content, though the condition or stage of decomposition of this organic matter is an important factor in indicating the nitrogen's availability.

Phosphoric Acid.—The phosphoric acid in Canadian soils of average fertility usually lies between ·15 and ·25 per cent. Some very good loams contain from ·25 to ·3 per cent and a few exceed the latter figure. The adequacy or otherwise, of phosphoric acid in a soil would appear to depend largely on the accompanying amount of lime. Increased crop production has usually followed the application of phosphatic fertilizers to soils containing less than ·15 per cent phosphoric acid.

In respect to the "available" phosphoric acid, which we already stated has been determined from a 1 per cent citric acid extract of the soil, it may perhaps be assumed that for cereal crops "a percentage as low as ·01 seems to denote an imperative necessity for phosphatic manure, while as much as ·03 would seem to indicate that there is no such immediate necessity" and "for root crops, more especially turnips, the limit would probably be higher" (Bernard Dyer: Proceedings of the Royal Society, Vol. 35).

Potash.—Our data indicate that good Canadian soils usually possess between ·25 and ·5 per cent of potash; less than ·15 per cent has, in many instances, pointed to the value of potassic fertilizers.

In the case of "available" potash as obtained by the citric acid method, we may tentatively adopt the conclusion of Dr. Dyer (Proceedings of the Royal Society, Vol. 68) that "probably when a soil in the surface depth contains as much as ·01 per cent of citric acid soluble potash, the special application of potassic salts is not needed."

Lime.—Lime ranks next in importance to potash and phosphoric acid in a consideration of the mineral constituents of plant food. It also promotes nitrification, improves tilth and by reason of the alkalinity, is of special value in correcting sour soils. Our experience goes to show, that light and sandy loams containing less than ·25 per cent of lime (CaO) and clay loams less than ·5 per cent will as a rule have their productiveness increased by a dressing of lime in one or other of its agricultural forms. Soils rich in organic matter, such as muck and peaty soils, very frequently respond to an application of lime, and may with advantage be raised to 1 or 1·5 per cent of that element (CaO) especially when supplied in conjunction with phosphoric acid and potash. The continued use of sulphate of ammonia as a nitrogenous fertilizer will call for an occasional application of lime or ground limestone to prevent sourness.

Humus.—Humus or semi-decomposed vegetable matter is to be regarded as the storehouse and guardian of nitrogen, and richness of a soil in the latter important element may be measured to a large degree by the organic or humus content. In reasonable quantities humus has a remarkable influence upon the texture and tilth of the soil. It increases the moisture holding capacity and supports the microscopic life of the soil, which has for its chief function the rendering assimilable of the inert plant food of the soil.

DISCUSSION OF SURFACE SOILS

Lab'y No. 64029 A: From Lot 45, Southport.

From the analytical data this soil would appear to be the richest soil of the series. Of the four surface soils analyzed, it contains the highest percentage of nitrogen, total phosphoric acid and potash. In nitrogen it compares favourably with good fertile loams. In phosphoric acid, both total and available, this soil is to be regarded as somewhat below the average of good productive loams, the data indicating a profitable response from phosphatic fertilizer. The potash content, while not low for this type of soil, would seem to indicate that for potash-loving crops, e.g. potatoes, roots and corn, an application of a potash fertilizer would prove beneficial. The percentage of lime approaches the lowest limits for the best returns. This receives confirmation from the "lime-requirement," data and points to the desirability of dressings with lime or preferably ground limestone. Applications of lime should be comparatively small, say, 600 to 1,500 pound per acre, but with ground limestone no injury would result from much larger dressings, say, 1 to 4 tons per acre. (In lime content, 1 ton of limestone is approximately the equivalent of 1,000 pounds of quick or burnt lime, both being of the same quality.)

Lab'y No. 64198: From Lot 32, York Point.

This soil must be adjudged of medium fertility only, the data pointing to the desirability of enrichment in all the elements of plant food. Further, it undoubtedly would be benefited greatly by the addition of humus-forming material, as furnished by farm manures and the growth of leguminous crops. In common with the other members of the series this soil shows a slight acidity, and the "lime-requirement" is in the neighbourhood of 1¼ tons of ground limestone per acre.

Lab'y No. 64200: From Lot 34, Marshfield.

This loam is not characterized by any marked deficiencies in plant food, though from the data it could not rank with soils of average fertility. With respect to nitrogen, the percentage is fairly satisfactory, considering the soil's history; it undoubtedly might be raised to advantage. The "total" phosphoric acid is low but the proportion of "available" is relatively high, which

may indicate that a profitable response from phosphatic fertilizer may only be expected when applied for crops specially calling for phosphoric acid. The "total" potash also is low but in "available" the soil compares favourably with the other members of the series. There would seem to be a necessity for potash fertilizers, more especially for potatoes and root crops, The lime content, in common with other members of the series, is markedly low and the soil has a slightly acid reaction. The data for "lime requirement" shows that the application of from 1 to 1¼ tons per acre of ground limestone would be desirable.

Lab'y No. 64202: From Lot 32, York Point.

This loam possibly ranks as the poorest of those examined, though the analytical data do not differ greatly from those of the other surface soils of the series. There are no very marked deficiencies. The percentage of nitrogen is such as to warrant the opinion that an application of this element in one or other of its manurial forms would be beneficial and profitable. Similarly, the results for "total" phosphoric acid and potash are low and it may safely be assumed—though the percentages of these elements considered as available are relatively high—that crop yields might be profitably increased by the judicious use of phosphatic and potassic fertilizer. The soil is distinctly though not strongly acid and the lime content is decidedly small. From the "lime requirement" data it may be concluded that an application of ground limestone, at the rate of 2 to 2½ tons per acre would be beneficial.

SUMMARY

In respect to texture, colour and physical characteristics generally, the surface soils of this series are very similar; they no doubt are typical in a large measure of the cultivated soils of the province—soils for the most part which have been derived from the soft red sandstones and other representatives of the Triassic formation. According to accepted classifications all these soils would be classed as "fine sandy loams." They must be regarded as capable of good tilth—being warm and readily worked and fairly mellow, but rather deficient in vegetable organic matter—a soil constituent of great importance.

From their physical make-up they may be adjudged suitable for a large number of farm crops and with judicial management, including the up-keep of humus-forming materials they may be expected to prove excellent soils, with good aeration, a fair absorptive capacity for moisture and such as would readily respond to applications of plant food. They are underlaid by sub-soils containing more or less gravel, an aid to their natural drainage.

From the standpoint of plant food content as measured by chemical analysis, these soils may probably rank with those of average productiveness; their percentages of nitrogen, phosphoric acid and potash while fair are not equal to those of our best soils. An excellent feature, however, in this connection is that though the total amounts of these constituents present are not large, the proportion which may be considered as more or less immediately available is relatively high.

The results in general from this investigation would suggest for the maintenance and increase of the fertility of these soils: (1) the addition of humus-forming material as furnished by the application of farm manures, the turning under of green crops, e.g. buckwheat, rye and clover and the adoption of comparatively short rotations in which clover or other legumes is a member; (2) the application of ground limestone or other lime-bearing material to correct acidity and furnish lime for crop use, and (3) the appropriate and rational employment of commercial fertilizers in accordance with the findings of this examination and the special requirements of the crops to be fertilized.

TABLE 1.—CHEMICAL ANALYSIS—ON AIR-DRIED SAMPLES

Lab'y. No.	Locality	Moisture	Loss on ignition (organic matter, etc.)	Insoluble mineral matter	Oxide of iron and alumina (Fe_2O_3, Al_2O_3)	Lime (CaO)	Magnesia (MgO)	Nitrogen	Phosphoric Acid		Potash		Lime requirement (pounds per acre $CaCO_3$)
									Total	Available 1 p.c. citric	Total	Available 1 p.c. citric	
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	
64029 (A)	Surface soil Southport	2·75	5·76	83·96	5·692	0·254	0·500	0·208	0·128	0·026	0·244	0·012	3,070
64029 (B)	Subsoil Southport	2·83	3·88	85·50	6·296	0·169	0·597	0·123	0·114	0·030	0·294	0·017	
64198	Surface soil North River	1·85	6·06	94·94	5·690	0·210	0·350	0·170	0·083	0·026	0·102	0·010	2,710
64199	Subsoil North River	1·69	4·19	87·05	5·710	0·080	0·350	0·047	0·071	0·025	0·135	0·017	
64200	Surface soil Marshfield	1·44	5·31	86·32	5·500	0·190	0·490	0·164	0·099	0·040	0·164	0·016	2,348
64201	Subsoil Marshfield	1·05	2·30	87·50	6·080	0·160	0·690	0·049	0·049	0·021	0·162	0·008	
64202	Surface soil North River	1·65	5·32	86·68	5·420	0·080	0·340	0·114	0·112	0·046	0·162	0·017	4,340
64203	Subsoil North River	1·02	2·25	88·91	6·180	0·040	0·460	0·041	0·071	0·042	0·172	0·009	

TABLE 2.—MECHANICAL ANALYSIS—ON AIR-DRIED SAMPLES

Lab'y. No.	Locality	Stones, rock fragments percentage left on 2 mm. sieve	Organic matter	Fine gravel 2–1 mm.	Coarse sand 1–·5 mm.	Medium sand ·5–·25 mm.	Fine sand ·25–·1 mm.	Very fine sand ·1–·05 mm.	Silt ·05–·005 mm.	Clay ·005–·00 mm.	Classification
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	
64029 (A)	Surface soil Southport	6·3	6·64	0·77	1·58	4·52	24·14	29·83	19·00	19·10	Fine sandy loam
64029 (B)	Subsoil Southport	18·0	4·76	0·66	1·81	5·96	25·62	31·25	17·22	17·48	Gravelly loam
64198	Surface soil North River	1·1	6·65	0·57	1·83	5·11	22·69	28·62	21·62	19·56	Fine sandy loam
64199	Subsoil North River	5·1	4·90	1·04	2·95	6·36	21·36	29·85	22·20	16·24	" "
64200	Surface soil Marshfield	8·1	5·87	0·93	1·48	4·11	27·05	33·99	16·84	15·60	" "
64201	Subsoil Marshfield	23·2	3·38	1·61	3·69	4·80	21·31	35·01	19·63	13·95	Gravelly loam
64202	Surface soil North River	5·5	6·07	0·95	2·19	4·50	22·91	30·11	20·56	18·78	Fine sandy loam
64203	Subsoil North River	8·5	3·07	1·08	4·00	7·38	25·61	34·81	16·10	11·02	" "

BRITISH COLUMBIA, QUESNEL DISTRICT

LOCALITY, HISTORY AND DESCRIPTION

Lab'y No. 75740.—A surface soil collected to a depth of 6 inches from a typical virgin area in the Quesnel district, west side of the Fraser river, growing "wild hay and small brush." The sub-soil was reported as clay.

This soil might be described as a dark grey silt-clay loam, consisting largely of silt and clay, with small percentages of fine and very fine sand. The coarse sand and gravel is almost negligible.

ANALYSIS

(On air-dried sample)

Moisture	4·44
Organic matter, etc. (loss on ignition)	16·62
Mineral matter, soluble in acid*	11·45
Mineral matter, insoluble in acid	67·49
	100·00
*Containing lime (CaO)	1·09
" magnesia (MgO)	0·57
" oxide of iron (Fe_2O_3), alumina (Al_2O_3)	8·82

Plant food constituents

	Total p.c.	Available p.c.
Nitrogen	·585	
Phosphoric acid	·301	·071
Potash	·232	·030

Soil showed an acid reaction to litmus.

Lime Requirement (Jones Method)

	Pounds per acre
Carbonate of lime (ground limestone, marl)	9950
or	
Slaked lime	7380
or	
Quick lime	5580

MECHANICAL ANALYSIS

(On air-dried sample)

Fine gravel, 2 mm.—1 mm	0·93
Coarse sand, 1 mm.—·5 mm	0·18
Medium sand, ·5 mm.—·25 mm	0·26
Fine sand, ·25 mm.—·1 mm	1·16
Very fine sand, ·1 mm.—·05 mm	7·18
Silt, ·05 mm.—·005 mm	31·88
Clay below ·005 mm	41·78
Loss on ignition (organic matter, etc.)	16·62

This soil may be considered as well supplied in respect to all the essential constituents of plant food, indeed its nitrogen content is notably high, comparing favourably with that of the best types of virgin prairie soil. In regard to phosphoric acid and potash, the percentages of both "total" and "available" are somewhat higher than the figures ordinarily recorded for fertile loams. In so far as chemical analysis can be used as a measure of soil productiveness, the present data certainly indicate no deficiency in the essential elements of plant food—they probably foreshadow excellent crops under good management and favourable seasonal conditions.

The soil has an acid reaction and analysis indicates a "lime requirement" of nearly 5 tons per acre of carbonate of lime. This is exceptionally high, pointing to an application of lime, in one or other of its forms, as likely to increase productiveness. Experience has shown, in satisfying this lime requirement, that the better plan is to make small dressings—say, 1 to 2 tons of ground limestone per acre—at frequent intervals rather than one large application at the outset.

In respect to tilth or physical condition this soil though deficient in coarse sand presents many favourable features; if judiciously "worked" it should prove mellow and offer good conditions for retention of moisture and root extension—the comparatively large proportion of organic matter (humus) being more particularly valuable in respect to moisture holding capacity.

The maintenance of fertility will largely depend on the upkeep of the organic content—as by the application of farm manures and the turning under of green crops, *e.g.*, clover, buckwheat—and careful tillage. Improvement may be expected from the addition of lime, both in respect to the working condition of the soil and crop yields.

INVESTIGATIONAL WORK WITH FERTILIZERS

During the season of 1924, a considerable number of experiments with fertilizers, have been conducted at the branch Farms and Stations of the Maritime Provinces (Charlottetown, P.E.I., Nappan and Kentville, N.S. and Fredericton, N.B.), Ste. Anne de la Pocatière, P.Q., and at the Central Farm, Ottawa.

In the western provinces, the experiments in progress on the stations at Sidney, B.C., Agassiz, B.C., Summerland, B.C. and Beaverlodge, Alta., have been carried forward satisfactorily and are yielding valuable data. The necessity for further information with respect to the rational use of commercial fertilizers and manure in western Canada, renders it desirable to enlarge as opportunity permits the activities of the division in this respect.

The newly developed farming districts of northern Ontario and Quebec are growing in importance, and experimental work dealing with the treatment of the heavy clay and muck soils of that section of Canada is being planned at the branch Stations, Kapuskasing, Ont., and La Ferme, P.Q.

The publication of detailed results from the various projects not being possible in this report, a brief summary of the principal experiments as conducted at the various stations is herewith submitted. In certain instances, in which the materials under investigation are of particular interest to the public as judged by the inquiries received in regard to them, a fuller discussion will be made.

FERTILIZER FORMULAE FOR POTATOES

Project No. C. 8.—This experiment was commenced in 1922 at the branch Experimental Stations at Charlottetown, P.E.I., Nappan, N.S. and Fredericton, N.B. In the Maritime Provinces there are many farmers who specialize particularly in growing potatoes and it is quite a common practice to apply ready-mixed fertilizers in large amounts, in some cases as high as one ton per acre. Naturally there are a great number of formulæ used and the amounts of plant food supplied vary between wide limits. In an endeavour to supply oft-requested information as to the amount and nature of plant food most profitable for the potato crop some work of an experimental character in this connection was undertaken. Ten formulæ were prepared, using nitrate of soda and sulphate of ammonia in equivalent amounts as the source of nitrogen; superphosphate (acid phosphate) as the source of phosphoric acid and muriate of potash as the source of potash. The rate of application for each formulæ was 1,000, 1,500 and 2,000 pounds per acre, applied to the potato crop in a three-year rotation of potatoes, grain and hay. The fertilizer was broadcasted on the prepared land previous to planting and incorporated with the soil by a thorough harrowing.

Omitting the detailed data which are necessarily voluminous, the results have shown that practically every one of the thirty treatments included in the experiment has given a profitable return. No decisive answer can be given as to

the most profitable formula to employ for the potato crop but from the information so far obtained good returns may be expected from such mixtures as 3:8:6, 3:6:6, 4:8:6, 4:8:8, or 4:8:10, depending on the character and fertility of the soil. For instance, in respect to potash a sandy loam calls for a formula with a high percentage of this element, whereas for a clay loam very little potash would be required. The greatest profit has not as a rule resulted from the largest application of the fertilizer mixture; the figures obtained indicating that a dressing of 1,200 to 1,500 pounds per acre of any of the above mentioned formulæ would, under average conditions of soil and season be ample for a maximum yield. It is well to point out in this connection that yields are largely determined by the character of the soil and the seasonal conditions and that market prices for the crop control to a large degree profits. It behooves the farmer to do a certain amount of simple experimental work on the land to be cropped and thus to determine to a degree which is not possible in any other way the most profitable amounts of plant food suitable for the type and conditions of his own soil. This need not entail any large amount of work or any large expenditure. The Division is at all times prepared to advise in matters pertaining to fertilizers and their application.

THE INFLUENCE OF MANURING AND CROP ROTATION ON POTATO YIELDS

Project C. 5.—This work was begun in 1923 at the Experimental Station at Charlottetown, P.E.I. The object was to obtain data on the growing of potatoes with "manure alone," "fertilizers alone" and "manure and fertilizers" (1) continuously and (2) in a rotation of potatoes, grain, clover hay and timothy hay. The soil may be described as a reddish sandy loam, of a light open character and rather low fertility.

The fertilizer applications with the yields of potatoes for the two years 1923 and 1924 are given in the following table—

TABLE 3.—POTATOES: MANURE AND FERTILIZERS CONTINUOUSLY AND IN ROTATION, CHARLOTTETOWN, P.E.I.

Treatment per acre	Potatoes grown continuously			Potatoes grown in rotation		
	Total yield 1923	Total yield 1924	Average of two years	Total yield 1923	Total yield 1924	Average of two years
	bush.	bush.	bush.	bush.	bush.	bush.
Manure—20 tons	143·4	258·7	201·0	133·7	280·0	206·9
Nitrate of soda—130 lb. / Sulphate of ammonia—100 lb. / Superphosphate—500 lb. / Muriate of potash—160 lb. — Equivalent to 1,000 lb. of a 4:8:8 mixture.	156·7	197·3	177·0	204·3	140·0	172·1
Manure—10 tons / Nitrate of soda—65 lb. / Sulphate of ammonia—50 lb. / Superphosphate—250 lb. / Muriate of potash—80 lb. — Equivalent to 500 lb of a 4:8:8 mixture	150·2	237·3	193·8	154·7	293·3	224·0
Check—(No manure or fertilizer)	72·5	66·7	69·6	29·5	96·0	62·7

NOTE.—The crop on all plots excepting the check plot of the "potato continuously" section were approximately from 75 to 85 per cent marketable. The crop on the check plot mentioned was only 48 per cent marketable.

The results of the two year's yields tabulated in table 3 show a very marked response to both the manure and fertilizer treatments on land of low fertility—as evidenced by the very low yields of check plot.

The largest yields in 1923 were obtained from the plots which received a full dressing of commercial fertilizer, closely followed by the yields from the "Manure and Fertilizer" plots. In 1924 the largest yields were from the plots which had received barnyard manure. Seasonal conditions were in all probability the influencing factor in this respect; the Superintendent in reporting on the work states, "The low yields of the fertilizer plots for 1924 may be due, in part at least, to the extremely dry weather following late planting. The manure used was applied the previous winter and had an opportunity to absorb and no doubt retain considerable moisture. The chemical fertilizers received little or no rain throughout a large part of the season and undissolved chemicals were found in the soil at harvest." These results furnish an illustration of the important function and high value of manure in dry seasons, by increasing the water-holding capacity of the soil.

MALAGASH SALT AND COMMON SALT

Project C. 130.—Malagash salt is mined in the neighbourhood of Malagash, Cumberland county, N.S. The material is essentially common salt (sodium chloride) but contains small and varying amounts of potash—seldom exceeding one per cent. It was largely on account of its potash content that a fertilizing value for Malagash salt was claimed and field experiments to determine this value were first undertaken in 1921. The results then obtained showed that its value as a potassic fertilizer was negligible. Claims subsequently made that this material was instrumental in increasing crop yields led to the inauguration of further investigatory work.

In the spring of 1924 an experiment was planned to determine (*a*) the effect of applications of Malagash salt and common salt when applied for the root crop in conjunction with barnyard manure and (*b*) the effect of applications of Malagash salt and common salt on the crop yields of a three-year rotation of grain, clover hay, clover and timothy hay, when applied alone and in conjunction with nitrate of soda and superphosphate. The experiment was established at the branch farms at Charlottetown, P.E.I., Nappan, N.S. and Kentville, N.S. Each section of the plan was carried out on quadruplicate plots of one-three hundred and twentieth of an acre.

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

TABLE 4.—MALAGASH SALT AND COMMON SALT (FOR THE ROOT CROP)

Treatment in addition to 15 tons barnyard manure per acre (pounds per acre)	Average yields per acre calculated from quadruplicate plots of 1/320 acre					
	Charlottetown, P.E.I.		Nappan, N.S.		Kentville, N.S.	
	Mangels	Turnips	Mangels	Turnips	Mangels	Turnips
	bush.	bush.	bush.	bush.	bush.	bush.
Malagash salt—200	692·8	787·2	..	798·4	591·3	736·0
" —400	752·0	790·4	..	793·6	678·4	672·0
" —600	822·4	808·0	..	830·4	710·4	780·8
Common salt—200	718·4	816·0	..	844·8	496·0	684·8
" —400	705·6	774·4	..	812·8	622·0	716·8
" —600	.....	.....	.....	.....	649·6	732·8
Check (no salt)	704·0	796·0	..	806·4	514·2	663·2

Mangels.—The data show that at Charlottetown slightly increased yields were obtained from the 400 and 600 pound dressing. At Kentville the increases were more marked. At both of the Stations Malagash salt has given somewhat better yields of mangels than has common salt.

Turnips.—For this crop neither Malagash salt nor common salt has proved of any appreciable benefit at Charlottetown and Nappan. At Kentville slight increases in yield were obtained from the use of these materials.

The data from the grain section (*b*) of this experiment show that on the oat crop at the three Stations mentioned above small increases in yield were in a few cases obtained from the application of Malagash salt or common salt. There is no evidence of a marked character to show that Malgash salt can be used effectively for the oat crop. On the completion of the rotation, data and detailed information from this inquiry will be published.

From its composition there would appear to be no reason to expect from Malagash salt used as a fertilizer, results other than those which might be anticipated from a similar dressing of common salt.

BASIC SLAG

Project C. 26.—An experiment to compare the effect of Fortified slag, Bessemer slag, Open Hearth slag, ground Florida rock phosphate, superphosphate and superphosphate with ground limestone on crop yields in a three-year rotation of grain, clover hay, timothy hay, was commenced in 1923 at Charlottetown, P.E.I., Nappan and Kentville, N.S. and Fredericton, N.B. Several brands of each of the Fortified and Bessemer types of slag were used in the experiment. In addition to the slag the whole area on which the work was conducted—including check plots—received an application of 100 pounds of nitrate of soda and 50 pounds muriate of potash per acre. A summary of the crop yields for 1923 and 1924 are shown in the following table:—

TABLE 5.—SUMMARY OF YIELDS: 1923—GRAIN; AND 1924—CLOVER HAY

Location	Charlottetown, P.E.I.				Nappan, N.S.				Kentville, N.S.				Fredericton, N.B.			
Pounds per acre of phosphoric acid (P_2O_5) supplied.	140 lb.		70 lb.		140 lb.		70 lb.		140 lb.		70 lb.		140 lb.		70 lb.	
Crops	Barley 1923	Hay 1924	Barley 1923	Hay 1924	Oats 1923	Hay 1924	Oats 1923	Hay 1924	Oats 1923	Hay 1924	Oats 1923	Hay 1924	Oats 1923	Hay 1924	Oats 1923	Hay 1924
	bush.	lb.	bush.	lb.	bush.	lb.	bush.	lb.	bush.	lb.	bush.	lb.	bush.	lb.	bush.	lb.
Average yields of all—																
Fortified slag plots	41·6	2,093	42·4	1,789	60·4	2,367	55·0	1,973	60·5	3,833	60·3	3,633	54·1	3,220	59·4	2,755
Bessemer slag plots	40·0	2,931	47·9	2,241	59·4	2,360	60·1	2,050	62·4	4,513	65·3	4,313	57·5	2,065	64·7	1,360
Open hearth slag plots	45·9	1,844	38·1	1,328	50·2	1,940	54·9	2,000	66·2	5,080	66·3	4,700	59·5	1,920	68·4	1,230
Ground natural rock (Florida) phosphate plots	34·0	2,259	40·9	1,293	50·2	1,800	53·3	1,320	62·2	3,820	60·1	4,480	56·6	375	71·0	900
Superphosphate plots	48·7	3,064	45·7	2,334	49·8	1,980	50·6	2,060	57·9	3,920	60·1	4,740	61·4	1,890	60·6	1,740
Superphosphate and ground limestone plots	.....	.....	41·6	2,791	.....	.....	.....	1,900	.....	.....	60·3	5,100	.....	.....	55·1	2,730
Check plots	Barley 45·0 bush.		Hay 1,609 lb.		Oats 52·6 bush.		Hay 1,890 lb.		Oats 60·3 bush.		Hay 4,010 lb.		Oats 56·0 bush.		Hay 1,060 lb.	

The period of experimentation is as yet too short to permit of final conclusions. The results however for the first two years do not indicate any marked or consistent influence of the phosphoric acid in any form on the grain yields.

In the case of clover grown the year after the application of the phosphatic fertilizer it will be observed at Charlottetown that the plots receiving Bessemer slag and superphosphate were the only ones that gave any marked increase in yield over the control. At Nappan an infestation of the area with couch grass very seriously reduced the growth of clover making it difficult to ascertain the influence of phosphoric acid on the crop. The plots dressed with fortified and Bessemer slags were the only ones which gave any notable increases. At Kentville the results are irregular; in a few instance notable increases presumably due to phosphoric acid were recorded.

The experimental area at the Fredericton Station was found to be quite variable as regards the fertility of the soil and the results given for that location are therefore questionable. At Kentville and Nappan, N.S. and Fredericton, N.B. this experiment is being repeated on new areas.

GYPSUM AND SULPHUR

Project C. 104.—Commenced in 1924 at the Central Farm, Ottawa, Ont., and at the Experimental Station, Kentville, N.S. The object of this experiment was (1) to determine the effect of gypsum and sulphur on the crop yields of a three-year rotation of potatoes, grain and hay; (2) to ascertain the effect of gypsum, sulphur and superphosphate on the suppression of potato scab. The applications of the various materials used in the experiment were broadcast on the prepared land and harrowed in shortly before the time of planting.

The plots at Ottawa were in duplicate and at Kentville in quadruplicate.

The results from the potato crop, the first crop of the rotation, are tabulated in table 6.

GYPSUM AND SULPHUR EXPERIMENT, 1924

TABLE 6.—POTATOES: INFLUENCE OF GYPSUM AND SULPHUR ON THE CONTROL OF SCAB

Treatment (per acre)	Yields per Acre					
	C. E. F., Ottawa, Ont.			Kentville, N.S.		
	Average yield. duplicate plots	Per cent marketable	Per cent scabby	Average yield. quadruplicate plots	Per cent marketable	Per cent scabby
	(bush.)			(bush.)		
Gypsum, 550 lb.	271·5	96·0	5·0	153·8	92·3	6·2
Gypsum, 1,100 lb.	310·5	98·0	25·0	144·6	92·7	6·7
Gypsum, 2,200 lb.	.....	.....	.....	179·9	94·4	9·2
Sulphur, 100 lb.	289·0	95·0	7·0	159·8	91·3	16·7
Sulphur, 200 lb.	298·5	98·0	10·0	171·9	95·0	9·7
Sulphur, 400 lb.	.....	.....	.....	164·5	93·6	10·5
Superphosphate, 890 lb.	332·5	97·0	30·0	171·9	91·5	3·2
Superphosphate, 1,780 lb.	.....	.....	.....	169·2	91·0	12·2
Ground rock phosphate, 500 lb.	288·0	98·0	10·0	183·2	92·7	7·5
Ground limestone, 4,000 lb.	230·0	97·0	8·0	152·6	92·6	9·5
Ground limestone, 4,000 lb. / Sulphur, 200 lb.	328·5	98·0	40·0	147·2	90·1	6·7
Gypsum, 550 lb. / Manure, 10 tons	340·5	98·0	20·0	198·5	94·0	9·5
Manure, 10 tons	349·0	94·0	5·0	176·4	92·1	6·5
Average of check plots	275·0	95·0	8·0	139·1	89·1	6·5

Yields.—The discussion of the value of the several treatments outlined in table 6 in respect to yields will be deferred until the completed data for the rotation are available.

Scab Control.—For the sake of comparison the degree of scabbiness has been indicated in percentages, arrived at by a careful examination of the tubers.

The results at Ottawa show that there was a development of scab on all plots—varying from 5 per cent to 40 per cent. The treated plots in the majority of cases produced tubers with a higher percentage of scab than did the check plots.

At Kentville scab appeared on the potatoes in every plot and was somewhat more pronounced on the tubers of the treated plots.

At both locations under the conditions of the experiment the data obtained have not shown gypsum or sulphur to have any deterrent effect on scab development.

ORCHARD FERTILIZER EXPERIMENTS, KENTVILLE, N.S., AND FREDERICTON, N.B.

Project C-13 (1).—This experiment was commenced at the Experimental Station at Kentville in 1913, at the time of setting out a new orchard, and was enlarged in 1916. Applications of different fertilizers in varying combinations are being investigated to obtain data with respect to the most satisfactory method of fertilizing an apple orchard as determined by the development and fruit production of the trees, and the intermediate crop yields. The yields of the intermediate crops over the first ten years have been recorded by the Superintendent of the Kentville Station in his report for the year 1923, and will not be repeated here. As the trees have only recently come into bearing the publication of the data from the apple crop will be deferred for the present.

Other experiments with fertilizers for the apple orchard recently put in progress are as follows:—

Project C-13 (2).—In this experiment begun last year (1924) at Kentville, N.S., the fertilizer ingredients are applied in varying proportions for the apple orchard, in an endeavour to ascertain the most effective ratio of nitrogen, phosphoric acid and potash.

Project C-13 (3).—Commenced in 1924 at Kentville, N.S., deals with fertilizer applications at different dates and includes different cultural treatments.

Project C-13 (4).—Commenced in 1923 at Kentville to ascertain the influence of nitrate of soda in small and large applications with and without superphosphate and muriate of potash on the production and keeping quality of the fruit of Wagner apple trees.

Project C-99.—Commenced in 1923 at Fredericton, N.B., to obtain data with respect to the value of different fertilizers and fertilizer mixtures for a young apple orchard.

Project C-143.—Malagash Salt as an Orchard Fertilizer—commenced in 1924 at Kentville, N.S.—to ascertain if Malagash salt is of any value as a soil dressing in apple production.

FERTILIZERS AND GROUND LIMESTONE EXPERIMENT, KENTVILLE, N.S.

Project C-15.—This experiment instituted in 1914 at Kentville, N.S., was planned to learn, primarily, the influence of ground limestone when used in conjunction with commercial fertilizers, and secondly to compare nitrate of soda and sulphate of ammonia as sources of nitrogen and basic slag, superphosphate and bone meal as sources of phosphoric acid. The soil—a light sandy loam—was, at the commencement of the experiment, low in fertility and deficient in

lime. The fertilizers were applied every three years to the potato crop in a three-year rotation of potatoes, grain and hay. The ground limestone was applied in the fall preceding the potato crop.

Lack of available space in this publication does not permit of a presentation of the data, obtained for the eleven years, in detail.

The outstanding result from the experiment is the marked and consistent increase in yields following the applications of ground limestone. The response to the ground limestone was most notable in the case of the clover hay crop.

Nitrate of soda has proved superior to sulphate of ammonia on the unlimed plots; on the limed plots these two sources of nitrogen gave practically the same returns.

The crops in the earlier rotations were more responsive to superphosphate and basic slag than to bone meal; in the later rotations bone meal proved to be almost as effective as a supplier of phosphoric acid.

The crop yields—oats—for 1924 are given in table 7 and serve to illustrate the beneficial results from the use of ground limestone at Kentville.

TABLE 7.—FERTILIZER AND GROUND LIMESTONE EXPERIMENT.—OATS: 1924.—KENTVILLE, N.S.

Plot No.	Fertilizers applied (pounds per acre)	Yields of oats in bushels per acre	
		With ground limestone (2 tons per acre)	Without ground limestone
		bush.	bush.
1	Nitrate of soda, 140; superphosphate, 150; basic slag, 150; muriate of potash, 101	41·00	33·04
2	Sulphate of ammonia, 105; superphosphate, 150; basic slag, 150; muriate of potash, 101	40·10	26·15
3	Nitrate of soda, 70; sulphate of ammonia, 52·5; superphosphate, 300; muriate of potash, 101	37·18	26·60
4	Nitrate of soda, 70; sulphate of ammonia, 52·5; basic slag, 300; muriate of potash, 101	39·80	28·60
5	Nitrate of soda, 50; sulphate of ammonia, 37·5; bone meal,* 240; muriate of potash, 101	42·15	32·15
6	Check	33·50	26·72

*Containing 2½ per cent nitrogen and 22 per cent phosphoric acid.

THE INFLUENCE OF PHOSPHORIC ACID ON THE DATE OF RIPENING AND YIELD OF WHEAT, SCOTT, SASK.

Project C-41.—In the western Prairie Provinces generally, impoverishment of the soil has not had as yet any material influence on crop yields; seasonal conditions, especially the amount and distribution of the rainfall during the months of April, May, June and July, have been the limiting factor. Investigational work with soils and fertilizer has not indicated any special deficiency of plant food in the soil, although there is a probability that in time the application of phosphoric acid may prove useful in increasing crop yields. Of the three essential elements of soil fertility,—nitrogen, phosphoric acid and potash—the prairie soils are least rich in phosphoric acid and the extensive growing of grain crops will tend to diminish more or less the available store of this element for crop use.

A matter of much importance in districts where early autumnal frosts endangers the ripening wheat crop, is the date of maturity of the crop. The application of phosphoric acid in a quickly available form has been advanced as a means of hastening the maturity of certain crops. To obtain data on this important question, an experiment has been carried on at Scott, Sask., during the years 1920 to 1924.

The plan was extremely simple, viz., the application of superphosphate at the rate of 300 pounds per acre to an acre plot of wheat at time of planting. A control plot was used for comparing yields and dates of ripening. In the third year both plots were summer fallowed.

The data are presented in the following table:—

TABLE 8.—THE INFLUENCE OF PHOSPHORIC ACID ON THE DATE OF RIPENING AND YIELD OF WHEAT, SCOTT, SASK.

Year	1920		1921		1923		1924	
	Check plot	Fertilized plot	Check plot	Fertilized plot	Check plot	Fertilized plot	Check plot	Fertilized plot
Date of seeding...	May 12	May 12	May 4	May 4	May 3	May 3	April 30	April 30
Date of harvesting	Aug. 25	Aug. 25	Aug. 20	Aug. 16	Sept. 7	Sept. 3	Aug. 5	Aug. 5
Yields per acre—								
Grain (bush.)...	22·5	23·8	26·0	27·0	40·0	47·5	0·5	2·5
Straw (lb.).....	2,270	1,930	1,290	1,570	3,290	4,670	50	165

The following notes from the Superintendent's records are of interest:—

1920: Favourable seasonal conditions until middle of July when several hot days occurred at time of heading. The crop on the treated plot was about three days earlier than that on the check plot in heading; it was more effected by the extreme heat and less benefited by the heavy rains late in July than that of the control plot.

1921: Dry weather prevailed during June, July and August; as a result only one ear-bearing stalk survived on each plant. The treated plot headed out two days earlier than the check plot and ripened four days earlier.

1923: There was an abundance of moisture in the soil during June and July; and there was a rank growth of straw on the treated plot with lodging. The crop on the check plot did not lodge and further was but little affected by disease. The treated plot showed considerable rust, glume spot and helminthosporium; it headed out three days earlier and ripened four days earlier than the check plot.

1924: There was ample moisture present for the germination of the seed but the total precipitations from June 1 to July 28 was only ·61 inches. Hence the yields were abnormally low.

It will be noted from the tabulated data, that in 1921 and 1923 phosphoric acid advanced the "date of ripening" of the wheat crop at Scott four days. In 1920 there was no difference in the date of harvesting; heading was three days earlier on the fertilized plots but this advantage was apparently offset by seasonal conditions favouring the crop which headed out a few days later. In 1924 the yield was abnormally low by reason of drought and records were in consequence of little value.

While this inquiry has yielded some evidence in support of the view that phosphoric acid hastens ripening, the experiment must be carried on for a number of years—which must include seasons of varying character—before it can be stated definitely that such treatment will or will not be generally effective in the prairie provinces.

In only one year—1923—did the fertilized plot show any marked increase in yield; this increase occurred in a season in which the rainfall was abundant. However, in no instance did the increased yield pay for the cost of the fertilizer.

OTHER FERTILIZER TESTS

In addition to the aforementioned experiments the following investigations with fertilizers are being carried on at the various Farms and Stations of the Experimental Farms system. Results will be reported at such stages in the several investigations as permit of definite conclusions being drawn.

FOR FIELD CROPS

Project C-12—Experiment E. 21.—Commenced in 1921 at Kentville, N.S., and Agassiz, B.C., to obtain data with respect to the most efficient distribution of commercial fertilizers over a three-year rotation.

Project C-39—Experiment 12.—Commenced in 1914 at Brandon, Man., and Scott, Sask., to ascertain the effect of applications of commercial fertilizers on western prairie field crops.

Project C-40—Basic Slag Experiment.—Commenced in 1923 at Cap Rouge, P.Q., to ascertain the influence, chemically and botanically, of basic slag on the herbage of meadows and pastures. An interim discussion on the results of this investigation appeared in the last report of this division.

Project C-75—Nitrate of Soda Experiments.—Commenced in 1922 at Beaverlodge, Alta., to ascertain the effect of nitrate of soda applications on cereals, grasses and rape in the Grande Prairie district of northern Alberta.

Project C-80—Sulphur as a Fertilizer.—Commenced in 1923 at Sidney, B.C., to obtain data on the value of sulphur as a fertilizer for alfalfa.

Project C-96—Basic Slag Experiment.—Commenced in 1923 at Fredericton, N.B., to learn the stock carrying properties of New Brunswick pasture dressed with basic slag as compared with untreated pasture.

Project C-98—" Fertilizers for Pastures " Experiment.—Commenced in 1923 at Fredericton, N.B., to determine the effect of various fertilizer treatments (including basic slag, nitrate of soda, superphosphate, ground limestone) on the yield of grass and quality of the herbage.

Project C-101—Mercuric Chloride Experiment.—Commenced in 1924 at the Central Farm, Ottawa, to obtain data in respect to the influence of mercuric chloride on the potato and cabbage crop.

Project C-109.—Commenced in 1924 at Sidney, B.C., to ascertain the value of applications of gypsum, sulphur and lime for field crops.

Project C-110—Time of Application of Fertilizers.—Commenced in 1924 at Sidney, and Agassiz, B.C., to ascertain the effect of applying commercial fertilizers at different times under dry seasonal conditions.

Project C-131—Fertilizers for Hemp.—Commenced in 1924 at Kentville, N.S., to ascertain the influence of commercial fertilizers on the yield and quality of hemp.

FOR MARKET GARDEN CROPS

Project C-50—Fertilizers for Potatoes.—Commenced in 1923 at Sidney, B.C., to obtain information with respect to the application of commercial fertilizers for the potato crop under dry seasonal conditions.

Project C-105—Sources of Organic Matter.—Commenced in 1924 at the Central Farm, Ottawa, to compare the value of barnyard manure, green manure and commercial fertilizers in market garden work.

Project C-106—Fertilizers for the Carrot Crop.—Commenced in 1924 at the Central Farm, Ottawa.

Project C-107—Fertilizers for the Beet Crop.—Commenced in 1924 at the Central Farm, Ottawa.

Project C-108—Fertilizers for the Onion Crop.—Commenced in 1924 at the Central Farm, Ottawa.

Project C-144—Nitrate of Soda for the Strawberry Crop.—Commenced in 1923 at Kentville, N.S., to ascertain the benefit derived from an application of nitrate of soda to strawberries early in the spring of their fruiting year.

Project C-157—Fertilizers for the Canteloupe and Tomato Crops.—Commenced in 1924 at Summerland, B.C.

Project C-23.—Ground Limestone at different Rates per Acre. Commenced in 1917 at Kentville, N.S., to obtain data on the rate of application of ground limestone most economical and advantageous in general farm practice.

Project C-78.—Ground limestone versus basic slag. Commenced in 1922 at Nappan, N.S., to compare the value of applications of ground limestone and basic slag when seeding down to clover.

Project C-102.—Calcitic and Magnesian ground Limestone. Commenced in 1924 at Kentville, N.S. and the Central Farm, Ottawa, to ascertain if ground magnesian limestone (dolomite) has any injurious effects on crop growth.

Project C-114.—To ascertain the value of waste lime from lime kiln in conjunction with various fertilizer treatments—commenced in 1916 at Fredericton, N.B.

Project C-132.—Experiment with Fertilizers, Lime and Ground Limestone. Commenced in 1924 at Ste. Anne de la Pocatiere, Que., to ascertain what response may be expected from applications of fertilizers and soil amendments to the heavy clay soils of the district.

Project C-139.—Waste Lime and Ground Limestone Experiment. Commenced in 1915 and 1922 at Fredericton, N.B., to obtain data with respect to applications of waste lime and ground limestone on hay yields.

AVAILABILITY OF PHOSPHORIC ACID IN SLAGS AND NATURAL ROCK (FLORIDA) PHOSPHATE

The question of the relative availability of phosphoric acid in the various types of slag and rock phosphates upon the market, has in recent years received considerable attention from agricultural chemists in Great Britain. A considerable amount of investigatory work both in the laboratory and the field has been undertaken by them with a view of determining the agricultural value of the phosphoric acid in the various phosphatic materials. The desirability of a laboratory method by which slags and rock phosphates could be readily classified as to availability is widely experienced.

To obtain data on this important question investigatory work was carried on in these laboratories, employing representative samples of the following materials:—

(1) Open Hearth Slag.
(2) Double X Quality Basic Slag and Florida Phosphate.
(3) Treble X Quality Basic Slag and Florida Phosphate.
(4) "Best of All" Quality Basic Slag and Florida Phosphate.
(5) Belgian Basic Slag.*
(6) English Basic Slag.*
(7) Thomas Phosphate.*
(8) Florida Rock Phosphate.

Methods of Analysis.—The employment of citric acid solutions of varying concentrations has long been recognized by agriculturists and the trade as a laboratory means of measuring the relative availability of the phosphoric

* As far as can be ascertained these three slags are of Belgian origin.

acid in these materials. Citric acid solutions of two strengths have been used in this inquiry. The three methods employed may be briefly outlined as follows:—

(1) Five grams of the material is shaken for 30 minutes with 500 cc. of a 2 per cent citric acid solution. This is the well known Wagner method which has been hitherto universally employed in the valuation of slag.

(2) The Robertson modification of the Wagner method in which 1 gram of the material is shaken for 30 minutes with 500 cc. of a 2 per cent citric acid solution.

(3) The C.E.F. Modification in which 1 gram of the material is shaken for 5 hours with 500 cc. of a 1 per cent citric acid solution.

This method differs from the Wagner method in the proportion of phosphate to solvent and in the concentration of the solvent and the length of time of shaking. It differs from the Robertson method in the concentration of the solvent and the length of time of shaking.

This modification, it will be observed, employs 1 per cent citric acid solution as a solvent. It was adopted for the reason that it is the solvent used in the well-known Dyer method for the determination of the "available" phosphoric acid and potash in soils.

The data obtained in this enquiry are given in table 9.

TABLE 9.—ANALYSIS OF "BASIC SLAGS" AND "GROUND FLORIDA ROCK PHOSPHATE"

Lab'y. No.	Brand name	Where manufactured	Vendor	Fineness; percentage passing a 100 mesh sieve	Total P_2O_5 2 gm. boiled with 30 cc. HCl 10 cc. HNO_3 50 cc. H_2O (A.O.A.C.)	Percentage P_2O_5—as found by different methods of analysis					
						5 gms. shaken 30 min. with 500 cc. of 2% citric acid solution (Wagner)		1 gm. shaken 30 min. with 500 cc. of 2% citric acid solution (Robertson)		1 gm. shaken 5 hrs. with 500 cc. of 1 % citric acid solution (C.E.F.)	
						P_2O_5 p.c.	Percentage availability	P_2O_5 p.c.	Percentage availability	P_2O_5 p.c.	Percentage availability
64729	Florida Rock Phosphate.....	Ground at Welland, Ont.	Cross Fertilizer Co., Sidney, N.S.	72	29·58	5·89	19·9	18·62	63·0	20·03	67·7
71124	Florida Rock Phosphate.....	"	"	75	26·25	5·70	21·7	16·79	64·0	18·03	68·7
64734	Open Hearth Basic Slag.....	Sydney, N.S	"	88	9·92	1·19	12·0	3·82	38·5	6·16	62·1
	Fortified slags—										
64732	Double X Quality Basic Slag and Florida Phosphate.	"	"	86	13·31	1·94	14·6	5·60	42·1	5·36	40·3
71622	" "	"	"	86	16·13	1·92	11·9	7·38	45·7	6·03	37·4
63526	Treble X Quality Basic Slag and Florida phosphate..	"	"	81	16·93	2·36	13·9	7·93	46·8	7·72	45·6
64731	" "	"	"	86	17·89	2·93	16·4	10·87	60·8	9·63	53·8
71623	" "	"	"	76	18·02	1·70	9·4	9·20	51·1	7·99	44·3
64733	"Best of All" Quality Basic Slag and Florida Phosphate.	"	"	78	20·26	2·43	12·0	11·13	54·9	9·98	49·3
	Bessemer Slags—										
64735	Belgian Basic Slag.....	Belgium....	Nova Scotia Fertilizer Co., Halifax, N. S.	85	14·24	13·49	94·7	13·68	96·1	14·13	99·2
64736	English Basic Slag.....	"	Anglo-Canadian Feed Co., Halifax, N.S.	75	17·19	14·64	85·2	16·35	95·2	16·45	95·7
64737	Thomas phosphate.....	"	Anglo-Canadian Chem Co., St. John, N.B.	80	16·63	15·68	94·3	16·31	98·1	16·45	98·9
71252	Belgian Basic Slag.....	"	Nova Scotia Fertilizer Co., Halifax, N.S.	75	16·24	14·22	87·5	15·24	93·8	15·62	96·2

DISCUSSION OF RESULTS

Florida Rock Phosphate.—By the Wagner method approximately 20 per cent of the total phosphoric acid present is brought into solution and hence may be termed, technically, "available." By the Robertson and C.E.F. modifications, about 65 per cent would be returned as "available."

Open Hearth Slag.—This sample had a phosphoric acid content of approximately 10 per cent. By the Wagner method the data show that 12 per cent of this total is " available." A large percentage, viz. 45 is given by the Robertson and a still larger, viz. 62 by the C.E.F. modification. It remains to be shown, from practical experience in the field, which method gives results nearest actual availability.

It is evident from the results of this inquiry that if the Robertson or C.E.F. modification were used the recorded data for availability, for both Florida rock phosphate and Open Hearth slag, would be decidedly higher than if the Wagner method were employed. Having in mind the composition of " fortified " slags it is further interesting to note—though in the present state of the inquiry it must not be unduly emphasized—that by the C.E.F. modification the availability of the phosphoric acid in Florida rock phosphate closely approximates that in Open Hearth Slag.

Fortified Slag.—It should first be pointed out that the " fortified " slags, Nos. 64731-2-3 and Nos. 71622-23 are mixtures of Open Hearth slag and Florida rock phosphate, but as they were samples drawn from purchased supplies there is no available information as to the proportions of slag and rock entering into the mixture, nor of the composition of these components.

Since each batch of Open Hearth slag, apart from its phosphoric acid content, may differ in its behaviour to solvents, no strict comparison can be made between the results obtained from the samples of fortified slags under examination and those which might be calculated from mixtures of Nos. 64729 or 71124 and 64734.

It may be safely assumed that the phosphoric acid content in a "fortified" slag increases with an increase in the proportion of rock phosphate in the slag. The "Treble X" will contain more rock phosphate than the "Double X" and "The Best of All" more than the "Treble X."

By the Wagner method the availability, *i.e.* the percentage of the total phosporic acid soluble in the solvent under examination, shows no regular trend in this series, though there is an indication that increasing the proportion of rock phosphate depresses the availability. Additional work in this inquiry using known mixtures may clear up the apparent anomaly. At the present stage it can only be said positively that by this method availability in Open Hearth and fortified slags is comparatively low, not exceeding 16 per cent. It is possible that it may be established that the Wagner method is not applicable to these slags.

The " availability " in the fortified slags by the Robertson and the C.E.F. methods is in the same order of magnitude and considerably higher than that obtained by the Wagner method. Somewhat higher results were given by the Robertson than by the C.E.F. method.

As in the case of the Wagner method neither the Robertson nor the C.E.F. method gives consistent results. It would appear that as yet no analytical method has been devised which would be strictly applicable to Open Hearth and Fortified slags for the determination of their "available" phosphoric acid.

Bessemer Slags.—It is first to be observed that the percentage of available phosphoric acid as determined by all three methods is very much higher than in the " fortified " slags.

Further, it is of interest to note that the results by all three methods are fairly consistent and very close. Apparently, as a laboratory means of appraising Bessemer slags either one of these three methods would prove satisfactory.

FEEDING STUFFS

BARLEY

Lab'y Nos. 76683-4-5.—The series analysed comprised three varieties, Himalayan, Bearer and O.A.C. 21, submitted for examination by the Cereal Division, C.E.F. These were grown on the Central Farm, Ottawa, during the season of 1923 and the principal object of the inquiry was to ascertain their relative fibre content. Himalayan is one of the hulless barleys.

Size and plumpness are in some degree denoted by weight of kernel; the particulars of the series in respect to the latter datum are as follows:—

	Weight of 1,000 kernels grams
Himalayan (hulless)	39·67
Bearer	34·20
O.A.C. 21	37·89

Calculating the essential data to a water-free basis, for the purpose of a strict comparison, we have:—

BARLEYS: PROTEIN, FAT, FIBRE

(Water-free Basis)

—	Protein	Fat	Fibre
	p.c.	p.c.	p.c.
Himalayan	13·79	4·14	2·99
Bearer	13·47	3·56	6·37
O.A.C. 21	13·91	3·65	6·08

In this series Bearer stands lowest in weight of kernel, protein and fat and highest in fibre. Himalayan, the hulless variety is naturally the lowest in fibre; it stands highest in fat and second in respect to protein.

DISTILLERS' DRIED GRAINS

This by-product is one of the most favourably known of the high-protein concentrates. It is the dried residue of the grains—barley, wheat, rye, corn, etc. after malting and distillation in the manufacture of alcohol. It constitutes a digestible, rich, satisfactory and, at recent prices, an economic feeding stuff for use in the ration of dairy cows and fattening steers. Its chief value has been found in milk production. Like other by-products from manufacturing processes, this product should always be purchased on guaranteed analysis.

The series now reported on comprises six samples, all the product of The Canadian Industrial Alcohol Company, Montreal and Corbyville.

Lab'y No. 71926.—The guarantee states protein 28 per cent, fat 5.0 per cent; the sample practically meets the guarantee in protein and considerably exceeds it in respect to fat.

Lab'y No. 72284.—This carries the same guarantee as No. 71926. It exceeds the guarantee in protein by 3 per cent and in fat by almost 4 per cent.

"Grains" from corn, according to analyses made in these laboratories, have always shown a higher protein content than those from rye. Grains from corn have also been found extremely palatable to stock.

Lab'y No. 72649.—The guarantee reads protein 20 per cent, fat 6 per cent; this guarantee is met.

Lab'y No. 77112.—The guarantee reads protein 23 per cent, fat 5 per cent, fibre 15 per cent. It slightly exceeds its guarantee in fat, and satisfactorily meets its guarantee in protein and fibre.

Lab'y No. 77275.—Its guarantee is that of No. 77112. It is 1 per cent low in protein but the figures for fat and fibre more than meet the requirements of the guarantee.

Lab'y No. 78645.—This sample, compared with the other " corn " grains of the series is quite satisfactory as to protein, fat and fibre.

During the past five years a considerable number of samples of this feeding stuff have been analyzed in these laboratories. From the results obtained the following averages have been calculated—they will prove of more than ordinary interest to purchasers of feed stuffs. It is evidently desirable that the source of the "grains"—corn, rye, etc.—should be stated on the tag or label in addition to the guaranteed percentages of protein, fat and fibre.

DISTILLERS' DRIED GRAINS

Source	Protein	Fat	Fibre
	p.c.	p.c.	p.c.
Corn,* 10 samples—			
Maximum	33·94	12·76	13·08
Minimum	27·74	6·46	9·45
Average	30·68	10·11	12·23
Rye,* 10 samples—			
Maximum	22·88	9·55	18·43
Minimum	17·44	3·80	12·33
Average	20·17	6·43	15·81

*In a few brands a number of cereals have been used. In such cases the terms corn and rye indicate the predominant grain.

CALF MEALS

Calf meals are compounded feeds used in conjunction with skim-milk, as whole milk substitutes, in the feeding of young calves. As a class they are to be regarded as highly nutritious feeds, being more or less rich in digestible protein, fat and carbohydrates and low in fibre, but in a few instances feeds of very poor quality have been found.

Lab'y Nos. 78778-78784.—These samples constitute a series of calf meals compounded by the Animal Husbandry Division and used by that division in a comparative feeding trial. Their ingredients, with proportions are as follows:—

No. 1.—Oats 2 parts, corn 2 parts, flaxseed 1 part, salt 1 per cent, bone meal 1 per cent.

No. 2.—Hulless oats 2 parts, corn 2 parts, flaxseed 1 part, salt 1 per cent, bone meal 1 per cent.

No. 3.—Oats 2 parts, hulless oats 2 parts, flaxseed 1 part, salt .5 per cent, bone meal 1 per cent.

Nos. 4 and 6.—Oat flour 2 parts, hulless oats 2 parts, flaxseed 1 part, salt .5 per cent, bone meal 1 per cent.

Nos. 5 and 7.—"Gold Dollar Calf Meal." Manufactured by W. R. Cummings, Ottawa. This meal is stated to be prepared from flax, corn, wheat and oatmeal. It carries a guarantee of protein 18 per cent, fat 5 per cent and fibre 4.2 per cent.

Nos. 1 and 2.—The substitution of hulless oats for ordinary oats has affected an increase in the percentage of protein and of fat and a reduction in the fibre content. No. 2 is decidedly superior to No. 1 on all three counts and should prove a very desirable Calf Meal.

Nos. 1 and 3.—The substitution of hulless oats for corn has raised the protein and fat content, without affecting the percentage of fibre.

NOTE.—The data would indicate that in the preparation of the meal the proportions of the formula have not been strictly adhered to, or that the meal, as represented by the sample, has not been thoroughly mixed.

Nos. 4 and 6.—These are stated to be identical. The differences in protein and fat clearly indicate imperfect mixing in the preparation of the meal.

The percentage of protein and of fat, associated with the fibre content found in this mixture, would appear to make this a desirable formula.

Nos. 5 and 7.—Gold Dollar Calf Meal. These samples are not identical, but the differences in the more important nutrients are not large.

This preparation closely approximates No. 3 in protein content.

In fat or oil it is the lowest in the series—containing, roughly speaking, about half that in the other preparations. This, we consider, an undesirable feature.

The percentage of fibre is practically half way between the highest and the lowest in the series. We should not consider it too high for a calf meal; indeed it may be a desirable content for other than very young calves.

It is interesting to record our previous analyses of this meal.

ANALYSIS OF GOLD DOLLAR CALF MEAL

—	No. 26527	No. 40530	No. 71696
Moisture	10·92	8·21	8·55
Protein	27·18	32·99	17·55
Fat	3·90	7·63	6·32
Carbohydrates	49·06	39·56	60·37
Fibre	4·96	7·21	4·75
Ash	3·98	4·40	2·46
	100·00	100·00	100·00

POULTRY 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.

Lab'y No. 74796.—Monarch Laying Mash manufactured by the Maple Leaf Milling Co., Toronto. A sample of this feed analyzed in 1920 carried the following guarantee: protein 15 per cent, fat 3 per cent, fibre 10 per cent.

From its high percentage of protein it is evident that this feed contains a large proportion of animal concentrate, *e.g.* beef scrap, blood meal, etc. While undoubtedly a preparation of high nutritive value, care should be exercised in its use to prevent digestive troubles. Too large a proportion in the ration of a food so rich in protein frequently leads to a serious derangement of the system, occasionally resulting in death. Forcing for eggs, especially when the laying stock has but limited exercise, is frequently fraught with danger to health and life.

Lab'y No. 75890.—This mash was forwarded by a correspondent who had had it prepared at a local mill from ingredients supplied, viz. oat chop 23 pound, bran 23 pound, shorts 23 pound, corn chop 23 pound, meat meal 12 pound and charcoal 2 pound. The correspondent was under the impression that oat hulls had been added by the miller.

This mash does not contain an excessive amount of fibre and there is no evidence from the analysis that oat hulls have been used. The mash is one of very fair qaulity.

Lab'y Nos. 76893-94.—These mashes, home compounded, were stated to have been made up as follows:—

—	No. 76893	No. 76894
	lb.	lb.
Bran	100	100
Shorts	100	100
Oats	100	100
Corn	100	.....
Buckwheat	.....	100
Meat meal	48	60

The difference between these two mashes in nutritive value as revealed by analysis are neither large nor significant. No. 76893, however, is slightly the richer in protein. The fibre content of these samples is perhaps not as low as in the higher grades of poultry mashes, however it is not excessive. Both may be considered fairly well balanced feeds of good quality.

Lab'y No. 77069.—This sample was submitted for data and information as to nutritive value, our correspondent considering that its use might be responsible for "bad results and some deaths" in his flock.

Acording to analysis this should prove a very satisfactory laying mash. Its percentages of protein and fat are closely in accord with those of established value and its fibre while somewhat high is not excessive.

OILCAKE MEAL

The extraction of oil from flax seed leaves a residue which, when ground, is known as oilcake meal. Oilcake meal, linseed meal or simply oil meal, is one of the most wholesome and highly nutritious of all the concentrates. Used judiciously and in limited quantities, it may form a most valuable ingredient in the ration for all classes of farm stock.

Lab'y No. 75878.—The guarantee of this sample stated 34 per cent protein; the analysis shows that this is fully met. The percentage of oil found, 5.57 per cent, indicates manufacture by the "screw" process. This oil content is practically mid-way between that in cake produced by the "old" process (simple pressure of the crushed flaxseed) and the "new" process, in which the oil is dissolved out by naphtha. The fibre in this meal is slightly above the average, which points to the use of a poorly developed seed in the manufacture of the cake.

Lab'y No. 78976.—The data are in accord with those of genuine oilcake meal. The percentages of protein and oil are quite satisfactory; the fibre content, however, is somewhat higher than in the best samples.

At the instance of the sender a microscopical examination was made of this sample, the presence of noxious weed seeds being suspected. The meal was found perfectly satisfactory as to the presence of all foreign or objectionable matter.

FLAX SEED

Lab'y Nos. 76386-87.—Seed from two varieties of flax—Novelty and Premost—grown on the Experimental Farm, Brandon have been analyzed. The special enquiry was as to their oil content.

For the purposes of comparison, the essential data of these samples may be tabulated with the averages from six "oil" varieties grown at the Central Farm, Ottawa, 1921.

Variety	Weight of 1,000 kernels	Protein	Oil
	grams	p.c.	p.c.
Novelty	5·76	23·50	36·78
Premost	6·44	22·42	39·46
Average of seven oil varieties, 1921	5·15	22·67	37·04

The plumpness of the Brandon grown seed, as shown by the weight of kernel, is notable; in no case did the Ottawa grown seed reach the weight of "Premost" as produced at Brandon.

PROLAC

Lab'y Nos. 78607-08 and 74409.—This product, manufactured by the Prolac Manufacturing Co., Des Moines, Iowa, is described in the advertising literature as "whole buttermilk reinforced with choice cereal and animal proteins and fats" for which the following analysis is given:—

	per cent
Protein	27·40
Fat	4·75
Fibre	3·00

This product though slightly high in fibre may be said to satisfactorily meet its guarantee. It appears to be a wholesome, nutritious preparation, specially marked by a high protein content.

ALFALFA MEAL

Alfalfa meal is simply finely ground alfalfa hay; its quality therefore will depend on the quality of the crop as harvested. A young and leafy crop well cured will yield a much more nutritious meal than a riper hay or one that has been partially spoiled in the curing. These meals should always be purchased on guaranteed analysis, special attention being given to the fibre content—which in no case should exceed 30 per cent.

Lab'y Nos. 77852-53.—These two samples of alfalfa meal, submitted by the grower and manufacturer at Maple, Ontario, are from the first and second cutting respectively. The nutritive value of the "crude protein" is indicated by the following results:—

—	No. 77852 — 1st cutting	No. 77853 — 2nd cutting
	p.c.	p.c.
Albuminoids	13·50	19·63
Non-albuminoids	2·54	0·75
Crude protein	16·04	20·38

The analysis clearly shows that No. 2 Second cut is much the superior; it possesses a higher protein content containing a larger amount of true albuminoids—the blood and tissue builders—and a lower percentage of fibre. No. 1 approaches the limit, both in protein and fibre for grades of medium quality. No. 2 would rank with the best grades of alfalfa meal as analysed in these laboratories.

Lab'y Nos. 78276 and 78277.—In the results of these two samples we have the opportunity of comparing a home-produced with a commercial alfalfa meal. No. 78276 (No. 1) was purchased from W. R. Cummings, Ottawa; No. 78277 (No. 2) was both grown and ground at the Central Farm, Ottawa.

The particulars of the crude protein are as follows:—

—	No. 78276 W.R.C.	No. 78277 C.E.F.
Albuminoids	14·57	11·00
Non-albuminoids	3·79	3·23
Crude protein	18·36	14·23

In all particulars No. 78276 is decidedly the better sample; it is richer in protein (with a larger proportion of true albuminoids) and lower in fibre.

MEAT PRODUCTS*

Meat products used as feeding stuffs and put on the market under several names according to composition or preparation—tankage, beef or meat scrap, beef and bone meal, etc., are by-products of the packing house.

As a class, they are highly nitrogenous, containing from 40 to 60 per cent of protein, with bone meals proper containing in the neighbourhood of 25 per cent. As a rule the fat will be between 5 and 10 per cent. The proportion of bone (phosphate of lime) is also variable, from a negligible quantity to 55 per cent tricalcic phosphate. These " concentrates " constitute a valuable source of protein and bone making material and are especially useful in the feeding of swine and poultry. It is essential that they should be prepared from fresh material and, as purchased, should be sweet and sound, free from rancidity and mould. Owing to their variable character, these feeding stuffs should always be purchased on guaranteed analysis.

Lab'y No. 77782.—This sample was labelled " Meat Scrap 60 per cent," but did not bear the name of the manufacturer. It was examined for a correspondent in Markdale, Ontario, who suspected its quality. In addition to the tabulated data the phosphate of lime content was determined and found to be 22·18 per cent.

Though below its guarantee in protein, there is otherwise no fault to find with this sample; it is apparently sweet, sound and wholesome.

Lab'y No. 78606.—This sample was submitted by the Animal Husbandry Division, C.E.F. It was labelled " Tankage 60 per cent " and was manufactured by the National Fertilizers Ltd., West Toronto.

The feeding stuff was in the form of a dark brown powder, sound, sweet and wholesome. Its guarantee in respect to protein is fully met.

FISH MEALS

Fish meal is a feeding stuff product obtained by the utilization of surplus fish and fish offal, the process of manufacture comprising the reduction of the fish or offal by steam cooking, the separation by skimming and pressure of the larger proportion of the oil and the drying and grinding of the residue. The fish and fish wastes employed must be fresh and sound and the several operations carefully and thoroughly carried out, if a wholesome, palatable meal with good keeping qualities is to result. Unsound fish or waste will result in unwholesome and rancid products, unpalatable to stock, likely to produce scouring and other digestive troubles, and apt to cause tainted meats, milk and eggs.

*During the past year a bulletin entitled "Meat and Bone Products", No. 49, New Series, has been issued by this Division. It gives a large number of analyses of these and allied feeding stuffs as found on the Canadian market and furnishes data towards the establishment of standards.

The composition of fish meal varies greatly, depending on the nature of the raw product—whole fish or offal—and the thoroughness with which the several steps in its preparation have been carried out. It appears to be essential to the keeping qualities of the meal that the oil should be extracted fairly thoroughly, and the high-grade meals are those with a low oil content.

Lab'y No. 75750.—This is the waste from the manufacture of "shredded fish" prepared at Port Maitland, N.S. The sample as received was quite moist, of a light yellowish colour and of a shredded or fibrous appearance.

The "ash," 23·64 per cent, contained 22·8 per cent of common salt.

This product while possessing a notable protein content contains 44 per cent of water. Its salt content is very high and, although no doubt useful in preserving this moist by-product, makes necessary the limited use of this feeding stuff, especially in pig and poultry feeding. Our correspondent states that he had fed it successfully to pigs and dairy stock in the proportions of 1 part to 6 parts of meal.

Lab'y. No. 77591.—This sample is an English fish meal imported by the Anglo-Canadian Feed Co., Halifax, N.S. It was forwarded by the Superintendent of the Experimental Farm, Nappan, N.S., where it was being used in feeding trials with pigs. As received a finely ground material, light yellow in colour with the characteristic odour of fish. The analysis shows 17·44 per cent of phosphate of lime. It is a sound and wholesome fish meal of excellent quality.

MISCELLANEOUS FEEDS

Lab'y No. 73223.—Semi-solid buttermilk, manufactured by the Toronto Buttermilk Co. As received, this sample was of a paste-like consistency, of creamy colour and with a less pronounced "cheesy" odour than is usually noticed in samples of this product.

This sample contains 24·75 per cent of total solids of which 10·30 per cent is protein, 2·55 per cent fat and 8·36 per cent of lactose and lactic acid.

The composition of a number of samples of semi-solid buttermilk analysed in recent years in these laboratories is given in the following table, together with the data for fresh buttermilk for comparison.

ANALYSIS OF SEMI-SOLID BUTTERMILK

Lab'y. No.	Manufacturer	Total solids	Protein (Curd)	Fat	Milk sugar and lactic acid	Ash
		p.c.	p.c.	p.c.	p.c.	p.c.
50696	Bowes Ltd., Toronto.....	21·04	7·87	3·04	8·10	2·03
50986	" "	33·61	11·21	4·80	14·75	2·85
59255	" "	30·26	12·24	2·86	12·40	2·76
66739	Ottawa Dairy Co.....	40·78	14·20	3·19	19·55	3·84
73223	Toronto Buttermilk Co., Toronto.....	24·75	10·30	2·55	8·36	3·54
	Fresh buttermilk.....	9·38	3·78	1·25	3·70	0·65

It is evident from these results that semi-solid buttermilk is a product that should be purchased on guaranteed analysis.

Lab'y No. 74774.—Salvaged wheat. This is a sample of wheat salvaged from an elevator fire at Fort William, Ont. The enquiry was as to its fitness and value in poultry feeding.

The wheat was strongly discoloured, some grains being scorched and almost black; the discolouration is probably due to wetting and subsequent fermentation. It is fairly dry; there is no visible evidence of mould. There is a slight admixture of oats and barley. The sample has a very disagreeable sour odour.

On cutting the grains many are found practically normal—the skin only being discoloured—while others are charred throughout. On grinding the resultant meal is quite dark, possessing a sour and bitter taste.

—	Acidity	Water soluble extract
Salvaged wheat	8·0	8·07
Normal	1·5	2·5

By reason of the high acidity of this damaged wheat we are of the opinion that serious changes have taken place—the result of fermentation. This apart from its unpalatableness leads us to conclude that this wheat could not be safely and satisfactorily used in poultry feeding—save perhaps very sparingly in the ration.

Lab'y No. 75658.—Vim Feed. Forwarded from Brandon, Man., and stated to be the product of the Quaker Oats Co., Saskatoon, Sask. This is essentially an oat feed, but the data indicate that the present sample contains a certain amount of flax seed, which increases both the protein and fat. Vim feed was sold under a guarantee of protein 5 per cent, fat 2·0 per cent, fibre 27·0 per cent; the present sample fully meets this guarantee. The following results are from analyses of Vim previously made in these laboratories:—

—	Protein	Fat	Fibre
	p.c.	p.c.	p.c.
Maximum	10·30	3·30	26·16
Minimum	6·69	2·02	22·12
Average	27·52	2·73	24·18

Vim and similar feeds must be regarded as of very poor feeding value, not merely by reason of their low percentages of protein and fat but because of their highly fibrous and indigestible nature, due to being largely composed of oat hulls.

Lab'y No. 76775.—Oat scalpings obtained from the Maple Leaf Milling Co., Ottawa, and submitted by the Animal Husbandry Division, C.E.F.

The data indicate a meal of fair feeding value. Its comparison with Recleaned Screenings and bran may be made from the following figures:—

—	Protein	Fat	Fibre
	p.c.	p.c.	p.c.
Recleaned screenings (average)	14·40	4·05	6·68
Bran (average)	16·40	4·47	10·88
Oat scalpings	13·70	5·96	15·43

Lab'y No. 76776.—"Mixed Feed" submitted by Animal Husbandry Division and described as similar to or slightly better than standard recleaned screenings.

This is not a high-grade product. It is decidedly inferior to average standard recleaned screenings and must be considered of extremely poor quality, especially if intended for swine feeding.

TABLE 10.—ANALYSIS OF FEEDING STUFFS

Lab'y. No.	Particulars	Moisture	Protein	Fat	Carbohydrates	Fibre	Ash
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
	BARLEY						
76683	Himalayan, C.E.F. 1923.....	11·07	12·39	3·73	68·10	2·69	2·02
76684	Bearer, "	11·02	11·98	3·17	65·49	5·67	2·67
76685	O.A.C. 21, "	6·40	13·02	3·42	68·83	5·70	2·63
	DISTILLERS' DRIED GRAINS						
71926	From corn.....	5·67	27·74	8·38	43·65	12·11	2·45
72284	" "	6·05	31·02	8·85	38·77	12·97	2·34
72649	" rye.....	5·13	20·16	6·55	49·25	16·40	2·51
77112	" "	2·75	22·88	7·51	49·47	14·29	3·10
77275	" "	6·24	22·06	8·17	48·18	12·33	3·02
78645	" corn.....	4·78	29·45	11·25	36·97	14·60	2·95
	CALF MEALS						
78778	No. 1 Animal Husb. Div. C.E.F.	11·51	13·85	10·15	54·82	6·29	3·38
78779	No. 2 " "	7·30	15·70	12·06	59·67	2·05	3·22
78780	No. 3 " "	11·77	18·80	13·75	44·71	6·27	4·70
78781	No. 4 " "	9·43	16·64	9·71	59·14	2·45	2·63
78784	No. 6. " "	7·86	17·53	12·17	57·36	2·69	2·39
78782	"Gold Dollar," W.R. Cummings.....	8·46	18·17	6·53	59·64	4·17	3·03
78783	" "	11·01	18·90	5·28	58·49	3·77	2·55
	POULTRY FEEDS						
74796	Monarch Laying Mash.....	10·96	21·75	3·37	51·11	6·32	6·49
75890	Mash—J.S.C.....	5·35	16·59	5·77	59·11	7·35	5·83
76893	" —H.M. No. 1.....	10·11	19·89	6·25	51·16	7·31	5·28
76894	" —H.M. No. 2.....	8·97	18·52	5·41	54·16	7·72	5·22
77069	" —G.S.D.....	8·48	20·32	6·13	52·30	7·68	5·09
	OIL CAKE MEAL						
75878	Mfg. by Spencer, Kellog & Sons, Buffalo, N.Y.....	7·75	34·44	5·57	38·10	9·35	4·79
78976	Mfg. by Alberta Linseed Oil Co., Medicine Hat, Alberta..	9·07	34·96	9·62	32·42	9·13	4·80
	FLAX SEED						
76386	"Novelty," Exp. Farm, Brandon, Man.....	9·20	23·50	36·78	21·28	5·89	3·35
76387	"Premost," " "	8·13	22·42	39·46	21·15	5·65	3·19
	PROLAC						
78607	Manufactured by Prolac Mfg. Co., Des Moines, Iowa.....	10·91	27·49	6·12	45·74	4·17	5·57
78608	" "	13·35	27·05	5·72	44·88	3·62	5·38
74409	" "	10·68	26·38	7·07	46·24	3·60	6·03
	ALFALFA MEALS						
77852	No. 1. First cut.....	6·98	16·04	3·36	38·20	28·25	7·17
77853	No. 2. Second cut.....	7·21	20·38	4·18	37·86	20·97	9·40
78276	Commercial No. 1.....	8·39	18·36	3·45	33·92	28·14	7·74
78277	C.E.F. No. 2, Second Cut.....	8·08	14·23	3·35	35·46	31·16	7·72
	MEAT PRODUCTS						
77782	Meat Scrap 60 G.S.D.....	5·61	56·08	12·37	.....	.....	24·19
78606	Tankage 60 N.F. Co.....	7·45	61·46	10·85	.....	.....	17·62
	FISH PRODUCTS						
75750	Fish waste—H.C.R.....	44·62	30·70	1·09	.....	.....	23·64
77591	Fish meal A.C.F. Co.....	5·62	58·32	6·99	.....	.....	26·77

TABLE 10.—ANALYSIS OF FEEDING STUFFS—*Concluded*

Lab'y. No.	Particulars	Moisture	Protein	Fat	Carbohydrates	Fibre	Ash
	MISCELLANEOUS FEEDS	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
73223	Semi-solid Buttermilk.....	75·25	10·30	2·55	8·36	.....	3·54
74774	Salvaged wheat.....	7·24	15·32	2·79	68·63	4·15	1·87
75658	Vim—an oat feed.....	6·24	8·27	4·31	53·30	22·79	5·09
76775	Oat scalpings.....	6·35	13·70	5·96	53·46	15·43	5·10
76776	Mixed feed.....	10·71	9·98	3·45	60·38	12·31	3·17

CORN: RELATION OF PROTEIN CONTENT TO SPECIFIC GRAVITY

At the instance of the Division of Forage Plants an inquiry was made into the statement that the protein content of corn could be estimated by determining the specific gravity of the kernels.

Investigations with high and low protein corn at the Experiment Station of Illinois had indicated that there was a distinct correlation between the relative size of the germ and the protein content. As the germ and endosperm are of different specific gravities it might be assumed that their relative proportions would influence the specific gravity of the grain. If such were found to be the case, a determination of the specific gravity could be employed for the classification of corn according to its protein content.

The ears (cobs) submitted were the progeny of high and low specific gravity parents. In addition to the series two corns with marked differences in respect to specific gravity were selected for examination: Wisconsin No. 7, Duke (White, Dent) and Quebec No. 28, Macdonald College (yellow, flint, small kernel). These, it was expected, might yield results of a decisive character.

The parent types—heavy and light—were separated on the basis of specific gravity as indicated by the action of a representative number of kernels when immersed in a solution of potassium carbonate. The concentration of the solution was such that the " lighter " kernels floated and the " heavier " sank.

The results of the examination are presented in table 11.

TABLE 11.—CORN: HEAVY AND LIGHT KERNELS—RELATION OF PROTEIN CONTENT TO SPECIFIC GRAVITY

Lab'y. No.	Variety	Description	Weight of 100 kernels	Specific gravity	Protein (N x 6·25)	Fat
			grams		p.c.	p.c
71561	Wisconsin No. 7...	Heavy (cob) 3, 1922.....	35·36	1·297	10·20	5·83
71562	Wisconsin No. 7...	Heavy, mother, composite, 1922.	33·06	1·300	10·65	5·40
71563	Wisconsin No. 7...	Heavy Progeny, 1923.....	31·28	1·282	9·87	5·32
71564	Wisconsin No. 7...	Light (cob) 8, 1922.....	29·09	1·227	10·53	5·07
71565	Wisconsin No. 7...	Light (Mother) composite, 1922..	32·04	1·255	11·14	4·88
71566	Wisconsin No. 7...	Light Progeny, 1923.....	33·45	1·260	9·54	4·73
71626	Wisconsin No. 7. Duke (White Dent).....	.....	32·06	1·213	8·57	4·55
71627	Quebec 28, Macdonald College (Yellow Flint)..	.....	27·25	1·306	11·99	6·04

Considering first the two samples selected and examined to procure data which might support the contention under discussion—Nos. 71626 and 71627—it will be found that there is a distinct relationship between specific gravity and

protein content—the higher the specific gravity the higher the percentage of protein. It is also of very considerable interest to note that in the whole series of eight members the Wisconsin No. 7 Duke (No. 71626) possesses the lowest specific gravity and the lowest protein content. Further, Quebec No. 28 (No. 71627) is characterized by the highest specific gravity associated with the highest percentage of protein.

The data of this examination do not support the contention that there is any direct relationship between the specific gravity, as determined by the potassium carbonate method, and the protein content.

The laboratory determinations of specific gravity, using a specific gravity bottle and a mineral oil, support the method of selection into heavy and light kernels by the potassium carbonate solution. It has been stated that there is no direct relation between specific gravity and protein content, considering the series as a whole, there is however a distinct trend within each group (a strain and its progeny) towards high gravity being associated with high protein. This work would indicate that specific gravity cannot be relied on for the selection of kernels as to protein content—high or low.

The results of this inquiry further show that the protein content of the parent has not determined the protein of the progeny; evidently, as has been shown in the case of wheat, the protein content may be profoundly influenced by environmental (climatic, etc.) conditions.

OFFICIAL GRADES OF WHEAT, 1924 CROP

The analysis of the official grades of wheat, 1924, was undertaken with the view of obtaining data which might bear upon the question of the substitution of "protein content" for the present method of grading—a matter which aroused considerable interest among western farmers and millers during the winter of 1924-25.

The samples examined were obtained through the Cereal Division from the Department of Trade and Commerce and were part of the wheats officially graded for use as standards.

The following table (No. 12) presents, in addition to protein data, the weight per bushel, weight of 1,000 kernels and the percentage of moisture in the wheat.

TABLE 12.—Analysis of Grades of Wheat, 1924

La'by. No.	Grade	Wt. per Bushel	Wt. of 1000 Kernels	Moisture	Nitrogen	Protein (N.x 5·7)
		lb.	gms.	p.c.	p.c.	p.c.
78538	No. 1 Northern	64·0	31·65	9·33	2·47	14·06
39	No. 2 "	62·5	27·99	9·20	2·44	13·91
40	No. 3 "	62·0	27·88	9·34	2·36	13·39
41	No. 4 "	62·0	28·27	9·07	2·42	13·79
42	No. 5 "	60·5	26·48	9·15	2·46	13·99
43	No. 6 "	58·5	23·48	9·05	2·35	13·37

It will be observed that there is no direct correlation between grade and protein contents. Assuming that the present method of grading correctly classifies wheats, this conclusion is in full agreement with findings from an inquiry into this matter made some years ago in these laboratories.

It confirms our contention that the "protein content" (as determined by chemical means) could not be solely used for the purpose of grading wheats, though it might be found to assist in the valuation of wheats within a grade.

Flours from these samples were milled by the Cereal Division, for analysis in order to learn how far the protein content of the flour corresponded with that of the wheat from which it was milled. The data are as follows (table 13):—

TABLE 13.—FLOURS MILLED FROM OFFICIAL GRADES OF WHEAT BY CEREAL DIVISION, 1924 CROP

Lab'y. No.	Grade	Moisture	Nitrogen	Protein (N. x 5·7)
		p.c.	p.c.	p.c.
78646	No. 1 Northern	9·35	2·39	13·66
47	No. 2 "	9·55	2·33	13·28
48	No. 3 "	9·44	2·26	12·87
49	No. 4 "	9·26	2·31	13·13
50	No. 5 "	9·36	2·16	12·32
51	No. 6 "	9·18	2·19	12·47

It will be observed from the results of this inquiry that the protein content of the flours (as produced by the experimental mill) does not throughout the series follow in the order of the grades of wheat. It may further be remarked that these flours, in respect to protein content, do not assume the same order as that of the protein data of the wheats from which they were milled. It may finally be pointed out that in the case of the wheats the difference between the highest and lowest in protein content was only ·69 per cent; in the case of the flours it was 1·32 per cent.

FLOURS

A series of seven flours, milled by the Renfrew Flour Mills Limited, Renfrew, Ont., has been submitted to critical examination. The results may be reported as follows (table 14):—

TABLE 14.—ANALYSIS OF FLOURS FROM RENFREW FLOUR MILLS

Lab'y. No.	Designation	Moisture Vac. at 70°C. for 18 hrs.	Protein (Nx 5·7)	Fibre	Ash	Gluten		Ratio: Moist Gluten to Dry Gluten	Physical Characteristics of Gluten
						Moist	Dry		
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.		
72171	No. 1, White Star	11·30	11·87	0·08	0·49	37·07	12·62	2·94	Firm and elastic.
72172	No. 2, White Star	10·85	11·91	0·07	0·63	39·98	13·51	2·96	Firm and elastic.
72173	No. 3, Majestic	10·95	12·25	0·31	0·51	39·85	13·27	3·00	Firm and elastic.
72174	No. 4, Three Stars	10·94	12·73	0·30	0·44	38·13	13·18	2·89	Firm and elastic.
72175	No. 5, White Star	10·47	11·40	0·13	0·46	34·84	11·72	2·98	Firm and elastic.
72176	No. 6, Harvest Queen	10·62	11·57	0·17	0·48	35·75	12·63	2·83	Tough
72177	No. 7, Keynote	10·09	12·93	0·24	0·52	38·35	13·87	2·76	"

Quality in flour, as far as may be deduced from chemical analysis, would be recognized by high protein, low fibre and low ash: the range in the above series is protein, 12·93 (No. 7) to 11·40 (No. 5) per cent; fibre, ·07 (No. 2) to ·31 (No. 3) per cent; ash, ·44 (No. 4) to ·63 (No. 2) per cent.

The moisture content of all the flours is distinctly low. If this were representative of the barrelled flour, it would be a feature of considerable importance and value, but as the samples were sent in small cotton bags and probably had so remained for some time previous to analysis, a "drying out" may have occurred, reducing the moisture content. It is quite possible that the flour as milled contained in the neighbourhood of 13 per cent moisture.

The determinations of wet and dry gluten are probably the most important guides to " strength ". It is generally held that flour of first class strength will show a ratio of wet to dry gluten of 2·9 to 3·1:1. Ratios higher than this would indicate a more or less soft or weak flour and lower ratios a toughness necessitating a stronger fermentation to soften the gluten.

THE COUMARIN CONTENT AND NUTRITIVE VALUE OF SELECTED TYPES OF SWEET CLOVER

This work was undertaken at the instance of the Department of Field Husbandry, University of Saskatchewan, which for a number of years past has carried on, under the direction of Prof. L. E. Kirk, an extensive investigation into the relative values of many types and strains of sweet clover. The clovers analysed were grown at Saskatoon during the seasons of 1922 and 1923, the samples submitted consisting of the (*a*) leaf and (*b*) stalk of eight varieties or types from the fall cutting of 1922 (year of seeding) and first and second cutting of 1923.

Sweet clover (*Melilotus alba* and *officinalis*) is a leguminous forage crop characterized by the presence of coumarin a bitter principle which affects palatability and imparts to both the green and dried plant a distinct but not unpleasant vanilla-like odour. It is generally considered that the young crop contains less coumarin than the more mature herbage and is therefore less bitter and more palatable to stock. Cured as hay it is stated to be less bitter due to the volatilization of a part of the coumarin in drying. One of the main objects of the work at Saskatoon has been to discover through the selection of widely distinct strains or types those with reduced coumarin content and hence the more palatable. Our co-operation was enlisted in order to secure data for coumarin content and nutritive value.

RESULTS OF 1922

Table 15 presents the results from the 1922 samples, the data for the coumarin content and nutrients being calculated to the water-free basis.

COUMARIN

Leaf.—The range in the series of eight types or strains is from ·81 to 1·08 per cent and the average .90 per cent.

Although between the highest and the lowest there is a difference of ·27 per cent coumarin, which represents a range of practically 30 per cent, no attempt will be made towards classifying from the leaf data the several types examined; before a classification from coumarin content would be justifiable further and confirmatory data must be obtained.

Stalk.—The range in the series is from 1.23 to 1.43 per cent and the average is 1·35 per cent.

First, it is to be observed that the coumarin content of the stalk is markedly higher than in the leaf.

Secondly, though the difference in coumarin content between the highest and the lowest is practically the same as in the leaf, the range per cent is much lower in the case of the stalk—practically 16 per cent.

NUTRIENTS

Leaf.—Though certain differences in protein content are to be observed these, in our judgment, are not of sufficient magniture to justify their use in differentiating between the strains and the same may be said in respect to the remaining constituents.

TABLE 15.—Analysis of Sweet Clover—Crop of 1922—Fall Cutting (September) of the Year of Seeding. Department of Field Husbandry—University of Saskatchewan, Saskatoon

Lab'y. No.	Variety	Block No.	Plot No.	Moisture on Air-dried Material	Calculated to Water-free Basis							
					Coumarin	Protein			Ether Extract	Carbo-hydrates	Fibre	Ash
						Albumi-noid	Non-albumi-noid	Total				
	Leaf			p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
62494	Arctic Saskatchewan 439	607	12	10·30	1·08	16·02	7·55	23·57	5·66	48·44	8·43	13·90
62496	" " 662	607	13	10·50	0·91	16·09	9·10	25·19	5·80	48·55	8·90	11·56
62498	" " 664	607	14	10·28	0·90	17·54	7·73	25·27	5·20	46·46	9·00	14·07
62501	Commercial Seed	607	15	9·89	0·94	17·01	8·78	25·79	4·90	46·98	9·73	12·60
62502	White Saskatchewan 432	607	16	10·98	0·83	16·61	8·65	25·26	5·61	46·10	9·91	13·12
62504	Suaveolens " 446	607	17	9·38	0·86	14·15	9·71	23·86	4·85	47·93	9·62	13·74
62506	Yellow " 442	607	18	8·64	0·81	16·63	6·94	23·65	5·77	46·28	9·51	14·87
62508	Daghestan " 447	607	19	9·78	0·88	15·96	10·27	26·23	5·05	45·05	9·36	14·31
	Stalk											
62495	Arctic Saskatchewan 439	607	12	7·33	1·29	10·40	10·38	20·78	3·44	34·55	33·81	7·42
62497	" " 662	607	13	8·41	1·42	10·68	9·11	19·79	3·36	36·69	32·40	7·76
62499	" " 664	607	14	8·26	1·41	10·75	9·70	20·45	3·46	33·48	34·83	7·78
62500	Commercial Seed	607	15	7·72	1·43	9·16	10·48	19·64	3·76	36·25	32·58	7·77
62503	White Saskatchewan 432	607	16	6·45	1·23	8·93	9·82	18·75	2·65	34·92	36·50	7·18
62505	Suaveolens " 446	607	17	7·50	1·32	8·83	9·16	17·99	2·91	39·11	32·22	7·77
62507	Yellow " 442	607	18	6·29	1·37	9·89	11·44	21·33	3·70	37·62	28·89	8·46
62509	Daghestan " 447	607	19	7·96	1·35	9·22	10·02	19·24	2·36	38·32	31·12	8·96

TABLE 16.—ANALYSIS OF SWEET CLOVER—CROP OF 1923—FIRST CUTTING, JUNE 25TH, SECOND CUTTING, AUGUST 15TH

Lab'y. No.	Variety	Blk. No.	Plot No.	Cutting	Moisture on Air-dried Material	Calculated to Water-free Basis					
						Coumarin	Crude Protein	Ether Extract	Carbo-hydrates	Fibre	Ash
	LEAF				p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
73731	Arctic Saskatchewan 439	607	12	First	9·56	0·25	30·30	6·43	40·05	10·82	12·40
73734	" 439	607	12	Second	6·88	0·57	30·97	3·49	47·87	9·64	8·03
73735	" 662	607	13	First	8·94	1·03	30·63	6·48	43·77	10·59	9·53
73737	" 662	607	13	Second	7·61	0·70	33·71	4·24	42·07	8·82	11·16
73739	" 664	607	14	First	8·81	0·90	29·95	5·66	46·69	8·99	8·71
73741	" 664	607	14	Second	8·32	0·67	34·46	4·82	39·48	8·87	12·37
73743	Commercial Seed	607	15	First	8·96	1·03	29·81	4·43	47·20	9·94	8·62
73745	"	607	15	Second	10·22	1·06	34·17	5·84	39·77	9·73	10·49
73747	White Saskatchewan 432	607	16	First	9·85	0·89	31·72	6·46	40·09	10·78	10·95
73749	" 432	607	16	Second	7·28	0·89	32·08	6·90	41·64	8·33	11·05
73751	Suaveolens Saskatchewan 446	607	17	First	7·81	0·67	28·54	6·51	41·51	9·55	13·89
73753	" 446	607	17	Second	7·88	0·90	32·24	7·75	39·98	8·98	11·05
73755	Yellow Saskatchewan 442	607	18	First	7·32	0·82	27·55	9·40	42·81	11·28	8·96
73757	" 442	607	18	Second	7·37	0·95	29·36	7·32	45·78	9·70	7·84
73759	Daghestan Saskatchewan 447	607	19	First	9·21	0·48	31·34	7·97	36·93	12·35	11·41
73761	" 447	607	19	Second	11·05	0·98	31·59	7·60	39·58	11·09	10·14
	STALK										
73732	Arctic Saskatchewan 439	607	12	First	6·81	0·29	17·07	3·77	34·32	36·20	8·64
73733	" 439	607	12	Second	6·52	1·18	13·43	3·44	34·66	40·84	7·63
73736	" 662	607	13	First	8·71	0·32	19·29	3·09	33·59	35·09	8·95
73738	" 662	607	13	Second	9·79	0·42	15·98	1·61	35·47	37·59	9·35
73740	" 664	607	14	First	7·60	0·68	17·41	1·75	37·00	34·27	9·57
73742	" 664	607	14	Second	6·73	0·45	15·25	2·23	34·95	39·01	8·56
73744	Commercial Seed	607	15	First	7·28	0·36	19·97	3·52	34·66	32·12	9·73
73746	"	607	15	Second	8·67	0·35	16·42	3·07	34·17	35·98	10·36
73748	White Saskatchewan 432	607	16	First	6·09	0·42	18·64	4·27	34·17	34·77	8·15
73750	" 432	607	16	Second	9·22	1·24	13·66	2·70	34·73	40·11	8·80
73752	Suaveolens Saskatchewan 446	607	17	First	5·96	0·28	14·16	4·69	35·56	36·34	9·26
73754	" 446	607	17	Second	10·72	0·81	16·09	4·16	34·62	35·53	9·60
73756	Yellow Saskatchewan 442	607	18	First	7·91	1·04	18·91	6·17	33·02	32·68	9·22
73758	" 442	607	18	Second	6·25	0·92	16·44	3·37	34·10	37·93	8·16
73760	Daghestan Saskatchewan 447	607	19	First	9·12	0·43	18·40	4·57	33·28	32·80	10·95
73762	" 447	607	19	Second	8·97	0·46	14·36	3·52	32·15	40·23	9·74

It should be pointed out that the data under the caption "ether extract" are not to be interpreted as representing percentages of true fat or oil; the "extract" is largely made up of resins, gums, chlorophyll, etc.—the percentage of true fat being comparatively very small.

For the purposes of comparison—and as the matter is of some interest—the data for the *leaf* of alfalfa may be given, as follows:

	Protein p.c.	Fibre p.c.	Ash p.c.
Leaf: Sweet clover (average, 1922)	24·84	9·31	13·52
" Alfalfa (average "Henry")	24·09	13·60	14·50

Stalk.—The main differences between leaf and stalk, as revealed by chemical analyses may be presented, as follows:

	Protein p.c.	Fibre p.c.	Ash p.c.
Leaf, average	24·84	9·31	13·52
Stalk, average	19·75	32·79	7·89

The proportion of albuminoids to non-albuminoids in the leaf is practically 2:1 and in the stalk 1:1.

All the data emphasize the higher feeding value of the leaf.

To complete the comparison with alfalfa, the following data are presented.

	Protein p.c.	Fibre p.c.	Ash p.c.
Stalk,* sweet clover (average 1922)	19·75	32·79	7·89
Stalk, alfalfa (average, "Henry")	6·67	57·63	5·19

RESULTS OF 1923

The data for the first and second cuttings for 1923, collected from the varieties examined in 1922, are presented in Table 16.

COUMARIN

Leaf.—The range and average for the first and second cuttings, respectively, are as follows:

COUMARIN CONTENT OF LEAF

	Maximum p.c.	Minimum p.c.	Average p.c.
First cutting	1·03	0·25	0·76
Second cutting	1·06	0·57	0·84

When compared with the results for 1922, these data present no new features of significance.

Comparing the coumarin content of the leaves of the first and second cuttings, the data show a very considerable range, but it is doubtful if they should be interpreted as indicating marked differences, either between the two cuttings or between the several strains. The reason for this conclusion is that the differences between duplicate determinations on the same sample are in many instances just as great as those between the various types and the two cuttings—they are within the limits set by the accuracy of the analytical method for coumarin estimation.

Stalk.—The range and average for the first and second cuttings, respectively, are as follows:

COUMARIN CONTENT OF STALK

	Maximum p.c.	Minimum p.c.	Average p.c.
First cutting	1·04	0·28	0·48
Second cutting	1·24	0·35	0·73

* The more favourable figures for sweet clover may possibly, in part, be accounted for by a younger growth when cut than in the case of the alfalfa.

In the series of 1922 the coumarin content for the stalks was consistently higher than that of the corresponding leaves; in the 1923 series there appears to be no direct relationship between the coumarin content of stalk and leaf—in some cases the percentage of coumarin is higher in the leaf than in the stalk, in others the reverse is evident.

A slight trend towards a higher coumarin content was noticeable in the leaves of the second cutting; this trend is much more marked in the case of the stalks. There is therefore a strong indication that the plants of second growth possess a higher coumarin content than those cut earlier in the season, i.e., of the first cutting.

One of the main objects of this inquiry was the breeding or selection of a type or strain with a reduced coumarin content. Do the present results indicate that any advance toward this object has been made? If the several types examined are arranged for 1922 and 1923, respectively, in the order of their coumarin content it will be found that the order of 1922 is not that of 1923; stated otherwise, a type relatively high in coumarin in the first year of this investigation may be relatively low in the second. It may therefore be inferred that if heredity is a factor in determining the coumarin content it is not the only one.

NUTRIENTS

Leaf.—The range in crude protein is from 27.5 to 34.5 per cent with an average of 31.15 per cent; these data are markedly higher than the corresponding figures for 1922, which are 23.57, 26.23 and 24.84.

If a comparison of the 1922 (fall cutting) protein results be made with those of the second cutting of 1923, the types or strains will fall more or less into the same order, that is, there is a certain rough parallelism between the strains of the two years, considered from the protein basis of these two series of samples. But the comparison of the 1922 protein (fall cutting) results with those of the first cutting of 1923, affords no support to the contention that protein content is fixed by heredity; and consequently there is not sufficient warrant to classify the strains according to protein content of leaf.

A marked difference in protein content exists between the first and second cutting; invariably that of the second cutting is decidedly the higher. The average of the eight strains for the first cutting is 29.98 per cent, that for the second, 32.32 per cent.

The percentage of fibre in the leaf of the second cutting is in every instance lower than that of the first—a feature presumably associated with the shorter period of growth of the second cut material.

The averages for the fibre of the 1922 series and the second cutting of 1923 are practically identical, viz., 9.31 and 9.39 per cent.

Stalk.—As in the case of the 1922 series, the percentage of protein of the stalk is very considerably lower than of the leaf; the averages are as follows:—

	Protein p.c.
Leaf, average	31·15
Stalk, average	16·59

Comparing the protein content of the stalk of the first and second cuttings, that of the first cutting is decidedly the higher—the reverse of that which was noted in the case of the leaf. The average for the eight strains for the first cutting is 17.98 per cent, that for the second, 15.20 per cent.

The fibre content of the stalk of the first cutting is in every instance but one lower than that of the second cutting. The reverse, as has been noted, is true for the leaf.

From a study of the tabulated data it is evident that there is a correlation between protein and fibre—high protein is associated with low fibre. This is true for both leaf and stalk.

—	Leaf		Stalk	
	Protein	Fibre	Protein	Fibre
First cutting, average	29·98	10·54	17·98	34·28
Second cutting, average	32·32	9·39	15·20	38·40

Though not strictly comparable with the averages given for protein, fibre and ash for the 1922 series (on account of the two cuttings in 1923) the following averages for the 1923 series, both cuttings, are of interest:—

	Protein	Fibre	Ash
	p.c.	p.c.	p.c.
Leaf	31·15	9·96	10·42
Stalk	16·59	36·34	9·17

Assuming that the plant as cut consists approximately of equal parts by weight of leaf and stalk, the percentages of protein for the whole plant may be calculated. They are as follows:—

	1922	1923
	p.c.	p.c.
Protein, whole plant	22·30	23·87

These averages show that the plant as a whole did not materially differ in protein content in the two years of the inquiry, although the distribution of the protein between leaf and stalk differs widely in the two years. The apparently exceptionally high figures for protein in leaf in 1923 are balanced, as it were, by a correspondingly low figure for stalk, resulting in an average comparable with data previously obtained in these laboratories for the whole plant.

While this enquiry has undoubtedly placed on record results of scientific and practical value in respect to the sweet clover crop, it has not apparently so far yielded data supporting the view that coumarin content may be materially affected by selection; in other words, it has failed to show that the coumarin content is an inherited, transmitted quality.

INFLUENCE OF EARLY AND LATE PLANTING AND SPROUTING ON THE YIELD AND DRY MATTER CONTENT OF POTATOES

The present record is that for 1924, the fifth year of this enquiry, which in so far as field work is concerned is being carried on at the Experimental Substation, Beaverlodge, Alberta. The experiment was planned by the Superintendent in 1920, and with certain slight annual modifications has been continued every season since that date.

The varieties employed were Country Gentleman and Irish Cobbler.

SERIES I

INFLUENCE OF DATE OF PLANTING AND SPROUTING ON FIELD AND DRY MATTER

Variety: Country Gentleman. Particulars as to dates and yields and the data for the dry matter content per acre, are given in the following table. (No. 17).

TABLE 17.—POTATOES: COUNTRY GENTLEMAN

Yield and Dry Matter, 1924

Laboratory No.	Date of planting	Not Sprouted			Sprouted			
		Yield per acre	Dry Matter		Weeks sprouted	Yield per acre	Dry Matter	
			Per cent	Pounds per acre			Per cent	Pounds per acre
		lbs.				lbs.		
76787	26-4-24	20,944	16·02	3,355				
76788	6-5-24	15,567	16·53	2,574				
76789	6-5-24				1 week	18,887	16·84	3,182
76790	10-5-24	15,754	16,19	2,550				
76791	10-5-24				2 weeks	18,466	17·32	3,199
76792	16-5-24	12,903	16·25	2,096				
76793	16-5-24				3 weeks	15,100	17·72	2,676
76794	23-5-24	14,773	17·83	2,633				
76795	23-5-24				4 weeks	17,250	17·87	3,082
76796	29-5-24	17,110	16·54	2,830				
76797	29-5-24				5 weeks	24,824	16·20	4,021

YIELD PER ACRE

Non-sprouted.—The highest yield per acre is from the earliest (26/4/24) planted crop, the second highest from that latest planted (29/5/24). There are six plantings in all with the yield decreasing from the first four followed by an increase of 1,870 pounds for the fifth week's planting and a further increase of 2,336 pounds for the sixth week.

Sprouted.—These results are eccentric. The yields fall off for the first three plantings, then increase, the results from the latest planting being the highest in the series.

In neither the non-sprouted nor the sprouted series are the 1924 results consistent with those of previous seasons. The explanation is probably to be found at least partially in the exceptionally dry weather which prevailed immediately preceding and following the planting dates. The drought continued until the middle of July.

DRY MATTER CONTENT

Non-sprouted.—The results throughout the series, with the exception of No. 76794 (23/5/24) so nearly agree as to be within the range of experimental error. There may not be any significance to the apparently exceptional results of No. 76794, but from the data of the remaining five samples, it might be concluded that "date of planting" had no influence on the dry matter content.

Sprouted.—While there is a steady though slight increase in the percentage of dry matter as the date of planting is deferred until May 23 (inclusive) the differences are not of such a magnitude as to justify any inferences therefrom. The dry matter of the later planting (29/5/24) is the lowest in the series, but yet it differs from the first by half a per cent.

DRY MATTER PER ACRE

In both the non-sprouted and the sprouted series the pounds of dry matter per acre follow closely the yields—as might be expected from the facts already considered. The exception to this sequence (yield to dry matter per acre) is No. 76794, which, as already noted, has exhibited an apparent irregularity in respect to dry matter content.

SERIES II

INFLUENCE OF SPROUTING ON YIELD AND DRY MATTER

Variety: Irish Cobbler (Estabrook). Plots in quadruplicate; (*a*) green sprouts (*b*) white sprouts and (*c*) no sprouts.

Laboratory No.	Condition	Dry Matter per cent	Yield per acre (Average)	Dry Matter per acre
			lb.	lb.
76789	Green sprouts	18·32	10,046	1,841
76799	White sprouts	19·68	10,996	2,164
76800	No sprouts	18·31	11,780	2,157

The samples in this series were composite in nature, each being made up of tubers from four separate plots. The "yields per acre" were calculated from the averages of these quadruplicate plots. Since the yields of these plots varied greatly, it follows that the averages from them calculated to the acre basis may not represent with any great degree of accuracy, the yields from the green, white and no sprout sets, respectively.

It is to be noted that this series, from Irish Cobbler, has yielded higher percentages of dry matter than the tubers of the Country Gentleman. It would not be safe however from evidence of such a limited character, to draw any final conclusions on this important point for the varieties examined.

The tubers from the "green sprouts" and from the "no sprouts", gave identical results for dry matter content; those from the "white sprouts" possessed a somewhat higher percentage. At present it would be quite unsafe to use these results as a basis for conclusions in this inquiry.

SILAGE*

SUNFLOWERS: OATS: CORN

The five samples of silage here reported on were analyzed for the purpose of furnishing data to be used in certain feeding tests carried on at the Experimental Station, Lacombe and Experimental Station, Lethbridge, Alta.

SUNFLOWERS

Lab'y No. 71664.—From Experimental Station, Lethbridge, Alta. Variety: Mammoth Russian, Received May 5, 1924. Grown on irrigated land and consequently stalks were coarser and taller than from crop on dry land. Crop fairly well matured when cut, some of the more advanced heads with seeds formed. Wilted twelve to thirty hours before ensiled.

As received, silage consisted essentially of stalk with no trace of flower or head, and very little leaf; brownish yellow; somewhat pungent odour but normal; cut moderately fine; decidedly fibrous in appearance.

In respect to dry matter content this silage is slightly above the average, but its low protein and high fibre place it among the poorer grades of sunflower silage.

Lab'y No. 71665.—From Experimental Station, Lacombe, Alta. This sample was forwarded by the Superintendent, Experimental Station, Lethbridge, who had procured it for comparison with sunflower silage produced at Lethbridge (No. 71664).

* Attention may be directed to the bulletin entitled "Silage" No. 50. New Series, issued during the past year. It contains analyses and information on sunflower, corn, sweet clover and other silages.

TABLE 18.—SILAGES, 1924-25

Lab'y No.	Particulars	As Received							Water-free					
									Protein					
		Moisture	Protein	Fat	Carbohydrates	Fibre	Ash	Acidity	Albuminoid	Non-albuminoid	Fat	Carbohydrates	Fibre	Ash
	SUNFLOWER	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
71664	Experimental Station, Lethbridge, Alta	74·21	1·79	1·12	10·08	9·84	2·96	1·75	4·64	2·29	4·32	39·14	38·16	11·45
71665	Experimental Station, Lacombe, Alta	76·96	2·34	1·04	8·65	7·59	3·42	2·30	7·75	2·42	4·51	37·57	32·96	14·79
79462	Experimental Station, Lacombe, Alta	83·08	2·36	1·01	5·82	4·61	3·12	1·16	12·27	1·65	5·99	34·42	27·26	18·41
	OATS													
79463	Experimental Station, Lacombe, Alta	72·72	4·06	1·87	10·81	7·52	3·02	1·22	13·06	1·83	6·87	39·64	27·55	11·05
	CORN													
79464	Experimental Station, Lacombe, Alta	79·28	2·32	1·43	8·84	6·28	1·85	1·96	8·54	2·72	6·88	42·64	30·32	8·90

As received, stalk with a very fair proportion of leaf; flower parts distinguishable; brownish-yellow; pungent odour; cut more finely than No. 71664.

Though this silage contains less dry matter than No. 71664, it is richer in protein and further is superior to the preceding sample in possessing a lower fibre content and a larger proportion of the crude protein in the form of true albuminoids. These points of superiority become more apparent in comparing the silages on the dry matter basis.

Lab'y No. 79462.—From Experimental Station, Lacombe, Alta. Variety: Mammoth Russian. Received May 2, 1925. The plants were fifty per cent in bloom when the crop was cut. Ensiled immediately on cutting.

Colour of silage, dark olive green; very finely cut; large proportion of leaf; flower heads and seeds, not noticeable; odour, characteristically pungent; silage in rather soft condition but no sign of mould; apparently sound.

This sample is decidedly below the average sunflower silage in percentage of dry matter and hence has not the feeding value of silage from a more mature crop, compared weight for weight. However, allowing for its higher water content this silage, as is made evident from a study of the dry matter (water-free) data, compares very favourably with other sunflower silages analyzed in these laboratories.

OATS

Lab'y No. 79463.—From Experimental Station, Lacombe, Alta. Received May 2, 1925. The crop was essentially oats (Banner) but there was a considerable admixture of pigweed. The crop was harvested and ensiled when about fifty per cent of the oats were in the dough stage.

This silage was of an olive-green colour; rather finely cut; odour, not marked; apparently sound, palatable and wholesome.

Compared with samples of oat silage previously examined in these laboratories the present sample is of superior quality, due no doubt in large part to the early stage at which the crop was cut.

CORN

Lab'y No. 79464.—From Experimental Station, Lacombe, Alta. Variety: Northwestern Dent. Received May 2, 1925. The crop was rather seriously frozen when the cobs were beginning to form—at which time it was cut and ensiled.

The sample as received was pale yellowish-green in colour; large proportion of leaf; no cob observable; odour strong but normal; sound and wholesome.

The percentage of water (moisture) is somewhat high for corn silage, no doubt resulting from the immaturity of the crop when cut. This high water content results in the dry matter (20.72 per cent) being about two and a half per cent lower than in average good corn silage. The protein data are satisfactory and the figures for fibre decidedly low. The acidity is below the average. Considered as a whole the analysis indicates a silage of good quality but somewhat low in nutritive value when compared with samples from more mature crops.

SUGAR BEETS FOR FACTORY PURPOSES

This chapter presents in summarized form the results from the 1924 experiments and brings up to date our inquiry, inaugurated in 1902, respecting the influence of seasonal conditions, etc. on the quality of sugar beets as grown in various parts of the Dominion.

The plan of work, in outline, has comprised the growing under approved cultural methods of well-recognized, high sugar varieties at a number of widely

distant points—The Farms, Stations and Substations of the Experimental Farms System—and the analysis at Ottawa of representative beets from the harvested crop.

Of the eight stocks of seed used, seven were obtained from the Dominion Sugar Co., Wallaceburg and Chatham, Ontario, who for a number of years past has generously donated seed for use in this investigation. This company imported the varieties Dr. Bergman, Dippe, Henning and Harving, Horning, Schrieber & Sons, and Sluice Bros., but the seed entitled Kitchener is Canadian grown. The variety Vilmorin's Improved was imported by us specially for this investigation from Vilmorin, Andrieux etc Cie., Paris, France.

The locations of the Experimental Farms and Stations at which this inquiry was conducted are as follows: Charlottetown, P.E.I., Kentville and Nappan, N.S., Fredericton, N.B., Lennoxville, Cape Rouge, Ste. Anne de la Pocatière and La Ferme, Que., Ottawa, Ont., Brandon, Man., Rosthern, Scott and Indian Head, Sask., Fort Vermilion, Beaverlodge, Lacombe and Lethbridge, Alta. and Agassiz, Sidney, Invermere and Summerland, B.C.—twenty-one points distributed among the nine provinces of the Dominion.

Lack of space unfortunately prevents the presentation of the data in detail; their study would prove of interest, not only in showing the differences in quality which may exist between strains or varieties grown under the same conditions of soil and season, but also in tracing a relationship between the factors of size, shape, etc., and sugar content. Two tables of averages, however, have been prepared, the first giving the averages of " sugar in juice " and " coefficient of purity " for the beets from the eight classes of seed, obtained from the data from twenty-one Farms and Stations (Table 19) and the second presenting the data for the average percentage of sugar in juice at the several Stations included in this investigation.

TABLE 19.—SUGAR BEETS: SUGAR IN JUICE AND COEFFICIENT OF PURITY

Averages from the several varieties grown on 21 Experimental Farms and Stations throughout the Dominion.

Source of Seed	Sugar in Juice	Coefficient of Purity
	p.c.	p.c.
Germany—"Dr. Bergman"	17·65	86·29
France—"Dippe"	18·00	85·85
Denmark—"Henning & Harving"	17·93	85·80
Russia (?)—"Horning"	17·85	86·02
Canada—"Kitchener"	17·70	85·80
Germany—"Schreiber & Sons"	17·77	85·96
Holland—"Sluice Bros."	17·80	86·28
France—"Vilmorin's Improved", Vilmorin, Andrieux et Cie, Paris	17·27	85·68

These averages are slightly higher than have been previously obtained, both in respect to sugar content and purity; they indicate an excellent quality for factory purposes and are of especial interest when it is remembered that they are from beets grown at many widely distant points across the Dominion.

It is further to be noted that these results indicate a rather remarkable similarity of quality among the varieties—the differences being slight and showing no outstanding member as the best of the series.

And lastly, it is satisfactory to observe that Canadian-grown seed has produced beets fully equal in sugar content and purity to those from imported seed of the most approved European varieties. In this the 1924 results fully confirm those of the previous seven years and establish the fact that within the boundaries of the Dominion, sugar beet seed of the highest grade can be produced.

Table 20 is still more interesting. It presents averages for the percentage of sugar in juice obtained on the several Farms and Stations in the Dominion for the season of 1924, each result being the average of the eight varieties under experiment. Averages similarly obtained for the preceding five years are included in the table for the purposes of comparison.

TABLE 20.—AVERAGE PERCENTAGE OF SUGAR IN JUICE IN SUGAR BEETS GROWN ON DOMINION EXPERIMENTAL FARMS AND STATIONS—1919-1924

Locality	1919	1920	1921	1922	1923	1924
Charlottetown, P.E.I.	18·33	16·44	16·40	.....	18·67	19·23
Kentville, N.S.	19·25	18·36	18·06	18·72	20·43	24·71
Nappan, N.S.	17·83	18·01	18·08	18·45	17·61	16·98
Fredericton, N.B.	20·94	18·34	18·09	16·61	15·60	21·42
Lennoxville, Que.	15·91	14·55	16·01	15·12	15·99	17·51
Cap Rouge, Que.	16·88	16·69	17·04	21·27	18·61	.....
Ste. Anne de la Pocatiere, Que.	18·89	13·24	17·31	17·69	15·30	19·72
La Ferme, Que.	16·05	.....	.....	.....	.....	.....
Ottawa, Ont.	17·79	15·09	15·61	16·44	16·16	16·36
Brandon, Man.	.....	15·24	16·82	14·14	12·19	13·36
Rosthern, Sask.	.....	14·15	13·56	17·27	13·13	14·19
Scott, Sask.	14·39	15·74	15·79	17·25	19·21	15·71
Indian Head, Sask.	15·68	20·24	.....	19·70	20·12	17·10
Fort Vermilion, Alta.	17·35	.....	14·47	16·00	14·32	13·01
Beaverlodge, Alta.	.....	.....	15·77	.....	19·16	.....
Lacombe, Alta.	.....	12·86	13·84	15·77	.....	.....
Lethbridge, Alta. (irrigated)	14·31	18·34	17·99	17·04	17·21	18·85
Lethbridge, Alta. (non-irrigated)	.....	19·35	16·63	17·57	15·92	.....
Agassiz, B.C.	17·02	16·46	15·87	16·67	17·62	16·75
Sidney, B.C.	17·98	14·29	.....	.....	16·67	14·90
Invermere, B.C.	14·72	19·26	15·78	17·56	20·02	17·44
Summerland, B.C.	.....	16·85	20·03	17·36	16·92	20·08

The results from Charlottetown, P.E.I., Kentville, N.S., Fredericton, N.B., Ste. Anne de la Pocatière, Que., Lethbridge, Alta., and Summerland, B.C. stand out as exceptionally high—considering they are averages from representative samples; indeed, in all but a few instances the data are those of beets which would prove quite satisfactory for sugar production. In six instances the sugar in juice averaged over 18 per cent and in six others it averaged between 16 and 18 per cent; in four cases only did it fall below 15 per cent.

This chapter, as has been stated, merely summarizes the results of this inquiry, but it affords satisfactory evidence of the possibility of growing, in many widely distant districts of the Dominion, beets of excellent quality and eminently suitable for sugar production.*

FARM OR FIELD ROOTS

For a number of years past the division has determined the relative feeding value, as measured by dry matter and sugar content, of the leading varieties of farm roots—mangels, turnips and carrots. This work has very clearly shown that large differences in this respect exist, not only between the several classes of farm roots, but also between varieties or strains in the same class.

Undoubtedly, farm roots have a value in the ration of live stock apart from their nutritive content; they are most useful in the maintenance of the health and thrift of the animal and this medicinal effect is perhaps the most important role played by them in the animal economy. It is nevertheless well worth while to know the varieties which have the highest dry matter content, for these assuredly will be the most valuable to sow, provided that other factors, as yield per acre, cost of harvesting, keeping quality are not overlooked.

* The report of this division for the year ending March 31, 1922, contains a table (page 72) presenting the yearly average percentage of sugar in beets grown and tested in this inquiry for the period 1902-1921.

MANGELS

The series comprise 141 varieties or strains grown on the Central Farm, Ottawa, during the season of 1924 under the direction of the Division of Forage Plants. The seed was obtained from a large number of sources—domestic and foreign.

The large differences which may occur in this class of roots will be apparent when it is stated that the range in dry matter content was from 15·04 to 6·53 per cent and in sugar from 8·05 to 1·03 per cent.

Since complete and detailed data cannot be included in this report the results may be summarized as follows in respect to percentage of dry matter.

Two varieties contained between 14 and 15 per cent (Leviathan and Half Sugar White).
Six varieties contained between 13 and 14 per cent. (Mammoth Prize Long Red, Select Giant Rose Intermediate Sugar, Yellow Globe, Gatepost, Giant Half Sugar and Yellow Intermediate).
Fourteen varieties contained between 12 and 13 per cent.
Thirty varieties contained between 11 and 12 per cent.
Thirty four varieties contained between 10 and 11 per cent.
Twenty six varieties contained between 9 and 10 per cent.
Nineteen varieties contained between 8 and 9 per cent.
Seven varieties contained between 7 and 8 per cent.
Three varieties contained between 6 and 7 per cent.

The following table (No. 21) presents the averages for dry matter and sugar for the past twenty years. The results for the past season (1924) are decidedly low, due in a large measure no doubt to the unfavourable conditions, cool and wet weather, which prevailed during August and September.

TABLE 21.—MANGELS—DRY MATTER AND SUGAR IN JUICE, 1904-1924

Year	Number of varieties analysed	Average weight of one root		Dry Matter	Sugar in juice
		lbs.	oz.	p.c.	p.c.
1904	10	2	11	11·69	6·62
1905	17	3	9	10·04	4·67
1906	16	2	7	11·63	5·93
1907	10	2	11	12·64	7·46
1908	12	2	2	11·87	5·33
1909	14	3	5	11·21	6·21
1910	8	5	10	10·04	4·46
1912	23	2	9	9·51	6·43
1913	13	2	14	10·51	5·63
1914	24	2	1	12·79	7·75
1915	36	3	9	9·25	4·27
1916	26	2	..	8·86	2·66
1917	31	1	15	12·64	6·72
1918	13	2	4	11·78	6·13
1919	80	..	14	12·58	6·26
1920	42	3	8	9·18	4·07
1921	41	3	..	9·73	4·00
1922	50	2	13	12·81	5·93
1923	129	2	10	12·37	5·27
1924	141	2	12	10·42	4·49
Average for 20 years	.....	2	11	11·08	5·51

TURNIPS

According to the analysis turnips possess a decidedly lower feeding value than mangels, partly due to slightly less dry matter but more particularly to the fact that they contain much less sugar.

Another feature in which turnips differ from mangels is that in dry matter content the several varieties show much less range or spread; between the richest and poorest the difference in feeding value is not of the same magnitude as in the case of mangels.

This series of swede turnips contained twenty-four varieties or strains, some of which were grown for the first time in this inquiry at Ottawa during the past season.

The range in dry matter content was from 12·35 to 9·83 per cent and in sugar from 2·36 to ·61 per cent.

The following summarized classification in respect to dry matter content will be of interest:—

One variety contained 12·35 per cent. (Hartley's Bronze Top).
Four varieties contained between 11 and 12 per cent (White Swede, Sutton's Champion Purple Top, Derby Green Top and Purple Top).
Fifteen varieties contained between 10 and 11 per cent.
Four varieties contained between 9 and 10 per cent.

Averages for the eighteen-year period 1905-24, for dry matter and sugar, are given in the following table (No. 22). The results for the past season (1924) are somewhat low in both dry matter and sugar.

TABLE 22.—TURNIPS: DRY MATTER AND SUGAR IN JUICE, 1905-1924

Year	Number of varieties analysed	Average weight of one root		Dry Matter	Sugar in juice
		lbs.	oz.	p.c.	p.c.
1905	20	2	13	10·00	1·10
1906	20	1	10	12·18	1·78
1907	14	3	5	10·14	1·11
1908	13	3	12	9·87	1·52
1909	13	2	10	11·30	1·43
1910	10	3	11	10·87	1·07
1912	19	3	12	8·65	1·10
1913	19	2	14	9·58	1·54
1914	30	2	..	9·68	0·76
1915	33	2	6	9·60	1·29
1916	33	1	13	10·67	0·92
1917	58	1	13	11·04	1·41
1918	16	1	..	11·18	1·06
1919	95	..	13	12·10	1·11
1920	22	1	12	12·60	1·84
1922	41	1	10	11·46	1·09
1923	126	1	8	11·22	0·61
1924	24	1	7	10·61	·94
Average for 18 years	.....	2	2	10·70	1·15

CARROTS

Forty-six varieties or strains of carrots were submitted to analysis, the series showing a very considerable range in both dry matter and sugar. The seed in the larger number of instances was from Canadian sources, but the series also contained roots from seed imported from Denmark and Sweden by the Forage Plant Division, under the direction of which all the field roots in this inquiry were grown.

The detailed data are of considerable interest but as these cannot be inserted it must suffice to summarize the results, as follows:—

The range in dry matter content was from 15·45 to 9·37 per cent and in sugar from 6·04 to 1·21 per cent.

In respect to dry matter the classification is as follows:—

One variety contained 15·45 per cent. (Champion, Sweden).
One variety contained 14·10 per cent. (Long Orange, Hamilton, Ont.).
Four varieties contained between 13 and 14 per cent. (Mammoth Half Long White, Yellow Belgian, James, White Belgian).
Eleven varieties contained between 12 and 13 per cent.
Fourteen varieties contained between 11 and 12 per cent.
Fourteen varieties contained between 10 and 11 per cent.
One variety contained between 9 and 10 per cent.

Averages for the past nineteen years during which this inquiry has been prosecuted are presented in table 23. The carrots of 1924 are somewhat lower in dry matter than those of the two preceding years, but slightly higher than the average for the whole experimental period.

TABLE 23.—CARROTS: DRY MATTER AND SUGAR IN JUICE, 1905-1924

Year	Number of varieties analysed	Average weight of one root	Dry matter	Sugar in juice
		lbs. oz.	p.c.	p.c.
1905	11	1 3	10·25	2·52
1906	10	1 2	10·59	3·36
1907	6	1 1	10·30	3·02
1908	6	1 3	10·89	3·34
1909	6	1 ..	10·40	2·30
1910	5	1 ..	10·17	3·23
1912	6	1 1	10·50	2·54
1913	6	1 8	9·11	2·11
1914	8	1 10	11·42	2·62
1915	10	.. 6	10·08	1·86
1916	10	.. 7	11·40	2·87
1917	13	.. 10	12·69	2·92
1918	3	.. 6	12·13	5·30
1919	36	.. 7	12·04	2·79
1920	15	1 7	9·48	2·25
1921	13	1 4	9·78	2·23
1922	23	1 3	12·04	2·28
1923	49	1 1	12·67	2·43
1924	46	.. 8	11·64	2·44
Average for 19 years	.....	14·6	10·92	2·75

The following table (No. 24) of summarized data is of considerable interest since it presents the averages from many hundreds of varieties of mangels, turnips, and carrots grown on the Central Farm, Ottawa, over an experimental period approaching twenty years.

TABLE 24.—AVERAGE DRY MATTER AND SUGAR IN JUICE OF MANGELS, TURNIPS, AND CARROTS

Class of Root	Dry matter	Sugar in juice
	p.c.	p.c.
Mangels. Average for period of 20 years	11·07	5·50
Turnips " " " " 18 "	10·70	1·15
Carrots " " " " 19 "	10·91	2·75

INSECTICIDES AND FUNGICIDES

A large portion of the investigatory work with insecticides and fungicides has been carried on in co-operation with members of the staff of the Entomological Branch at Annapolis Royal, N.S., where there are facilities for closely correlating laboratory results with practical experience in the orchard. This collaboration of chemist and entomologist has already given satisfactory promise of materially advancing our knowledge of sprays and dusts and their respective values in combating insect and fungus pests.

The details of this investigatory work are too voluminous for this report; it will suffice for present purposes to present very briefly the analyses of certain insecticides and allied materials submitted for examination. In view of the rapidly increasing use of spraying and dusting materials in all fruit-growing districts of the Dominion, the information thus afforded becomes of considerable practical value.

PARIS GREEN

This is the oldest and in many districts still the most popular of the arsenical poisons used as an insecticide. It is widely employed for the control of the potato bug and with Bordeaux mixture as a combined spray for orchard work. Cheaper and for some purposes equally effective arsenical compounds, however, have to some extent in recent years taken its place.

Three samples, all of different manufacture, are now reported on.

ANALYSIS OF PARIS GREEN, 1924-5

Lab'y No.	Source of Sample (Manufacturer)	Vendor or Submitter	Arsenious Oxide (As_2O_3)		Cupric Oxide (CuO)	Residue insoluble in ammonia
			Total	Water-soluble		
			p.c.	p.c.	p.c.	p.c.
71898	Mfg. for Dupuy & Ferguson.....	Domina Robert, St. Michel, Que.	56·97	0·89	30·47	Trace
71899	Lewis Berger & Sons, Ltd., London, England.	" " "	51·13	1·42	30·79	"
78280	Perry & Hope, Ltd., Nitshill, Glasgow.	Morrison and Robinson, Winnipeg, Man.	55·02	1·29	30·36	"

In total arsenious oxide all three samples are perfectly satisfactory; in two samples the percentage of water-soluble arsenious oxide slightly exceeds the generally accepted safety limit. No. 71898 is by a small margin the best of the series, but all three are well made and free from adulterants.

The accepted standards in Canada for Paris Green have been: total arsenious oxide (As_2O_3), not less than 50 per cent; water-soluble arsenious oxide, not more than 1· per cent.

ARSENATE OF LEAD

Of the six samples of arsenate of lead examined, five met very satisfactorily the requirements, viz., total arsenic oxide (As_2O_5) not less than 31 per cent water-soluble arsenic oxide not more than .5 per cent. One sample (No. 72113) was a distinctly fraudulent material, containing little more than traces of arsenic oxide.

ANALYSIS OF ARSENATE OF LEAD, 1924-5

Lab'y No.	Source of Sample (Manufacturer)	Vendor or Submitter	Arsenic Oxide (As_2O_5)		Lead Oxide (PbO)	Moisture (at 100° C.)
			Total	Water-soluble		
			p.c.	p.c.	p.c.	p.c.
71643	Imperial Trading Co., Montreal, Que.	Dominion Entomologist, Ottawa.	31·15	0·11	64·43	0·51
71644	Deloro Chemical Co., Deloro, Ont.	" " ..	30·37	0·06	63·61	0·25
71645	"Corona," Niagara Brand Spray Co., Burlington, Ont.	" " ..	31·50	0·28	63·30	0·21
78765	Deloro Chemical Co., Deloro, Ont.	A. Kelsall, Annapolis Royal, N.S.	32·48	0·91*	62·78	0·14
78767	Canada Paint Co., Montreal, Que.	" ..	30·48	0·38	65·79	0·31
72113	John Dorland, Cobalt, Ont.....	Stanislas Dolpé, Waterloo, Que.	0·10	0·09	Calcium sulphate 90·72 Calcium carbonate 7·56	

*This percentage while not exceeding the usually accepted limit is decidedly higher than is desirable.

No. 72113 is essentially a mixture of sulphate and carbonate of lime, with traces only of arsenic. In addition to its uselessness as an insecticide, attention may be drawn to the fact that it contained innumerable fine hairs, about one and a half inches long, which undoubtedly would quickly clog the spraying apparatus. The sample, which is in the form of a fine white powder, was received in an original container. This is probably as gross a case of fraud—it does not contain sufficient arsenic to be considered simply as adulterated—as has been met with in our examination of insecticidal preparations.

SULPHUR PREPARATIONS

Under this caption the analysis is given of a number of insecticidal and fungicidal preparations in which sulphur—in fine powder or colloidal—is an important or a dominating element.

SUKOL COLLOIDAL SULPHUR (CONCENTRATED)

Lab'y No. 71689.—This preparation, a dark yellow coloured liquid from which a dense sulphur-like mass had separated out and formed a lower layer, was obtained from the Imperial Trading Co., Montreal. It was submitted for examination by the Dominion Entomologist, who had it under test on apples and peaches at the Vineland (Ontario) Station.

ANALYSIS

Water	58·50
Sulphur (free)	34·49
Calcium sulphate	3·07
Glue (N. x 5·6)	1·55
Undetermined*	2·39
	100·00

*Containing traces or small percentages of lime, thio-sulphates and insoluble matter.

This is a neutral, colloidal suspension of sulphur, containing approximately 35 per cent of free sulphur, with about 1·5 per cent of glue to aid in maintaining the colloidal condition of the preparation.

NIAGARA 3 IN 1

Lab'y No. 71976.—Manufactured by the Niagara Dust Co., Kentville, N.S., and submitted for examination by the Superintendent, Experimental Station, Kentville, N.S.

A very fine dust of a light brownish colour, with a pronounced odour of nicotine.

ANALYSIS

	Found per cent	Guarantee—as stated on label per cent
Sulphur	54·11	50·0
Nicotine	0·34	tobacco 40·0
Arsenate of lead	9·24	10·0
Water-soluble arsenic oxide	0·75	

In percentage of free sulphur this "dust" very fully meets its guarantee; in arsenate of lead it is three-quarters of a per cent below its guarantee.

With respect to nicotine content it is impossible to say how closely the guarantee is met, since the label merely states the percentage of tobacco present—and the nicotine content of tobacco is extremely variable. It would be more satisfactory if the manufacturer guaranteed a definite percentage of the active ingredient, nicotine.

The carrier is hydrated dolomitic lime, which according to certain authorities is one of the most effective liberators of nicotine in preparations of this character.

NIAGARA 90 : 10

Lab'y No. 72266.—Manufactured by the Niagara Dust Co., Kentville, N.S. A fine yellowish-grey powder.

ANALYSIS

	Found	Guaranteed
	p.c.	p.c.
Sulphur (free)	83·40	90·0
Arsenate of lead	10·84	10·0
Water-soluble arsenic oxide (As_2O_5)	0·59	

This preparation meets its guarantee in respect to lead arsenate but is low in sulphur. There is present a small percentage of lime (from dolomitic limestone), which, it is held, is of value in facilitating the flow or distribution of the "dust."

SULPHUR-LEAD ARSENATE DUST 85 : 15

Lab'y No. 72267.—Manufactured by the Deloro Chemical Co., Ltd., Deloro, Ont. A fine, pale-yellow dust showing particles of lime throughout the mixture.

ANALYSIS

	Found	Guarantee
	p.c.	p.c.
Sulphur (free)	41·42	85·0
Arsenate of lead	12·17	15·0
Water-soluble arsenic oxide (As_2O_5)	0·50	

This preparation is very seriously below its guarantee, both in free sulphur and arsenate of lead. Orchardists expecting results from this dust as from an 85:15 formula (its guarantee) would undoubtedly be disappointed—more especially in its effect as a fungicide. It would appear to be one of the worst cases of failure to comply with the guarantee met with in our examination of this class of products.

This dust contains approximately 40 per cent of lime, the influence of which is doubtful.

WETTABLE SULPHUR

Lab'y No. 74201.—Manufactured by the Deloro Chemical Co., Deloro, Ont. This sample was received for analysis from the Entomological Laboratory, Vineland Station, Ontario, with the statement that it had caused defoliation on Rochester and Yellow Swan peaches.

ANALYSIS

Moisture, at 100° C.	2·68
Sulphur, free	80·60
Lime (CaO)	9·66
Oxide of lead (PbO)	0·12
Arsenic oxide (As_2O_5)	4·13
Arsenious oxide (As_2O_3)	0·86
Undetermined	1·95
	100·00
Water-soluble arsenic oxide	0·73
Water-soluble arsenious oxide	0·84

The "undetermined" in this analysis contains oxide of iron and alumina and probably a trace of calcium caseinate.

This analysis discloses the cause of the defoliation referred to by the Entomologist of the Vineland Station, viz. the presence of appreciable amounts of water-soluble oxides of arsenic—the foliage of the peach being particularly susceptible to arsenical injury.

Further, our work on this sample showed that this product had been poorly prepared, in that there is no formation of foam or lather on shaking with water for from five to ten minutes—the mass of sulphur, etc., settling quickly, leaving a practically clear supernatant fluid.

BORDEAUX DUSTS

Lab'y No. 71975.—"Niagara Apple Bordeaux Dust" manufactured by the Niagara Dust Co., Kentville, N.S.

A white, fluffy powder.

ANALYSIS

	Found	Guarantee
	p.c.	p.c.
Hydrated lime $Ca(OH)_2$	53·24	78·0
Magnesia (MgO)	24·06	
Sulphate of copper ($CuSO_4$)	11·03	12·0
Arsenate of lead ($PbHAsO_4$)	10·23	10·0
Water-soluble arsenic oxide (As_2O_5)	0·37	

Though a little below the guarantee in anhydrous copper sulphate, the statement of quality as given on the label, viz., the proportion of Bordeaux and arsenate of lead, is sustained by the analysis.

Lab'y No. 78592.—"Lead Bordeaux Dust, 12:10:78," manufactured by the United Fruit Co., Kentville, N.S.

A finely ground bluish-grey dust, with slight tendency to cake.

ANALYSIS

	Found	Guaranteed
	p.c.	p.c.
Arsenate of lead ($PbHAsO_4$)	9·85	10·0
Sulphate of copper ($CuSO_4$)	10·27	12·0
Lime (CaO)	50·10	
or as		
Hydrated lime $Ca(OH)_2$	66·2	78·0
Water-soluble arsenic oxide (As_2O_5)	0·51	

This product meets fairly closely its guarantee. Its colour denotes changes due to age—the production of carbonates with formation of water-soluble arsenical compounds, the proportion of which latter in this preparation is decidedly high. There would seem a strong probability that this dust would cause injury to foliage.

Lab'y No. 78766.—"Deloro Bordeaux 5:3" manufactured by the Deloro Chemical Co., Deloro, Ont.

A bluish-white powder, somewhat gritty due to hard green particles.

ANALYSIS

	Found	Guarantee
	p.c.	p.c.
Copper, as metallic copper	4·96	5·0
Arsenic, as metallic arsenic*	1·32	3·0
Water-soluble arsenic oxide (As_2O_5)	0·04	

*Equivalent to 2·01 per cent calculated as arsenic oxide (As_2O_5).

The arsenic is present as arsenate of lime. While the percentage of water-soluble arsenic as determined by the usually accepted method is quite satisfactory, the amount liberated by passing carbon dioxide through acqueous suspension of the dust was ·45 per cent—a concentration likely to prove injurious to foliage. In respect to percentage of copper the guarantee is satisfactorily met.

TOBACCO DUST

Lab'y No. 72618.—Special Tobacco Dust. Manufactured by Niagara Dust Co., Kentville, N.S.

A brownish coloured dust with a slight odour of nicotine; strongly alkaline and effervescing vigorously on addition of acids.

ANALYSIS

Arsenate of lead ($PbHAsO_4$)	11·19
Nicotine	0·53
Sulphur (free)	Nil
Lime (CaO)	39·22
Magnesia (MgO)	13·85

The general composition of this dust may be stated as follows:—

Hydrated lime	65·0
Arsenate of lead	11·0
Refuse tobacco, containing 0·53 per cent nicotine	24·0
	100·00

This "dust," we understand proved unsatisfactory in the orchard and has since been withdrawn from the market.

It may be well to observe, in connection with dusts of this character, that a statement with respect to the percentage of tobacco present is not any guarantee as to the amount of the active ingredient, nicotine, which it contains.

STERLING RED PARAFFIN OIL

Lab'y No. 69215.—This oil was submitted for examination by the Entomologist in charge of the Vineland Station and was in use for the preparation of an insecticidal emulsion.

ANALYSIS

Appearance	red
Ash	·004
Volatility (loss at 105°–110° C. after 4 hours)	·41
Flash point (open cup)	186·2° C.
Ignition point (open cup)	205·3° C.
Viscosity (10 cc. pipette at 20° C.)	17·0
Specific gravity (Westphal at 20° C.)	·898
Reaction to litmus	neutral

These data are in very fair accord with those of oils which have been satisfactorily used in the preparation of insecticidal emulsions.

HYDRATED LIME

This product is specially prepared for use in the making of sprays and dusts; for this purpose it should be free from foreign matter and all grittiness.

A series of seven samples was submitted by the Entomological Branch and the data from our examination are presented in tables 26 and 27. Table 26 in addition to particulars of brand and source give the detailed analytical data, the percentage of fineness and the apparent density. Table 27 presents the chemical data in combined form.

TABLE 26.—HYDRATED LIMES—BRAND AND SOURCE, DETAILED ANALYTICAL DATA, PERCENTAGE OF FINENESS AND APPARENT DENSITY

Lab'y. No.	Brand and source	Silica (SiO_2)	Oxides of iron and alumina ($Fe_2O_3 + Al_2O_3$)	Lime (CaO)	Magnesia (MgO)	Sulphuric anhydride (SO_3)	Carbonic anhydride (CO_2)	Water		Fineness	Apparent density
								Hygroscopic	Combined		
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
77214	Hydrated lime, The Albastine Co., Paris, Ont.	0·35	1·09	46·50	31·34	0·46	4·80	0·81	14·65	99·2	46·8
77809	Agricultural Hydrated Lime, The Albastine Co., Paris, Ont.	0·45	1·10	48·45	32·20	0·29	2·43	0·18	14·90	99·4	46·6
77810	Hydrated Finishing Lime, The Albastine Co., Paris, Ont.	0·43	1·02	48·25	32·67	0·25	1·44	0·02	15·92	99·8	46·7
77829	Hydrated Lime, Standard White Lime Co., Guelph, Ont.	0·63	0·82	49·40	35·43	0·33	1·31	.....	12·08	99·3	46·5
77830	Hydrated Lime, The Albastine Co., Teeswater, Ont.	1·32	1·20	46·60	31·17	0·60	4·39	0·84	13·88	99·0	44·6
77838	White Hydrated Lime, Christie Henderson Co., Hespeler, Ont.	0·22	0·74	47·80	35·10	0·54	1·12	0·02	14·46	99·8	45·3
77839	Grey Hydrated Lime, Christie Henderson Co., Hespeler, Ont.	1·10	1·47	47·45	34·20	0·18	2·99	0·69	11·92	99·0	45·1

TABLE 27—HYDRATED LIMES—RESULTS IN COMBINED FORM

Lab'y. No.	Silica (SiO_2)	Oxides of iron and alumina (Fe_2O_3 + Al_2O_3)	Calcium sulphate ($CaSO_4$)	Calcium carbonate ($CaCO_3$)	Calcium oxide (CaO)	Magnesium oxide (MgO)	Water	
							Hydroscopic	Combined
	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
77214	0·35	1·09	0·78	10·92	40·06	31·34	0·81	14·65
77809	0·45	1·10	0·49	5·53	45·15	32·20	0·18	14·90
77810	0·43	1·02	0·43	3·27	46·24	32·67	0·02	15·92
77829	0·63	0·82	0·55	2·98	47·51	35·43	.....	12·08
77830	1·32	1·20	1·01	9·98	40·60	31·17	0·84	13·88
77838	0·22	0·74	0·92	2·55	45·99	35·10	0·02	14·46
77839	1·10	1·47	0·30	6·80	43·52	34·20	0·69	11·92

All the samples may be considered of excellent quality both from the standpoint of composition and physical condition. They consist essentially of hydrated lime and hydrated magnesia, with varying but small amounts of the caustic (non-hydrated) oxides.

The amount of matter insoluble in acid (silica) is very small (except in the case of Nos. 77830 and 77839), betokening in the first instance a high grade of limestone rock, which throughout the series has evidently been dolomitic.

Nos. 77810 and 77838 may be particularly mentioned as "flowing" very freely, a desirable quality in dusts.

No. 77829 contains a certain small percentage of caustic (quick) lime and magnesia, in other words, the oxides had not been fully hydrated. While this would not in any way affect the value of the material in the preparation of sprays, we are inclined to think it might be a factor of more or less importance in "dusts."

Nos. 77214 and 77830 contain notable percentages of carbonates. In the present stage of our knowledge it is impossible to say how far this may be an undesirable feature in hydrated limes to be used as dusts.

FORMALDEHYDE

Lab'y No. 70578.—Manufactured by the Standard Chemical Co. Ltd., Montreal and submitted for examination by the Division of Illustration Stations.

ANALYSIS

Formaldehyde, by volume	37·94 per cent.
Specific gravity at 20°C	1,0835

The label stated 40 per cent of formaldehyde by volume; the percentage found is lower than that stated but is quite similar to that usually present in the various brands on the market, viz. from 37 to 39 per cent.

LARVEX

Lab'y No. 78859.—Manufactured by the Larvex Corporation, New York and St. Louis, U.S.A. Submitted for examination by the Entomological Branch, Ottawa.

A colourless, limpid, non-inflammable fluid, with a faint (unidentified) odour.

ANALYSIS

Total solids, at 212° F.*	1·60 per cent
Sodium fluoride	1·14 "
Arsenic, as As_2O_3, approximately 2 p.p.m.	

*Containing traces of silica, iron, alumina, etc.

This preparation is essentially a 1 per cent solution of sodium fluoride.

The slight traces of silica, etc., present are to be considered merely as the natural impurities in the commercial sodium fluoride used, and are of no moment.

The arsenic present does not exceed the amount permitted by the Foods and Drugs Act (Department of Health, Canada) in baking powders, preservatives, colours used in foods, etc., which ranges from 1 to 10 parts per million; it may therefore be considered, from the standpoint of danger in use, as negligible.

INSECT POWDERS

Lab'y No. 71668.—Imported as an insecticide from France under the name of "Poudre foudroyante Roseau" by M. Hy L. A. Moronval, Montreal, P.Q.

It is a fine, light brown coloured powder, with a distinct odour of the oil of citronella.

Analysis shows that its principal constituent is carbonate of lime (74.59 per cent), coloured with oxide of iron (3.75 per cent). The active ingredients are apparently flowers of sulphur (13.08 per cent) and pyrethrum (1.96 per cent). The small quantity of oil of citronella present cannot be of any material value. The carbonate of lime is naturally a carrier or vehicle, permitting the more ready and efficient distribution of the sulphur. The oxide of iron is merely added to colour the mixture.

ALUM

Lab'y No. 78634.—Manufactured by Brace & Co., and submitted for examination by the Dominion Entomologist.

ANALYSIS

Aluminium potassium Sulphate $(Al_2SO_4)_3\ K_2SO_4,\ 24\ H_2O$	99·92 per cent
Silica	0·09 "

This alum is of high grade quality, foreign matter being present in traces only.

ORBITE

Lab'y No. 75748.—A tree branding composition manufactured by Kay Bros., Ltd., Stockport, England, and submitted for examination by the Dominion Horticulturist.

A yellowish brown viscous, sticky substance, with very faint acid reaction.

Examination indicates that it has been prepared by boiling resin with castor, rape seed or linseed oil to the proper consistency.

The partial analysis to which it was subjected did not reveal the presence of any substance or chemical likely to prove injurious to the trees on which it may be used.

We judge from its exceedingly "tacky" nature that this preparation would prove effective for entrapping or holding insects.

DAK

Lab'y No. 75749.—Manufactured by Kay Bros., Ltd., Stockport, England, and submitted for examination by the Dominion Horticulturist.

This is described as a "non-poisonous, sticky ratlime, for trapping rats, mice, ants, cockroaches, flies, etc.—no germs, no danger."

A dark yellowish-brown, very sticky substance, of a gummy semi-rubbery consistency. Odour of organic chemical used as solvent—probably a benzene.

Analysis shows the absence of poisons as commonly used in rat exterminations—arsenic, barium, etc. Resin and rubber are apparently the chief constituents, brought to the desired consistency with a suitable and common solvent.

The physical condition of this material would indicate a high efficiency in holding small rodents.

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

During the past year two thousand five hundred and two samples were examined and reported on.

As in previous years this report is limited to a brief summary of the analytical results obtained for each class of product.

CLASSIFIED LIST OF THE SAMPLES REPORTED ON DURING THE YEAR 1924-25

Condensed and evaporated milks	1,404
Milk powders	205
Evaporated apples	412
Colours and inks	4
Spices and condiments	29
Salts and preservatives	10
Denaturing oils	31
Lards, lard compounds and edible oils	23
Canned and preserved fruits	236
Sausages, potted and preserved meats	45
Canned vegetables and tomato products	45
Miscellaneous	32
Dehydrated fruits and vegetables	26
Total	2,502

CONDENSED AND EVAPORATED MILKS

Fourteen hundred and four samples were examined. A complete summary of results is given in table 28.

TABLE 28.—SUMMARY OF RESULTS OF ANALYSES OF CONDENSED AND EVAPORATED MILKS

Description	Net weight			Total solids			Fat		
	Number of samples	Net weight	Per cent number under weight	Number of samples	Total solids	Per cent number below standard	Number of samples	Fat	Per cent number below standard
		oz.			p.c.			p.c.	
Condensed	455	Ave. 14·0	32				512	Ave. 8·29	4
		Max. 15·13						Max. 10·29	
		Min. 13·39						Min. 6·89	
	59	Ave. 7·02	32						
		Max. 7·22							
		Min. 6·83							
Evaporated	710	Ave. 16·15	20	478	Ave. 31·70	Nil.	474	Ave. 9·16	1·5
		Max. 16·67			Max. 33·25			Max. 10·09	
		Min. 14·88			Min. 30·0			Min. 8·93	
	7	Ave. 11·86		404	Ave. 26·17		405	Ave. 7·89	
		Max. 12·67			Max. 29·14			Max. 8·13	
		Min. 11·59			Min. 25·54			Min. 7·62	
	162	Ave. 6·14	14						
		Max. 6·47							
		Min. 5·55							

Sixty two samples (12 per cent) of condensed milk were found to have "Sugar down," that is, a deposit of milk sugar at the bottom of the can.

One can only of evaporated milk was found to have undergone gaseous fermentation and to be quite unfit for edible purposes.

Although the percentage numbers of condensed milks under weight is rather high, on the whole the results indicate a very satisfactory condition in the condensed and evaporated milk industry.

SKIM-MILK, WHOLE MILK AND MALTED MILK

Two hundred and five samples were examined. A complete summary of results is given in table 29.

All samples examined were found to be free from borates, carbonates or bicarbonates.

TABLE 29.—SUMMARY OF RESULTS OF ANALYSES OF WHOLE MILK, SKIM MILK AND MALTED MILK PRODUCTS

Description	Moisture			Ash		Fat		
	Number of samples	Moisture per cent	Per cent number above standard	Number of samples	Ash per cent	Number of samples	Fat per cent	Per cent number below standard
Skim milk powder	140	Ave. 2·53 Max. 4·73 Min. 1·08	Nil	140	Ave. 8·17 Max. 8·64 Min. 7·77			
Whole milk powder	64	Ave. 1·38 Max. 3·05 Min. 0·55	Nil	64	Ave. 5·52 Max. 7·40 Min. 3·75	49 9	Ave. 26·79 Max. 28·92 Min. 24·87 Ave. 42·73 Max. 44·45 Min. 41·63	12
Malted milk powder	1	2·54		1	3·07	1	8·58	

Six samples of "Trucream" milk powder were examined. The average maximum and minimum percentages of fat were 69.74, 71.91 and 64.45, respectively.

EVAPORATED APPLES

Four hundred and twelve samples were examined.

Table 30—gives a comparison of the results of analysis for the last five years.

TABLE 30.—WATER CONTENT OF EVAPORATED APPLES

Year	Number of samples	Water per cent			Number of samples containing water in excess of standard (25 per cent)	Per cent number containing water in excess of standard
		Average	Maximum	Minimum		
1920–21	449	21·4	33·5	8·5	43	9½
1921–22	729	20·6	29·9	5·1	44	6
1922–23	604	21·4	33·3	2·8	101	17
1923–24	300	22·1	31·1	6·2	53	18
1924–25	412	21·8	31·3	4·8	56	14

SPICES AND CONDIMENTS

Twenty-nine samples were examined.

Three were found to be adulterated.

SALTS AND PRESERVATIVES

Ten samples were examined. All samples were free from adulteration. Two samples of "Bonsante", preservative for jams, were examined. They were found to be about 25 per cent solution of formic acid in water.

COLOURS AND INKS

Four samples of colour were examined. Two were found to be non-permissible colours. All samples were free from arsenic. Two branding inks were examined and were found to be satisfactory.

DENATURING OILS

Thirty-one samples were examined. A summary of results is given in table 31.

TABLE 31.—NUMBER AND PERCENTAGE NUMBER OF DENATURING OILS, WHICH SATISFY VARIOUS STANDARD TESTS

Tests	Standards required	Satisfied requirements	
		Number	Percentage number
All		14	45
Flash point	Not below 75°C (167° F)	27	87
Boiling point	Not below 205° C (401° F)	18	58
Specific gravity	Not below 0·819	31	100
Taste	Easily recognized when present in proportion 1 part oil to 1,000 parts fat	24	77

LARDS, LARD COMPOUNDS AND EDIBLE OILS

Twenty-three samples were examined. Three samples of lard gave low values for the melting points of the glycerides of the fatty acids and were considered to be adulterated.

CANNED AND PRESERVED FRUITS

Two hundred and thirty-six samples were examined, including eleven samples of whole fruits, pulps and juices, eighty-six samples of Canadian-made jams and marmalades and one hundred and thirty-nine samples of imported jams and marmalades.

A full summary of results of analyses of Canadian and imported jams and marmalades is given in table 32.

TABLE 32.—SUMMARY OF RESULTS OF ANALYSIS OF JAMS AND MARMALADES FOR GLUCOSE, PRESERVATIVES AND COAL TAR COLOURS

Description	Glucose			Preservatives Benzoates and Salicylates			Coal tar colours		
	Number of samples examined	Number containing glucose	Per cent number containing glucose	Number of samples examined	Number containing preservatives	Per cent number containing preservatives	Number of samples examined	Number containing coal tar colours	Per cent number containing coal tar colours
Jams and marmalades made in Canada	77	4	5	86	7	8	70	28	40
Imported jams and marmalades	139	6	5	139	Nil	Nil	139	21	16

Of the seven samples which contained preservatives, six contained benzoate and one contained salicylate. In all the samples the amount of preservative was less than the maximum allowed by the regulations.

Two samples were examined for the presence of formic acid and were found to contain small amounts of this preservative.

All coal tar colours which were found in jams made in Canada were permissible colours.

In twenty-one imported jams which contained coal tar colour, ten colours were permissible and eleven were non-permissible.

Thirty samples of jams were examined for the presence of added fruit juice. Four samples were considered to contain added fruit juice in excess of that allowed by the regulations.

In six samples of jam especially examined, the presence of apple pulp was clearly shown under the microscope.

SAUSAGES, SAUSAGE MEATS, POTTED AND PRESERVED MEATS

Eleven samples of sausages were examined for water, protein and starch content.

Summaries of results are given in table 33 and table 24.

TABLE 33.—SUMMARY OF RESULTS OF ANALYSIS OF SAUSAGES FOR WATER, PROTEIN AND STARCH

11 samples	Water per cent	Protein (N.x 6·25) per cent	Water: protein ratio	Starch per cent
Average	58·1	12·2	4·8	5·0
Maximum	62·8	15·7	5·4	8·7
Minimum	51·9	9·9	3·7	1·5

TABLE 34.—NUMBER AND PERCENTAGE NUMBER OF SAUSAGES CONTAINING WATER AND STARCH IN EXCESS OF AMOUNTS ALLOWED BY THE REGULATIONS, AND SUMMARY OF WATER: PROTEIN RATIOS

—	Samples containing more than 60 per cent water	Samples containing more than 5 per cent starch	Samples having Water: Protein Ratios				
			Above 5	Above 4·5	Above 4	Above 3·6	Below 3·6
Number	5	6	5	8	10	11	Nil
Per cent Number	45	54	45	73	91	100	Nil

Comparatively few samples of sausages were examined this year for water, protein and starch content, but the results of analysis seem to show that there is still considerable adulteration of this type of foodstuff, and that the improvement which was noticed during previous years has not been maintained.

Twenty-seven samples of sausages were examined for preservatives—sulphites, borates, benzoates and salicylates—and for coal tar colours.

All were free from these preservatives. Six were found to contain coal tar colour in the casings.

Seven samples of canned lunch tongue were badly "blackened" on the surface of the meat. It was found on investigation that this black deposit was iron sulphide. A sample of agar-agar used in making the tongue was found to contain considerably more iron than is usual in such products, and it was thought that this iron might have combined with the sulphur in the meat proteins and caused the blackening.

CANNED VEGETABLES AND TOMATO PRODUCTS

Thirty-eight samples of tomato paste were examined. The average, maximum and minimum percentages of total solids were 33·64, 41·24 and 17·53, respectively.

Forty-three samples of tomato paste and catsup were examined for preservatives (benzoates and salicylates) and coal tar colours. One only contained preservatives, benzoate. All were free from coal-tar colour.

Two samples of canned peas were examined for copper. One was found to contain 98·4 parts per million.

MISCELLANEOUS

Thirty-two samples were examined. These included all samples which could not be classified under the above headings and covered a wide variety of materials such as oils, binders, rat exterminator, jellies, lemon curds, etc.

DEHYDRATED PRODUCTS

Twenty-six samples were examined.

Eight varieties of cherries which were dehydrated in the experimental dehydrator at the Central Experimental Farm were analysed.

A summary of results of analysis is given in table 35.

TABLE 35.—SUMMARY OF RESULTS OF ANALYSES OF DEHYDRATED CHERRIES

Treatment	Time period of dehydration hours	Water p.c.	Total sugars p.c. (as invert)		Acidity per cent (as sulphuric acid)	
			As received	Dry basis	As received	Dry basis
Cherries were pitted, sulphured for 15 minutes and dried at temperatures 130°F-170°F.....	Average–10.....	18·5	48·9	59·9	3·60	4·42
	Maximum–13....	21·6	52·8	65·0	6·30	7·61
	Minimum–8.....	16·0	43·6	52·7	1·60	1·90

The average maximum and minimum percentage losses of water per hour in the process of dehydration from four samples of cherries were found to be 7·2, 8·6 and 5·7, respectively.

Five samples of Californian dehydrated fruits were examined. Results of analyses are given in table 36.

TABLE 36.—RESULTS OF ANALYSES OF CALIFORNIAN DEHYDRATED FRUITS

Fruit	Sulphur dioxide (parts per 2,000)	Water p.c.	Total sugar p.c. (as invert)		Acidity per cent (as sulphuric acid)	
			As received	Dry basis	As received	Dry basis
Prunes.....	Nil	20·1	47·3	59·3	1·42	1·78
Prunes.....	"	19·4	45·0	55·9	1·35	1·68
Pears.....	1·17	16·0	39·9	47·5	1·57	1·86
Peaches.....	2·60	17·1	53·1	64·7	2·89	3·44
Apricots.....	2·03	17·9	51·5	62·6	3·25	3·96

Four samples of fruits dehydrated at the Central Experimental Farm were examined. Particulars of treatments and results of analyses are given in table 37.

TABLE 37.—RESULTS OF ANALYSIS OF FRUITS DEHYDRATED AT THE CENTRAL EXPERIMENTAL FARM

Fruit	Treatment	Sulphur dioxide (parts per 2,000)	Water per cent
Pears	Lye peeled and sulphured for 3 hours. Dehydration temperature—160°-172° F.	5·60	18·2
Peaches	" "	4·14	24·6
Greengages	2 per cent carbonate dipped for 15 seconds. Sulphured 30 minutes. Dehydration temperature 160-172°F.	.....	30·9
Plums	" "	.....	28·8

Nine samples of apples dehydrated at Grimsby, Ont., were analysed. The average, maximum and minimum percentages of water were 22·0, 30·4 and 18·1, respectively.

SPECIAL INVESTIGATORY WORK

PRODUCTION OF A NEW CANCELLING INK FOR STAMPING BACON SIDES FOR EXPORT

Some years ago a formula for a satisfactory and economical ink for the use of the Inspectors in the packing houses was produced in these laboratories.

Recently it became necessary to procure another ink for the stamping of bacon sides for export and this laboratory has succeeded in producing a formula for an ink, which has now been in use for some months and has proved thoroughly satisfactory.

ESTIMATION OF DEGREE OF RIPENESS OF FRUITS FROM DETERMINATIONS OF THEIR SPECIFIC GRAVITIES

At the request of the Fruit Commissioner, Department of Agriculture, an investigation was carried out to ascertain if it is possible to estimate the degree of ripeness of fruits—plums, peaches and grapes—from determinations of specific gravity.

Eighty samples were received, covering ripening periods of from two to five weeks. It was found that for plums and grapes there was a gradual rise in specific gravity with ripening. In the case of peaches, there was found to be a gradual fall in specific gravity with ripening. The correlation of specific gravity and ripeness appeared to be more uniform for peaches and grapes than for plums.

CORRELATION BETWEEN SPECIFIC GRAVITY, TOTAL SOLIDS AND STARCH CONTENT OF POTATOES

Requests have frequently been made for information as to the value of specific gravity determinations for indicating the starch content of potatoes. During the past year some preliminary work was carried out to see if any correlation could be found between specific gravity, total solids and starch content. Fifteen samples of "Irish Cobbler" and ten samples of "Dakota" potatoes were analysed and the results show a close correlation between specific gravity, total solids and starch content of the fresh potatoes.

INFLUENCE OF THE FEEDING OF COD LIVER OIL ON THE DEPOSITION OF LIME COMPOUNDS IN THE SHELL OF HENS' EGGS

Owing to the part that some factor present in cod liver oil has been found to play in the metabolism of lime, it was thought that the feeding of cod liver

oil to laying hens might have some influence in causing the deposition of lime compounds in the egg-shell. In co-operation with the Division of Poultry Husbandry an investigation was carried out with this end in view. Three hundred and twenty-five eggs were examined. The results of this enquiry gave no evidence in support of the view that the feeding of cod liver oil tends to a heavier deposition of lime compounds in the shell.

WELL-WATERS FROM FARM HOMESTEADS

Space will not permit the insertion of the detailed data from the examination of farmers' water supplies but the results of the year's work in water analysis may be epitomised as follows:—

	per cent
Pure and wholesome	31·5
Suspicious and probably dangerous	30·7
Seriously polluted	19·6
Saline (not potable)	18·2

These percentages do not differ greatly from those obtained in recent years from this work of water supply examination, but there is satisfactory evidence that farmers are paying greater attention year by year to the purity and care of their well-waters.

In addition to well-waters from farm homesteads we have analysed waters from Indian schools, cheese factories and creameries in several parts of the Dominion. We have also critically examined the supply at the Government Printing Bureau at Ottawa and made recommendations in connection therewith.

Heavily saline waters were received from widely distant localities in Canada, including Schuler, Alta., Tate, Sask., Laurier, Man., St. Catharines, Galetta, Morrisburg, McGregor, and South Indian, Ont., Luskville, P.Q., and Fredericton, N.B.

Correspondence is invited from farmers and stock breeders who have lost animals from the use of saline waters, as it is desirable to obtain further information respecting the limits of safety within which such waters can be used.

We would again call attention to the mistake which is so frequently made when choosing the site of the new well, namely, sacrificing safety for convenience. Ideally, the well should be at least 150 feet from the nearest building, be it house, barn or stable and the same distance from manure pile, cesspool or other possible source of dangerous pollution.

In all cases we believe it desirable to secure a fair degree of filtration by lining the well with concrete or puddled clay to a depth of, say, ten feet, continuing this lining, if concrete, one foot above ground level to prevent the entrance of surface wash. Ten feet of earth filtration will thus be imposed on all water before it gains admittance to the well, which, provided the earth does not become water-logged or heavily polluted, will ensure a reasonable measure of purification and safety. A good sound water-tight cover is also of first importance.

In a bored well, tight sealing is imperative between pipe and rock, as also between joints in the pipe and cover of the well. The extraction of water by pumping reduces the normal atmospheric pressure within the pipe. This reduced pressure acts as a suction force within the pipe and, provided there be but a trivial imperfection in pipes and joints will draw in polluted water if such surrounds the pipe.

WATERS FROM FISH HATCHERIES

The detailed analyses of the water samples from Canadian hatcheries is given in table 38.

TABLE 38.—ANALYSIS OF FISH HATCHERY WATERS

Results in parts per million

Hatchery	Free ammonia	Albuminoid ammonia	Nitrogen in nitrate and nitrites	Chlorine	Solids at 212°F	Solids after ignition	Loss on ignition
Bedford	0·02	0·08	0·313	4·3	40	18	22
Middleton	0·02	0·18	0·247	6·5	54	40	14
Margaree	0·04	0·58	0·132	60·0	284	224	60
Windsor	0·04	0·18	0·165	4·5	242	234	8
Grand Falls	0·20	0·22	0·247	0·2	132	114	18
Miramichi	trace	0·07	0·082	1·4	116	108	8
Restigouche	0·05	0·03	0·222	1·7	180	158	22
St. John	nil	0·04	0·165	5·4	88	52	36
Kelly's Pond	nil	0·07	0·461	10·9	116	96	20
Collingwood	trace	0·06	0·197	3·0	86	46	40
Kenora	0·06	0·25	0·125	1·0	98	72	26
Kingsville	trace	0·09	0·132	7·9	124	110	14
Port Arthur	0·02	0·30	0·181	0·5	70	40	30
Sarnia	trace	0·05	0·280	3·2	136	94	42
Southampton	trace	0·11	0·074	9·4	204	170	34
Thurlow	0·25	0·90	0·008	1·5	192	148	44
Wiarton	0·03	0·12	0·238	2·0	124	100	24
Dauphin River	0·08	0·92	0·165	188·0	698	606	92
Gull Harbour	trace	0·27	0·263	6·5	240	200	40
Winnipegosis	trace	0·23	0·395	200·0	502	464	38
Banff	trace	trace	0·296	nil	200	190	10
Spray Lakes	0·04	trace	0·263	1·0	252	240	12
Fort Qu'Appelle	0·04	0·64	0·132	48·0	850	692	158
Anderson Lake	0·02	0·05	0·181	1·2	44	20	24
Babine Lake	0·02	0·10	0·214	1·7	70	56	14
Cowichan Lake	nil	0·07	0·263	1·3	67	42	25
Cultus Lake	0·02	0·10	0·115	0·8	114	100	14
Harrison Lake	0·02	0·04	0·378	0·4	68	54	14
Kennedy Lake	nil	0·08	0·099	4·2	62	32	30
Pemberton	0·02	0·10	0·181	1·34	54	40	14
Pitt Lake	trace	0·02	0·263	3·7	22	10	12
Rivers Inlet	trace	0·12	0·132	1·36	28	18	10
Lakelse Lake	0·02	0·08	0·181	0·2	30	22	8
Stuart Lake	nil	0·17	0·165	0·3	60	20	·40

The above table shows a predominating number of remarkably pure waters. Many are upland surface waters containing very little extraneous matter in solution. Some, in fact, have such a scanty mineral content that it might be thought there would be scarcely sufficient to supply the bone requirements of the growing fish, but no complaint has been received which would lead to the conclusion that there is any insufficiency in this particular.

Since fish derive the oxygen necessary for their life and growth from that which is dissolved in the water in which they live, the presence of a sufficient quantity of this life-supporting gas is imperative in all water supplies used for hatchery purposes. An excessive quantity of dissolved organic matter, when decaying, may use up so much of the naturally dissolved oxygen of the water as to constitute a danger of shortage of oxygen for the fish. It is desirable therefore, especially in a brown peaty water, to determine the amount of dissolved oxygen, from time to time, in water used in hatcheries.

The low figures in the ammonias and nitrates columns of our table indicate a high degree of freedom from the products of decay. Hence we may infer that the larger number of waters examined have not been robbed of their normal quantity of the dissolved oxygen which is so essential to the life and health of the young fish.

Canada is therefore to be congratulated on the possession of these admirable water supplies to aid the good work of its fish hatching enterprise.

DETERMINATION OF DISSOLVED OXYGEN IN WATERS OF FISH HATCHERIES

During the year we were requested by the Superintendent of Fish Hatcheries, Department of Marine and Fisheries to evolve a method for the determination of dissolved oxygen in water which could readily be carried on by one who had no especial training in chemical technique.

Oxygen content of the water is perhaps the most essential requirement of the fry in growth. Field methods of analysis as a rule are only approximate. There has been evolved a colorimeter method depending on the pyrogallic acid reaction which with many types of water is very satisfactory. When the water is highly coloured or turbid a colorimetric method is obviously deficient. We have advised the Department of Fisheries to use a well known chemical method for the determination of dissolved oxygen depending essentially on the oxidation of ferrous sulphate in alkaline solution and have so modified the apparatus and methods of analysis that one untrained in chemical technique can arrive at accurate results.

We have already had word from the Superintendent of Fish Hatcheries, that this method in operation has been effective in the preservation of fry.

THE NITROGEN COMPOUNDS IN RAIN AND SNOW

The study of the character and amount of the nitrogen compounds in rain and snow has formed the subject of an enquiry by the Division of Chemistry of the Dominion Experimental Farm system during the past seventeen years. This investigation which has determined the quantities of the several nitrogen compounds contributed, per acre, per annum to the soil by the rainfall and snowfall in the district of Ottawa, has now been brought to a close and the present paper presents the results obtained in summarized form.

During this period (1907-1924) every fall of rain and snow which yielded from the catchment area a sufficiency for the work, has been analysed, the determinations comprising nitrogen present as free ammonia, as albuminoid ammonia and as nitrates and nitrites.

The chief object of the investigation has been to ascertain the fertilizing value of rain and snow as suppliers of nitrogenous plant food—a phase of the nitrogen problem in the maintenance of soil fertility—but incidentally the work has yielded data which allowed the study of other and more or less closely related matter; *e.g.* the relative cleansing action on the atmosphere of rain and snow and the factors affecting the many changes in nitrogen concentration of the precipitation.

COLLECTION OF SAMPLES

The rain has been caught on a slightly concave lead-lined tray, erected outside a second story window on the north side of the Chemical Building (Central Experimental Farm, Ottawa) and lead by glass tubing into a bottle within the building. The snow has been collected from a stone parapet which is shovelled clean after the taking of each sample. The snow, placed in a tall glass jar, is allowed to melt in the laboratory. In times of continuous precipitation collections for analysis are made twice daily.* The analytical work has always been taken in hand with the least possible delay after each collection.

During the 17-year period, 1,709 samples have been analysed; of these 1,214 were of rain and 495 of snow.

* More detailed information respecting the method of collection, etc., will be found in previous papers on this investigation. Trans. Royal Society of Canada, Vol. II, 1909, pp. 181-185; Vol. IV, 1911, pp. 55-59; Vol. VIII, 1914, pp. 83-87; and Vol. XI, 1917, pp. 63-72.

FACTORS INFLUENCING THE COMPOSITION OF THE PRECIPITATION

The character of the surrounding country, the density of population, and the near presence of factories are all factors influencing the condition or relative purity of the atmosphere and hence of the rain and snow falling through it. High winds and thunder storms, further, may markedly affect the composition of the precipitation, for it has been found that rain, more especially, collected during or subsequent to such phenomena contain a large amount of suspended matter (of the nature of dust) and is invariably high in both free and albuminoid ammonia.

YEARLY RECORD OF PRECIPITATION AND AVERAGE NITROGEN CONTENT
1908-1924

Table 39.—This table gives for each year of the seventeen year period the precipitation in inches of rain, snow, and total in inches of rain, the average nitrogen content in the three combined forms expressed in parts per million, and the total pounds of nitrogen furnished per acre. The average results of the first ten-year period are separately stated; the average results for the whole 17-year period are also given.

TABLE 39.—YEARLY RECORD OF PRECIPITATION AND AVERAGE NITROGEN CONTENT, 1908-1924

Year ending	Precipitation in inches			Nitrogen, in parts per million				Pounds of nitrogen per acre
	Rain	Snow	Total	As free ammonia	As albuminoid ammonia	As nitrates and nitrites	Total	
February 29, 1908	24·05	133·00	37·35	0·298	0·082	0·131	0·311	4·323
" 28, 1909	22·99	96·25	32·61	0·834	0·095	0·203	1·132	8·364
" 28, 1910	28·79	80·75	36·86	0·418	0·133	0·272	0·823	6·869
" 28, 1911	19·67	73·00	26·97	0·486	0·128	0·249	0·863	5·271
" 29, 1912	20·33	104·25	30·75	0·505	0·074	0·282	0·861	6·100
" 28, 1913	30·34	96·25	39·96	0·379	0·108	0·192	0·679	6·144
" 28, 1914	23·21	84·75	31·68	0·498	0·110	0·254	0·862	6,208
" 28, 1915	16·70	86·25	25·32	0·376	0·182	0·297	0·855	4·905
" 29, 1916	23·13	105·25	33·65	0·334	0·347	0·597	1·278	9·765
" 29, 1917	24·62	118·25	36·45	0·509	0·130	0·315	0·954	7·877
" 28, 1918	20·99	128,75	33,86	0·422	0·117	0·302	0·841	6·259
" 28, 1919	27·77	77·97	35·59	0·346	0·098	0·281	0·725	5·845
" 29, 1920	23·39	98·50	33·23	0·670	0·076	0·199	0·945	7·117
" 28, 1921	27·21	66·90	33·90	0·570	0·065	0·214	0·849	6·525
" 28, 1922	27·11	79·25	35·05	0·605	0·062	0·228	0·895	7·111
" 28, 1923	23·01	93·00	32·31	0·663	0·077	0·273	1·013	7·413
" 29, 1924	27·32	105·80	37·90	0·837	0·061	0·440	1·338	11·485
Average for first 10 years	23·39	97·80	33·173	0·461	0·138	0·277	0·876	6·583
Average for 17 years	24·15	95·77	33·727	0·515	0·114	0·278	0·907	6·916

Precipitation.—The maximum annual rainfall during the period was 30·34 inches (1912-13) and the minimum, 16·70 inches (1914-15). The average for the first 10-year period was 23·39 and for the 17-year period 24·15 inches.

The maximum annual snowfall was 133·0 (1907-08), the minimum 66.9 inches (1920-21). The average for the 10-year period, 97·8 and for the 17-year period 95·7 inches.

While the volume of the precipitation necessarily influences the amount of nitrogen furnished annually per acre, the results clearly show there is no direct relation between these data—the concentration of the nitrogen compounds in the precipitation is a further factor and a very variable one.

Nitrogen Concentration.—By far the largest amount of nitrogen occurs as free ammonia. The high concentration for this constituent recorded for 1908-09

was accounted for by the prevalence of bush fires during that year. Disregarding this year, there has been a more or less steady increase in this datum and this tendency is well emphasized when comparing the average for the first ten years with that for the whole 17-year period, viz. ·461 and ·515 respectively. We conclude that this increased enrichment of the precipitation in free ammonia has been very largely due to the more general use of bituminous coal in Ottawa during the past few years. In this conclusion we have the reason for the decision to bring this investigation to a close at the present time, feeling that the atmosphere about Ottawa, especially in the winter time, no longer represents, in respect to degree of purity, that of the surrounding country.

With respect to albuminoid ammonia, the concentration fluctuates within certain small limits—the variation being probably the result of change of the direction and force of the winds.

The nitrogen as nitrates and nitrites is next in importance to that of free ammonia. It is the most constant of all the three forms of nitrogen present in the atmosphere and the average amount for the first 10-year period is practically identical with that for the whole period.

Nitrogen per Acre.—This amount varies from year to year and it is not always possible to account for the variations—which, as will be seen, may be somewhat wide. It is the product of the precipitation and the concentration and both of these are subject to considerable fluctuation. In previous papers on this inquiry attempts have been made to throw light on this matter but subsequent work has not always confirmed our conjectures. It is however, we believe, quite plain from the figure, for the year 1923-24, viz. 11·485 pounds, that the atmosphere has become suddenly and seriously changed in respect to its nitrogen compounds; the previous year, 1922-23, showed but 7·413 pounds. The data in general would indicate that the nitrogen furnished per acre is between six and seven pounds per annum.

TABLE 40.—AVERAGE MONTHLY RECORD OF PRECIPITATION AND AVERAGE NITROGEN CONTENT, 1908–24;

Months	Precipitation in inches			Nitrogen in parts per million				Pounds of Nitrogen per acre
	Rain	Snow	Total	As free ammonia	As albuminoid ammonia	As *nitrates* and nitrites	Total	
January	0·769	24·129	3·182	0·258	0·099	0·179	0·536	0·385
February	0·238	22·809	2·519	0·238	0·112	0·248	0·598	0·341
March	1·136	16·14	2·749	0·302	0·152	0·231	0·685	0·427
April	2·161	3·96	2·557	0·666	0·203	0·398	1·267	0·734
May	2·879	0·441	2·924	0·576	0·095	0·259	0·930	0·617
June	2·824	.....	2·824	0·555	0·102	0·302	0·959	0·613
July	2·768	.....	2·767	0·476	0·089	0·404	0·969	0·608
August	2·915	.....	2·915	0·709	0·150	0·420	1·279	0·845
September	2·683	.....	2·683	0·750	0·103	0·274	1·127	0·685
October	3·130	0·221	3·152	0·754	0·072	0·253	1·079	0·771
November	1·889	8·295	2·719	0·508	0·085	0·199	0·792	0·488
December	0·817	19·55	2·772	0·352	0·090	0·187	0·629	0·395
Average for first 10 years	23·39	97·80	33·173	0·461	0·138	0·277	0·876	6·583
Average for 17 years	24·15	95·77	33·727	0·515	0·114	0·278	0·907	6·916

Table 40: This table presents an average monthly record of the precipitation in inches and of the pounds of nitrogen, per acre; it also gives the monthly average of the nitrogen content in parts per million. The data cover the seventeen-year period of the investigation.

Precipitation.—During the seventeen-year period ending February 29, 1924, the largest average monthly rainfall is recorded for October, viz. 3·13 inches, the lowest is for February ·238 inches.

TABLE 41.—AVERAGE NITROGEN-CONTENT OF RAIN, 1908-1924—AMOUNT OF NITROGEN PER ACRE AS FREE AND ALBUMINOID AMMONIA AND AS NITRATES AND NITRITES

Year ending	Precipitation in inches	Nitrogen										
		Parts per million				Percentage			Pounds per acre			
		As free ammonia	As albuminoid ammonia	As nitrates and nitrites	Total	As free ammonia	As albuminoid ammonia	As nitrates and nitrites	As free ammonia	As albuminoid ammonia	As nitrates and nitrites	Total
February 29, 1908	24·05	0·396	0·114	0·142	0·652	61	17	22	1·987	0·553	0·716	3·256
" 28, 1909	22·99	1·096	0·132	0·234	1·462	75	9	16	5·710	0·685	1·216	7·611
" 28, 1910	28·79	0·429	0·148	0·310	0·896	48	17	35	2·800	0·990	2·040	5·830
" 28, 1911	19·67	0·575	0·122	0·295	0·992	58	12	30	2·515	0·532	1·327	4·424
" 29, 1912	20·33	0·694	0·078	0·330	1·102	63	7	30	3·198	0·355	1·522	5·075
" 28, 1913	30·34	0·409	0·129	0·216	0·754	55	16	29	2·812	0·818	1·483	5·113
" 28, 1914	23·21	0·600	0·118	0·265	0·983	61	12	27	3·168	0·622	1·402	5·192
" 28, 1915	16·70	0·400	0·214	0·460	1·064	38	20	42	1·529	0·804	1·689	4·022
" 29, 1916	23·13	0·390	0·319	0·830	1·539	25	21	54	2·020	1·695	4·350	8·065
" 28, 1917	24·62	0·532	0·165	0·419	1·116	48	15	37	2·988	0·934	2·304	6·226
" 28, 1918	20·99	0·533	0·124	0·335	0·992	54	12	34	2·535	0·588	1·596	4·719
" 28, 1919	27·77	0·424	0·100	0·259	0·783	54	13	33	2·666	0·632	1·631	4·929
" 29, 1920	23·39	0·826	0·084	0·205	1·115	74	8	18	4·378	0·445	1·086	5·909
" 28, 1921	27·21	0·587	0·050	0·205	0·842	70	6	24	3·620	0·312	1·263	5·195
" 28, 1922	27·11	0·693	0·056	0·246	0·996	69	6	25	4·238	0·353	1·527	6·118
" 28, 1923	23·01	0·754	0·083	0·287	1·124	67	7	26	3·937	0·432	1·491	5·860
" 29, 1924	27·32	1·030	0·060	0·535	1·625	63	4	33	6·376	0·371	3·317	10·064
Average for first 10 years	23·39	0·541	0·151	0·342	1·034	53	14	33	2·878	0·799	1·805	5·481
Average for 17 years	24·15	0·610	0·123	0·328	1·061	58	11	31	3·322	0·654	1·762	5·738

TABLE 42.—AVERAGE NITROGEN CONTENT OF SNOW, 1908-24 AMOUNT OF NITROGEN PER ACRE AS FREE AND ALBUMINOID AMMONIA AND AS NITRATES AND NITRITES.

Year ending	Precipitation in inches	Nitrogen										
		Parts per million				Percentage			Pounds per acre			
		As free ammonia	As albuminoid ammonia	As nitrates and nitrites	Total	As free ammonia	As albuminoid ammonia	As nitrates and nitrites	As free ammonia	As albuminoid ammonia	As nitrates and nitrites	Total
February 29, 1908	133·00	0·216	0·038	0·132	0·386	56	10	34	0·597	0·107	0·363	1·067
" 28, 1909	96·25	0·204	0·038	0·103	0·345	59	11	30	0·444	0·083	0·226	0·753
" 28, 1910	80·75	0·269	0·097	0·203	0·569	47	17	36	0·490	0·179	0·370	1·039
" 28, 1911	73·00	0·286	0·092	0·134	0·512	56	18	26	0·473	0·151	0·223	0·847
" 29, 1912	104·25	0·228	0·053	0·157	0·438	52	12	36	0·533	0·123	0·369	1·025
" 28, 1913	96·25	0·265	0·104	0·104	0·473	56	22	22	0·577	0·227	0·227	1·031
" 28, 1914	84·75	0·265	0·090	0·174	0·529	50	17	33	0·508	0·173	0·335	1·016
" 28, 1915	86·25	0·176	0·116	0·159	0·451	39	26	35	0·341	0·230	0·312	0·883
" 29, 1916	105·25	0·243	0·242	0·228	0·713	34	34	32	0·578	0·577	0·545	1·700
" 28, 1917	118·25	0·279	0·109	0·228	0·616	45	18	37	0·742	0·298	0·611	1·651
" 28, 1918	128·75	0·193	0·083	0·252	0·528	36	16	48	0·563	0·243	0·734	1·540
" 28, 1919	77·97	0·185	0·070	0·263	0·518	36	13	51	0·327	0·124	0·465	0·916
" 29, 1920	98·50	0·231	0·070	0·240	0·541	43	13	44	0·516	0·157	0·535	1·208
" 28, 1921	66·90	0·493	0·129	0·256	0·877	56	15	29	0·748	0·196	0·386	1·330
" 28, 1922	79·25	0·291	0·086	0·175	0·553	53	15	32	0·521	0·154	0·318	0·993
" 28, 1923	93·00	0·429	0·060	0·247	0·736	58	8	34	0·905	0·125	0·522	1·552
" 29, 1924	105·80	0·337	0·066	0·190	0·593	57	11	32	0·807	0·158	0·455	1·421
Average for first ten years	97·80	0·240	0·097	0·160	0·497	48	20	32	0·528	0·215	0·358	1·101
Average for 17 years	95·77	0·270	0·090	0·190	0·551	48	17	35	0·568	0·194	0·412	1·174

The heaviest average monthly snowfall belongs to January 24·129 inches; this is followed closely by the month of February with 22·809 inches. December is the third month in order of snowfall, with 19·55 inches and March the fourth with 16·14 inches.

The highest total precipitation occurs in January, but of the 3·182 inches recorded 2·413 are in the form of snow. October follows very closely with 3·152 inches. The data for total precipitation when averaged over the 17-year period show a remarkably equable distribution of the moisture throughout the year—for ten months of the twelve the range is from 2·5 to 2·9 inches.

Nitrogen Concentration.—The concentration as expressed by total nitrogen in parts per million follows in a general way the *rainfall;* the months April to October inclusive furnish figures between the limits .93 and 1.279 p.p.m. whereas January, February, March, November and December, the snow months, have a range .536 to .792 p.p.m.

Nitrogen per Acre.—The average monthly amount of nitrogen per acre varies from .341 pounds (February, pre-eminently snow month) to .845 pounds (August with 2.915 inches rain). It has been pointed out in the preceding paragraph, that the "concentration" of nitrogen follows the rainfall; it is equally the case that the amount of nitrogen per acre is closely related to the rainfall and finds in the same rainfall its principal determinant.

AVERAGE NITROGEN CONTENT OF RAIN AND SNOW

Table 41 and 42 present the annual data for the composition in respect to nitrogen compounds of the rain and snow, respectively, throughout the period of investigation.

The figures for the rain indicate that approximately 60 per cent of the nitrogen of this form of precipitation is present as free ammonia, 30 per cent as nitrates and nitrites and 10 per cent as albuminoid ammonia; consequently the nitrogen furnished to the soil by the rain will be in this proportion. The average annual amounts of these three forms of nitrogen for the 17-year period, per acre are 3·32, 1·76 and ·65 pounds, making a total of 5·73 pounds as yearly supplied by the rain.

Snow is decidedly poorer in nitrogen compounds than rain. The concentration figure for free ammonia is less than half that for rain; similar data for nitrates and nitrites and albuminoid ammonia though not showing as large a difference are also much lower than in rain. The total nitrogen content of snow is practically one-half that of rain.

The relative annual contribution of nitrogen in its several forms in rain and snow respectively may be more readily grasped from the following table:—

	Rain (pounds per acre)	Snow (pounds per acre)
Nitrogen, as free ammonia	3·322	0·568
Nitrogen, as albuminoid ammonia	0·654	0·194
Nitrogen, as nitrates and nitrites	1·762	0·412
	5·738	1·174

AMOUNTS AND PROPORTIONS OF NITROGEN FURNISHED BY RAIN AND SNOW

Table 43 presents the amounts and proportions of nitrogen furnished annually by the rain and snow.

The proportion of nitrogen furnished by the rain has varied from 75 to 91 per cent of the total; during 11 years of the period it was between 79 and 85 per cent and the average for the seventeen years was 83 per cent.

TABLE 43.—AMOUNTS AND PROPORTIONS OF NITROGEN, FURNISHED BY RAIN AND SNOW, 1908–1924

Year ending	Total	By rain		By snow	
		Pounds	Proportion	Pounds	Proportion
	lb.		p.c.		p.c.
February 29, 1908	4·322	3·256	75	1·067	25
" 28, 1909	8·364	7·611	91	0·753	9
" 28, 1910	6·869	5·830	85	1·040	15
" 28, 1911	5·271	4·424	84	0·847	16
" 29, 1912	6·100	5·075	83	1·025	17
" 28, 1913	6·144	5·113	83	1·031	17
" 28, 1914	6·208	5·192	84	1·016	16
" 28, 1915	4·905	4·022	82	0·883	18
" 29, 1916	9·765	8·065	83	1·700	17
" 28, 1917	7·877	6·226	79	1·651	21
" 28, 1918	6·259	4·719	75	1·540	25
" 28, 1919	5·845	4·929	84	0·916	16
" 29, 1920	7·117	5·909	83	1·208	17
" 28, 1921	6·525	5·195	80	1·330	20
" 28, 1922	7·111	6·118	86	0·993	14
" 28, 1923	7·413	5·860	79	1·553	21
" 29, 1924	11·485	10·064	88	1·421	12
Average for 17 years	6·916	5·741	83	1·175	17

The data for the amount of nitrogen furnished yearly per acre show a range of 4.322 to 11.485 pounds. The average for the seventeen years period is 6.916 pounds.

From the agricultural point of view this enquiry has been of very considerable interest in showing that the rain and snow supplied annually per acre, nitrogen in available forms equivalent approximately, to an application per acre, of 44 pound of commercial nitrate of soda.

Rain and snow have for their principal function the distribution of moisture so necessary for the support of animal and plant life. It has been shown that they possess a fertilizing value. We may conclude that they also play an important hygienic part in the "washing" of the atmosphere and the data recorded in this paper may possibly serve towards measuring their influence in this useful work.

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