The following Annual Reports for 1930 have not been published:—

Director of Experimental Farms
Division of Chemistry
Division of Animal Husbandry
Division of Forage Plants

Progress reports of the Division of Chemistry and the Division of Forage Plants covering the years 1930 to 1933, inclusive, have since been published but are not included in this present series.

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DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

DIVISION OF CHEMISTRY

PROGRESS REPORT

FOR THE YEARS 1930, 1931, 1932 AND 1933

C. H. ROBINSON, *Acting Dominion Chemist*

Printed by Authority of the Hon. Robert Weir, Minister of Agriculture, Ottawa, 1935

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Progress Report of the Division of Chemistry

For the years 1930, 1931, 1932, and 1933.

INTRODUCTION

No annual report on the work of the division has been published since March, 1930. The present progress report covers in brief form the activities of the division for the past three years. Such tables as are presented are of a summary nature. Anyone interested may secure complete data from the records of the division. Footnotes indicate bulletins and technical papers issued by the division.

The work of the division is broadly classified under four headings: Soils and Fertilizers; Plant Chemistry; Animal Nutrition; and Food Investigation.

SOILS AND FERTILIZERS

The work with soils as carried on by this division may be divided into two main classes: (1) the examination and report of soil samples, soil amendments, peats, mucks, muds, etc., submitted by farmers and farmers' organizations and (2) the complete physical and chemical analyses of soil series in connection with special studies on soil fertility work as carried on at the Central Farm and at the branch farms and stations of the Experimental Farms System.

The investigational work with fertilizers is conducted in co-operation with the superintendents of a number of the branch farms and stations and at the Central Farm, Ottawa. The object of this work is to obtain data which may be used as a basis in making recommendations to farmers in regard to the economic employment of fertilizers, soil amendments, etc.

Investigational Work with Soils

The analyses of several series of soils were made in connection with special soil fertility studies carried on at the branch experimental farms at Nappan, N.S.; L'Assomption, P.Q.; Scott, Sask.; Beaverlodge, Alta.; and at the Central Farm, Ottawa, Ont.

At *Nappan* the soils were collected in 1931 from plots of an experiment devoted to a study of fertilizer formulæ for the potato crop. On certain of the plots of this experiment the subsequent crop of clover hay was consistently poor. A study of field notes and yield data showed that the marked non-uniformity of the clover hay crop could not be attributed to any differences in the amount or ratio of the plant food elements supplied in the fertilizer of various formulæ. The data of chemical analyses indicated that the soil of this area was naturally low in fertility and that the poor stands of clover hay were probably due in a large measure to a deficiency of lime in the soil.

The series of soils from the *l'Assomption* Station was submitted in 1933 by the Tobacco Division to determine the adaptability of certain areas to the growth of cigarette tobacco. Of nine soils examined only two, which contained less than 15 per cent of silt and clay, appeared to be well adapted physically to the growth of flue-cured tobacco of good quality. The other soils contained too high a percentage of these constituents for best results with this crop. The data of chemical analysis indicated that all the soils were somewhat high in nitrogen and organic matter for the proper maturing of flue-cured tobacco and in some cases they appeared to be low in potash.

At *Scott* three series of soils were collected in 1932 from areas devoted to experimental work with fertilizers. The analytical data showed that the surface soils of two of the areas were dark grey to brownish grey clay loams containing a high percentage of silt and that the underlying soil to a depth of 12 inches was of much the same make-up as the surface. The soil of the third series was somewhat "lighter," containing more sand and less silt and clay. With the exception of their percentages of lime the soils of all three series were much alike in plant food content, being quite well supplied with nitrogen, organic matter and potash but somewhat low in phosphoric acid. The lime content (CaO) varied from a minimum of 0·41 per cent to a maximum of 1·41 per cent.

Two series of soils from *Beaverlodge* were submitted to a chemical analysis. The first series was collected in 1932 from an alfalfa area to study the causes of pronounced irregularities in the growth of this crop. The data of analysis showed a great variation in the lime content of samples taken at different horizons to a depth of 7 feet. Samples representative of the surface sandy loam soil to a depth of 7 inches contained an average of 2·11 per cent of lime (CaO); samples representing light greyish lenses at 3 to 4 feet depth contained an average of 23·80 per cent of lime; at depths of 4 to 6 feet the soil was sandy and contained from 2 to 12 per cent of lime.

The second series of soil samples from the Beaverlodge Station was collected in 1932 from twenty plots of an area devoted to a cereal variety test on which considerable differences occurred in crop growth and yield. A sample of the Reward wheat grown in 1932 on each plot was also obtained and analysed for protein content. The data of analysis showed that there was no apparent relation between the nitrogen content of the soil and that of the wheat.

At the Central Farm, *Ottawa*, the examination of a series of soils was undertaken in 1933 at the instance of the Cereal Division to obtain some knowledge of the fertility of the soil of Block "A" and "B" and to learn if any marked deficiencies in plant food occurred in these areas. The samples were found to be sandy loams with a considerable variation in the proportion of sand to silt and clay. There did not appear to be any serious deficiency in organic matter, nitrogen, phosphoric acid or lime but the majority of the samples showed a somewhat low content of potash.

Investigational Work with Fertilizers

NITROGENOUS FERTILIZERS

During the past three years experimental work dealing with the use of nitrogenous fertilizers for various field crops has been continued. A very brief summary of the results of these investigations is as follows:—

Nitrogenous Fertilizers for Oats (Project C.163).—In this experiment, conducted at the Kentville Station since 1931, nitrate of soda, sulphate of ammonia, cyanamide, urea, calcium nitrate, nitro-chalk, calurea, leuna saltpetre, and cal-nitro were applied in conjunction with a phosphatic and potassic fertilizer for the oat crop. In each instance 22 pounds of nitrogen per acre were supplied. The data showed that the average increase in yield of oats due to the nitrogen applied ranged from 27·8 to 40·3 per cent. The influence of the nitrogenous fertilizers on the subsequent clover and timothy hay crops was quite marked. The plots treated with cal-nitro, calcium nitrate and nitrate of soda were among the highest yielding plots of the series.

Another experiment (Project C.191) at Kentville, N.S., permitted of a comparison of nitrate of soda and sulphate of ammonia as sources of nitrogen for oats. The results over the period 1931 to 1933 showed a very slight advantage for nitrate of soda.

Nitrogenous Fertilizers as a Top-dressing for Grain Crops (Project C.24).—In this experiment, conducted at Kentville, N.S., in 1932, the following percentage increases in yields of oats were obtained from the several materials applied when the crop was about 9 inches high at rates to furnish 22 pounds of nitrogen per acre: calcium nitrate, 35·2; nitro-chalk, 25·7; nitrate of soda, 24; sulphate of ammonia, 20·7; and cyanamide, 5·7.

Nitrogenous Fertilizers as a Top-dressing for Timothy Hay (Project C.25). —At Kentville, N.S., in 1932 several nitrogenous fertilizers were applied for the timothy hay crop in amounts to furnish 22 pounds of nitrogen per acre. The percentage increases in yields were: nitrate of soda, 27·6; nitro-chalk, 26·7; sulphate of ammonia, 22·2; cyanamide, 14·2.

Sources of Nitrogen for the Potato Crop (Project C.161).—This experiment was conducted at Kentville, N.S.; Nappan, N.S.; Charlottetown, P.E.I.; Fredericton, N.B.; Sidney, B.C.

At Kentville various sources of nitrogen were used in conjunction with a phosphatic and potassic fertilizer for the potato crop in 1929. The mixtures applied were equivalent to 1,500 pounds of a 4-8-4 per acre. The yields of potatoes varied from 176 bushels per acre for the mixture in which cyanamide was used to 229·3 bushels where calcium nitrate was employed as the source of nitrogen. When nitrogen was eliminated from the mixture the yield was 169·3 bushels per acre.

At Nappan in 1929 and 1933 sulphate of ammonia, nitrate of lime and urea were each used to furnish the nitrogen of a complete fertilizer for potatoes. Nitrate of lime gave slightly better results than the other sources of nitrogen used in this experiment.

At Charlottetown over a period of seven years an application of 1,000 pounds per acre of a 4-8-8 mixture gave 12·1 per cent greater yield of potatoes (grown in rotation) where nitrate of soda was used as the source of nitrogen than where sulphate of ammonia was employed.

At Fredericton in 1929 cyanamide, nitro-chalk and urea were compared with a mixture of nitrate of soda and sulphate of ammonia as sources of nitrogen in a 4-8-6 fertilizer for potatoes. Where the complete mixture was applied at 1,000 pounds per acre the yields were 213 bushels for the cyanamide plot, 232 bushels for nitro-chalk, 228 bushels for urea and 232 bushels for the mixture of nitrate of soda and sulphate of ammonia. Where the complete fertilizer was applied at 2,000 pounds per acre the yields were 215, 237, 283, and 289 bushels, respectively.

At Sidney over a period of seven years, 1927 to 1933, sulphate of ammonia has proved slightly superior to nitrate of soda as a source of nitrogen in a complete fertilizer mixture for potatoes.

PHOSPHATIC FERTILIZERS

The results of investigational work with fertilizers conducted by this division for many years have emphasized the importance of applications of phosphoric acid in the production of field and market garden crops. Some recent data from trials with various phosphatic fertilizers are very briefly summarized as follows:—

The experiment on Sources of Phosphoric Acid for the Oat Crop (Project C.191) has been conducted at the Kentville Station since 1929. In this experiment, 16 per cent basic slag, 16 per cent superphosphate, and 45 per cent treble superphosphate were applied alone and also in conjunction with a nitrogenous and potassic fertilizer. The results showed that all three sources of phosphoric acid proved equally effective and gave very fair increases in yield throughout the three-year rotation.

In the experiment on Fertilizers and Ground Limestone (Project C.15) conducted at Kentville, N.S., since 1914, 16 per cent superphosphate, basic slag and bone meal were each used to furnish the phosphoric acid of a complete mixture applied for the hoed crop of a three-year rotation on limed and unlimed land.

On both the limed and unlimed sections of this experiment basic slag has proved the most effective source of phosphoric acid. Where lime was applied there was little difference between the returns from superphosphate and bone meal but on the unlimed area superphosphate gave slightly better results than bone meal. The beneficial effect of lime was very marked.

An experiment to compare Sources of Phosphoric Acid for Field Crops (Project C.26) was conducted at the Experimental Station, Cap Rouge, P.Q., during the period 1925 to 1930. Superphosphate (16 per cent), Bessemer slag, fortified (Sydney) slag, and ground rock phosphate (Ephos) were applied for the corn crop in a rotation of hoed crop, oats, clover hay, timothy hay, timothy hay, in amounts to furnish 140 pounds of phosphoric acid per acre. Superphosphate was also applied in conjunction with ground limestone (2 tons per acre) and a treatment with the latter alone was also included.

The application of phosphoric acid resulted in notable increases in yield, especially of the hay crops, and the beneficial influence of lime was quite marked in all the crops of the rotation. The values of the increased yields per acre less the cost of the fertilizer during the period 1925 to 1930 were as follows: superphosphate plus limestone, $41.98; limestone, $39.86; fortified slag, $22.42; Bessemer slag, $18.99; ground rock phosphate, $18.14; and superphosphate, $9.61.

An experiment on Sources of Phosphoric Acid for the Mangel Crop has been conducted at the Experimental Farm, Agassiz, B.C., since 1930. Three phosphatic fertilizers, 16 per cent superphosphate, treble superphosphate and basic slag were used in amounts to furnish 80 pounds of phosphoric acid per acre and were applied in conjunction with a nitrogenous and potassic fertilizer for the mangel crop. The results showed phosphoric acid to be an important constituent of the fertilizer mixture. The two grades of superphosphate gave about equal returns and were somewhat superior to basic slag. Apparently, there was no appreciable residual effect of the fertilizers on the subsequent grain and hay crops.

EXPERIMENTS WITH AMMONIUM PHOSPHATES

These fertilizers furnish both nitrogen and phosphoric acid. They are manufactured in the form of mono-ammonium phosphate containing, approximately 10 per cent of nitrogen and 45 to 48 per cent of phosphoric acid and as diammonium phosphate containing, approximately, 17 per cent of nitrogen and 53 to 55 per cent of phosphoric acid. In some cases the ammonium phosphate is mixed with ammonium sulphate, the mixture being given a trade name such as ammo-phos or leunaphos. The addition of a high-grade form of potash—muriate or sulphate of potash—results in a complete mixture having a high concentration of the plant food elements found in commercial fertilizers. During the last few years a number of experiments have been conducted with ammonium phosphates to determine their fertilizing value as compared with the carriers of nitrogen and phosphoric acid commonly used. Data of experimental work conducted at the Experimental Stations at Kentville, N.S.; Fredericton, N.B.; Charlottetown, P.E.I.; and Agassiz, B.C., have shown that ammonium phosphates proved quite satisfactory as a source of nitrogen and phosphoric acid for field crops.

MANURES AND FERTILIZERS FOR THE POTATO CROP

In an experiment (Project C.5) conducted at Charlottetown, P.E.I., since 1927 it was found that where potatoes have been grown continuously, the yields were consistently lower than those obtained when the crop was grown in a three-year rotation. This result was much more marked where fertilizers only or a combination of fertilizers and manure were used than where manure only was applied. However, fair yields of potatoes were obtained on the same land during the seven-year period.

Under both systems of growing potatoes the largest yields were obtained from the treatment with manure alone (15 tons per acre). The application of one-half the quantity of manure (7½ tons) supplemented with 500 pounds of a 4-8-8 mixture gave the next highest yield, the returns being appreciably higher than those from the treatment with the fertilizer alone at 1,000 pounds per acre.

An experiment was commenced on the branch Experimental Farm, Nappan, N.S., in 1923 in an endeavour to obtain information as to the most suitable ratio of the plant food elements of a complete fertilizer mixture for the potato crop and the most profitable rate of application.

Ten different formulæ, viz. 3-6-6, 4-6-6, 5-6-6, 6-6-6, 3-8-6, 4-8-6, 5-8-6, 4-8-4, 4-8-8 and 4-8-10 were prepared and applied at three rates per acre, viz. 1,000, 1,500 and 2,000 pounds per acre. Nitrogen was supplied in equivalent amounts by nitrate of soda and sulphate of ammonia; phosphoric acid by superphosphate and potash by muriate of potash. The fertilizers were applied for the potato crop in a three-year rotation of potatoes, oats and clover hay.

The average yields of eight crops of potatoes indicated that a ratio of 1:2:2 for nitrogen, phosphoric acid and potash, respectively, in the fertilizer mixture was quite satisfactory, although on light sandy loams a slightly higher proportion of phosphoric acid or potash might be used. With respect to rates of application of the formulæ used in this experiment, the data indicated that the higher rate—2,000 pounds per acre—was the most profitable when market prices were good.

The effect of varying the proportion of potash in a complete fertilizer for potatoes was studied at the Kentville Station in 1932 and 1933. The percentages of nitrogen and phosphoric acid were kept constant at 5 and 8 per cent, respectively, and potash varied from zero to 13 per cent. In both years the highest yield of potatoes was obtained from the 280-pound per acre rate of application of muriate of potash—equal to 7 per cent of potash in the complete fertilizer applied at 1 ton per acre. When the percentage of potash was decreased to 3 per cent (5-8-3) the yields dropped somewhat and when the potash was omitted entirely (5-8-0) there was a still further decrease in yield—particularly in 1933. Under the conditions of this experiment there apparently was not any marked response of the potato crop to heavy applications of potash and the use of a fertilizer containing more than 7 per cent of potash was not profitable.

In 1930, an experiment was instituted at Beaverlodge, Alta., to study the effect of various fertilizer treatments on the composition and yield of potatoes. Three varieties of potatoes were planted, viz. Gold Rain, Irish Cobbler and Early Rose. The data for dry matter, nitrogen and ash content revealed no significant differences in composition attributable to fertilizer treatment. The average data for each of the three varieties showed that Irish Cobbler possessed the highest dry matter content. Early Rose ranked first in respect to percentages of protein and ash (dry matter basis). The largest yield of marketable tubers was 226·7 bushels obtained from the plots fertilized with 300 pounds of ammonium phosphate and 150 pounds of muriate of potash per acre. This was an increase of 16·8 per cent over the unfertilized check plot, which yielded 194·2 bushels per acre. A complete fertilizer mixture of 217 pounds nitrate of soda, 300 pounds treble superphosphate and 150 pounds muriate of potash gave an increase of 5·7 per cent. Under similar fertilizer treatment Irish Cobbler stood first in respect to yield of marketable tubers and composition.

An experiment was commenced in 1928 at the Experimental Station, Windermere, B.C., to study the plant food requirements of the soil of that district. Various combinations of a nitrogenous, phosphatic and potassic fertilizer were applied (1) alone, (2) in conjunction with manure and (3) in conjunction with a green crop of clover turned under. The fertilizers were applied for the potato crop of a four-year rotation of potatoes, peas, oats and sweet clover grown under irrigation. The average yields of potatoes during the five-year period 1928 to 1932 showed very large increases from the application of barnyard manure. The ploughing under of sweet clover proved slightly beneficial. Phosphoric acid proved to be the element of plant food chiefly required in the soil for maximum production. Potash and nitrogen proved of considerable benefit when applied in conjunction with phosphoric acid but when applied alone or in conjunction with one another there was practically no increase in yield.

FERTILIZERS FOR THE MANGEL CROP

The effect of varying the proportion of potash in a complete fertilizer mixture for mangels was studied at the Kentville Station in 1931-33 (Project C.205). Nitrogen and phosphoric acid were kept constant at 5 and 8 per cent respectively and potash was varied from zero to 13 per cent. The rate of application of the several mixtures was 1 ton per acre.

The data showed that all crops benefited to a very marked degree from the application of the complete fertilizer. When the latter contained 3 per cent of potash the yield of mangels increased by 42·5 per cent over the no-potash treatment; when the mixture contained 5 per cent of potash there was no additional increase and with 7 per cent of this element present in the fertilizer the increase was 44·3 per cent. Further increases in the amount of potash applied did not prove beneficial.

FERTILIZERS FOR FIELD CROPS—KAPUSKASING, ONT.

An experiment was commenced in 1926 at the branch Experimental Station at Kapuskasing, in Northern Ontario, to obtain data with respect to the employment of fertilizer materials in the growing of field crops. The outstanding feature of the results of this work was the response of all crops of a rotation of O.P.V. barley, clover hay and timothy hay to applications of phosphoric acid. The data clearly indicated that phosphatic fertilizers might be economically employed for the growth of field crops on the heavy clay soils of the Kapuskasing district.

MANURES AND FERTILIZERS FOR VEGETABLE CROPS—C.E.F., OTTAWA

The employment of fertilizers, barnyard manure and green manure in the growth of cabbage and tomatoes has been investigated at the Central Farm, Ottawa, since 1924. A 4-8-5 mixture was applied for early cabbage at the rate of 1,000 pounds per acre (1) alone, (2) with an application of 10 tons barnyard manure per acre, (3) following the turning under of a green crop of sweet clover and (4) with barnyard manure and green manure. The following crop of tomatoes was not fertilized.

A summary of the results over a seven-year period showed the commercial fertilizer treatment increased the total yield of cabbage and tomatoes by 45 and 106 per cent, respectively. Used in conjunction with the fertilizer the turning under of a green sweet clover crop proved of slightly greater benefit for the cabbage crop than an application of ten tons of manure per acre. For the tomato crop, however, the green manure did not materially increase yields, whereas barnyard manure gave large increases.

FERTILIZERS FOR PEAT LANDS

Working in co-operation with the Division of Illustration Stations, the Division of Chemistry has been making a study of the plant food requirements of peat soils at Caledonia Springs, Ontario, since 1930. While the investigation has not been in progress long enough to make statements in regard to the most suitable fertilizer treatment for this type of peat land, some valuable inferences may be made from the results so far obtained.

The field results indicated that potash was the most essential of the three elements furnished in the complete fertilizer mixture. The yields stressed the necessity of an application of manure at the outset at least; they indicated that from 10 to 15 tons of manure supplemented with 500 to 600 pounds of a 2-10-12 fertilizer for hoed crops should give fairly good results. The application of lime on this area did not appear to be of special benefit as no marked response to this element by any of the crops sown could be noticed.

FERTILIZERS FOR PASTURES

Investigational work dealing with the close-grazing system of pastures was commenced by the Division of Chemistry at the Central Farm, Ottawa, in 1927. In the spring of 1932 experiments were commenced to compare various sources of nitrogen for pastures and to study the effect of successive applications of nitrogen on dry matter and protein yields. In 1933 further work was started dealing with the employment of fertilizers for pasture improvement, in which various rates and dates of application of nitrogen and minerals were studied.

MANURE, FERTILIZERS AND LIME EXPERIMENT—STE. ANNE DE LA POCATIÈRE, P.Q.

This investigation was commenced at the Experimental Station, Ste. Anne de la Pocatière, P.Q., in 1924, the object being to ascertain to what extent the productiveness of the heavy clay soils of the district could be improved by the application of fertilizers and lime. Treatments with manure were included, the materials being applied for the hoed crop of a four-year rotation of turnips, barley, clover hay and timothy.

The results showed that the application of barnyard manure gave substantial increases in the yields of turnips and barley. Applied alone at 20 tons per acre the manure gave an increase in the turnip yield of 35·7 per cent and when supplemented by 2 tons of ground limestone per acre the increase was 41·8 per cent. The increases in the yield of barley from these two treatments were 14·4 and 15·7 per cent, respectively, and the influence of the manure was also reflected in the timothy hay yields. The application of lime appeared to be of some slight benefit for all the crops of the rotation but the data were somewhat inconsistent in this regard.

The complete fertilizer treatment increased the yields of turnips 27·9 per cent, but did not prove of benefit on the succeeding barley and clover hay crops and of only slight benefit on the timothy hay. Of the three elements furnished in the complete fertilizer, phosphoric acid was distinctly the most effective in increasing yields.

Soil Amendments

In the Maritime Provinces the reaction of the soil is perhaps one of the greatest factors influencing crop yields, particularly those of the legume crops. In many districts of these provinces the soils are quite strongly acid and until the acidity has been lessened by a dressing of some form of lime, best results from the use of fertilizers are not usually obtained. This has been well demonstrated in the Fertilizers and Ground Limestone Experiment conducted at the Experimental Station at Kentville, N.S., during the last twenty years. The results of this work stressed the importance of applying lime for the satisfactory growth of grain and clover hay crops on acid soils such as exist in the Kentville district; they clearly showed that for these crops on this type of soil fertilizers could not exert their full beneficial influence unless the land had been given an application of some form of lime. For the potato crop, dressings of lime are not essential or desirable unless the soil is extremely acid. A moderately acid soil is the most suitable for potato culture since the susceptibility of the crop to scab development increases as the soil approaches the neutral or alkaline point in reaction.

An experiment to study the effect of soil acidity on clover growth and potato scab development has been conducted at the Experimental Station, Kentville, N.S., since 1931 (Project C.179). The area selected was broken in 1927. It was manured and fertilized in 1929 for a potato crop but had never been limed. The soil was a sandy loam of low fertility and strongly acid, the pH value ranging from 4·60 to 4·90. Six rates of application of ground limestone ranging from 250 pounds to 4,000 pounds per acre were applied for the oat crop of a three-year rotation of grain, clover hay and potatoes. The whole area received 500 pounds of superphosphate for the oat crop and 1,200 pounds of a 4-8-10 fertilizer per acre for the potato crop.

The data clearly showed the importance of a dressing of lime to recently broken land at the Kentville Station. The beneficial effect of the lime was quite marked on all crops of the rotation and was very pronounced on the clover hay crop. There was a fairly consistent increase in yields with each successive increase in the rate of application of the ground limestone; when the latter reached a rate of 1,500 pounds per acre there was a very noticeable "jump" in the yield of clover hay. The largest yields of the series were from the heaviest rate of limestone and they indicated that an application of at least 2 tons per acre was required for best results on this soil from the yield standpoint. The data showed that the potato crop of 1933 was free from scab infection on this soil when the latter was limed at the rate of 2 tons per acre of ground limestone in 1931.

The effect of gypsum and sulphur on crop yields and on the suppression of potato scab was studied at Kentville, N.S., during the period 1924 to 1932 (Project C. 104). The land selected for the test had been previously limed twice at the rate of two tons per acre and potatoes grown on this area in 1923 had been infested with scab. The pH value of the soil in 1924 varied from 5·0 to 5·8. Sulphur was applied for the potato crop in 1924 at 100, 200 and 400 pounds per acre in the form of flowers of sulphur and gypsum. The plan also included treatments with superphosphate at 890 and 1,780 pounds per acre, ground rock phosphate at 500 pounds per acre, manure at 10 tons per acre with and without gypsum, and ground limestone with and without sulphur. In 1929 the above treatments were repeated and scabby potatoes planted. Potatoes were again planted in 1932 but without further application of sulphur or gypsum. Intermediate crops were either grain or hay.

In total value of crops produced during the nine years' period, the manure and gypsum treatment gave an increase of 26·7 per cent over the average of the check plots. The next best return was from the ground rock phosphate treatment and this was closely followed by manure at 10 tons and by superphosphate at 1,780 pounds per acre, the latter resulting in an increase of 15·3 per cent. The increases in total value of crops produced from the various gypsum and sulphur applications varied from 2·0 per cent (gypsum at 1,100 pounds per acre) to 8·2 per cent (sulphur at 200 pounds per acre).

The data in connection with potato scab development were somewhat inconsistent. The percentage of scab was much higher in 1932 than in 1924 and 1928 for all treatments except that in which 2,200 pounds of gypsum were applied. This appeared to indicate that neither gypsum nor sulphur proved effective in controlling scab development. However, the heaviest rate of gypsum (2,200 pounds) applied in 1924 and 1929 resulted in only 4·7 per cent scab on the 1932 potato crop as compared with 61·1 per cent in 1929 and 9·2 per cent in 1924. With all other treatments there was practically 100 per cent scab infection on the 1932 crops.

PLANT CHEMISTRY

The Influence of Environment on the Quality of Wheat[1]

Quality in wheat is largely determined by the character and quantity of the protein, commonly known for this cereal as gluten. The character of the gluten appears to be chiefly an inherited factor but investigations extending over a period of thirty years have shown that the amount of this valuable constituent is largely determined by environmental conditions, chiefly precipitation but also, temperature and hours of sunshine. Those environmental factors which hasten the maturation of the kernel and shorten the period during which carbohydrates are being synthesized in the wheat berry assist in the production of high protein wheat. The chief of these factors are scanty precipitation and high temperatures during the later weeks of development and ripening. It may be pointed out, however, that the character of the soil more particularly in respect to its absorptive capacity for moisture is a factor closely associated with precipitation.

As far back as 1905, it was observed that newly broken scrub soil in the Dauphin Lake District, Manitoba, produced starchy, piebald wheat when the parent seed had been hard, vitreous, and of high protein content. Conversely, the piebald wheat sown on soil which had been cultivated for a number of years yielded a crop, approximately, four per cent higher in protein than the parent seed. These observations led to a study of the causes of the deterioration of wheat grown on "breaking". Analysis of the soils of the 1906 plots showed the humus and nitrogen of the " breaking soil " were very considerably higher than those of the cultivated, although the former produced the lower nitrogen wheat. Obviously, deficiency of nitrogen in the soil did not afford an explanation of the failure of newly broken land to produce hard wheat. The great difference in the two soils lay in the moisture content. Samples were taken on seven dates, from May 5 to August 24 and the "breaking" soil was always the moister, the differences ranging from 9 to 14 per cent.

With this evidence possibly furnishing a clue to the cause of protein diminution in certain localities, it was decided to extend the investigation to include a number of points at which temperatures and precipitation differed widely and from time to time. With the acquisition of new experimental farms and stations new experimental plots were started and data accumulated. The number of points at which wheat was grown for this experiment was increased from eleven to twenty-one.

Since 1912 the seed sown at the stations co-operating in this inquiry was from the same stock—Marquis grown at Indian Head, Sask. It appeared therefore that heredity was not an influencing factor and that differences between the parent seed and its progeny had to be attributed to environmental conditions.

The analytical data on samples from 1912 to 1932, have been tabulated, thus giving the results for a period of twenty-one years. With this accumulation of data, it was possible to draw certain conclusions from various phases of the inquiry.

DISCUSSION OF RESULTS

(1) Variation of protein content of progeny from that of parent.—A consideration of the maximum and minimum protein content of the progeny, as grown on the several stations, showed wide variations from the percentage of protein found in the parent seed. Environmental factors increased the protein content by 8·40 per cent and reduced it by 6·18 per cent.

(2) Influence of Irrigation: If soil moisture is one of the important environmental factors influencing the wheat kernel, adjacent plots irrigated and non-

[1] "The Quality of Wheat as Influenced by Environment", by Frank T. Shutt, and S. N. Hamilton, The Empire Journal of Experimental Agriculture. Vol. 2, No. 6, April, 1934.

irrigated should produce wheat with protein content confirming this hypothesis. Since 1916, the Experimental Station at Invermere, B.C. (Windermere, B.C.), has grown wheat on irrigated and non-irrigated plots. The results of analysis have been consistent and have markedly shown the influence of soil moisture due to irrigation. The trends were as follows: (1) The period required for maturation was longer in the irrigated plots. The average number of growing days over a period of eight years was 116 for the irrigated and 104 for the non-irrigated plots. (2) Irrigated land produced a larger berry than that from the dry plots. The average weight of 1,000 kernels, for 12 years, was 25·4 grams from the non-irrigated and 34·4 grams from the irrigated plots. (3) The irrigated wheat had an average protein content 4 per cent lower than that of the non-irrigated wheat. The two averages for a twelve-year period were 13·9 per cent and 18·0 per cent.

Since among the environmental factors affecting these areas the only one markedly differing was soil moisture, it is clear that the evidence of this experiment supports the contention that shortening the growing period (hastening the ripening of the grain) increases the protein content.

(3) Influence of Rainfall: Rainfall is the most important factor determining soil moisture content and the supply of available plant food. According to the present hypothesis it is the drying-out of the soil, due to scanty precipitation and high temperatures, during the latter weeks of development and ripening of the kernel, which constitutes the chief environmental factor conducive to high protein content. In consequence there should be a correlation between protein content and rainfall. It was decided to select four stations for detailed study—two in districts of scanty precipitation, and two in which ample rainfalls prevail especially during the latter weeks of the growing season. The two former are at Invermere, B.C., and Scott, Sask., and the latter are at Charlottetown, P.E.I., and Kentville, N.S., in the Maritime Provinces.

The following table presents the average temperature and precipitation data for July and August with the average protein content of the wheat (dry matter basis) at the four above mentioned stations over a period of twenty-one years—1912-1932.

TEMPERATUTE, RAINFALL AND PROTEIN CONTENT AT INVERMERE, B.C., SCOTT, SASK., CHARLOTTETOWN, P.E.I., KENTVILLE, N.S. 1912-32

Stations	Temperature		Rainfall		Protein average
	July, average of maxima	August, average of maxima	July, average	August, average	
			in.	in.	p.c.
Invermere, B.C.	92°	90°	1·05	1·38	17·37
Scott, Sask.	93°	91°	2·49	1·53	17·41
Charlottetown, P.E.I.	84°	82°	3·22	3·21	13·11
Kentville, N.S.	85°	86°	3·07	3·09	13·49

It will be observed that these data fall into two groups, one consisting of the two western stations characterized by high ripening temperatures, scanty rainfall—especially in August—and high protein wheat, the other—the two maritime stations—with lower temperatures, heavier rainfall and wheat of low protein content.

Since the parent seed wheat sown each season throughout the series was of the same stock, this investigation showed indisputably that environmental factors very largely determined the protein content.

The two western stations, with an average maximum temperature of 92° for the two ripening months, and an average precipitation of 1·50 inches, produced wheats with an average protein content 40 per cent higher than that from the two points in the Maritimes, at which the average maximum temperature was 8° lower, and the precipitation double that at the two western farms.

SUMMARY

The data amassed in this investigation covering a period from 1905 until the present time—28 years—and conducted at a considerable number of stations located at strategic points throughout the Dominion, very clearly prove that the excellent quality of the wheat in general of the Prairie Provinces is very largely due to favourable seasonal conditions which include high temperatures and absence of excessive moisture (resulting in the drying out of the soil) during the latter stages of the development of the grain. For the production of high quality wheat the economic value of these conditions—and they are those which usually obtain over the larger part of the wheat belt of the great North West—has not been sufficiently recognized as being of equal importance to that of desirable inherited characteristics, e.g. quality of gluten, earliness in ripening, etc., and a wonderfully fertile soil.

The Close Grazing Scheme of Pasture Management[1]

In 1927, four plots were laid out in the arboretum at the Central Experimental Farm to learn the effect on the composition and yield of grass as cut at intervals of one, two and three weeks, respectively, the fourth plot being cut as hay with aftermath. This was the first scientific examination in Canada of the Hohenheim system of pasture management, a scheme which aims by close grazing and heavy fertilization to furnish young, highly nutritious grass throughout the season. This review presents in summarized form the results from field and laboratory work for the five-year period of the investigation at Ottawa, 1927-31.

The field selected for this investigation had been cut for hay for a number of years. For at least thirty years it had not been ploughed, pastured or manured.

The soil was a deep, moderately heavy clay loam with an abundance of humus. The nitrogen content of the surface soil (to a depth of 6 inches) was 0·258 per cent (water-free basis) and of the subsoil (from 6 to 12 inches) was 0·08 per cent. The surface soil had a pH value of 6·39 and a lime requirement of 2,000 pounds of carbonate of lime per acre (Jones method). The strong, vigorous growth of grass gave evidence of a high degree of fertility. Each year, at the beginning of growth, the area was fertilized at the rate of 25 pounds of nitrogen to the acre.

A botanical survey of the area early in May, 1927, revealed a remarkably even " stand " of grass. The dominant grasses were meadow foxtail (*Alopecurus pratensis*) and timothy (*Phleum pratensis*), with the former greatly preponderating. Kentucky blue grass (*Poa pratensis*) was present, but in almost negligible amounts. Legumes were not visible. A very few plants of tall buttercup (*Ranunculus acris*) and dandelion (*Taraxacum officinale*) were noticed.

Meadow foxtail is an early perennial grass of good quality, requiring a rich soil, moist climate and three or four years to come to perfection. Though not among the heaviest hay grasses, it is valuable for pastures on account of earliness, rapidity of growth after cutting, and rich aftermath.

Four adjacent plots (A, B, C, D) were laid out on this area. The frequency of cutting adopted was as follows: A, weekly; B, fortnightly; C, every third week; and D, at stage for hay (seed formed) with aftermath. A, B and C were cut with a lawn mower, leaving a close-cut sward. Every cutting was immedi-

[1] High Protein Pasture: The Rotational or Close-Grazing System of Pasture Management". Frank T. Shutt, S. N. Hamilton, H. H. Selwyn. The Journal of Agricultural Science, Vol. XXII.. July, 1932, page 647.
" A Contribution from Chemistry to the Close Grazing System of Pasturage." Frank T. Shutt, S. N. Hamilton. Transactions of the Royal Society of Canada. Third Series, Vol. XXVI, Section III, 1932.

ately weighed, sampled and total moisture determined. The remainder of the sample was air-dried, ground and analysed.

At the close of the season of 1931, a five-year period of investigation having been completed, it was desired to end this investigation and pursue other phases of the problem of high protein pastures.

A summary of results for the five-year period (1927-31) follows:—

SUMMARY

(1) The plot "cut as hay with aftermath" gave the heaviest yield of dry matter in every year of the experimental period. The average yield of dry matter per acre per annum from this plot exceeded the average of those from the plots cut fortnightly and every third week by, approximately, 1,600 pounds. All the evidence of this inquiry has gone to show that yield of dry matter decreases with frequency of cutting.

(2) This inquiry has emphatically shown the high protein character of young grass and this fact undoubtedly constitutes the outstanding feature of the scheme. Herbage of from one to three weeks' growth is a rich protein forage; its dry matter has a range of from 20 to 25 per cent of this nutrient.

(3) Compared with the grass of the frequently cut areas, that cut for hay had a much lower protein content. Taken year by year, it was less than one-half that of the younger grass.

(4) The incursion of white Dutch clover as the scheme proceeded, due no doubt to exposure of the sward to light, markedly raised the protein content of the herbage. Apparently, this clover growth reached a peak in the second or third year of the scheme and then declined. The dry matter of cuttings, with a large proportion of clover, possessed a protein content as high as 32 per cent.

(5) It is in protein production that the rotational scheme of pasture management finds its distinguishing and most valuable feature; the average protein yield of the rotational plots per acre per annum exceeded that of the plot cut for hay by, approximately, 185 pounds. Under seasonal conditions as obtaining at Ottawa, a period of three weeks appeared to be that productive of the highest protein yields of herbage rich in protein.

(6) Up to and including a three weeks' growth period the digestibility of the herbage is very high. As lignification develops the digestibility is depressed and in consequence, the difference between the yield of digestible protein from the closely grazed plots and that from the hay plot is greater than is indicated by the figures for total crude protein. The average protein yield from the hay plot, for the five-year period, was 847 pounds less than the average for the close-grazed plots. This was equivalent to a 20 per cent decrease. The calculated increase in digestible protein from the mowed plots was almost 75 per cent.

(7) The main conclusion from this investigation is that the close-grazing scheme is one furnishing throughout the season, provided there is a sufficient and well-distributed rainfall, pastures rich in protein of a highly digestible nature. The dry matter of the herbage is really a high protein concentrate. Further, this scheme of pasture management is the best so far devised for producing the maximum amount of digestible protein per unit area.

Pasture Value of Cereal Crops[1]

An experiment to determine the relative value of different cereal crops and their power of regrowth when grazed at various stages of development was planned by the Division of Forage Plants, Central Experimental Farm, and car-

[1] The detailed data for this investigation (season of 1932-1933) appeared in "Scientific Agriculture" Vol. XIV, No. 10, June, 1934, under the title "Cereal Grain Crops for Annual Pastures". L. E. Kirk, J. G. Davisdon, Stella N. Hamilton.

ried out on plots at the Experimental Farm, Indian Head, Sask. It was begun in the spring of 1932 and continued in 1933.

Four cereals (wheat, oats, rye and barley) were used in this work. These were sown on two dates, the earlier in May and the second sowing in June, on five groups of four plots each, one plot for each cereal. The cuttings of the first group were made at "three-leaf stage," of the second group at "four-leaf stage," of the third group at "shot blade" stage and of the fourth and fifth groups at "early heading" and "fully headed" stages, respectively. The whole scheme was carried out in duplicate, the groups of plots being designated first series and duplicate series.

The green weight of each cutting was taken and a 2-pound sample of this material air-dried and forwarded to Ottawa for dry matter and protein determinations. From these data, the yields of these two constituents were calculated for each cutting and for the same season.*

The results for the two seasons were in very fair agreement and a summary of the deductions to be drawn from the data of the two years of investigations (1932-33) follows:—

SUMMARY

1. The oats were lowest of the four cereals, in dry matter.

2. Percentage of dry matter increased in all the cereals, with advance towards maturity.

3. For the same cereals, cut at the same stage of growth, there was no difference in percentage of dry matter due to difference in date of sowing.

4. The dry matter of oats was richest in protein.

5. Wheat and rye possessed dry matter poorest in protein.

6. Dry matter of cereals became poorer in protein as forage matured.

7. For the same cereal, cut at the same stage of growth, there was no difference in the protein content of the dry matter of the first and second sowings.

8. Oats of the May sowings produced the heaviest yields of protein, those cut at "five-leaf stage" ranking first.

9. Barley and oat plots, both sowings took first twenty places in respect to protein yields (forty plots in series).

10. The rye and wheat plots, both sowings, yielded the lowest weights of protein.

10. For the same cereal cut at the same stage of growth, yields of both dry matter and protein were heavier for the May than for the June sowing. This was especially true for the oats, when the increases ranged from 20 to 40 per cent.

12. The highest yields of dry matter and protein were not from the same plots.

13. Oats had the longest growing season. In 1933 cuttings were made from June 24 to October 10 (seven cuttings). The other three cereals were not cut after the 18th of August and only four cuttings were made of the wheat, rye and barley. The three last cuttings of oats yielded 1,445 pounds of dry matter, for the stage of cutting (3-4 leaf) for which the season's yield was 3,664 pounds, the corresponding figures for protein were 364 pounds for the last three cuttings and 921 pounds for the seasonal yield.

Western Prairie Forage Plants

In 1927,[1] an investigation was begun at the request of the Division of Forage Plants into the composition of the representative species of native forage, especially those found on the federal ranch at Manyberries, Alta. These were chiefly

[1] Reports of the Dominion Chemist ending March 31st, 1928-30.

grasses, legumes, sages, and thistles, and were collected when at various stages of growth, from early leaf to ripened seed, and in some cases samples were received which had weathered till March or April of the year succeeding growth. Thus, the samples received represented the forage over the entire period during which the stock grazed these areas.

It was desirable to ascertain the differences in composition among the various types of herbage and the changes in composition due to growth (especially changes in protein and ash content), in order to link up, if possible, lack of thrift among the stock to lack of nutrients in the native forages. When received, notes were made on the condition of the samples and determinations of protein, fibre, total ash, lime and phosphoric acid were made. There are now data on 325 samples collected over a period of five years.

It is not possible to present in detail the tabulated data of all the samples analysed. Study of these data, however, has revealed certain well-marked and consistent trends and characteristics, year after year, and these are reviewed.

SUMMARY OF RESULTS OF ANALYTICAL DATA OF WESTERN PRAIRIE FORAGE PLANTS, 1927-32

1. Each year, a number of the species was collected at various stages of growth, the dates of cutting ranging from the latter weeks of May when the plants were in leaf until March or April of the succeeding year when "weathering" had markedly changed the nutrient value. The plants showed, in general, consistent changes in composition, notably in protein and ash content, with differences in the stage of maturity.

The protein content of numbers of these forages decreased rapidly as growth advanced.

The following data show the range of protein in the same species, at different stages of growth:—

PROTEIN CONTENT OF FORAGES AS INFLUENCE BY STAGE OF GROWTH (DRY MATTER BASIS)

Stage of growth	Stipa comata (spear grass)	Koeleria gracilis (June grass)	Agropyron Smithii (blue joint)	Eurotia lanata (silver sage)	Calamagrostis montanensis (blue stem)
	p.c.	p.c.	p.c.	p.c.	p.cp
Leaf	17·73	19·32	19·80	25·75	12·87
In the boot	16·63	14·49	11·90	16·45	—
Flowering	12·23	7·96	9·83	—	9·07
Seed ripe	11·95	6·24	—	—	8·16
Seed shed	6·03	4·49	—	11·09	—

These figures are from the analytical data for 1929, and serve to illustrate the gradual decrease in the percentage of protein from early stages of growth to maturity.

The protein content is as much as four times greater in the young plant, just leafing out, than it is after the seeds have ripened and been shed, and while all the species do not show so rapid a decrease, there is always a marked difference between the percentage of this nutrient in young plants and those nearer or at maturity. This is a decrease in percentage only and not in yield, i.e. total amounts. With leaf development the carbohydrates are synthesized and as a result of the increasing proportion of starches, sugars, etc., the percentage of protein is lowered.

2. A certain proportion of this herbage is cropped during the winter and in the early spring of the succeeding season. Numbers of samples of these "weathered" forages, chiefly grasses (spear grass, June grass, blue joint, blue

grama grass and meadow grass), were analysed. They are of very low feeding value, as the following figures will show:—

PROTEIN CONTENT (DRY MATTER BASIS) OF CURED AND WEATHERED GRASSES

Species	1927	1928	1929	1930	1931	1932
	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
Stipa comata (spear grass)	2·00	4·91	—	5·88	6·97	5·37
Bouteloua gracilis (blue grama grass)	2·14	2·87	—	—	6·62	—
Poa laevigata (dwarf meadow grass)	1·37	2·47	—	—	—	—
Koeleria gracilis (June grass)	—	2·29	4·49	5·43	5·70	5·53
Agropyron Smithii (blue joint)	—	3·32	—	—	4·34	3·82
Poa confusa	—	—	—	3·31	6·98	—

The figures of the above table show that "weathering" is accompanied by a distinct loss in feeding value. This may be due to loss of leaf, as these samples are chiefly stalk, stem and empty seed heads. The fibre content is also very high, averaging about 35 per cent. Whether due to breakdown, leaching or loss of the more nutritious parts of the plant, the nutritive content of these cured grasses is very low.

3. Certain of these forages, especially in the early stages of growth, are very rich in protein. Several varieties of legume were received, bushy purple pea, tall white pea, purple pea, lupins, etc. These have a range in protein content of from 28 per cent in early leaf to 16 per cent (dry matter basis) in the flowering stage. The sages, represented by several varieties (prairie sage, silver sage, salt sage and sage bush), are also characterized by a dry matter rich in protein. In the earlier stage of growth these plants may possess a protein content of 27 per cent and the cured samples as much as 11 per cent of this nutrient. Wild barley, cut in the early stages of growth, is almost entirely composed of leaf and the protein of this plant can be very high, in one case almost 29 per cent.

4. The ash content, especially in the percentages of lime and phosphoric acid, is of special interest. There are evidences of a lack of bone-building minerals in the feed of the stock-ranging areas in the parts of Alberta where the federal ranch is situated. Lack of general thrift among the cattle and a tendency to chew bones, led to an inquiry into the question of mineral supply. The ash data from the analysis of several years' samples of the prairie forages are very informative.

Lime.—For the years 1929-33, inclusive, lime content has been determined, on a total of 225 samples. There is considerable variation in the lime content of these samples and the differences seem to be dependent upon species as well as upon stage of growth. For the samples analysed, the lime content of the grasses, at stages of growth from "early leaf" to "seed shed," are as follows:—

Variety	CaO (water-free basis)
Stipa comata (spear grass)	0·575
Bouteloua gracilis (blue grama grass)	0·545
Agropyron Smithii (blue joint)	0·468
Koeleria gracilis (June grass)	0·459
Poa confusa	0·381
Poa Buckleyana	0·375

None of these figures indicate any serious lack of lime in the prairie herbage. Study of these data in detail indicate that the lime content tends to decrease at "flowering" stage and is also low at stage of "seed shed."

The lime content of specimens weathered until the early spring of the year succeeding growth is higher than at any time during growth. This is probably due to the comparative insolubility of the calcium compounds present in these plants.

Certain of these prairie forages possess notably high percentages of lime. The sages have, in many cases, a lime content of well over 1 per cent. The legumes carry from 1 to 2 per cent of lime.

Phosphoric Acid.—The phosphoric acid content of these plants is rather low, especially at certain stages of growth. While exceptions may be noted, the trend is for the percentage of this constituent to decline rapidly after the flowering stage. For five grasses, viz. needle grass, blue grama grass, June grass, blue joint and Poa confusa, the average percentage of phosphoric acid (dry matter basis) at the flowering stage, over a period of four years, is 0·558; that for "seed shed" stage is 0·199. When mature the phosphoric acid content of these prairie plants is very low. The content of this mineral constituent suffers a further decrease, due to weathering being as low as 0·096 per cent, in plants collected in March or April of the year succeeding growth. The sages, legumes, Russian thistle, and wild barley carry percentages of phosphoric acid higher than those of the grasses.

Nitrogen Storage in Alfalfa Roots

A series of thirty-six samples of alfalfa roots collected at the Experimental Station, Lethbridge, Alberta, crop of 1932 were received for nitrogen determination—percentages and total weights.

Three groups of samples were sent. One of these groups was from a crop cut on September 6, another cut October 1, with an additional series of samples from an uncut crop. All the roots were dug during the period December 1 to 6, from an area of 1 square yard, and were representative of two depths, 0 to 1 foot and 1 to 2 feet. Each group was comprised of six replicates.

The weights of the roots as dug and of the dry matter and nitrogen differed greatly among the replicates and, therefore, the consideration of average data only is of value.

DISCUSSION OF DATA

The average weight of roots, from both depths, for Group I (cut September 6) was 1,386 grams. The corresponding weight for Group II (cut October 1) was 1,440 grams. The average weights of dry matter from these two groups were 431 grams and 499 grams, respectively. The corresponding nitrogen figures were 8·37 grams for Group I and 9·69 grams for Group II. The figures for Group III, samples from the crop left uncut, were the lowest in total yield, but intermediate betweeen Groups I and II in respect to weights of dry matter and nitrogen.

There is, therefore, some evidence that delaying the cutting of the crop until the close of the season has resulted in a greater storage of nitrogen. The figures are interpreted to mean that nitrogen storage was proceeding in the roots between September 6 and October 1 in the crop left uncut until the latter date and also in the crop left uncut until the roots were dug.

Western Rye Grass

The Superintendent of the Experimental Station at Scott, Sask., requested the analyses of ten samples of Western Rye Grass, which he selected as representing the best ten out of sixty strains grown at the station during the season of 1932.

It was hoped that the analysis of these grasses would reveal differences in composition which would assist in a further selection of strains most suitable for commercial use.

The data showed that the differences in composition of these various strains were not great. The proteins ranged from 8·81 per cent to 10·33 per cent. Strain No. 77 possessed the lowest protein content and "Mecca" the highest. There were no notable differences to be observed among the other nutrients.

Soybeans

SUMMARY VARIETY TESTS, 1928-32

For the past six years (1928-33) several series of soybeans have been analysed at these laboratories, and the weight of 100 beans, protein and oil content determined. The samples submitted have consisted of series from the Experimental Station at Harrow, and the Experimental Farms at Ottawa and Brandon. During this period 139 samples from Harrow (1928-32), 54 from Ottawa (1929-32) and 13 from Brandon (1932-33) have been analysed, making a total of 206. From the tabulated and summarized data, certain conclusions and deductions have been made, viz. average protein and oil content (water-free basis), the relation of protein to oil and the selection of strains which have consistently shown high protein or high oil content. In 1931 and 1932, eight strains were sown at Harrow from parent seed grown at Harrow and the same varieties from the previous year's crop grown at Ottawa. The Ottawa samples for these two years also comprised the same varieties, the progeny of both Ottawa and Harrow grown seed. The results from these four series permit a study of the influence of environment and heredity on the protein and oil content of the beans.

PROTEIN AND OIL CONTENT

During the period of this investigation, certain trends at the three stations have been observed. Data of the maximum, minimum and average content of protein and oil for each station, each year and average for the entire period of investigation, permit the following observations:—

(1) The beans as harvested at Harrow had a higher protein content than those grown at Ottawa. For each year the maximum, minimum (with the exception of those grown in 1932), and average protein was higher at Harrow. The average for the entire period (data from 193 samples) was 43·74 per cent at Harrow, 38·31 per cent at Ottawa, a difference of 5·43 per cent.

(2) Conversely, the oil content was higher on the average at Ottawa and lower at Harrow. The difference was not so great as in the case of protein. The average for the entire period was 0·81 per cent higher for the Ottawa-grown seed.

(3) The total number of samples from Brandon was only 13, but the data from these indicated composition very similar to those of Harrow.

(4) There was no constant relation between protein and oil content but study of yearly averages and also of individual varieties showed these two constituents to be reciprocals.

DISCUSSION OF INDIVIDUAL VARIETIES

An attempt was made to select those strains which for a number of years have consistently produced seed rich in protein and a similar list made for those conspicuous for their oil-bearing capacity. Certain factors made this a little difficult. The chief of these were (1) difficulty in identifying the strains, due to designations used, and (2) non-duplication of the same varieties in succeeding years and at both stations. Over the five-year period, however, certain consistencies in composition were evident, and from these a selection was made but this list cannot be considered final.

PROTEIN

Harrow.—In the series from Harrow for 1928 and 1929, eighteen varieties were duplicated in the two years and conclusive results obtained. For these two years the following varieties possessed the highest percentages of protein and low oil contents (although not the lowest in all cases): Ste. Anne, Mandarin, Summerland, Green, Ito San, and Black China.

In 1930, thirteen additional varieties were received, notably Wisconsin Black and varieties designated by letters "A," "B," "C," etc. Further additions were made to the series in 1931 and 1933.

The following varieties, high in protein, might be selected from the crops of 1930, 1931, and 1932: Wisconsin Black, "C" variety, "O" variety, and Early Brown, with the following as a second list, closely following the above: Yellow 210, Mandarin, "A" variety, Ste. Anne's 92, Ito San, and Summerland.

Ottawa.—A smaller number of varieties was received each year from Ottawa than from Harrow, and certain of the strains from Harrow, with a high protein content, were not included in the Ottawa-grown varieties, e.g. Ito San, Ste. Anne's 92, and Summerland.

The varieties from Ottawa most valuable for protein production were "O," "C," Mandarin, and Manitoba Brown.

Brandon.—The varieties from Brandon numbered only six in 1932 and seven in 1933, and none of those designated by letters were received from this farm. Wisconsin Black, Mandarin, and Manitoba Brown were the varieties possessing the highest protein content of the seven varieties grown at Brandon.

OIL

Harrow.—The varieties for 1928 and 1929 having high oil contents in both years were Yellow 17, E. Korean, Manchu, Golden, and A.K.

For the years 1930, 1931, and 1932, the following ranked high for all three years: Yellow 17, Manchu, Golden, A.K. Mention should perhaps also be made of "A" and "B" varieties grown at Harrow from Ottawa seed.

Ottawa.—"A," "I," "B" varieties have quite consistently produced beans with a high oil content, also Wisconsin Black, in the years 1931 and 1932.

Brandon.—Dropmore, O.A.C. 211, and Manchu had maximum oil contents for the two small series, received from Experimental Farm, Brandon, Man.

Reviewing the selection from the various series, it was found that at both Harrow and Ottawa the varieties "O" and "C" have produced beans with high protein content, also Mandarin and Manitoba Brown. Wisconsin Black, at Harrow and Brandon, was rich in protein, but at Ottawa ranked among the varieties highest in oil,

At both Ottawa and Harrow "A" and "B" varieties have been among those varieties with a high oil content.

At one of the stations certain varieties have consistently ranked high in protein or oil, but have not shown the same trend at the other station; e.g., "A" variety tended to be high in protein at Harrow and high in oil at Ottawa.

INFLUENCE OF ENVIRONMENT AND HEREDITY ON THE PROTEIN AND OIL CONTENT OF SOYBEANS

In 1931 and 1932, the series of soy beans included a number of varieties grown at Harrow and at Ottawa from parent seed of the previous year's crop grown at Harrow and also at Ottawa. This short series in both years was tabulated and averages for protein and oil calculated.

The protein data for the four groups of the 1931 crop furnished satisfactory evidence of the influence of environment. The percentage of protein in the beans grown at Harrow the progeny of Harrow- and Ottawa-grown seed was, approximately, 6 per cent higher than the corresponding crop at Ottawa. The oil content of the Harrow seeds was slightly lower than that from Ottawa. There was some evidence that heredity had also influenced the composition of the bean, since the protein content of each variety with one exception from Harrow-grown parent seed was higher than the same variety from Ottawa seed, and in most cases the beans of Ottawa parentage possessed the higher oil content. Unfortunately, the data for 1932 did not lend support to the 1931 conclusions.

It was thought that possibly an analysis of the soils or a study of precipitation data would afford an explanation of the higher protein content so consistently found in the Harrow crop.

Samples of soil from both stations, on which the 1932 crops were grown, showed that the soil from the Central Farm had a higher nitrogen than that from Harrow—0·170 per cent and 0·108 per cent, respectively.

The precipitation at Harrow for these three years and for the months during which moisture was supplied to the soybean crop was considerably lower than at Ottawa, from 7 to 10 inches of rain each year. Higher protein content was associated with lower precipitation.

Rainfall is probably the environmental factor which so influences growth that differences in protein content result.

SOYBEANS, 1933

The Division of Forage Plants submitted for analysis fifteen samples of soybeans, crop of 1933. Eight of these were grown at Ottawa, C.E.F., and represented the following varieties: "I," Mandarin, "J," O.A.C. 211, Manitoba Brown, Fukunaga, "A," Wisconsin Black. Three samples, viz. Wisconsin Black, Manitoba Brown, and Mandarin, came from Winnipeg, Man. Two samples, O.A.C. 211 and Mandarin, were sent from Avonport, N.S., and one, Manchu, from Hudson, and one, Wisconsin Black, from Bark.

This series did not lend itself to comparison with samples formerly received, since varieties and locations of growth were not the same as in the preceding years of investigation. It was also decided to determine iodine numbers for the oils of these beans, a determination not formerly made. For these reasons, the series for 1933 has been considerably separately.

A study of the data for weight of 100 beans, percentages of protein and oil, and the iodine number permitted the following comments:—

Mandarin, Manitoba Brown, and Wisconsin Black grown in Manitoba and at Ottawa all showed a higher percentage of protein and lower oil content for the bean grown in Manitoba. O.A.C. 211, grown at Ottawa, Ont., and at Avonport, N.S., showed a higher protein and lower oil content for the Nova Scotian sample.

The iodine numbers were interesting: The two highest figures were those for the two varieties grown at Avonport, N.S., viz. 144·7 for O.A.C. 211 and 137·9 for Mandarin.

Mandarin from Manitoba had an iodine figure of 130·7 and from Ottawa of 128·8.

O.A.C. 211, from Ottawa, had an iodine figure of 135·4.

For this short series, the Nova Scotian-grown beans were those possessing oils of high iodine values.

Flax Seed

Seven varieties of flax, grown at the Experimental Farm, Brandon, Manitoba, in 1930 were received for analysis.

There were no great differences in the percentages of protein among the seven varieties—the range was from 28·62 per cent to 27·02 per cent. The percentage of oil in these seeds varied more than the percentages of protein. "Walsh" had the greatest oil content—42·92 per cent; No. 1676 ranked second with 41·25 per cent, and "Bison" third with 40·88 per cent. The minimum oil content was that of the variety "Crown No. 5"—36·95 per cent.

"Brown Heart in Turnips"

At a meeting held March 11, 1931, in the office of the Dominion Botanist to consider the details of a co-operative investigation into the cause or causes of this disease, it was decided that this division should at the outset undertake the planning of plot work to learn the influence of the several fertilizer elements on the occurrence of the disease and to make an analysis of sound and diseased roots to determine the chemical changes attendant upon the development of the disease.

CHEMICAL EXAMINATION OF SOUND AND DISEASED ROOTS

Samples of sound and diseased turnips for this work were furnished by the Superintendent of the Experimental Station, Fredericton, N.B., the diseased (variety Ditmar) being grown from the 1930 crop at the station and the sound (variety Invictus) from the farm of Mr. Fred Corbett, situated about one mile from the experimental station. It was stated that "good eating turnips" had always been obtained on the Corbett farm and that, to date, there had been no signs of this disease. Manure, about 12 tons per acre, and a small amount of wood ashes were the only fertilizers used for this crop by Mr. Corbett, who usually sowed his turnips during the last week of June or the first week of July.

The manurial treatment at the experimental station was as follows: 15 tons of barnyard manure per acre ploughed under and 1,000 pounds of 2-12-5 fertilizer harrowed in before ridging land. The dates of seeding at the station were June 4, 5, and 6.

The storage conditions were, briefly, as follows: at Corbett's farm, in house cellar, no furnace; at experimental station, in room under approach to barn.

Of the seventeen roots from the Experimental Station, Fredericton, N.B., only four on examination were found to be sound. All the turnips furnished by Mr. Corbett were sound.

	Average weight in grams	Specific gravity
Sound turnips: Experimental Station, Fredericton, N.B..	1,210	0·996
Diseased turnips Experimental Station, Fredericton, N.B..	1,340	0·956
Sound turnips (Corbett)................................	1,391	0·986

From these results, it would appear that diseased roots have a distinctly lower specific gravity than those which are sound. This difference between sound and diseased roots is not associated with differences in water content as the chemical data indicate.

In preparing the roots for analysis, whole sound and whole diseased turnips were analysed and also tissue from diseased zones and tissue from corresponding zones of sound turnips. It is not possible to publish the analytical data but the following comments may be made:—

(1) The differences in dry matter content between sound and diseased whole turnips and sound and diseased central zone tissue did not disclose any relationship between the disease and percentages of dry matter.

(2) The protein content (dry matter basis) of the sound whole turnips and sound central zone tissue was, approximately, 1·5 per cent higher than the corresponding material from the diseased roots.

(3) The differences in ether extract were not very significant but the percentage of ether extract was higher for diseased roots.

(4) The carbohydrates showed differences of considerable significance. They were from 2 to 5 per cent higher in the sound tissue.

(5) The fibre was from 2 to 4 per cent higher in the diseasesd than in the sound tissue. This seemed to indicate that the occurrence of the disease upset the proportion of fibre to carbohydrates. In the sound whole roots and sound central zone tissue the ratio of fibre to carbohydrates was 1:11, the corresponding ratio for the diseased roots and zone tissue was about 1:7.

(6) The diseased roots possessed a higher total ash content. This could be interpreted to mean that the breakdown had resulted in a loss of organic matter and a consequent increase in the percentage of mineral matter.

INVESTIGATORY WORK CONDUCTED IN 1931 AT FREDERICTON, N.B., NAPPAN, N.S., AND CHARLOTTETOWN, P.E.I.

This investigatory work was undertaken to learn if there was any influence of the several fertilizer elements on the occurrence of the disease and to make further analyses of the sound and diseased roots which might appear to have some relation to the fertilizer treatment.

The experiment was planned so that the influence of increasing amounts of each of the three elements of plant food—nitrogen, phosphoric acid and potash—in a complete fertilizer could be compared with the incidence of the disease. The various fertilizer formulae thus employed were built around a 2-12-6 mixture applied at 1,000 pounds per acre. Plots to study the influence of manure and lime on the occurrence of the disease were also included. The turnips were planted on three dates and the plots were laid out in duplicate.

FIELD RESULTS

The field data included " yields per acre " and " percentage brown heart ". In a study of these data the following points were noted:

(1) For the greater number of the formulae used there was a great divergence in both the yields and the percentage of " brown heart " from the duplicate plots.

(2) Increasing or decreasing the proportion of any one of the three elements of the 2-12-6 fertilizer mixture did not give any consistent increase or decrease in the percentage of " brown heart ".

(3) There was an indication that the barnyard manure treatments at heavy rates of application gave a slight measure of control.

(4) On the plots treated with slaked lime in conjunction with the complete fertilizer the percentage of " brown heart " was relatively high.

(5) The highest percentages of " brown heart " appeared to occur on the plots giving the largest yields.

(6) At Fredericton the yields from the third date of seeding (July 17) were considerably lower than those from the two earlier dates (May 22 and June 19). There were indications that the occurrence of the disease was less pronounced on the roots from the third date of seeding.

LABORATORY RESULTS

Samples of the turnips grown at Fredericton in 1931 under the various fertilizer treatments were submitted to the Division of Chemistry for analysis. All samples contained both diseased and sound roots. Roots grown under eight of the fertilizer treatments were selected and composite samples made of both the diseased and sound turnips from the three dates of seeding. Samples of the tops of diseased and sound roots from the 2-12-6 fertilizer treatment were also prepared for analysis. The following is a very brief discussion of the analytical data:—

(1) *Dry Matter.*—The dry matter content was very slightly lower in the diseased roots than in the sound roots, but the differences, while consistent, were so small as to be of no significance.

(2) *Protein.*—There was no significant difference between the protein content of diseased and normal roots, the data being somewhat inconsistent and irregular in trend.

(3) *Fibre and Ash.*—The fibre and ash were, approximately, 10 per cent higher in the diseased roots.

(4) *Ether Extract.*—The ether extract was, approximately, 20 per cent higher in the diseased roots.

(5) *Sugar in Juice.*—The diseased roots were, approximately, 20 per cent lower in sugar.

(6) *Carbohydrates.*—The diseased roots tended to be slightly lower in carbohydrates but the data were somewhat irregular.

(7) There was no appreciable difference in composition between the tops from diseased roots and those from sound roots.

Comparing the results of the two years 1930 and 1931, the following comments may be made:—

(1) In both years differences in dry matter between sound and diseased roots were insignificant.

(2) The protein results were not consistent; in 1930 the percentage of this constituent was higher in the sound roots and in 1931 the data were irregular.

(3) Ether extract, carbohydrates, fibre and ash showed consistent differences for both years. In the diseased roots the ether extract, the fibre and ash were higher and the carbohydrates were lower.

This investigation is being continued with particular attention given to the effect of the addition to the soil of elements other than the ordinary nutrients viz: boron, zinc, manganese, iron, iodine, aluminium, sulphur, etc.

The Influence of "Early Topping" on the Composition and Yield of Turnips

For three years 1929[1], 1930 and 1931 the Experimental Station, Charlottetown, P.E.I., carried on an experiment to determine if the practice of "topping" turnips some weeks before the date of "pulling" in order to use the leaves while still green in the feeding of live stock was an economic one. Samples were received from the Experimental Station, Charlottetown, P.E.I., and from Rustico, of leaves and roots, from one section of the crop, topped early, and from a second area on which the leaves were left until the roots were "pulled". Analytical work has afforded data from which composition and yields of total dry matter and nutrients per acre have been calculated.

For the three years of experiment, the results in respect to both composition and yield have been consistent and may be reviewed as follows:—

Tops: Crown and leaves.—The leaves from the earlier topped turnips contained a lower percentage of dry matter than the leaves of the crop harvested a month later. The yield of dry matter, however, was heavier from the leaves of the earlier topped roots. In consequence, considering leaves only, the argument would be in favour of early topping but a consideration of the data of the roots reverses this decision.

Roots.—The yield of dry matter from the roots harvested at the later date was much the heavier, an increased weight of from 15 to 25 per cent. Also the total weight of dry matter of the leaves and roots was always greater from the turnips topped when pulled. The total dry matter of the crop was every year increased by leaving the leaves on the turnips until the crop was harvested. The yield of sugar from the untopped crop was also the heavier. In one crop the increase was almost 50 per cent. This was an unusually high figure, the average being about 12 per cent.

It is evident that there was a marked growth of the turnips during the latter weeks of the season, resulting in considerable increase in the weight of the roots and in consequence in yield of nutrients. This normal increase was seriously checked by early topping; a practice which all the data showed to be non-economic.

[1] Report of the Dominion Chemist for the year ending March 31, 1930.

Summary of Sugar Beet Investigation[1]

About the year 1890 information on the growing of sugar beets was first published by the Dominion Chemist and since that time analysis of sugar beets from different provinces and districts have been made. In 1902 the Division of Chemistry at the Experimental Farm, Ottawa, started investigational work on sugar beets with two main objects in view: (1) to ascertain the suitability of various districts in Canada, in regard to soil and seasonal conditions, for the growing of beets of sufficiently high sugar content for sugar extraction; (2) to determine what variety of sugar beet gave the highest sugar content under similar conditions. The seed was obtained from strains developed in France, Germany, Russia as well as Canadian grown seed. The growing of the beets was done at twenty-four branch farms and stations situated in various districts throughout the nine provinces.

In the same year that the above experiment was started, the establishment of four sugar beet factories in Western Ontario was instrumental in awakening a keen interest amongst the farmers and inquiries were received from every province in the Dominion with regard to the suitability of the climate and soil of the district for sugar beet culture.

Experimental work was still carried on but as an industry no development took place and in 1931 three beet root factories were in operation, those of the Canada and Dominion Sugar Company at Chatham and Wallaceburg, Ontario, and that of the Canadian Sugar Factories, Limited, at Raymond, Alberta. The total acreage sown was 43,000 with 30,000 in Ontario and 13,000 in Alberta. The average yield per acre was 10 tons which is considered a fairly good yield. Owing to the comparative newness of the industry in Canada only 11·07 per cent of the total sugar consumed is grown but this represents a return of over three million dollars to the growers.

Since 1931 the low price of wheat and the difficulty experienced by the western farmers in selling their wheat and realizing a profitable return has made them interested in sugar beet growing and associations of sugar beet growers and the boards of trade of several districts have begun experiments in the growing of sugar beets in their district with the view of having a beet sugar factory erected for the benefit of the farmers. These experiments have shown fair results so far but from the data of the last twenty years it is doubtful if sugar beets can be grown in the northern parts of the western provinces, successfully with consistently good quality.

From the data collected during the last twenty years, a good general idea of where sugar beets can be grown successfully has been obtained. Of the two main factors considered, namely soil classification and climatic conditions, the latter appears to be the determining factor for both yield and sugar content. A cool wet spring prevents seed germination and a poor stand results, a hot dry summer retards growth giving small roots and a low yield, and a cold dull autumn, often with frosts before harvesting, prevents the proper maturing of the beets at a time when sugar formation is taking place. Thus the ideal seasonal conditions are a warm spring with sufficient precipitation to ensure good seed germination, a growing season with plenty of rain and a mild open autumn with considerable sunshine. These conditions vary each year and explain why one district produces good beets of high sugar content one year and beets of poor quality the next.

A good dark loamy soil seems to be the best for sugar beet growing. Beets are very susceptible to soil acidity and liming of the soil is necessary. It is now recognized that for the best results plenty of fertilizer must be used and phosphoric acid seems to be the most important element. Some agriculturists

[1] Detailed analyses giving average percentages of sugar in juice, coefficient of purity weight per root and yield of sugar beets grown at twenty-five stations throughout Canada may be obtained from the records of the Division.

recommend a 2-16-6 fertilizer. Dr. Brown of the Dominion Sugar Company has found that fields infested by blackrot were deficient in phosphorous and some fields given up as worthless, after being treated with phosphates, recovered and gave good yields.

The seed used in the experimental work was of such varieties as Vilmorin's Improved, Rabbethge and Giesecke and Home Grown seed, Klein Wanzleben, Très Riche, Dippe and Fredericksen. The differences in the sugar content of the varieties grown in the same locality were so slight that it was difficult to say which seed was the best in considering the sugar content but wide variations were noted in the yields and no doubt a certain variety was more suitable to one district than another.

The best and most constant results were obtained from beets grown in the warmer parts of Ontario, the Maritime Provinces, Southern Alberta and British Columbia. In Alberta and British Columbia beets were grown mostly in irrigated districts.

The average sugar content of the juice for the last five years was 17·4 per cent, with the percentage varying from 13·3 to 20·3. It was found that the sugar content of beets grown on the same farm from year to year varied as much as 5 per cent, depending on whether the season was favourable or not. In districts where conditions were consistently favourable and a sugar content of 18 to 20 per cent was maintained, with a purity of 80 or more, sugar culture from an agricultural standpoint was a profitable undertaking, but economic conditions were such that commercially it was not a very profitable enterprise.

Insecticides and Fungicides[1]

(1931-32, and to December 31, 1933)

In co-operation with the Entomological Branch, through the several branch stations studies and analyses were made of many fungicidal agents; analyses of apples and leaves during the period that attractants and poisons were being applied for the control of the apple maggot; analyses of residues, arsenic, sulphur and iron on foliage and apples from the several combination sprays were made and a careful check was maintained for arsenic residues on fruit at picking time. As a citation of this co-operation, mention may be made of the erection of a lime sulphur plant at Aylesford by the United Fruit Companies of Nova Scotia for the manufacture of lime sulphur concentrate. This resulted in a material saving in cost of this valuable fungicide to the orchardists. In co-operation with the Pollination Committee* determinations were carried out in numerous cases of bee poisoning; analysis was made for soluble arsenic and copper, of pollen from the nests of the several species of wild bees in the Annapolis Valley, also analysis of poisoned foliage and bloom, and analysis of rainwater from leaves, petals and blades of grass after spraying. The services of this laboratory were commissioned frequently by the Advisory Board, Agricultural Pests' Control Act, on questions of technical analysis of products coming under the domain of the board.

Of the number of preparations analysed, for field work and under the program of control, a brief review of some of the more important preparations examined follows:—

ARSENATE OF LIME

Eight samples of arsenate of lime from local and foreign sources were examined; three were low in total arsenic and high in water-soluble arsenic and one additional sample was exceptionally high in water-soluble arsenic. In certain spray combinations these compounds would cause foliage injury; with the iron sulphate mix no foliage injury would occur.

[1] See Apple Pollination Studies, Dominion of Canada, Department of Agriculture—Bulletin No. 162—New Series.

ARSENATE OF LEAD

Eight samples of lead arsenate were all low in water-soluble arsenic and were high grade acid-type compounds of lead ($PbHAsO_4$).

PARIS GREEN

Two samples of local manufacture were found to be satisfactory and free from adulteration.

COPPER PREPARATIONS

Five samples examined conformed to the composition of finely ground crystal copper sulphate.

SULPHUR PREPARATIONS

These materials included liquid, solid and colloidal sulphur preparations.

Analysis indicated that freezing resulted in a decrease of total and sulphide sulphur in lime sulphur solutions.

Trials conducted in a commercial lime-sulphur plant indicated a period of 53 minutes boiling of ingredients as the optimum time of operation. Small increases in total sulphur and sulphide sulphur on longer boiling did not compensate for increased costs.

Samples of sulphur-bentonite mixture known as "Koloform" contained from 56·0 to 59·0 per cent free sulphur and contained arsenic in traces only.

WEEDICIDES

Within the past few years, a number of chemical preparations have appeared on the market for the purpose of killing weeds in the field, on the roadside, on fire guards, and about the farm buildings. In order to intelligently plan experimental work with a view to ascertaining their relative effectiveness, a series of the more widely advertised of these preparations, collected and submitted by the Associate Committee on Weed Control, National Research Council, was submitted to analysis. This series comprised samples of the more prominent brands sold in Canada.

The larger number of these preparations contained chlorates as their principal constituent. Sulphate of iron, copper compounds and dichromates were other ingredients found.

OILS

Ten samples of petroleum oils used in spray mixtures for peach and plum trees were examined for specific gravity, viscosity, volatility and per cent unsulphonated.

NICOTINE AND TOBACCO PREPARATIONS

Nicotine preparations—sold under various names—"Black Leaf Forty," "Neotine," "Nicotume," "Hyco," "Nicoteen"—ranged in percentage nicotine as alkaloid from 40 to 42 per cent.

TOBACCO WASTES

Various samples ranged in percentage nicotine as alkaloid from 0·98 to 3·68.

ARSENICAL POISONING OF BEES

Analyses of dead bees showed the danger of arsenical poisoning from sprays. Data obtained from the analyses of dead bees, which had died from natural causes lead us to believe that when the internal arsenic (As) is greater than 0·00004 to 0·00008 mg. per bee or the total arsenic (As) per bee is greater than 0·00018 to 0·00020 mg. per bee, arsenical poisoning is indicated.

STUDY AND EVALUATION OF CANADIAN GROWN PYRETHRUM

The Pyrethrum plant contains the toxic constituents Pyrethrin I and Pyrethrin II. Pyrethrin I is considered to be the more toxic agent and, hence, from a determination of this constituent, one may determine the insecticidal value of the sample under consideration.

Since 1928, when the project of growing pyrethrum in Canada was actively undertaken, samples grown at several points in Ontario, in Nova Scotia and in British Columbia have been examined.

Samples of pyrethrum plants, C. *cineariaefolium* grown at Vineland Station, Ont., from seed received from South Eastern Agricultural College, Wye, England, were forwarded in July and August for analysis. The plants were harvested at three stages of growth; the bud stage, with attached stems; the semi-open bud stage, with attached stems; the open flower stage, with attached stems. The stems were separated from the heads and each stage of growth evaluated separately, chemically and biologically when the sample was of sufficient size.

Briefly, the toxicity of the flower parts was highest in the open flower, less in the semi-open and only faint in the unopened bud. The toxicity of the stems was much less than the flower parts, highest in stems from the unopened bud, decreasing in the stems from the semi-open to practically no toxicity from stems of the open flower.

The insecticidal value of samples from the Experimental Station, Kentville, N.S., was found to be somewhat higher than that found in commercial products. Samples submitted from the Experimental Station, Saanichton, B.C., were found to be exceptionally high in insecticidal value.

CHEMICAL COMPOSITION OF APPLE SPURS

(Nutritional Changes as related to Cultural Practices)

In co-operative work with the Pollination Committee working toward the production of better apple crops in Nova Scotia, it was thought desirable to obtain information on the composition of fruit spurs from varieties grown in orchards receiving different cultural treatments.

For this study four orchards were selected, respectively A. D, E and L as representative of divergent conditions.

Orchard A, grass mulch system, well cared for orchard.

Orchard D, little cultivation, suffering from poor treatment.

Orchard E, grass mulch, good care.

Orchard L, orchard well-cared for, but trees too severely pruned and thinned.

Two collections of spurs were made, one in July and one in October. The number and weight of spurs as well as variation in moisture content, total nitrogen and total carbohydrates between the two periods of collection were determined.

These data will be published in bulletin form.

5. RELATIVE ADHERENCE OF ARSENICAL PREPARATIONS

In order to obtain information on the adherence of various arsenical preparations to be used in forest dusting, small Scotch pines were dusted with the preparations and samples taken for analysis. The first collection was made immediately after dusting, the second six days later. These samples were received through the office of the Associate Entomologist, Ottawa.

Considerable variation in residual arsenic was found with the several preparations used.

MISCELLANEOUS PREPARATIONS

Miscellaneous insecticides and fungicides sold under trade names have been analysed.

Horticultural Investigations

The Division of Chemistry has co-operated with the Horticultural Division in plant nutrition studies. The main projects are

1. Nutritional studies using artificial materials with (1) Strawberries, (2) Apples (3) Tomatoes and (4) Chrysanthemums.
2. Cold Storage Experiments with apples to determine the effect of fertilizer treatment and temperature of storage on the keeping quality of apples, involving a study of the metabolism of the fruit.
3. Investigation of the physiological disorder " cork " in apples.
4. The Effect of Varying Fertilizer Treatments on the development of apple trees as measured by the analysis of leaves, twigs and fruit for mineral, carbohydrate and nitrogenous constituents.

A large amount of data has been accumulated, part of which has been published.[1]

Animal Nutrition

Reference has been made in previous annual reports of this division to the establishment at the Experimental Farm, Ottawa, of a unit for conducting investigatory work in animal nutrition. Such work, in its immediate scope, comprises a study of the digestibility of Canadian feeding stuffs and of the various factors affecting this digestibility. The results from these investigations will be published in detail elsewhere. They are reported below in brief.

Four main projects are in progress as follows, (1) the determination of the digestibility of Canadian feed stuffs (2) investigations into the biological values of protein for milk production (3) a study of the effect of " association " of feeds upon their digestibilities and (4) a study of the effect of the plane of nutrition upon digestibility.

Digestibility of Canadian Feeding Stuffs [2]

Under the first project, viz. the determination of the digestibility of Canadian feeding stuffs, two of the newer feeds, Vim Oat Feed and Canadian Soy Bean meal, have been studied, as well as some of the more common ones—corn silage, timothy hay, oat straw, oat hulls and mixed hay. In the case of the evaluation of the newer feeds, the determination of the digestibility has been supplemented by feeding trials with cattle, either in co-operation with the Division of Animal Husbandry or else solely by that division. The results of this work up to the present time are summarized below.

VIM OAT FEED

Vim oat feed is a by-product obtained in the manufacture of rolled oats. It contains about 70 per cent oat hulls together with such outer portions and fragments of the oat groat as are scoured off in removing the hull. It is defined by the Feeding Stuffs Act as follows:—

Oat feed consists of offal obtained in the milling of rolled oats from clean oats, and containing less than 28 per cent fibre. It must include not less than the mill-run of oat middlings and not more than the mill-run of oat hulls.

[1] Nutritional Studies with Fragaria—Scientific Agriculture, Vol. XIV. No. 8.

[2] For details of work on Vim Oat Feed see "Studies on Vim Oat Feed. I. The Digestibility of Vim Oat Feed" by C. J. Watson, G. W. Muir, W. M. Davidson and J. T. Dore, in Scientific Agriculture *13*. 382 (1933).

With steers as experimental animals, the digestibility of this feed was determined both in combination with a mixed clover and grass hay and when fed alone. The calculated coefficient of digestibility of Vim Oat Feed and its chemical composition when fed with hay are given in table 1. Similar data obtained when Vim Oat Feed constituted the sole ration are given in Table 2.

TABLE 1—CHEMICAL COMPOSITION AND DIGESTIBILITY OF VIM OAT FEED WHEN FED WITH HAY

Nutrient	Percentage in feed	Coefficient of digestibility	Percentage digestible in feed
		p.c.	
Dry matter	91·80	25·7	23·59
Organic matter	85·82	27·0	23·17
Crude protein	4·20	52·0	2·18
Ether extract	1·33	—	—
Crude fibre	26·90	18·4	4·95
N-free extract	53·39	30·0	16·02
Total nutrients			23·15
Starch values*			15·22

*Calculated as follows. Digestible crude protein × 0·94 = 2·05
Digestible carbohydrates × 1·00 = 20·97

23·02
Total crude fibre × 0·29 .... = 7·80

15·22

TABLE 2—CHEMICAL COMPOSITION AND DIGESTIBILITY OF VIM OAT FEED WHEN FED ALONE

Nutrient	Percentage in feed	Coefficient of digestibility	Percentage digestible in feed
		p.c.	
Dry matter	93·31	35·9	33·43
Organic matter	86·95	37·6	32·66
Crude protein	4·65	47·5	2·25
Ether extract	1·88	69·8	1·31
Crude fibre	29·91	34·8	10·38
N-free extract	50·53	36·7	18·50
Total nutrients	—	—	34·07
Starch value	—	—	24·81

OAT HULLS

Oat hulls are defined by the Feeding Stuffs Act as follows:—

Oat hulls are the outer covering of the oat, and any by-products obtained in the milling of rolled oats from clean oats, and containing 28 per cent or more of fibre shall be designated as "oat hulls."

Oats hulls and Vim oat feed are thus two separate grades of oat by-products; both, however, containing a large percentage of fibre. In order to make a comparison of these products the digestibility of oat hulls was determined under conditions similar to those in the case of Vim Oat Feed.[1]

The coefficients of digestibility and chemical composition of oat hulls when fed in combination with a mixed clover and grass hay are given in table 3 and when fed alone are given in table 4.

[1] For a more detailed report see "Studies on Vim Oat Feed". II. The Digestibility of Oat Hulls". Scientific Agriculture *14* (1934) by C. J. Watson, G. W. Muir, W. M. Davidson.

TABLE 3—CHEMICAL COMPOSITION AND DIGESTIBILITY OF OAT HULLS FED WITH A MIXED CLOVER AND GRASS HAY RATION

Nutrient	Percentage in feed	Coefficient of Digestibility	Percentage digestible in feed
		p.c.	
Dry matter	92·40	26·9	24·86
Organic matter	86·94	29·0	25·22
Crude protein	1·74	—	—
Ether extract	0·58	—	—
Crude fibre	32·98	33·0	10·88
N-free extract	51·65	27·3	14·10
Total nutrients	—	—	24·98
Starch value	—	—	15·42

TABLE 4—CHEMICAL COMPOSITION AND DIGESTIBILITY OF OAT HULLS WHEN FED ALONE

Nutrient	Percentage in oat hulls	Coefficient of digestibility	Percentage digestible in feed
		p.c	
Dry matter	93·56	40·3	37·70
Organic matter	88·19	42·2	37·21
Crude protein	1·75	—	—
Ether extract	0·51	46·5	0·23
Crude fibre	33·52	50·7	16·99
N-free extract	52·42	38·1	19·97
Total nutrients	—	—	37·51
Starch value	—	—	27·71

A comparison of oat hulls and Vim Oat Feed upon the basis of their content of digestible nutrients reveals the fact that they possess similar feeding values. The oat feed, however, contains somewhat over two pounds of digestible crude protein per 100 pounds of feed whereas this nutrient could not be determined in oat hulls. The latter are not, of course necessarily devoid of digestible protein.

OTHER FEEDS

The chemical composition and digestibility of some Canadian feeding stuffs are given in Table 5. As with the previous work, steers were used as experimental animals. Attention should be called in the table to the results for soy bean oil meal. As may be seen it is a very digestible, high-protein concentrate.

TABLE 5—CHEMICAL COMPOSITION AND DIGESTIBILITY OF SOME CANADIAN FEEDING STUFFS

Nutrients	Mixed clover and grass hay (18 trials)			Timothy hay (2 trials)			Oat Straw (1 trial)			Corn silage (4 trials)			Soy bean oil meal (4 trials)		
	Percentage in hay	Coefficient of digestibility	Pounds digestible per 100 pounds	Percentage in hay	Coefficient of digestibility	Pounds digestible per 100 pounds hay	Percentage in straw	Coefficient of digestibility	Pounds digestible per 100 pounds straw	Percentage in silage	Coefficient of digestibility	Pounds digestible in 100 pounds of Silage	Percentage in meal	Coefficient of digestibility	Pounds digestible per 100 pounds meal
Dry matter	91·83	58·6	53·80	92·51	54·4	50·32	91·78	50·2	46·08	21·72	67·4	14·67	94·21	88·2	83·10
Organic matter	84·56	59·5	50·31	88·44	55·6	49·18	85·35	52·2	44·55	20·49	69·2	14·18	87·32	90·0	78·57
Crude protein	11·17	60·7	6·78	4·94	40·7	2·01	7·05	40·9	2·88	1·80	55·2	0·99	36·75	89·3	32·83
Ether extract	2·30	45·3	1·04	2·79	52·9	1·48	3·32	35·8	1·19	0·62	76·4	0·47	6·47	88·3	5·71
Crude fibre	30·45	53·9	16·42	35·01	55·0	19·26	32·46	52·3	16·97	5·52	63·2	3·49	6·52	117·3	7·65
N-free extract	40·46	65·7	26·59	45·70	57·6	26·32	42·52	54·7	23·26	12·54	73·2	9·18	37·58	87·9	33·03
Total nutrients	–	–	52·13	–	–	50·92	–	–	45·79	–	–	14·72	–	–	86·36

Investigations into the Biological Values of Protein for Milk Production

Starch plays an important role in feeding trials. It is used not only to balance rations but also to furnish energy. This raises the pertinent question of how the addition of this pure, easily-available carbohydrate will affect the digestibility of a ration. This subject has been studied as the first step in investigations into the biological values of protein. The preliminary results are briefly presented in table 6.

TABLE 6—RESULTS OF INVESTIGATIONS

Nutrient	Coefficients of digestibility						
	Timothy hay 15 pounds	Timothy hay corn starch 5 pounds	Oat straw 6 kilos	Oat straw 6·45 kilos corn starch 0·3 kilos	Oat straw 4·16 kilos corn starch 2·57 kilos	Oat straw 4·16 kilos corn starch 2·27 kilos casein 0·3 kilos	Oat straw 6·45 kilos casein 0·31 kilos
Dry matter	54·4	54·7	50·2	51·4	58·9	66·2	54·5
Organic matter	55·6	55·5	55·2	53·0	60·2	68·0	56·3
Nitrogen	40·7	20·4	40·9	44·1	28·3	51·6	64·9
Ether extract	52·9	48·3	35·8	42·3	44·9	41·6	43·6
Crude fibre	55·0	26·9	52·3	49·1	27·9	49·2	53·8
N-free extract	57·6	68·7	54·7	57·7	73·4	77·3	56·6

From these data the following conclusions are made:—

(1) The addition of starch to grass, hay or cereal straw depresses the digestibility of the roughage.

(2) This depression is indicated by the low digestibility of the crude fibre and nitrogen in the ration with starch.

(3) The addition of small quantities of starch, to the order of 300 grams, does not materially affect the digestibility.

(4) The addition of larger quantities to the order of 2,270 grams produces a large depression in digestibility.

(5) The addition of casein in small amounts to the order of 300 grams, counteracts the depressive action of the starch; the nitrogen of the casein, however, being partly eliminated in the feces.

(6) It is assumed that the addition of starch reduces the fermentation of the fibre in the digestive tract, and, in consequence its digestibility. The further addition of casein provides a suitable medium for bacterial growth and so fibre is fermented to a greater degree.

(7) The depression of the digestibility of the nitrogen may in part be apparent, due to the variable factor of metabolic nitrogen in the feces, but there are indications of a true depression in digestibility.

The Influence of Sunlight, Ultra Violet Rays, Cod Liver Oil, etc., on the Development of Bone in Chicks

This investigation, begun in 1928[1] was continued in 1930 and 1931. It was planned and conducted by the Division of Poultry Husbandry and had for its object the determination of the influence on leg bone (femur and tibia-fibula) development of various factors and treatments which might be considered as substitutes for direct sunlight.

1930

Fourteen pens of chicks were under experiment. All were Plymouth Rocks, four weeks old, when the bones were analysed. The same basal ration was fed

[1] Report of the Dominion Chemist for the year ending March 31, 1930

in all the pens made up as follows: Equal parts of shorts, middlings, yellow corn meal and oat flour, to which was added 2 per cent each of bone meal, fish meal, powdered milk, 6 per cent of meat meal and 5 per cent salt. In addition the chicks were given fresh cut clover daily. After the first week they were also fed a commercial scratch grain mixture. Different methods of adding sources of supplies of vitamins A and D were used as follows:—

Pen No.	Treatment
9	Direct sunlight through open window
4	No " " "
5	Sunlight through vita glass.
1	1 per cent cod liver oil in ration
2	2 " " " " "
3	3 " " " " "
11	5 " " " " meal in ration
12	10 " " " " " "
6	Irradiation with mercury vapor lamp 5 minutes daily
7	" " " " " 10 " "
8	" " " " " 15 " "
10	" " " " " 30 " "
13	Mash irradiated.
14	Iodine (potassium iodide in water, daily)

The femurs and tibia-fibulae were dissected out and analysed. The weight of green and dry bone and percentages of water, fat and ash of green bone were determined.

DISCUSSION OF RESULTS

Three pens (Nos. 4, 13 and 14) of this series gave evidence of bone development, markedly poorer than that of the remainder of the series. The water content of the bones from all these three pens was very high viz, 65·04 in pen No. 4, " no direct sunlight ", 61·26 in pen No. 13 " Mash irradiated " and 63·77 in pen No. 14 " potassium iodide in drinking water." The range of water content in the remaining 11 pens was 46·03 to 54·17 and the average 48·25.

The fat content of bones from these same pens were very low. It was as follows: Pens No. 4, 3·24; No. 13, 3·23; No. 14, 1·46. The range in fat content for the remaining 11 pens was 8·65 to 17·59 and the average was 14·02.

The percentages of ash in the green bone from these three pens was also low. They were, respectively, 11·45, 13·73 and 12·74. The range for the other pens was 15·53 to 18·81 and the average 17·20.

The three diagnostic factors seeming to indicate poor bone development viz, high water, low fat and ash (lime compounds) were all consistent in indicating that the treatments for pens Nos. 4, 13 and 14 had all resulted in producing chicks with weak leg bones. These treatments were in pen No. 4 " No sunlight," in pen No. 13 " Mash irradiated. 45 minutes daily " and in pen No. 14 " potassium iodide in the drinking water."

It was difficult to rank the remaining eleven pens. The results were somewhat irregular but all the treatments appeared to have resulted in good bone development. The pens successfully treated were as follows: No. 9 " direct sunlight through open window," No. 5 " Sunlight through Vita Glass " Nos. 1, 2, 3 " cod liver oil in ration " (1, 2 and 3 per cent, respectively), Nos. 6, 7, 8 and 10 " irradiation with Mercury vapour lamp " for periods of, respectively, 5, 10, 15 and 30 minutes each, daily. Low water content with high fat and ash (lime compounds) characterized the bones from these pens, and these were the features denoting good bone development.

1931

The plan of work adopted in this enquiry in 1930 was continued in this year with the following modifications. The bones from six weeks old chicks were analysed instead of from chicks four weeks old and pilchard oil was compared as to efficiency with cod liver oil.

The chicks used were the result of crossing Barred Rocks with White Leghorns. Cockerels and pullets were treated separately. The analytical data, in each case, were from the bones of two chicks.

The examination of the oils used furnished the following data:—

Lab'y No.	Ident. No.	Source	Free fatty acids as oleic	Vitamin A. (by Drummond test)
108151	Pilchard No. 1	Can. Fishing Co., Vancouver, B.C.	0·60	nil
108152	Pilchard No. 2	Can. Fishing Co., Vancouver, B.C.	0·89	nil
108153	Steam Cod liver oil	W. A. Munn, Newfoundland	2·16	six (6) Lovibond units.

These oils were not tested for vitamin D, the particular function of which is the prevention of rickets. There is no analytical method for the determination or detection of this vitamin.

The particulars of treatment were as follows:—

PULLETS

Pen No.		Treatment
2	Basal ration	2 per cent pilchard oil No. 1.
4	" "	2 " " " No. 2.
8	" "	2 per cent cod liver oil.
9	" "	Direct sunlight.
10	" "	1 per cent pilchard oil No. 2.
12	(White corn replacing yellow)	2 " " " No. 2.
14	Basal ration	1 per cent cod liver oil.

COCKERELS

Pen No.		Treatment
1	Basal ration	Direct sunlight.
3	" "	Vioray.
6	" "	No sunshine or substitute.
5	" "	Sunlight through vita glass.
7	" "	" " windowlite.
10	" "	ultra violet mercury lamp.
13	" "	" " sunlight lamp.

As before, it may be assumed that aside from weight of green bone, the percentages of dry matter, fat and ash are all important, the higher the percentages the better the bone.

PULLETS

Pens 8, 9 and 10, according to these standards, showed the best bone development. The treatments were 2 per cent cod liver oil, direct sunlight, and 1 per cent pilchard oil No. 2, and all resulted in the development of femur and tibia-fibula bones containing over 50 per cent dry matter, 15 per cent fat, and 16 per cent ash.

Pen 2, the chicks of which received 2 per cent pilchard oil No. 1 added to the ration, gave evidences of the poorest bone development. The percentage in the bone of dry matter was 46·52, of fat 9·47, and of ash 14·11.

It was difficult to rank the other pens.

COCKERELS

Pens 1, 5, and 11, treated respectively with direct sunlight, sunlight through vita glass, and radiation from mercury lamp, might be grouped as those showing the most satisfactory bone development as evidenced by high percentages of dry matter, fat, and ash, averaging 49·67, 13·52, and 16·29 per cent, respectively.

The other four pens treated as follows: no direct sunlight, sunlight through vioray and through windowlite, and radiation from sunlight lamp, constituted a group with distinctly inferior results. The average percentage of dry matter was 40·15, of fat 8·95, and of ash 12·50, respectively.

In both years the pens receiving direct sunlight and cod liver oils in the ration all indicated good bone development. The results of the addition of pilchard oil were variable, in one instance the bones being among the best received, while in another, the bones were the poorest in a series of seven pens.

Other pens successfully treated were as follows:—

(1) Sunlight through vita glass, (2) irradiated with mercury lamp for periods of 5, 10, 15, and 30 minutes daily. Radiating the mash or adding potassium iodide to the drinking water resulted in poor bone development, neither of these treatments being substitutes for sunlight. The pens into which no direct sunlight entered invariably gave bones of poor quality—high water content associated with low percentages of fat and ash.

Food Investigations

This section includes a summary report of the analytical examination of samples of food stuffs and the materials used in their preparation, submitted by other branches of the Department of Agriculture in connection with the administration of The Meat and Canned Foods Act and The Maple Sugar Industry Act.

The Health of Animals Branch submitted 2,447 samples, of which 8 per cent were found to be adulterated or below standard. Forty-five per cent of denaturing oils and 23 per cent of pickled meats were below standard. Salts, preservatives, spices, seasonings, and edible oils and fats showed only 1 per cent adulteration, which may be considered quite satisfactory.

The Fruit Branch submitted 3,163 samples, of which 14 per cent were found to be adulterated or below standard. Fruit pulps, jams, and maple products were the largest groups, and more detailed information with regard to these products is tabulated below.

Eight hundred and seventy-seven samples, mostly condensed, evaporated, and powdered milks, were sent in by the Dairy and Cold Storage Branch. Fifteen per cent did not satisfy the requirements of the regulations.

Maple Products

During the year 1930, in accordance with The Maple Sugar Industry Act, the regulation of maple products was taken over by the Fruit Branch and the chemical examination of this class of foodstuff has been undertaken in these laboratories.

Besides the analysis of over 1,000 samples, a considerable amount of work of an investigatory character has been done and for the past three years the division has co-operated with the Association of Official Agricultural Chemists in collaborative work to improve the methods of analysis of maple products. The results of this work have been published.[1]

The results of our examination of maple products for adulteration other than excess water are given below in percentages:—

Season	1931	1932	1933
Syrups	2·7	6·6	8·0
Sugars	30·0	6·0	27·0
Butters, waxes, creams	—	—	70·0

The ranges of values of Canadian lead numbers and specific conductivities of maple syrups and sugars, which were considered genuine, for the three seasons 1931, 1932, and 1933 are given in tables 1 and 2:—

[1] Journ. A.O.A.C. Vol. XV. No. 2, Vol. XVI, No. 2. Vol. XVII No. 2.

TABLE 1—RANGE OF VALUES OF CANADIAN LEAD NUMBERS

Season	Per cent samples giving values within ranges						
	1·5-2	2-3	3-4	4-5	5-6	6-7	7-8
Syrups.....1931	0·4	7	41	36	10	5	0·6
1932	2	22	35	27	8	5	1
1933	2	11	46	28	8	3	2
Sugars.....1931	0·5	24	32	36	7·5	—	—
1932	0	18	47	32	3	—	—
1933	4	17	42	27	10	—	—

TABLE 2—RANGE OF VALUES OF SPECIFIC CONDUCTIVITIES

Season	Per cent samples giving values within ranges				
	950-1200	1200-1400	1400-1600	1600-1800	1800-2100
Syrups.....1931	2	6	25	46	21
1932	8	54	22	7	2
1933	4	44	41	8	3
Sugars.....1931	5	19	24	40	12
1932	12	47	35	6	0
1933	8	60	26	2	4

All determinations of specific conductivities were made on a sugar ash bridge correcting readings to 20° C.

The percentage number of genuine maple products containing excessive amounts of water is shown below:—

Season	1931	1932	1933
Syrups (maximum allowed = 35 per cent)	19	19	24
Sugars (maximum allowed = 10 per cent)	12	6	10
Butters, waxes, creams (maximum allowed = 15 per cent)	—	—	16

FRUITS AND FRUIT PRODUCTS

During the four years under review a survey has been made of jams made in Canada, for the purpose of collecting analytical data, which might be of assistance in grading jams.

A number of samples were received together with the cook's recipes and a summary of the results of the examination of these Grade 1 and Grade 2 jams is given in tables 3 and 4.

TABLE 3—SUMMARY OF RESULTS OF ANALYSIS OF STRAWBERRY JAMS OF KNOWN GRADE

Grade	Water insoluble solids				Acidity (as citric acid)				Pectin (calcium pectate)			
	Number of samples	Per cent			Number of samples	Per cent			Number of samples	Per cent		
		Average	Minimum	Below 1·5%		Average	Minimum	Below 0·5%		Average	Minimum	Below 0·3%
1	25	1·8	1·3	8	15	0·55	0·27	7	25	0·36	0·27	16
2	61	1·2	0·53	Below 0·8% 3·3	40	0·47	0·27	Below 0·35% 2·5	—	—	—	—

Grade I. strawberry jam requires 55 pounds fruit per 100 pounds jam.
" II. " " " 32 " " " 100 " "

TABLE 4—SUMMARY OF RESULTS OF ANALYSES OF RASPBERRY JAMS OF KNOWN GRADE

Grade	Water insoluble solids				Acidity (as citric acid)				Pectin (calcium pectate)			
	Number of samples	Per cent			Number of samples	Per cent			Number of samples	Per cent		
		Average	Minimum	Below 3·0%		Average	Minimum	Below 0·8%		Average	Minimum	Below 0·3%
1	12	3·3	2·8	8	8	0·87	0·78	12	12	0·35	0·15	16
2	56	2·2	1·1	Below 1·3% 5	41	0·52	0·36	Below 0·4% 7	—	—	—	—

Grade I. raspberry jam requires 50 pounds fruit per 100 pounds jam.
" II. " " " 27 " " " 100 " "

In co-operation with the Fruit Branch several samples of strawberries and raspberries, grown in various parts of the country during seasons 1932 and 1933 and used for jam making, were collected and analysed. A summary of the results of analyses of these berries is given in table 5.

TABLE 5—SUMMARY OF RESULTS OF ANALYSES OF STRAWBERRIES AND RASPBERRIES

Fruit	Total solids	Water insoluble solids	Water soluble solids	Pectin (calcium pectate)	Acidity (as citric acid)	Number of seeds in 100 grms. berries	Dry weight of seeds in 100 grms. berries
	p.c.	p.c.	p.c.	p.c.	p.c.		
STRAWBERRIES (28 samples)							
Average	12·6	3·2	9·4	0·59	1·15	—	—
Maximum	18·6	4·1	14·6	0·84	1·62	—	—
Minimum	10·0	2·6	6·6	0·18	0·70	—	—
RASPBERRIES (43 samples)							
Average	18·1	8·0	10·1	0·59	1·85	6,164	6·4
Maximum	21·4	12·7	12·3	0·85	2·03	8,405	8·0
Minimum	12·5	5·8	3·2	0·13	1·02	3,700	4·8

In co-operation with the Fruit Branch an investigation was undertaken to determine the correlation between " hand grading," percentage of soluble solids in the expressed juice as determined by the " hand " refractometer and the total sugar content of the expressed juice as found by chemical analysis. Four varieties of peaches, fourteen of plums, nine of pears, and three of cantaloupes, each variety in two stages of maturity, were analysed. Results seemed to show that the degree of maturity of fruits could be more accurately determined by the refractometer than by " hand " grading.

Canadian Honey: Its Composition and Fermentation

In the annual report of this division for the year ending March 31, 1930, a summary with conclusions was given of the complete analysis of some 100 samples of Canadian honey. These were part of a series of 211 samples collected in duplicate from all parts of Canada by the Division of Apiculture. One sample of each pair of duplicates was kept in storage by the Bee Division for the determination of keeping qualities and the other sample submitted, first, to a bacteriological examination and then to a chemical analysis.

This analysis comprised the determination of moisture, invert sugar, sucrose, levulose, dextrose, ash, nitrogen, titratable acidity and hydrogen ion concentration. In the present report the results for the complete series are given.

CHEMICAL COMPOSITION OF CANADIAN HONEYS

Based upon complete analysis of 200 samples the following conclusions were reached:—

1. The average composition of Canadian honey was found to be as follows:—

Moisture	18·3%
Ash	0·069%
Nitrogen	0·038%
Invert sugar	75·1%
Dextrose	35·3%
Levulose	41·4%
Sucrose	2·0%
Titratable acidity	16·7 cc. of tenth normal sodium hydroxide per 100 grams of honey
pH	3·9

2. The following factors were found to have an influence upon the chemical composition:—

(a) Floral origin.
(b) Geographical distribution.

RELATION OF CHEMICAL COMPOSITION TO FERMENTATION

One of the main reasons in undertaking this analysis was to discover if possible any relation between the chemical composition of honey and its keeping quality. In order to facilitate the comparison of the analysis of the fermented samples (that is, those samples which were analysed and whose duplicate sample at the Bee Division subsequently fermented within, approximately, a year in storage) with the analysis of those samples which had not fermented up to that date, distribution curves were plotted for each constituent determined.

From the graphs it was evident that as causative agents of honey fermentation, other factors being equal, the following might be eliminated: (1) pH, (2) ash, (3) levulose-dextrose ratio, (4) sucrose. As causative agents of fermentation, other factors being equal, moisture was very important, nitrogen and titratable acidity might have played a part.

ESTIMATE OF MEAN

	Fermented	Unfermented	Difference	Standard error of difference
Moisture	19·9%	18·1%	1·8%	0·244%
Nitrogen	0·054%	0·036%	0·018%	0·0073%
Titratable acidity	20·4 cc.	16·3 cc.	4·1 cc.	1·499 cc.

These statistics bear out the deductions derived from an examination of the frequency distribution curve..

CHANGES OCCURRING IN THE COMPOSITION OF HONEY DURING FERMENTATION OR WHILE IN STORAGE

Of the 200 samples in storage, five which had fermented and five which had remained sound, were analysed; the duplicate samples had previously been analysed, at the beginning of storage. The results indicated that except in the case of sucrose, no consistent changes had taken place in chemical composition during fermentation or in the sound samples while in storage. In both cases, percentage of sucrose continued to decrease until inversion was complete.

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