MUSEUM OF IRISH INDUSTRY.

REPORT

OF

INQUIRY INTO THE COMPOSITION AND CULTIVATION

OF THE

SUGAR BEET IN IRELAND,

AND ITS

APPLICATION TO THE MANUFACTURE OF SUGAR.

MADE TO

THE RIGHT HONOURABLE THE CHIEF COMMISSIONER OF WORKS,

BY

THE DIRECTOR OF THE MUSEUM OF IRISH INDUSTRY.

Presented to both Houses of Parliament by Command of Her Majesty.

DUBLIN:

PRINTED BY ALEXANDER THOM, 87, ABBEY-STREET,

FOR HER MAJESTY'S STATIONERY OFFICE.

1852.

CONTENTS.

REPORT

OF

INQUIRY INTO THE COMPOSITION AND CULTIVATION OF THE SUGAR BEET IN IRELAND, AND ITS APPLICATION TO THE MANUFACTURE OF SUGAR.

To The Right Honourable Lord John Manners, M.P., Chief Commissioner of Works.

My Lord,

I have the honour to report, for your Lordship's information, the results of the inquiry into the composition and practical value of root crops grown in Ireland, especially the Sugar Beet, which has been conducted in the Museum of Irish Industry under my direction.

This inquiry, the practical bearing of which on many important sources of employment in Ireland, will not fail to attract your Lordship's attention, was commenced on occasion of the request of the Royal Agricultural Improvement Society of Ireland, that some information should be afforded to Irish Agriculturists as to the relative composition and feeding value of different varieties of Turnips and of Mangel Wurzel; and was extended to the Sugar Beet with special reference to the availability of that plant as a source of Sugar on a manufacturing scale in Ireland, with the sanction of the Right Honourable the Earl of Clarendon, then Lord Lieutenant of Ireland, who, uniformly anxious for the advancement of the industrial interests of this country, had been attracted by the circumstances of the previous inquiry, and who recognised the advantage of having the practical conditions of the Beet Sugar manufacture in Ireland defined and illustrated by a scientific examination of the plant and of the processes of its treatment.

Your Lordship will find appended to this General Report the detailed results of the inquiry into the composition of the root crops above referred to: the Appendix contains also the full report of the information collected as to the cultivation of the Beet of various varieties, the analytical investigation of its composition, and the detailed report of all the circumstances of the extraction of the Sugar from it on a manufacturing scale. There are also appended tables of all the analytical results, to which reference can be easily made by such persons as may require to consult the special details connected with the subjects discussed.

The detailed operations of these inquiries have been conducted by Dr. William Sullivan, Chemist to the Museum, and Mr. Alphonse Gages, Assistant Chemist; and I take this opportunity of expressing to your Lordship my sense of the zeal, ability, and diligence manifested by these gentlemen in the performance of the various laborious and responsible duties belonging to the chemical department of this Museum.

Referring to the several special reports in the Appendix for scientific details, I shall here bring under your Lordship's notice only the general conclusions to which the inquiry has led, in as brief a form as the nature of the subject allows.

As an important portion of the inquiry consisted in ascertaining the influence exercised by locality, soil, and cultivation, on the nature, produce, and cultivation of the Beet crops, I communicated on the part of this Museum with a number of gentlemen and agriculturists in different parts of Ireland, whom I have to thank for their assistance and co-operation. By this means specimens of Beet grown under a great variety of circumstances as to locality, soil, and manures, were obtained for experiment, and a circular form of inquiry, of which a copy is given in the Appendix A, having been sent to each person, a large amount of valuable information as to the practical cultivation of the Sugar Beet was obtained, the substance of which will be found incorporated with the detailed report.

Although I feel indebted to all those whose names are given in the annexed tables for donations of roots and information as to their culture, it would be wrong not to particularize the assistance given by Lord Talbot de Malahide, Mr. William Dargan, Mr. Charles F. Johnson, Mr. Sinclair, and Mr. M'Crea of Strabane; the Rev. Mr. Townsend of Aghada, Professor Murphy and Mr. Jennings of Cork, and Mr. Edward Carroll of Beg Erin, Wexford, from each of whom much definite numerical information was obtained as to the Beet culture, besides a most liberal supply of roots. We are also indebted to the Royal Dublin Society for having instituted, at our request, in their Botanic Garden, a number of experiments on the growth of Beet under the nfluence of various manures. Those experiments, by means of which materials were obtained for instituting inquiries on some highly interesting points referred to in the following Report, were conducted by Mr. Moore, Curator of the Botanic Garden, from whom otherwise valuable assistance was derived.

A similar series of experiments with manures was instituted for this inquiry at the Garden Farm, Drumcondra, by Mr. Ninian Niven, who thereby afforded the most useful means of controlling and verifying the results obtained by the series of similar experiments in the Botanic Garden.

As general results of the examination of the Irish grown Beet, I feel myself justified in concluding—

1. That the Sugar Beet requires for its successful cultivation a rich loamy soil, thoroughly and deeply worked, thoroughly drained and divided; and that the presence of organic matter in excess, or undecomposed in the soil is an important disadvantage.
2. That the employment of saline or rich nitrogenous manures immediately before, or during the growth of the Beet, acts unfavourably on the employment of the plant for making sugar, by rendering the juice impure and increasing the proportion of azotized materials which readily ferment, and thereby convert the crystallizable into uncrystallizable sugar, which is the most usual and important source of loss in the manufacture.
3. That it is fully established that the entire quantity of sugar in the Beet exists naturally as crystallizable cane sugar; and that uncrystallizable sugar makes its appearance only as a product of decomposition in the manufacture (molasses), and is, therefore, so far a source of loss, which may be avoided by improved treatment.
4. That the quantity of sugar present in Irish grown Beet is in no way inferior to that usually found in the Beet roots used in the sugar manufactories of the Continent, and that, in some cases, the per centage of sugar yielded by Beet approaches to that afforded by the sugar cane as usually cultivated.

In regard to the information which has been collected on the subject of the cost of production of the Sugar Beet in Ireland, I do not wish to announce any positive conclusions, but rather to direct attention to the estimates contained in the Appendix C, all of which are derived from practical agriculturists, and all of which would indicate that the cultivation of the Sugar Beet would prove at least as profitable as other green crops usually are, provided that cultivation be carried on in a proper manner.

It is frequently objected, that experiments of a purely scientific character, and performed only in the chemical laboratory, on small quantities of material, do not afford results comparable with what might be expected in manufacturing processes on the great scale, and that, consequently, although interesting in a theoretical point of view, the quantity of sugar proved to exist in Irish grown Beet, by the researches given in the Special Report, Appendix B, could not be safely calculated on as working produce in a manufactory. It is certain, that by no process as yet employed, are the manufacturers able to extract absolutely all the sugar really contained in the Beet in its crystallizable form: yet this is the object to which manufacturers should aspire, and towards which, almost every day, a closer approximation is made, and, it is now well established, that by the application of the most perfect mechanical arrangements and the adoption of the improved chemical processes of refining, the quantity of sugar extracted in a marketable form approaches closely to that really existing in the Beet, while the proportion of molasses formed is but trifling. In considering, therefore, the position of the manufacture as to Ireland, it must be assumed that the manufacture should be conducted with the most perfect means, most accurate knowledge, with careful economy and judicious business management; for, should those conditions be not fulfilled, the manufacture would necessarily fail to succeed here, as it should fail elsewhere from the like causes, and the country or the period would be stigmatized as unsuited or improper for the manufacture, when the fault really lay with the ignorance or inattention of the individuals who had taken up an occupation for which they did not possess the necessary qualifications.

In reference, however, to the amount of sugar obtainable on the great scale, it was evidently of much interest that we should be enabled to control the merely analytical results by some operations of manufacture in which the produce of crystallized sugar could be accurately ascertained. By the assistance of Mr. Crossly and the Directors of the Beet Sugar Company, who kindly placed at our disposal the necessary machinery, we were enabled to erect in the basement rooms of the laboratory of the Museum a model sugar works, in which Dr. Sullivan, Chemist to the Museum, conducted the manufacture from the Beet roots on a tolerably large scale, so as to afford satisfactory means for ascertaining the proportion of sugar actually obtained in marketable form. The results of these trials are given fully detailed in the Appendix D, and it will be found that although conducted under the disadvantages which necessarily attend a manufacturing experiment, with machinery temporarily arranged, the yield of sugar was fully equal to that usually calculated on by the continental makers.

In the Appendix will be found the examination of the scum and residual pulp of the Beet root—materials both highly useful as manures, the latter also as food for cattle, and, therefore, forming an important element in estimating the true value of the products of the manufacture of Beet root Sugar. The facts of their utilization are, however, too well known to require any further explanation in this place, and the analyses by which their relative values, as compared with other similar materials, can be estimated, are given in the Appendix D.

Finally, I beg to observe that the researches which have been conducted in this Museum, and which I have now the honour of reporting to your Lordship, fully point out the advantage which may accrue to Ireland from the establishment of the manufacture of sugar from the Beet root, and it appears to me as eminently calculated to be of service, not only as creating a new and extensive source of manufacturing employment, but also that, as the material used can only be profitably obtained by means of improved agriculture, and that an important element in the profits of the manufacture would be the careful economy of the scums and pulp either as manures or as food for cattle, the manufactories of Beet root Sugar should exercise a powerful influence on the agriculture of their districts, inducing a greater variety of cultivation, a more thorough preparation of the soil, and a more careful economy of manures; and that in this way, even should the manufacturing speculation become hereafter, by improvement in the management of the Colonial sugar industry, or by any other cause less probably successful than it now appears to be, there should still have been conferred on Ireland a great advantage in the improved practice of green crop husbandry which would be certain to remain.

Trusting that the arrangements made for conducting this important inquiry, and the conclusions which the results have enabled me to submit in this Report, will appear satisfactory to your Lordship and conducive to the public service,

I have the honour to be, my Lord,

Your Lordship's most obedient servant,

ROBERT KANE,

Director of the Museum of Irish Industry.

APPENDIX.

PAPERS APPENDED TO THIS REPORT.

Appendix A.

Queries relative to the Cultivation of the Sugar Beet.

County, *Parish.*
Barony, *Townland.*

1. What is the probable depth of tilled soil?

2. What is the presumed depth of your subsoil?

3. How is your land exposed, whether to the North or South, &c.

4. Is it flat or inclined, and if the latter, at what angle?

5. Is it much exposed to or sheltered from winds, especially from North and North-East?

6. What is your usual rotation?

7. What crop did you grow on the land under Beet this year, in the year 1849, 1850?

8. What manure, and what quantity per statute acre, did you employ for the crop of 1849?

9. What was the resulting produce?

10. What manure, and what quantity per statute acre, did you employ for the crop of 1850?

11. What was the resulting produce?

12. Is the land thorough drained?

13. Has it been subsoiled, and to what depth?

14. Could you give an estimate of the expense of tillage per statute acre, for this year's crop of Beet, stating the cost of the several items, such as number and expense of ploughings, harrowings, weedings, hoeings, and cost of seed, &c.?

15. What is the estimated value per acre of the land?

16. What is the present poor-rate per acre?

17. What is the amount of county cess and other charges?

18. Have you grown any other green crops, and if so, could you give the results in the following tabular form?

Name of Crop and Variety.	Time of Sowing.	Time of Pulling.	Manure employed.	Quantity per Statute Acre.	Total Cost of Manure.	Mode and Time of applying Manure.	Weight of Bulbs.	Weight of Tops.	Remarks.
Sugar Beet (naming variety), .									
Yellow Globe Mangels, . . .									
White Globe do.,									
Long Red Mangels, ...									
Swedish Turnips,									
Parsnips, ...									
White Belgian Carrot, ...									
&c., &c.									

19. What is the usual price of turnips per ton in your district (sold in the field)?

20. What are the highest and lowest prices you have ever known turnips to sell for? (stating whether carted to any distance, &c.)

21. What is the usual price of mangel wurzel (orange globe or long reds) per ton in your district, sold in the field?

22. What are the highest and lowest prices you have ever known mangels to sell for in your district? (stating whether carted to any and what distance.)

23. What would you consider a remunerating price for white Silesian beet carted say on an average $2\frac{1}{2}$ miles?

24. What could you get roots carted for in your district per ton per mile, for distances not exceeding 5 miles?

Appendix B.

Special Report on the Composition of the White Silesian Beet grown in Ireland in 1851, considered in reference to its employment for the Manufacture of Beet Sugar, prepared under the direction of Sir Robert Kane, Director of the Museum of Irish Industry. By William K. Sullivan and Alphonse Gages, Chemical Officers of the Museum.

Section 1.—Introductory remarks on the varieties of Beet employed as sources of Sugar.

The numerous varieties of the sugar beet are derived, according to some, from the *beta cicla*, and the common mangel wurzel from the beta vulgaris; according to others the beta cicla itself is but a variety of the former. They belong to the *chenopodiaceæ* or *atripliceæ*, a family which includes a number of genera remarkable for the alkaline character of their ashes, such as *salsola, atriplex, salicornia*, &c., and having in general maritime *habitats*. Like most cultivated plants, a great number of varieties have been produced, both from the red and white beets, which, for convenience sake, we shall consider to be both derived from the beta vulgaris, and to differ from one another, therefore, only in form and colour. These varieties may be divided into three groups depending upon the form of the bulb—first, the cylindroidal; second, the spindle, or rather pear-shape; and third, the globular.

To the first class belongs the common "field beet," or *disette* of the French, having white flesh and white skin, leaf stalks white, bulb almost cylindrical and protruding very much over the ground, sometimes to the extent of fifteen inches, while four or five only are covered with soil. It is the largest of all the varieties of the beet, sometimes reaching a weight of 30lbs., but its juice is very watery, rarely exceeding 6° of Beaumé, or a specific gravity of 1·0411. There is a sub-variety which is externally reddish, or rose-coloured, and the cross section of which exhibits an alternation of white and rose-coloured rings. This kind is now much cultivated under the name of *Long Red Mangels.* The blood-red garden beet may be considered as the link between the varieties of the first form and those of the second or spindle-shaped.

The second group is represented by the *white Silesian* beet, having a somewhat pear-shaped form, white flesh and white skin, leaf stalk white, occasionally, although rarely, rose-red rings in the flesh. It is smaller than the varieties of the first group, the largest roots generally averaging 5lbs., although in calcareous loams it has sometimes reached 20lbs. It contains somewhat less juice than most of the other varieties, is much harder, and is hence less liable to injury from mechanical agents in the removal, storing, &c. The juice usually averages 7° of Beaumé, or a specific gravity of 1·0483, when fully ripe and properly cultivated, but it frequently exceeds 8°, and has been known to reach 14° and 15°.

There are three principal kinds of the white Silesian distinguished by the colour of a ring presented by a cross section of the crown close to the bulb:—

1. The *collet rose*, having a rose-red ring.
2. The *collet vert*, which exhibits a green ring in the same place.
3. The *collet jaune*, which has a yellow ring.

The group of the second form may be considered to be linked to the third, by the variety called the *Quedlinburg beet*. Its form is between pear and spindle shape, skin rose-red, flesh white, somewhat softer than the Silesian. It has a small crown, long thin greenish-white leaf stalk, with a sharply-marked red rim on the upper part, a smaller development of leaves, and not given to protrude above the soil. The average density of its juice is about 7° of Beaumé, sometimes reaching 10° or 12°.

The type of the group of the third form is presented by the *yellow globe mangel wurzel* or *Castelnaudary beet*. It is pear-shaped, approaching the globular, has a yellow skin and yellow flesh, sometimes passing into orange, leaf stalks yellowish green, flesh soft and juicy, and yields a juice marking from 5° to 7° of Beaumé. It grows to a much larger size than the Silesian beet, but is inferior in this respect to the varieties of the first group. Four sub-varieties may be distinguished—first, with red flesh and skin and red leaf stalks, known in these countries as the red globe beet; second, small yellow spindle-shaped, like carrots, becoming frequently globular, with yellow leaf stalks; third, pear-shaped, much rounded, yellow skin, white flesh, and white leaf stalks; and fourth, pear-shaped, approaching the globular, skin and flesh white. Its juice marks about 5° of Beaumé, or a specific gravity of 1·034; it grows to a very large size. This sub-variety is now much cultivated under the name of the white globe beet.

The *Siberian beet* may also be classed in the third group. It is of a flattened pear shape, spread out almost like a plate, flesh white, occasionally rose-red, leaf stalk white, softer than the Silesian, yielding more juice, but of a lower specific gravity, and its foliage is also smaller. The bulb grows nearly altogether out of the soil.

There is a great tendency in all the varieties of beet to change their colour, and especially in the white and yellow, to develope a red colour in the skin, and a slight rose tinge in the flesh. In chemical composition they do not appear to differ, two specimens of the same variety often presenting a wider variation in this respect than the most distinct varieties. They all contain sugar, and may be employed in its manufacture, but the variety most employed for that purpose is the white Silesian, usually called the sugar beet, and of that variety the kind known as the collet rose is most prized, not only because it contains most sugar, but because the juice is purer. The Quedlinburg beet is now preferred in Northern Germany, as it is considered to keep better than the Silesian, the juice alters less by exposure to the air, and the amount of sugar is said to be even greater than in the collet rose.

In Russia, the Siberian beet is much employed, but experiments made in other countries have led to the conclusion that it is inferior as a source of sugar to the varieties just mentioned.

The anatomical structure of the beet is of considerable importance in judging of the quality of a variety. According to the examination of Decaisne,* confirmed by Payen and others, a section of the beet perpendicular to its axis, exhibits a series of concentric rings; there is first the epidermic tissue, consisting of from four to six layers of cells, and composed principally of cellulose, and containing a great part of the silica found in the beet root; it also abounds in nitrogen. Immediately under the epidermic layer comes the herbaceous tissue, in which is principally contained the colouring principle, an essential oil, and one or two substances peculiar to the beet. The true saccharine part succeeds to this: reaching to the centre, and consists of alternate layers of vascular and cellular tissue. The vascular tissue is doubled into several distinct bundles, surrounded by elongated or cylindroidal cells placed almost regularly in a series forming with the vessels or vascular tissue an ellipsoidal figure, and forming the whitest zones. These zones are the most voluminous in the good varieties of beet, and contain the largest amount of sugar, a fact first surmised by Decaisne and confirmed by Payen, who states that a specimen of the cellular tissue examined by him, contained but 6·8 per cent. of sugar, while the zone of cylindroidal cellular tissue, surrounding the vascular tissue, yielded 13 per cent. We have also obtained a corresponding result; the internal zone of vascular tissue, and its accompanying cylindroidal cellular tissue, of a specimen of beet grown in the Botanic Garden of the Royal Dublin Society, and pulled on the 10th of October, gave 12·42 per cent. of sugar, and the ordinary cellular layer only 5·35 per cent. The leaf stalks take their roots pretty deeply in the bulb, and form what is called the heart, which is characterized by its greenish colour, and by the great abundance of fibrous vessels. The heart occupies, in some varieties, a considerable region in the bulb, compared with the rest, of which it contains but very little sugar, whilst it abounds with salts, especially with nitrates, and in this respect approximates in composition to the leaves.

The general opinion has hitherto been, that the cells contained no starch; but we have obtained a small quantity of starch on several occasions in the early part of the autumn, but never observed it in the latter part of the year. The whole of the sugar, in a liquid form, is found in the cellular tissue, and, as we have already remarked, in much greater quantity in the cylindroidal cells surrounding the fibrous tissue; the latter contains no sugar, but frequently salts, in a crystalline form. It also frequently happens, as in the sugar-cane, that crystals of sugar are found occupying a number of cells in roots having

* Recherches sur l'organisation anatomique de la Betterave à sucre, par J. Decaisne, forming part of a Memoir by M. Peligot, entitled "Recherches sur l'analyse et la composition chimiques de la Betterave à sucre." Paris, 1839.

a very high density, such as from 12° to 14° of Beaumé. It is probable that the principal seat of the peculiar nitrogenous substance, which acts so rapidly on the juice when pressed, and of which we shall speak hereafter, is in the fibrous tissue, for when a thin slice of beet, cut perpendicular to the axis, is exposed to warm air, the concentric rings of the vascular tissue first become black.

With these cursory remarks upon the varieties and anatomical structure of the beet, we shall now proceed to examine, as briefly as possible, the results of its chemical examination, confining ourselves, however, principally to those which have reference to the per centage of sugar, and its nature, as we shall have occasion further on to discuss the other points connected with its chemical history.

In the year 1747, Margraf, of Berlin, undertook some investigations upon a great number of plants indigenous to Germany, for the purpose of determining the amount of sugar which they contained. His process was exceedingly good, and his results must therefore be looked upon as accurate. It consisted in drying the roots, pulverizing them, and extracting the sugar with alcohol. He obtained from the bulb of the white, or sugar-beet, 6·25 per cent. of sugar; from the roots properly so called, five per cent.; and from the red beet four and a half per cent. More than half a century later, Hermbstädt made an examination of the beet, and obtained as the result 4·5 per cent. of crystallizable sugar, and 3·5 per cent. of uncrystallizable, or as he called it, mucilage sugar. He hence concluded that a part of the sugar contained in the beet was uncrystallizable, an opinion which very generally prevailed until the year 1831, when M. Pelouze* published his researches upon the subject. He proved that the entire of the sugar contained in the beet was crystallizable cane-sugar, and that neither grape sugar nor mannite existed in the beet unless when it had undergone alteration. The mode by which he established this important fact consisted in cutting the beet into very thin slices, treating them at a temperature of about 86° F. with alcohol of 0·834, or about 57° over proof, some drops of a very dilute solution of caustic potash having been first added to neutralize the free acid of the beet. At the end of thirty-six hours the alcohol was not sensibly coloured, and was then evaporated at a very gentle temperature, when it left a white residue with a very slight tinge of grey, which was dried in a water bath, and treated with absolute alcohol obtained by distillation three times over lime. This alcohol did not dissolve the slightest trace of sugar. On evaporation, it only left a very small quantity of fatty matter, devoid of taste. If sugar of grapes or mannite existed in the beet, it would have been dissolved by the alcohol; or if uncrystallizable sugar existed, it would have been at once seen. For the determination of the amount of sugar, he first converted it into alcohol, which he determined by a modification of the pro-

* Annal. de Chim. et de Phy., t. xlvii. p. 411.

cess proposed by Gay Lussac. The following table contains the results of his analysis :—

Variety of Beet, &c.	Date of Experiment.	Density of the Juice in degrees of Beaumé's Areometer, at a temperature of 59 degs. Fahr.	Specific Gravity, temperature 59 degs.	Per centage of Sugar.
White Silesian beet (grown after tobacco), from near Lille,	2 Sept.	5°·6	1·0382	5·8
Ditto,	,,	5·1	1·0347	6·2
Ditto (after tobacco),	6 ,,	5·5	1·0375	6·3
Ditto,	,,	5·7	1·0389	7·2
Ditto (after tobacco),	9 ,,	5·1	1·0347	7·2
Ditto,	,,	5·1	1·0347	7·5
Ditto (after tobacco),	15 ,,	5·8	1·0396	8·0
Ditto,	,,	6·0	1·0411	8·0
Ditto (after tobacco),	22 ,,	6·2	1·0425	8·3
Ditto,	,,	6·0	1·0411	8·5
Ditto (after tobacco),	28 ,,	6·4	1·0439	9·0
Ditto,	,,	6·3	1·0432	9·2
Rose-coloured beet (after tobacco),	28 ,,	6·4	1·0439	9·8
Ditto,	,,	6·4	1·0439	9·8
White Silesian beet from near Valenciennes,	13 ,,	5·7	1·0389	7·2
Red beet from the same field as the last,	,,	5·4	1·0368	6·6
White, with a slight tinge of rose, from same field,	,,	6·6	1·0453	9·2
Rose-coloured,	27 ,,	6·4	1·0439	9·8
White Silesian,	,,	6·2	1·0425	8·5
Yellow, or Castelnaudary beet,	,,	6·5	1·0446	9·0
Red beet,	,,	7·5	1·0519	9·0
Beet of two years, in seed,	17 ,,	1·9	1·0126	0·
Rose-coloured, with flower stalk,	28 ,,	7·0	1·0482	7·5
White beet from the environs of Dunkerque,	20 ,,	6·3	1·0432	8·2
Slightly rose-coloured, from Dunkerque,	20 ,,	6·6	1·0453	9·5
White, from the factory of M. Crespel, of Arras,	31 ,,	7·0	1·483	9·5
Slightly rose-coloured,	,,	7·2	—	10·

These results of M. Pelouze were fully confirmed, and extended by M. Peligot in a series of analyses of roots grown in the neighbourhood of Paris.* The process which he adopted for the determination of the nature and quantity of sugar was a modification of that proposed by M. Pelouze for ascertaining the nature of the sugar. M. Peligot found that by carefully drying the slices of beet the sugar underwent no alteration; instead, therefore, of treating the slices of moist beet directly with alcohol, he dried them in a water bath, reduced them to a coarse powder, treated this powder with alcohol of specific gravity of 0·831, adding, as M. Pelouze recommended, a few drops of a very weak solution of caustic potash to neutralize the free acid of the beet, repeating the treatment with alcohol as long as a few drops left any residue evaporating the alcohol, and treating the residue with absolute alcohol to

* Recherches sur l'analyse et la composition chimiques de la Betterave à sucre. Paris, 1839.

remove salts, fat, &c. There are several advantages in employing this method in preference to that of determining the amount of sugar indirectly from the alcohol, but the chief one is its extreme simplicity.

The results obtained by M. Peligot are very important; for besides conforming the two important results of M. Pelouze, namely, that the whole of the sugar was crystallizable cane sugar, and that the per centage of sugar gradually increased until the beet was fully ripe, he has shown that the amount of sugar which the beet may contain is very large, very little inferior indeed to the sugar-cane, and thus fixed a sort of goal to which good cultivation should finally arrive. He has endeavoured to establish another point, namely, that the composition of the *raw* beet was the same at all stages of its growth, and that, consequently, a given weight of beet will always contain the same amount of sugar. That he has established the important fact, that the beet contains sugar at every stage of the development of the bulb, is certainly true; but that an element like water should remain in a constant ratio in the cells of plants, to the matters composing those cells, when we consider how much the amount of water is influenced by the moisture of the soil and the evaporation from the surface of the leaf, we cannot but consider as a hasty generalization. In a subsequent part of the Report we shall have occasion to notice this subject again. The following table contains the results of M. Peligot:—

Locality and condition of the Beet.	Date of Pulling.	Weight of Bulbs.	Solid Residue per Cent.	Per Centage of Water.	Per Centage of Woody Fibre.	Per Centage of Albumen.	Per Centage of Sugar.	Density of Juice in Degrees of Beaumé's Areometer.
Botanic Garden, ...	Aug. 2	20 to 25 grammes*	9·5	90·5	4·5		5·0	.
Grenelle, ...	„ 7	300 „	15·5	84·5	6·6		8·9	6°·4
„	„ 7	600 „	12·6	87·4	2·8	1·6	8·2	.
„	„ 30	1 kilogramme, †	13·1	86·9	3·1	1·4	8·6	6·2
Botanic Garden, ...	Sept. 1	1,100 grammes,	7·4	92·6	2·1	1·0	4·2	3·2
„	„ 1	460 „	9·4	90·6	2·8	1·6	5·0	4·2
„	„ 7	800 to 900 „	10·0	90·0	1·9	0·8	7·3	4·5
Vigneux, ...	„ 23	500 „	16·7	83·1	3·2	1·8	11·9	7·0
„	„ 23	700 „	13·0	87·0	2·7	1·7	8·6	6·4
Botanic Garden, ...	„ 26	80 to 100 „	15·1	84·9	3·3	1·8	10·0	.
„	Oct. 9	150 grammes 1	14·7	85·9	.	.		.
		2	14·2	85·8	.	.	.	.
Grenelle, ...	„ 19	700 „ 1	9·7	90·3	.	.	.	.
		2	15·4	94·6	.	.	.	.
Botanic Garden, ...	Nov. 13	500 „	13·9	86·1	.	.	.	.
Grenelle, ...	„ 15	.	19·6	80·4	.	.	14·4	9·0
Botanic Garden; exceedingly small, requiring 14 to make 4 grammes, or about 62 grains, and not more than the size of straws; sown very late, ...	Dec. 29	.	13·7	86·3	4·4	3·4	5·9	.
Beet in flower from Grenelle, .	.	200 „	16·5	83·5	3·3	3·4	9·8	.
Beet, 2 years old, in seed from Grenelle, . . .	.	.	5·5	94·5	2·5	1·1	0·0 Sugar; 1·9 Nitrate of Potash.	.

* 1 Gramme = 15·433 grains. † 1 Kilogramme = 1,000 grammes = 2 lbs. 3 oz. 4 drms. 19 grs. (avoirdupois.)

The substances classed by M. Peligot, under the head albumen, can contain but little of that substance and consist in reality of a mixture of pectine and one or two peculiar azotised bodies; and his woody fibre consists of that substance, the whole of the true albumen, the entire of the insoluble salts, and, occasionally, a portion of undissolved pectine. M. Braconnot drew attention to these defects in M. Peligot's results, which have arisen from the defective process which he adopted to determine these constituents. The amount of saline ingredients was not determined, and it is to be regretted that M. Peligot has not furnished some further particulars with regard to the nature of the soil and of the manures employed; indeed this objection may be urged against nearly all the examinations of the beet hitherto published.

The eminent agriculturist and sugar manufacturer, Matthieu de Dombasle, being of opinion that the greater part of the molasses obtained in the manufacture of sugar pre-existed in the beet, and that, consequently, the researches of M.M. Pelouze and Peligot could not be considered as sufficient, induced M. Braconnot to re-examine the question.* This accurate and observant chemist, in following the process of M. Peligot, obtained the following numerical results from a specimen of white Silesian beet:—

Dry Solid residue,	15·8	Sugar, ...	10·6
		Albumen, ...	2·1
		Fibre, ...	3·1
Water, ...	84·2		15·8
	100·0		

The whole of this sugar was not, however, crystallizable, and, on treating it with boiling alcohol of a specific gravity of 0·831, he separated it into a sort of gummy matter, into crystallizable sugar, and into uncrystallizable sugar, all of which he is inclined to consider as pre-existent in the beet. We shall have an opportunity further on of returning to this point, and shall at present merely notice the list of substances, which, according to M. Braconnot, exist in the beet.

1. Crystallizable sugar.
2. Uncrystallizable sugar.
3. Albumen.
4. Pectine.
5. Mucilaginous substance.
6. Woody fibre.
7. Phosphate of magnesia.
8. Oxalate of potash.
9. Malate of potash.
10. Phosphate of lime.
11. Oxalate of lime.
12. Fatty acid, having the composition of mutton fat.
13. Substance analogous to wax.
14. Chloride of potassium.
15. Sulphate of potash.
16. Nitrate of potash.
17. Oxide of iron.
18. Nitrogenized substance, soluble in water.
19. Sharp odoriferous matter, not known.
20. A small quantity of an undetermined salt of ammonia.
21. Pectic acid. (?)

* Annales de Chimie et de Physique, t. lxxii., p. 428. 1839.

Many years previously, M. Dubrunfaut had attempted a complete analysis of the sugar beet with the following results :*

1. Water.
2. Woody fibre.
3. Crystallizable sugar, identical with cane sugar.
4. Liquid, or uncrystallizable sugar.
5. Vegetable albumen, coloured.
6. Jelly, (pectine).
7. Black nitrogenized matter, precipitable by acids, and transforming the sugar into mucilage.
8. A fatty substance, solid, at the ordinary temperature.
9. A fixed oil.
10. An essential oil.
11. A green bitter resin.
12. A gummy substance.
13. One or two colouring substances, yellow and red.
14. A free acid, the nature of which has not been determined; it developes itself in the pits where the roots are preserved, and keeps the cut root from undergoing the alteration which is manifested in the fresh beet by the cut surface becoming black. (According to Dumas, this acid is probably the lactic)
15. Oxalate of ammonia.
16. Oxalate of potash.
17. Oxalate of lime.
18. Chloride of ammonium.
19. Sulphate of potash and phosphate of ditto.
20. Silica.
21. Alumina. (?)
22. Traces of oxides of iron and manganese.
23. Traces of sulphur.

M. Payen† gives the following as the results of his examination of the beet .—

Water,	83·5
Sugar,	10·5
Cellulose,	0·8
Albumen, caseine, and other nitrogenous substances,	1·5
Malic acid, gummy substance, fatty substance, aromatic and colouring principles, essential oil, chlorophyle, asparamide; oxalate and phosphate of lime, phosphate of magnesia, muriate of ammonia, silicate, nitrate, sulphate and oxalate of potash; oxalate of soda; chloride of sodium and of potassium; pectates and pectinates of lime, of potash, and of soda; sulphur, silica, oxide of iron, &c.	3·7
	100·00

M. Payen considers the whole of the sugar as crystallizable cane sugar.

A number of analyses of beet have been made from time to time in Germany and Russia, of which we shall give the principal results.

* L'Art de Fabriquer le Sucre de Betterave. Par M. Dubrunfaut. Paris, 1825.
† Précis de Chimie Industrielle, p. 406. Paris, 1849.

A very important memoir was published by R. Hermann,* in which he showed that, at least in Russia, geographical position has but little influence upon the per centage of sugar, but that it depended almost entirely upon culture and manures. The experiments having been undertaken at the request of a society of sugar manufacturers in Moscow, all the roots examined were grown from the same seed, which was that of a variety of the white Silesian, with a light red skin. The process which he adopted to determine the amount of sugar consisted in a modification of Pelouze's, the latter estimating it from the quantity of spirit, the former from the amount of carbonic acid liberated during fermentation. The following table contains his principal results :—

Government.	Remarks on Manures, &c.	Weight of Bulb.	Per Centage of Ash.	Per Centage of Sugar.
EUROPEAN RUSSIA.		oz. oz.		
Moscow (Wereja).	Manured two years before the sowing of the seed. The weather during the period of growth was not unfavourable. The soil contained 13 per cent. of organic matter.	9 to 13	0·75	11·96
Käsan (Speschnewo).	Grown in dark loamy soil. The weather during the period of growth was favourable, with a little frost in some nights in May and July. The soil contained 15½ per cent. of organic matter.	26 to 28	.	10·3
Tula.	Black loamy soil, . . . No. 1	21 to 45	.	9·20
	No. 2		.	10·27
Don Cosacks (Kaschenko).	Unmanured dark loamy soil, on elevated and dry flats (most probably never manured), and forming part of the great Steppes of Southern Russia. The soil contained 17 per cent. of organic matter	15 to 23	.	12·13
Orenburg (Bowzuluk).	Grown in a field near a village. The season was favourable, but no month without night frosts. The soil contained 17½ per cent. of organic matter.	27 to 41	.	8·33
SIBERIA.				
Omsk.	Grown in freshly and heavily manured land, with a rich black loamy soil, containing 18 per ct. of organic matter.	32 to 56	1·87	6·7
Büsk.	. . . . .	27	.	7·66
Buktarminsk .	No. 1, ...	8 to 10	.	11·1
	,, 2, unmanured.	3	0·86	12·7
	,, 3, manured 2 years previously.	6	.	11·5
	,, 4, manured with cow dung immediately before sowing.	10	1·37	10·1

* Ueber die Bedingungen von Welchen der Zuckergehalt und das Gewicht der Runkelrübe abhängen.—Erdmann's Journal für Praktische Chemie, Bd. iv.

These districts include a region lying between the parallels of 48° and 55° north latitude, the mean temperature of which varies from 48° Fahr., (Land of the Don Cossacks), to 32° (Omsk in Siberia); facts which seem to prove that climate and temperature have, within certain limits, but little influence upon the composition of the beet. Subsequently we shall have to compare these results with those obtained in France, and by ourselves in Ireland, when we shall have occasion to make some further remarks upon this subject.

Dr. Bley* examined some specimens of German beet; he first rasped the roots, then treated the pulp with two parts of alcohol of 90 per cent., pressed the mass, filtered the expressed liquid, and evaporated it carefully over a water bath. His maximum result with the Silesian beet with red skin was 12·5 per cent.

Krocker determined the non-nitrogenized elements of beet grown near Giessen, in Germany, and Horsford determined the amount of nitrogen; the following are the combined results :—†

	Red Beet.—Beta Vulgaris rapacea. I.	II.	White Beet.—Beta Cicla. I.	II.
Water,	81·61		82·25	
Sugar,	10·20	10·48	12·22	12·31
Albumen,	3·03		2·04	
Cellulose,	3·98		2·60	
Ash,	1·18		0·89	
	100·00		100·00	

The process followed by Krocker was the same as that employed by Hermann, and already described. He says nothing upon the nature of the sugar, nor does he or Bley give any particulars about soil or manures, and, in the case of Krocker, the weight of the bulb is not given.

As the main object of our investigation was to compare beet grown in Ireland with that grown on the continent, with a view of discovering whether Irish grown roots were equally adapted for the purposes of the sugar manufacturer as those grown in districts where the manufacture of beet sugar has already succeeded, we have considered it necessary to give as complete a summary of the analyses of continental grown roots as possible, in order to enable such comparison to be properly made. An examination of this brief summary will show that the question whose solution we sought, although apparently very simple, is in reality exceedingly complex, as it involves the consideration of the influence of soil, the influence of manures, and many other points, for the elucidation of which the data at our command were very scanty. And in addition to this special difficulty, we must add that there are

* Ueber die Zuckerbereitung aus Runkelrüben. Halle, 1836.
† Liebig's Annalen der Chemie, Bd. 58. 1846.

few points in vegetable physiology so little understood at present, or to which science has contributed so little, as the influence of the soil, of manures, of sunshine, &c., upon the production and transformation of those substances known as the *proximate principles* of plants, such as sugar, albumen, &c. Under these circumstances we cannot claim to have thrown much light upon the purely scientific part of the subject, but shall feel satisfied if the consideration of the results which we shall now bring forward, and their comparison with those of others given in the preceding summary, will serve to establish the suitability of this country to produce beet adapted for the manufacture of sugar.

The first points we had to consider, were, the mode of analysis, and a proper selection of roots grown under as various circumstances as possible. With regard to the first point, there were five different modes open to us—1st., Pelouze's process, consisting in the fermentation of the sugar and the determination of the resulting alcohol; 2nd., Hermann's, consisting in the fermentation of the sugar and the determination of the carbonic acid evolved; 3rd., the method followed by Pelouze in determining the nature of the sugar, consisting in cutting the raw beet into thin slices, and extracting the sugar with alcohol; 4th., Peligot's modification of this process, consisting in drying the slices of raw beet over a water bath before treating them with alcohol; and 5th., by means of the polarimeter of Biot as recommended by Soleil and Clerget. The first and second processes appeared to us too complicated to be employed, where it was necessary, as in our case, to make a great number of analyses within a given time, and especially as there were no reasons for supposing that they would afford more accurate results than some of the others. The third process is unobjectionable as to accuracy and simplicity, but is rather expensive in consequence of the large quantity of alcohol required. The fifth we consider very objectionable and liable to give very erroneous results. We make this statement with great hesitation as we are aware that considerable diversity of opinion prevails upon the subject. The polarizing saccharometer is a very difficult instrument to manage, and will often deceive the most experienced eyes. Even with solutions of pure sugar, it does not always give constant results. Dumas, and he is certainly entitled to some authority upon such matters, stated in the French National Assembly, that in examining a solution of pure sugar, which should give a result represented by 100° one frequently obtains 104°. If such be its results with solutions of pure sugar, how much more difficult must be its use with such substances as the juice of beet, even though the greatest precautions are taken to clarify it with basic acetate of lead. Even its illustrious inventor, Biot, on being referred to by the commission appointed by the French Assembly, gave it as his opinion, that it was not applicable to the exact determination of the quantity of sugar contained in solutions of comparative purity to beet juice. And then again, even if its results were perfectly accurate, it gives no information whatever as to whether the sugar is capable of being extracted in a crystallizable or uncrystallizable form, and in this respect is therefore no better than the first and second processes above described, which also labour under this disadvantage. We therefore adopted the fourth process, or that recommended by M. Peligot. It possesses the advantage of great simplicity, and was especially adapted for our purposes, as it admits of making a great number of determinations at the same time. There are some disadvantages connected with it, however, of which we shall speak subsequently, from which the third process, or that pursued by Pelouze, for the determination of the nature of sugar is free, and which consequently induced us to control some of our results obtained by M. Peligot's process, by a few experiments made according to that recommended by Pelouze.

With regard to the selection of roots, great exertions were made to obtain them from as many parts of the country as possible, and with the exception of the western coast, the ten counties from which we obtained them will be found to represent very fairly the most diverse circumstances under which it is probable they could be grown. With reference to the manures employed, we believe that in this respect too it will be found that the greater number of those now in use will be represented.

The greater part of the seed employed, was, we believe, obtained from one source, and was not altogether unobjectionable, being a mixture of the *collet vert, jaune* and *rose*, the former predominating, judging from the specimens of roots which came under our observation. They also displayed a great tendency to throw out flower stalks, which well grown seed does not; on the whole we would consider the seed to have been inferior, and to have been, considering the object, very carelessly saved.

We shall now proceed to the examination of our results, which we shall class under the following heads:—

1. Nature of the sugar.
2. Per centage of sugar in Irish roots, and comparison with continental grown ones.
3. Causes influencing the per centage of sugar:—
    1. Size of roots.
    2. Period of growth.
    3. Action of soil and general cultivation.
    4. Action of manures.
4. Action of all these causes upon the general composition of the beet.
5. Comparison of the white Silesian beet with the other varieties of that plant, with some considerations upon the erroneous views usually entertained upon the comparative value of different root crops.

Before proceeding further it may not be unimportant to describe more in detail the mode of analysis adopted.

MODE OF DETERMINATION OF THE SUGAR AND OTHER PROXIMATE PRINCIPLES OF THE BEET.

The root was first well washed and a slice cut out of the centre in a direction at right angles to the axis, the epidermal tissue was then carefully removed, but not the herbaceous, the disc was then cut into small parallellopipeds, which were weighed in a porcelain capsule, and then dried in a water bath until they ceased to lose weight. The loss of weight was estimated as water. The dried residue was then reduced to a coarse powder, and a part employed for the determination of sugar and woody fibre, another for the ash, and a third for the amount of nitrogen.

From 100 to 120 grains of the dried residue were introduced into a small flask, and treated in the cold with alcohol of a specific gravity of 0·830, to which was added one or two drops of an exceedingly dilute solution of pure caustic potash, in order to neutralize any free acid present. It was allowed to remain in contact with the alcohol for two days, when the latter was decanted off and fresh alcohol added, which was allowed to remain in contact with the beet for twelve hours; this operation was repeated five or six times, or as long as the alcohol took any thing up. The alcoholic liquors resulting from all these treatments were added together and carefully filtered, and any solid matter remaining upon the filter added to the residue in the flask; the alcohol was then carefully evaporated at a gentle temperature to dryness; the dried mass washed with absolute alcohol made by the distillation of spirits of wine partially dried by two or three successive agitations with dried carbonate of potash and simple rectification, over anhydrous sulphate of copper. This alcohol dissolved no sugar, but removed all fat, colouring matter, and salts.

The residue, after the extraction of the sugar by alcohol, was then successively treated with cold water, boiling water, solution of caustic potash, strong acetic acid, and finally hydrochloric acid, by which the whole of the nitrogenous substances, pectine and organic acids, and nearly the whole of the salts were removed, leaving a nearly pure cellulose behind, which was well washed for several days by decantation in a small porcelain capsule, dried and weighed.

The ash was determined by burning a portion of the residue until it was fully charred, weighing the mass, washing with water and hydrochloric acid, by decantation, taking care not to lose any of the charcoal, drying and again weighing; the difference was the weight of the ash, less the silica remaining with the charcoal, which was then burned off and the silica remaining weighed, which, added to the other, gave the true weight of the ash.

The nitrogen was determined by the method of Varrentrapp and Will, and the nitrogenous matter calculated on the supposition of its having the composition of albumen.

The mode adopted for the examination of the soils upon which the beet had grown does not call for any particular observation. We have not, however, as is sometimes done, determined any of the constituents soluble in water except the sulphuric acid and the chlorine, as the amount of these constituents fully indicates the condition of the soil in this respect; nor have we examined the residue left after the treatment of the soil with hydrochloric acid, further than separating it into two parts, one consisting of siliceous sand, and the other which may be called clay, and which consists of the still undecomposed, at least to a great extent, detritus of the rock or rocks from which the soil is derived, and which we have included under the term "Silicates undecomposable by acids," the composition of which may be judged of sufficiently well from the nature of the rocks from which it is derived, and which is in most cases represented by the pebbles in the soil, an accurate description of which we have given. Except mechanically, this part of the soil can have no influence upon vegetation, and it would be just as useful to analyze the pebbles, indeed frequently more so, as the pebbles of many soils very frequently yield a considerable amount of their constituents to strong hydrochloric acid.

Nature of the Sugar contained in Beet Root grown in Ireland.

An impression appears to prevail, that heat and sunshine are so intimately connected with the production of sugar in plants, and especially of cane sugar, that as we proceed north from the tropics, its quantity must gradually diminish. Such a view applied to the case of the beet would, of course, lead to the conclusion, that the south of Europe would be best adapted for its cultivation as a source of sugar, and that cold countries like Ireland, however well they may be adapted to produce foliage, and large roots, would necessarily produce beet of inferior saccharine properties. Another opinion has gained ground, that with the diminution of sugar would occur a change in its nature; or, in other words, that the same quantity of crystallizable cane sugar would not be contained in roots grown in Ireland, and, of course, for the same reason, in the northern parts of Europe generally—that is, in places north of the actual beet sugar districts. Let us first consider the latter point, which is, in fact, the fundamental point of the whole subject. It appears to us that the same substance may be the result of very different transformations in the vegetable world, and that hence it does not by any means follow that when we find sugar in a particular part of a plant, that it was produced in precisely the same way as in a different part of another plant. Braconnot and others have shown that both cane and grape sugar exist simultaneously in the female organs of a vast number of plants, whilst, as one of us has found by Trommer's test, that the entire of the sugar of some pollens is a cane sugar, and yet the two systems of organs are produced at the same period of growth. Does it necessarily follow, because we get the sweetest fruits in warm countries, that no sugar can be produced in cold ones in other organs, or is it not rather the whole organization of the plant which requires a warm and sunny climate. Succulent plants, like many of the tropical plants rich in sugar, fruits like the water melon, &c., produce, under the influence of a warm sun, abundance of cells, within a very short time; their juice must, therefore, abound with materials for the construction of those cells, that is, with sugar of somekind. If an acid be present in the juice, the sugar will, in all probability, be grape or uncrystallizable sugar, especially under the influence of a strong sun; if no acids, or but very little, be present, as in the sugar-cane, the sugar will, in all probability, be crystallizable cane sugar. In temperate and cold countries the growth of plants is not nearly so rapid; there is, therefore, less need for soluble materials for the formation of cells in the sap of the stem and leaves; and it will hence be found, that plants of the same species will contain less solid matter in solution in the juice of the stem in cold countries, or in the same country in cold and unfavourable years. But there is no reason to suppose that this deficiency of growing powers in a plant should necessarily be accompanied by a change in the nature of its proximate principles, at least from those causes alone. As in warm countries, where, from the nature of the plant, acids co-exist in the juice with the sugar, grape sugar or uncrystallizable sugar will be found; when the acidity is not very marked, cane sugar will in general exist.

The bulbs and tubers of plants, like the beet, the turnip, the potato, &c., in the first year of their formation, represent, in some measure, in their functions, the seed; in them is accumulated a quantity of materials which is to serve for the formation to some extent of the flower stalk during the ensuing spring; in some we find starch, in others sugar, which may be grape or cane, according to the nature of the plant; exactly as we find in some seeds starch, in others grape sugar, in others, as in the chestnut, cane sugar. There is, therefore, a very close relation between the plant and the nature of the sap, which in fact, like the blood of animals, cannot undergo any change, except within very narrow limits, without being fatal to the existence of the plant. It is, therefore, more than probable, for these reasons alone, that the production of crystallizable or uncrystallizable sugar in a plant is more connected with the organization of that plant than upon the amount of sunshine, an opinion which is very strongly supported by the fact, that the maximum amount of sugar is found in the sugar-cane just before it flowers, or about the period of maximum temperature and sunshine; whilst the maximum amount of sugar is found in the beet in November, when the sunshine and heat are very nearly at a minimum; and, on the other hand, it contains but little sugar in the warmest period of summer. Again, those varieties of the beet which protrude themselves very much out of the soil, and, in fact, all parts of a bulb exposed to the full action of the sunshine, contain less sugar than that portion covered by the soil; and finally, practical experiments and chemical investigation have shown that there is no material difference in beet grown over a region extending from the Atlantic Ocean to the Caspian Sea, and from the Mediterranean Sea to very nearly the Arctic Ocean.

We can, therefore, see no reason why Ireland should be an exception;

and, indeed, but for the assertion having been made, we would not have entertained the matter at all. The idea that uncrystallizable sugar existed as such in the sugar-producing plants, was not first made of the beet, but of the sugar-cane. Amongst the sugar planters of the tropics the molasses has always been considered not to have been made by their absurd system of manufacture, but to have existed as such, ready formed, in the juice of the cane—a point first insisted upon by Proust,* in his examination of the Spanish sugar-cane, and again in 1831, by M. Avequin, who, in his analysis of the sugar-cane of the West Indies, stated that a variable portion of uncrystallizable sugar was always present in it. The later researches of Peligot, Plagne, Dupuy, and Casaseca, have completely disproved this view, and placed beyond doubt the fact, that the entire sugar of the cane is crystallizable. In the case of the beet, too, the great weight of authority is in favour of the view that the whole of the sugar is in a crystallizable form; M. Braconnot being the only chemist of any authority whose researches would lead to the belief that a portion of the sugar was uncrystallizable. We think we can point out the cause of this difference between the results of M.M. Pelouze and Peligot, and those of M. Braconnot. The latter states, that on drying the beet, and treating it with *boiling* alcohol, he obtained a coloured solution, which, on evaporation, along with crystals of sugar, yielded a kind of uncrystallizable mucilaginous substance, somewhat less soluble than the true sugar in alcohol, but which could never be separated perfectly from it. A portion of this substance, which M. Braconnot calls *mucososucre,* also separated from the hot solution in alcohol, even before evaporation. He further states, that he always found with this substance a quantity of uncrystallizable sugar. During the course of our examination we had several opportunities of witnessing these appearances, so accurately described by Braconnot. We found, for instance, that specimens of beet which had been grown on land either too heavily manured, or which was just reclaimed, were dried with great difficulty in a water bath, without undergoing considerable alteration, which was rendered sensible by the high colour which the dried residue communicated to alcohol, and by the quantity of this mucilaginous substance which was left on the evaporation of the alcoholic solution. At first, we imagined that there must be a difference in the sugar; but on drying a few slices carefully and rapidly, at a low temperature, in a current of air, we found that the colour was much less intense, and that the alcoholic solution left scarcely any of the mucilaginous substance on evaporation. On drying a few slices with sulphuric acid under the air-pump, we in general obtained an alcoholic extract but slightly coloured, provided we treated the dried mass with alcohol, at the ordinary temperature of the atmosphere. On examining a portion of the root by the method of Pelouze, a perfectly colourless solution of sugar was obtained, which by spontaneous evaporation yielded a beautiful crystalline

* Annal. de Chim. et de Phys., 1st Ser., t. lvii., p. 148.

mass, which, on being washed with absolute alcohol, left a quantity of perfectly pure white sugar. In every case where we obtained results similar to those of M. Braconnot, we could trace the cause to the change produced by the drying of the beet, or to its subsequent boiling with alcohol; and in no instance did we fail to obtain satisfactory results by treating the raw beet with alcohol, at ordinary temperatures. In several instances where we obtained a dry alcoholic extract of a dark colour, and where we were unable to operate upon the raw beet, we tried Trommer's test, in order to place beyond doubt the fact, that the sugar contained in the beet, even under very unfavourable circumstances, is always cane sugar, and always with the same unvarying results—unless where the root had undergone alteration, or the heat employed in drying the slices too high. We may mention that Trommer's test had hitherto been often tried with continental roots, and always with like results.

In all cases where we succeeded in drying the beet properly, and especially where it was rapidly dried, and not left too long exposed to the heat of the water bath, we obtained results quite as satisfactory as those described by M. Peligot. From these results we think we are fully justified in concluding that the sugar of the beet grown in Ireland is crystallizable, and thus add a further testimony to the accuracy of M.M. Pelouze and Peligot's observations.

We have not had many opportunities of examining the roots preserved to a late period of the year; but the few which we have examined, and which are marked in Table I.* as Nos. 114, 115, 116, 117, and 118, have convinced us that the preservation of roots is a matter of great difficulty. In the first three specimens, the sugar had undergone no perceptible alteration; but in the other two, especially in No. 117, not only had it diminished in quantity, but it had altered in nature, having become completely uncrystallizable. Whether this change took place in the pits where they were preserved, or subsequently in the laboratory, we could not decide, nor had we an opportunity of studying this part of the subject much farther. A specimen of dried beet prepared from a mass of these roots taken at random, and intended to be employed in the manufacture of sugar, according to Schutzenbach's process, yielded a crystallizable sugar, with an exceedingly small quantity of uncrystallizable sugar.

Quantity of Sugar contained in Irish-grown Beet.

The saccharine quality of beet root is determined by two circumstances: first, the proportion which the sugar bears to the other constituents; and second, the quantity of water in which that sugar is dissolved. The latter point is of considerable importance to the sugar manufacturer, as it is quite evident that he not only requires that the roots upon which he operates should contain a certain quantity of sugar, but that he should have a dense

* See pp. 68-75.

juice—that is, have as small a quantity of water as possible to evaporate. If the juice of the beet was a solution of pure sugar without any foreign ingredients, its specific gravity would always indicate the proportion of sugar contained in it, and a determination of the proportion of water would give the amount of sugar in the raw beet. But beet juice is not a solution of pure sugar, and that its specific gravity can give but very doubtful results, a glance at Table II.* will at once show. No. 56 has a specific gravity of 1·0553, and contains 12·904 per cent. of sugar in the juice, or 10·891 in the raw beet; whilst No. 117, which has a specific gravity of 1·0556 contains only 4·195 per cent. of sugar in the juice, and 3·553 in the raw beet. This is an extreme case however, but it will serve to show that, although, generally speaking, it does give an approximation to the true quantity of sugar contained in the juice, its indications must be employed with great caution. The amount of foreign matter contained in the beet juice is very variable; but as we shall have to examine the causes of this variation, when speaking of the action of manures, we shall make no further remarks upon the subject here.

Table I. contains the results of the examination of 118 specimens of the white Silesian beet grown in Ireland. An analysis of this table gives the following results:—

Of 118 roots,	12	contained above	12 per cent. of sugar.
	9	between	11 and 12 per cent.
	19	"	10 " 11 "
	32	"	9 " 10 "
	18	"	8 " 9 "
	16	"	7 " 8 "
	2	"	6 " 7 "
and	10	contained under	6 per cent.

Or in other words, 72 roots contained more than 9 per cent. of sugar, 18 between 8 and 9 per cent, or 90 above 8 per cent., and 28 below 8 per cent.

Roots containing less than 8 per cent. of sugar, could not, at the usual price paid for them, be employed with economy in the manufacture of sugar, at least not generally. We have, therefore, as the result of our examination of beet, grown on the most various soils, manured in every possible manner, and labouring under the disadvantage of being a plant in a great measure new to Irish farmers, and consequently its proper cultivation by no means well understood; that about 76 per cent. of the beet which we examined, contained sufficient sugar to enable a manufacturer to extract it with profit, and 24 per cent. unfit for that purpose.

The analyses of continental roots have not been made on the same extensive scale as the Irish, and cannot therefore be compared with the latter, with any thing like accurate results. It may not be uninteresting, however, to contrast an analysis of the tables of determinations of sugar contained in the

* See pp. 76. 77.

summary of the analyses of beet which we have given above, with that of our own results. In doing so, we shall add the analyses of Belgian roots made by ourselves, the results of which are given at the end of Table I. The total number of analyses, including our own, of which we have been able to get a record, amount to 62, which may be distributed as follow:—

There were 4	roots which contained above	12	per cent. of sugar.
4	„	11	„
9	„	10	„
14	„	9	„
13	„	8	„
8	„	7	„
4	„	6	„
6	„	under 6	„

Which would give a total—31 above 9 per cent., 11 above 8 per cent. and 18 below 8 per cent., or about 70 per cent. adapted for the manufacture of sugar, and about 30 per cent. unfit for that purpose. To render this comparison of value, it would be necessary to take into account the weight of the roots, the periods of growth, &c., points which are of the greatest importance in judging of the saccharine qualities, and to the consideration of which we shall now pass.

Effect of Increase of Size on the per centage of Sugar.

The size of the bulb has a remarkable influence upon the amount of sugar which the beet contains, or rather upon the relation between the solid matter left on drying the root and the water driven off. An examination of Table I. shows, in a very remarkable manner, that the larger the root grown in the same field is, the smaller is the quantity of solid matter which it contains. Thus No. 28 weighed 3 lbs. 9½ oz., and yielded 14·383 per cent. of solid matter; while No. 29, which weighed but 15 oz., yielded 19·337 per cent. And as the per centage of sugar contained in the dried matter does not vary very much, being, except under very peculiar circumstances, a little under or a little over ⅔ of its weight, it will be found that the quantity of sugar will diminish as the weight of the bulb increases; No. 28, for instance, contains but 9·885 per cent. of sugar, and No. 29, 12·132 per cent. This rule may be considered to hold good for all roots, no matter where grown; although good cultivation, a suitable soil, and proper manures may enable one farmer to produce roots of a large size, containing more solid matter, and therefore more sugar, than much smaller ones grown by another under less favourable circumstances. Thus all the roots which yielded a very low per centage of sugar, weighed from 5 to 9 or 10 lbs., whilst those remarkable for the quantity of sugar which they contain, were always small roots, seldom exceeding 2 lbs. in weight. In the tables representing the result of Peligot and Hermann, given in the commencement of this Report, this fact is strikingly shown, especially in that of the latter, from which it appears that all the Russian roots which gave high per centages of sugar, were rarely above

1 lb. in weight, and in general much smaller than Irish-grown roots examined by us, which yielded corresponding quantities of sugar.

INFLUENCE OF THE PERIOD OF GROWTH UPON THE PER CENTAGE OF SUGAR.

The researches of Pelouze and Peligot have proved that the per centage of sugar gradually increases in the beet with its growth, and attains a maximum before ripening, that is before the commencement of the formation of the flower stalk, from which period it begins to diminish, until at the formation of the seed it is almost nothing. An examination of Table I. will, taken as a whole, bear out this view, and more especially the results of the analyses of the roots obtained from the Royal Dublin Society, which exhibit a most decided increase in a space of three weeks. Our investigation did not, however, embrace a sufficient period to enable us to show this gradual increase in beet grown upon the same land, from the first development of the bulb until its full maturity. A few specimens of beet taken at different times would certainly not be sufficient for that purpose, as a difference in the weather might produce changes fully equal to that effected by growth; thus, if the second specimen happened to be pulled after constant wet weather, and the first after continued dry weather, the amount of water would increase in the second instance from this cause alone, and would diminish in the first; producing of course corresponding effects upon the per centage of sugar, and thus completely mask the effects of growth.

If, as Peligot states, the proportion of water to solid ingredients is the same at all periods of growth, and that the sugar continually increases, as his analyses show in the clearest manner, some other ingredient must evidently diminish in proportion as the sugar increases; what that substance is he does not say, for in a part of his memoir he very distinctly states that the woody fibre, water, sugar, &c., increase proportionally throughout the whole period of growth. If this was the case there would be a mere increase of weight, but no increase in the per centage of sugar, and the conclusion he seems to draw from it would be true, namely, that the same amount of sugar would be obtained from the same weight of roots at all periods of their growth. There is an evident contradiction here, and we may add that our results are not in complete accordance with this view. By a reference to Table I., in which we have calculated the proportion which the sugar bears to the other solid ingredients, as well as its per centage in the raw root, it will be seen that previous to the period of maturity the relation of the sugar to the other solid constituents is, within rather narrow limits, the same; not only in beet pulled at different periods of its growth, but in that grown under very various circumstances. Taking $\frac{2}{3}$ as the average proportion of sugar which dried beet would yield, or 66 per cent., we find that the usual extremes are 3 or 4 per cent. above, or 3 or 4 per cent. below that quantity. The same per centage of sugar in the dried beet, in the case of two specimens of beet, not at all necessarily indicating the same per centage in the raw roots. To give an example, No. 58, Table I., contains 65·294 per cent. of sugar in the dried beet, and No. 59, grown on the same soil and with the same manure, 65·644 per cent., or practically the same quantity; yet the former contains only 10·948 per cent. in the raw, while the latter contains 12·417. Again, to take an example at random, Nos. 46 and 94 contain very nearly the same amount of sugar in the dried root, but the former only contains 8·644 of sugar in the raw root, and the latter 13·185. We could multiply these examples if necessary, but an examination of the table will at once convince every one that there is not a constant proportion between the water and the other constituents; although it would appear that the relation of the solid constituents to one another was pretty constant, a result which would indeed be anticipated from the nature of the functions of the bulb of the beet.

After the beet has reached its period of maturity the sugar begins to diminish, and the woody fibre to increase, whilst the proportion of solid matter, to the water, sensibly diminishes. Thus, if we compare two specimens of beet grown on the same field and pulled at the same time, but one of which had just passed its period of full maturity and thrown out its flower stalk, we will be very well able to observe this change.

	No. 37. Beet nearly matured.		No. 38. Beet which had just thrown out its flower stalk.	
	Dried.	Raw.	Dried.	Raw.
Sugar, . .	64·251	7·357	56·780	6.101
Woody Fibre, .	8·175	0·936	19·895	2·137
Water, . .		88·549	89·255	
Solid Matter, .		11·451	10·745	

The change is by no means so perceptible in the raw root as upon the dried mass, being an additional proof that the amount of water has no very close relation to the other constituents. It is to the relation between the constituents of the dried beet we must look, in order to study the changes produced in a plant by growth or by the action of manures, &c.

Influence of the Soil upon the Amount of Sugar.

The soil influences the growth of plants in two ways; the first depending upon its mechanical composition, the second upon its chemical. Notwithstanding the great attention which has been bestowed upon this department of scientific agriculture, it is to be regretted that as yet no general laws have been established. Nor is this to be wondered at, when we recollect how difficult it must be to assign to each of the numerous causes which influence the vegetation of a plant, the precise share which it has had in its development. Nor can we congratulate ourselves upon having thrown the least light upon the subject, for any of the views which we may put forward under this head must only be looked upon as mere conjectures.

Beet will undoubtedly grow upon all kinds of soil, but experience has shown that a light rich loam is the best adapted to produce abundant crops of good quality. No plant more than the beet requires that the soil be well worked, and to a considerable depth, in order that the bulb may have room to expand, and that it may not have to throw out too many roots in search of food, a rule indeed which applies equally well to all bulbous and tap roots. Stiff clays do not answer these conditions, and should therefore be avoided. Light sandy soils give crops of good beet, but small in quantity. Gravelly subsoils are exceedingly unfavourable to all deep-rooted plants, and too large a quantity of gravel and especially of large pebbles in the soil, which cause the bulb to fork, are equally unsuited. A sandy soil resting on a deposit of marl has been found very well suited, but probably the worst combination of circumstances, would be a stiff clay soil resting upon a porous gravel.

It is difficult to say in what manner the growth of a plant is influenced by the chemical composition of the soil. The plant derives all its inorganic constituents from the soil, and there can therefore be no doubt that if any one or more constituent of a plant, such as lime, &c., be entirely absent from the soil, the plant cannot grow. But there are few soils entirely devoid of all the necessary constituents of plants, and it has not been at all decided at what point a soil must be considered unfertile, in consequence of the smallness of the quantity of a particular ingredient. It often happens that a soil which experience has shown to be really fertile, will be found on analysis to contain much less of all those ingredients which are necessary to supply plants with their inorganic constituents, than another which has always borne very inferior crops. It is not, therefore, to the quantities of certain ingredients to which we must entirely attribute their fertility, but rather to the condition in which they exist. But what are the proper conditions in which they should exist? we are unable to say.

The mechanical properties of soils depend in a great measure on the relation of the sand to the clay, taking into account of course the amount of pebbles which may be mingled with the soil, and which act in some measure as sand, though in a much less degree. The determination of what is sand in this point of view is very difficult, it may be composed of lime, of silica, or may be fragments of decomposing felspar or other minerals. When a soil is treated with hydrochloric acid, the part which is dissolved, except in the case of a limestone soil, is usually very fine, and mechanically must be considered as clay. In Table VI., we have included under the head clay, only the part of the soil insoluble in acid, but in the following observations we shall consider as clay, in a mechanical point, the sum of the silicates undecomposable by acid, the soluble silica and the alumina and iron. The quantity of lime present in all the soils examined by us was exceedingly small; we regret this, as we would wish to ascertain whether a calcareous loam was as well adapted for beet as it has been found to be in some districts upon the continent. The following tables* contain the tabulated results of the analyses of the beet soils examined by us.

The conclusion which may be deduced from a comparison between the mechanical composition of the soils which we examined, and the beet which was grown upon them, fully bears out the preceding remarks, as the following summary will show.

* See pp. 78–83.

Name of Grower.	Gravel.	Silt.	Clay.	Sand.	Lime.	Organic Matter.	Character of Soil.	Per Centage of Solid Matter in Beet grown thereon.	Per Centage of Sugar.
Professor Murphy's soil, . .	17·	83·	54·9	34·8	1·5	5·7	Tenacious clay, requiring a great amount of working, .	12·7 max., 11·6 min.,	8·5 max. 7·3 min.
William Dargan, Esq., . .	24·4	75·6	62·4	22·0	3·6	8·1	Heavy clay, not so tenacious as the last, . . .	10·9 min., 15·0 max.,	7·4 min. 9·5 max.
Robert Forster, Esq., . .	23·	77·0	34·9	55·4	0·3	3·6	Loam, ...	13·6 min., 15·5 max.,	7·5 min. 8·2 max.
James Sinclair, Jun., Esq., .	22·5	77·5	35·1	51·2	0·6	10·9	Rich loam, ...	19·3 min., 22·0 max.,	13·1 min. 14·5 max.
William Sinclair, Esq., . .	30·2	69·8	27·9	61·8	0·5	7·4	Slightly sandy loam, ...	15·8 min., 20·4 max.,	9·4 min. 13·5 max.
Robert M'Crea, Esq., . .	.	100·	64·3	13·4	0·6	17·8	Rich clay, consisting of river or tidal silt, having the mechanical properties of sand. The soil must be considered as a very rich loam, ...	14·8 max., 16 0 min.,	10·4 min. 11·1 max.
Rev. W. R. Townsend, . .	29·6	70·3	62·8	24·6	2·2	6·2	Rich clay, naturally tenacious, but apparently very much improved by good tillage, ...	12·20 min., 14·7 max.,	8·5 min. 7·5 max.
Lord T. de Malahide, . .	33·6	66·4	45·4	44·0	0·4	7·8	Clay loam, but rather tenacious, ...	12·7 min., 15·5 max.,	8·5 min. 10·8 max.
B. J. Hackett, Esq., . .	25·6	74·4	48·1	42·1	0·6	7·3	An exceedingly tenacious clay loam, ...	11·2 min., 15·4 max.,	6·2 min. 9·8 max.
John Newton, Esq., . . .	35·9	64·1	48·2	40·5	0·8	9·2	A rather clayey loam, but owing to the size of the grains of sand sufficiently porous, ...	18·6 max., 12·3 min.,	12·8 max. 8·7 min.
Messrs. Dickson & Co., . .	17·	83·	50·5	26·1	2·2	16·8	A stiff clay, loaded with inert organic matter, . .	6·2 min., 11·5 max.,	2·6 min. 5·7 max.
N. Niven, Esq., ...	27·8	72·2	48·8	28·1	5·9	11·4	A good clayey loam, but rather tenacious, . . .	9·2 min., 16·5 max.,	5·1 min. 11·4 max.
Messrs. Jennings, ...	15·7	84·3	51·2	34·9	3·7	6·4	Tenacious clay, requiring a great amount of tillage, .	11·4 min., 15·3 max.,	7·3 min. 9·3 max.
Royal Dublin Society's Botanic Garden soil, . .	33·	67·	44·9	32·7	5·	11·6	Rich clay loam, not tenacious; whole character porous,	10·6 min., 18·0 max., 19·4 max., 9·2 min.,	5·1 min.* 12·5 max. 12·5 max.† 5·1 min.

* In October. † In November.

In every case, with the exception of the soil of Messrs. Dickson, the subsoil has the same character as the soil, a little more clayey, however; but in this instance the subsoil is sandy, and, in all probability, rests upon gravel, the worst possible combination; and hence it is the worst beet of the whole. The superiority of the light loams, is in every case very marked, and proves in the clearest manner, the great influence of the character of soil upon the quality of the beet. The soil of the Rev. Mr. Townsend is interesting, for by great labour he has given it to some extent the character of a loam.

All the soils examined contained abundance of every element necessary for plants, having been all heavily manured; but whether these substances existed in the best form, our analyses do not enable us to pronounce. There cannot be the slightest doubt that the condition of the organic matter in a soil is of considerable importance, for all fertile loams, when treated with water, yield a considerable quantity of organic salts of ammonia, and from the solution of which acids throw down abundant flocculent precipitates. All the soils of Belgium, remarkable for giving crops of superior quality flax and the beet soil analysed by us possessed this quality, which was likewise possessed in a considerable degree by the soils of Mr. J. Sinclair, jun., of Mr. W. Sinclair, Mr. M'Crea, of the Rev. Mr. Townsend, and of the Right Honourable Lord T. de Malahide. Autumn manuring conduces to this condition of the soil, but spring manuring, although it gives a large amount of ammonia and salts to the soil, does not produce this effect in the same degree.

INFLUENCE OF MANURES UPON THE PER CENTAGE OF SUGAR IN BEET, AND OF ALL THE CAUSES ABOVE ENUMERATED UPON THE GENERAL COMPOSITION OF THE BEET.

The influence of manures upon plants is one of the most fundamental, but at the same time, difficult questions in scientific agriculture. That well-manured land will give larger and better crops than unmanured and exhausted land, is a fact known to the peasants of every nation in the world. But the best kind of manure to employ, and the best mode and time for employing it, are not so well known. Practical experience has shown what manures give large returns of produce; but it has not been equally successful in showing what are the best adapted for producing quality, or for making a plant develope the maximum quantity of a particular ingredient which may be required. This latter point is, in some cases, of the greatest importance; thus the flax-grower wishes to produce as large a quantity of fibrous tissue of delicate quality as possible, and the sugar-maker wishes to produce the largest possible quantity of sugar; whilst the cattle-feeder wishes for a fair proportion of all the constituents of the plant, and especially of the muscle-forming principles, containing nitrogen, which are useless, and sometimes positively injurious to the other two. The remarks which we have already made upon the uniformity of composition of the solid matter of the beet, show that the limits within which a plant can develope a particular principle are very narrow, and that, practically, there can be no great difference between the mode

c 2

which a good farmer ought to adopt for growing beet or other crops, whether he requires it for feeding, for fibre, or for sugar.

M. Dubrunfaut, and subsequently M. Pelouze, showed that strong manuring does not diminish the amount of sugar, a fact admitted by M. Blanquet, the eminent sugar manufacturer of Valenciennes.* Experience since then has still further confirmed this opinion, subject, however, to some important exceptions. But M. Blanquet states, and dear-bought experience has shown, that although the quantity of sugar may not be diminished by heavy manuring, other substances are increased in quantity, which render the sugar difficult of extraction, and rapidly alter the juice, especially under the action of heat. These substances are the nitrogenous elements of the beet, which were usually classed under the term albumen, until Hochstetter showed that there were several substances containing nitrogen, and having very different properties. He found, for instance, that the beet contains—†

1. Pure vegetable albumen, which possesses the property of coagulating in the form of a white clot, when the fresh juice is heated to the boiling point, and which seldom forms more than $\frac{1}{3}$ to $\frac{1}{2}$ of the whole nitrogenous matter of the beet.
2. A nitrogenous substance, which, when exposed to the air, is first reddened, then becomes a dirty blackish brown; and lastly, inky black, from the action of the oxygen of the air. It is to this substance that the darkening of beet juice after expression is attributable. When first expressed, this substance is in solution, but in proportion as the oxidation proceeds, it is precipitated, and gives to the juice, at first transparent, a muddy appearance. It may be separated by filtration, and is soluble in potash, but is not again precipitated by acids, although it is very slightly soluble in them. This is, in all probability, the same substance which exists in apples, and in potatoes, and many other saps, and which causes the freshly-cut surfaces of those substances to become black.

We have already remarked that its chief seat is in the concentric rings of fibrous tissue; but it is not always confined to these vessels, as many specimens of beet will be found to become black over their whole cut surface, even when the section is made in the direction of the axis of the root. This only occurs, however, with beet which yields a very impure juice. It is not coagulated by heat nor by lime. Chloride of calcium, and other salts of lime, however, form a white precipitate with it, which becomes black the moment it is exposed to the air. Acids prevent this substance from blackening.

3. A nitrogenous substance resembling gelatine precipitated by lime, but

* Lettre de M. D. Blanquet à M. Pelouze, Annal. de Chim. et de Phys. t. xlviii., p. 100. 1831.

† Knapp's Chemistry applied to the Arts. Translated by Drs. Ronalds and Richardson, vol. iii., p. 340.

not by chloride of calcium. It decomposes sugar in solution, even in the cold, the liquor becomes mucilaginous and contains lactic acid.

4. A nitrogenous substance, which, like No. 2, is neither precipitated by boiling nor by lime, but can be thrown down by basic acetate of lead.
5. Nitrogenous substances, which are not precipitated by any of the reagents just enumerated, but are thrown down by nitrate of silver.

The first and second are normal constituents of the beet, and are always present in the juice, but it is not yet decided whether the others are so, or whether they are only products of decomposition of the first two. According to Schatten the amount of nitrogen yielded by the precipitates with basic acetate of lead and which, therefore, may be considered as No. 4 in combination with the lead, is very variable, and is sometimes even absent altogether. Such an experiment, however, amounts simply to this, that this peculiar substance may exist along with substances precipitable by basic acetate of lead, or may be sometimes altogether absent, which is probably the case with some of the other substances also, especially with No. 3, which we have not always found present.

That the nitrogenous substances present in the beet readily undergo change is proved by the presence of salts of ammonia in the juice of the beet. According to some recent experiments, it would appear that the presence of this ammonia is due to the action of alkalies or of lime upon the nitrogenous constituents, for neither beet juice, rasped beet, nor sliced beet yield ammonia by treatment with lime in the cold. Although this may be true in general, we do not see any reason why the evolution of ammonia may not sometimes take place in the living plant, and a series of changes of the nitrogenous bodies be brought about in them, especially when a plant of the same family, the *chenopodium vulvaria*, evolves ammonia during its growth, as was shown by Chevallier.

It is to the action of these substances that the changes in the crystallizable power of the sugar are to be principally attributed, and which render its profitable extraction often difficult. That their quantity, and even the absence or presence of some of those named, is very much influenced by the kind of manure, and probably also by the soil, is quite certain. Thus we found that No. 3 was often entirely absent from soils manured with saline manures, such as those given in Table I., whilst in others, as, for instance, Nos. 94, 95, and 96, the quantity was often so great, as to convert the whole of the juice in a few hours into a kind of jelly. In the specimens of beet which we examined, which had been grown upon land manured with nitrate of soda, and which are numbered in Table I., as follow :—5, 7, 8, 19, 21, 66, 67, 70, 71, 72, and 73, we found that they were much less liable to become black when a fresh surface was exposed to the air, and to give a juice which on no occasion became perfectly black, even when, as in some instances, as in 7, 21, &c., sulphate of ammonia was applied along with the nitrate of soda.

In general, the soils which had been heavily manured with fresh farm-yard dung, and especially if they happened to be stiff clays, yielded more of the nitrogenous substances described as No. 3, and, indeed, we may add of all the other nitrogenous substances.

The per centage of nitrogen, in a specimen of beet, does not appear to indicate whether a beet will yield a pure or impure juice, as we have found that many specimens which yielded an exceedingly impure juice contained but little of that constituent; while others, again, which were rich in nitrogen, gave a very pure one. We may particularise, in an especial manner, the roots grown by the Rev. Mr. Townsend, which, although rich in nitrogen, yielded an exceedingly pure juice, and one which did not rapidly alter by exposure to the air. This is, in all probability, accounted for by the smaller quantity of nitrogenous substances similar to those described as Nos. 2, 3, and 4, and by the larger amount of pure albumen.

A quantity of pectine is sometimes found in the juice, but its quantity is comparatively small, unless the pulp is remoistened with water and again pressed. The foreign matter which thus exists in the juice, consists principally of nitrogênous substances, salts of organic and inorganic acids, and a little pectine. The pectine is of little importance, as it is completely removable by lime, and is rather an accident in the juice; the action of the manures must, therefore, be sought for on the nitrogenous matter and on the salts, principally. The latter is comparatively easy, but the former is a task of great difficulty, owing to the imperfect nature of our knowledge of these substances, which require to be thoroughly investigated, now that the path is opened. The absolute per centage of nitrogen being, as we have remarked before, insufficient to judge of the entire action of a manure, we have endeavoured to construct a table to indicate the purity of the juice. Supposing the whole of the sugar, found by analysis to be dissolved in the whole of the water contained in the raw beet, we have calculated, from the Tables of Niemann,* what the specific gravity of such a solution would be; and, by comparing this specific gravity with that actually found for the juice, the difference indicates the amount which the specific gravity is raised by the presence of foreign matter.

We, of course, do not wish that any great importance should be attached to a table constructed on such a basis; it will serve, however, to give a comparative idea of the relative purity of the different juices. To arrive at a conclusion upon this point, it will be necessary to take into account the per centage of sugar; for, it is quite clear, that the larger the proportion of sugar in the juice, the less will be the relative value of a given difference. Thus, the difference between the specific gravities of the juices of Nos. 33 and 44,

* Annalen der Pharmacie, Bd. II., p. 340. We regret not having had an opportunity of consulting the tables of Ventzke, published in Marchand and Erdmanns' Journal für Prak. Chem.

in Table I., supposing them solutions of pure sugar, and the observed specific gravities is ·0064; but No. 33 contains 14·180 per cent. of sugar in the juice, and No. 44 only 11·605; the proportion of foreign matter to sugar is, therefore, relatively greater in No. 44 than in 33. An inspection of this table, whatever be its intrinsic value, indicates some curious results. It will be found, for instance, that saline manures have a considerable influence in raising the specific, when they consist of a large amount of soluble salts, and that this is especially the case with nitrates; that farm-yard dung laid upon stiff clay soils, especially when in a fresh state, produces the same result. This is remarkably illustrated by Nos. 84, 85, 86, and 87, grown by Messrs. Dickson, of Belturbet, and by 35 and 36, grown by B. J. Hackett, Esq., of Midleton, Co. Cork, and by 37, grown by Messrs. Jennings, of Cork, and manured with fresh pig manure. Fresh manure, although apparently always injurious, is not nearly so much when applied upon loamy soils, upon which the oxygen of the air has more power to act. The series of roots grown with different manures, specially for us, at the Botanic Garden of the Royal Dublin Society, by the Curator, David Moore, Esq., and by Ninian Niven, Esq., at the "Garden Farm," Drumcondra, are particularly interesting, as they show, in a remarkable manner, the influence of each manure. The experiments of a single year are not, however, sufficient to establish any important results, especially in the absence of investigations upon the nature of the nitrogenous constituents of the beet.

We have determined the amount of the nitrogenous constituents of a number of the specimens of beet, for the purpose of exhibiting the variations to which those substances are subject, and to endeavour to ascertain how far manures act upon the total quantity of these bodies. The following Table, which contains the proportions of all the constituents of the beet, embraces these results, and will be found to exhibit examples of nearly all the various circumstances under which the beet was grown; and also the various classes of soils which we have already alluded to. The numbers refer to the corresponding ones in Table I.; the names are those of the persons on whose land the specimens were grown. The nitrogenous substances are calculated on the supposition of their having the composition of albumen.

Name of Substance.	No. 1. Royal Dublin Society. — Weight of bulb, 2 lbs. 1 oz.	No. 2. Ditto. — Weight of bulb, 2 lbs. 8¼ ozs.	No. 3. Ditto. — Weight of bulb, 2 lbs. 4 ozs.	No. 4. Ditto. — Weight of bulb, 1 lb. 14½ ozs.	No. 5. Ditto. — Weight of bulb, 1 lb. 15¾ ozs.
Water, . . .	81·959	85·331	84·936	83·412	84·440
Sugar, . . .	12·520	10·091	9·381	10·667	9·682
Nitrogenous substances,	2·320	1·420	2·256	2·427	1·120
Cellulose, . . .	0·929	1·193	1·034	0·851	1·386
Pectine, Organic Acids, Fat, &c., . .	1·247	0·715	2·393	1·458	2·068*
Ash, ...	1·025	1·250		1·185	1·304
	100·000	100·000	100·000	100·000	100·000

* Partly nitric acid, in combination with potash.

Name of Substance.	No. 6. Royal Dublin Society. Weight of bulb, 2 lbs. 6¾ ozs.	No. 7. Ditto. Weight of bulb, 3 lbs. 9¼ ozs.	No. 8. Ditto. Weight of bulb, 2 lbs. 6½ ozs.	No. 9. Ditto. Weight of bulb, 2 lbs. 14 ozs.	No. 10. Ditto. Weight of bulb, 3 lbs. 6½ ozs.
Water, . . .	83·943	90·798	84·523	87·416	88·811
Sugar, . . .	9·996	5·129	10·234	8·651	7·206
Nitrogenous substances,	2·327	0·846	1·561	0·620	0·890
Cellulose, . . .	1·332	0·945	1·286	1·023	1·251
Pectine, Organic Acids, Fat, &c., .	1·232	1·329*	1·035*	0·947	0·905
Ash, ...	1·170	0·953	1·361	1·343	0·937
	100·000	100·000	100·000	100·000	100·000

Name of Substance.	No. 11. Royal Dublin Society. Weight of bulb, 3 lbs. 7½ ozs.	No. 12. Ditto. Weight of bulb, 2 lbs. 1½ oz.	No. 13. Prof. Murphy. Weight of bulb, 2 lbs. 2 ozs.	No. 14. Ditto. Weight of bulb, 2 lbs. 15½ ozs.	No. 15. Ditto. Weight of bulb, 2 lbs. 13 ozs.
Water, . . .	86·614	89·304	87·923	88·387	87·227
Sugar, . . .	8·210	7·294	8·531	7·337	7·458
Nitrogenous substances,	1·024	0·601	0·820	1·226	2·251
Cellulose, . . .	1·493	0·805	1·199	1·142	0·889
Pectine, Organic Acids, Fat, &c., . .	1·258	0·658	0·649	0·991	1·347
Ash, ...	1·401	1·338	0·878	0·917	0·838
	100·000	100·000	100·000	100·000	100·000

Name of Substance.	No. 16. Prof. Murphy. Weight of bulb, 2 lbs. 1 oz.	No. 34. Mr. M'Nab. Weight of bulb, 3 lbs. 3¾ ozs.	No. 37. Messrs. Jennings. Weight of bulb, 6 lbs. 2½ ozs.	No. 38.† Ditto. Weight of bulb, 6 lbs. 5½ ozs.	No. 45. Mr. Demsdale. Weight of bulb, 4 lbs. 9½ ozs.
Water, . . .	88·152	87·950	88·549	89·255	87·537
Sugar, . . .	8·421	7·451	7·357	6·101	7·645
Nitrogenous substances,	0·620	1·472	1·437	0·921	0·720
Cellulose, . . .	1·238	0·942	0·936	2·137	1·320
Pectine, Organic Acids, Fat, &c., .	0·558	0·859	0·725	0·705	1·573
Ash, ...	1·011	1·326	0·996	0·881	1·205
	100·000	100·000	100·000	100·000	100·000

Name of Substance.	No. 46. Mr. Copland. Weight of bulb, 3 lbs. 1 oz.	No. 41. Mr. Carroll. Weight of bulb, 2 lbs. 0½ oz.	No. 42. Ditto. Weight of bulb, 1 lb. 5¼ ozs.	No. 43. Ditto. Weight of bulb, 4 lbs. 8¾ ozs.	No. 48. Mr. Forster. Weight of bulb, 2 lbs. 2¼ ozs.
Water, . . .	87·458	84·882	86·093	87·593	86·387
Sugar, . . .	8·644	9·098	9·438	7·896	7·523
Nitrogenous substances,	0·927	2·430	0·820	1·611	2·240
Cellulose, . . .	0·765	0·959	1·382	0·897	1·419
Pectine, Organic Acids, Fat, &c., . .	0·945	1·242	1·112	0·952	1·195
Ash, ...	1·261	1·389	1·155	1·051	1·236
	100·000	100·000	100·000	100·000	100·000

* Partly nitric acid, in combination with potash. † Beet about to flower.

Name of Substance.	No. 47. Mr. Newton. Weight of bulb, 1 lb. 12½ ozs.	No. 50. Mr. Demsdale. Weight of bulb, 3 lbs. 8¾ ozs.	No. 51. Mr. N. Niven. Weight of bulb, 5 lbs. 13¾ ozs.	No. 82. Lord Talbot de Malahide. Weight of bulb, 6 lbs. 2 ozs.	No. 2. Mr. W. Sinclair. Weight of bulb. 1 lb. 12¼ ozs.
Water,	81·302	88·773	88·119	87·254	83·726
Sugar,	12·858	5·942	7·209	8·559	10·747
Nitrogenous substances,	2·863	0·950	1·840	0·982	2·257
Cellulose,	0·888	1·164	0·904	1·113	1·205
Pectine, Organic Acids, Fat, &c.,	1·391	1·885	0·872	0·654	1·089
Ash,	0·698	1·286	1·056	1·438	0·976
	100·000	100·000	100·000	100·000	100·000
	No. 84. Messrs. Dickson. Weight of bulb, 8 lbs. 0¾ oz.	No. 86. Ditto. Weight of bulb, 3 lbs. 9¼ ozs.	No. 88. Mr. M'Crea. Weight of bulb, 3 lbs. 6½ ozs.	No. 90. Mr. Dargan. Weight of bulb, 6 lbs. 11½ ozs.	No. 92. Mr W. Sinclair. Weight of bulb, 2 lbs. 0¾ oz.
Water,	93·054	88·610	85·186	89·026	84·138
Sugar,	3·127	5·626	10·480	7·453	7·483
Nitrogenous substances,	1·047	2·062	1·320	0·941	3·002
Cellulose,	0·827	1·153	1·194	0·897	1·188
Pectine, Organic Acids, Fat, &c.,	0·735	0·959	0·746	0·692	1·097
Ash,	1·210	1·590	1·074	0·991	1·092
	100·000	100·000	100·000	100·000	100·000
	No. 94. Mr. J. Sinclair, jun. Weight of bulb, 1 lb. 14¾ ozs.	No. 100. Rev. W. R. Townsend. Weight of bulb, 4 lbs. 4 ozs.	No. 103. Mr. Hackett. Weight of bulb, 4 lbs. 15½ ozs.	No. 105. Mr. Newton. Weight of bulb, 4 lbs. 2¼ ozs.	No. 123. Beet from near Antwerp, in Belgium. Weight of bulb, 5 lbs. 7½ ozs.
Water,	80·623	85·981	88·704	87·634	90·980
Sugar,	13·185	8·845	7·309	8·702	5·687
Nitrogenous substances,	2·970	1·840	1·111	1·127	0·871
Cellulose,	1·326	0·936	0·951	0·820	0·950
Pectine, Organic Acids, Fat, &c.,	0·960	1·088	0·763	0·967	0·723
Ash,	0·936	1·310	1·162	0·750	0·789
	100·000	100·000	100·000	100·000	100·000

The influence of manures upon the quantity of nitrogen is strikingly exhibited in these tables. Farm-yard manure and guano appear, as a general rule, to increase the quantity of albuminous substances. This is especially remarkable in beet grown upon loamy soils, but is not so apparent in those grown upon heavy clays, as Lord Talbot de Malahide's, Mr. Dargan's, and Mr. Hackett's, the effect of the manures being masked by the influence of the soil. The beet grown upon clay soils grows to a large size, and is, as we have remarked already, more watery than that grown upon rich loams; the effect of this is to lower the per centage of nitrogen and sugar in the raw beet, but the per centage in the dried is to a great degree uninfluenced by these causes, and accordingly we find, that in such cases also, the effect of heavy manuring with farm-yard manure and guano is to increase the per centage of nitrogen. Sulphate of ammonia appears to have the same effect, judging from No. 6, grown in the Botanic Garden, at Glasnevin; nitrates, on the contrary, do not appear to affect the per centage of the organic nitrogenous constituents, but are rapidly absorbed by the plant, and will be found in the juice along with the sugar. We have got nitrates in the juice of all the plants manured with nitrate of soda, before enumerated; and, in the case of No. 5, to the extent of 0·685 per cent. of nitrate of potash in the raw beet. Dumas* mentions the case of a factory near Douai, where beet which had been grown upon some land covered with old plaster, and which, as is generally known, contains nitrate of lime, yielded more nitrate of potash than sugar. Large quantities of nitrates are often produced in beet, even when the land has not been manured with nitrates. In one of the large roots grown by Messrs. Dickson, of Belturbet, we found 0·827 per cent. of nitrate of potash, and all the other roots grown on the same land were more or less impregnated with it.

Beet manured with saline manures appears in every case to contain less nitrogen than when manured with guano, or good, rich farm-yard manure. No. 15, grown by Professor Murphy, affords a good example of the influence of rich nitrogenous manures upon the per centage of nitrogen. The land generally was manured with street manure, which is usually poor in nitrogen, and on land so treated Nos. 13 and 14 were grown; but No. 15 was transplanted into ground prepared with guano and vitriolized bones, and the result has been that the quantity of nitrogen contained in the plants so treated has been fully doubled.

It would appear from No. 37, in the last table, that not only does the sugar diminish in beet about to flower, but that the nitrogen also slowly disappears during that period of growth.

The composition of the specimens of beet grown by Mr. Demsdale upon "red bog," and marked 45 and 50 in the last table, are curious, as they show that beet grown under such circumstances, or indeed in all land abounding in organic matter of a peaty character, appear to expend its energies in the production of cells containing an exceedingly dilute juice. The parenchyma of the cells of beet consists of cellulose which is coated, as it were, with lime salts of some of the forms of pectine; hence, there appears to be a certain relation between the amount of pectine and cellulose in the early stages of growth; but when the beet is about to flower, true woody encrusting matter alone increases. The proportion of pectine substances in the beet grown on the bog is unusually large, some turnips, and yellow globe mangel wurzel, grown on land reclaimed from cut away bog, is equally rich in pectine, but how far this is to be attributed to the nature of the soil, or to the abundance of lime derived from the underlying marl beds, it is difficult to say.

* Traité de Chimie., t. vi., p. 146.

The influence of manures upon the inorganic constituents of the beet is very decided. As a general rule, soluble saline manures increase the per centage of each, not only in the raw, but in relation to the other constituents of the solid matter. This is remarkably instanced in Nos. 9, 10, 11, and 12, Table I., which were manured with saline mixtures. Common salt has this property in a remarkable degree, as is shown by No. 12. Stiff clays heavily manured with fresh manure appear to give very high per centages, as, for example, the following numbers in Table I.

	Per centage of Ash in Dried Beet.	Per centage of Ash in Raw Beet.	
No. 34	11·005	1·326,	or about 17 per cent. of the entire sugar.
„ 35	9·510	1·135	17 „ „
„ 36	8·703	1·149	12 „ „
„ 52	11·289	1·438	16 „ „
„ 84	17·420	1·210	39 „ „
„ 86	13·960	1·590	27 „ „
„ 97	9·673	1·294	14 „ „
„ 100	9·349	1·310	14 „ „
„ 101	10·192	1·582	17 „ „

The whole of this ash is not soluble, and would not, of course, be found in the juice; yet a large quantity would, and hence a large amount of the sugar would be converted into molasses during the process of manufacture by the action of the salts composing the soluble ash, especially by the action of caustic potash and soda, which would be rendered caustic by the action of lime in the process of defecation. These free alkalies would also dissolve several of the nitrogenous substances.

Moderately well grown roots, produced on suitable loamy soils, would contain a much smaller per centage of ash in proportion to the sugar. Thus, the roots rich in sugar, marked 92, 93, 94, 95, and 96, in Table I., would give the following results :—

No. 92 contained a quantity of ash in the raw root equal to about 10 per cent. of the sugar.

„ 93 about 9 per cent.

„ 94 somewhat less than 7 per cent.

„ 95 about 7 per cent.

„ 96 less than 8 per cent.

These quantities are even too high, for if roots were carefully grown upon proper soils, and properly manured, but not immediately before sowing, the ash ought not to exceed 5 or 6 per cent. No. 47, although not grown under all these conditions, fresh manure having been employed, contained little more than 5 per cent. of the weight of the sugar, in ash.

There cannot be the slightest doubt that spring manuring is exceedingly injurious to the growth of healthy plants, either of beet or of any thing else, and as experience has shown on the continent, roots grown under such circumstances do not keep well. M. Blanquet, in the letter already quoted, states that roots grown under such circumstances, although they may yield sugar in abundance in the commencement of the season, are worked with difficulty after being kept for a short time. The observations which we have already made will account for this circumstance so clearly, that we think we are justified in saying, no good farmer ought to manure his land with fresh manure in spring, whether his object be to sell his roots for the manufacture of sugar, or employ them for the feeding of cattle.

COMPARISON BETWEEN THE WHITE SILESIAN BEET AND OTHER ROOT CROPS.

The value of a crop depends upon two circumstances, the quality of the produce grown and its quantity. The preceding part of this Report shows to what an extent the quality of beet may vary, and the researches of numbers of chemists have shown that other crops vary just as well. The following table* which contains the results of the analyses of several specimens of yellow globe, and long red mangel wurzel, &c., grown on the same land and in general manured in the same way as the specimens of white Silesian beet supplied by the same gentlemen, is very suggestive. An examination of that table shows that those crops which give very large returns in weight give in general but poor returns in quality, a fact which is still more forcibly shown by Table I. To take an example—Mr. M'Crea obtained 18 tons of white Silesian beet per statute acre, and the Messrs. Dickson and Co., 46 tons. The average solid matter contained in the beet grown by the former, was 15·442, and in that grown by the latter, 9·047. Eighteen tons of Mr. M'Crea's beet contained 2·779 tons of solid matter, and 46 tons of the Messrs. Dickson's, 4·16 tons; but the gross crop of the latter was little more than $2\frac{1}{2}$ times that of the former, and yet the real available crop was very little more than $\frac{1}{4}$ less, or to render it more intelligible:

The gross weight of Mr. M'Crea's crop, formed but 39 per cent. of the Messrs. Dickson.

And the real solid matter formed 66 per cent.

A calculation made upon such a basis must, of course, be only considered as an approximation, especially as the cases are extreme. To render it absolutely correct, we should compare the constituents each with one another. It will, however, serve to show that judging root crops by their mere weight, or giving prizes for the largest roots, is very fallacious.

Applying these observations to the question—"Whether is it better for the farmer to grow crops which give large returns, such as long red mangels, &c. or to grow crops like white Silesian beet, which although in general gives a smaller gross produce, yield roots of superior quality?" we think we are justified in concluding that those who assume that because in some instances long red mangels have yielded a gross produce per acre, exceeding that of

* See pp. 86, 87, Table VI.

the white Silesian beet by 25 per cent., which is about the extreme limits, it must necessarily be the better crop of the two, do so without sufficient data. In several cases which came under our observation, the balance was decidedly in favour of the sugar beet, and we are rather inclined to think that a thorough examination of the subject would, in general, show that good farming does not consist in producing immense roots, consisting of cells filled with water, but the largest quantity of solid food. This point is very well worthy of the attention of farmers, to whom we would recommend the experiment of very close sowing and early harvesting of root crops, by which it is probable they would obtain larger acreable returns of solid matter than they do by the present system.

General Conclusions deducible from the preceding Observations.

We shall give here a summary of the principal conclusions which we think we are justified in drawing from the preceding observations, whether founded upon the experiments of continental chemists, or those made by ourselves. Whether more extended, or better conducted experiments will confirm them all or not remains to be seen. We shall consider, however, that we have fully performed our duties, if our results will have the effect of removing some of the difficulties which stand in the way of the successful introduction into Ireland of a manufacture, which, if conducted with the same prudence, skill, and perseverance as in France, Belgium, and Germany, should prove a source of individual profit, and exercise a most beneficial influence upon Ireland, by increasing the sources of employment, and promoting the improvement of general agriculture.

Properties of Good Roots.

1. They must have a symmetrical form, and as few forkings as possible, in order that they may be readily cleaned, and that as little loss as possible be sustained from too great a development of epidermal tissue.

2. They must not be too large, not exceeding four or five pounds at the utmost, as large roots are too spongy, and contain but very little sugar.

3. They must have a solid, hard flesh, with a large development of cylindroidal cellular tissue, must break short and with a cracking sound, and must rapidly sink in water.

4. The crown and heart must be as small as possible, in order that there may be as small a loss as possible from the removal of those parts which contain little sugar, but abound in salts, and because the smaller the cut surface of the beet is, the less liable it is to suffer decomposition from the action of the air.

5. The roots must have grown as little as possible out of the earth, and must not therefore exhibit a green segment about the crown, as all parts of the beet which grow out of the soil, contain scarcely any sugar, having the

composition of the crown and leaves. Care should therefore be taken in hoeing them, to keep the tops of the bulb covered with earth, close around the leaf-stalks.

6. The juice must be concentrated, and must have a sweet taste, free from any accompanying acrid or cooling saline taste.

7. They ought to yield a juice, which, when heated and precipitated with chloride of calcium, ought to yield scarcely any precipitate with lime water, and the precipitate with the chloride of calcium ought to be very small.

8. A fresh section of the beet ought not to exhibit a rapid blackening of the whole surface, which should be confined to the rings of vascular tissue.

9. The roots must exhibit as uniform a colour as possible, and above all, must not show any streaks of pale rose red, as they then exhibit a remarkable tendency to throw out flower stalks, and to otherwise deteriorate. The only remedy for this defect, as well as for the tendency to produce bunches of fine roots like tassels, and to fork, where it does not arise from fresh dung or from stones in the soil, is a change of seed.

10. The roots should not be allowed to remain too long in the ground, or exhibit the slightest tendency to throw out their flower stalks, or to have the least symptoms of decay.

Properties of Soil suited for the Beet.

11. The soil should be a rich loam, inclining rather to clayey than to sandy, but should not partake in the slightest degree of a peaty character—that is, the organic matter should be fully decomposed and thoroughly well distributed through it.

12. It should be exceedingly well cultivated, and free from all clumps of hard clay, or from stones.

13. The subsoil should neither be a stiff cold clay, or an open stoney gravel.

14. The soil should be deep, and drained as thoroughly as possible.

15. Newly reclaimed land is unfitted for the cultivation of beet for the manufacture of sugar.

16. No labour should be spared upon the pulverizing of the soil, not only before the sowing of the seed, but during every period of the growth of the plant.

Manures suited for the Beet and mode of applying them.

17. Rich nitrogenous manures, such as farm-yard manure, guano, &c., should never be applied to land intended for the cultivation of beet, immediately before sowing, but should either be applied with the previous crop, or applied during the preceding autumn, or at least should be put on as a winter compost. This rule applies equally well to all crops.

18. Soluble saline manures should be applied very sparingly, and never during the growth of the plant.

19. Salt should never be applied except with the greatest care, or any substance containing nitrates, or capable of forming them.

20. Ashes, such as those of wood, peat, coal, &c., may be employed, and bone earth in any form apparently without any injury.

21. Lime is always good, and calcareous soils seem to be the best adapted for the growth of all the varieties of the beet, and of most of the other root crops.

22. Green manuring has always been attended with success, and crops of rape or of other plants having the general composition of the beet may be grown upon land heavily manured in the autumn, with fresh farm-yard manure, and then ploughed in early in spring.

23. That the whole of the sugar in the Irish beet is crystallizable cane sugar.

24. That the per centage of sugar in Irish grown roots is not inferior to that of continental roots grown under the same circumstances.

Appendix C.

Considerations of the Probable Cost of Cultivation of the Sugar Beet in Ireland.

Although the consideration of the economical questions involved in the manufacture of beet sugar do not, properly speaking, come within the province of a purely scientific report, nevertheless we shall bring together here the results of a few inquiries made to ascertain the acreable produce of the beet crops of 1851, and the cost of growing them. We have put the results of these inquiries, relative to the produce, in the following tabular form:—*

An examination of this table will show that it is very imperfect; indeed, we found it nearly impossible to get the whole of our queries answered by any one person, not from any feeling of unwillingness on their parts. The defects must be attributed, we regret to say, to the want of accurate statistics being kept by farmers, a neglect which, if permitted in ordinary manufactures or mercantile transactions, would involve inevitable ruin. This neglect of reducing agriculture to the ordinary rules of other manufactures, is very strikingly illustrated in the very loose statements which we have sometimes received of the cost of cultivating an acre of beet. Now, we are of opinion, that it would be very difficult for a farmer to decide what he could sell his crop for, unless he knew what it had cost him to grow it. Yet such is the case, we firmly believe, with fully 90 per cent. of the farmers in Ireland. This state of things is, to some extent, perpetuated by a kind of feeling, that agriculture is not a manufacture. It is, however, time that, at a period when,

* See pp. 86–89.

owing to rapid improvement and eager competition, every manufacture depends for its success upon accurate calculations, agriculture should leave the old beaten track of routine, and subject itself to those numerical laws which govern every other branch of industry.

The gross produce per acre, shown by these returns, is very satisfactory, and proves, beyond a doubt, if such could exist, the admirable adaption of this country for the growth of all green crops. We could have given many more returns of the amount of produce, but preferred confining ourselves to those cases where we examined the soils and beet.

The estimates furnished to us did not, of course, include the cost of cartage to the factory, and as our object in ascertaining the cost of cultivating beet had reference solely to its employment as a source of sugar; it will be necessary, therefore, to take this item into account. We have, in general, filled up any omissions which we conceived necessary in several of the estimates, and have, in the following pages, printed these additions in italics.

Professor Murphy has furnished the following estimate of the crop of beet, the particulars of which are given at No. 16, Table VII.

Cost of Cultivating One Statute Acre of Beet.

	£	s.	d.
Ploughing wheat stubble in autumn,	0	8	0
Two grubbings in spring, and harrowing,	0	4	0
Forming drills,	0	2	0
25 tons of mixed street manure and stable manure, at 2*s.* per ton,	2	10	0
Carting and spreading same,	0	7	6
Closing drills,	0	2	0
Seed, 4 lbs., at 1*s.* per lb.,	0	4	0
Sowing,	0	2	6
After culture, viz.: singling, hand and horse hoeing, &c.,	0	12	0
Harvesting, viz.: raising, divesting of leaves and earth, drawing to yard, and clamping,	0	12	0
	£5	4	0
Deduct value of 3 *tons of tops, at* 3*s.* 4*d. per ton,*	0	10	0
	£4	14	0

	£	s.	d.		£	s.	d.
Add rent,	1	14	0				
„ poor rate,	0	2	0		2	2	0
„ county cess,	0	6	0				
				Total cost,	£6	16	0

or at 16 tons of roots to the acre, the cost of growing one ton of roots was eight shillings and sixpence.

COST OF GROWING ONE CUNNINGHAM ACRE OF BEET.

The following estimate was supplied by William Sinclair, Esq., of Strabane, and refers to the crop, the particulars of which are given at No. 2, in Table VII.

	£	s.	d.
Three ploughings,	0	18	0
Three harrowings,	0	9	0
Weeding,	0	6	0
Hoeing,	0	4	0
Digging nine inches deep between drills after weeding,	0	8	0
Seed,	0	5	0
Manure, 50 loads, say at 2s. per load,	5	0	0
Carting and spreading do.,	0	15	0
Harvesting,	1	0	0
	£9	5	0
Deduct value, say of 6 *tons of leaves, at* 3*s.* 4*d. per ton,*	1	0	0
	£8	5	0
Add rent and taxes, say,	2	0	0
Total cost,	£10	5	0

which, at 28 tons of roots to the acre, would be equal to seven shillings and threepence three farthings per ton of beet. We have not reduced the Cunningham acre to the statute, as our object was to ascertain the cost per ton, an object which could be attained equally well by the use of either measure. It would be very desirable, however, if farmers would generally calculate by the statute acre, as great confusion would thereby be avoided.

The following estimate was supplied by William Dargan, Esq.:—

COST OF CULTIVATING ONE STATUTE ACRE OF BEET.

	£	s.	d.
Two ploughings,	0	11	0
Two harrowings,	0	4	0
Sowing and manuring,	0	18	0
Twenty loads of manure (farm-yard),	2	0	0
Four cwts. of guano,	2	1	0
Hoeing, weeding, and pulling,	1	12	0
Seed,	0	4	0
	£7	0	0
Deduct value of 13 *tons of leaves, at* 3*s.* 4*d. per ton,*	2	3	4
	£4	16	8
Add rent and taxes, say,	2	0	0
	£6	16	0

or at 26 tons of roots to the acre, the cost per ton was five shillings and two-pence three farthings.

D

The following is the estimate of the Right Hon. Lord Talbot de Malahide, for the cost of cultivation of the crop, the particulars of which are given at No 5, Table VII.

Cost of Cultivating One Statute Acre of Beet.

	£	s.	d.
Three ploughings,	1	8	0
Four harrowings,	0	13	6
Four rollings,	0	6	0
Opening and closing drills,	0	15	0
Carting manure,	1	0	6
Sowing seed,	0	1	6
Hoeing, weeding, and seed,	0	10	0
Forty-five tons of stable-yard manure, at 2*s.* 6*d.* per ton,	5	12	6
Pulling, carting home, and clamping, at 9d. per ton,	1	14	8
	£12	1	8
Deduct value of leaves—12 tons, at 3s. 4d. per ton,	2	0	0
	£10	1	8
Add rent, taxes, &c.,	3	4	0
	£13	5	8

The produce being from 48 to 52 tons per acre, this would make, taking the lowest estimate, the cost of one ton five shillings and sixpence farthing.

The cost of cultivation in England is much about the same. We are indebted to Richard Noverre Bacon, Esq., of Norwich, the author of the well-known able report upon the agriculture of Norfolk, for the two following estimates. Our object in procuring such estimates was to show, by comparing the cost of cultivation in those parts of England where the rent and charges on land are certainly as high, if not higher, than in most parts of Ireland, and where the workmen are paid enough to live upon, and, finally, where an excellent system of agriculture is pursued, that many of the statements put forward from time to time about the impossibility of growing beet at a profit in this country, to be unfounded, and the estimates of cost of cultivation greatly exaggerated.

First Estimate of the Cost of Cultivating One Acre of Beet in Norfolk.

	£	s.	d.
Four ploughings, at 5*s.*,	1	0	0
Six harrowings, at 1*s.*,	0	6	0
Three rollings, at 6*d.*,	0	1	6
Balking the muck, at 2*s.* 6*d.*,	0	2	6
Back balking the muck,	0	2	6
Carting mould from bottom,	0	1	6
Carting long muck into the bottom, filling, and throwing off,	0	4	0

	£	s.	d.
Turning over muck heaps, ...	0	1	6
Filling, carting, and spreading muck, ...	0	6	0
Twelve loads of short muck, at 4*s.* per load, . .	2	8	0
Drilling, 1*s.*, seed, 4*s.*, ...	0	5	0
Hand-hoeing, picking, horse-hoeing, &c., from 8*s.* to 15*s.*, say 12*s.*, ...	0	12	0
	£5	10	6

To which should be added, the rent, taxes, and the cost of harvesting, &c., less the value of the leaves, items which depend upon the locality and the amount of produce.

Second Estimate of the Cost of Cultivating One Acre of Beet in Norfolk.

	£	s.	d.
Three ploughings, at 6*s.*, ...	0	18	0
Two scarifyings, at 2*s.*, ...	0	4	0
Twelve harrowings, at 6*d.*, ...	0	6	0
Ridging up and closing, to cover manure, . . .	0	7	0
Twelve tons of farm-yard manure, and labour, . .	3	0	0
Rolling, planting, and seed, ...	0	7	0
Guano, or other artificial manure, ...	1	0	0
Hoeing and singling, ...	0	10	0
Cutting off tops and taking up, ...	0	6	6
Loading, carting and storing, ...	0	8	0
Waste of straw to cover, and covering up, . . .	0	3	0
	£7	9	6
Add rent, tithes, and taxes, ...	1	12	0
	£9	1	6

From which must be deducted the value of the leaves, depending upon the amount of crop.

Being anxious to ascertain the system adopted in Suffolk, and the cost of cultivation in that county, we applied to Mr. William Raynbird, one of the authors of the prize essays upon the agriculture of Suffolk, and one whose opinion upon any matter connected with green crop cultivation or general agriculture, is of the highest value; and he referred in the kindest manner to the essays of his brothers upon the cultivation of the mangel wurzel. According to Mr. Hugh Raynbird, the cost of cultivating one acre of beet, including rent and taxes, and deducting value of leaves, is £9. According to Mr. George Edmund Raynbird, the cost of growing one acre of beet, including rent, and deducting value of leaves, is £8 3*s.* 1*d.* We do not give the particulars of these estimates, as they have been already published, and must be well known.

A great error is sometimes committed in estimating the cost at which a farmer could deliver roots at a sugar factory, by simply forgetting that there is a wide difference between delivering a number of tons at a given time at one place, and being thus able to keep the horses fully employed, and sending a few tons of roots to market, where an entire day of a horse and a man is lost in effecting a sale. A factory, unless under peculiar circumstances, would rarely obtain its supply of beet from a greater distance than five miles, and very rarely from a greater distance than two and a half miles. Now one ton could be carted five miles for 2*s.* 6*d.* on an average in every part of Great Britain and Ireland, and in many places for much below that sum. That this opinion is not merely hazarded, we give the following statements received in answer to queries upon the subject:—

According to Robert M'Crea, Esq., Strabane, the cost of carting one ton is about five pence per mile, or rather five miles Irish for two shillings.

Lord Talbot De Malahide, County of Dublin, sixpence per ton per mile.

Thomas Demsdale, Esq., Kildare, sixpence per ton per mile.

A. M'Nab, Rostellan, Cork, sevenpence per ton per mile, or rather five miles for three shillings.

Rev. W. R. Townsend, County of Cork, sixpence per ton per mile, or rather fifteen cwts. carted eight miles for three shillings.

Professor Murphy, City of Cork, eightpence per ton per mile, or rather two shillings per ton per three miles.

—— Newton, Esq., Wilton, County of Wexford, sixpence per ton per mile.

John Newton, Esq., Mount Leinster, Carlow, eightpence per ton per mile.

In Norfolk, according to Richard Noverre Bacon, Esq., the rate is sixpence per ton per mile.

William Raynbird, Esq., judging from his experience of Suffolk and other English counties, considers that sixpence per ton per mile would remunerate the farmer.

Assuming, however, that it costs on an average 2*s.* 6*d.* per ton to deliver one ton of roots at a sugar factory, we find, for instance, that it would cost to lay down at a sugar factory one ton of beet, of the crop of 1851, to—

	s.	*d.*
Professor Murphy, ...	11	0
William Sinclair, Esq., . . .	9	$9\frac{3}{4}$
William Dargan, Esq., . . .	7	$8\frac{3}{4}$
Lord Talbot de Malahide, . . .	8	$0\frac{1}{4}$

These four estimates afford examples of a large return and expensive cultivation, and of unusually small returns and fair average cultivation, and we think that, without wishing to give an opinion as to what ought be the value of one ton of roots, we are confident that, with good average cultivation, beet could be produced in Ireland for the manufacture of sugar at a very fair profit to the farmer.

In the foregoing estimates we have assumed the value of a ton of beet leaves at 3*s.* 4*d.*, and as in the case of a large crop, the total value of the leaves would form an item of considerable importance, in some cases equal to the sum of rent and taxes. In so difficult a question as the determination of the money value of a crop, we do not pretend to have arrived at a definite answer; all we can do is to state our opinion and the data upon which it is founded.

The value assumed for the beet leaves is founded, firstly, upon the opinion of agriculturists, and secondly, upon their chemical composition. According to Mr. Hugh Raynbird,* the value of the leaves of a crop of beet of 20 tons to the statute acre, when fed off on the land or ploughed in green, may be taken at £1. Mr. George Edmund Raynbird† considers that the tops of a crop of $7\frac{1}{4}$ acres of mangel wurzel, yielding 26 tons to the statute acre, would be fed off by 200 sheep in 15 days, which, at 4*d.* per week each, would give 19*s.* $8\frac{1}{2}$*d.* per acre. The weight of the tops is very variable in all green crops, and especially in the sugar beet, as will be seen by reference to Table VII. appended to this Report; but taking the statement of the Rev. Mr. Huxtable, as given in the very admirable Report of Mr. Way, on the ashes of plants,‡ we find in the first instance, that a crop of 24 tons per statute acre yielded 5 tons of tops, which, if valued at the rate of 3*s.* 4*d.* per ton, would be 16*s.* 8*d.*; another crop of mangels of 22 tons to the acre, yielded about 6 tons, which at 3*s.* 4*d.* per ton, would be £1. Now, as there is very little difference between the tops of the sugar beet and those of the other varieties of the beet, such as the mangel wurzel, and any difference which does occur is in favour of the former, which are usually richer in potash, phosphoric acid, sugar, and nitrogen, the value which we have assigned to beet leaves is practically below that assumed by eminent English agriculturists. Irish agriculturists, who have directed their attention to the subject, also consider beet leaves more valuable for feeding or manure than we have considered them in the preceding estimates. In a letter addressed by Mr. Kelly, steward of Mrs. Evans, of Portrane, near Dublin, to the Committee of Agriculture of the Royal Dublin Society§ and written with the evident object of proving that it would be impossible to grow beet in Ireland with a profit to the farmer, it is assumed that the tops of the white and red carrots, white Silesian beet, yellow globe mangels, red globe mangels, and long red mangels, are worth, for feeding purposes, 4*s.* per ton. Mr. Kelly states that he obtained 36 tons, $5\frac{3}{4}$ cwts. of white Silesian beet, and 25 tons $1\frac{1}{2}$ cwts. of tops, the value of which he puts down at £5 0*s.* 6*d.*, but which in our estimates would be considered at about £4 8*s.* 6*d.*

* "Journal of Agriculture and Transactions of the Highland and Agricultural Society," March, 1851.

† Prize Essay, "Journal of the Royal Agricultural Society of England," vol. viii., part 1.

‡ "Journal of the Royal Agricultural Society," vol. viii., pp. 158, 159.

§ Dublin *Freeman's Journal*, Nov. 13, 1851.

We shall now endeavour to show that the chemical composition of beet leaves will prove in the clearest manner that we have not over estimated their value.

The composition of the leaves of plants like the beet is quite as variable as that of the bulb ; the following numbers must therefore be considered as only an approximation to the mean value. The specimen of beet leaves examined was grown by Thomas Demsdale, Esq., on bog land, being, in fact, the entire top of No. 50 specimen of white Silesian beet in Table I., and pulled November 2nd. The plant was perfectly fresh when examined, and the foliage remarkably luxuriant. The entire top was cut off close to the crown, accurately weighed, and dried upon fine muslin, stretched upon a frame at a temperature of about 120° to 130° Fahr. When dried it was of a beautiful green colour, and was then reduced to a coarse powder and further dried at 212°. It contained in 100 parts—

Water, ...	90·155
Solid Matter, . .	9 845
	100·060

The dried residue gave in 100 parts—

Nitrogen, . . .	2·645=16·896 of vegetable albumen.*
Ash, . . .	18·699
Sugar, . . .	12·625

This would give in the raw leaves—

Water, . . .	90·155
Albumen, . . .	1·663=0·260 of nitrogen.
Sugar, . . .	1·243
Woody fibre, organic acids, nitric acid, &c.	5·138
Ash, . . .	1·841
	100·000

Peligot† has examined a specimen of beet leaves with the following results :—

Woody fibre, &c., ...	3·6	6·4
Nitrate of potash, . . .	1·5	
Sugar and albumen, . . .	1·3	
Water, ...		93·6
		100·00

* Calculated upon the supposition that vegetable albumen contains 15·66 per cent. of nitrogen.—(Dumas.)

† Recherches sur l' analyse et la composition chimiques de la Betterave à sucre, page 19.

He remarks, however, that the beet grown in the locality from whence he obtained the leaves, always contain from 1 to 1·5 per cent. of nitrate of potash, and as this salt may be considered to replace to some extent the nitrogen existing as albumen, we shall find that the sum of the sugar and nitrate of potash in Peligot's analysis, which is 2·8., does not differ very much from the sum of the albumen and sugar in ours, which is 2·906. We may also remark that when nitrate of potash is absorbed, the plant will be found to be more watery than otherwise, as may be seen by referring to the analysis given in Table I. where the occurrence of this salt has been noticed. The most remarkable point connected with the leaves examined by us, is that they contained more nitrogenous elements than the bulb. (See pp. 39–41 of the Report.)

0·260 per cent. of nitrogen is equivalent to 0·316 of ammonia, so that one ton of the leaves examined by us contained nitrogen enough to yield about 7 lbs. of ammonia. The analyses of beet leaves are not however sufficiently numerous to enable us to say how far our results would differ from a mean; there can, however, be no doubt that they usually contain at least enough of nitrogenous substances to yield 5 lbs. of ammonia, that is about 1 per cent. We are the more convinced of this when we recollect that the amount of these substances found by the method of proximate analysis in use a few years ago, was not generally more than one quarter of that now found by the direct determination of the nitrogen. The observation made at page 18 of this Report with reference to the mode adopted by M. Peligot, for determining the amount of albumen, applies equally well to his analysis of beet leaves.

We have not had an opportunity of making an analysis of the ash of beet leaves, but as the composition of the same variety of beet grown under different circumstances varies quite as much as the different varieties do when compared with one another, for our present purpose we may take the mean of the analyses of the leaves of the other varieties, which have been published.

Mr. Way* has published analyses of the yellow globe beet and of the long red mangel wurzel, and if we combine the mean of his three analyses with our own determination of nitrogen, and estimate the value of the principal constituents at the prices at which they could be obtained in their usual form in commerce, we shall obtain the following results:—

One ton of leaves would contain—

	lbs.			£	s.	d.
Ammonia,	7	which at 6*d*. per lb.	would be equal to	0	3	6
Phosphoric acid,	1·94	at 1½*d*. per lb.	„	0	0	3
Sulphuric „	2·20	at 0¾*d*. „	„	0	0	1½
Potash,	7·86	at 2*d*. „	„	0	1	3½
Soda,	2·52	at 1*d*. „	„	0	0	2½
				£0	5	4½

* In the Report already quoted.

The two most valuable elements are unquestionably the ammonia and potash, and they are also the most variable, but there is margin enough between 3*s.* 4*d.* and 5*s.* 4½*d.* to compensate for any variation which may take place in these elements; and we may also add, that although we have not included the other constituents, they are not without value, and, in fact, would go very far to compensate for the variations which would occur in the other elements.

Comparing the composition of the leaves of the beet therefore with that of other substances used as food for animals, and joining with it the opinions of practical men, we think we are justified in considering them fully worth 3*s.* 4*d.* per ton for feeding purposes, and that as green manure there cannot be the slightest doubt they are also worth that sum.

Appendix D.

Special Report of the Results of some Practical Experiments to determine the Amount of Sugar capable of being manufactured from Irish-grown Beet. Conducted by William K. Sullivan, Chemist to the Museum of Irish Industry.

The absolute quantity of sugar contained in a specimen of beet, as determined by chemical analysis, does not afford sufficient data to determine whether sugar could be profitably made from it; because, if it happened to have been grown upon heavily manured land, or upon freshly reclaimed salt marshes, although containing abundance of sugar, it would yield an impure juice, from which it would be impossible to manufacture sugar. But even without assuming such an extreme case, the amount of sugar which the manufacturer can extract from a given quantity of beet is by no means in direct proportion to the absolute quantity which it contains, being influenced by all those causes which have been noticed in the preceding Report. Of two specimens of beet, yielding to the chemist exactly the same per centage of pure crystallizable sugar, one might give to the manufacturer a highly-coloured juice difficult to work, and affording but a small return of marketable sugar, and probably of inferior quality, whilst the other might yield so pure a juice as to render the extraction of the whole of the sugar comparatively easy. It was therefore considered of considerable importance to make a few experiments on a scale sufficiently large to test this point, without, of course, attempting to ascertain the cost of extraction. On the continent the usual per centage of marketable raw sugar, now obtained, varies from 6½ to 7½, and sometimes even 8 is obtained, being fully double what was obtained twenty-five years ago. This extraordinary improvement is partially owing to improved processes of extraction and improved machinery, but probably in an equal degree to the progress made in the cultivation of the roots, which is now so well understood, that not only is beet grown containing a much larger per centage of sugar than formerly, but yielding an exceedingly pure juice, from which the greater part of the sugar can be obtained in a crystallizable form, and with the formation of very little molasses. The beet grown in Ireland, in 1851, was produced under the most various circumstances of soil, aspect, manure, &c., and it is unnecessary to remark, that its cultivation was by no means well understood, especially in reference to the production of roots adapted for the purposes of the sugar manufacturer. It was also grown on land which had been freshly manured immediately before the sowing of the seed, a course never adopted on the continent, and abounded therefore in soluble nitrogenous constituents. It is, therefore, needless to remark, that the conditions under which the experiments were made were very unfavourable. And, if to these it be added, that the season of the year at which they were made was one at which vegetation begins to commence, and a series of changes to occur in most roots, which produces not only a diminution in the quantity of sugar, but which gives rise to the production of bodies which affect the crystallizing power of the sugar. From the facts developed in the preceding Report, as well as from the experience of the continental manufacturers, these changes are more liable to occur in roots grown under the circumstances under which all the Irish beet was grown, than in those grown for the express purpose of being employed in the manufacture of sugar, by persons thoroughly acquainted with the proper mode of cultivation.

I have considered it necessary to make these few preliminary remarks in order that the real importance of the following experiments may be understood; as it would, undoubtedly, be unjust to look upon results as a mean, which, when obtained at a corresponding season on the continent, would be considered rather as a minimum.

The machinery and apparatus employed consisted of—

1. A *rasp*, fed by hand, and having a drum, 12 inches in diameter and 12 inches in length, and provided with 85 saws. When making about 800 revolutions per minute, it was capable of rasping up about 5 tons of roots in 12 hours.
2. A *hydraulic press*, with a four-inch barrel, and having a pressing surface of $55\frac{1}{2}$ square inches. This press not being calculated for more than 60 lbs. of pulp, after some trials an additional lever press, presenting from 180 to 200 square inches of pressing surface, was added. With this press 2 cwts. of pulp could be pressed at each operation. In both cases knitted woollen yarn bags were employed for holding the pulp, the bags being separated from each other by plates of thin sheet-iron.

3. The defecation was effected in two pans, one with a double hemispherical bottom, and capable of holding $4\frac{1}{2}$ cwts. of juice, and the other, a simple-tinned copper pan, heated by a simple $\frac{3}{4}$-inch bore serpentine, and capable of defecating $1\frac{1}{2}$ cwts. of juice.
4. The filters consisted of a series of 6 copper buckets, 15 inches high and 9 inches in diameter, and provided with perforated false bottoms. A small coil of steam pipe passed between the bottoms, so that the syrup in the second filtration could be kept hot.
5. The evaporation was effected in a shallow pan, 2 feet 4 inches in diameter, 12 inches deep in the centre, and 9 inches at the sides, and having a double bottom, heated by steam. Occasionally part of the filtered juice was evaporated in the boiling pan in order to save time.
6. The boiling was effected in a cylindrical pan, 22 inches in diameter and 18 inches deep, and provided with a coil of copper steam pipe, half an inch in diameter, arranged as in Hallette's pan, and capable of being worked with Crosley's "air-diffusing wheel," the air being supplied by a set of three small air pumps.
7. The crystallization was effected in the shallow evaporating pan. When the grain was fully formed, the whole mass was heated, and intimately mixed, and then transferred into ordinary wrought-iron cones of the size usually employed for double refined loaves. These were placed in a hot air chamber, and kept at a temperature varying from 75° to 80° Fahr. as long as the molasses drained off.
8. The motive power was a small high pressure engine, of about three horse power.

The defecation was effected in the ordinary way with milk of lime, the defecated juice was then passed through the charcoal filters, the filtered juice evaporated to 25° of Beaumé, again passed through the charcoal, and boiled to the crystallizing point. In the second experiment, however, the syrup at 25° was clarified with white of egg previous to being passed through the charcoal. The air-diffusing wheel was used in the boiling of the syrup until it had reached 36° or 37° of Beaumé, but not afterwards, as whether from inexperience or otherwise, I did not succeed with it. Its limited use is, however, attended with one great advantage—it completely deprives the sugar of the disagreeable flavour of the beet. Although I am inclined to think that the prolonged action of air, at a high temperature, must be prejudicial to syrup, and must tend to convert a part of the sugar into an uncrystallizable condition, I would not venture to give an opinion of its value further than as to its action upon the taste of the sugar, which is most decided, as I am not sufficiently experienced in the manufacture of sugar. It may be, however, remarked, that it is an established fact, that the juice, at every stage, should be alkaline, otherwise it becomes acid, and the sugar is rapidly transformed; if, therefore, we pass a strong current of air, which always contains a certain quantity of carbonic acid, through syrup which has been deprived of the greater part of its free lime by the animal charcoal, and which exhibits but a very slight alkaline reaction, the lime will be converted into carbonate, and the syrup become acid. This defect might, however, be remedied by maintaining the juice in an alkaline state, by the addition, from time to time, of small quantities of syrup highly charged with lime.

The raw sugar obtained was not weighed until it had become perfectly air dried, and consequently contained much less moisture than sugar of the same quality found in commerce; and in no case did it contain a quantity sufficient to effect the first decimal of the per centage result.

First Experiment.

The beet employed in the first experiment was grown by John Newton, Esq., of Mount Leinster, County of Carlow. The roots were of an uniform size, varying from 2 to 3 lbs. and were well grown, although apparently heavily manured immediately before sowing. They had few forkings, and the crown was not too much developed, although a large number belonged to the kind known as the *collet vert*. They were not, unfortunately, worked up immediately after their arrival in Dublin, having lain upon a flagged floor for about three weeks, during which time a considerable amount of vegetation took place, and a number of them had commenced to decay. Great care was taken to remove all that had much grown, or which exhibited the slightest tendency to rot; but there can be no doubt that the whole had undergone considerable alteration.

Twenty six cwts. of beet were rasped, giving eight separate defecations; the juice averaging from 7° to 7½° of Beaumé, before defecation, and about 4° after defecation.

From this quantity there was obtained 18 cwts. 1 qr. 15 lbs. of juice, and 7 cwts. 2 qrs. and 13 lbs. of pulp; or—

Juice, . . .	70·35 per cent.
Pulp, . . .	29·65 „

In consequence of the smallness of the operations, and especially of the inefficiency of the presses, the pulp was not remoistened; had such been done, 12 per cent. more of juice might have been obtained. In the beet sugar factories this is frequently done, although not universally, as it is considered by some to be more economical to endeavour to get as much juice as possible in the first pressing, and to sell the pulp, than to moisten it and repress it, by which its feeding qualities are considerably diminished, whilst the juice so obtained is much more impure than that obtained by the first pressure, containing more salts and soluble azotized bodies, as well as pectine, which observation has shown will rapidly dissolve when treated with water, although but comparatively little is found in the juice of the first pressing.

The result of the first boiling was :

	45 lbs. of sugar, and	
	122 lbs. of syrup.	
Total,	167 lbs. saccharine matter.	

This syrup was reboiled, but yielded no sugar, partially owing to its bad quality and partially owing to an error in the boiling, which appeared to have been pushed too far. The results of this experiment may therefore be stated as—

Sugar, ...	1·54	per cent.
Molasses, . . .	4·19	„
Total saccharine matter,	5·73	„

Various causes combined to produce this very unsatisfactory result: 1st, the change which the season had produced in the quality of the root ; 2nd, the alteration which they underwent from lying on a damp floor, exposed to the air for several weeks ; and 3rd, the accidents which occurred in working with new machinery for the first time, as well as the inexperience of all engaged in the operations.

From the smallness of the hydraulic press, sufficiency of juice could not be obtained in the commencement of the experiments, for a defecation in less than from four to five hours, during the whole of which time a portion of the juice exposed to the air was undergoing rapid change. The consequence of this alteration, as well as of that which had previously taken place in the roots, was, that an unusually large quantity of lime was obliged to be used in the defecation. That the first juice was considerably deteriorated was evident from the large quantity of free acid which it contained. Strong alcohol separated a considerable mass of foreign matter, especially of a substance resembling gum, and Trommer's test indicated the existence of sugar different from cane-sugar. These reactions were sensibly increased by the exposure of the juice to the air before defecation. A portion of the filtered juice treated just before that operation with chloride of calcium yielded a very large precipitate, notwithstanding the amount of oxidation and consequent precipitation of the peculiar azotized substance precipitable by that re-agent. The liquor filtered from this precipitate yielded a very considerable one with lime-water, showing the presence in considerable quantity of the peculiar nitrogenous substance which possesses the property of converting cane-sugar into mannite and lactic acid. On separating this precipitate, and adding basic acetate of lead, another precipitate was obtained, abounding in nitrogen. Although fresh beet juice from unaltered roots very frequently contains all these substances, especially when grown upon freshly-manured land, the quantities in the present case were so marked as to prove in the clearest manner the extent of the alteration.

A solution of pure cane-sugar, when boiled with alkalies, even for a few hours, undergoes very little alteration of colour, although a small quantity of uncrystallizable sugar is produced. Grape sugar, on the other hand, is decomposed under similar circumstances, and the solution rapidly browns. Lime, although it separates a considerable portion of the foreign matters in the process of defecation, when properly done, does not separate the whole; the purer the juice, however, the more effectual is its action. Thus, a specimen of the juice under consideration, having a density of 7° of Beaumé, yielded, after a very successful defecation, a precipitate with basic acetate of lead amounting to 1·320 per cent., and after the separation of this precipitate, nitrate of protoxide of mercury threw down another precipitate. After the juice had passed through the charcoal, the precipitate with basic acetate of lead diminished to 1·027 per cent., and that with nitrate of mercury nearly disappeared. During the evaporation of the syrup these foreign substances were in part decomposed, and produced a permanent darkening of its colour, which was not removable by charcoal, over which it was passed twice. During the boiling this syrup became acid.

Although an exaggerated importance has been attributed in general to the form of boiling-pan, and a great deal of complex and frequently absurd apparatus contrived to effect the boiling of the syrup, there can be no doubt that the more equally the syrup is heated, and the more rapidly the evaporation is conducted, and the less the air is allowed to act upon it, the larger will be the produce, and the better the grain of the sugar. Perfectly pure sugar boiled for twenty-four hours will become uncrystallizable, especially if a current of air be passed through it. The form of pan which I employed was not the one best adapted to effect a rapid evaporation, and in addition, the steam coil leaked and diluted the syrup to such a degree that, with all the causes combined, the boiling occupied fully eighteen hours. It is, therefore, rather a matter of surprise that the whole sugar was not decomposed.

The experiment was, however, instructive, inasmuch as it represented a combination of disadvantages which it is probable will never be met with in practice, and which may be summed up as follows:—1st, lateness of the root season; 2nd, considerable alteration and growth after removal from the pits; 3rd, exposure of the juice to the air for a period of three hours after expression; 4th, defective means of evaporation; and 5th, the leakage of steam, and other accidents connected with the first use of new machinery.

Most of these disadvantages were got rid of in the second experiment. The beet, although the season was very advanced, had not undergone much alteration, and great care was taken to avoid working up any decayed roots. By means of a large lever press, as already mentioned, sufficient juice for a defecation in the small defecating pan was obtained in one pressing, and for the large pan in three pressings, the juice was consequently but little altered from the action of the air.

The roots employed were grown by Lord Talbot de Malahide on the island of Lambay, and by William Dargan, Esq., at Raheny, County of Dublin, the proportions being about 6 cwts. of the former to 4 cwts. of the latter. Both had been grown on highly manured land, and on rather unfavourable soils, as is evident from the preceding Report. Lord Talbot de Malahide's beet was also grown close to the sea, and contained abundance of saline constituents, especially of chloride of sodium.

The density of the juice averaged from $6\frac{1}{2}°$ (Dargan) to 7° and even $7\frac{1}{2}°$ of Beaumé (L. T. de M.), the weaker juice having been yielded by the larger roots, many of which were fully 5 lbs. in weight, and some even 7 lbs. The defecated juice came nearly colourless from the charcoal, but was highly alkaline because from the lateness of the season, it was necessary to use a large dose of lime. A portion of the juice, after defecation, but before passing through the charcoal, gave in 100 parts 0·922 per cent. of precipitate with basic acetate of lead, and 0·537 after having passed through the filters. The raw juice was rich in nitrogenous matter, and contained a large quantity of those forms precipitable by lime and by chloride of calcium. By the action of the substance precipitated by the latter, a minute portion of the sugar was altered in one pan of juice which occupied a little more time in the defecation than usual; this gave rise to some colour in the syrup during the subsequent boiling. The air-diffusing wheel was used in the commencement of the boiling, but only until the syrup had attained a density of 35°.

The greatest care was taken in every stage of this experiment; no oil or butter was used in the boiling, which was only carried a very little above 39° of Beaumé, to avoid the danger of alteration, a greater amount of time being subsequently allowed for crystallization to take place. The following are the results:—

Second Experiment.

The quantity of beet employed was only 10 cwts., which was defecated in four distinct operations. This quantity gave :

Pulp, ...		3 cwts. 0 qrs. 0 lbs.
Juice, ...		7 cwts. „ „
Saccharine matter, . .	1st jet,	44 lbs. 9 oz.
„ . .	2nd „	28 lbs. 7 oz.
„ . .	Molasses	18 lbs. 0 oz.

These quantities correspond to :

Pulp, ...	30·17 per cent.
Raw Sugar, . . .	6·51 „
Molasses, . . .	1·63 „

The total saccharine matter being thus 8·11 per cent.

As the juice obtained in the first pressing does not represent the total quantity obtainable by moistening the bags, and repressing, an operation which would have raised the per centage of juice from 70 to at least 80, an increase which would have raised the per centage of sugar from $6\frac{1}{2}$ to $7\frac{1}{2}$.

The sugar obtained was of excellent grain, being fully equal to that sold under the name of centrifugal sugar, although somewhat highly coloured, and was almost wholly free, to a remarkable extent, from the peculiar flavour of the beet. Sugar of this quality would give fully 6 per cent. of refined sugar.

I consider this experiment demonstrative of the perfect practicability of introducing the sugar manufacture into Ireland. If with beet grown on highly manured stiff clayey land, and near the sea-coast, and which had arrived at a period when germination rapidly proceeds, with very imperfect apparatus, without the aid of the vacuum pan, or the newly discovered processes by carbonic acid, &c., $6\frac{1}{2}$ per cent. of sugar can be obtained, or I should rather say $7\frac{1}{2}$ per cent., it is justifiable to conclude that a well arranged and properly conducted factory could, by the use of all the new discoveries in this branch of industry, produce from $6\frac{1}{2}$ to $7\frac{1}{2}$ per cent. of sugar, that is the quantity obtained by the manufacturers of the continent. A reference to the preceding Report shows that the beet operated upon was by no means the best that was grown in Ireland in 1851, whilst the circumstances under which it grew were exceedingly bad.

Examination of Manufactory Residues.

The pulp which remains after the expression of the juice is of considerable value, not only to the manufacturer, by the sum which its sale produces, but also in an agricultural point of view, as it affords an admirable food for sheep and cattle, and thus makes up to a certain degree for the loss which may be sustained by removing the crops off the land. The composition of the pulp must of course depend in a great degree upon that of the beet employed; we may, therefore, expect to find considerable variation in its value; but where beet is carefully grown for the manufacture of sugar, and upon suitable soils, the limits of this variation are narrow. The variations in its price on the continent bear no proportion to the variations in its quality, being estimated in some districts at more than double the value of the raw beet, whilst in others it is estimated at only 8*s.* 6*d.* or 9*s.*, that is about two-thirds of the value of raw beet, and some persons in Ireland have even gone the length of asserting that it possessed no value at all; this opinion, of course, must be entirely attributed to want of acquaintance with the result of the experience of half of Europe, and I may add, of a little reflection upon the nature of the beet itself. In order to obtain some more accurate data for estimating its value than mere random conjectures, I have made a few analyses, of which I shall give the results here.

The specimens of pulp examined were taken without selection from the heaps emptied from the sacks. In order to obtain as close an approximation to a mean as possible, the entire cake forming the contents of a sack was employed. The following were the results of the determination of nitrogen, in the dried pulp, by the method of Varrentrapp and Will:—

No.	Name of Grower of Beet.	Nitrogen Per Cent.	Equivalent of Vegetable Albumen.
1	John Newton, Esq., . .	0·853	5·448
2	William Dargan, Esq., . .	0·613	3·915
3	Lord Talbot de Malahide, .	0·820	5·242

A specimen of No. 2 pulp contained, as it came from the press—

Albumen, ...	0.652	
Pectine, &c., ...	3·313	8·363 (Pectine and Sugar)
Sugar, ...	5·050	
Woody fibre, ...	6·444	
Ash, ...	1·205	
Water, ...	83,335	
	100,000	

When dried at 212° it consisted of—

Albumen, ...	3·915	
Pectine, &c., ...	19·878	50·183 (Pectine and Sugar)
Sugar, ...	30·305	
Woody fibre, ...	38·670	
Ash, ...	7·232	
	100·000	

This specimen was only subjected to one pressing; but as the pulp is now almost universally subjected to a second pressure after being slightly moistened, it was necessary to examine some pulp thus treated, and which had, therefore, lost from 12 to 15 per cent. more juice than the former. The second pressure was given with a hydraulic press, hence this specimen more properly represents manufacturers' pulp than the first. In its moist state it consisted of—

No. 3 Pulp.

Albumen, ...	1·336	
Sugar, ...	4·945	11·432 (Sugar and Pectine)
Pectine, ...	6·487	
Woody fibre, ...	11·922	
Ash, ...	1·180	
	100·000	

Dried at 212° it consisted of—

Albumen,	5·167	
Sugar,	19·113	44·188
Pectine,	25·075	
Woody fibre,	46·084	
Ash,	4·561	
	100·000	

A comparison between these numbers and those given at page 40 of the preceding Report lead to the singular result that pulp is as nearly as possible of the same value as raw beet, one constituent merely replacing another. In the raw beet the sugar forms the preponderating constituent belonging to the class of non-nitrogenous substances capable of being assimilated by animals, in the pulp, a considerable part of the sugar is replaced by pectine, which fills the same office as food.

The parenchyma of the cells of beet consists of cellulose coated with pectine, in combination with lime, and probably with magnesia also. In the cells thus formed of these substances, insoluble in water, are contained all the other constituents of the beet in a state of solution. If we break these cells, and press out a portion of their contents, the juice which still remains will have exactly the same composition as that pressed out, and the whole chemical change which the residual mass will have undergone will be the slight change which will be affected in the relative proportions between the different constituents, caused by an increase in the quantity of pectine and of woody fibre, all of which remain in the residual mass. The effect of this is to diminish the amount of sugar, ash, and albumen relatively to the fibre and pectine. Hence the ash of pulp ought not to differ in any considerable degree from that of the raw root, except in being a little richer in lime and magnesia, in consequence of the greater part of these substances existing as encrusting matter, and in an insoluble form, an opinion which is fully borne out by the following analysis—

Composition of Ash of Pulp.

Potash,	25·050
Soda,	16·050
Lime,	4·532
Magnesia,	3·250
Peroxide of iron,	0·641
Phosphoric acid,	4.754
Sulphuric acid,	1·542
Silica,	9·221
Carbonic acid,	16·853
Chloride of sodium,	11·979
Sand,	5·928
Total,	99·800

The results of these analyses would appear to point out that the value which ought to be assigned to the pulp per ton should be that at which the beet was purchased.

Scum or Écumes.

The scum which comes to the surface in the defecation of the raw juice, and the residue left in the filters after the separation of the filtered juice, is used, with the waste of the bone black employed in the filters, as a valuable manure upon the continent. It is unnecessary for me to notice the value of the latter, which has the composition of burnt bones, containing a variable amount of nitrogenous substances separated from the juice in its passage through the filters. The scum consists of an excess of lime, phosphate of lime, and magnesia separated from the juice, a great part of the nitrogenous substances found in the juice, organic acids in combination with lime, &c., and although its composition must vary much at different seasons of the year, with beet grown under different circumstances, and even in each separate defecation, I have thought it worth while to make an analysis of one specimen, in order more to indicate the nature of its composition than its mean value. It consisted of—

Organic substances, . .	75·604	and containing 1·201 per cent. of nitrogen, equal to 7·670 of albumen.
Ash, ...	24·396	
	100·000	

The Ash consisted of—

Lime, ...	42·935
Magnesia, . . .	7·855
Phosphoric acid, . .	9·734
Carbonic acid in combination of lime, &c.	25·948
Alkaline salts derived from adhering juice, &c.	13·127
	100·000

Appendix E.

TABLES REFERRED TO IN THE PRECEDING PORTIONS OF THE REPORT AND APPENDIX.

TABLE I.—Representing the Per Centage of Sugar, &c.,

No.	County.	Grower's Name.	Date of Pulling.	Weight of Bulb.	Specific gravity of Juice.	Corresponding density, in degrees of Beaumé's Areometer. *	Per centage of Water.	Per centage of Dried Residue.	Per centage of Sugar in Raw Beet.	Per centage of Sugar in Dried Beet.
				lbs. oz.						
1	Dublin, .	Royal Dublin Society,	Oct. 9,	2 1	1·0648	9·24	81·959	18·041	12·520	69·402
2	„	(Botanic Garden at Glasnevin),	„	2 8¼	1·0483	7·00	85·331	14·669	10·091	68·796
3	„	„	„	2 4	1·0455	6·47	84·936	15·064	9·381	62·280
4	„	„	„	1 14½	1·0549	7·87	83·412	16·588	10·667	64·309
5	„	„	„	1 15¾	1·0489	7·03	84·440	15·560	9·682	62·083
6	„	„	„	2 6¾	1·0504	7·30	83·943	16·057	9·996	62·256
7	„	„	„	3 9¼	1·0250	3·70	90·798	9·202	5·129	55·747
8	„	„	„	2 6½	1·0518	7·50	84·523	15·477	10·234	66·129
9	„	„	„	2 14	1·0401	5·87	87·416	12·584	8·651	68·747
10	„	„	„	3 6½	1·0342	5·08	88·811	11·189	7·206	64·402
11	„	„	„	3 7½	1·0393	5·77	86·614	13·386	8·210	61·339
12	„	„	„	2 1¼	1·0342	5·08	89·304	10·696	7·294	68·201
13	Cork, .	Professor Murphy, .	„	2 2	1·0402	5·88	87·923	12·077	8·531	70·639
14	„	„	„	2 15¼	1·0351	5·20	88·387	11·613	7·337	63·177
15	„	„	„	2 13	1·0388	5·71	87·227	12·773	7·458	58·391
16	„	„	„	2 1	1·0394	5·78	88·152	11·848	8·421	71·079
17	Dublin, .	Ninian Niven, Esq.,	Oct. 10,	2 8¾	1·0400	5·85	87·053	12·947	8·499	65·646
18	„	„	„	2 0¼	1·0463	6·63	85·064	14·936	9·532	63·824
19	„	„	„	2 14½	1·0460	6·60	85·409	14·591	9.042	61·974
20	„	„	„	1 15¾	1·0600	8·56	84·095	15·905	11·456	72·030
21	„	„	„	3 1½	1·0358	5·29	88·235	11·765	7·229	61·446
22	„	„	„	1 10	1·0478	6·80	84·292	15·708	9·590	61·051
23	„	„	„	2 9½	1·0564	8·10	83·479	16·521	10·977	66·446
24	„	„	„	2 1	1·0573	8·20	84·472	15·528	10·967	70·629
25	„	„	„	2 5¼	1·0497	7·18	84·940	15·060	9·831	65·282
26	„	„	„	1 13¼	1·0394	5·78	86·570	13·430	8·513	63·389
27	„	„	„	5 15¼	1·0260	3·85	90·744	9·256	5·154	55·686
28	Cork, .	Rev. W. R. Townsend,	„	3 9½	1·0503	7·30	85·617	14·383	9·885	68·724
29	„	„	„	0 15	1·0656	9·35	80·663	19·337	12·132	62·739

* In converting the centesimal scale into degrees of Beaumé's Areometer, we have, in every case, employed the Tables of Francoeur.

in the several specimens of Beet examined.

Per centage of Ash in Raw Beet.	Per centage of Ash in Dried Beet.	OBSERVATIONS.
1·025	5·684	Sown May 28th, and manured with farm-yard dung at the rate of 20 tons per acre. Variety, the *collet rose.*
1·250	8·527	Sown May 28th, and manured with 20 tons of farm-yard dung and 3 cwts. of Peruvian guano per acre. Variety, the *collet rose.*
.	.	Sown May 28th, and manured with 3 cwts. of Peruvian guano and 5 bushels of bone dust. Variety, the *collet rose.*
1·185	7·147	Sown on the 28th of May, and manured with 20 tons of farm-yard manure and 5 bushels of bone dust per acre. Variety, the *collet rose.*
1·304	8·384	Sown on the 28th of May, and manured with nitrate of soda, at the rate of 2 cwts. per acre. Variety, the *collet rose.*
1·170	7·292	Sown on the 28th of May, and manured with sulphate of ammonia at the rate of 2 cwts. per acre.
0·953	10·366	Sown on the 28th of May, and manured with 2 cwts. of sulphate of ammonia and 2 cwts. of nitrate of soda per acre. Variety, the *collet rose.*
1·361	8·796	Sown on the 28th of May, and manured with 2 cwts. of nitrate of soda and 20 tons of farm-yard manure per acre. Variety, the *collet rose.*
1·343	10·675	Sown on the 28th of May, and manured with 2 tons of prepared peat charcoal per acre. Variety, the *collet rose.*
0.937	8·374	Sown May 28th, and manured with a mixture consisting of ½ cwt. of bone dust, ½ cwt. of carbonate of potash, 14 lbs. of carbonate of soda, and 20 lbs. of carbonate of magnesia, applied at the rate of 2 cwts. of the mixture per acre. Variety, the *collet rose.*
1·401	10·472	Sown May 28th, and manured with a mixture consisting of 1 cwt. of sulphate of ammonia, ½ cwt. of nitrate of soda, ½ cwt. of sulphate of soda, 28 lbs. of sulphate of potash, 28 lbs. of sulphate of magnesia, and ½ cwt. of superphosphate of lime, applied at the rate of 5 cwts. of the mixture per acre. Variety, *collet rose.*
1·338	12·509	Sown on the 28th of May, and manured with a mixture consisting of 4 cwts. of common salt, ½ cwt. of sulphate of ammonia, and ½ cwt. of superphosphate of lime, applied at the rate of 5 cwts. of the mixture per acre. Variety, *collet rose.*.
0·878	7·275	Sown on the 26th of April, the land having been manured with Cork street-manure at the rate of 25 tons per acre.
0·917	7·899	Sown on the 26th of March, on soil similar to that upon which No. 13 was grown, and manured in the same manner.
0·838	6·561	Sown on the 26th of March, (part of No. 14,) and transplanted on the 13th of June, into ground previously prepared for them, by an application of 3 cwts. of guano and 4 bushels of vitriolized bones per acre.
1·011	8·538	No. 16, also a part of No. 14, transplanted on the 13th of June, to fill blanks in the ground manured with Cork street-manure, and in which beet was sown on the 26th of April.
0·842	6·509	Sown on 24th of May, and manured with farm-yard dung, at the rate of 40 loads to the acre.
1·013	6·785	Sown 24th of May, and manured with 40 loads of farm-yard dung and 5 bushels of bone dust to the acre.
1·050	7·199	Sown 24th of May, and manured with nitrate of soda at the rate of 2 cwts. per acre.
1·014	6·375	Sown 24th of May, and manured with sulphate of ammonia at the rate of 2 cwts. per acre.
0·748	6·365	Sown 24th of May, and manured with 2 cwts. of nitrate of soda and 2 cwts. of sulphate of ammonia per acre.
0·908	5·780	Sown 24th of May, and manured with 2 tons of prepared peat charcoal per acre.
0·912	5·525	Sown 24th of May, and manured with a mixture consisting of ½ cwt. of bone dust, 21 lbs. of sulphuric acid, ½ cwt. of carbonate of potash, 14 lbs. of carbonate of soda, and 20 lbs. of carbonate of magnesia, at the rate of 2 cwts. per acre.
1·541	9·925	Sown 24th of May, and manured with a mixture consisting of 1 cwt. of sulphate of ammonia, ½ cwt. of nitrate of soda, ½ cwt. of sulphate of soda, 28 lbs. of sulphate of potash, 28 lbs. of sulphate of magnesia, and ½ cwt. of superphosphate of lime, at the rate of 3 cwts. of the mixture per acre.
0·906	6·017	Sown 24th of May, and manured with 4 cwts. of common salt, ½ cwt. of sulphate of ammonia, and ½ cwt. of superphosphate of lime, applied at the rate of 5 cwts. of the mixture to the acre.
1·034	7·701	Sown 24th of May, no manure of any kind, whatever, was applied on this plot.
1·513	16·349	Sown on the 12th of April, and manured with farm-yard manure at the rate of 40 loads per acre.
1·135	7·895	Sown in latter end of May, and manured with farm-yard dung of the best quality, and sea weed afterwards dug into the intervals. The land was heavily trenched 3 years before.
1·255	6·494	

[*continued.*

TABLE I.—Representing the Per Centage of Sugar, &c.,

No.	County.	Grower's Name.	Date of Pulling.	Weight of Bulb.	Specific gravity of Juice.	Corresponding density, in degrees of Beaumé's Areometer.	Per centage of Water.	Per centage of Dried Residue.	Per centage of Sugar in Raw Beet.	Per centage of Sugar in Dried Beet.
				lbs. oz.						
30	Cork, .	Rev. W. R. Townsend,	Oct. 10,	2 15¼	1·0411	6·00	87·780	12·220	8·596	70·340
31	"	"	"	0 14½	1·0474	6·75	85·240	14·760	9·567	64·822
32	"	"	"	4 6½	1·0500	7·22	85·016	14·984	10·092	67·352
33	"	"	"	0 13	1·0625	8·87	83·282	16·718	11·809	70·636
34	"	A. M'Nab, Esq., .	"	3 6¾	1·0381	5·61	87·950	12·050	7·451	61·836
35	"	B. J. Hackett, Esq.,	Oct. 13,	3 8¼	1·0353	5·22	88·064	11·936	6·263	52·476
36	"	"	"	4 12½	1·0493	7·12	86·795	13·205	9·049	68·534
37	"	Messrs. Jennings, .	Oct. 14,	6 2½	1·0392	5·76	88·549	11·451	7·357	64·251
38	"	"	"	6 5½	1·0302	4·42	89·255	10·745	6·101	56·780
39	Wexford,	Edward Carroll, Esq.,	Oct. 18,	1 13	1·0456	6·55	85·594	14·406	8·324	57·786
40	"	"	"	1 8	1·0512	7·40	83·880	16·120	9·504	58·956
41	"	"	"	2 0½	1·0470	6·70	84·882	15·118	9·098	60·188
42	"	"	"	1 5¼	1·0482	7·00	86·093	13·907	9·438	67·868
43	"	Frederick Jones, Esq.	"	4 8¾	1·0401	5·87	87·593	12·407	7·896	63·647
44	"	"	"	2 7½	1·0502	7·25	84·266	15·734	9·779	62·153
45	Kildare, .	Thos. Demsdale, Esq.	Oct. 19,	4 9½	1·0393	5·77	87·537	12·463	7·645	61·337
46	Dublin, .	Samuel Copland, Esq.	Oct. 20,	3 1	1·0421	6·11	87·458	12·542	8·644	68·920
47	Carlow, .	John Newton, Esq. .	Oct. 24,	1 12½	1·0661	9·43	81·302	18·698	12·858	68·768
48	Tyrone, .	Robert Forster, Esq.	Oct. 25,	2 2¼	1·0483	7·00	86·387	13·613	7·523	55·265
49	"	"	"	2 0	1·0486	7·03	84·436	15·564	8·286	53·236
50	Kildare, .	Thos. Demsdale, Esq.,	Nov. 2,	3 8¾	1·0304	4·46	88·773	11·227	5·942	52·926
51	Dublin, .	Ninian Niven, Esq.,	"	5 13¾	1·0355	5·25	88·119	11·881	7·209	60·681
52	"	Right Hon. Lord Talbot de Malahide, .	Nov. 11,	6 2	1·0408	5·95	87·254	12·746	8·559	67·156
53	"	"	"	4 2½	1·0483	7·00	86·260	13·740	9·130	66·451
54	"	"	"	3 8¼	1·0503	7·30	84·977	15·023	10·030	66·766
55	"	"	"	3 13¼	1·0526	7·59	85·125	14·875	10·535	70·826
56	"	"	"	3 9¼	1·0553	7·93	84·405	15·598	10·891	69·827
57	"	"	"	3 13½	1·0477	6·78	85·905	14·095	9·530	67·768
58	"	Royal Dublin Society,	"	2 5½	1·0561	8·05	83·232	16·768	10·948	65·294
59	"	"	"	1 4	1·0658	9·38	81·084	18·916	12·417	65·644
60	"	"	"	2 15¼	1·0442	6·36	85·273	14·727	9·002	61·128
61	"	"	"	1 8¾	1·0501	7·28	83·610	16·390	10·021	61·139
62	"	"	"	1 12	1·0564	8·10	82·107	17·893	10·646	59·499
63	"	"	"	1 2	1·0652	9·30	80·952	19·048	12·131	63·689

in the several specimens of Beet examined—*continued.*

Per centage of Ash in Raw Beet.	Per centage of Ash in Dried Beet.	OBSERVATIONS.
1·086	8·888	Sown in the latter end of May, and manured with sea-weed put into the drills, and again dug into the intervals.
1·060	7·184	
1·141	7·619	Manured with farm-yard dung only. Sown in the latter end of May.
0·845	5·056	
1·326	11·005	Sown the 1st of May, and manured with farm-yard manure.
1·135	9·510	Sown on the 1st of May, and manured with stable and cow-stall manure and sea sand. Variety of the *collet rose* with red skin.
1·149	8·703	Specimen of the *collet vert* from same field as No. 35.
0·996	8·702	Sown on the 15th of April, the ground having been limed in October. The land was manured before sowing with stable and pig manure.
0·881	8·199	Specimen from the same field as No. 37, which had thrown out its flower stalk. The land was exhausted corn land.
1·233	8·558	Sown April 20th, and manured with farm-yard manure in compost. Variety, the *collet vert.*
1·370	8·498	
1·389	9·193	Transplanted on July 1st from the plot on which Nos. 39 and 40 were grown into land simply trenched, 18 inches deep, *but not manured.*
1·155	8·312	Sown June 1st, and manured in the same manner as Nos. 39 and 40.
1·051	8·478	A peculiar variety of beet, of a delicate orange red colour, and tapering somewhat like a carrot; flesh white, with a very slight tinge of rose colour. Sown on the 20th of May, and manured with farm-yard dung in compost.
1·345	8·554	
1·205	9·671	Sown 25th of May on deep peat, simply drained by large open drains; the *skraw,* or superficial covering, burned; and burnt clay, marl, Dublin street dung and night-soil having been applied as manure.
1·261	10·059	Grown in a garden; date of sowing unknown. Variety, the *collet jaune.*
0·698	3·737	Sown 20th of May, and manured with farm-yard dung. Variety, the *collet rose.*
1·226	9·006	Date of sowing unknown, but rather late in the season. Variety, the *collet vert.* The land was heavily manured with fresh litter.
1·408	9·046	
1·286	11·462	Second specimen of No. 45, pulled a fortnight later.
1·056	8·893	Second specimen of No. 17, pulled three weeks later.
1·438	11·289	Grown on the eastern side of the Island of Lambay, and therefore fully exposed to the influence of the sea. Land manured with stable-yard manure. No. 52 was *collet vert;* 53, 54, 55, 56, *collet rose;* 57, *collet jaune.*
1·548	11·270	
1·692	11·263	
1·672	11·230	
1·757	11·268	
1·580	11·242	
1·196	7·137	Sown May 28th, and manured with farm-yard dung, at the rate of 20 tons to the statute acre. Variety, the *collet rose.* Second specimens of No. 1, pulled one month later.
1·339	7·083	
1·026	6·966	Sown May 28th, and manured with farm-yard dung 20 tons, and Peruvian guano 3 cwts., per acre. Variety, the *collet rose.* Second specimens of No. 2, pulled one month later.
1·164	7·106	
1·093	6·111	Sown on the 28th of May, and manured with 3 cwts. of Peruvian guano and 5 bushels of bone dust. Variety, the *collet rose.* Second specimens of No. 3, pulled one month later.
1·177	6·182	

[*continued*

TABLE I.—Representing the Per Centage of Sugar, &c.,

No.	County.	Grower's Name.	Date of Pulling.	Weight of Bulb.	Specific gravity of Juice.	Corresponding density, in degrees of Beaumé's Areometer.	Per centage of Water.	Per centage of Dried Residue.	Per centage of Sugar in Raw Beet.	Per centage of Sugar in Dried Beet.
				lbs. oz.						
64	Dublin, .	Royal Dublin Society,	Nov. 11,	1 11¾	1·0581	8·30	81·995	18·005	11·226	62·353
65	„	„	„	1 0½	1·0621	8·82	80·850	19·150	11·926	62·281
66	„	„	„	2 8½	1·0507	7·33	84·589	15·411	9·074	58·885
67	„	„	„	2 7	1·0533	8·33	84·051	15·949	9·821	61·580
68	„	„	„	2 6	1·0614	8·74	81·973	18·027	11·323	62·813
69	„	„	„	1 15¾	1·0678	9·78	80·526	19·474	12·120	62·237
70	„	„	„	3 4¾	1·0463	6·63	86·210	13·790	8·872	64·337
71	„	„	„	1 2¼	1·0618	8·79	82·562	17·438	11·272	64·644
72	„	„	„	2 4¾	1·0463	6·63	83·160	16·840	8·784	52·164
73	„	„	„	2 1	1·0528	7·62	82·690	17·310	9·804	56·638
74	„	„	„	2 10½	1·0514	7·43	82·791	17·209	10·478	60·889
75	„	„	„	2 14	1·0535	7·70	82·211	17·789	10·715	60·249
76	„	„	„	2 3¼	1·0472	6·72	83·548	16·452	9·362	56·906
77	„	„	„	2 4¼	1·0477	6·78	83·523	16·477	9·507	57·698
78	„	„	„	1 15	1·0381	5·61	86·488	13·512	7·322	54·195
79	„	„	„	1 8	1·0483	7·00	83·378	16·622	9·350	56·252
80	„	„	„	2 0¾	1·0486	7·03	84·756	15·244	8·930	58·585
81	„	„	„	1 12	1·0520	7·51	83·294	16·706	9·730	58·244
82	Tyrone, .	Wm. Sinclair, Esq. .	Nov. 19,	1 12¼	1·0563	8·07	83·726	16·274	10·747	66·040
83	„	„	„	1 9¾	1·0572	8·18	83·324	16·676	11·121	66·693
84	Cavan, .	Messrs. Dickson & Co.	Nov. 20,	8 0¾	1·0188	2·83	93·054	6·946	3·127	45·023
85	„	„	„	9 8¾	1·0175	2·63	93·714	6·286	2·699	42·940
86	„	„	„	3 9¼	1·0318	4·63	88·610	11·390	5·626	49·396
87	„	„	„	3 12	1·0320	4·66	88·432	11·568	5·716	49·415
88	Tyrone, .	Robert M'Crea, Esq.	Nov. 26,	3 6¼	1·0520	7·51	85·186	14·814	10·480	70·748
89	„	„	„	1 10	1·0580	8·30	83·929	16·071	11·191	69·640
90	Dublin, .	Wm. Dargan, Esq. .	Dec. 4,	6 11¼	1·0400	5·86	89·026	10·974	7·453	67·916
91	„	„	„	3 0¼	1·0500	7·22	84·956	15·044	9·557	63·530
92	Tyrone, .	Wm. Sinclair, Esq. .	Dec. 13,	2 0¾	1·0532	7·67	84·138	15·862	9·483	59·784
93	„	„	„	1 1	1·0790	11·08	79·568	20·432	13·507	66·107
94	„	Jas. Sinclair, Jun. Esq.	„	1 14¾	1·0748	10·61	80·623	19·377	13·185	68·048
95	„	„	„	1 2½	1·0808	11·30	79·091	20·909	13·867	66·321
96	„	„	„	1 0½	1·0846	11·80	77·974	22·026	14·551	66·068

in the several specimens of Beet examined—*continued.*

Per centage of Ash in Raw Beet.	Per centage of Ash in Dried Beet.	OBSERVATIONS.
1·020	5·665	Sown on the 28th of May, and manured with 20 tons of farm-yard manure a[illegible] 5 bushels of bone dust to the acre. Variety, the *collet rose.* Second specimens of No. 4, pulled one month later.
1·097	5·730	
1·058	6·865	Sown on the 28th of May, and manured with nitrate of soda, at the rate of 2 cwts. per acre. Variety, the *collet rose.* Second specimens of No. 5, pulled one month later.
1·084	6·800	
1·053	5·846	Sown on the 28th of May, and manured with sulphate of ammonia, at the rate of 2 cwts. per acre. Variety, the *collet rose.* Second specimens of No. 6, pulled one month later.
1·123	5·771	
1·407	10·205	Sown on the 28th of May, and manured with sulphate of ammonia and nitrate of soda, at the rate of 2 cwts. of each. Variety, the *collet rose.* Second specimens of No. 7, pulled one month later.
1·794	10·287	
1·390	8·254	Sown May 28th, and manured with 2 cwts. of nitrate of soda and 20 tons of farm-yard manure per acre. Variety, *collet rose.* Second specimens of No. 8, pulled one month later.
1·419	8·202	
1·111	6·458	Sown May 28th, and manured with 2 tons of prepared peat charcoal per acre. Variety, the *collet rose.* Second specimens of No. 9, pulled one month later.
1·151	6·474	
1·535	9·334	Sown May 28th, and manured with a mixture consisting of ½ cwt. of bone dust, ½ cwt. of carbonate of potash, 14 lbs. of carbonate of soda, and 20 lbs. of carbonate of magnesia, applied at the rate of 2 cwts. of the mixture per acre. Variety, the *collet rose.* Second specimens of No. 10, pulled one month later.
1·541	9·358	
1·216	9·000	Sown May 28th, and manured with a mixture consisting of 1 cwt. of sulphate of ammonia, ½ cwt. of nitrate of soda, ½ cwt. of sulphate of soda, 28 lbs. of sulphate of potash, 28 lbs. of sulphate of magnesia, and ½ cwt. of superphosphate of lime, applied at the rate of 5 cwts. of the mixture per acre. Variety, the *collet rose.* Second specimens of No. 11, pulled one month later.
1·505	9·059	
1·350	8·857	Sown on the 28th of May, and manured with a mixture consisting of 4 cwts. of common salt, ½ cwt. of sulphate of ammonia, and ½ cwt. of superphosphate of lime, applied at the rate of 5 cwts. of the mixture per acre. Variety, *collet rose.* Second specimens of No. 12, pulled one month later.
1·488	8·907	
0·976	5·999	
0·997	5·965	
1·210	17·420	Date of sowing not ascertained. The land was highly manured, probably with farm-yard dung.
1·098	17·482	
1·590	13·960	
1·620	14·010	
1·074	7·256	Sown on the 24th of April, and manured with 30 tons of good farm-yard, 2 cwts. of salt, and 3 cwts. of kelp. Variety examined, the *collet vert.*
1·164	7·243	
0·991	9·036	Sown on the 8th of May, and manured with farm-yard manure and guano. Variety, the *collet rose.*
1·352	8·987	
1·092	6·885	
1·399	6·850	
0·936	4·832	Sown on the 27th of April, and manured with about 50 tons of pig manure. Variety examined, the *collet rose.*
1·015	4·857	
1·080	4·903	

[*continued.*

TABLE I.—Representing the Per Centage of Sugar, &c.,

No.	County.	Grower's Name.	Date of Pulling.	Weight of Bulb. (lbs. oz.)	Specific gravity of Juice.	Corresponding density, in degrees of Beaumé's Areometer.	Per centage of Water.	Per centage of Dried Residue.	Per centage of Sugar in Raw Beet.	Per centage of Sugar in Dried Beet.
97	Cork, .	Rev. W. R. Townsend,	Dec. 13,	5 9¾	1·0420	6·10	86·614	13·386	8·491	63·432
98	„	„	„	2 8	1·0513	7·42	84·468	15·532	9·775	62·936
99	„	„	„	2 9	1·0547	7·85	83·042	16·958	10·771	63·516
100	„	„	„	4 4	1·0441	6·35	85·981	14·019	8·845	63·095
101	„	„	„	4 1½	1·0450	6·47	84·473	15·527	8·786	56·589
102	„	„	„	3 5	1·0504	7·29	83·624	16·376	9·449	57·701
103	„	B. J. Hackett, Esq. .	Dec. 14,	4 15½	1·0360	5·35	88·704	11·296	7·309	64·706
104	„	„	„	2 1	1·0512	7·40	84·590	15·410	9·846	63·896
105	Carlow, .	John Newton, Esq. .	Dec. 17,	4 2¼	1·0452	6·50	87·634	12·366	8·702	70·375
106	„	„	„	4 6¼	1·0573	8·20	83·736	16·264	10·811	66·475
107	Carlow, .	John Newton, Esq. .		3 12¼	1·0470	6·70	85·136	14·864	9·655	64·957
108	L.Derry, .	Samuel Leathem, Esq.	Dec. 26,	2 8½	1·0517	7·48	84·505	15·495	10·419	64·356
109	„	„	„	3 7	1·0491	7·10	85·165	14·835	9·910	63·961
110	Cork, .	Messrs. Jennings, .	Jan. 1,	4 15	1·047	6·70	84·964	15·036	9·125	60·693
111	„	„	„	2 4	1·0493	7·12	84·603	15·397	9·341	60·669
112	Louth, .	—— Marron, Esq. .	Jan. 8,	8 14½	1·0216	3·20	92·021	7·979	3·655	45·816
113	„	„	„	9 7¾	1·0204	3·04	92·487	7·513	3·523	46·894
114	Queen's, .	Irish Beet Sugar Co.	Stored until the 11th of April.	1 15½	1·0706	10·01	82·515	17·485	12·131	69·383
115	„	„		1 2¾	1·0653	9·30	81·407	18·593	12·139	65·291
116	„	„		1 1½	1·0703	9·98	80·462	19·538	11·612	59·432
117	„	„		2 1½	1·0556	8·00	84·710	15·290	3·553	23·241
118	„	„		3 7½	1·0436	6·28	87·867	12·133	7·597	62·614

RESULTS OF THE ANALYSES OF

No.	Grower		Date of Pulling.	Weight of Bulb. (lbs. oz.)	Specific gravity of Juice.	Corresponding density, in degrees of Beaumé's Areometer.	Per centage of Water.	Per centage of Dried Residue.	Per centage of Sugar in Raw Beet.	Per centage of Sugar in Dried Beet.
119	MM. Claës, Lembecq, near Brussels,		.	2 5	1·0443	6·37	86·245	13·755	9·584	69·681
120			.	2 14½	1·0451	6·48	85·336	14·664	9·774	66·657
121			.	3 3¼	1·0380	5·60	86·995	13·005	8·536	65·790
122			.	1 3	1·0503	7·28	84·654	15·346	10·258	66·847
123	Neighbourhood of Antwerp,		.	5 7½	1·0245	3·62	90·980	9·020	5·687	63·059
124			.	3 8¼	1·0370	5·50	87·972	12·028	8·164	68·034
125			.	3 14	1·0348	5·20	88·170	11·830	7·804	65·972

in the several specimens of Beet examined—*continued.*

Per centage of Ash in Raw Beet.	Per centage of Ash in Dried Beet.	OBSERVATIONS.
1·294	9·673	Sown in the latter end of May, and manured with farm-yard manure of the best quality, sea weed having been afterwards dug in, in the intervals. The land was heavily trenched three years previously. The specimens analyzed were of the *collet rose* variety. Second specimens of 28 and 29, pulled two months later.
1·489	9·591	
1·631	9·620	
1·310	9·349	Sown in the latter end of May, and manured with sea weed only. A second specimen of Nos. 30 and 31, pulled two months later. Variety, the *collet rose.*
1·582	10·192	Sown in the latter end of May, and manured with farm-yard dung only. Variety, the *collet rose.* Second specimens of Nos. 32 and 33, pulled two months later.
1·661	10·146	
1·162	10·290	Sown the 1st of May, and manured with stable and cow-stall manure and sea sand. Variety, of the *collet rose,* with rose-coloured skin. Second specimens of No. 35, pulled two months later.
1·588	10·311	
0·750	6·068	Sown on the 20th of May, and manured with farm-yard dung. No. 104, *collet vert;* Nos. 105 and 106, *collet rose.* Second specimens of No. 47, pulled nearly two months later.
0·976	6·005	
0·907	6·106	
1·185	7·323	Date of sowing and nature of manure, &c., not ascertained.
1·108	7·153	
1·313	8·734	Sown from the 15th to the 28th of April, and manured with fresh pig manure. It was exhausted corn land.
1·347	8·750	
1·395	17·493	Sown in the early part of May. Other particulars not known.
1·307	17·408	
.	.	Date of sowing and other particulars not ascertained, the specimens having been taken from a large stock of roots purchased for the manufacture of sugar.
.	.	
.	.	
.	.	
.	.	
ROOTS GROWN IN BELGIUM.		
1·195	8·691	Date of sowing and other particulars not ascertained.
.	.	
.	.	
.	.	
0·789	8·750	
.	.	
.	.	

TABLE II.—Showing the Relative Proportion of Foreign Ingredients in the Juice, as the Juice should have if it was

No.	Per centage of Sugar in Juice.	Specific gravity of Juice.	Specific gravity of Juice calculated upon the supposition of its being a solution of Pure Sugar.	Difference between calculated and observed densities.		No.	Per centage of Sugar in Juice.	Specific gravity of Juice.	Specific gravity of Juice calculated upon the supposition of its being a solution of Pure Sugar.	Difference between calculated and observed densities.	
				Centesimal Scale.	Degrees of Beaumé's Areometer.					Centesimal Scale.	Degrees of Beaumé's Areometer.
1	15·276	1·0648	1·0613	0·0035	0·53	35	7·112	1·0353	1·0257	·0096	1·45
2	11·826	1·0483	1·0447	·0036	0·54	36	10·406	1·0493	1·0385	·0108	1·63
3	11·045	1·0455	1·0412	·0033	0·50	37	8·308	1·0392	1·0302	·0090	1·36
4	12·789	1·0549	1·0495	·0054	0·81	38	6·836	1·0302	1·0248	·0054	0·81
5	11·466	1·0489	1·0433	·0056	0·84	39	9·725	1·0456	1·0356	·0100	1·51
6	11·908	1·0504	1·0451	·0053	0·80	40	11·330	1·0512	1·0425	·0087	1·31
7	5·649	1·0250	1·0202	·0048	0·72	41	10·719	1·0470	1·0398	·0072	1·09
8	12·108	1·0518	1·0461	·0057	0·86	42	10·963	1·0482	1·0408	·0080	1·21
9	9·896	1·0401	1·0363	·0038	0·57	43	9·015	1·0401	1·0328	·0073	1·10
10	8·113	1·0342	1·0294	·0048	0·72	44	11·605	1·0502	1·0438	·0064	0·96
11	9·479	1·0393	1·0346	·0047	0·71	45	8·733	1·0393	1·0318	·0075	1·13
12	8·168	1·0342	1·0297	·0045	0·68	46	9·884	1·0421	1·0362	·0059	0·89
13	9·702	1·0402	1·0355	·0047	0·71	47	15·815	1·0661	1·0639	·0022	0·33
14	8·301	1·0351	1·0302	·0049	0.74	48	8·708	1·0483	1·0317	·0066	1·00
15	8·550	1·0388	1·0311	·0077	1·16	49	9·813	1·0486	1·0359	·0127	1·92
16	9·553	1·0394	1·0349	·0045	0·68	50	6·693	1·0304	1·0243	·0061	0·92
17	9·763	1·0400	1·0357	·0043	0·65	51	8·181	1·0355	1·0297	·0058	0·87
18	11·206	1·0463	1·0419	·0044	0·66	52	9·810	1·0408	1·0359	·0049	0·74
19	10·587	1·0460	1·0391	·0069	1·04	53	10·584	1·0483	1·0396	·0087	1·31
20	13·623	1·0600	1·0534	·0066	1·00	54	11·803	1·0503	1·0447	·0056	0·84
21	8·193	1·0358	1·0298	·0060	0·90	55	12·376	1·0526	1·0474	·0052	0·78
22	11·377	1·0478	1·0427	·0051	0·77	56	12·904	1·0553	1·0500	·0053	0·80
23	13·150	1·0564	1·0511	·0053	0·80	57	11·093	1·0477	1·0414	·0063	0·95
24	12·983	1·0573	1·0500	·0073	1·10	58	13·154	1·0561	1·0511	·0050	0·75
25	11·574	1·0497	1·0435	·0062	0·93	59	15·314	1·0658	1·0614	·0044	0·66
26	9·833	1·0394	1·0360	·0034	0·51	60	10·557	1·0442	1·0390	·0052	0·78
27	5·680	1·0260	1·0203	·0057	0·86	61	11·985	1·0501	1·0455	·0046	0·69
28	11·545	1·0503	1·0435	·0068	1·03	62	12·966	1·0564	1·0502	·0062	0·93
29	15·040	1·0656	1·0602	·0054	0·81	63	14·986	1·0652	1·060	·0052	0·78
30	9·792	1·0411	1·0359	·0052	0·78	64	13·691	1·0581	1·0538	·0043	0·65
31	11·224	1·0474	1·0420	·0054	0·81	65	14·751	1·0621	1·0587	·0034	0·51
32	11·870	1·0500	1·0450	·0050	0·75	66	10·728	1·0507	1·0398	·0109	1·65
33	14·180	1·0625	1·0561	·0064	0·96	67	11·685	1·0533	1·0441	·0092	1·39
34	8·472	1·0381	1·0308	·0073	0·10	68	13·813	1·0614	1·0543	·0071	1·07

indicated by the difference between the Density found by Observation, and that which a solution of Pure Sugar.

No.	Per centage of Sugar in Juice.	Specific gravity of Juice.	Specific gravity of Juice calculated upon the supposition of its being a solution of Pure Sugar.	Difference between calculated and observed densities.		No.	Per centage of Sugar in Juice.	Specific gravity of Juice.	Specific gravity of Juice calculated upon the supposition of its being a solution of Pure Sugar.	Difference between calculated and observed densities.	
				Centesimal Scale.	Degrees of Beaumé's Areometer.					Centesimal Scale.	Degrees of Beaumé's Areometer.
69	15·051	1·0678	1·0601	·0077	1·16	103	8·239	1·0360	1·0299	·0061	0·92
70	10·291	1·0463	1·0380	·0083	1·25	104	11·640	1·0512	1·0440	·0072	1·09
71	13·653	1·0618	1·0535	·0083	1·25	105	9·930	1·0452	1·0364	·0088	1·33
72	10·563	1·0463	1·0390	·0073	1·10	106	12·911	1·0573	1·0500	·0073	1·10
73	11·857	1·0528	1·0449	·0079	1·19	107	11·341	1·0470	1·0426	·0044	0·66
74	12·656	1·0514	1·0488	·0026	0·39	108	12·329	1·0517	1·0473	·0044	0·66
75	13·034	1·0535	1·0505	·0030	0·45	109	11·637	1·0491	1·0439	·0052	0·78
76	11·208	1·0472	1·0419	·0053	0·80	110	10·740	1·047	1·0399	·0071	1·07
77	11·382	1·0477	1·0427	·0050	0·75	111	11·041	1·0493	1·0412	·0081	1·22
78	8·466	1·0381	1·0308	·0073	1·10	112	3·972	1·0216	1·0142	·0074	1·12
79	11·476	1·0483	1·0432	·0051	0·77	113	3·809	1·0204	1·0135	·0069	1·04
80	10·537	1·0486	1·0389	·0097	1·46	114	14·702	1·0706	1·0585	·0121	1·83
81	11·682	1·0520	1·0441	·0079	1·19	115	14·912	1·0653	1·0595	·0058	0·87
82	12·836	1·0563	1·0496	·0067	1·01	116	14·431	1·0703	1·0572	·0131	1·98
83	13·347	1·0572	1·0521	·0051	0·77	117	4·195	1·0556	1·0150	·0406	6·15
84	3·360	1·0188	1·0118	·0070	1·06	118	8·646	1·0436	1·0315	·0121	1·83
85	2·880	1·0175	1·0103	·0072	1·09	119	11·113	1·0443	1·0414	·0029	0·43
86	6·349	1·0318	1·0229	·0089	1·34	120	11·454	1·0451	1·0430	·0021	0·31
87	6·464	1·0320	1·0234	·0086	1·30	121	9·812	1·0380	1·0359	·0021	0·31
88	12·303	1·0520	1·0471	·0049	0·74	122	12·118	1·0503	1·0462	·0041	0·62
89	13·335	1·0580	1·0520	·0060	0·90	123	6·251	1·0245	1·0225	·0020	0·30
90	8·371	1·0400	1·0305	·0095	1·43	124	9·280	1·0370	1·0339	·0031	0·46
91	11·250	1·0500	1·0421	·0079	1·19	125	8·851	1·0348	1·0323	·0025	0·37
92	11·270	1·0532	1·0421	·0111	1·68	*1. Yel. Globe Mangel. Prof. Murphy, Cork.	8·360	1·0355	1·0304	·0051	0·77
93	16·975	1·0790	1·0694	·0096	1·45	3. Ditto, Rev. W. R. Townsend, Cork.	7·855	1·0351	1·0286	·0065	0·98
94	16·354	1·0748	1·0665	·0083	1·25	6. Do. Messrs. Jennings, Cork.	8·797	1·0403	1·0321	·0082	1·24
95	17·533	1·0808	1·0717	·0091	1·37	10. Do. Thomas Demsdale, Esq. Kildare.	9·277	1·0421	1·0339	0081	1·22
96	18·662	1·0846	1·0767	·0079	1·19	11 and 12. Do. Wm. Dargan, Esq. Dublin.	9·302	1·0400	1·0340	·0060	0·90
97	9·803	1·0420	1·0359	·0061	0·92		9·559	1·0424	1·0349	·0075	1·13
98	11·572	1·0513	1·0436	·0071	1·07	4. Small Long Red Mangel. (Rev. W. R. Townsend.)	13·444	1·0582	1·0526	·0056	0·84
99	12·970	1·0547	1·0503	·0044	0·66	5. Large Red Mangel. (Rev. W. R. Townsend.)	7·997	1·0361	1·0291	·0070	1·06
100	10·287	1·0441	1·0380	·0061	0·92	13. Do. pulled in December. (Rev. W. R. Townsend.)	8·037	1·0342	1·0291	·0051	0·77
101	10·401	1·0450	1·0384	·0066	1·00	14. Long Red Mangel. (Messrs. Jennings.)	6·233	1·0304	1·0224	·0080	1·21
102	11·299	1·0504	1·0424	·0080	1·21	15. Do. 2nd specimen. (Messrs. Jennings.)	6·308	1·0306	1·0227	·0079	1·19

* Numbers corresponding to those in Table VI.

TABLE III.—Table representing the Per Centage of Gravel, and its specimens of Beet

No.	County.	Barony.	Parish.	Townland.	Name of Grower.	Per centage of Gravel in Soil.	Per centage of Gravel in Subsoil.	No. of Specimens of Beet grown upon soil corresponding to Table I.
1	Tyrone.	Lower Strabane.	Urney.	Backtown.	James Sinclair, jun., Esq.	22·50	40·00	94, 95, and 96.
2	Tyrone.	Lower Strabane.	Leckpatrick.	Hollyhill.	Wm. Sinclair, Esq.	30·200	29·60	82, 83, 92, and 93.
3	Tyrone.	Lower Strabane.	Donogheady.	Grange-Foyle.	Robt. M'Crea, Esq.	0·92	14·20	88 and 89.
4	Tyrone.	Middle Dungannon.	Donaghmore.	Mullaghmore	Robt. Forster, Esq. of Springfield.	23·02	0·76	48 and 49.
5	Cavan.	Lower Loughtee.	Annagh.	Straheglin.	Messrs. Dickson and Co., Belturbet.	17·02	45·20	84, 85, 86, and 87.
6	Dublin.	Nethercross.	Rush.	Lambay Island.	Right Hon. Lord Talbot de Malahide.	33·60	32·30	52, 53, 54, 55, 56, and 57.
7	Dublin.	Coolock.	Raheny.	Maryville.	William Dargan, Esq.	24·42	19·38	90 and 91.
8	Dublin.	Coolock.	Glasnevin.	Glasnevin.	Royal Dublin Society. (Soil of higher ground in Glasnevin Botanic Garden.)	33·06	48·40	1 to 12 inclusive, and 58 to 81 inclusive.
9	Dublin.	Coolock.	Clonturk.	Clonturk.	Ninian Niven, Esq. Drumcondra.	27·80	27·40	17 to 27 inclusive, and 51.

Mineralogical Character, in the Soils and Subsoils upon which the examined were grown.

Nature of subjacent Rock.	Description of Gravel of Soil.	Description of Gravel of Subsoil.
Gritty shales of the silurian period.	A very fine gravel of quartzose sand, greenish, and some greenish blue, highly metamorphic slate debris, and a few fragments of vein quartz, and very minute traces of lime. Apparently drift.	A coarse gravel of bluish and bluish green, highly metamorphic slate debris, and nodules of vein quartz. No traces of lime. Pebbles much rolled.
Silurian slates and grits.	A rather coarse gravel of bluish and greenish blue, highly metamorphic slate debris, quartzose sand, nodules of reddish brown grits, containing spangles of mica, and fragments of vein quartz. The grit pebbles much rounded.	A very fine gravel of quartzose sand, some blue metamorphic slate debris, and nodules of vein quartz.
Silurian slates and grits.	A very fine gravel of decomposing yellow shale, a few fragments of green grits and bluish metamorphic slate.	A fine gravel of blue metamorphic slate debris, quartzose sand, fragments of vein quartz, and greenish grits, and a very few fragments of limestone. Apparently drift.
Limestone surrounded by a belt of sandstone.	A rather fine gravel of quartzose sand, with minute fragments of highly altered slate, rounded pebbles of vein quartz, fragments of yellow sandstone and of trap. Apparently drift.	Very fine gravel of quartzose sand, and fragments of greenish altered slate, with a few spangles of mica.
Limestone.	A fine grained gravel of quartz sand and small quartz pebbles, fragments of blue slate and of shales, apparently burned, and, in all probability, derived from coal ashes, and abundance of minute fragments of limestone.	Fine grained gravel of quartzose sand, with a slight admixture of grit debris, some large pebbles of reddish brown, greenish grey, and greyish black, very quartzose grits, and fragments of yellowish white vein quartz. A few particles of limestone.
Siliceous shales and grits and trap rocks.	A rather coarse gravel of greenstone or trap rock, and bluish green shale debris, containing a number of rolled pebbles; quartzose sand, reddish brown grits, containing spangles of mica, nodules of vein quartz, and a few fragments of yellowish shale, and particles of limestone. The pebbles much rolled.	A coarse gravel of greenstone, bluish green, and yellowish brown shale debris, containing a great many rolled pebbles; fragments of greenish, greyish, and reddish grits, the latter containing spangles of mica. Many of the greenish-coloured grits having the character of trap. No lime appreciable.
Calp limestone, but covered with drift gravel.	A rather coarse gravel of blackish cherty limestone calcareous grits, nodules of greyish black and blackish grey chert, and quartzose and chert sand. The pebbles much rounded.	A rather coarse gravel of cherty, greyish, greenish, and blackish brown grit debris and quartzose and limestone sand, and small pebbles of limestone. The pebbles much rounded.
Calp limestone, but covered with drift gravel.	A rather coarse gravel of blackish grey limestone calcareous grits of the same colour and chert nodules. Pebbles much rounded.	A coarse gravel of blackish cherty limestone, chert, vein quartz, greenish and brownish grits, and quartzose and calcareous sand. Pebbles much rounded.
Calp limestone, but covered with drift gravel.	A coarse gravel of greyish black limestone debris, with nodules of whitish and greyish chert.	A rather coarse gravel of greyish black limestone, calcareous grits, chert, and a few fragments of yellowish grey grits and fragments of anthracite coal.

[*continued.*

Table III.—Table representing the Per Centage of Gravel, and its specimens of Beet

No.	County.	Barony.	Parish.	Townland.	Name of Grower.	Per centage of Gravel in Soil.	Per centage of Gravel in Subsoil.	No. of Specimens of Beet grown upon soil corresponding to Table I.
10	Carlow.	Idrone East.	Kiltennell.	Mount Leinster.	John Newton, Esq.	35·90	32·34	47, 105, 106 and 107.
11	Kildare.	West Offally.	Lacka.	Derrylea and Aughrim.	Thomas Demsdale, Esq.	...	...	45 and 50.
12	Wexford.	Shelmaliere East.	Part of Northern Shores of Wexford Harbour flooded by the tide.		Edward Carroll, Esq.	...	...	39, 40, 41, and 42.
13	Cork.	Cork.	St. Finbars.	Ballygaggin.	Professor Murphy, (Cork Agricultural Model Farm.)	17·0	37·60	13, 14, 15, and 16.
14	Cork.	Cork.	St. Finbars.	Farrenmactiegue.	Messrs. Jennings.	15·70	3·22	37, 38, 110, and 111.
15	Cork.	Barrymore.	Aghada.	Aghada.	Rev. W. R. Townsend.	29·68	36·40	28 to 33, inclusive, and 97 to 102 inclusive.
16	Cork.	Imokilly.	Midleton.	Broomfield.	B. J. Hackett, Esq.	25·60	29·80	35 and 36, 103 and 104.
17	Soil from farm of M. Cläes, at Lembecq, near Brussels, Belgium.				...	13·94	...	119, 120, 121, 122.

Mineralogical Character, in the Soils and Subsoils upon which the examined were grown.—*continued.*

Nature of subjacent Rock.	Description of Gravel of Soil.	Description of Gravel of Subsoil.
Granite near junction with altered slate.	A rather coarse gravel of black and greyish chert, greyish and yellowish brown grits, quartzose sand, abundance of small fragments of limestone, and a few fragments of green gritty shales.	A rather fine gravel of quartzose sand, black, blackish grey, and grey chert fragments; fragments of greyish blue shale from the neighbourhood of altered slate; fragments of green shale and reddish brown grits and spangles of granitic mica. The quartzose sand apparently of granitic origin. Abundance of minute fragments of limestone and a few of felspar.
Peaty.	Soil consisting entirely of peat, being part of an extensive bog varying from 15 to 25 feet deep.	Immediately below the peat is found a deposit of white friable marl about 18 inches in thickness, and containing abundance of fresh-water shells. Below this occurs a deposit of blue clay marl about 2 feet in thickness, containing no pebbles. This marl rests upon limestone drift gravel.
Sides of the bay bounded by lower limestone, having on the western side a narrow belt of old red sandstone.	Land reclaimed by embankment from the sea, and consisting of fine silt without gravel.	A fine gravel of quartzose pebbles, bluish, brownish, and greenish shales, and grits and nodules of chert.
Limestone.	A rather fine gravel of purplish red shaly grit debris quartzose sand, a few fragments of greenish grits, nodules of vein quartz, and abundance of fragments of limestone.	A rather coarse gravel of purplish red and some greenish shaly grit debris, nodules of yellowish grey grit, vein quartz, and abundance of fragments of limestone. Pebbles much rolled.
Near junction of sandstone and limestone.	A rather fine gravel of purplish red gritty shale debris, quartzose sand, fragments of greenish shaly grits containing spangles of mica, abundance of particles of limestone.	A fine gravel of purplish red gritty shale debris, quartzose sand, and fragments of purplish red grits and shales, and abundance of fragments of limestone.
Slate near junction with yellow sandstone.	A rather coarse gravel of purplish red greenish and yellowish gritty shale debris. The shale containing occasional spangles of mica.	A coarse gravel of yellowish green and purplish red gritty shale debris.
Limestone near junction with sandstone.	A rather fine gravel of purplish red shaly grit debris, a few fragments of greenish grits, nodules of vein quartz, and abundance of fragments of limestone.	A rather coarse gravel of purplish red shaly grit debris, a few fragments of greenish grits containing spangles of mica; nodules of vein quartz and fragments of limestone. Pebbles much rolled.
..	A fine gravel of quartzose and green shaly slightly micaceous grit debris, blackish decomposing metamorphic slate, minute fragments of limestone, and large pebbles of vein quartz.	Subsoil not examined.

TABLE IV.—Representing the Composition of the Soils

Number.	Potash.	Soda.	Magnesia.	Lime.	Alumina.	Peroxide of Iron.	Phosphoric Acid.
1 Soil, .	0·084	0·313	1·058	0·523	3·778	6·029	0·189
„ Subsoil, .	0·403	0·130	0·685	0·442	3·193	5·841	0·172
2 Soil, .	0·026	0·680	0·684	0·601	3·254	5·764	0·320
„ Subsoil, .	0·404	0·398	1·000	0·319	3·078	4·771	0·188
3 Soil, .	0·271	0·547	1·337	0·624	6·256	7·549	0·197
„ Subsoil, .	0·003	1·045	1·324	0·233	6·660	8·907	0·101
4 Soil, .	0·107	0·154	0·415	0·335	4·168	3·906	0·208
„ Subsoil, .	0·110	0·383	0·441	0·148	4·060	4·386	0·084
5 Soil, .	0·203	0·317	0·673	2·242	4·399	5·228	0·213
„ Subsoil, .	0·364	0·129	0·385	0·555	4·213	4·806	0·252
6 Soil, .	0·301	0·547	0·457	0·418	2·341	4·446	0·223
„ Subsoil, .	0·065	1·002	1·159	0·362	3·824	7·009	0·315
7 Soil, .	0·071	0·711	0·525	3·618	4·191	4·970	0·274
„ Subsoil, .	0·001	0·883	0·445	0·720	5·168	5·429	0·075
8 Soil, .	0·369	0·435	0·218	5·479	3·273	5·394	0·525
„ Subsoil, .	0·562	0·360	0·262	5·714	3·232	5·586	0·281
9 Soil, .	0·049	0·900	0·607	5·965	4·228	6·575	0·382
„ Subsoil, .	0·062	1·013	0·491	2·000	3·415	5·551	0·173
10 Soil, .	0·096	0·320	0·443	0·861	3·679	3·542	0·236
„ Subsoil, .	0·171	0·270	0·379	0·819	3·708	3·540	0·199
11 Peat, .	Analysis given in Peat Report.	·	·	·	·	·	·
„ Shell Marl,		·	·	·	·	·	·
„ Clay Marl,		·	·	·	·	·	·
12 *a* (Fine Silt reclaimed.)	0·309	0·317	0·245	0·212	4·669	5·954	0·181
„ *b*	0·290	0·332	0·571	0·200	3·334	3·774	0·074
„ *c*	0·285	0·262	0·166	0·141	2·118	2·664	0·120
„ *d*	0·294	0·291	0·235	0·309	7·053	3·245	0·328
13 Soil, .	0·319	0·748	0·508	1·547	3·297	4·297	0·365
„ Subsoil, .	0·024	0·472	0·610	0·722	3·824	4·906	0·139
14 Soil, .	0·349	0·345	0·130	3·738	2·815	4·805	0·290
„ Subsoil, .	0·317	0·461	0·122	0·352	2·669	4·117	0·261
15 Soil, .	0·086	1·791	0·462	2·262	3·242	4·682	0·156
„ Subsoil, .	0·418	1·491	0·296	0·834	4·104	5·565	0·223
16 Soil, .	0·530	0·755	0·608	0·695	2·799	4·573	0·220
„ Subsoil, .	0·410	0·647	0·501	0·466	2·951	3·693	0·142
17 Belgian, .	0·260	0·327	0·023	0·146	1·385	2·018	0·270

upon which the Specimens of Beet examined were grown.

Sulphuric Acid.	Hydrochloric Acid.	Silica, in compounds decomposable by Hydrochloric Acid.	Clay, or Silicates undecomposable by Acids.	Siliceous Sand.	Water and Organic Matter.	Total.
0·182	0·005	6·957	11·188	61·840	7·495	99·651
0·115	0·006	5·759	25·384	50·307	6·575	98·912
0·194	0·020	6·651	19·462	51·224	10·931	99·811
0·033	0·013	5·732	13·960	67·333	3·315	100·514
0·432	0·034	20·759	29·834	13·422	17·861	99·123
0·386	0·093	23·400	39·554	4·798	13·352	99·586
0·069	0·010	9·516	17·378	55·492	8·673	100·431
0·022	0·025	10·128	17·980	60·392	2·749	100·908
0·358	0·008	9·166	31·711	26·103	16·846	97·667
0·095	0·008	5·155	20·126	57·794	5·728	99·610
0·100	0·008	7·579	31·098	44·013	7·831	99·462
0·022	0·014	8·661	42·983	30·672	3·901	100·193
0·202	0·018	11·937	41·520	22·032	8·184	98·253
0·073	0·018	16·549	40·332	26·839	3·274	99·855
0·307	0·028	10·193	26·067	32·780	11·680	96·758
0·159	0·014	8·443	40·623	23·096	7·976	96·308
0·410	0·007	6·632	31·404	28·197	11·466	96·822
0·198	0·006	4·488	48·257	28·488	6·200	100·342
0·140	0·008	5·946	35·120	40·559	9·235	100·185
0·162	0·007	6·959	47·833	30·359	6·438	100·844
·	·	·	·	·	·	·
·	·	·	·	·	·	·
·	·	·	·	·	·	·
0·578	0·074	13 964	52·278	8·214	12·137	99·132
0·418	0·020	9·547	34·864	37·957	8·709	100·090
0·404	0·015	5·983	15·875	66·640	5·606	100·279
0·293	0·024	7·738	7·108	65·815	8·315	100·048
0·157	0·006	13·666	33·730	34·897	5·767	99·304
0·107	0·004	10·750	27·681	46·029	4·617	99·885
0·162	0·006	7·118	36·511	34·951	6·491	97·621
0·063	0·003	9·069	60·830	19·111	3·192	100·567
0·147	0·034	8·369	46·564	24·692	6·221	98·708
0·067	0·019	3·859	47·213	31·967	3·199	99·265
0·184	0·004	7·204	33·537	42·170	7·360	100·740
0·156	0·003	9·489	36·282	39·164	5·899	99·803
0·078	0·010	4·146	42·909	43·327	5·356	100·255

TABLE V.—Tabulated results of Answers to Queries as to the pursued, &c., of several of

Corresponding No. in Table III.	Probable depth of Soil.	Probable depth of Subsoil.	Aspect, &c.	Inclination.	Exposure to Winds.	Rotation of Crops.
3	16 inches.	2½ feet.	A low-lying drained marsh, on the banks of the Foyle.	Very flat and but little elevated above the tidal level, being only protected from flooding by an embankment.	Exposed on all sides, but is most subject to the prevailing South and South-west winds.	A four course shift consisting of, 1st, drilled green crops; 2nd, grain, usually oats; 3rd, grasses; 4th, oats.
1	9 inches.	12 inches.	To the South-east.	Inclined.	Well sheltered from North, but a good deal exposed to Westerly winds.	A four course shift.
6	12 inches.	Varies from 2 feet to 10 feet.	Southward.	Inclined.	Only exposed to the South and South-west.	Recently reclaimed.
7	10 inches.	...	Northward.	Flat.	Exposed to North and North-east winds.	Lea oats, green crops and barley, with grass seeds.
11	20 inches to 2 feet.	Marl full of fresh-water shells, 2 feet; blue calcareous clay, 2 feet; then gravel, depth unknown.	Slopes gradually to the North.	Varies from 2 feet to 5 feet in 100.	Exposed on all sides.	Land in second year of cultivation; successive green crops until a workable soil is obtained.
10	12 inches.	3 or 4 feet.	Very much exposed to the South.	Greatly inclined to the South.	It is greatly sheltered artificially (by plantation) and naturally from the North and North-east winds.	Oats, green crops, barley, clover and grass seeds, pasture.
16	10 inches.	18 inches, though in some parts much less.	Aspect Southern.	One-half flat, the rest inclined at an angle of about 20°.	Exposed to the South-east and West winds; sheltered from the North.	Oats on the lea or fallow, potatoes, wheat, turnips, barley, with grass seeds.
14	7 inches.	7 inches.	Flat.	...	Rather sheltered.	Not long in possession, being exhausted corn land allowed to run into natural grass.
13	8 to 12 inches.	Upwards of 4 feet.	Exposed to all points but that part of the land which produced the sugar beet may be considered as having a Northern aspect.	Inclined at an angle of about 10°.	Sufficiently sheltered from North and North-east winds by higher lands.	First crop of present occupier; the usual rotation has been, 1st, potatoes; 2nd, wheat; 3rd, barley; 4th, oats with grass seeds.
15	18 inches.	Not ascertained.	A Northern aspect.	Inclined 1 foot in 20.	Much exposed to the North; slightly sheltered towards the East by a hedge and a few trees.	Green crop, corn, clover and grasses.

position of the Land, present condition of Tillage, Rotation of Crops the Beet soils analyzed.

General character of Soil.	Name of Crop grown in 1849, and produce per Statute Acre.	Manure Employed.	Name of Crop grown in 1850, and produce per Statute Acre.	Manure Employed.	Whether thorough Drained.	Whether Subsoiled and to what depth.
...	Grass, at the rate of $2\frac{1}{2}$ tons per Cunningham acre.	No manure.	Oats after hay, 240 stones per Cunningham acre.	No manure.	Drained at 3 feet deep and 20 feet apart.	Subsoiled to a depth of 18 inches.
...	The field was fallow while being subsoiled.	...	Wheat, which produced 8 barrels of 20 stone.	15 bush. bones sown broadcast with seed per Cun. acre.	Thorough drained.	Subsoiled to a depth of 18 inches.
...	Wheat, which produced 12 barrels to the acre.	No manure.	Barley, at the rate of 12 barrels to the acre.	No manure.	No drains, but naturally dry.	Not subsoiled, but ploughed as deep as 4 oxen could reach.
...	Oats.	No manure.	Wheat, 10 barrels per Irish acre.	None.	Not thorough drained, but a few sewers through it, but at distances about 150 yards.	Not subsoiled, but ploughed deep.
...	...	...	Potatoes; crop not weighed, but very small.	Peat ashes and Dublin dung.	Well drained by large open drains.	Not subsoiled.
...	Pasture.	Droppings of cattle and sheep.	Oats on the lea, yielding a produce of 10 barrels of 14 stone.	None.	Thorough drained.	Not subsoiled.
...	Potatoes and turnips; the produce of turnips being 40 tons per acre.	Farm-yard dung, with about 2 cwts. of Peruvian guano.	Same as in 1849.	Same as in 1849.	Not thorough drained.	Not subsoiled.
...	...	...	..	...	Not drained, but naturally dry soil.	Not subsoiled.
...	Potatoes, yielding from 5 to 6 tons.	80 loads of 10 cwts. each, of mixed street and stable manure.	Wheat, the produce being about 7 barrels per acre.	None.	Not thorough drained, the land being naturally dry.	Not subsoiled.
...	Lucerne, yielding 3 good cuttings.	None.	Lucerne.	...	Not thorough drained, being perfectly dry.	Subsoiled to full 2 feet by spade labour; but too much of the subsoil was brought to the surface.

TABLE VI.—Table representing the Per Centage of Sugar, &c., in Mangel Wurzel, Turnips,

Name of Plant.	County.	Grower's Name.	Date of pulling.	Weight of Bulb.	Specific gravity of Juice.	Corresponding density in degree of Beaume's Areometer.	Per centage of Water.
1. Yellow Globe Mangel.	Cork.	Professor Murphy.	Oct. 9.	lbs. oz. 3 6	1·035	5·25	86·367
2. Blood-red Garden Beet.	Dublin.	Ninian Niven, Esq.	Oct. 10.	1 9½	...	...	90·594
3. Yellow Globe Mangel.	Cork.	Rev. W. R. Townsend.	„	2 13¼	1·0351	5·20	89·889
Long Red Mangel. 4. Small.	„	„	„	1 3	1·0582	8·31	83·813
Long Red Mangel. 5. Large.	„	„	„	9 2	1·0361	5·36	90·230
6. Yellow Globe.	„	Messrs. Jennings.	Oct. 14.	5 14	1·0403	5·90	88·117
7. White Belgian Carrots.	Wexford.	Edward Carroll, Esq.	Oct. 18.	1 10¼	...	...	86·902
8. Dale's Hybrid Turnips.	Kildare.	Thos. Demsdale, Esq.	Oct. 19.	4 10	...	...	90·604
9. Swedish Turnips.	„	„	„	2 14	...	...	88·266
10. Yellow Globe Mangel.	„	„	„	2 12	1·0420	...	87·677
11. Yellow Globe Mangel.	Dublin.	William Dargan, Esq.	Dec. 4.	10 12½	1·0400	5·86	87·645
12. Yellow Globe Mangel.	„	„	„	...	1·0424	6·14	86·992
13. Long Red Mangel.	Cork.	Rev. W. R. Townsend.	Dec. 13.	9 6	1·0342	5·08	88·465
14. Long Red Mangel.	„	Messrs. Jennings.	Jan. 1.	8 15	1·0304	4·45	90·266
15. Long Red Mangel.	„	„	„	7 8¼	1·0306	4·48	90·160

TABLE VII.—Table representing the Results of Inquiries

No.	County.	Grower's Name.	Time of sowing.	Time of pulling.	Manure employed.	Quantity per Statute Acre.
1	Tyrone.	Robert M'Crea, Esq.	April 24.	Nov. 1.	Farm-yard manure. . Common salt. . . Kelp.	30 tons. 2 cwts. 3 „
2	„	James Sinclair, jun., Esq.	April 27.	October 12.	Pig manure. . . .	50 tons (about).
3	Cavan.	Messrs. Dickson & Co.	...	...	...	...
4	Louth.	—— Marron, Esq.	...	...	...	...
5	Dublin.	Right Hon. Lord Talbot de Malahide.	Last week in April.	...	Stable-yard manure. .	45 tons.

the several Specimens of Long Red Mangel Wurzel, Yellow Globe &c., examined.

Per centage of Dried Residue.	Per centage of Sugar in Dried Bulb.	Per centage of Sugar in Raw Bulb.	Per centage of Ash in Dried Bulb.	Per centage of Ash in Raw Bulb.	OBSERVATIONS.
13·633	52·963	7·220	6·684	0·911	Sown in the middle of April, and manured with mixed street and farm-yard manure. Grown on the same land as that which produced Nos. 13 to 16 white Silesian beet.
9·406	63·822	6·003	...	...	Sown in April, and manured with farm-yard manure. Grown on the same soil as that which produced Nos. 17 to 27 specimens of white Silesian beet.
10·111	69·836	7·061	9·404	0.9509	Sown in the latter end of May, and manured with farm-yard dung, and sea weed afterwards dug into the intervals. Same land as that which produced Nos. 28 and 29 white Silesian beet.
16·187	69·608	11·268	4·921	0·796	Sown in the latter end of May, and manured with farm-yard manure. Grown on the land which produced Nos. 30 and 31 white Silesian beet.
9·770	73·861	7·216	11·785	1·151	
11·833	65·507	7·751	7·581	0·897	Sown from the 15th to the 28th of April, and manured with pig manure. Grown on the same land as that which produced Nos. 37 and 38 white Silesian beet.
13·098	50·104	6·563	7·673	1·005	Sown June 2nd, and grown without any manure, and with very little attention.
9·396	40·297	3·786	7·698	0·723	Sown in the middle of May, and manured with vitriolized bones, guano mixed with ashes, turf mould, and soap lees. The land was in very bad condition, and in a sort of marly, more or less peaty stiff soil.
11·734	56·417	6·620	4·764	0·559	
12·323	66·007	8·134	8·037	0·990	
12·355	65·590	8·153	7·204	0·890	Sown on May 12th, and manured with farm-yard dung and guano. Grown on the same land as that which produced Nos. 90 and 91 specimens of white Silesian beet.
13·008	64·078	8·316	...	...	
11·535	61·643	7·110	10·158	1·171	Sown late in April, and manured with farm-yard manure. Grown on the same land as that which produced Nos. 101 and 102 specimens of white Silesian beet.
9·734	57·807	5·627	10·614	1·033	Grown on the same land as that which produced Nos. 37 and 38 specimens of white Silesian beet, and manured in the same manner.
9·840	57·798	5·687	...	...	

relative to the Produce, &c., of Beet grown in Ireland in 1851.

Total cost of Manure.	Mode and Time of applying Manure.	Weight of Bulbs per Statute Acre.	Weight of Leaves per Statute Acre.	OBSERVATIONS.
£ s. d.				
...	The dung was spread in the drills, and dug in with spades. The salt and kelp were harrowed in. The manure was applied immediately before the sowing of the seed.	18 tons.	Not weighed.	
...	Put in the drills at the time of sowing.	28 tons per Cunningham acre.	Not weighed.	
...	...	46 tons.	...	
...	...	30 tons per Irish acre.	...	
Estimated at 2*s.* 6*d.* per ton: 5 12 6	Placed in the bottom of the drills immediately before sowing.	48 to 52 tons.	About 12 tons.	

[*continued.*

TABLE VII.—Table representing the Results of Inquiries

No.	County.	Grower's Name.	Time of sowing.	Time of pulling.	Manure employed.	Quantity per Statute Acre.
6	Dublin.	Wm. Dargan, Esq.	May 8.	Dec. 10.	Farm-yard manure. . Guano.	20 loads. 4 cwts.
7	Kildare.	Thos. Demsdale, Esq.	7th to 25th of May.	...	Burned clay and marl, farm-yard manure, Dublin street dung, with as large a proportion of night soil as could be obtained, all mixed with soap lees to the extent of 10 or 12 cwts. per acre.	30 tons.
8	Carlow.	John Newton, Esq.	May 20.	End of Nov.	Farm-yard manure. .	60 tons.
9	Wexford.	...	May 15.	End of Nov.	Farm-yard manure. .	60 tons.
10	"	Edward Carroll, Esq.	April 20.	...	Farm-yard dung in compost.	30 tons.
11	"	"	Transplanted July 1.	...	No manure.	...
12	"	"	June 1.	...	Farm-yard dung in compost.	30 tons.
13	"	"	July 12.	...	Farm-yard dung in compost.	30 tons.
14	"	Frederick Jones, Esq. (presented by Mr. Carroll.)	May 20.	...	Farm-yard dung in compost.	35 tons.
15	Cork.	Messrs. Jennings.	From 15th to 28th April.	November.	Pig manure. . . .	35 tons.
16	"	Professor Murphy.	Middle of April.	Middle of November.	Mixed street and farm-yard manure.	25 tons.
17	"	Rev. W.R. Townsend.	Last week in April.	...	Sea weed. . . .	12 horse loads.
18	"	B. J. Hackett, Esq.	1st of May.	1st week in November.	Stable and cow-stall manure, with sea sand.	...

relative to the Produce, &c., of Beet grown in Ireland in 1851—*continued.*

Total cost of Manure.	Mode and Time of applying Manure.	Weight of Bulbs per Statute Acre.	Weight of Leaves per Statute Acre.	OBSERVATIONS.
£ s. d. 4 1 0	Manure placed in the drills at the time of sowing.	26 tons.	13 tons 2 cwts.	
2 0 0	Drilled in with the plough just before sowing.	Estimated on some divisions at 18 tons, but on the worst not above 9 or 10 tons.	Not weighed, but particularly fine.	
6 0 0	Placed in the drills at the time of sowing.	20 tons.	...	
6 0 0	Placed in drills at the time of sowing.	25 tons.	...	
...	Manure applied at time of sowing.	20 tons 10 cwts.	5 tons 10 cwts.	This crop was grown in beds 4½ feet wide, and in drills 18 inches apart, the plants being about 1 foot asunder in the drills; cabbages having been grown in the alleys, yielding 24 tons per acre. The object of this mode of cultivation was to show that the most common mode of culture, such as the lazy bed system of growing potatoes, would answer for the growth of beet.
...	...	31 tons 10 cwts.	7 tons.	This crop was transplanted from No. 1, on land subsoiled or trenched 18 inches deep, in order to show the advantage of deep spade husbandry.
...	...	22 tons 5 cwts.	5 tons.	This land was cultivated as farmers usually do for turnips. The drills were 30 inches apart, and the plants 30 inches in the lines.
...	...	2 tons 10 cwts.	1 ton.	To show the inferiority of produce from late sowing.
...	...	42 tons.	16 tons.	The land was cultivated as it is usually done for turnips in the district. It was a peculiar variety of the white Silesian beet, with an orange red passing into rose-coloured skin and white flesh; the root tapered like a carrot.
...	Ploughed in from November in a fresh state.	22 tons.	6 to 7 tons.	
2 10 0	In drills at the time of sowing.	16 tons.	3 tons.	
...	In the drills.	39 tons.	...	Six drills of Silesian beet, manured with dung, gave at the rate of 13 tons only to the statute acre.
4 10 0	Applied during the sowing.	30 tons.	...	

Appendix F.

Report on the Composition of the Swedish Turnips and other Root Crops, prepared at the request of the Agricultural Improvement Society of Ireland. By William K. Sullivan, Chemist to the Museum of Irish Industry.

The Council of the Royal Agricultural Society having requested an examination of three lots of Swedish turnips, with a view of determining their relative feeding value, the following analyses were made. The results are, however, unfortunately of very little value, if I except the ash, as the specimens were selected without the slightest care, and were subsequently exposed for some time in a very dry atmosphere—one lot, I believe, for a space of three or four weeks, and no information whatever accompanied them. The numerical results were communicated to the Society, but no report was made of their comparative values, as it was clearly impossible to do so; every one, however unacquainted with science, being aware that plants when taken from the soil lose water, and that the slightest loss of that constituent would necessarily exert considerable influence upon their value weight for weight. Their richness in saccharine matter having attracted my attention, I endeavoured to utilize the results by examining some other plants with reference to the quantity of sugar contained in them, and thus compensate for the waste of time caused by inattention to the conditions under which scientific experiments should be conducted. I offered to report to the Council upon this subject, but that body would hear of nothing but of "turnips." They are now put together in the present Appendix, not for their intrinsic value, but as being the experiments, the partial publication of which led to the inquiry on the sugar beet being carried out.

Method of Analysis Adopted.

Proximate Analysis.

Water.—The water was determined in exactly the way described for the beet at page 24.

Nitrogen and Ash.—The nitrogen was determined by the method of Varrentrapp and Will, and the ash in the manner described for the beet at page 24.

Remaining Constituents.—The fat, woody fibre, pectine, and gum were separated in the following manner:—

a. Fat.—The residue, after extraction of the sugar with alcohol of 0·831, was treated with successive portions of ether; the ether was then distilled off, and the washings of the sugar with absolute alcohol added to the residue, the alcohol evaporated off, and the whole mass re-dissolved in ether, filtered, the ether evaporated off, and the residual oily matter heated in a small capsule to 212°., and weighed.

b. Pectine.—The residual solid matter, after separation of the fat by ether, was then treated with dilute caustic potash, with which it was boiled about twenty minutes, filtered through muslin, the potash neutralized with hydrochloric acid, and the pectine precipitated with excess of alcohol, collected on a filter, washed first with acidulated water, then with water, and finally with alcohol. It was then dissolved in ammonia, and filtered through paper to separate any fibre which may have passed through the muslin, the ammonia neutralized with hydrochloric acid, and the pectic acid washed with acidulated water, then alcohol, and finally dried and weighed.

The solution of the pectic acid in potash when simply filtered through muslin is never clear, and would require to be again filtered through paper, an operation which would require about a fortnight; the ammoniacal solution on the other hand, filters readily. The object of washing with alcohol is, that pectine and pectic acid, when washed with water, assumes an extremely gelatinous consistence, and covers the filter like a varnish, through which one drop of fluid cannot pass; with alcohol, on the contrary, it shrivels up, and assumes the character of fibre, and may be perfectly washed. The pectic acid, during its filtration on muslin, should be pressed from time to time with the hands, otherwise, from its gelatinous character, the surface only could be washed. The pectic acid obtained in this way is very pure, and free from inorganic matter, but care should be taken in boiling out the pectic acid that the solution of potash be not too strong or the boiling continued for too long a time, otherwise metapectic acid, or some other of the numerous stages of transformation of pectic acid might be formed, and as many of these substances are soluble in water, an erroneous result might easily be obtained.

c. Woody Fibre.—The residue, after treatment with potash, was washed with acidulated water, treated with acetic acid, and then with strong hydrochloric acid, washed, dried, and weighed.

d. Gum, &c.—About 1,000 grains of the fresh root were then grated over muslin, and the pulp well washed, and repeatedly squeezed in the hand until every thing soluble was removed. The liquor which passed through the muslin was rapidly heated up to the boiling point and immediately removed from the sand bath, allowed to cool, and the clear liquid decanted, and the precipitate washed with water and again allowed to settle. All the liquors were then added, and treated with acetic acid, and the precipitate, which is usually very small, and sometimes even nothing, is thrown down washed by decantation. The entire liquors are then evaporated to a small bulk, and the gum precipitated with excess of strong alcohol which dissolves the sugar, &c. It is then collected in a capsule, washed with alcohol, dried, weighed and incinerated to determine the amount of inorganic matter precipitated with it. It is impossible to say whether this gum exists as such in the turnip; my own opinion is that it does not, but is simply formed from the sugar by the action of some nitrogenous substance in the juice as in that of beet after expression.

I made determinations of the nitrogenous substances directly from the juice and from the dried root, but place no reliance upon any determination made in that way; there is but one accurate method of determining those substances, and that is by an ultimate analysis for nitrogen. As has been observed by others, the quantities found by the former method scarcely ever amount to more than one-third that found by the latter.

Ash Analysis.

The dried turnips were first charred until all volatile matter had been given off, the residue was then washed until every thing soluble was removed, dried, and incinerated; the perfectly white ash which was obtained was then added to the filtered liquor, and the whole evaporated to perfect dryness. In other respects the mode adopted in determining the different constituents did not present any thing deserving of mention.

Composition of Swedish Turnips.

	1	2	3
Water,	85·060	82·203	85·458
Woody Fibre,	3·421	3·116	2·242
Pectic Acid,	1·870	1·690	1·410
Fat,	0·270	0·310	0·180
Gum,	0·130	0·160	0·110
Sugar,	6·701	8·172	7·535
Albumen, and other nitrogenous substances,	2·082	1·361	1·368
Ash,	0·400	1·171	0·636
	99·934	99·183	98·939

Composition of the Ash of Swedish Turnips.

Constituents of Ash.	1	Per Centage of Oxygen.		2	Per Centage of Oxygen.		3	Per Centage of Oxygen.	
Potash,	29·167	4·952		45·127	7·662		30·241	5·134	
Soda,	17·102	3·574	14·480	4·046	0·223	13,608	21·737	4·792	15·244
Lime,	13·581	3·880		12·672	3·620		11·846	3·384	
Magnesia,	5·347	2·074		5·422	2·103		4·986	1·934	
Protoxide of Iron,	1·291	—	0·286	1·360	—	0·302	0·684	—	0·152
Phosphoric Acid,	7·490	4·200		6·300	3·533		5·720	3·207	
Sulphuric Acid,	13·876	8·325	16·495	13·470	8·082	15·366	13·260	7·956	14·860
Hydrochloric Acid,	3·842	.		3·746	.		3·749	.	
Silica,	7·641	3·970		7·220	3·751		7·115	3·697	
Total,	99·337			99·363			99·338		
Chloride of Sodium,	—	—	6·157	—	—	6·003	—	—	6·008

The almost total absence of carbonic acid in these ashes must be accounted for by the heat employed in the burning of the ash, and by the unusually large quantity of sulphuric acid which they contained.

The examination of the bulbous roots for sugar having been undertaken merely as a preliminary to a fuller investigation of the subject, and having been very much occupied with other researches at the time, very few particulars connected with their growth could be obtained, and in other respects the results are much less complete than those given in the preceding Report. The following table contains the tabulated results :—

Variety.	Locality.	Weight of bulb.	Water.	Solid Matter.	Sugar.
		lbs. oz.			
Long Red Mangel Wurzel, . .	Dublin, .	1 8	84·520	15·480	9·62
Short ditto, . . .	,, .	0 14	83·680	16·370	10·70
,, ,, . . .	Kildare, .	0 13½	81·441	18·559	12·106
Orange Globe ditto, . . .	Wicklow,	2 4½	85·974	14·026	9·00
,, ,, ,, . . .	Cork, .	1 2	82·878	17·122	11·00
White Silesian Beet, . . .	,, .	1 1¾	80·512	19·488	13·240
,, ,, ,, . . .	Dublin, .	0 13	80·802	19·198	11·980
,, ,, ,, . . .	,, .	0 12	81·530	18·470	12·600
,, ,, ,, . . .	Belgium,	1 3¼	83·150	16·850	10·970
White Belgian Carrot, . .	Kildare, .	1 0	83·590	16·410	8·10

Observations.—The greater part were pulled in November, and some in December; part having been obtained from the collection of roots exhibited at the Royal Dublin Society, or from the exhibitors, when the specimens exhibited were too large. They were all very small roots, and were selected simply for convenience. They had all lost, in some degree, water; the Belgian root especially.

A comparison between these results and those given in the tables appended to the General Report, lead precisely to the same conclusion, all the roots of the same size examined in 1851–52, giving equally high per centages of sugar; and no doubt, had very large roots been examined, smaller per centages of solid matter and sugar would have been observed. So far however, as they go, the results are perfectly accordant.

DUBLIN: PRINTED BY ALEXANDER THOM, 87, ABBEY-STREET,
FOR HER MAJESTY'S STATIONERY OFFICE.