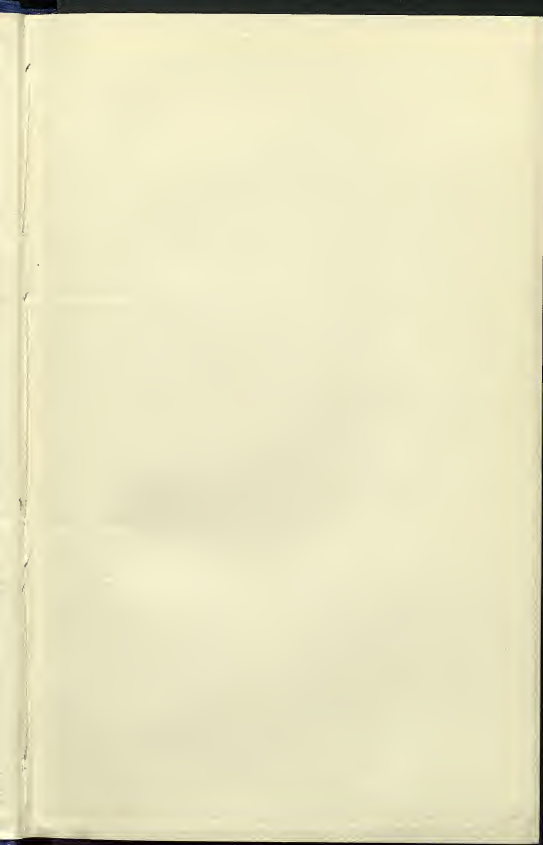


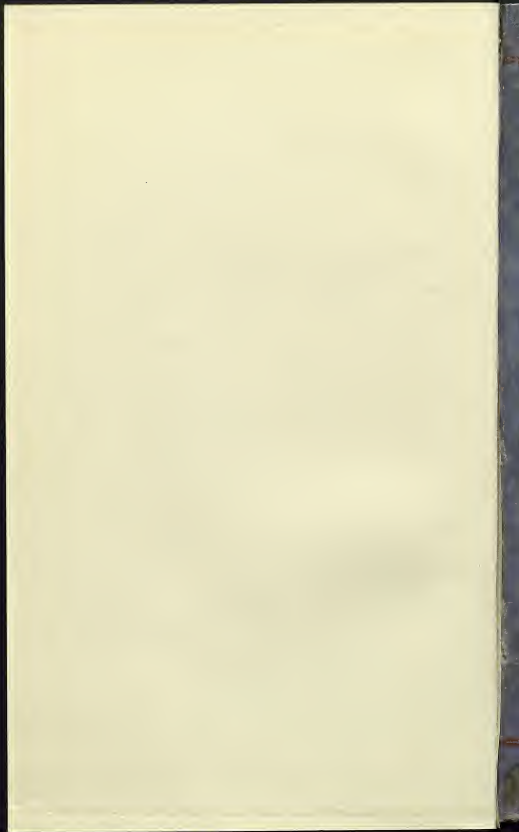
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BEET ROOT
AND
BEET ROOT SUGAR:

A PAPER READ BEFORE THE MEMBERS OF
The Cork Literary & Scientific Society,
AT THE ROYAL CORK INSTITUTION,
ON THURSDAY, THE 19th APRIL, 1877.

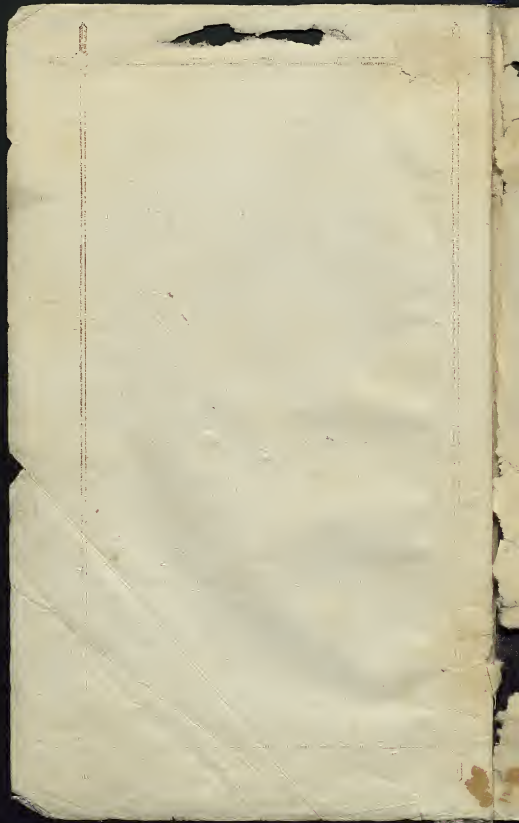
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JAMES OGILVIE.

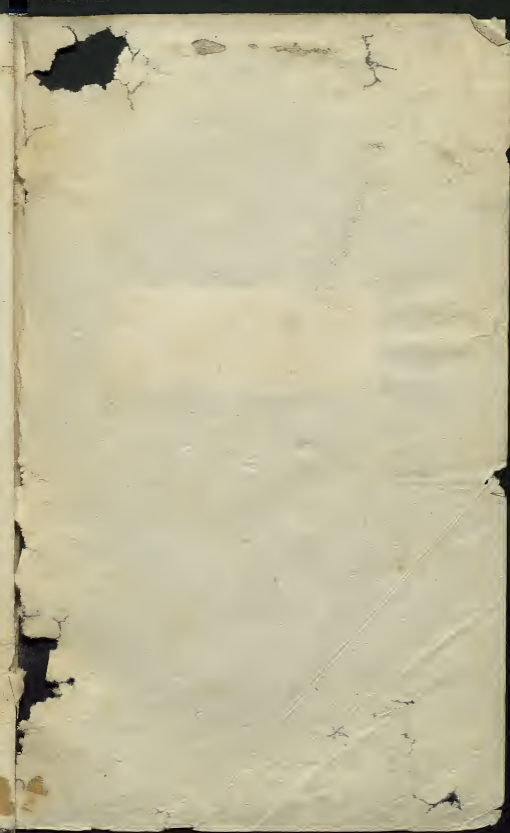
[Published at the request of the Society.]

With an Appendix,
GIVING FULL INSTRUCTIONS FOR THE CULTURE OF BEET ROOT,
BY
WM. K. SULLIVAN, PH. D., M.R.I.A.,
President of Queen's College, Cork.

CORK:
FRANCIS GUY, MUNSTER STEAM PRINTING WORKS,
70, PATRICK STREET.

Any profit resulting from the Sale of this Pamphlet, will be divided amongst the Charitable Institutions of the City, by the Council of the Literary and Scientific Society.





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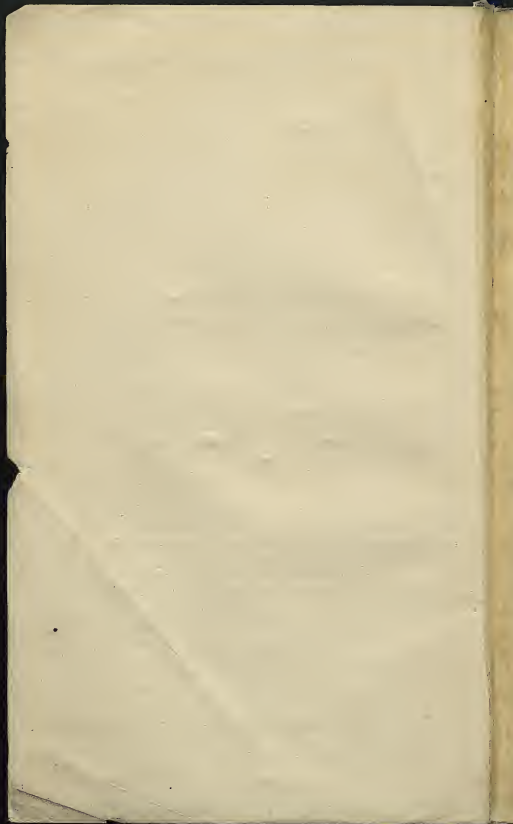
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P R E F A C E .

The following Paper on "BEET ROOT AND BEET ROOT SUGAR," was read before the members of the Cork Literary and Scientific Society, last month, and is now published at their request.

Since the reading of the Paper a good deal of attention has been directed to the subject, and already the matter has assumed something of a practical form, several farmers in this neighbourhood having during the past fortnight purchased seed, for the purpose of cultivating beet root during the coming season. Such being the case, it is to be hoped that there will be a good competition for the £10 prize, offered by Mr. Fox, and referred to at the end of this pamphlet.

Various persons having within the past few days called on the writer for the purpose of getting information with respect to the growth of beet root, he asked for, and at once got from Doctor SULLIVAN, full instructions for its culture, which are now given as an appendix. Such information, from such an authority, is of the greatest importance, as, if farmers give Doctor SULLIVAN'S instructions the attention which they deserve, beet root is certain to be successfully grown in Ireland, and the first step will have been taken towards the introduction of an industry called by THIERS, the great French historian, and late President of the French Republic, "the Providence of the Empire."

Since the writer read his Paper, he was favoured by our fellow-citizen, Mr. BALLARD, with the perusal of an interesting Paper on "Sugar, and Sugar-producing Countries," from which the following paragraph is taken—"By direction of the British Government, the British consul at Belgium was requested to report on the beet sugar manufacture in that country, and in his published report he makes the following statement :—'The beet sugar industry is productive of unmixed advantages and profits to Belgium ; it enriches the farmer, the landlord, and the treasury ; it provides good wages for agricultural labourers near their own homes during the winter months, thus counteracting the noxious temptations offered by the great towns, and promoting the interests of social order, as well as of agriculture. This industry doubles the produce of the land in cattle and corn. It thus supplies man with bread and meat, as well as with sugar and alcohol. Why does not the United Kingdom cultivate such a valuable resource ? Our soil and climate are certainly suited to the culture, as roots grown in the United Kingdom have been found as rich in sugar as the best Continental specimens.'"

This is valuable testimony in favour of beet root cultivation, and beet sugar manufacture, and as it strongly corroborates the views given expression to in the following pages, its introduction here may not be considered out of place.

HIBERNIA BUILDINGS,
KING STREET, CORK.
May, 1877.

Beet Root and Beet Sugar.

INTRODUCTION.

MR. PRESIDENT, LADIES AND GENTLEMEN,

On the reading before this society in the early part of the present session of Mr. Thomas Scott's admirable paper on "The Commercial possibilities of Cork," a discussion arose with reference to beet root sugar, in which I took part. I then held, and still maintain, that in the present depressed state of the sugar refining trade of the United Kingdom, consequent chiefly on the unequal competition of bounty-fed foreign refined sugar, refineries in Ireland would not be profitable undertakings.

But while holding those views on the subject of *sugar refining* in this country, I hold quite the opposite opinion with reference to the *manufacture* of *raw* beet sugar. I believe that Ireland is eminently suited for the growth of beet root, and that therefore raw beet sugar could be profitably manufactured here, for the purpose of exportation to England and Scotland for refining purposes, as it would there compete on equal terms with foreign-manufactured raw sugar, the export-bounty given by Continental Governments being confined altogether to the refined article.

The object of the latter portion of this paper is to show that such is the case, and I trust that it may be the means of something practical being done towards the introduction of the beet sugar industry amongst us.

HISTORY OF BEET SUGAR MANUFACTURE ON
THE CONTINENT.

The common beet is indigenous to the shores of the Mediterranean, where it grows wild. It is the mother plant from which the sugar-yielding beet has been derived, and which is now in very general cultivation all over Europe, as well as in America.

Germany was the first country in which it was cultivated specially for the manufacture of sugar. In the year 1747 a Prussian chemist, named Marggraf, made known the fact that of all plants beet root contained the largest quantity of sugar, and at a meeting of the Royal Prussian Academy of Sciences he stated that the sugar derived from beet root was identical with that derived from sugar cane. Shortly afterwards he tried to obtain sugar on a large scale, but his efforts were not successful. In 1772 another Prussian chemist, named Archard, turned his attention to the subject, and endeavoured to do what Marggraf had failed to accomplish. He induced Frederick the Great, who was a devoted lover of art and science, to take an interest in his experiments. Frederick perceived in the application of this discovery a means by which to develop the resources of Prussia, and to diminish the exportation of specie in payment for the imports of cane sugar, but his death in 1786 prevented Archard from pursuing

his researches ; however, he resumed them in 1795, when he planted 60 to 70 acres of beet on a small estate of his own in Silesia, and in 1796 established the first beet root sugar manufactory. In a pamphlet which he published about the same time he stated that in addition to its yield of sugar, the beet would be a valuable pulp to serve as food for cattle, that the head of the root would also be eaten by them, that much valuable manure would be the result, that this manure in returning to the ground would promote an abundant harvest of cereals, that the molasses could be converted into alcohol or vinegar, and that the leaves were an excellent substitute for tobacco. When Archard made public his opinion that the manufacture of beet sugar would be profitable on a large scale, the persons interested in Colonial sugars got alarmed, and offered him, it is said, a bribe of £7,500 if he would publish a pamphlet stating that he was convinced that the beet root could never be used as a substitute for sugar cane. The late Emperor of the French asserted that the British Government offered Archard as much as £30,000 if he would report that his experiments had resulted unfavourably, but that this humiliating offer was rejected with contempt. Shortly after writing the pamphlet referred to, Archard communicated to a French chemical periodical a series of letters which produced a great sensation in that country. Some regarded him as a quack, and others looked on him as their deliverer from the commercial and industrial monopoly of England, but the attention of men of science, and of the French Government, was arrested by his assertion that brown sugar could be produced for about three pence per pound,

and that if the manufacture was improved, and the value of the residue deducted, the price might be still less.

Such an important statement could not be neglected, and a commission of ten eminent chemists was appointed by the Institute of France to investigate this new branch of industry, and to report on Archard's writings on the subject. The result was somewhat disappointing. That the root contained crystallizable sugar was evident, but that the percentage would repay the cost of extraction was not so apparent, especially as the failure of Archard's manufactory threw discredit on the scheme. The Commissioners reported that the root yielded only a little over one per cent. of sugar (or less than a sixth of what is now considered as barely satisfactory), and again the subject dropped out of the public mind. At length, however, beet sugar was brought prominently and successfully into notice by the industrial complications consequent on the vast Continental blockade established by Napoleon the First; for, in attempting to destroy the Colonial prosperity of Great Britain by excluding British sugar and other produce from the countries under his control, he deprived large numbers of his subjects of what long use had taught them to regard as an indispensable necessity of their daily life; and the discontent thus caused led him to hold out splendid inducements to chemists to provide an equivalent. The price of foreign sugar had at this time risen to 3*s.* 9*d.* per pound. It was, therefore, possible now to cultivate and manufacture beet at a profit. The celebrated chemist Chaptal, then Minister of the Interior, and other chemists, roused by the

importance of the occasion, having turned their careful attention to the causes which led to the previous failures of the advocates of the manufacture of beet sugar, soon introduced various improvements into the process hitherto adopted, and the erection of two Imperial factories was followed by the general spread of the manufacture, thus producing sugar at a price considerably below that to which it had recently risen. The first samples were received by Napoleon with great joy, and he placed them under a glass shade in his drawing-room, proudly exhibiting them as amongst his greatest treasures. In 1812 Napoleon issued a decree, establishing chemical schools, and imperial manufactories for the extraction of sugar from beet, granting licenses to owners of factories, and various other persons who had made sacrifices in promoting this new branch of commerce, and ordering the cultivation of 100,000 acres, calculated to produce 37,500 tons of sugar, at that time sufficient for the wants of France. This inland product was to be free of duty or any other tax for four years from the date of the decree, and every manufactory had to make or furnish at least ten tons during the first year. Great enthusiasm was excited by this announcement, which led to the establishment of manufactories in all parts of France, but being generally erected in unsuitable localities, and by persons without a knowledge of agriculture, and having neither practical or scientific skill, they nearly all turned out failures, so that even with Government aid, most of those who made the attempt were seriously disappointed. Continued rain, and excessive drought happened just at this period, to deepen the anxiety and loss

caused by bad processes of cultivation and manufacture. Political vicissitudes in 1814 and 1815 brought foreign troops into the country to trample down this and other plants. Matthew de Dombasle, one of the greatest promoters of agricultural improvements in France, writes, that when, for the first time, he planted beet, the French troops were in Moscow, and when later in the same year he was manufacturing the root, a detachment of Cossacks occupied his premises. Once more, therefore, this ill-fated enterprise was on the point of extinction. The lower prices of sugar which resulted from the events of 1814 and 1815—namely, the restoration—completed the ruin of the new establishments, and it appeared certain that the manufacture of beet sugar could not survive the extraordinary circumstances to which it owed its existence. The French ports were opened to the commerce of all maritime nations; bonded warehouses, long empty, were filled with Colonial sugar, and prices sustained a great decline. One establishment only continued to exist, that of Crespel Delisse, who lived to see this become a flourishing branch of industry. The Imperial origin of this industry did not increase the sympathy towards it of the restored Bourbons, under whose rule, therefore, there was no disposition to encourage it at the expense of the revenue. After various legislative modifications, however, the duty on foreign sugar was raised, and colonial and home-grown placed on an equality. Then, beet sugar began again to show signs of life, and from 1822 to 1825, more than a hundred small manufactories worked regularly, producing annually about 5,000 tons. The stability of this new home

product appeared an accomplished fact, and it continued to progress until 1829, when reports of large profits made by it attracted the attention of Government, and the manufacturers were informed that their produce would ere long have to bear an increased taxation. The Revolution of 1830, however, put a stop to the intended change of duty, and until 1837 a regular and rapid progress followed; the production in the former year being only 5,500 tons, while in the latter there were between 400 and 500 factories at work, which produced 40,000 tons. This remarkable progress alarmed importers and ship-owners, whose influence induced the Government to almost extinguish the new branch of industry—at all events, so to clog it by fiscal laws and heavy duties as to prevent its materially interfering with the colonial and shipping interest.

On the 18th of July, 1837, the Chamber passed a law, which was to take effect on the 1st of July, 1839, adding an extra duty of 15 francs (or 12s.) per hundred kilogrammes on beet sugar above colonial. This check was irresistible—the year following many of the manufactories suspended operations, and the production which in 1838 was 49,000 tons, fell in 1840 to 22,000 tons. Notwithstanding this protection, the imports from the colonies only increased by 3,000 tons, and prices did not advance. Additional pressure was, therefore, brought to bear on the Government by the importers and shipowners, the consequence of which was that the duty on colonial sugar was reduced 10s. per hundred kilogrammes, so that in one year the difference of duty was altered to the extent of 22s. per hundred kilogrammes, or about 11s. per

hundred weight in favour of colonial sugar above the native product. This had the effect of increasing the imports of colonial sugar, which, from 55,000 tons in 1837, rose to 89,000 in 1842. Even with the great and unjust pressure put on beet sugar in 1839, its vitality remained, and in 1842 the production had slightly increased. The protectionists, consequently, recommenced their agitation, and on the 10th of January, 1843, it was proposed in the Chamber that the manufacture of beet sugar should be suppressed altogether, but, fortunately, this was not carried. For some years the production continued to gain ground, until in 1848 slavery was abolished by the Republic, and the colonial interest thus received a heavy blow and great discouragement. Thenceforth the supply from the colonies diminished. A considerable reduction in the duty on beet sugar was effected, placing it on the same footing as Havannah, Brazil, Manilla, and other foreign sugars, which paid only three to five francs per hundred kilogrammes more than those produced in the French colonies. Since 1849 the progress has been amazing and uninterrupted, except so far as unfavourable seasons have influenced the harvests, and the beet sugar industry has now grown to be one of the wealthiest in France. In 1850 the production was 64,000 tons; in 1860 it had risen to 120,000 tons, or nearly double what it was ten years previously, and last year (1876) France produced the enormous quantity of 462,259 tons, which, at an average of £22 per ton, represents a money value of £10,696,698.

It would occupy too much time to trace the history of beet sugar in other countries, and I

have chosen France as being the one which chiefly witnessed the development of this enterprise; but to give an idea of the value of the beet sugar industry generally, I may mention the production last year of the various Continental countries, and after hearing the figures I think you will, with me, be amazed, that while the growth of beet, and the manufacture of beet sugar, is so successfully carried on in nearly every country on the Continent, Ireland has not yet even made a beginning, more especially when we consider that this climate is *as* suitable for growing beet as that of *any* of those countries which I will name, and *far more suitable* than some of them. France last year was at the head of the list with 462,259 tons of sugar manufactured. Germany came next with 346,646 tons. Russia and Poland were third with 245,000 tons. Austro-Hungary was fourth with 153,922 tons. Belgium was fifth with 79,796 tons, and the other countries (including Holland), produced 30,000 tons—the entire Continental production being 1,317,623 tons of sugar, which, at an average of £22 per ton would amount to £28,987,206.

The quantity of roots grown in Germany for the production of 346,646 tons of sugar was 3,500,000 tons, so that, calculating at the same rate, the entire growth of beet root on the Continent last year must have been between 13 and 14 million tons.

SKETCH OF THE SUGAR REFINING INDUSTRY
ON THE CLYDE.

Having given an outline of the history of beet sugar manufacture on the Continent, I now ask

your attention to the sugar *refining* industry on the Clyde, that being the district into which raw beet sugar was first introduced for refining purposes.

But little is known of the early history of the sugar industry on the Clyde, except perhaps the names of some of the original refiners, and the position of their refineries. It will be sufficient for the present, however, to say that the industry was commenced in Greenock upwards of a hundred years ago, and that it flourished in Glasgow at a much earlier period. Since then it has been prosecuted with increasing success, the trade, however, manifesting a strong tendency to gravitate towards Greenock, until at the present time the latter is the only port on the Clyde where the industry is carried on. Sugar refining was prosecuted in Port Glasgow for many years, until it died out about 1866, while it lingered on in Glasgow until about a year ago, when the only refinery then working was closed. The concentration of the industry in Greenock is, doubtless, owing to the great facilities which it possesses in a good, safe harbour, where sugar-laden ships can be discharged, cheap dues, short cartage, and above all, in an abundant supply of good soft water, suitable for refining purposes. Until within the last thirty years the process of refining raw sugar was very much the same as it had been at the commencement of the present century. Various improvements were introduced from time to time, chief amongst which may be mentioned Howard's vacuum pan in 1813, which enabled the filtered liquor to be concentrated at a very much lower temperature than under the old system of heating

over an open fire. The introduction in 1815 of bone black or animal charcoal for decolouring sugar solutions was also productive of great benefit to the industry, but there still remained much to be done to bring it to its present state of perfection. With the old process, the first product of a refinery could not be turned out sooner than seven or eight days after the raw material was melted, and before the inferior products were ready for market a month or six weeks had to elapse. Sugar, in fact, moved slowly through the refinery, having for the most part to be manipulated by hand. The demand for sugar, which was now increasing annually, stimulated the trade to renewed efforts to meet it, and refiners turned their attention to the application of improved machinery to shorten the process, and reduce labour. The earliest attempt in this direction is due to Hardman, who, in 1843, patented the use of a centrifugal machine for rapidly removing syrups and molasses. Hardman's process did not, however, meet with much favour until 1849, when another patent was obtained for the use of steam in connection with the centrifugal machine. In 1851, eight of these machines were started in the refinery of Robertson & Co., of Glasgow, but their use did not become general in the district until nine or ten years afterwards. The introduction of centrifugals led the way to a new system of refining called the "Greenock," or "in and in" system, from the fact that no syrup is turned out of the refinery. In this system, the syrup resulting from the treatment of the last products of one day is returned to form part of the next day's melting.

By this method of working, the fine products

are not made into loaves, and sugar passes very quickly through the refinery. The rapidity of the process is such that raw sugar taken into the refinery on any day is melted, filtered, decolourised, boiled, dried in the centrifugal machine, and the first product sent into market *next morning* a pure, white, crystalline sugar, while the remainder is turned out on the third day after melting. To work this system successfully it is necessary to use *good* raw sugars, but notwithstanding this drawback, it rapidly grew in the estimation of refiners, until the old system, and the making of loaf sugar, was abandoned altogether in the Clyde district. The advantages attending this process were many:—In the first place, it enabled refiners to treble their turn out, without increasing the size of their refineries; in the second place, it enabled them to make the increased quantity in very much less time; and in the third place, the expedition of the process greatly reduced the tendency of the liquors to ferment, which they are liable to do, especially if kept for any length of time. The great progress made during the twenty succeeding years (from 1852 to 1872) was, in a large measure, due to the introduction of the centrifugal machines, and the Greenock system of working. The turn out for these years was 41,664 tons, and 208,870 tons respectively, that is to say, the production of refined sugar in the Clyde district increased considerably more than four-fold during that period. The introduction of beet root sugar, for refining purposes, in the year 1858, marks an epoch in the history of the industry on the Clyde. As the industry grew, refiners sought new sources of supply, and naturally looked

to the Continent, where beet sugar was being produced cheap, and in large quantity. Many, however, were prejudiced against its use, and looked with disfavour on the proposal to introduce it, but the enterprise of some refiners was not to be baffled by prejudice, and two or three firms made trial of this variety of raw sugar for refining, with satisfactory results, if we may judge from the fact of there having been 2,500 tons refined on the Clyde that year. Once introduced, the consumption of the new raw sugar gradually increased to 9,085 tons in 1862, while in 1872 it had risen to the large quantity of 48,865 tons, or equal to about one-fourth of all the sugar refined on the Clyde. The growing consumption of beet sugar did not do much to remove the prejudice of some refiners towards it. When anything went wrong in the refinery, beet sugar was blamed. If the refined sugar went down in colour, or syrup accumulated, the fault was traced to the beet. In fact anything, no matter how trifling, when it occurred in a refinery where this class of sugar was used, was always attributed to the beet. Although these complaints were often overstated, there was, nevertheless, occasionally good ground for dissatisfaction. Refiners were accustomed to buy and judge of sugar by colour and other physical appearances, and they applied the same mode of valuation to beet sugar. In this they were wrong, for, unlike colonial sugar, beet sugar might have a good colour and a good round crystalline grain, and still be unsuitable for refining by the Greenock process.

With some knowledge of this fact, and with some misgivings, refiners continued to buy beet

sugar in the old way for ten or twelve years before adopting the French system of valuation, which is based on chemical analysis. When, however, it was introduced, refiners knew exactly what they were doing, and complaints about the working of beet sugar became less frequent. The *standard* strength on the French system is 88 per cent. of net realizable sugar—that is to say, were 100 parts of raw sugar of the standard strength refined to pure loaf sugar and molasses, there would be 88 parts of the former, and 12 parts of the latter. The price is fixed at so much for the standard strength, advancing and receding at a fixed rate for each per cent. above and below the standard. Refiners have now gone in so fully for this system of valuation, and now place so much confidence in it, that sugar is often bought months before it is made. On delivery the bulk may be in any physical condition as far as regards colour and crystalline appearance, provided on analysis a check sample, drawn when landing, is found up to the sale analysis. The analyses of check samples have proved to be very necessary, as it often happens that sugar delivered in the United Kingdom differs by two or more per cent. from what it was said to be when shipped on the Continent. The mode of valuing raw beet sugar is a very good one. The beet sample is sent to two chemists for analysis. Should their results differ to a greater extent than one-half per cent. another portion of the same sample is sent to a third chemist, and the mean of the results of the two chemists between whose analyses the least difference exists, is taken as the true percentage on which the valuation is based ; but so perfect is the

method of analysis, and so easy of execution, that it is seldom necessary to call in the services of a third chemist.

CULTIVATION OF THE BEET ROOT.

Having given a sketch of the history of beet sugar *manufacture* on the Continent, and of sugar *refining* in one of the principal refining centres of the United Kingdom, I now turn to the consideration of the root itself.

The beet root, as already stated, is indigenous to the south of Europe. It was introduced into the Netherlands by the Spaniards, and thence brought into Germany. There are many varieties of it, differing in character of root, nature of leaves, and colour. Two sorts are usually cultivated—one producing succulent leaves only, and the other distinguished by its large fleshy root. The common field beet, of which the German name is *mangel wurzel* or “scarcity root,” has long been known in Germany, from whence it was introduced into this country, and has become a very popular crop for the feeding of cattle. Beet root has been an object of regular cultivation from the beginning of the present century only, and since that time several varieties have been obtained, partly as the result of cultivation, and partly as a consequence of climate and soil. The whole of the sugar in beet is secreted during the first year’s growth, consequently, for manufacturing purposes, it is an annual, though otherwise a biennial plant, bearing seed in the second year of its growth. The *white silesian* variety so far exceeds all others in the amount of sugar to be got from it that it is called the “sugar beet.”

The *white silesian* root is slender and tapering, and shows very little above the ground, penetrating about twelve inches into the soil. Its shape unsuits it for a clayey tenacious soil, but it does well in rich, light, loamy earth, easily penetrated by water, and containing nutritious elements at a good depth. The leaves and stalks, which lie close to the earth, are green, as is also that portion of the root which rises above the ground. The leaves will sometimes rise very high before spreading, but at other times, spread close to the root, and this variation, which depends on many circumstances, requires to be studied with care, for when the closeness of the leaves shades the roots from the sun, that portion which rises above the ground is protected from solar action, and the otherwise white root is not turned green, but when the loftiness of the leaves permits this, the change of colour has an injurious effect on the quantity and quality of the saccharine matter. Good white silesian roots have a white, firm, and dense tissue, and a clean sugary taste. Such roots are readily reduced to a fine pulp by proper machinery. Soft and spongy thick-skinned roots are always more watery than beets of a uniformly hard and close texture. Good sugar beets have always small tops, and no tendency to become what is termed "necky." Such roots do not show much above ground, but grow almost entirely in the ground. Roots, the tops of which grow above ground, do not yield as much sugar as others that bury themselves better in the soil, besides which, the parts above ground contain a large quantity of crystalline salts, especially saltpetre.

Some species of beet grow nearly half out of

the soil, the consequence of which is that their saline qualities are so greatly increased, and their sugar proportionately lessened, that they are used only for distilling and cattle feeding. The presence of salt is above all things inimical to the production of sugar from this root, consequently whatever increases its saline qualities is a serious obstacle to success, and must be avoided. In some instances the undue proportion of salt in sugar has nearly rendered the sugar unsaleable, and so generally is this recognised abroad, especially in Germany, that the manufacturers in contracting with the growers of the root, stipulate that it shall not be grown on certain soils, and often even name the manure which shall be used. They also frequently provide the seed themselves to ensure the right quality being grown. Manufacturers of sugar cut off the greenish coloured heads of the roots before they are pulped, and hence much waste takes place when beet roots grown in large measure above ground are sent to the manufactory. Generally speaking, the higher the specific gravity of a beet root, the more it is esteemed for its sugar-producing qualities. Good roots are considerably more dense than water, and rapidly sink to the bottom of a vessel filled with water. The average composition of sugar beet is 82 to 88 per cent. of water, 7 to 12 per cent. of sugar, and 4 to 6 per cent. of insoluble matter. The quality of sugar in beet also varies according to the method of its cultivation, the dryness or otherwise of the season, and the nature of the fertilisers employed. Good sugar beets generally weigh from $1\frac{1}{4}$ to 2 pounds. Very small or very large roots, are not usually well suited for the

manufacture of sugar. Roots weighing under three-quarters of a pound are frequently woody, and, besides sugar, contain a large proportion of other constituents, which, in a large measure, prevent the extraction of crystallized sugar from the juice; whilst roots weighing more than $2\frac{1}{2}$ pounds are generally too watery and too poor in sugar. Walkoff states that having analyzed twelve roots, gathered by him at the same time, out of the same field, he found that three roots, each under one pound weight, contained nearly 14 per cent. of sugar; four roots, each under one and a half pound weight, contained only 11 per cent.; and five roots, each under two pounds weight, contained rather less than 10 per cent. of sugar: from which he concluded that the smaller the root, the richer will be its saccharine qualities. With reference to this matter of *size*, which is of the utmost importance in beet root culture, our president, Doctor Sullivan, in his lecture to the Cork Farmers' Club, two years since, said "Next to variety and race, size is that quality of roots which most influences their composition. The bigger the root, as a rule, the less sugar it will contain. It must, however, be borne in mind that big roots of a superior race, when grown under favourable conditions, and fully matured, may contain more sugar than small roots of another race. The comparison of roots, as to size, should only be made between those grown on the same soil, and from the same seed, sown at the same time. Indeed, it is probable that part of the difference observable between large and small roots, grown in the same field, is frequently due to race, or to congenital characteristics, which retard or accele-

rate their maturation. Some idea, however, of the influence of size may be formed from a comparison of two roots, grown side by side, which I analyzed. The larger, which weighed 9lb. 8 $\frac{3}{4}$ oz., contained nearly 94 per cent. of water, and about 6 $\frac{1}{4}$ per cent. of solid matter. The smaller weighed 3lb. 9 $\frac{1}{4}$ oz., and contained only 89 per cent. of water, and about 11 $\frac{1}{2}$ per cent. of solid matter. I shall put these numbers more intelligently by telling you that one ton of the big roots would give 140lbs. of real food, and 2,599lbs. of water, while one ton of the small roots would give 255lbs. of real food, and 1,984lbs. of water. But this is not all. The food of the big roots would be by no means of the same quality as that of the small ones. For instance, the big roots abound in saltpetre, in fact they are rather medicine than food for cattle. It will be still more instructive to compare with these inferior roots others raised from ennobled seed, and containing more than 14 per cent of sugar, but weighing between one and two pounds. One ton of these roots would contain 500lbs. of real food, and only 1,739lbs. of water, but the solid matter of such roots would possess, weight for weight, a much higher feeding value than that of watery roots, and a crop of such roots would also exhaust the land less. These few figures will show you that big roots would not do for making sugar. Judge for yourselves, whether the custom of giving prizes for the largest roots is the way to promote agriculture." In another portion of his lecture Doctor Sullivan said, "the improvement of seed applies to all crops, especially potatoes, and it is well worthy the attention of agriculturists. It is in this direction encourage-

ment should be given by Agricultural Societies, and not to the production of monster roots, *which is a negation of all the teachings of science.*" On the same subject Professor Cameron says—"the practice of growing enormous roots of any kind is undoubtedly open to serious objections. Monster roots are almost always very watery, and they do not store well. As a larger number of small roots can be grown than large ones, and as the former, weight for weight, contain more actual nourishment, I have no doubt that a crop of moderate sized mangels or turnips is more valuable than one composed of overgrown roots. Though the farmer may have a very large quantity of roots to cart in from his field of monster mangels, yet it should be borne in mind that the extra weight, as compared with a crop of moderate sized roots, is merely water." In France, the duty is levied *on the sugar* as it comes from the manufactory, but in Germany, *on the root* when entering it. The great advantage of the German over the French plan is that the manufacturers find it necessary to examine the beet roots with great care, preferring not the largest, but the most productive, and thus the farmers are stimulated to produce those of a more superior quality, the result being that in Germany *fully two per cent. more sugar* is extracted from the small roots grown closely, than from those of a more imposing appearance in France. The vast importance to the country of this matter of the size of roots, and the universality of the mistaken ideas with respect to it, not merely as regards beet root, but mangels, turnips, and other crops, are my excuses for dwelling at such length on this part of the subject.

Few cultivated plants thrive under more varied conditions of climate than beet. It is grown in Europe from the shores of the Mediterranean to very near the Arctic Circle, and from the Atlantic to the Caspian Sea. Excepting the northern parts of Scotland, and the high moor grounds, the United Kingdom is as favourably situated for the cultivation of the sugar beet as any portion of the Continent—the south of Ireland, according to various authorities, being particularly well suited for it. Doctor Voelcker says, “there are many persons in this country who are either altogether unacquainted with, or very imperfectly instructed on matters relating to the growth of beet, who entertain the view that neither the climate nor the soils of England and Ireland are conducive to the economical growth of that crop. It is believed by them that beet roots require a large amount of heat to arrive at maturity, and therefore do not do so well when grown in the more temperate climate of England, as on the Continent in localities having a much higher temperature than most places in Great Britain. This, however, is a mistake, for the localities most favourable to the cultivation of sugar beet on the Continent are not the south of France or Germany, but the northern departments of France and the plains of Magdeburg and other localities in the north of Germany, which districts, I need hardly observe, are much more temperate than the southern countries of Europe. In the south of Germany, with few exceptions, the growth of sugar beet has not made any progress, whilst in the north of Germany and France it is increasing considerably year by year, and the beet root is considered one of the most

important and profitable crops that can be raised on the farm. Again, it may be noted, that the climate of the districts in which beet root culture is carried on with the greatest success resembles closely that of England, and that neither the temperature of Holland or Belgium materially differs from that of many parts of England and Ireland." In his pamphlet on the "Chemistry of Sugar Beets" Doctor Voelcker also says:—"Many persons with whom I have conversed on the subject of sugar beet culture have entertained doubts whether our English summers are warm enough to ripen sugar beet sufficiently, because they have an idea that this crop requires a great amount of heat for coming to perfection. Whether or not England is a country favourable to beet culture experience alone can decide, but if beet root culture should ultimately prove to be a failure in England, it will not be on account of want of summer heat. In point of fact, sugar beets do not nearly so well in central France or Germany, nor in the south, as in the north where the summer temperature is much lower. It is not so much heat as a dry autumn which makes the sugar in the beet. It is further of much consequence whether the end of April and the month of May are wet or dry. The more rain falls on the land during the first two months of the growth of the beet, the better the crop is likely to turn out if a dry autumn follows." Professor Cameron in his work on the "Culture of the Silesian Beet" says:—"there can be little doubt as to the suitability of Ireland as a root-producing country. Larger crops of mangels are more frequently obtained in Ireland (other things being

equal) than in England or Scotland, and in this respect Ireland is far superior to France or Germany. The beet, being of the same nature as the mangel, may be grown under almost identical circumstances, and such being the case, it is evident that very large crops of white beet could be grown in Ireland. The mild and moist climate of this country is favourable to the culture of the beet. In most parts of the Continent where the crop is cultivated it sometimes fails from spring and early summer droughts, and occasionally from premature frosts. In Ireland there is usually abundance of rain in the early summer months, and frost seldom appears until Christmas, or later. The mildness of climate would permit the growth of the beet to go on until December, if necessary, and would favour the conversion of the non-saccharine carbo-hydrates of the root into sugar. It is quite a fallacy to think that brilliant sunlight and tropical heat are necessary factors in the production of sugar. They are indeed when the sugar is developed in the foliage, but they *lessen or prevent* the production of sugar *in the roots*. Beet roots, carefully protected from the solar beams, contain far more sugar than is found in those roots which are partly exposed to direct sunlight. Doctor Voelcker found in that portion of a beet root which lay completely below the soil $8\frac{1}{2}$ per cent. of sugar, and only 4 per cent. in the portion of the root which grew above the ground, and which was exposed to the sun. In Ireland the summers are not hot, but that is not a disadvantage, but rather the contrary, for although this plant grows indigenously in Portugal, it does not thrive as a sugar-producing crop in

warm climates." Doctor Sullivan says that he considers this country *eminently* suited to the cultivation of the beet root, and in pamphlets which he has published at various times, he gives the most convincing proof by analysis and otherwise that such is the case. The fact is, that this root *flourishes* only in the temperate zones, such as the north of France, the north of Germany, Russia, &c. The growers generally entertain a great dread lest too much heat should injure it. The sky of Ireland is continually overcast, and the amount of light greatly intercepted, which circumstance is adverse to the successful growth of wheat. Fogs in the harvest months frequently cover the country and retard the ripening action of the sun, hence blights and failures of the grain crops are frequent, and the quality is on the whole inferior in its organic constituents to that of similar harvests in eastern and southern Europe. Beet does not need a brilliant sky, with much light and heat. Light has comparatively little to do with producing its saccharine matter, for this is formed not in the portion above ground (where the saline particles gather) but in that beneath. A moist climate, with moderate sun, is what it requires, and such is the climate of Ireland. As the average of inches of rain falling yearly here is similar to that in France and Belgium, being however distributed over a greater number of days, it is clear that in this respect our climate is *even more* suitable than that of either of those countries. It is a remarkable fact that while the sugar cane increases in saccharine richness as it approaches the equator, the reverse is the case with the beet, which up to a certain degree north

or south, secretes more sugar as it approaches the poles.

The land most suitable for growing beet is that on which the soil is free from peat and salt, but is rich, light, and loamy. Clay land is too cold, the roots do not easily penetrate it, and they would be deficient in saccharine matter. On moorland and very heavy marshland the result is the same; nor does dry sandy soil, or soil with a hard rocky bottom, yield a satisfactory crop. Stony ground is also to be avoided, as it cannot be thoroughly worked, while newly cleared ground contains matter detrimental to the sugar-producing power of the beet. Experience has shown that the best crops as regards both quantity and quality come from light, deep soil, free from excessive moisture and acidity. As this root takes up three to four per cent. of mineral salts, lime, potash, and soda, and as the bases of these may interchange one with another, all attempts to make good sugar from the product of salt land, soil too much manured, or ground recently cleared of timber, are certain to be entirely futile. Doctors Sullivan and Voelcker say that the chief requisites in soil upon which this crop is intended to be raised are a sufficient depth and ready penetrability by the plant, and the last-named authority adds that all soils in which potatoes grow to perfection are perhaps the most suitable of all for the growth of beet-roots. Any soil incapable of being cultivated to a depth of 16 to 18 inches is unsuitable. On land deficient in lime the sugar beet is apt to get what is termed "fingered and toed," and hence care should be taken, before taking land for the cultivation of this

crop, to see that it contains a fair proportion of lime.

Next to the soil, manure has a powerful influence on the quality of sugar beet. If possible, beet should not be grown on newly-manured soils. In heavily and newly-manured land the roots become poor in sugar, and overcharged with saline matters; which, as before explained, prevent largely the extraction of the sugar in a crystallizable state. Of course, if the soil is poor, it is impossible to grow anything like a good crop without manure, and in that case, artificial manure may be used with advantage; but the greatest care and judgment require to be exercised in this matter, particularly with respect to the application of farm-yard manure, which should be used in autumn only, and never in spring. Common salt, so largely applied to mangels in this country, and nitrate of soda, retard the ripening process, and, in consequence, act injuriously on sugar beets. On the other hand, phosphate manures favour early maturity. Doctor Voelcker, in describing some white silesian beets grown in Devonshire, which contained a very large per centage of water, and only $3\frac{1}{2}$ per cent. of sugar, says, "in raising these roots no particular attention was paid to the condition of the land. They were grown like ordinary mangels, with plenty of fresh dung, and owing to this cause, they were no better than common mangels, and were unsuitable for the manufacture of sugar." Referring to another lot of roots which he had analyzed, he says, "the heavily-manured beets, as might be expected, were very poor in sugar, and contained a larger proportion of nitrogenous and saline matters than the

roots grown without any manure." One sample of white silesian beet, grown in rich vegetable mould, was found by Doctor Voelcker to be so full of nitrates, that the dried root burned with scintillations like touch-paper.

In the early part of the century the yield of beet was very small on the Continent, only 8 tons per acre being then obtained in France, whilst at present the quantity per statute acre in France is from 16 to 20 tons, 16 tons being considered a fair yield for good land. In Germany the yield is only 12 to 15 tons per acre, but the difference between the two countries is more apparent than real, as in the latter country the fiscal considerations, already explained, lead the growers to regard not the weight of the root, but the quantity of saccharine matter obtained, and accordingly they cultivate a small rich species. In the matter of quantity produced, recent experiments prove that Ireland will compare favourably with the Continent in that respect. In 1875 several farmers in this neighbourhood were induced to grow sugar beet, by the offer of a prize of £10 for the best acre. Mr. James Byrne, J.P., of Wallstown Castle, chairman of the Mallow Farmers' Club, and Mr. Alex. Ferguson, of Belvidere, were appointed judges, and from their report to the Messrs. Richardson Brothers and Company, of this city, dated 26th November, 1875, I gather the following particulars. Nine persons entered their crops for competition, but as only three of them complied with the necessary conditions of submitting a dozen average roots for analysis to Mr. O'Keeffe, County and City Analyst, the competition was confined to that number. The three competitors were:—

Mr. E. Farrell, of Ballydulea, Queenstown; Mr. D. J. Riordan, of Rafeen, Monkstown; and Mr. David Bradley, of Carrigrohane. Mr. Farrell's crop was estimated at 15 tons to the acre; Mr. Riordan's, at 17 tons; and with reference to Mr. Bradley's crop, the judges say, "We had some perches weighed, and were astonished at the result. They were topped, tailed, and washed, and although none of them were large, on account of being so thickly planted, yet the roots were so deep that Vilmorin's species gave 22 tons per statute acre, the red top $25\frac{1}{2}$ tons, and the green top 27 tons per statute acre."

The per-centage of sugar contained in the roots is of course of the utmost importance, and in that respect Irish-grown roots will also bear favourable comparison with Continental ones. The roots grown by Mr. Farrell were found to contain $14\frac{1}{4}$ per cent. of sugar, but though the roots grown by Mr. Bradley were exactly the same sort as Mr. Farrell's they contained only 9 per cent. The judges very properly attributed the small per centage in Mr. Bradley's case to the fact of his having used farm-yard manure, which as I have before explained, has the effect of seriously diminishing the amount of saccharine matter in the beet, while Mr. Farrell used dissolved peruvian guano. In 1853, Doctor Sullivan analyzed 59 beet roots grown in various parts of Ireland, and compared them with 62 foreign-grown ones analyzed about the same time. Of the foreign-grown only 49 per cent. of the roots contained over 9 per cent. of sugar, while 67 per cent. of the Irish were above that standard, some of the latter containing as much as 15 per cent of sugar, and with one single

exception all the Irish contained over 8 per cent. In 1870, some roots sent from the Cork model farm to Doctor Voelcker for analysis, were found to contain from 10 to 11 per cent. of sugar. Roots sent him at same time from Ballymoney model farm, contained $9\frac{1}{2}$ to $10\frac{1}{2}$ per cent., while in roots sent to Doctor Hodges from Glasnevin model farm, there was found from 10 to $12\frac{1}{2}$ per cent. of sugar. In 1872, which was a very wet season, the Revd. J. H. Jellett, late President of the Royal Irish Academy, analyzed some roots grown at Glasnevin model farm, the *average* amount of sugar being a little over $12\frac{1}{2}$ per cent. In 1869, Doctor Voelcker analyzed, for the Hon. Leopold Agar Ellis, some roots grown in the county Kilkenny, the highest per centage of sugar being 11 per cent. Next year (1870) he analyzed more from the same place, some of which contained over 14 per cent., the average being $12\frac{1}{2}$. The superior quality of the roots grown in 1870 over those grown in the same ground in 1869 was simply the result of experience in the cultivation of the crop. In the letter which accompanied Doctor Voelcker's report of the analysis he said, "I question much whether better and richer sugar beets have been grown this season in the most favoured beet root districts of Belgium or France."

Apart altogether from the manufacture of sugar, and considering beet root as a *purely farm crop*, there is no reason why farmers should not cultivate it here. Professor Cameron says, "the white beet is a well-flavoured root, and is eagerly eaten by cattle. The non-nitrogenous substances which it contains are chiefly sugar, a food material, probably more valuable, and certainly more palatable

than starch or pectin, which constitute the greater part of the nutriment of the animals of the farm. The sole object of converting barley into malt, to be used as a cattle food, is to change the starch into sugar, an operation attended by expense, as well as a waste of material. Some expensive articles, such as locust beans and molasses, which are often given to cattle, are valuable only for the sugar they contain. If it be desirable then to feed cattle on saccharine food, why not produce it on the farm? Why not grow the silesian beet, which contains from 8 to 13 per cent. of this valuable aliment? If there were never to be established a sugar factory in Ireland, it would clearly be to the interest of the stock-feeder to grow a crop, yielding him a couple of tons of sugar per acre, and in cultivating which he need not in the slightest degree interfere with his usual system of cropping. Not only does the beet crop enable the farmer to grow immense quantities of that which Mr. Banting terms the most fat-producing of all foods—namely, sugar; but it also takes out of the soil and air a greater quantity of absolute nutriment—of dry matter—than a turnip does, and a much larger amount of absolute nutriment than a potato crop." Doctor Voelcker says, "the farmer will run very little risk by trying the experiment of growing sugar beets instead of common mangels, for if he cannot obtain a good price for his roots from the sugar manufacturer, he can use the beet for cattle food; and, although he may not get as heavy a crop as he does when he plants mangels, it has to be borne in mind that one ton of sugar beets is equivalent in nutritive qualities as cattle food to at least one-and-a-half

ton of good common mangels. Sugar beets exhaust the land far less than mangels, and as the former should not be grown with farm-yard manure, the whole expense of the manure for a crop of beet roots will be the cost of 3 to 4 cwts. of superphosphate. A few acres of sugar beet, I cannot help thinking, would supply more solid feeding matter, and food of a more nutritious character, than a good many acres of watery, spongy, tasteless, and unnutritious turnips." Common mangels are now being grown much more largely in Ireland than they were a few years since. In 1869 there were only 21,000 acres cultivated; in 1870 it had increased to 25,000; in 1871 to 31,000; in 1872 to 34,000; in 1873 and 1874 to 38,000; and in 1875 the number of acres under that crop were more than double what were cultivated in 1869—namely, 43,000, the produce of which was 715,173 cwts., and the estimated value at 15s. per ton, £536,378." From the remarks of Professor Cameron and Doctor Voelcker which I have quoted, it appears to me that farmers make a great mistake in year after year increasing their crops of mangels to the exclusion of beet; but as this is a matter of great importance, I will give you the opinion of another authority on the subject. He says:—"I also wish to allude particularly to the mistaken ideas prevalent with agriculturists, that until a manufactory in their neighbourhood is erected, to purchase the root, its cultivation will be unprofitable compared with that of mangels. So far from this being the case, there is good reason to assert that were no sugar factory in operation, still beet should be grown *instead* of mangel, for

sugar, which is an important article of nutrition in both roots, is never less than 8 per cent. in beet and often as high as 13 per cent., but is never more than 4 per cent. in mangels."

It follows, therefore, that a small crop of beet will equal in usefulness a large crop of mangels. I believe this is true to such an extent that one cwt. of the beet will be equal in value to $1\frac{1}{2}$ cwt. or 2 cwt. of the mangels. This is easily proved by the quantity of solid matter contained in the two roots, there being in mangolds 91 per cent. of water and 9 per cent. of solid matter, while in silesian beet there is only 82 per cent. of water and 18 per cent. of solid matter. Now, as the difference in weight grown per acre is on the average one-third more of mangel than of beet, it naturally results that it is more advantageous to grow beet than mangels. Other advantages are that the milk derived from cattle fed with beet is far sweeter and more abundant than that from those fed with mangels; and as mangels contain two per cent. of salt, and beet only one per cent., the latter is less exhausting to the soil. In Messrs. Byrne and Ferguson's report, referred to before, they say, "every care was taken to arrive at a just and satisfactory conclusion, and also to obtain as much information as possible, for the benefit and guidance of future growers of a green crop, which we think eminently adapted to the south of Ireland, and worthy the attention of our farmers as a valuable, and *in comparison with others, a superior forage crop.*" It will thus be seen that all who have given the subject attention, unhesitatingly pronounce beet root to be a more desirable crop *for purely farm purposes* than

mangels, and still the farmers of Ireland persist in growing what is apparently the best, but really much the reverse.

It has been stated that the culture of beet exhausts farms, but such is not the case. Various instances could be cited where land in France, which before beet root culture was introduced, yielded 19 hectolitres of wheat per acre, now yields 27, or even more. Of 225,000 acres occupied by farmers in a certain district, only 1,447 were formerly sown with beet for the use of cattle, and the number now is 21,405. Formerly, 4,202 hectares of wheat were sown there, now 9,290, and the cattle have increased from 6,995 to 40,656. The Département du Nord, which produces the largest quantity of beet sugar, at the same time raises and exports more wheat and cattle than any other. In one case of a farm of 900 acres, divided into 300 for beet, 400 for wheat, 50 for rye, and the remainder for clover, carrots, potatoes, &c., it was found that the yield of wheat, after beet was thus introduced, became nearly as large as when the whole 900 acres were used for its production. Mr. David Lee Child, a gentleman who has given a great deal of time to the study of the beet crop in Europe and America, and who has written largely on the subject says, "the beet is an enriching and a cleaning crop, exterminating every noxious plant, and leaving good stuff in the ground, which, ploughed in, is equal to a quarter or half manuring, or in other words, to five or ten loads of manure per acre, and the expense of carting." He also says that "it requires no fallow, it is the very best forerunner of other crops, and instead of impoverishing the soil, constantly improves it."

An eminent French writer says, "all cultivators and economists are unanimous in recommending the cultivation of the sugar-producing plant, which is the source of deep tillage and increased production. No one believes now that it exhausts and impoverishes the soil, or that it hurts other crops. These are the prejudices of a bygone age, which science and practice have banished, to set up in their place a recognition of benefits of the highest order, produced by the culture of the beet."

I have shown that the climate of Ireland is as suitable as the most favoured portions of the Continent for the growth of beet, and far more so than some parts of it where the root is extensively grown. I have pointed out that the quality of roots per acre is as large here as the produce on the Continent, and that the percentage of sugar, in carefully grown roots, is fully up to the Continental average, if not beyond it. I have also shown that the beet crop, instead of impoverishing the land, actually enriches it, and that apart altogether from the manufacture of sugar, it should be grown by farmers as a purely farm crop, being more fattening, and the milk from cows fed with it being richer and more plentiful than when mangels are used. Why is it then that farmers do not grow beet here? It is manifest that the recently discovered process of conveying fresh meat from America to this country is destined to exercise a powerful influence, not only on the price of beef to the householder, but on the price of cattle to the farmers. As the supply of meat increases, the price of cattle must inevitably decline, and farmers will find the rearing of stock far less remunerative than it has been. Under

these circumstances they will be obliged to turn their attention to a considerable extent from grazing to mixed husbandry, and as no crop would pay them better than carefully grown beet, the sooner a commencement is made the better.

BEEET SUGAR MANUFACTURE IN IRELAND.

In the concluding paragraph of the judges (Messrs. Byrne and Ferguson) from which I have already quoted, they say, "on speaking to the different competitors, all were satisfied that the crop was one which could be grown to advantage in this part of Ireland if a sugar factory was established. They looked hopefully forward to see such a branch of industry spring up in the southern capital, and promised as far as in them lay to assist such an undertaking by every means in their power." When the subject of beet root sugar was discussed before this Society a few weeks since, our president, Doctor Sullivan, told us that in his opinion, it would be unwise to erect a factory for the manufacture of sugar here, until the farmers were better acquainted with the cultivation of the root. With that opinion I entirely agree, there being so many things the want of attention to which would quite unfit the roots for manufacture. For instance beets grown much above ground do not yield as much sugar as ones properly covered, besides which their saline qualities are so greatly increased as sometimes to unfit them altogether for the manufacture of sugar. Then again the land may be quite unsuitable, for any of the following reasons—it may not be capable of being cultivated sufficiently deeply, it may be too salt, or have too little lime in its composition, either of which

would be the means of producing roots unsuitable for sugar manufacture. Manuring the crops would also require to be studied carefully, as the wrong sort of manure, or too much of the right sort even, would have the effect of producing roots from which it would be impossible to extract a paying per centage of crystallizable sugar. Great care is also needed in harvesting the crop, as the slightest injury to the roots is sure to be followed by a proportionate loss of sugar. To the farmer who uses the roots for his cattle this is of comparatively little importance, but to the manufacturer it is a very serious matter, as when roots are injured by careless manipulation in trimming or otherwise, fermentation rapidly sets in, and the crystallizable sugar is converted into fruit sugar or glucose, which does not crystallize, and is consequently lost. For these reasons I think it unreasonable of Irish farmers to expect that any individual or company should initiate the enterprise instead of themselves, particularly when it is beyond question that they can profitably grow the root on a small scale for use on their farms, at the same time that they gain the necessary experience to enable them to grow on a large scale, roots suitable for sugar manufacture, which they might easily do after two or three experimental seasons.

Then doubtless there would be many willing to join in starting a sugar manufactory, and there is no reason why (supposing *suitable* roots were grown), such an undertaking should not be successful.

Every week there are large importations into England and Scotland of raw beet sugar from the Continent for refining purposes, and here we are as favourably situated for exporting it as could

be desired. We have steamers sailing (often nearly empty) from once to four times a week to Greenock, Bristol, Liverpool, London, and Plymouth, which are the principal refining centres in the United Kingdom, and no doubt the directors of the different companies would be very glad to take the produce of a manufactory, or manufactories, at considerably lower freights than have to be paid on sugar imported into England and Scotland from the Continent.

The manufacture of beet sugar was tried before now in Ireland, and as its failure has been made use of as an argument against any further attempt to introduce the industry, I will let you hear the account which Doctor Sullivan gives. He says :—
 “After the publication of the first edition of my first pamphlet on beet root sugar, a company was formed in London to carry on the manufacture in Ireland, and a factory was established at Mountmellick, which, after two or three years bungling, miserably failed. It would have been almost a miracle if it had succeeded. The locality was unsuited, at least for a first experiment. Instead of erecting a new building, in which the most economical system could be carried out, it was determined to take an old building and alter it. There were two old buildings in the town, one on the canal, by means of which roots and coal might be cheaply transported, the other at some distance from the canal. The latter, an old mill, was selected. No building could be worse adapted for the purpose, and in the end it almost disappeared, so many additions and subtractions were made. It was situated so low that the yard in which the stock of roots was stored, exposed to all the action

of the weather, was occasionally flooded, and the roots partly immersed in water. Sometimes too the water rose so high as to put out the fires under the steam boilers. These same boilers which in Belgium would have burned only about 400 to 500 tons of coal to do the work calculated upon, burned at Mountmellick double, on account of the way they were set. The machinery was not equal to that then in use in the best factories, part indeed appeared to be second-hand, like the patents which the company purchased. Two steam engines, one of them a most wasteful one, were employed where one would have done the work, and the amount of steam pipe, all uncovered, was about four times what would have been necessary in a building erected for the purpose. None of the parties connected with the enterprise knew anything about sugar making, and even the mounting of the rasps by which the beet was to be reduced to pulp, and upon which depended all the work of the factory, were so set that only one of them could be fed with roots. But why go on enumerating blunders where there was nothing but blundering? Let me add only this last and greatest, sugar making, which is always more profitable in the months before Christmas, *began* at Mountmellick in spring. The Mountmellick factory was not consequently in any sense a test as to whether the beet sugar industry could be successfully introduced into this country." Though Doctor Sullivan does not refer to it, I may mention that the failure of the Mountmellick factory gave rise to considerable newspaper discussion, and in a letter to the *London Times* from the gentleman who acted as secretary to the

company, he acknowledged and explained that the failure was traceable entirely to the want of capital, and errors of judgment.

That this industry will prosper everywhere, and under all circumstances, it is unreasonable to expect, as blundering agriculture or blundering manufacture will certainly end in failure; but the success which it now uniformly achieves on all sides, shows that its triumph is certain in every country suitable for the growth of the beet, where it is introduced with care, and cultivated with reasonable patience and skill.

In Germany, the co-operative principle has taken root amongst the persons connected with this interest. A common arrangement is that by which a number of adjacent farmers unite to erect a sugar manufactory in a central spot, and they bind themselves to furnish a fixed quantity of roots. Whatever additional crop they may grow, is offered to the managers, who are at liberty to decline this further purchase, in which case the growers find a market elsewhere. This arrangement enables the farmers to obtain a manufacturing, in addition to an agricultural profit. It also decreases the expense of manufacture, as the increased capital thus at command leads to the erection of extensive premises, where labour, transport and material, are more economised than in the smaller ones of private persons. Indeed, Germany is remarkable for the immense size of its beet sugar factories—one in Galicia, is calculated to produce eight millions pounds weight of sugar yearly, and includes within a circle of seven leagues, a central factory, and fourteen other establishments. Another employs three

thousand people in seven establishments, which cover twelve acres of ground, and engage a capital of £300,000.

In Germany, but especially in Austria, the great landed magnates give considerable attention to this matter, several of them having become extensive growers of beet root, at the same time erecting sugar manufactories, refineries, and distilleries. They also maintain vast herds of cattle, and bring under one management all the varied enterprises which cluster round this one product of their estates. All authorities appear to agree in stating that the extraction of sugar from beet cannot be conducted profitably on a very small scale, and the general opinion seems to be that a manufactory capable of working the produce of 500 acres is about the best size to start.

There are various reasons in favour of the introduction of beet sugar manufacture into Ireland. It would be a new branch of industry, adding to the industrial resources of the country. It would not interfere with our labour market as at present constituted, except in furnishing good employment to large numbers of those who most need it, and this too at a season when employment is scarcest, for the beet harvest commences when the regular harvest has terminated, and its manufacture into sugar is carried on during the winter, when a great many labourers and others connected with the building and other kindred trades are unemployed. Thus it is that in the beet districts on the Continent little or no pauperism exists, as no sooner has one means of self-support disappeared than another presents itself. The beet sugar industry retains workmen in the country, and gives

employment during the dullest months of the year. It diffuses amongst the agricultural classes good methods of culture, calling to their aid industrial science, and the arts of practical chemistry and mechanics. It promotes, in consequence, those sound principles upon which rest the organisation of society and the security of governments, for the prosperity of a people is the basis of public order.

Wherever the beet is cultivated, the value of land is enhanced, the wages of workmen are increased, and the general prosperity is promoted. Napoleon the Third, when he was imprisoned at Ham, wrote a good deal on the subject of sugar production, and in one place, as the mouthpiece of the beet sugar industry, he says, "Respect me, for I improve the soil. I make land fertile which, without me, would be uncultivated. I give employment to labourers, who would otherwise be idle. I solve one of the greatest problems of modern society. I organize and elevate labour." The beneficial effects of this industry are not confined to the narrow circle which surrounds the factory. The large sums which are expended on roots and labour, foster industry in the surrounding villages and towns. The distribution of these large amounts for labour, and the crop, opens up a better market for the productions of other branches of industry—agricultural, mechanical, manufacturing and commercial—in fact, to use the words of an eminent French writer, I may say, in conclusion, that the beet sugar industry would be a source of riches to the agriculturist who produces the raw material, the foundation of honourable fortunes to those who cultivate it as a business, and an element of general national prosperity.

Opinions of Practical Farmers

AND OTHERS, WITH RESPECT TO

THE CULTURE OF BEET ROOT, AND THE
MANUFACTURE OF BEET ROOT SUGAR,
IN THE SOUTH OF IRELAND.

Subsequent to the reading of the foregoing paper, a public discussion took place, in which such practical farmers as Mr. ALEXANDER FERGUSON, of Belvidere; Mr. D. J. RIORDAN, Chairman of the Cork Farmers' Club; Mr. FARRELL, Mr. DORGAN, Mr. BRADLEY, and Mr. M'DONNELL, took part, all of them agreeing that this country is particularly well suited for the growth of beet root, and each speaker expressing a hope that it would be largely cultivated here before long.

Mr. FERGUSON stated that, in the event of a sugar manufactory being established in Cork, he would give a guarantee to grow not less than 50 acres of beet each year, for a certain number of years.

Mr. BRADLEY said that two or three years since, he commenced with half an acre of beet, and that he is now growing six acres, *solely for cattle feeding purposes*, his experience being that it is about the best food to give cows, as it produces a larger quantity of milk, and milk of a better quality than when mangels are used.

Mr. DENNY LANE suggested that a Company should be formed for the purpose of starting a sugar manufactory, in which he would be glad to take shares. His idea was, that if a Company was formed, they should take an acre or two from each farmer, at a rent of £8 to £10 per acre, the farmer to prepare the land and cultivate the roots, under the supervision of an inspector, appointed by the Company, on the same principle as that on which the government sends round an inspector to examine drainage improvements for which money is advanced. In this way, he said, the farmers would be compensated for their trouble, and at the same time educated in the cultivation of the beet.

Mr. FERGUSON, in reply to Mr. LANE's observations, said that beet requires a great deal of care in its cultivation, and he did not think it would succeed in "conacre," as that plan had been tried with flax, and failed.

Mr. FARRELL said that he would be happy to take shares in a Company, and also guarantee to grow beet.

Mr. JOHN FOX, T.C., was of opinion that the beet sugar industry could be established in Cork with advantage, the soil and climate being well suited to produce the raw material, and the cost of labour being as low, if not lower here than on the Continent. He said that the entire outlay to efficiently start a concern capable of working up 60 tons of beet roots per day, for a season of about 22 weeks, or about 8,000 tons in the season, might be fixed at £20,000. He then put before the meeting figures, which (calculating on realizing 8 per cent. of sugar), would show a profit of over 20 per cent. per annum to be divided amongst the shareholders. These figures, he said, had been very carefully prepared, upon what he believed to be a reliable basis, and it was his firm belief that the establishment of a beet sugar manufactory in this district would be a profitable undertaking, as it has all the elements of success in it if well managed, and provided that a regular and reliable supply of roots could be obtained at a fair price. He suggested that in order to give farmers an interest in the concern, they should be induced to become shareholders, by taking three-fourths payment for their roots for a few seasons, in cash, and one-fourth in shares; two of the largest and most influential farmers to be on the Directory, which should not exceed five. He intimated his intention of giving a prize of £10 (either in money or a Silver Cup), for the best dozen roots, grown during the coming season, by any farmer within 20 miles of the City of Cork, who had grown at least a quarter of an acre of sugar beet; the roots entered for competition to be analyzed, and the prize to be given for the ones most suitable for sugar manufacture. Mr. FOX concluded by stating that he was prepared to invest £500 or £1,000 in a Company, and that he would be happy to give all the information in his power respecting the establishment of a sugar manufactory, as well as to co-operate in any movement for that purpose.

INSTRUCTIONS
FOR THE
GROWTH OF SUGAR BEET.

BY
WM. K. SULLIVAN, Ph. D., M.R.I.A.;
PRESIDENT OF QUEEN'S COLLEGE, CORK.

SOIL.

The best soil for producing sugar in beet root, or other amylaceous plants, is a deep, sandy, calcareous loam. Any good turnip or barley land would be well suited. The sugar beet may, however, be grown in any kind of land, provided it be well drained and deeply tilled. As sugar beet must be entirely covered up with earth—that is, no part of the root should be grown out of the soil—stiff, undrained clay lands, into which the roots can with difficulty penetrate, and in which they consequently tend to push themselves out of the ground, are not suited for sugar beet. Whatever be the nature of the soil it should be deeply cultivated and free from stones, which distort the roots and cause them to throw out fibres. As beet root adapted for sugar making can only be well grown on land on which autumn or winter tillage can be practised, wet land which can only be ploughed in spring, is not, except under certain conditions, adapted for its growth.

PREPARATION OF THE GROUND.

In the North of France, and especially in the Département du Nord, where sugar beet is extensively cultivated, the land is prepared for the purpose in the following way:—In autumn the moment the preceding crop is removed the ground is scarified; the weeds torn up are allowed to wither for a few days in the sun, and are then removed by harrowing. As soon as the seeds of such weeds as in the still warm ground have germinated, the operations of scarifying and harrowing are repeated. In the beginning of winter, and before frosts set in, the land is deeply ploughed, and is then left so until the beginning of spring. If the land is to be manured with farm-yard dung it should be spread out before ploughing and ploughed in. Some farmers cart the manure on the land before winter, and plough it in when the second ploughing is given. The first method is the one to be recommended in every case where it is practicable. In the beet sugar district of Belgium the land is ploughed in November, and the farm-yard dung is put in the furrows. But better results are always obtained by distributing the manure over the whole ground, and thus equally enriching it.

As the whole of the root of a sugar beet must be covered with earth, the ground requires to be well tilled to a sufficient depth, to allow of a good-sized root and its rootlets or fibres and tapering point to readily penetrate the earth without loss of power; the ploughing should, therefore, be deep enough to loosen and allow the air to penetrate to the depth of 18 inches, that being the usual depth to which beet root sends its fibrous rootlets. The average depth of the winter ploughing is about 12 inches, but some farmers go as deep as 16 inches; in the loam soils of central Belgium the usual depth is 10 inches.

In spring the land is again ploughed to the depth, usually, of 6 inches ; then harrowed and rolled, and again harrowed, so as to thoroughly pulverize the superficial layer. In the case of very light land, such as is to be found in chalk districts and sandy plains, the grubber or cultivator and harrow only are used before winter, and one deep ploughing is given in spring.

THE PLACE OF SUGAR BEET IN THE ROTATION.

Sugar beet may succeed any crop without injury, provided that the soil be well tilled, and that the land be kept well manured. A manufacturer would prefer roots grown after a well manured white crop, no manure being applied to the stubbles. This course is frequently followed in Germany and Belgium. But no general rule can be given on this head. In Ireland, the sugar beet would naturally take the place of other root crops in our rotations.

MANURES.

The chief and essential condition to be observed in the application of farmyard dung, pig manure, animal offal, and in general all bulky carboniferous manures, to land intended for sugar beet, is that the manure should be thoroughly amalgamated with the soil, and above all, *that no unrotten manure should be applied in Spring*. By carboniferous manures are meant those of vegetable or animal origin, and containing a good deal of carbon, as distinguished from marl, bones, ammoniacal salts, saline manures, and even guano. The importance of having the manure thoroughly amalgamated with the soil, and of having no fresh manure, saline or ammoniacal, in what may be called a free state in the soil when beet roots begin to develop their sugar, is so well understood in the neighbourhood of Magdeburg, in Prussia, where roots of extraordinary richness in sugar are grown, that the beet root is not the manured crop of the rotation, but rather a fallow crop following a manured crop. This mode of growing beet is however the exception, and really excellent crops, remunerative to the farmer and to the sugar manufacturer, can be grown upon well tilled land manured in Autumn. Whenever it is practicable, Autumn manuring is in all cases to be strongly recommended to the farmer. The manure suffers less deterioration ; it is better fitted in Spring to supply food to plants ; it will save time, and it is less expensive to have the manure carted and spread just before Winter than in Spring, and above all, preserves the tilth from being destroyed by Spring cartage.

Artificial Manures are also used on sugar beet land for two purposes :— 1. As a substitute for farmyard dung—to return to the soil what is taken away by the crops ; and 2, as stimulants. A manure intended for either of these purposes should contain ammonia or a substance capable of readily yielding it, phosphoric acid and potash. If the manure be intended as a stimulant, the ammonia should exist, ready formed as a salt, such as the sulphate, the ammonia-magnesian phosphate, &c., or at least in great part. The following are the manures usually employed as stimulants :—Peruvian Guano, with or without the addition of sulphate of potash ; poulencée, or dung of fowl ; columbine, or pigeon's dung ; Engrais Flamand, made with night soil ; superphosphate and sulphate of ammonia, with or without the addition of sulphate of potash. Instead of raw guano, in which the ammonia is not fixed, guano treated with

sulphuric acid, so as to fix the ammonia and render the phosphate more soluble, seems to be largely used in Germany. Thus "dissolved or soluble guano" is necessarily a safer, and in some respects a more energetic manure than raw guano. This word "energetic," as applied to manures, requires a word of explanation. The "quantity" of energy in a manure depends upon the total quantity of its active constituents; the "intensity" of the energy of a manure upon the state of combination or condition in which the constituents of a manure exist. Thus one cwt. of bones simply crushed, and one cwt. of bones crushed and treated with sulphuric acid, have the same quantity of energy as regards the phosphoric acid, but the "intensity" of the energy of the bones acted upon by the sulphuric acid is very greatly increased. When it is said the dissolved guano is more energetic than the raw, it is the "intensity" which is meant. Manures prepared from superphosphate, sulphate of ammonia, and sulphate of potash, are also much used. The "quantity" of the energy depends upon the percentage of the three active ingredients which they contain—phosphoric acid, ammonia, and potash; the "intensity" of their energy would be the same as that of dissolved guano, which depends upon precisely the same compounds.

If we apply an energetic manure to the young plants, so as to give them an impetus, and then allow them to depend upon the natural resources of the soil, the plants instead of increasing rapidly in size by the formation of watery cells, will grow slowly in size, but their density will increase by the formation of starch and sugar according as the plant is an amylaceous or saccharine one. In a word, if you want to grow roots rich in sugar, you must if you use farm-yard manure plough it in autumn, so that it may become thoroughly decomposed and amalgamated with the soil before spring, when stimulating manures containing ammonia, phosphoric acid, and potash, may be employed in small quantities to push forward the plants before summer. You should above all *avoid unrotted farm-yard dung*, which besides retarding the maturation of the roots causes them to produce fibres and to be misshapen. So injurious are manures when the sugar begins to accumulate in the cells that a sugar manufacturer would prefer to grow roots without any manures at all. Manures do not diminish the amount of sugar, but they render the roots unfit for storing, increase in a remarkable degree the difficulty of extracting the sugar, a good deal of which remains as treacle. But when we remember that a crop of beet roots absorb about 40 per cent. of a full manuring, even after allowing for the leaves of the crop of roots, which in France are considered equal in value to one-fourth of a full manuring, such an idea could not be entertained, nor is there any necessity, as all the evils of manuring may be avoided by autumn tillage and early sowing. Amongst the best stimulating manures are pig manure—the richest roots examined by me were grown with it. Dissolved guano is now largely used in the sugar districts for pushing forward the young plants. It contains ammonia, phosphoric acid, and potash, the three substances which I mentioned as the essential constituents of such manures.

SOWING.

The seed is sown either directly or in seedling ground from which the young plants are transplanted.

The ground being prepared as above described, a series of shallow furrows are marked out on the rolled ground from 20 to 24 inches apart,

in which the seed is deposited at intervals of about 3 to 3½ inches apart. It is unnecessary to describe the machines by which these operations are done, as every one now uses sowing machines, and improved ones are being introduced every day. The smaller farmers formerly used very much a simple barrow sower, invented by Matthieu de Dombasle, which was effective and cheap. I suppose it is not even yet superseded altogether. The depth to which the seeds should be buried varies according to the consistency of the soil from three-fourths of an inch to one inch and a quarter. The distance between the rows should be such as to admit of all the subsequent operations being easily and thoroughly performed; allowing for this, the distance may vary within certain limits, according to the quality of the soil, as regards moisture, tenacity, manure, &c. In our moist climate, and in our soils, which are rarely subject to drought, the distances between the plants when singled, if the soil be well tilled and manured, need not exceed nine inches; the distance between the rows being, as has been above stated, from 20 to 24 inches. Indeed the rows need only be so far apart as to just conveniently admit of the passage of a horse-hoe between them. After the sowing of the seed the ground is harrowed with a peculiar kind of harrow, composed of an oblong frame of wood, on which are fixed branches of thorn. The ordinary harrow would displace or bury the seeds too deeply. The ground is then levelled by a more less powerful rolling, according to the compactness and humidity of the ground.

As late frosts would injure the young plants when their primordial leaves or cotyledons appear above ground, the sowing does not take place until there is no danger of frost, and when the mean temperature reaches 46 to 48 degrees. In the north of France this period is about the second week in April. The sooner the sowing can take place with safety the more time will be for maturation in autumn, that is, for the accumulation of sugar. When the young plants are nipped by the frost, they are likely to prematurely throw out their flower-stalk, and are then equally bad as food and as material for sugar-making. In unfavourable seasons it may be necessary to re-sow even more than once. Hence one of the great advantages of moistening the seed, so as to hasten germination, and thus gain time should it be necessary to re-sow.

HOEING, &c.

The quality and quantity of a crop of sugar-beet, and, indeed, of all root crops, depend a good deal upon the careful removal of weeds, and the loosening of the soil. The first weeding, which is effected by hand-hoeing, should take place when the two primordial leaves are about 1½ to 2 inches long. Three weeks after, or when the plants have three or four leaves, the operation is repeated by means of a horse-hoe. After this, that is to say towards the end of May, the plants are thinned. If all the seeds sown at intervals of 3 to 3½ inches apart germinate, this operation would necessitate the removal of two plants from between each two plants left standing, supposing the distance between the plants in the rows to be fixed at 9 inches; and in addition the double plants, or those where two or more plants come up together. This operation requires a good deal of intelligence. The plants to be destroyed are not pulled up, for by so doing the others would be disturbed, but are cut below the crown. After this, and before the leaves entirely cover the ground, one or two hoeings are given according to the growth of weeds. In well cleaned lands one hoeing

in the last week of July or the first week of August is usually found to be sufficient. But it should be borne in mind that the number depends on the weeds, which should never be visible in a field of sugar-beet.

If part of a beet root rises above the ground, the per centage of sugar diminishes considerably, and the absolute and relative quantity of saline matter, especially of saltpetre, increases. The nitrogenous bodies also increase relatively. As these bodies interfere with the extraction of the sugar it is necessary to earth up the roots for making sugar. This operation, which is done twice, is performed with a small double mould-board plough. The first earthing takes place when the roots are about $2\frac{1}{2}$ inches in circumference. This first earthing dispenses with one of the horse-hoings.

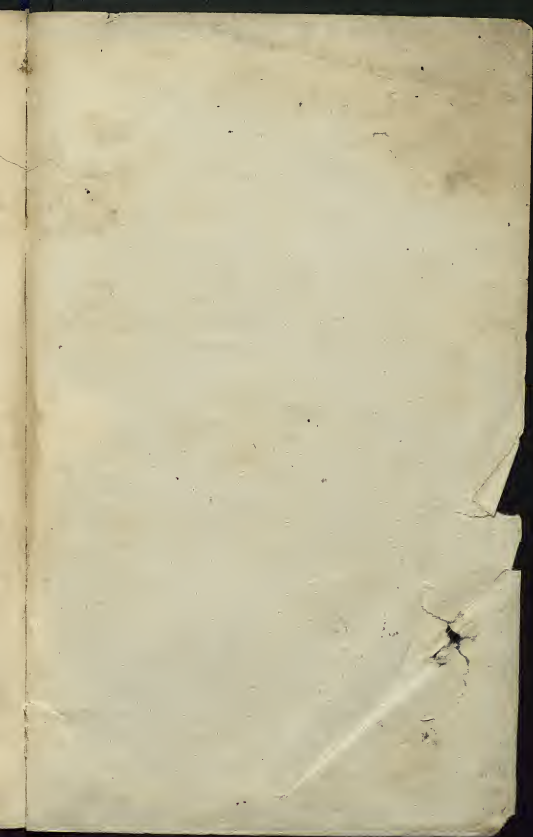
HARVESTING.

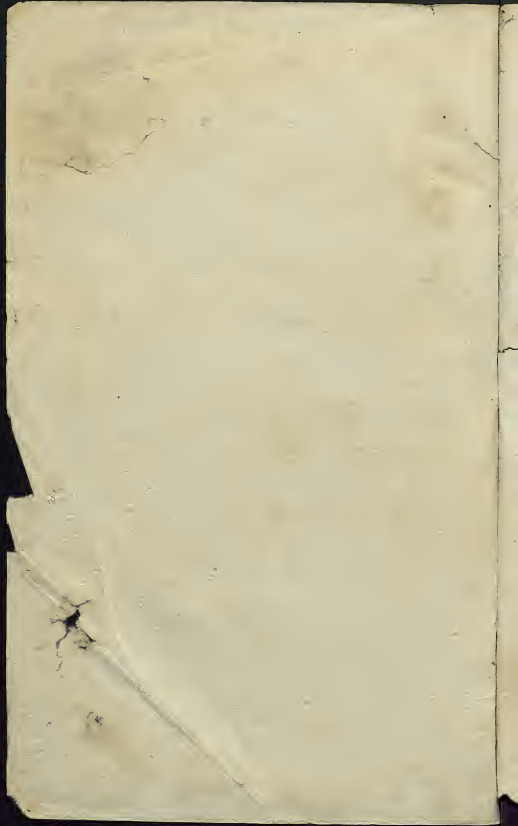
As long as a beet-root continues to grow without showing any symptom of throwing out its flower-stalk, it can hardly be said to be ripe. If the soil be free from too much saline matter, and that the manure was thoroughly rotten and amalgamated with the earth before sowing, the autumn growth will be to a large extent sugar. In our fields if there be no frost, the roots might safely be left in the ground until the end of November, unless required earlier by the sugar maker. The requirements of the farm, the wants of the manufacturer, the kind of soil, the weather, must, however, guide the farmer as to the best time for gathering in the crop. In heavy land they should, of course, be harvested earlier than on light land.

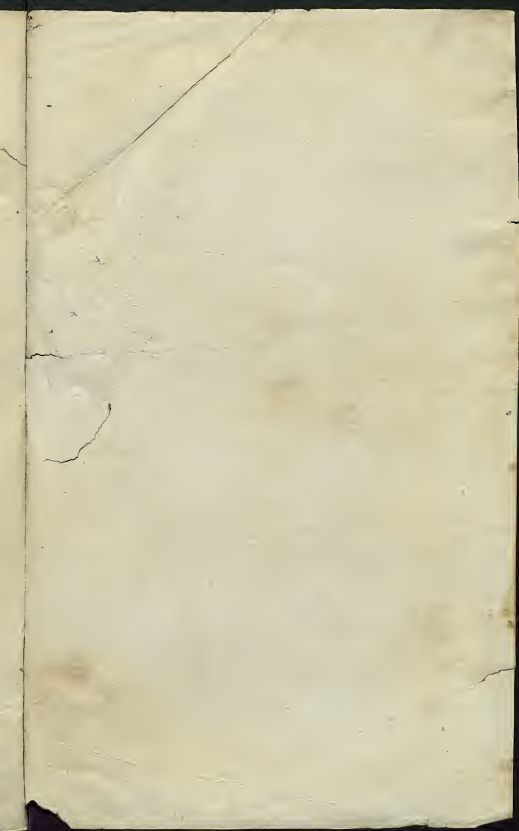
The pulling is done either by means of a fork, which is an expensive and slow process, or by a kind of plough, first constructed by Matthieu de Dombasle. This plough consists of a sole plate and share, to which is attached a piece of wood in the form of the anterior part of the mould-board, and has no coulter. I believe several instruments have been contrived for the purpose. The one described is, however, effective, and a common plough may be easily turned into it. To use this plough, it is brought a little to the left of the line of roots, the share being pointed sufficiently deep to penetrate underneath the roots, and is then drawn along under the row, lifting it a little, but owing to the form of the mould-board, not turning the earth. On the surface the work of the implement can hardly be noticed; nevertheless, the roots are so thoroughly detached from the soil that it is only necessary to catch them by the leaves to remove them without resistance. This plough is capable of loosening five acres of roots in a day.

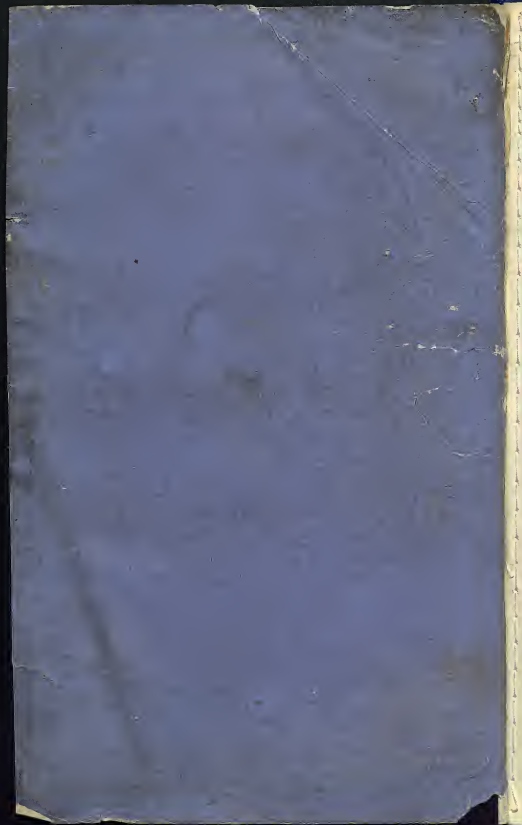
As the roots are pulled the leaves are cut down to, and including the crown, so as to prevent them from developing new leaves when stored. This is an operation requiring great attention. The fine extremity and small fibres are also removed. They are also freed from adhering earth; not, however, by knocking the roots together, but by means of a blunt, wooden knife. Whether the roots are to be stored or used for making sugar, it is essential that they should not be wounded or bruised.

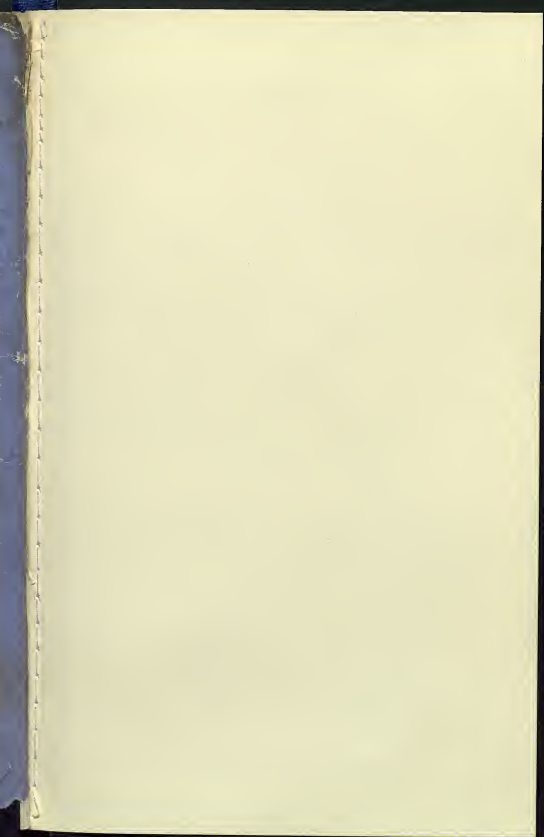
If a farmer be in want of green food, he may use the tops when cut off, but in no case should the roots, while growing, be stripped of their leaves. On the whole, it is better to leave the leaves on the field and plough them in. In France they are considered as equal to one-fourth of a full manuring of 12 tons of farm-yard dung to the acre. In Ireland the foliage is more abundant than I have seen it in France and Germany, and I am disposed to estimate the value of the leaves higher.









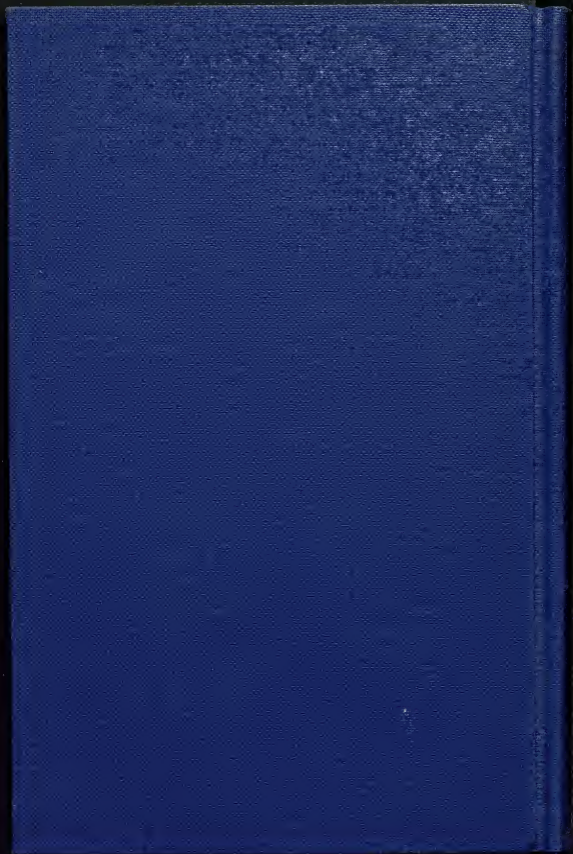


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