

ON THE  
CULTURE OF THE SILESIAIAN BEET,  
IN RELATION TO THE  
PRODUCTION OF SUGAR,  
AND THE  
FEEDING OF THE ANIMALS OF THE FARM:

Including Directions for the Cultivation of the Crop,  
and Results of the Analyses of Sugar Beets  
grown in Ireland.

A PAPER

Read before the Royal Agricultural Society of Ireland,  
11TH NOVEMBER, 1873,

THE RIGHT HON. THE LORD TALBOT DE MALAHIDE

In the Chair,

BY CHARLES A. CAMERON, M.D.,

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REPRINTED FROM THE TRANSACTIONS OF THE SOCIETY.

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DUBLIN:  
EDWARD PURDON, 23, BACHELOR'S-WALK.  
1874.

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Price Sixpence.



## ON THE GROWTH OF SILESIAN BEET AS A SUGAR PRODUCING AND A FARM CROP.

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A paper on the above subject was read by Professor Charles A. Cameron, on December 11 last, at the house of the Royal Agricultural Society, 42, Upper Sackville-street. On the motion of Sir George Hodson, Bart., seconded by Mr. Hans H. Woods, D.L., Lord Talbot de Malahide occupied the chair. The Chairman said he felt highly honoured in being called upon to occupy the chair. The question which they had before them was a very important one, if it could be carried out. It was not the first time he had given his attention to the subject. He perceived Mr. Sproule present, who, in conjunction in some degree with himself, had worked up the subject many years ago, but there were so many difficulties in the way that the results were not then successful, although there was a manufactory established in Ireland for the purpose. The present movement, he hoped, would be a most successful one, and he was confident that they would hear much interesting matter from his friend, Dr. Cameron, so that it would be unnecessary to take up any more of their time; and he would merely call upon Dr. Cameron to deliver the lecture which he kindly promised to favour them with (hear, hear). Dr. Cameron then read his paper.

### NATURE AND SOURCES OF SUGARS.

The term sugar is a general one, applied to several compounds of carbon, hydrogen, and oxygen (carbo-hydrates), all of which possess a sweet flavour. Of the various sugars, only four are of importance, namely, cane sugar (sucrose), grape sugar (glucose, or starch sugar), fruit sugar (fructose, \*inverted, or uncrystalizable sugar), and milk sugar (lactose, or lacticin). Cane sugar occurs abundantly in the sugar cane, the sugar grass (*Sorghum saccharatum*), several varieties of the maple, in beet roots, mangels, carrots, turnips, pumpkins, chesnuts, and many other plants. Grape sugar is found in fruits, especially when they have been dried and kept for some time; and it is the sugar produced from

Because it rotates a ray of polarized light to the left, whilst cane sugar rotates it to the right.

starch by the action of sulphuric acid, and during the germination of seeds. Fruit sugar, or fructose, is found in a great variety of fruits, and cane sugar is converted into this substance by prolonged boiling. Treacle consists of a mixture of 50 parts non-crystalizable sugar and a little grape sugar, 25 parts water, and 25 parts of saline matter.

The quantity of starch sugar manufactured for sale is trifling, but enormous amounts of this saccharine substance are incidentally produced in the manufacture of malt liquors and alcohol. Cane sugar, as a commercial product, is at present obtained from only three sources—namely, the sugar cane, the beet, and the maple. The consumption of sugar is rapidly increasing, not only in the United Kingdom, but throughout the civilized world. Last year the enormous quantity of 16,000,000 cwts. were imported into the United Kingdom, and of this amount  $14\frac{1}{2}$  million cwts. were entered for home consumption. Of the sugar consumed last year in these countries, only 5,224,470 cwts. were imported from British possessions, and of the balance of  $9\frac{1}{4}$  millions of cwts. more than one-third was beet root sugar, and came from the Continent. France alone in 1872 exported into the United Kingdom, for home consumption therein, no less than 2,238,811 cwts. of sugar, consisting, no doubt, nearly altogether of the produce of the beet.

Even in America the beet sugar industry is extending; and one sugar company (Alvaredo, California) produced last year 1,000,000 lbs. of sugar, and fed 350 cattle on the pulp.

#### IMPORTANCE OF THE SUGAR MANUFACTURE.

The consumption of sugar in the United Kingdom has now reached the high proportion of about 50 lbs. per unit of the population, and it is, therefore, a question well worthy of serious consideration, whether it is desirable to produce this valuable food in our own land or to continue to import it from foreign and colonial countries. The sugar in beet is worth  $2\frac{3}{4}$ d. per lb., and experience has shown that from  $1\frac{1}{4}$  to  $2\frac{1}{2}$  tons of sugar may be produced from a statute acre of beets. Except in market gardens, there is hardly a food crop cultivated in this country which realises from £35 to £60 per statute acre, the values of the variable quantities of food produced from a statute acre of beet roots. No doubt, the whole value of an acre of beet sugar does not go to the farmer; it is divided with the manufacturer; but the profits of each are sufficiently ample. The late rapid spread of beet root cultivation throughout so large a portion of the Continent, and the yearly increase in the number of European beet sugar factories, unmistakably prove that the growth and treatment of beet sugar must be operations amply remunerative to those engaged in them. Walk-

hoff in his *Praktische Rübenzuckerfabrikant*,\* page 7, gives the following account of the state of the beet sugar industry:—

	Number of Manu- factories.	Quantity of Beet-roots used. In cwts.	Quantity of Sugar extracted. In cwts.	Average con- sumption per manufactory. In cwts.
Germany ... ..	296	51,495,494	4,319,640	172,619
France ... ..	434	82,850,000	5,800,000	190,915
Russia ... ..	300	42,400,000	3,792,000	141,334
Austria ... ..	212	42,300,000	3,400,000	199,530
Belgium ... ..	108	14,200,000	1,000,000	131,482
Holland ... ..	18	2,143,000	150,000	119,060
Sweden ... ..	4	770,000	61,600	192,500
	1370	236,158,494	18,523,240	172,380

A Prussian cwt. is equal to 113.426 lbs. English.

In 1827 there were only 39 sugar factories in France, and in 1850 the amount of sugar produced was only 64,000 tons; last year the quantity manufactured was 400,000 tons. Only a few years ago there was not a beet sugar factory in Russia; now that empire promises to rival Germany in this great industry.

Mr. Pauw in his excellent pamphlet on the beet sugar manufacture in Ireland states that in Holland the dividends from the beet sugar factories vary from 8 to 16 per cent.

#### THE SUGAR BEET.

The mangel wurtzel, the common garden beet, and the white Silesian beet are all mere varieties of one plant, *Beta vulgaris*. The composition of all the varieties of this plant is essentially the same, but one kind—namely, *Beta alba*, or white (Silesian) beet—contains a larger amount of sugar than is found in the other varieties. By careful selection of seed and other means, the growers of beet have succeeded in producing varieties very rich in sugar; and it is these kinds that are chiefly cultivated when the roots are intended for the sugar manufacturer.

\* Der Praktische Rubenzuckerfabrikant und raffinadeur. Braunschweig, 1871.

Payen has minutely analyzed the white beet, and, according to him, its composition is as follows:—100 parts contain:—

Water	...	...	...	...	...	83.5
Sugar	...	...	...	...	...	10.5
Cellulose (woody fibre)	...	...	...	...	...	0.8
Albumen, casein, and other nitrogenous substances	...	...	...	...	...	1.5
Malic acid, gummy substances, fatty substances, aromatic and colouring principles, essential oil, chlorophyll, asparamide, muriate of ammonia, silicate, nitrate, sulphate, and oxalate of potash, oxalate and phosphate of lime, phosphate of magnesia, oxalate of soda, chlorides of sodium and potassium, pectates and pectinates of lime, potash, and soda, sulphur, silica, oxide of iron, &c.	...	...	...	...	...	3.7
						<hr/> 100.0

Since Payen made his analysis the composition of the beet has been greatly improved. The sugar in the beet is pure sucrose (cane sugar), neither inverted nor grape sugar being present. Formerly not more than half the amount of sugar present could be practically extracted in a crystalline condition; but by means of certain improvements—notably the diffusion process—from 80 to 85 per cent. of the sugar can be extracted. Those roots which are not less than one pound nor more than three pounds in weight contain most sugar. When the specific gravity of the juice of the root exceeds 1.070, they are pretty certain to be rich in sugar. Excessive luxuriance of foliage exercises an injurious effect upon the quality of the beet root, as indeed it does upon the common mangel. 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 nutriment, 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.

F. Sestini and G. Del Torre have recently experimented on the growth of sugar beet, and they state\* that the gross produce or weight of each is the same with both thick and thin sowing, but that the amount of sugar is greater when the roots are small. It is clearly, then, an advantage to sow thickly.

The produce of Silesian beet per statute acre varies very much, according to conditions of climate, soil, manure, and tillage, and depends to a great extent upon the kind of seed sown. It is found that the beets richest in sugar produce seeds from which plants

\* Gazzetta Chimica Italiana iii., pp 190—195, 1873.

rich in saccharine matter can in time be developed. By attention to this point, as well as to some others, beet growers—notably, M. Vilmorin—have succeeded in producing roots containing from 13 to 18 per cent. of sugar. It is not difficult to procure the seed of the varieties of beet richest in sugar; and I cannot understand why other kinds, containing only from 6 to 9 per cent. of sugar, are still largely cultivated even in France and Germany.

In the early part of the century the yield of beet was very small on the Continent: only 8 tons per acre were obtained in France; whilst at the present time, according to Mr. Barruchson, 16 tons is about the average yield. In the "Report of an inquiry into the composition and cultivation of sugar in Ireland," by Sir Robert Kane and Messrs. Sullivan and Gages, a table is given, showing the quantity of sugar beet obtained per acre in various parts of Ireland. The beet was sown in 18 districts, and the produce in roots varied from 12 to 52 tons per statute acre. On the farm of Lord Talbot de Malahide the yield was from 48 to 52 tons per statute acre, and 12 tons of leaves were also obtained. The crop had been manured with 45 tons of farm dung per acre. Out of the 18 crops one yielded  $2\frac{1}{2}$  tons (this crop failed, it was stated, because it had been sown late), one gave 16 tons, one 18 tons, seven from 20 to 30 tons, and eight from  $31\frac{1}{2}$  tons to 52 tons. In the *Mark-lane Express* for October 4, 1852, Mr. James Reeve, of Leatherhead, Surrey, states that he obtained 38 tons 17 cwts. 96 lbs. of Silesian beet per acre; whilst the orange globe gave him a crop of 30 tons 10 cwt. 9 lbs.; and mangel wurtzel a crop of 32 tons 13 cwt. 6 lbs. per acre. It is stated that by judicious management 40 tons of beets per acre may be obtained; but this is a very high estimate.

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 than, *cæteris paribus*, in England or Scotland, and in this respect Ireland is far superior to France and Germany. As the beet is a close congener of the mangel, and may be properly grown under almost identical circumstances, 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 this 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. This mildness of climate permits the growth of the beet to go on until December if necessary, and favours the conversion of the non-saccharine carbohydrates of the root into sugar. It is quite a fallacy to think that brilliant sun light and tropical heat are necessary factors in the production of sugar. They are, indeed, when the sugar is deve-

loped 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 sun light. Dr. 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 soil. In Ireland the summers are not hot, but that is not a disadvantage, but rather the contrary in the case of beet culture; for although this plant grows indigenously in Portugal, it does not thrive as a sugar producing crop in very warm climates.

A company has recently been established in Dublin for the purpose of introducing the manufacture of beet sugar into Ireland. It has secured a large farm at Bodenstown, county of Kildare, whereon it proposes to grow beets and manufacture beet sugar. It also proposes to purchase beets from the neighbouring farmers, for which it offers £1 per ton. As it is important that only the varieties of beet richest in sugar should be grown, the company decided to make some experiments with the view of ascertaining the kind which it could cultivate with most advantage, and which it could recommend to be grown by the farmer. Accordingly, ten kinds of seeds were sown in the demesne farm of Mr. Hamilton, at Abbotstown, county of Dublin, which were kindly placed at its disposal by that gentleman. The land in which the beet was grown is a rather stiff clay, and at the time of sowing it was almost impossible to get a fine tilth, owing to the drought which then prevailed. The consequence was that the seed germinated very unevenly, the young plants in some instances not coming up for several weeks. The crops were manured with thirty tons of dung, some bone superphosphate, and two cwts. of kainit (crude potash compounds) per statute acre; the land was well limed. I think that the amount of farm-yard manure applied to the crops was excessive, and with less manure the result would have been more satisfactory. The results of this experiment are given in the following table:—

*Sugar Beets grown at Abbotstown, Co. Dublin, sown 2nd of May, lifted 5th of November, 1873.*

Numbers.	Name of the Varieties.	Cultivated surface in square feet.	Weight of Produce in Pounds.	Produce per Statute Acre.		
				Tons.	Cwts.	Qrs.
1	White, green-necked	610	784	24	19	1
2	" rose-necked	"	728	23	3	2
3	" gray-necked	"	644	20	10	1
4	German, green-necked	"	756	23	18	3
5	" acclimatized in France	"	644	20	10	0
6	Imperial (true Knauer)	"	560	17	6	3
7	" acclimatized in France	"	896	28	11	1
8	Electoral (true Knauer)	"	700	22	6	1
9	" (acclimatized in France)	"	728	23	3	3
10	Improved Vilmorin	"	644	20	10	1
	Totals	6,100	7,084	225	0	0
	Averages	610	708	22	10	0

Some of the roots grown in each plot were submitted to me for analysis, and the following were the results obtained:—

*Composition of Sugar Beets, grown at Abbotstown, Co. Dublin, 1873. 100 parts of each kind contain:—*

No.	Names of Varieties.	Water.	Albuminous substances.	Sugar.	Pectose, fibre, &c.	Mineral matter (ash.)	Total.	Produce of Sugar per Statute Acre, deducting one-fifth from the weight of the crop, for unsuitable roots, &c. Tons. Cwts. Lbs.
1	White green-necked ...	84.24	1.62	6.80	6.15	1.09	100	1 7 20
2	White red-necked ...	84.66	1.40	7.25	5.71	0.98	100	1 6 100
3	White gray-necked ...	83.67	1.30	10.14	3.24	1.55	100	1 13 34
4	German Green neck ...	82.02	1.20	9.20	6.33	1.25	100	1 15 26
5	„ acclimatized in France ...	82.18	1.13	4.65	11.10	0.94	100	0 15 29
6	Imperial (true Knauer) ...	83.68	1.32	8.50	5.40	1.10	100	1 4 30
7	„ acclimatized in France ...	79.72	1.88	11.11	5.92	1.37	100	2 10 94
8	Electoral (true Knauer) ...	80.84	2.04	12.40	3.74	0.88	100	2 4 30
9	„ acclimatized in France ...	84.15	1.25	9.18	3.79	1.63	100	1 14 6
10	Improved Vilmorin ...	79.00	1.57	12.66	5.63	1.20	100	2 1 44
	Average ...	82.416	15.69	9.209	5.701	1.209		1 13 30

The analysis of each kind of beet represents the average com-

position of three roots ; the average weight of each kind was as follows :—

*Average Weight of Roots.*

1	2	3	4	5	6	7	8	9	10
1½ lb.	1½ lb.	1 lb. 6 oz.	1 lb.	1¼ lb.	1½ lb.	1¼ lb.	1⅓ lb.	1¼ lb.	1¼ lb.

These results are very satisfactory. If the three best kinds of beets (Nos. 7, 8, and 10), as shown by these experiments, be grown, the yield of sugar (for manufacturing purposes) will be from 2 tons 1 cwt. 44 lbs. to 2 tons 10 cwt. and 109 lbs. of sugar per acre.

The Rev. Professor Jellett has determined the amount of sugar in Irish grown beets by means of his new saccharometer, and found the proportion to vary from 11.02 to 12.59 per cent.

#### THE BEET AS A PURELY FARM CROP.

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 and pectose, 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 of the grain into sugar—an operation attended by expense as well as waste of material. Some expensive articles, such as locust beans and molasses, which are often given to cattle, are valuable only for the sugar which 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 crop does, and a much larger amount of absolute nutriment than a potato crop.

In the following table the amounts of solid food yielded by the Imperial (the true Knauer), acclimatized in France, and by an

average of the 10 kinds of beet grown at Abbotstown (some of which ought not to be cultivated) are contrasted with the amounts of dry food furnished by an acre of Swedish turnips, of mangel wurtzel, and of the potato :—

*Composition of Roots and Tubers.*

	Imperial Beet acclimatized in France.	Average of ten kinds of Beets.	Swedish Turnip.	Common Mangel.	Potato.
Water ... ..	79.72	82.416	90	88	75
Solid Matters ... ..	20.28	17.584	10	12	25
	100.00	100.00	100	100	100
	Tons.	Tons.	Tons.	Tons.	Tons.
Produce per statute acre ...	28.56	22.56	30	30	8
Amount of dry food per acre	5.78	3.97	3.00	3.6	2

Professor Wilson, in his "Farm Crops," vol. 1, page 309, states that the average yield of swedes in 37 farms in Morayshire during five years was 21 tons 19 cwts. 7 lbs. per acre, and he considers that 20 tons constitute a fair crop, and indicate good cultivation. I may have under-estimated the yield of common mangels; but if from 40 to 50 tons per statute acre are attainable by good management, abundance of manure, &c., we must bear in mind that by good management it is also possible to produce proportionately large crops of the sugar beet.

#### BET ROOT CULTURE.

The soil for the growth of the sugar beet may comprise every kind of land suited for root crops generally, except boggy or moory soil. The sugar beet resembles the carrot or parsnip in the manner of its growth rather than the turnip or common mangel, which are so much above ground: the lighter soils are therefore unsuitable. The clayey loams constitute the best soils for the sugar beet; the heavier soils, when not too stiff to admit of due pulverization, producing the best roots.

In the growth of the sugar beet quality is equally important with gross weight, and for manufacturing purposes it is still more so. Ordinarily this consideration has been too much neglected; and hence, by heavy manuring, the farmers have sought to grow large crops, altogether irrespective of quality. Direct applications of farm-yard manure in large quantity are always injurious in

this respect. This manure is best applied in the autumn, before the first ploughing of the land intended for the sugar beet. Unless lime exists in the soil it should be applied during the preparation of the land for the crop, as it is an essential ingredient for the proper development of the beet plant. At the time of sowing it is advisable to use a liberal supply of bone superphosphate, as that substance not only pushes forward the young seedling plants at a time when they are peculiarly susceptible to injury, but it also forms a most suitable manure for the crop afterwards. The quantity must depend on the state of the land, but may usually be about four to five cwt. to the statute acre. As the beet is very rich in potash salts, it is advisable, in most cases, to apply 1 or 2 cwts. of kainit to a statute acre of this crop. The soil for the sugar beet should be naturally fertile, or have been enriched by previous applications of manure, rather than direct applications for the crop beyond that of the superphosphate just indicated.

The place in the rotation may be that of the ordinary root crop, a portion of the land which would otherwise be in Swedish turnips or mangels being reserved for the sugar beet; or it may follow Swedish turnips or potatoes with great advantage—the previous preparation and treatment of the land for these crops forming an admirable preparation for the beet.

The preparation of the land consists of deep and minute pulverization. A much greater depth of tilled soil is required for the beet than for the turnip, on account of the former growing in the soil and the latter on it. The sugar beet must not, in fact, be grown overground under any circumstances, and this condition shows the necessity of deep tillage. The preparation of land for root crops generally is so well understood by our farmers that it is quite unnecessary to enter into minute details; besides, the number of ploughings, harrowings, and cleanings must be regulated by the condition of the soil to be operated on. Pulverization, though absolutely essential to the proper development of the roots, is not more necessary than proper cleaning of the land from weeds in the preparatory stage. Unless this be done the young beet plants are liable to be injured by the weeds growing up vigorously amongst them; and without due preparation of the land in this respect it is expensive and difficult—indeed, almost impossible—in wet seasons to keep down the weeds during the growth of the crop. These considerations show the advantage of making the sugar beet follow a manured crop wherever it may be practicable to do so. The due exposure of the soil to the atmosphere in winter is also well known to our farmers as essential in the preparation of the land for all root crops.

The most approved mode of cultivating the sugar beet is on the flat surface, after the soil has been duly prepared by the necessary ploughings, harrowings, grubbing, and rollings, in rows 16 to 18

inches apart—distances quite wide enough to admit of the action of the drill grubber between the rows during the growth of the crop. These distances would not suffice for raised drills in which farm-yard manure is to be applied, but, as before observed, no liberal application of farm-yard manure can be made without proving detrimental to the quality of the roots. Hence, on soils exhausted by cropping, however suitable the kind of land, sugar beet should not be grown, as heavy, direct manuring must not take place. Where raised drills are determined on, they will rarely be less than 20 to 24 inches apart, and in such cases 8 to 10 tons of well-rotted farm-yard manure may be used in the rows, though any application in this way is not to be commended, for the reasons already explained. A greater depth of pulverised soil is obtained by using the raised drill, and it may have some advantage over the flat surface in very wet seasons. But, under ordinary circumstances, the latter is to be preferred.

The proper seed time, as in the case of all farm crops, must depend a good deal on the character of the season. In the sugar-producing districts of the Continent every matter connected with the production of the beet roots has become so much the object of attention that the seed time there is frequently determined by the temperature of the soil at the depth of a few inches, as indicated by the thermometer. But farmers generally will not trouble themselves with minutiae of this kind. Observation, founded on long experience, enables them to determine with sufficient accuracy when seed operations should take place. In the case of biennial plants, like the beet and the turnip, they have a tendency, if sown too early, to throw up the flower stem during the first year, instead of the first season being altogether devoted to the development of the roots, which thereby have stored up the requisite supply of nutriment for the development of the seed stem in the following year. As a rule, however, the beet tribe are sown earlier than any of the turnips, and, in fact, as early in the season as the proper germination of the seed can be reckoned on. The state of the soil at the time of sowing is of much more importance than a few days earlier or later seed time. In wet weather, as a rule, the seed cannot be safely sown, on account of the injury done to the pulverisation of the land by working it when wet. On the other hand, if the soil be very dry at the time of sowing, and drought continue for some time, germination may so imperfectly take place as to lead to failure. The last week in April seems to be the most approved seed time in this country for the sugar beet, as far as the weather will permit.

Moistening the seed is frequently practised, to hasten germination. When the seed time has been unduly delayed, a gain of some four or five days may in this way be had; but should the sowing be further delayed by unfavourable weather, the moistened

seed may be irretrievably injured. When the soil is dry at the time of sowing, and rain does not soon follow, the effect of damping the seed will be to stimulate vegetation without the circumstances being available for nourishing the young plants, by which they will become stunted in their growth, or, perhaps, be destroyed; whereas, without damping, the seed would have remained inert in the soil without injury till moisture would be available. The moistened seed must not be placed in heaps, where it would heat before sowing. Dilute liquid manure of the farm-yard is recommended for the purpose, and ashes or fine mould should be mixed with the seeds before sowing, to prevent them from sticking together.

The seed is sown continuously in the row, or dibbled in at the distances apart at which the plants are eventually to remain: in either case good results may be had. On a large scale the latter system will scarcely be practicable, on account of the very considerable amount of manual labour which it entails, though even this would be to some extent compensated for by the saving of seed. If sown continuously in rows, about 12 lbs. to 14 lbs. of seed to the statute acre will be required. The depth to which the seed is to be covered is an important consideration; but this again depends a good deal on circumstances, chiefly the amount of moisture present in the soil. In damp weather the covering can scarcely be too light, but in dry weather it should be at least one inch. The seed may be sown by the sowing machine or by hand, with both of which methods our farmers are acquainted. The quantity of seed mentioned may appear to many persons to be excessive, and there can be no doubt that a very much smaller quantity would suffice were it not desirable to guard against the effects of large numbers of the seeds not germinating, through defective covering in the soil or from some other cause; and the sacrifice of a few pounds extra of seed is small compared with the advantage of securing a proper supply of vigorous plants.

The after culture of the crop of sugar beet presents little peculiarity from that of root crops generally. The intervals between the rows are to be kept pulverised and free from weeds, and if the crop be on raised drills the final tillage will consist of earthing up the plants, so that the crown of the roots only may be exposed to the sun. The thinning of the young plants will be performed in the ordinary way. The distances apart of the plants in the rows may be about eight inches, which distance, with the rows eighteen inches apart, would give 43,560 plants to the statute acre. With roots only 1 lb. each, this would give in round numbers 20 tons to the acre; but as the roots will range from 1 lb. to over 3 lbs. each, it will be seen that, by careful tillage, under favourable circumstances, 25 tons to the acre would be a moderate crop.

INFLUENCE OF BEET ROOT SUGAR CULTURE ON THE FERTILITY  
OF THE SOIL.

When the beet is grown for the purpose of feeding cattle on the farm, the substance which it takes from the soil will be returned to the latter in the form of manure, *minus* the amount carried away in the carcasses of the animals sold off the farm. Under these circumstances, the influence which the beet exercises upon the soil differs but little from that produced by other root crops. But when the beet is sold to the sugar manufacturer, a large amount of phosphates, and a still larger quantity of potash, are taken altogether away from the farm. The question, therefore, naturally arises—How is the fertilising matter withdrawn from the farm by the beets sold to the sugar manufacturer to be restored to it? It is not difficult to reply satisfactorily to this question. Sugar, as I have already stated, is composed merely of carbon and the elements of water; it does not contain nitrogen, phosphates, or potash—the three manurial agents which are of any value. The beet as a whole contains nitrogenous matters, phosphates, and potash, but these ingredients are not what the sugar maker wants; and when he separates them from the sugar they constitute incidental or by-products—namely, pulp and molasses. The pulp is too bulky an article to admit of its being transported to a distance greater than that from which the beets are brought to the factory; consequently, the natural destination of the pulp is the farm on which the beets that produced it are grown. On the Continent the farmer brings his beet roots to the factory, and he returns home with beet pulp. As the pulp contains nearly all the nitrogen and a large proportion of the mineral matter originally present in the beet, it is evident that if it be returned to the farm, the fertility of the latter will be fully maintained. The molasses produced at the sugar factory contains a large proportion of the potash originally present in the beet: if it be also consumed on the farm, then everything which is of manurial value goes back to the soil.

If the waste products of the beet sugar factory be consumed on the farms that supply the roots—and that is the natural and usual course of events—the farms certainly cannot decrease in fertility. The amount of plant food in the soil is practically inexhaustible; but only a very small proportion of it exists in an immediately available condition. Tillage adds to the stock of effective nutritive matter in the soil, and tillage is therefore, to a great extent, a substitute for manure. Messrs. Lawes and Gilbert have been growing grain crops every year in the same field for more than a quarter of a century without any manure, and the crops show no sign of a diminished yield. Every year's tillage sets free from the stony fortresses of the soil adequate supplies of phosphates, potash, and other food of plants. In growing the beet the mechanical operations to which the soil is subjected adds to its stores of effective

fertilizing matters. Of these a portion is removed in the beet crop, but it is returned to it again from the factory as pulp, either directly, or indirectly in the form of animal manure. The foliage produced by the beet is also a valuable source of manure. The farmer who sells milk, cheese, meat, and grain, and especially potatoes, sends off his land a greater amount of phosphates and nitrogen than he usually applies to it in the form of manure. It is clear, then, that a beet sugar factory must necessarily increase the fertility of the district in which it is situated; because it keeps in the farms on which it depends for roots the phosphates, potash, and nitrogen—substances which ordinary crops remove in great part from the soil.

#### BEEF PULP AS A FOOD FOR CATTLE.

At present it is found impossible to extract from beets all the sugar which they contain. A portion of it, the albuminous substances, pectose bodies, cellulose, and some other matters, remain after all the sugar that can be obtained is extracted from the roots. The residue, termed pulp, has been analysed by Voelcker and other chemists, all of whom have reported most favourably as to its nutritive properties. The following analyses of the pulp have been made by Voelcker:—

*Composition of Beet Root Pulp (from the Sugar Factory). 100 parts contain:—*

	Belgian Beet Pulp one year old.	French Beet Pulp.	English Beet Pulp (Lavenham Factory).
Moisture ... ..	70.00	70.88	70.11
Albuminous compounds ..	2.43	2.38	2.25
Sugar, pectose, digestible fibre, &c.	18.67	6.59	20.45
Woody fibre ... ..	6.48	16.43	5.32
Mineral matter ... ..	2.42	3.72	1.87
	100.00	100.00	100.00

The amount of dry matter in a ton of pulp is nearly equal to that contained in two tons of fresh beets; therefore, notwithstanding the large amount of cellulose contained in the pulp, it is evidently the more nutritive food of the two. This is the general opinion amongst the farmers who grow beets for the sugar manufacturer. In Belgium and some parts of France fattening beasts are chiefly, sometimes solely, fed on beet pulp. If farmers sell

beets at £1 per ton, they would do well to buy pulp if they can get it at 15s. per ton.

Pulp is easily kept in good condition for a year or two by placing it in trenches, and covering it with earth. Mixed with palm nut meal or decorticated cotton seed cake, a valuable and concentrated food would be the result.

#### BEEET MOLASSES AS A FOOD FOR STOCK.

Although inverted, or uncrystalisable sugar does not occur naturally in the beet, this substance is formed from cane sugar (sucrose) during the boiling, &c., of the beet juice. It constitutes a large proportion of the molasses or portion of the beet juice which remains after the separation of the crystalisable sugar. Molasses is an excellent fat-forming food for stock, and is much used for that purpose in many parts of England, especially in Norfolk. It is mixed with roots, and sometimes with meal or chopped straw. Beet molasses is not so palatable as that obtained from the sugar cane; but it is easy to render it fit for even human use, by successive treatment with a little sulphuric acid and chalk.

Molasses contains potash salts, and if this substance and the pulp be sold to the farmers who supply the roots, then every substance of manurial value taken from the land will be restored to it.

In concluding this paper, I beg to thank the Royal Agricultural Society of Ireland for its kindness in permitting me to read it before it. The subject matter of it, however, appears to me to be of sufficient importance to bring it under the notice of a society which aims at the improvement of agriculture; for I truly believe that the establishment of beet sugar factories in Ireland would react most favourably upon the husbandry of this country. To use the words of a well-known French writer—M. Basset\*—“this 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.”

\* Guide pratique du fabricant de succe.

# THE BEET SUGAR MANUFACTURE IN IRELAND.

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THE Directors of the Irish Beet Sugar Company submit the following statement for the consideration of Capitalists desirous of promoting the extension of Manufacturing Industry in Ireland:—

The suitability of our climate for the production of the Sugar Beet has been established by repeated investigations to be equal to that of the most celebrated Sugar producing districts of the Continent. The manufacture of Beet Sugar has, therefore, only to be introduced amongst us, with the requisite conditions for its development, to secure a highly successful result.

The supply of the Beet Roots, on any extensive scale, has hitherto formed the chief difficulty to be surmounted. In England an impression generally prevails that, owing to the high price of butcher's meat, roots would there yield a better return for stock feeding than could be obtained from the manufacturer. In Ireland the gradual decrease of tillage, and the usually careless manner in which farming operations are conducted, preclude any reasonable hope being entertained of a supply of properly grown roots being available from the farmers; and in any case the area of production must be confined to within a moderate distance of the Sugar Factory. In such circumstances, therefore, a primary condition of success must be the production by the manufacturer of at least the chief supply of his raw material.

The promoters of the Irish Beet Sugar Company, acting on this principle, entered into a provisional contract for the purchase of the leasehold interest in an excellent farm of land, of over three hundred acres, near Sallins, in the County of Kildare. Adjoining said farm there is another farm of over five hundred acres, which may also be had on advantageous terms. All these lands have been long in grass, and are in a high state of fertility, and admirably calculated for producing a permanent supply of Beet Roots.

In the immediate proximity of these farms a site was obtained for the Sugar Factory, on the bank of the canal, within a few minutes' walk of Sallins, which is both a canal and a railway station, distant nineteen statute miles from Dublin. The canal will provide the requisite facilities for the conveyance of fuel, manures, and manufactured products, with an ample supply of water for manufacturing purposes. The proposed arrangement, in fact, presents a combination of the essential elements for successfully carrying on the production of Beet Sugar to an extent rarely, if at all, to be found elsewhere throughout the country.

Shortly after the formation of the Company, the Directors were induced to commence operations, on the assurance that the further capital required would be forthcoming, once it was seen that a beginning had actually been made. In this expectation they have, however, been disappointed; and they now appeal to Irish Capitalists to aid them in introducing a branch of industry which they feel assured is destined to effect a great improvement in the social condition of the country, by providing employment, and that of a healthy kind, at the period of the season when country business is most slack; by stimulating the mental faculties, and thereby increasing the intelligence of those engaged therein, from the care and attention which must be devoted to the different processes of the manufacture; as well as by the introduction of an improved system of tillage, which has generally been the case on the Continent, and which must lead to increased production, and to the increase of farming profits generally; while to the capitalist an unusually large return will be assured on the investment.

The entire funds placed at the disposal of the Directors has been £8,000 for share capital, and a credit to the extent of £3,000 procured from the Company's bankers. A further sum of about £6,000 will be required to complete and fit up the factory to commence work, and about £6,000 for the current farming purposes consequent on obtaining possession of the adjoining farms as proposed. The Directors hope to receive applications for the unissued *Preference* Shares, amounting to £12,000.

The plans for the Factory and Machinery embrace the most recent improvements from the best establishments in Austria and Bohemia, where the development of the manufacture has been most remarkable. Considerable progress has been made with the works for the new Factory, in the execution of which the greatest economy has been practised; and a large amount of the machinery has already been delivered.

If the existing available facilities be *promptly* taken advantage of, the Directors are in possession of reliable evidence to show that they will be able to produce the Beet Roots at less than 15s. per ton. Taking this rate as the basis of calculation, and assuming a production of only 7,000 tons, though the Factory will be on a scale to work up 12,000 tons of roots in the season, which quantity they hope shortly to be able to obtain, and assuming also the per centage of sugar to be considerably under the average of the few acres produced by the Company last season (and which they are now selling as cattle food), the following may fairly be reckoned on as the return:—

DR.	
7,000 tons of roots at 15s. per ton . . . . .	£5,250
Expenses of Manufacture, 10s. 6d. per ton of roots	3,675—£8,925
CR.	
568 tons of Sugar at £23 . . . . .	£12,964
1,400 tons of Pulp, at 15s. . . . .	1,050
175 tons of Molasses, at £5 . . . . .	875
Other products . . . . .	300—15,189
Balance net profit . . . . .	£6,264

It is almost needless to observe that increased production up to the full capabilities of the Factory would largely increase the returns without involving the necessity for a corresponding increase of capital.

The foregoing figures will enable us to account for the rapid progress of the manufacture on the Continent, where it has yielded returns sometimes amounting to 50 per cent. per annum on the capital invested in it. The entire facts fully justify the anticipation that once successfully in operation at a single factory in Ireland, the manufacture would soon extend itself throughout the country, as would long ago have been the case had the same practical and scientific knowledge, both of the growing of the roots and of the manufacturing of the Beet, been applied to it that the Company now possesses.

The Directors invite not only an increase of capital, but further co-operation in the management of the Company. The services of one or two active business men to join the Board would be required to efficiently work the concern.

(Signed) W. B. SMYTHE, D.L.,  
Chairman of the Company.

60 UPPER SACKVILLE STREET, DUBLIN.  
February 1875.

NOTICE.

*The Directors, in inviting Subscriptions for the further Capital required, will regard such applications as conditional upon Preference Shares to the amount of at least £10,000 being applied for, as the smallest sum requisite to fully insure the objects of the Company being fully carried out. In the event of less than such amount being subscribed, the applications shall be considered null and void. Shares to the amount of £1,000 have already been applied for on these terms.*

# Houses of the Oireachtas