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2d. AN EXPLANATION OF THE PROCESS OF EXTRACTING ITS SUGAR.

P R E C E D E D

BY A FEW REMARKS ON THE ORIGIN AND PRESENT STATE OF THE

INDIGENOUS SUGAR MANUFACTORIES

O F

F R A N C E .

Translated from the works of Dubrunfaut, De Domballe, and others.

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ON THE

B E E T S U G A R :

CONTAINING

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OF THE PLANT.
- 2d. AN EXPLANATION OF THE PROCESS OF EX-
TRACTING ITS SUGAR.

PRECEDED

BY A FEW REMARKS ON THE ORIGIN AND PRESENT STATE OF THE
INDIGENOUS SUGAR MANUFACTORIES

OF

FRANCE.

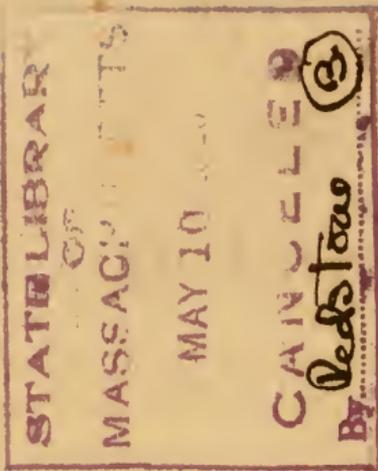
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NORTHAMPTON:

PUBLISHED BY J. H. BUTLER.

BOSTON, HILLIARD, GRAY, & Co, NEW-YORK, D. APPLETON, & Co.
PHILADELPHIA, Wm. MARSHALL, & Co.

1837.



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TO THE READER.

As I am conscious I owe some apology to my Readers for the crude compilation I am about to offer, I must beg to be allowed a very few words in explanation. Having a property near Paris in 1830, it was my intention to devote it to the culture of the Beet, and there to establish a manufactory of indigenious sugar, these undertakings were already generally successful in France, and I then was, and I still am fully persuaded, that this eminently important discovery, must sooner or later prove of inestimable value to our country; and that the experiment I was about to make, might prepare me to assist at some future time in its introduction. With these views, I collected such information from books and otherwise as I could; but before my project was matured, a Revolution suddenly burst upon France; every thing became unsettled there, and any thing but encouraging for a new undertaking; I immediately renounced my intention, and determined to return home. The project which I was forced to forego has ever remained a favorite one, and nothing but an occasion was wanting to induce me to call the attention of my countrymen to the subject of the following pages; that occasion has now arrived, a just sense of the advantages France is gathering from her *Indigenious Sugar* manufactories is fast gaining ground with us, information is eagerly sought, and I am desirous (for want of better) to impart what little I have been able to collect. In this town, the matter has lately been taken up in the most spirited manner: some

JAN 27 1903

gentlemen have united, and engaged in their service. M. Maxamin Isnard, French Vice Consul in Boston, a gentleman every way fitted to render them, and the cause, the most efficient aid, he was amongst the very first in France, to contribute his talents and labors to the success of this discovery, and such was the confidence his services inspired, that he was appointed so early as 1811, by the Imperial Government, superintendant of a school of instruction established at Strasburg, at the public expense, for the purpose of fitting young men to take the management of the sugar manufactories, which were beginning then to spring up in many parts of France. Mr. Isnard's chemical knowledge, his experience long since acquired on this subject, his extensive acquaintance with men of science, and those largely interested in the manufacture of the beet sugar, peculiarly fit him for the mission with which he is intrusted of collecting every information as to the *present state* of the beet culture; and most approved process of extracting its sugar; and, the voyage he has lately undertaken with this view, cannot fail to produce important and favorable results.

Measures have already been adopted to insure for the approaching season a sufficiency of the sugar beet seed to be distributed *at cost* to such farmers as may wish to try it, they will be procured by Mr. Isnard himself in France from the best sources and forwarded direct. We have reason to expect to have at our disposal the approaching season, a crop of two or three hundred acres of beets, and the means of manufacturing them into sugar, and the experiment (if it can be called one) will be fairly made in the course of the next year. We look with confidence to our legislature for every support and encouragement which our infant enterprize can fairly ask, the liberality extended to the *indigenous silk producers* will not surely be with-

held from *us* ; for if there is any one undertaking which deserves the special patronage of a wise and paternal government, it is one like ours, which eminently promotes our first, best, and most permanent source of wealth and comfort, *Agriculture* ; this Notice will show how far the *Beet Culture* fulfills this condition ; it will be seen that it *does more* ; for the *production of Indigenous Sugar* (one of its consequences) creates an entirely new branch of manufacture, and that from a product of our own soil, it offers moreover by its *novelty* a fresh field to that genius and enterprize for which our countrymen stand pre-eminently conspicuous.

Though the following information may be quite inadequate to satisfy the reasonable expectation of a reader, yet it should be remembered that *some* benefit may flow from these hints, they may *attract attention* to a subject of great moment, little known, and less understood, and induce some more valuable contributions to our common stock of knowledge ; should such be the result my object will be completely attained ; I shall have thrown in my mite.

EDWARD CHURCH.

Northampton, 10th. December, 1836.

INTRODUCTION.

A NEW and most important source of wealth and prosperity has prevailed within a few years in Europe, and more particularly in France, which bids fair to render that country entirely independent of all foreign supplies for one of the essential articles of its consumption. Early in this century, some remarkable experiments of the Prussian Chymist *Margraff* on the Beet Root, induced Achard, another man of science, to found in Silesia a manufactory of Sugar from this plant on an extensive scale; his success induced the establishment of others of the like nature in the same Province, and in 1811 this new branch of Industry made its way into France under the special patronage of the Imperial Government and to all appearance perished with it; the general impression seemed to be, that it was a hollow dream, induced by the extreme rigor with which Napoleon's continental system was enforced, and must vanish as soon as those restrictions were removed. But these anticipations, founded on a superficial view of things, have been abundantly refuted by the event; a few of the most substantial manufacturers were able to weather the storm for some years, whilst the process of extracting the sugar was gradually improving; their perseverance under the most disheartening discouragements was crowned with success, and encouraged new undertakings until at the present day we find the number to exceed four hundred, and this year from 60 to 80 *millions* of pounds of sugar will be supplied to France, the product of her

own soil, and the industry of her citizens! and this too at a price to the manufacturer who understands his business, not exceeding *four to five* cents per lb. a cost (moderate as it is) constantly diminishing by an improving process, and better machinery. But an abundant supply, at a cheap rate, of a very essential article of consumption, important as it surely must be considered, is not the *only* advantage to which we are to look in the culture of the sugar Beet; every man who has the least knowledge of agriculture is aware how important to the *improvement of land* is the introduction of a culture destructive to weeds; artificial meadows will not *alone* answer the desired object, *weeded crops* must form a part of a sound system, and it is to *these* that Flanders and some other countries owe their agricultural riches, but generally speaking the expense and attention required has proved an insuperable obstacle. The establishment of manufactories of Beet Root Sugar would unquestionably be the most effectual means of introducing this, with the best rotation of crops, and producing one of those rare and happy revolutions in the prosperity of a nation, which if not thoroughly understood by contemporaries will nevertheless be noted by posterity as an epoch in its agricultural and commercial wealth. It must not be supposed that the benefits anticipated will be limited to the extent of territory necessary for the supply of the raw material for these manufactories; or when once the benefits of the root crops are clearly demonstrated, as they unquestionably must be, by the wants of the sugar manufacturer, farmers will see that not only *Beets*, but *pctatoes*, *carrots*, and many other varieties cultivated as food for cattle offer an easy and profitable means of varying their rotations and supplying at the same time the largest possible amount of nutriment for their stock and as a consequence, the best way of producing manure in abund-

ance and therewith ample crops. That this *has been* the constant result of the establishment of beet root sugar manufactories in France the surrounding country clearly shows, they not only confer a benefit on their neighborhood by the capital expended there, but teach the inhabitants how they can employ this capital most usefully; the consequence is that a sentiment almost amounting to enthusiasm is now felt in that kingdom in favor of these new undertakings. Russia, Prussia, Germany, indeed the whole continent of Europe has now awakened to the primary importance of *indigenous sugar*, even in England, with all her immense sugar producing colonies in the East and West Indies, a company has been formed with a capital of two hundred and fifty thousand pounds to be employed for this purpose. With such examples before us can it be for a moment admitted that *our* country, with all its advantages of soil and climate, and a people inferior to no other in enterprise and genius, should long remain behind the rest of the civilized world in the pursuit of an object so eminently important. I have no such fear, but on the contrary a firm belief that if she was not the *first* in the race, she will not long lag behind; be this as it may, we shall never I am sure be disposed to contest the praise due to those enlightened and persevering Frenchmen who, under every discouragement have reared and preserved the precious boon, and must be now justly considered, not only amongst the benefactors of their own country, but of the civilized world. To disseminate the fruits of their experience they spare no pains, gratuitously dispensing them to whoever may ask; such liberality and disinterestedness is beyond all praise as it is almost without example: Had these men yielded to popular prejudice, to the shafts of ridicule, to pecuniary considerations, or even to the opinion of men of science, whose sentences

were generally considered, on certain subjects, as without appeal,* this precious discovery would have been lost to the present generation, and might have remained dormant for ages, under a persuasion that the manufacture of Sugar from the beet had been fairly tested and clearly proved to be impracticable as a profitable undertaking: But the courage of these pioneers of the cause was invincible—they have won and fairly wear the Palm.

As the manufacture of beet root sugar *must* shortly excite a degree of interest in our enlightened country proportionate to its real merits, the present state of this new branch of industry in France, now the school to which other nations resort for instruction in it, becomes important; and in this little essay I shall make free use of its authors for our benefit: In that kingdom, success is no longer problematical, it is already attained; and should it stop where it is, which cannot reasonably be supposed, that Kingdom can now supply all the demands of her vast population with indigenous sugar as cheap, and ere long cheaper than it can be supplied by her own colonies,—leaving a great profit to the manufacturer. So thoroughly are the colonies impressed with this important and alarming truth, that they have called on the mother country for protection against this formidable Monster, the subject of their unceasing ridicule whilst in its cradle. A serious deficit in the Treasury induced by diminished im-

* Sir Humphry Davy says in his Treatise on Agricultural Chemistry, “The Beet Root gives by ebullition and evaporation of its extract, a *particular sort of Sugar*, of which the general properties seem to be analogous to those of the Sugar of Grapes, with the exception that it is *rather bitter*.” It is difficult to conceive, says De Domballe, how this eminent Chymist could be ignorant that the Sugar of *Beets* is *identic* with that of the *Cane*.

portations would have disposed ministers to lend a favorable ear to this demand, were they not prevented by momentous considerations which they dared not disregard.

Having said thus much as relates to the general prosperity of these undertakings in France, I will now proceed to mention under what peculiar circumstances they seem more especially to thrive; for *this* we must look to three or four of her northern departments, not that these are specially favored by nature, for the borders of the Loire and several other rivers of that kingdom would seem to offer equal if not superior advantages, possessing a soil as fertile as that of the northern departments, at a price incomparably lower, and fuel in general at a more moderate price, with a position, geographically speaking, nearly the same. The advantage of the north then, here principally arises from the circumstance that these manufactories were there *first* established, that the whole population is disciplined to every trade and employment, required by the manufacturer or grower of the beet, and these therefore dispensed with the cost and trouble of procuring from a distance the numerous tradesmen and laborers, necessary to the efficient management of their undertakings; this state of things is not without its evils, the most essential of which is a tendency to concentrate in one spot benefits which it would, (in a national point of view at least) be desirable to see more widely disseminated. This objection is, however, gradually disappearing—new establishments are springing up in different parts of France—the local difficulties are wearing away, and in the mean time the new manufacturer will receive a compensation for any increased obstacles he may have for a time to encounter in the cheapness of land and fuel, and a better market for the purchase of the raw material.

At what price can beet root sugar be made? this is the first and main question to examine; for on its solution depends the realization of all the hopes that can be founded on the ultimate success of its manufacture, the extent of its production, the amount of land devoted to it, the number of men employed, in short the demand for and consumption of the Sugar. I shall endeavor, aided by late authentic documents to place this matter in the clearest and fairest point of view I can, in reference to the state of things in France, and with these elements we shall I trust be able to form a pretty correct judgment of what we may ourselves expect.

In the first place the cost of the raw material, (*the beets*) is on an average of ten establishments situated in different parts of France 16 francs the 1000 Kilograms, or three dollars 20 cts. for 2200 lbs. there is a prospect that by an improved culture they may be supplied at less than this, leaving the farmer a handsome profit. But we will take the Beets as here estimated. In the origin of this manufactory 2 to 3 per cent. of brown sugar was obtained from 100 lbs Beets, then 4 per cent. were made, then 5 per cent. and now 6 per cent. of very fine sugar: In some manufactories the 100 lbs of beets have given 6 1-2, and even more than 7 is confidently spoken of in some of the accounts I possess from men worthy of implicit credit, at 6 per cent. the 2200 lbs beets will give 132 lbs sugar.

Purchase of beets 16 francs or.	\$ 3, 20
Expence of manufacturing 2200 lbs of beets (deduction made of the value of the pulp cakes, and molasses), 8 francs.	1, 60*
	<hr/>
132 lbs of sugar for	\$ 4, 80

* The aggregate of the expenses of manufacturing, (1000 kilograms,) or 2200 lbs, of beets, is 12 francs or \$ 2, 40 cts. the value of the pulp and molasses 80 cts. to be deducted leaving \$ 1, 60 cts.

According to this estimate a pound of sugar costs the manufacturer 3 cts., 84-100ths, now the beet generally contains 10 per cent. of saccharine matter susceptible of crystallization and it is to the imprefection alone of the process employed in extracting this, that is to be attributed their obtaining at present but little more than half that amount. If (as it is quite rational to anticipate,) we shall be able to extract 8 per cent. the sugar, will then cost the manufacturer, but 2 cents. 1-5th! It is difficult to conjecture to what a prodigious extent the consumption of an article of such general use might increase by such an extraordinary reduction in its cost, for there appears to be hardly any limit to the use of sugar, but that which is drawn by an inability to purchase it: whilst Napoleon's continental system prevailed, France consumed a fraction more than 1 lb. *per head*, per annum, now she consumes 3 lbs. *per head*: In England, where the price of sugar is more moderate, than in France, and the ability of the people to purchase it, generally speaking, greater, the consumption amounts to *sixteen lbs. per head*! In the East and West Indies, the amount of sugar, used would almost exceed belief. In the Island of Cuba, for instance, it is asserted, that no less, than 120 lbs. *per head*, are consumed, by the free population! Whenever, then sugar shall cost, in this country, less than flour, and half the price of meat, born in digenous production, free from all the contingencies of a foreign supply, and produced, and consumed almost on the same spot, who can conceive the extent to which the use of sugar, may attain; and when it is considered how essentially, beneficial the culture of the beet is to the land, on which it grows, we can hardly doubt that the wealth, and comforts, of our country will increase in an equal ratio, for in fact, the result of this discovery, is to convert into a wholesome and pleasant aliment for *Man*, a plant of which lit-

tle was before used except as food, for animals. And let it not be thought that the beet, is unworthy of a place amongst the other main sources, from which man derives his subsistence—a few facts may serve to elucidate the truth of this position.

It is found that in France, the lands employed to supply the sugar manufactories with the raw material, produce on an average from seventeen to eighteen, tons of beets per acre, there is no reason to believe that ours will fall short of this, taking then the product of sugar, at 6 per cent. the amount per acre, would be 2040 lbs. and in some instances from 4 to 5000 lbs. per acre, have been produced by a heavy crop of beets. This estimate, by no means exaggerated, shows clearly that *double the weight of sugar* is obtained from an *acre* of land, that the same land will supply in *wheat*; again the *leaves* of the beet supply a useful manure for the soil which produced it, and the *pulp cakes* applied as food for stock give more than an equivalent for the wheat straw as a means of maintaining and encreasing, the fertility of the ground. We have seen that a given surface of land will supply double the weight of *sugar*, that it will furnish of *wheat*, now if the price of this last product is lower than that of the first, it is solely because the culture of the beet. and the expense of converting it into sugar, requires more manual labor; but it is precisely on this account that we may fairly look for new sources of employment for the industry and ingenuity of our fellow citizens, and increased prosperity for our country.

Sugar manufactories must then necessarily increase the alimentary resources of the country, at the same time its population, and with that the demand for labor, and productions of every description, they will moreover supply agriculture with one of the most effectual means of

introducing a good rotation of crops, and artificial grasses, for these benefits never fail to accompany them. It is proper here to remark, that by the beet culture a *new* and important article of food is *created* without in any manner, diminishing the usual production of grain, or the feed for stock, but on the contrary materially increasing them both, as it is peculiarly fitted to take the place of the *fallow*, or to alternate with crops of grain and thus essentially facilitate a good system of farming.

In this anticipation of increased prosperity to our country *in general*, from the production of *indigenous sugar*, there is nothing fanciful, or exaggerated, and it is especially applicable to our *own New England*, whose hardy and enterprising sons are yearly and daily deserting their fire sides, in pursuit of fortune in the *far West*, whilst their own native soil endeared by so many associations contains mines of wealth which only require to be sought, to be found. When therefore it is considered that this culture may open a new source of profit for our fellow citizens, which will attach them to their homes I know of no aspect in which it can be contemplated with equal gratification. If this agricultural *revolution* (and perhaps the term is not too strong) is but a provision with *us*, it is a reality in France, and why should it not shortly become so here? I hear it said that the high price of labor, here is a serious, if not an insuperable obstacle to our success, but are there not a thousand countervailing influences in our favored country that will more than compensate the discrepancy between the wages here and in Europe. I have for sixteen years of my life had much to do with laborers in Europe, frequently a hundred or two laborers and tradesmen at one time in my employ, and seen enough in my own country to satisfy me that this subject is much misunderstood by men who have not had the means of making this comparison; it is the

amount of work performed for a *given sum* and *not the price of a days* labor, that we have to consider, and in this view of the subject there are few undertakings in which I should fear competition more particularly where *intelligence* and *ingenuity*, can come in aid of the task. Again *fuel* which enters largely into the expenses of the manufacture of the beet sugar, is generally incomparably cheaper in our country than in France; in the town I inhabit, not 1-3 the price, *land* not one quarter, *taxes* comparatively nothing; and no fear hanging over *us* as it now does over the French manufacturer, that Government, is standing ready and will ere long pounce upon him and claim the Lion's portion. Of those who entertain fears from the comparative price of labor I should be inclined to ask, how it happens that our *cotton* and a variety of other manufactories can stand a competition even in *foreign markets* with those of Europe for many kinds of goods? the answer is obvious, it is to the superior *intelligence* and *activity* of our countrymen that we owe the prosperity of these undertakings, and why should not these which are universal elements of success work as well in a *beet sugar*, as a *cotton* manufactory: It is true in some few manufactures the almost entire value of which is the labor required to produce them, and which demand the aggregation of an endless variety of talents and arts that *time* only can produce; such for instance as the rich and costly tissues of Lyons, in these I admit we could not expect to compete with any fair prospect of success, (though in the more common silk goods we might), nor is it of any importance to us that we should; the case before us is very different and far from seeing any cause of discouragement for the manufactory of indigenous sugar, I perceive every security for the most complete success. We have furnished France, and Europe, with many important discoveries of which they are reaping the advantage.

France is now paying us in the same coin, she has traced the road for us, it is a plain and easy one, and I am sure we shall not long remain behind, but contribute largely, by unfolding the benefits of the precious gift of Margraff and Achard, to the celebrity of *their* names, and essentially promote the riches and prosperity of our country.

CHAPTER I.

OF THE DIFFERENT VARIETIES OF THE BEET, AND THE BEST SORTS TO BE EMPLOYED.

The 1st variety *Beta sylvestris*, commonly called Scarcity plant.

2 do (*Beta Alba*) Silesian White Beet, recommended as the most productive of Sugar.

3 do White Beet, long and thin.

4 do Red Beet, (*Beta Rubra Romana*) oblong, well formed, cultivated principally for the Table.

5 do Yellow Beet, (*lutea major*) long, thin.

The 2d variety is now generally used in preference to every other and the moderate sized roots are considered to contain more sugar to their weight than the very large, this variety is moreover more easily kept, a consideration of no small moment, especially in our country. Next to this in point of value comes the yellow 5th variety, though some, prefer the red skinned beet, white flesh. The different nature of the soils in which they may have been cultivated, and difference of seasons may have occasioned this diversity of opinion. Some experiments of the chymist Payen brought him to the conclusion that they should stand classed as follows in reference to the amount

of crystallizable sugar they would produce to a given weight.

1. Beta Alba—2d variety.
2. Lutea Major, Yellow Beet—5th variety,
3. White, pink skin, (a sub variety of the 2d).
4. The striped.
5. The Red—4th variety).

On the whole, however, it must be admitted that the *comparative worth* of these varieties may be so modified by climates, soils, and seasons, that too much confidence must not be attached to the result. *Small* roots, provided they have reached a perfect maturity to whatever variety they may belong, are always preferable for the Sugar Manufacturer to *large* ones, and that for several reasons,

1. Because they are invariably more abundant in the saccharine matter, and consequently less watery.
2. Because they are more easily kept, and
3. They are more easily worked.

From these facts there naturally arises a conflicting interest between the Cultivator and the Manufacturer, and is it not for this reason principally that the 2d variety, the white beet, seems to have the preference with the generality of the latter? This root is *always* comparatively *small*. Is it not for this same reason that the 3d variety which is also a *small* root, takes the second rank in their favor. If the scale furnished by Payen is referred to, it will be found that the different sorts stand in the order of their *dimensions*, the smallest first and the scarcity (Beta Sylvestris) *largest* and *last*. These observations are extremely important to the agricultural interest. It is easy enough for the refiner to assign to each beet its proportionate value by comparing its product in sugar to its weight. But this is only one side of the question, and if we extend this comparison a little farther and ascertain the

quantity of sugar supplied by a given surface of ground, we shall arrive at a very different conclusion ; the *large* roots will then be found decidedly preferable in this respect, and the advantage of the farmer in giving a preference to these can admit of no doubt, at least till long experience shall have assigned a proportionate value to each variety, and a Tariff shall be settled between the producer and the manufacturer. On the whole, then, we are forced to conclude that there is no description of beet that may not be turned to good account *under proper management*, this is the opinion of Dubrunfaut, of M. Crespel of Arras, a manufacturer who will this year himself alone contribute three millions of pounds of indigenous sugar towards the consumption of France! I say *under proper management*, because the large and watery roots require a different treatment from the smaller and richer sorts, and unless this is well understood it would certainly be much safer to use the latter kind only.

A beet of a hard, solid texture, is always preferable to the soft tough ones, the former will cut brittle, the latter the reverse. The Areometer, after all, will offer the surer means of discovering the real value of the roots, for this purpose a certain and equal quantity may be rasped by hand of the roots to be submitted to trial, the juice is then expressed through a linen cloth—that which shows the highest degree on the Areometer (i. e. the greater density) is the richest in sugar.

The plants intended for *seed* should be set out three feet apart every way, when ripe the plant must be cut down and the seed collected by hand ; it must then be first spread on a cloth in the open air, then in the sun to dry it completely ; without this precaution this seed is so liable to heat that it would certainly be injured in the barn. In a general way twenty plants will give about a bushel of

seed. The assertion that the roots which have produced grain have lost all their saccharine properties is erroneous, these roots contain generally as much sugar as in the first year of their vegetation.

CHAPTER II.

CHOICE OF SOILS.

Distinction in the choice of soils for the culture of this root is exceedingly important: Its nature is to penetrate low into the ground, and therefore prefers a deep loose mould, it then vegetates without obstacle; its radicles easily collect the nourishment necessary for its support, and it thrives luxuriantly.

The position of the ground employed for this culture is not a matter of indifference: in high land the beet succeeds but imperfectly in dry seasons; but it is then easily worked, and produces *in regard to its weight* a more considerable portion of sugar, but as the crop in this case is light, the result is that the product in sugar is light. Also on these same high grounds the crops, on the other hand are abundant in rainy years and the *proportionate* product of sugar is very much *less* than in dry years. In low marshy grounds the case is reversed, in wet seasons the crop is drowned, and the beet so saturated with water, that but a small quantity of sugar is obtained from it at a great increase of expense, whilst in *warm dry* years, the crops are excellent, because the heat and drought are counteracted by the fresh and moist sub-soil. To obtain average crops it is therefore prudent when it can be done to choose a situation exposed to neither of these extremes. Nevertheless there are few *deep* soils, marshes excepted where the beet under proper culture may not be grown with suc-

cess.* One remark however, that hardly admits of dispute is, that as far as experiments have gone the more northern the latitude in which this plant is placed the more completely it succeeds. The *north* of France other things equal has been found more congenial to the beet than the south; Germany, Prussia and Sileria, where this Manufacture had its origin, produce a root more productive in sugar than that of France, and there is every reason to believe that Russia is among the highly favored Countries, for the culture of the sugar beet; although the experiments made with *us* are very limited, yet I have little doubt that they will bear me out in the belief that many of our states, New England especially, will not prove inferior to Russia for this eminently important object. In support of the opinion that cold climates are peculiarly favorable to the beet culture; it should be observed that the beets on which Achard made his experiments in Silesia in the very infancy of the discovery, and consequently, with a very imperfect process, gave a result equal to the maximum of what has ever been obtained in France under the most favorable circumstances and that too without the aid of *animal carbon*, whilst it is doubtful whether in that kingdom the production of sugar from the beet could *even now* be profitably carried on by a large portion of the manufacturers without that all important agent. In 1824 Russia already possessed a number of successful undertakings of the kind, and several Russians of distinction visited France in 1825 with a view of obtaining the necessary information, to extend these on a more improved system; Prince Gargarin, Col. Mieshart and M. Poltoroskow were among the number and all declared, that with bad machin-

* The meadows of the Connecticut offer probably some of the finest soil in the United States for this culture.

ery, a worse process and *without animal carbon*, they had produced favorable results. From all these facts no doubt can remain, that *northern* climates greatly favor this production and that *southern* are proportionably unfavorable.* Much astonishment has been expressed by many that this should be the case. This astonishment may probably be traced to the analogy which we naturally and involuntarily conceive exists between the *sugar cane* under the solar influence and the beet and other roots which contain sugar but growing *in the earth*. The least reflection will show us that under circumstances so distinct, such a supposition is groundless. In the cane, that part of the plant which produces the sugar is above the soil, and requires the direct contact of the sun's rays, the action of which is eminently favored by the structure of the plant itself. The beet on the contrary is a *root* the part productive of sugar is, or ought to be entirely covered with earth, and was never therefore intended by nature for receiving the sun's rays, since she has provided it besides its covering of earth with an ample shield of leaves to shelter any part of it which may accidentally protrude above the soil. These two distinct modes of formation have then no analogy, and there is nothing after all surprising in the fact that the *beet* should produce in the *north* a sugar identic with that supplied by the *cane* under the burning sun of the tropic. No doubt, the beet requires the influence of the sun as well as other plants, but the part containing sugar is only *indirectly* submitted to its effects; thus for instance this root requires three, four, and sometimes even five months of vegetation and after that time generally about the month

* This position has been contested by one or two writers, but has been abundantly maintained by others and what is more *by experience*.

of September it has finished its growth and is acquiring its maturity, generally attained in less than a month when ever the weather is favorable, that is to say dry and warm. This dryness and heat of the soil produced by a warm sun renders the beet less watery, and in *no other way* influences the productiveness of the root in sugar. It is easy therefore to concieve that northern latitudes may as they do, offer the most favorable circumstances for the success of the beet. The seed may be sown in April, or the time at which generally the frost has left the ground and the weather becomes favorable for culture; the roots continue to grow through June, July, and August, and the heat which is usually great in high latitudes at this season continues to the maturity of the plant and is highly favorable to its richness in saccharine matter. It is well known that if the northern summers are short, the sun's rays act during that season with redoubled intensity, and its rapid influence on vegetation is a source of surprise and delight to the inhabitants of more temperate regions.

From all that has been said, therefore, we must conclude that a manufacture of the beet root sugar has the better chance of success the farther it is placed (extremes excepted) to the north, all other things equal, and in addition to the other causes which tend to produce this result in favor of the North, I would venture to suggest whether the severe *frosts* of these climates, of New England for instance, which tend to expand and loosen the soil (a most important consideration for the beet) do not exert a powerful agency in favor of the North. This conjecture seems to me rational, though I have not met with it anywhere.*

Argilaceous and deep soils, with a mixture of silicious

* It is a fact too well known to need observation perhaps that our North American climates are incomparably colder than those of Europe under the same parallel of latitude.

matter are exceedingly favorable to the growth of the beet ; chalky soils are less favorable, because they are usually shallow, and consequently impede the developement of the root. The sandy soils in the vicinity of the sea-coast might probably suit them well, as they frequently do other roots, but I am not aware that the experiment has been made. Alluvious soils must in general be highly favorable. In all cases it is suitable that any land devoted to this culture should have a depth not less than eight or ten inches of arable land.

CHAPTER III.

OF THE PREPARATION OF THE GROUND.

The importance of thorough ploughing, harrowing, rolling, and all other means of improving soils, is now pretty well understood ; and no good farmer doubts that they are as important to production as manuring. All plants do not require *in the same degree* these precautions, and those which require them *least*, generally rank among *exhausting* plants, whilst those that can least dispense with them are considered *fertilizing*. The beet is of this latter description and one of the leading advantages which it offers to agriculture, is the *necessity* it creates not only of deep and thorough ploughings, but moreover, the careful culture it requires, and the means necessary for gathering it ; these must in the aggregate necessarily leave the soil in a highly improved state, and the benefits therefore to rural economy which an extensive culture of this plant must produce are incalculable. The rotations recommended in France are of course various, arising from a diversity of soils, and also a diversity of opinions. M. De Domballe whose experience and talents are entitled to respect, recommends

a four years rotation, which he says succeeded remarkably well with him.

- 1st. year, Wheat, *manured*.
- 2 Beets.
- 3 Barley, or oats with clover.
- 4 Clover.

M. Dubrunfaut doubts whether this system, could be followed with advantage in most situations, he objects to giving all the manure to the wheat, and nothing to the beets, he would prefer,

- 1st year Oats.
- 2 Beets.
- 3 Wheat with Clover.
- 4 Clover.

with a heavy manuring once in four years, and a light one for the others, should it seem necessary. The beet following in both these rotations a grain crop, the ground will require a thorough preparation; that is, two or three plowings, harrowing and rolling. The first plowing should be *deep*; and the second, (when two only can be given) should be done just before the sowing.

The following rotation is found to answer well in the northern Departments of France.

- 1st year Oats manured.
- 2 Beets.
- 3 Wheat.

sometimes Potatoes the 1st year, has been found to answer well.

The famous beet cultivator, and manufacturer, M. Crespel of Arras, has raised beets on the *same land for eight years in succession, and constantly obtained good crops*, a proof that if a change of crops, is, generally speaking, favorable to land, it can nevertheless in good hands,

be made to produce the same crop for many years without a depreciation, or a diminution in the produce. There is also in a continued succession of beets in the same soil a great saving of labor, because the ground being constantly kept well dug up and loose, by this penetrating plant, requires only one ploughing after harvest, and one or two harrowings before planting. In this respect, it is also an advantage that beets should succeed potatoes.

CHAPTER IV.

OF MANURES.

The object of manures being to excite and procure a luxuriant vegetation, it follows, that it must in general, increase the size of the beet, now as it is understood that large roots are more aqueous and less easily worked into sugar an opinion is professed, and believed by many manufacturers, that *manure is unfavorable to this plant*. This belief is adverse to every principle of rural economy, and does not deserve a refutation, for it is clear that as all means suitable for increasing production are favorable to agriculture generally; so also are they equally applicable to the beet, and for this purpose manure is pre-eminently suitable here. All manures are not, however, equally beneficial to the beet, and it may be serviceable to mention here their different modes of action.

Manure from the farm-yard usually composed of a mixture of horse and cow dung, and sometimes that of sheep, is *excellent* for beets; and should, as far as that is possible, be laid on before the winter, and intervene between two plowings, or if but *one* is given, *before* this, so that it may be turned into the soil. There is no fear of laying on *too much* for it can be of *no possible injury, to the vege-*

tation, and it may be safely avered that there never is employed *as much* as would be useful; if there is a mixture of long straw, it will operate for several years with good effect.

Sheep manure possesses a remarkable energy, and is exceedingly appropriate for improving the vegetation of the beet.

Animal Carbon that has been used in the factory, and the skimmings from the boilers, which are collected in great quantity, during the whole time the sugar works are in activity, should be carried in preference on to such lands as are cold and inert, for this manure possesses properties highly stimulating: this effect is especially to be attributed to the black color of the carbon, which absorbs the sun's rays. and imparts them to the soil.

When the beets are harvested, the top is cut off *just to the root of the leaves*, these during the month required for this object, form considerable masses and cannot be fed away, they remain on the ground; decompose, and serve to enrich the land they cover.

Another good manure is produced by the scrapings of the beets mixed with the earth which covers them, the fibres, ends of roots, &c. collected in cleaning the roots for the rasps, as we shall more particularly explain in another place.

CHAPTER V.

OF SOWING.

The beet seed is usually sown in France on the first fine days in the Spring, that is to say the end of March, or in the course of the month of April; however if the season should be late or the weather unfavorable, it can be done

safely in the month of May, or even June, but it is better if possible to do it earlier. It is desirable for beets, as well as for other seed, to choose a day when the ground is moist, so that the grain may soften, and germinate quickly.

From seven to eight pounds of seed per acre is the usual quantity employed, and it will not, if grown by the farmer himself, cost him over twenty cents or twenty five at most per pound.

It may happen that in consequence of a season too wet, or too dry, that the seed does not come up, or comes up so thin, as to be of little value. If this accident proceeds from weather *too wet*, there is no other resource but to sow again. If on the contrary, it arises from *too dry* weather it is proper to wait for a favorable change, and in such case it will be found that the germination has only been retarded. It is not an uncommon thing to see seed in such cases sprout well a month or six weeks and even two months after they have been sown. Again, it will sometimes happen after sowing, that *frost* may attack the sprout about to appear, or that *has* appeared; in such case there is no other remedy than to sow over again, for it would be in vain to expect that the seed should germinate a second time. In such a case it is nevertheless prudent to wait a fortnight or three weeks after the frost to ascertain beyond doubt whether the vegetative faculty is really destroyed, or only suspended.

These different accidents separately, or combined often unluckily, oblige the farmer to sow more than once, but fortunately, the beet on the other hand, will generally admit of the delays consequent to these disappointments; an advantage which many other plants could not. Three sowings may be sometimes required; the first, as I before said, about the end of March, then if unfavorable circumstances prevent or delay vegetation, it is proper to wait till the end

of April, or perhaps even to the beginning of June, then sow for the second time, and if this even should fail, the third is recommended in France to be tried even if a month later.

That no disappointment may arise from a want of seed, it is always proper after estimating the quantity of land to be sown, to provide seed for at least half as many acres more, that is to say, if eight pounds are required for an acre, to provide twelve pounds for every acre to be sown, this would occasion an expense of about three dollars an acre for seed, at the price it may be produced.

A sowing lost must always be a source of considerable disappointment to the farmer, for it not only obliges to new expense for seed, and labor, but reduces his prospects of a favorable crop by restricting his time for the cultivation and harvesting; however this may be, there is no doubt it is better for him to obtain but an indifferent return in beets, than to leave his ground in fallow.

As, has been before said the ground to be in a proper state to receive the seed should be thoroughly and deeply ploughed and well harrowed and rolled, and moreover sufficiently manured.

The distance between the roots, in a good rich soil, should be about a foot in the rows, in land less fertile about fifteen inches and in a close clayey soil eighteen inches or even two feet. These premises are applicable to all the methods of sowing of which we are about to speak.

1. Broad cast, which involves thinning and transplanting where required.

2. Sowing in nursery beds for the purpose of transplanting the whole crop,

3. Drilling thinning and transplanting where required.

These three methods have their respective advantages

and disadvantages. We shall now examine them in succession and explain the methods, practiced.

SECTION I.—*Sowing the beet seed broad east.* This mode is liable to many objections.

1. The increased quantity of seed required from the irregularity with which it is necessarily spread.

2. The operation of *thinning* (where too thick) to do which without injury to the plants intended to remain, requires experience, and attention, this is not a *serious* difficulty

3. The *transplanting*, to replace deficiencies in the rows is attended with *weighty objections* in the first place it is necessary to wait before this should be undertaken till the plant has attained the size of the finger; that is about a month or six weeks after the vegetation has begun, at this time the plants are growing vigorously, and after thinning, (which is done simultaneously with the first weeding) the root which has not been disturbed, in a fortnight has undergone a surprising change, whilst the transplanted ones are languishing under the effects of their removal, and before they recover their vigor, are frequently over shadowed and stifled, by their robust and thriving neighbors, or at least remain weak and puny plants, nevertheless wherever the *broad cast* method is practised, no doubt transplanting is an unavoidable consequence and must be done, but much return need not be expected from the plants so treated. On the whole this mode of sowing though frequently practised in France, is decidedly very inferior to sowing in drills, of which we shall presently speak, which last method must necessarily prevail over every other now practised, as soon as its advantages are properly understood.

SECTION II.—*Sowing in nursery beds for the purpose of transplanting the whole crop.* This method is recommended by De Domballe: the seed is sown in beds prepared in the

best manner, and occupying about one 10th of the surface which the plants are intended to cover when transplanted, when at the end of a month or six weeks, the plants have reached the size of the finger, they are pulled up made in bundles and carried into the field, here the laborer provided with a *dibble* makes his holes to the depth and at the distance required, children usually follow, place the plants in the holes, and with their feet press the earth up to the roots. This operation is done pretty quickly, some agriculturists think it necessary to *cut off the end of the root*, but this opinion is considered by others to be unfounded and injurious as it prevents the plant from penetrating by one principal taproot into the soil, and engenders a number of small roots and fibres, that are not only unproductive of sugar, but increase the difficulty and consequently the expense of cleaning the plant; besides the root itself is less bulky and the crop therefore diminished. It seems then on the whole decidedly objectionable to cut off the taproot when transplanting beets, and the whole system indeed of *transplanting* when applied to *entire crops* would seem to be equally bad, and probably the worst of the three employed, for—

1. If the land cultivated is extensive, it follows of course that the pulling up and planting many acres must require prodigious labor and very great expense, again.—

2. The transplantation taking place at least a month or six weeks after the sowing, carries us forward to a period when the weather may not be favorable to the young plants taking root, which would necessarily delay the vegetation and throw the crop back to a time when the season for re-sowing may have gone by.

3. The chances, difficulties, and expense of this method do not seem to be compensated by *any* countervailing advantages, unless (which cannot be admitted) we may con-

sider a saving of seed to a small amount worthy of consideration; It is nevertheless as we have before said recommended by that distinguished agriculturist De Domballe or it would not perhaps otherwise have been worthy of consideration.

SECTION III.—*Drilling, thinning, and transplanting where required.* This method consists in drilling in the seed in lines at the distance required, sowing a sufficiency of seed to supply by the superabundant plants all deficiencies from the failure of vegetation.

The first steps towards this important improvement in the mode of sowing the beet seed consisted in tracing furrows, with a harrow prepared for the purpose at equal distances followed by laborers equal in number to the furrows, in these were dropped the seeds at a suitable distance from each other. Then followed another harrow with the teeth inverted which covered the seed. The advantage of this method was very soon perceived, and at the same time its imperfections, to remedy these, a number of tools were invented. Among the best of these is undoubtedly Hill's horse drill; for besides the great saving of time and seed and the regularity with which this is distributed, the labor required for weeding, rolling, harrowing, and gathering, becomes much easier and cheaper.

So decided a superiority, must necessarily introduce it amongst intelligent farmers here, as well as in France and England where it is getting into general use, and properly appreciated; with this drill, the seed is sown at any given distance with perfect regularity, covered and rolled at one operation: the distance between the drills is usually 2 feet 6 inches; that between the plants one foot or more according to the soil; the distance between the rows (of 2 1-2 feet) is sufficient to admit the use of a Horse hoe.

CHAPTER VI.

WEEDINGS AND OTHER LABOR NECESSARY FOR THE PROPER CULTIVATION OF THE BEET.

Weeding is generally performed in France by women or children; they follow the rows, and with a small light hoe chop out the weeds and collect them in small piles where they are left to rot.

This operation is indispensably necessary for the beet, and it should be repeated three times during its growth. The first time when the beet has attained the size of the finger or before; and second and third, may follow at from three to four weeks apart. In all cases where the beet has attained a sufficient size to shade the ground, weeding is useless; it will then protect itself sufficiently from all noxious plants. It may be proper here to remark, that the importance of *weeding*, generally speaking, is not adequately appreciated; and were it only for the purpose of clearly demonstrating its importance to the agricultural interest (no matter to what crop applied) the introduction of the beet culture would confer on that account alone, a benefit on the country which it would be difficult sufficiently to appreciate.

In the drill culture, the horse hoe may be used with great advantage, and may in a day hoe from three to four acres. This tool, however, (as it will be perceived) can only *facilitate* the *first*, but hardly the *second* weeding. It merely works the soil between the lines in their longitudinal direction; the weeders, therefore, must necessarily follow it to complete what is left imperfectly finished in the lines and between the plants. In Flanders where this operation is thoroughly understood and done by women and

children ; the weeding of an acre does not cost over 60cts. each weeding ; but this expense must necessarily be more with us, where wages are higher and practice is yet wanting.

If weeding with the horse hoe alone is an *imperfect* operation, it is nevertheless highly beneficial in more than one respect it not only in a great measure clears the ground of noxious plants, but turns it over and loosens it to the depth of one or two inches, and in so doing is useful not only to the *present*, but the following crop.

CHAPTER VII.

GATHERING THE BEET ROOT.

It is easy to ascertain the proper time to gather the beet, it is manifested by appearances which can hardly be mistaken. The leaves which during the vegetation were of a deep green, firm, and erect, now become covered with brownish spots, are curly, droop towards the earth, and finally assume a yellow tint ; they have ceased to vegetate, as also the root which is now ready for the manufacturer and will not increase in volume. They are generally found in this state in the month of September or October, climates and seasons will of course advance or retard this maturity.

It is not desirable to gather in the whole harvest before the sugar Factory begins its operations ; the works may be supplied from the time the beet is ready till the end of October or beginning of November, by beets gathered daily in the field and taken to the works.

It is extremely important in gathering the beet to choose if possible, favorable, that is to say, *dry weather*. A field of beets dug in a *rainy*, will furnish roots much more aqueous, than if gathered in a *dry time*,

It is therefore, prudent as soon as the plant has reached maturity to profit of the first favorable occasion to secure it against any adverse contingencies; more particularly as the chance of these increases as the season advances.

There are other advantages exceedingly important in gathering the beet in *dry* weather; for instance, the digging is much facilitated, and the earth attached to the fibres of the roots is easily detached by simply shaking it *when dry*, whilst when *wet* it adheres firmly, and in considerable quantities, so that it requires more expense for carriage to the factory, is more difficult to clean, and occasions a collection of earth where cleaned which more or less embarasses this operation. When the root is out of the ground, and the weather dry and warm, it should be left in the field where it will be improved for all the purposes of manufacture; the state of the roads too is more favorable for wagoning in fine weather, and this is no trifling consideration, when it is a question of the carriage of perhaps several hundred tons.

Having now taken a *general view* of the harvesting the beet, it may be well to consider the details of this operation separately.

1st The digging.

2 The mode of cutting off the top.

3 The collecting in piles and carriage to the store houses.

SECTION I. When the time for taking up the beets has arrived, a number of laborers proportionate to the amount of work and the celerity required in its execution, is to be provided, to dig, *top*, and *pile* them for the wagons. The workmen are divided two and two; to each couple one spade is necessary and this given to the strongest hand, who forces it perpendicularly, into the ground near the beet, but so as to avoid injuring it, and using the

handle as a lever throws up the root, the boy who follows takes one in each hand by the neck and by striking them against each other detaches as much of the earth as he can, and then lays them in a line the roots on one side and the neck on the other.

SECTION II.—*Cutting off the tops.* When the beets are disposed in lines, as has been described in the preceding section, a man with a sharp spade follows between the lines, and with a stroke of the spade cuts off the tops, one at each blow: with a little habit this is done so expeditiously, that a single man will in France, top more beets than can be dug and disposed in lines by twenty. It is essential that this cutting off the top should be managed with care and skill, so that he should neither take off too *much* nor too *little*; it is the extreme, or neck of the beet, which should alone be cut off. This operation is intended to prevent a new vegetation of the leaves, which would frequently happen if they were only *pulled* off, and this sprouting would considerably diminish the saccharine principle in the root. It is only done therefore, for the preservation of this; for it occasions a wound in the root which, after all is only the lesser of two evils.

SECTION III.—*Collecting in piles, and carriage to the store-houses.* When the beets are dug and topped it is well to let them remain spread over the ground for some days to dry the wound made by the last operation, described; this exposure will be favorable to the plant in other respects if the weather is dry and warm; in this case, indeed, it cannot be exposed too long; but if *rainy*, injury instead of benefit might be expected.

Whenever it is considered that the beets have been sufficiently long on the field they are to be collected in *piles* containing on one square yard the produce of sixty to a hundred. A number of these must be made in the

most convenient way for the wagons to load, these piles may without injury, but rather with advantage remain in the field, for a few days if desirable. This piling not only facilitates the loading, but prevents injury to the roots which would be unavoidable if the wagons were to enter a field covered promiscuously with the roots; whereas, none can happen when they are piled as described. In the departments of the north of France, the cost of digging, topping, and piling an acre of roots, does not exceed two dollars. The expense of wagoning to the store-house, must necessarily be very variable, from the state of the roads, the distance, &c. But supposing that the fields are at a suitable distance from the manufactory, and that a three horse wagon will load from thirty hundred to two tons, and costs two dollars a-day to the farmer; then the carriage of an acre of roots will cost about three dollars, which may be considered an average in France. The leaves remain on the soil, and are estimated to be equivalent to a light manuring.

CHAPTER VIII.

PRESERVATION OF THE BEETS.

The preservation of the beets for four or five months, is necessarily an indispensable condition to the success of the sugar manufactory, and it is also one of the operations which requires the closest attention.

If the beet could be managed in the same way, the cane is, i. e. manufactured as it is taken from the field, there would be no difficulty; but such is not the case. The beets must, as we have seen, be gathered in September or October, and preserved till January or February. This important object is best effected by avoiding the stowing of them in

very large masses, by giving them air, and keeping them dry, and in a temperature as near as possible to 54° Fahrenheit. When the manufactory of sugar was first begun in France, but little precaution was taken to preserve the roots, they were piled in large heaps in yards or under sheds; the only precaution taken, was to throw straw over those that were not under cover; and it was not long before the evils of this carelessness became apparent; the beets were frozen; so long as they remained in this state, the manufacturing of them into sugar experienced no unfavorable result, except in an increased difficulty in rasping, but the moment a thaw supervened, decomposition of course followed, and sugar making was at an end. It was remarked that the roots richest in sugar were the last to freeze; they would resist any temperature above 9°, whilst the most aqueous roots would freeze at 25° of Fahrenheit. If suitable *store-houses* are not at hand to secure the beet, *trenches* may be dug near the sugar works, on ground high and dry, four feet deep, if quite safe from water, otherwise more shallow; the width should be from three to four feet at most, the length must be determined by the locality, and other circumstances. The trenches thus prepared, the roots are brought and thrown in without order, and when full, the middle is raised with earth so as to form a roof, and covered with not less than from a foot and a half to two feet of soil. In this manner the roots are kept perfectly safe, particularly if they have been gathered in dry weather. There is nothing to fear from this method, but a wet soil; in France, a covering of 18 inches is always sufficient for the protection of the root, *with us* perhaps, *two feet* might be better. It was at first supposed that a coating of straw was beneficial to the preservation of the beet in the trench, but experience has shown that it was injurious.

Cellars in general being more or less damp, besides the very large quantity required to be heaped together to fill these; the expense of making them and ventilating the beets, when in such masses, to prevent heating and fermentation are serious obstacles to this method.

Store-houses incontestably offer the most convenient and best method of preservation for the beet, they should be near the sugar works. The walls should be of sufficient thickness to prevent the frost from penetrating; they should have sky-lights, sufficient for the work-men there employed, but no windows.

The beets are disposed in layers of 15 to 16 feet high, and not more, because the weight of these columns pressing always on the lower strata, might injure them if increased. To prevent this, before the roots are brought to the ware-house, bundles of brush wood are disposed on the floor or ground six inches deep, then piles of these of a foot thick are placed eight feet apart, and in the intervals are stowed away the beets; each pile of brush wood doing the duty of a ventilator, constantly renewing the air; a passage should be preserved the whole length of the building, so that in case of any appearance of fermentation at any point, the injured roots might be easily removed.

A cubic yard of beets will generally weigh about 1350 lbs. Let us suppose that 6,000,000lbs. are to be worked up during the 5 months, that the manufactory is in operation, and that for two months of that time the roots will be used as taken from the field 3-5ths only or 3,600,000 lbs. require to be stored for the supply of the sugar works, for the last three months. To find the number of cubic yards required in a building for this purpose, it is only to divide the 3,600,000 by 1350 (the weight of a cubic yard of beets,) this gives us 2666 and a fraction, as the whole number of cubic yards to be provided for.

It is not desirable that the building should exceed 9 yards in width, nor that the beets should be piled over 6 yards in height; these numbers multiplied by the other, give 54 yards as the cubic capacity of a transverse section of the store-house in one yard of its length, to find the *whole* length required, we have therefore only to divide 2,666 i. e. the whole capacity by 54, this gives us (within a fraction,) 50 yards as the length wanting.

But as there is a passage to be reserved the whole length of the building, and some additional room for the brush wood before mentioned, as necessary for the preservation of the roots, we will consider 60 instead of 50 yards as the suitable length for storing 3,600,000lbs. of beets.

I do not find that any attempts have been made in France to raise the temperature in the store houses, although it is admitted that in severe winters, the frost has sometimes penetrated into them, and injured the beet; it seems to me that a steam pipe passing through the buildings might completely obviate any danger from this accident; in case of need, a small portion of the steam constantly at hand in the factory, might be turned into the pipes, for the purpose of heating the store house with perfect success, and at an inconsiderable expense, as the necessity would probably but rarely occur.

PART II.

OF THE MANUFACTURE OF THE BEET SUGAR.

Having explained what relates to the culture of the beet, and the method of obtaining from the earth the greatest amount of these, and the best mode of preserving them, it is proper now, to proceed to describe briefly, the most approved process employed for obtaining from the beet the finest quality, and the greatest quantity of sugar. It has already been noticed, in the introduction to this little essay, how many, and how great were the difficulties with which the first manufactures of the beet root sugar had to struggle in France.—Their ignorance of the proper mode of cultivating and managing the plant, the political catastrophe which deprived them of the protection they so much *needed*, and inundated the country with foreign sugar, in short overthrew all their calculations, prostrated their credit, and almost their hopes. Yet such proved to be the intrinsic worth of this discovery, that it finally carried them through triumphant, and is at this day, deservedly a source of pride and prosperity to *them*, and to their Country.

A new and all important auxiliary to the success of the manufacture (and which I have before noticed,) was brought into use in 1812.—This was the application of the decolorating properties of *animal carbon* to the manufacturing and refining of beet root sugar, by M. Ch. Durosne; this discovery produced most surprising results in every trade and employment, in which sugar is in any manner used. It is now, in fact an indispensable agent to the confectioner, the refiner, and the manufacturer of beet root sugar.

CHAPTER I.

CLEANSING OF THE BEET ROOTS.

The object of this operation is, to separate from the roots the green parts of the neck, which may not have been removed, the radicles, the defective parts, and the earth and the gravel, which may adhere to these; when this is properly done, the washing should it be required (which is not the case in many places,) is easily and quickly performed. In all cases the cleansing should be effectually done, otherwise the gravel and earth (should there any remain,) will injure the rasps. Women and children perform this operation in France. For this purpose, each hand is provided with a sharp knife from 2 to 3 inches broad and 10 long, with this tool seated near a pile of beets, the laborer takes the beets one after another, scrapes them lengthwise to detach the earth and stones, takes off the neck all round, and even a thin slice when this has not been already done, by the operation described in the 1st Part, Chap. VII. Sec. II.

When a beet is too large to be applied conveniently to the rasp, the workmen should cut it in two, or in quarters according to its dimensions, this must always be done longitudinally.

The cleaning of the beets should always take place in a room near the rasps and presses, in order that these different operations may follow conveniently and quickly. The place should be, when possible, a building sufficiently large to contain beets enough for the consumption of the works for at least four or five days, and leave room enough besides for the laborers to do their work easily. As fast

as the roots are cleansed, they should be thrown into baskets about 18 inches high, and a foot wide, of a conical shape with handles; when several of these are filled they are carried to the rasp: there they leave the full baskets and take back the empty ones. Two women in France who understand their business, can clean easily from 3 to 3 1-2 tons of roots in 12 hours work, and carry them to the rasp. The wages of these women in some parts of France do not exceed 12 or 15 cents each per day; at this rate the cleaning of a ton of beets would not cost over 10 cents. It of course reduces the weight of the beet—the loss is estimated usually at from 6 to 7 per cent.

The operation of washing the roots is, (as we before said) by no means generally requisite, and a careful cleansing, as described above, is decidedly preferable, and it is not always that water in sufficient quantity can be conveniently obtained. When a little stream is at hand, and they can be placed in baskets in the water and remain till the earth is washed off by its motion; such a peculiar advantage should never be neglected; but this is of rare occurrence.

This washing is the more difficult too, as it must be executed in the winter and the water frequently may be frozen. A general opinion once prevailed that the cleansing with water was indispensable, and that the manufacture of sugar could not be undertaken without a locality which supplied an abundance of it; but this supposed necessity is groundless, for there are few spots where a sufficiency of water may not be found for the inconsiderable wants of a beet sugar manufactory.

CHAPTER II.

RASPING THE BEETS.

The first idea of the famous Achard when in search of the best mode of extracting the sugar from beets, was to *boil* them and reduce them to paste, but he soon found insuperable difficulties in the way of this process. The simple pressure without rasping has been repeatedly tried, and recently again by an improved press, and the rasp is as yet the only effectual mode employed, and too much care cannot be used in having this operation well done, as on it depends, in a great measure, the more or less sugar that is obtained. There is a great diversity in the construction of this machine, but the cylindrical rasp of Moulard appears to have the preference: the cylinder is of cast iron, into which 120 saw plates are inserted; as a description of this would probably be unintelligible without a representation of it by an engraving, I will not attempt it. A man presses the beets enclosed in a box against the circumference of the cylinder, another workman on the opposite side of the machine removes the pulp, and with the ladle with which he removes it fills bags as we shall more particularly explain in the next chapter, from 80 to 100 lbs of beet are reduced to pulp in one minute.

The rasping requires, as well as every other operation of this manufacture, great activity, and as much as possible the rasping more beets than are *immediately* wanted must be avoided, as a prejudicial change takes place in the pulp from a quarter to a half hour at most after it is produced; a blackish color, which gradually increases is the indication of this change. It is therefore prudent that no more should be rasped than can be immediately pressed.

The rasp must be kept perfectly clean by repeated washings; once a day at least, every part of the machine, and all the tools appertaining to it, should be carefully cleansed, because every portion of juice or pulp which is suffered to remain on them, would soon serve as a leaven to excite fermentation.

It is immaterial what power is used to drive the rasps; animal, water, and steam power, and even wind is sometimes used in France.

CHAPTER III.

EXTRACTION OF THE BEET JUICE,

A variety of machines and of power has been used, for the pressing the pulp, as well as for rasping the roots; of late the Hydraulic press has superceded almost every other; for this last operation at least, in large manufactories. The pulp enclosed in bags is submitted to the action of this machine, the bags are usually made of Russia duck, the cloth, though required to be strong, must not be so close that the *juice* cannot easily pass through it, or they will otherwise burst, on the other hand it must be sufficiently so to prevent the *pulp* passing through the tissue.

This last defect, however, is less to be feared than the first, so that the caution most to be attended to, is to avoid too close a texture, and it must be recollected that it will become closer when saturated with the juice. The size of the bags may be varied, but generally speaking half a yard wide, and one yard long is a convenient dimension; they should not be more than 3-4ths filled. The bags must be kept perfectly clean, they should be washed every day in *boiling water*, with a small addition of the

sub-carbonate of soda. Wicker work'frames on which the bags are to be piled must be provided, they should be made strong and proportioned to the size of the platform of the press, that is of the same dimensions ; they serve to support the piles of bags in their vertical position on the hand wagon, with which they are removed from the rasp to the press, and are themselves kept in place when on the press by stanchions fixed to the platform of the press at the lower end, the other, sliding through a groove fixed to the frame work. These wicker frames and bags are placed alternately under the press, usually to the number of thirty of each. As regards these frames, the caution of the cleanliness is renewed, and in a word must be applied to every branch of this manufactory.

A *Reservoir* is next to be provided, to receive the juice from the press, to be subsequently conveyed to the defecating boiler, it must be supplied with pipes of communication with the press, and a pump to convey the juice it contains to the defecating boiler, it should be placed on a lower level than the press, and receive the juice by an inclined plane. It must be made substantially of wood, and lined with copper, having a concavity in the centre, into which the bottom of the pump must be inserted, so as to empty it completely. The capacity must of course depend on the extent of the manufactory.

MODE OF OPERATING WITH THE PRESS.

When the bags and wicker frames have been piled as before described, alternately to the number of 30 or more of each, on the platform and the stanchions placed, the weight of the pulp alone causes a pretty plentiful flow of juice ; if the press used is a *screw* press, a *workman* takes hold of the lever and turns it, then a second man assists

and then a third, when they have exerted their united strength on the lever the job is done, and after allowing the bags to drain, whilst they are filling others the press is unscrewed, the bags removed, the pulp cakes disposed of, the bags cleansed, and the operation first described is continued till the whole quantity of pulp prepared is disposed of.

CHAPTER IV.

DEFECATION OF THE JUICE.

The juice of the beet as it comes from the press carries with it all the soluble parts of the root. It contains in this state not only *sugar*, and *water*, but other component parts, which cannot be separated by evaporation alone, they must be precipitated by chemical agents; many and expensive experiments were made in search for these, which I shall not here attempt to explain. The present process is as follows, suppose a boiler containing 400 galls. of juice, add *before lighting the fire*, 8 lbs. sulphuric acid at 66°, 1 part acid, 3 parts water, diluted, mix quickly and thoroughly with the juice, then take 9lbs. of quick lime weighed before it is slaked, then slake with warm water to the consistency of milk, throw this also into the juice and stir the whole completely, the fire is now to be kindled under the boiler, and its contents raised to the temperature of 190 Fahrenheit, then animal carbon that has been employed in clarification is added and well mixed, and a portion of diluted ox blood, stirred in carefully, the fire is withdrawn, the juice allowed to settle and is drawn off clear, through a cock placed near the bottom of the boiler. It is important to observe that the juice when the sulphuric acid is added

must *not be warm*. This process has failed in the hands of some imitators of M. Crespel, from a mistake on this point. M. Dubrunfaut acknowledges that he himself committed it.

CHAPTER V.

CONCENTRATION OF THE JUICE.

For this purpose one or more boilers are necessary, with which the evaporation is begun and finished, in these the juice from the defecating boiler is received clear; then a slow fire is kept up in the beginning, and some albuginous matter (white of eggs, or blood) added, if it should seem to be required. After this a man must attend closely to the boiler, and manage the fire. When froth appears it will be his duty, to throw a small piece of butter or other grease (which he should have near him) into the vessel, which will immediately cause it to subside, he should also have a ladle to stir it when required. When the juice has reached the proper point, that is to say 26° of Baumes's areometer when *boiling*, that is 30° when *cold*, it is time to proceed to the operation of clarifying.

CLARIFYING.

The object of this, is to separate the syrup concentrated to 30° or near it, from the extraneous matter which it holds in suspension, and moreover to deprive it by clarifying agents of all coloring matter, and other foreign substances which *were* in the juice, or have formed there whilst under the preceding operation, all which matter is injurious to the sugar. *Clarification* may be divided into two distinct branches, the one *chemical*, having for its object by clarifying agents, such as animal carbon, albumine &c. to purify

the sirup; the other *mechanical*, having for its object to separate from the same, the carbon and other solid bodies agglomerated by the albumine.

The first is managed with a boiler, only because the action of the chemical agents employed require to be aided by heat.

Of all the means hitherto devised for clarification none has been found so simple and so effective as that offered by the use of animal carbon, and albuginous or caseous matter.

* We will here suppose that the object in view is to clarify the portion of *sirup* supplied by the defecation of 100 gallons of *juice*, that is 16 1-2 gallons of sirup concentrated to 26° boiling and 30° cold, (it follows that for any other quantity is only required to follow the same proportion) to do this we must proceed to weigh 8 pounds of animal carbon and throw it into the boiler, the sirup when boiling should be well stirred with the ladle, then with the skimmer, the black agglomerated matter which rises to the surface should be broken up and mixed again with the liquid; when it is apparent that the carbon is sufficiently separated and mixed with the sirup, it may be left to boil for a few minutes. The sirup now assumes a turbid and murky appearance; whilst this operation is proceeding a quart of ox blood, or the white of 4 eggs should be beat up and diluted with water, or otherwise two quarts of skimmed milk. This mixture must now be thrown into the boiler, taking care to mix the whole well together. The ebullition will of course have been stopped by this addition, and it is proper till it begins

* The process we are about to describe is varied by *different* manufacturers, by some the acid is omitted altogether and other agents substituted.

again to boil, that it should be constantly stirred to prevent the precipitation of the ingredients, the ebullition must be kept up for a few minutes and the sirup is then prepared for filtration.

FILTRATION.

This is an exceedingly simple operation, a flannel cloth fixed to a frame is all that is required.

Sirup at the density of 30° cold, as it comes from the filterer is not sufficiently concentrated to crystalize, it is therefore necessary to submit it to another boiling to evaporate the superabundant water it still contains, and so to produce the required crystalization.

This operation is only a continuation of the concentrating process and also its completion; the same boiler which is suitable for the first part of this process is the one now again required, the fire must be carefully attended to, the sirup skimmed when required, and if it rises in foam, must be stopped as before by a piece of grease: when the proof shows 90 1-2 to 91 of Reaumur, 236° Fahrenheit which point it may reach, if the sirup is *very good*, it is time to stop and empty the boiler; it would be more prudent to do so at 89 1-2, the sugar would purify more easily and as the molasses must necessarily be reboiled, this supports the operation all the better for being a little richer in sugar.

The 16 1-2 gallons with which we began our experiment will now be reduced to 10 1-2 gallons. In this state it may be turned into a vessel to cool gradually, where it may stay for 10 or 12 hours when it will fall to the temperature of 170° or 180° of *Fahrenheit*, and then may be put into the pots for crystalization, these usually contain 6 to 8 gallons, in turning it into these, masses of the crystals will be found already at the bottom and sides of the vessel, if the sirup is good, some

attention is necessary in this operation that the sirup should not be left to get too cold before it is turned into the pots, as this would in some degree impede the crystalization, these should be kept in a close room and at a steady temperature ; the pots are of a conical form with a hole in the bottom which is stopped with a cork or clay, 36 or 40 hours after the sirup has remained in them, and when the temperature is reduced to 77° Fahrenheit or thereabout, the cork is removed and the point of the cone placed over a vessel into which the molasses (which begins immediately to run) is received, in about 15 days, in a temperature of from 60 to 65° Fahrenheit, they have furnished above 2-3 of their molasses, in this degree of heat the *whole* of the molasses will not separate from the sugar, the pots are therefore removed to another room where the temperature is kept at from 120 to 140° Fahrenheit, there they are again placed over the recipients, but before doing this a rod is thrust through the hole in the point of the cone to break the incrustation of sugar within, and facilitate the draining of the molasses ; after remaining here fifteen days the sugar must be completely freed from the molasses, and must now be taken out ; for this purpose the cone is placed on its base shook against the platform on which it stands, and in an hour or so, the sugar is detached in the form of the cone, the point of this is, impregnated with molasses and is to be removed, it makes an inferior sort of brown sugar, the rest of the product will be generally fine light colored sugar, which is found to produce a larger proportion of refined sugar to the weight than any made from the cane, and is therefore much preferred by refiners ; the sugar made at the beginning of the season is easier made, and better than that made later.

The molasses collected in the process of crystalization, is reboiled, and subjected to the same process as the sirup,

and a certain portion of sugar is the result ; the residuum is used for many purposes, and is especially useful for cattle.

CHAPTER VI.

USE OF THE BEET PULP FOR FEEDING CATTLE.

It has been long since known, that the beet is an excellent food for cattle, and consequently wherever agriculture is properly understood, this precious root is cultivated ; it improves the soil, occupies it but a short time, and furnishes them abundant nutriment. The manufacture of sugar from this root, besides its other great advantages, offers this additional one, that it requires but a *portion* of its nutritive matter, and furnishes for 3 or 4 winter months, a moist food, equally valuable for the purpose of *fattening* cattle, or for milch cows, which are apt on dry food to lose their milk partly or entirely.

An ox will eat daily from 60 to 70lbs. of the pulp ; and a sheep from 10 to 12lbs. to this it is well to add for the ox when intended for the butcher ; from 2 to 3lbs. of oil cake the residuum of oil mills, this addition renders the pulp more nutritive.

Estimating the amount of the juice from the beet at 70 per cent., 30 per cent. will remain in the form of pulp ; so that a manufactory working up daily 36 tons of roots, would supply 21,600lbs. of pulp in the same time, more than sufficient to feed 300 head of cattle, or 2000 sheep. Hogs are also exceedingly fond of the pulp, and fatten well on it. The time to which the manufacturing season is

limited, 4 months, or 120 days is amply sufficient to fatten cattle, and it not unfrequently happens when fed on the pulp cake, that at the end of *three* months they are fit for market; a factory might either buy lean stock to fatten, or (which is perhaps better) sell the pulp to farmers or graziers, for the same purpose. This product sells in France for 3 dollars the 2200 lbs, and a celebrated manufacturer of Arras declares that it was worth to him in stall feeding cattle 4 dollars 75 cents, the (1000 kilograms) 2200 lbs, as shown by a very exact account of an experiment he made to satisfy himself on this important point; but taking its value at *three* dollars for 2200 lbs, of pulp it will return to the manufacturer nearly 1-4 of the cost of the beets, valued at 3 dollars 50 cents, besides leaving a handsome profit to the farmer or grazier who may employ it. The pulp can be easily preserved *moist* for 3 to 4 months, and by drying it, a much longer time, every kind of animal give it a preference over almost any other food.

The manufacture of the beet sugar may be undertaken on almost any scale, but not with equal advantage, the result of a careful estimate of the comparative profits of large and small factories, and of the manufactory carried on with, or without *intermission*, by which is understood during the *day only*, or otherwise continued *night and day*, is as follows.

1 That the Factories worked night and day are more profitable, other things equal, than those worked only during the day.

2. That in all cases those on the largest scale are always the most lucrative.

3. That the sugar made by a *small factory* working by day alone, should not cost the maker more than from 5 to 6 cents per lb, and that one four times as large, and continu-

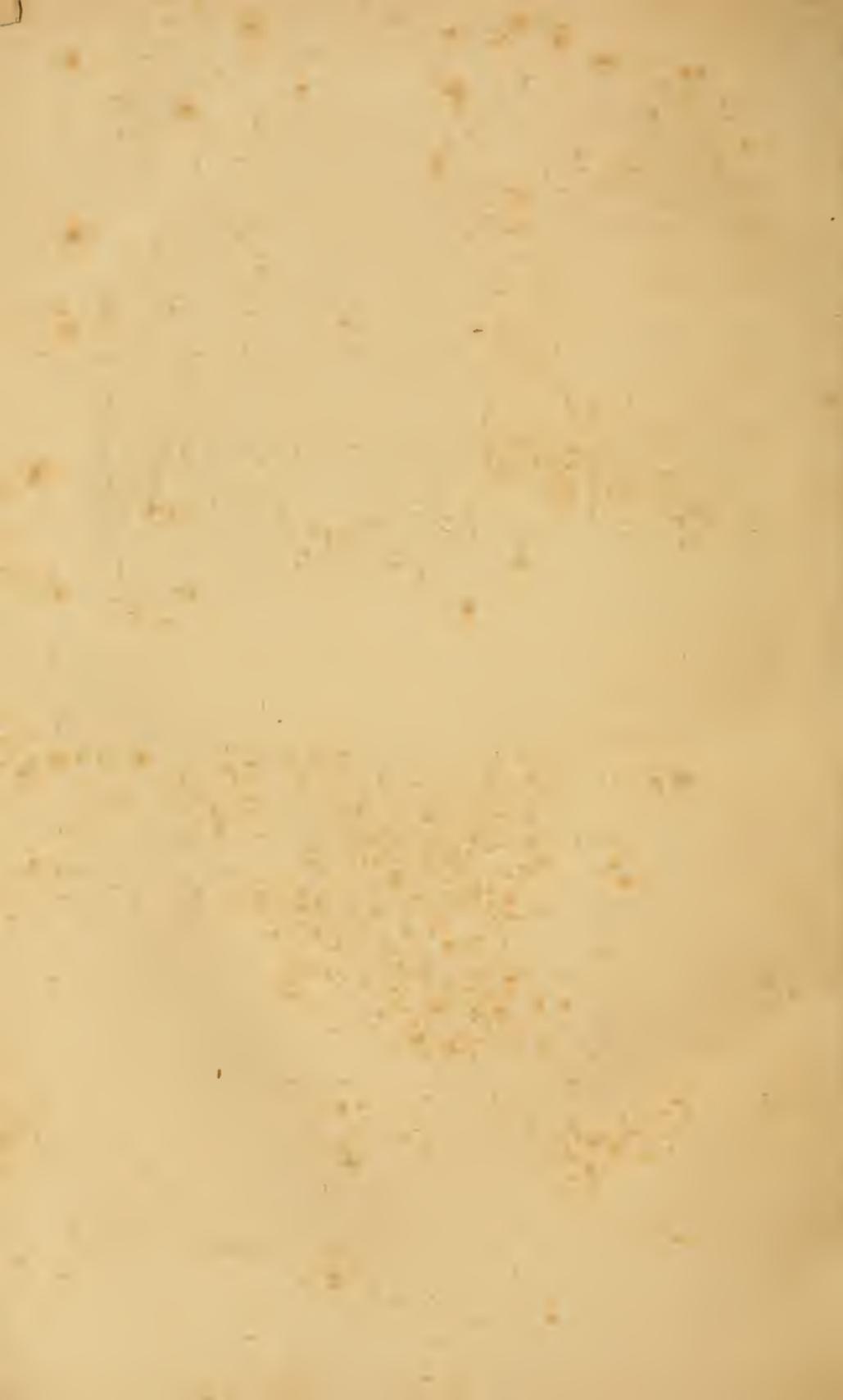
ed night and day, could make it for a fraction less than 5 cents.

4. That if we consider in the accounts which have furnished the above result, *all* the advantages resulting from the sugar manufacture *are not* embraced, such for instance, as the fattening cattle, distillation, the improvement of lands &c. it is fair to conclude that the price above mentioned (a fraction less than 5 cents,) is not the lowest cost at which it can be made, and this too *it must be particularly remarked* upon an estimate of only 4 1-2 lbs, of *brown sugar to the 100 lbs*, of beets, whilst 5, 6 and even 7 per cent, have of late been obtained!

5. That on the basis of only 4 1-2 per cent, the indigenous sugar manufactories of France can now support a competition with the sugar of her colonies, and that when this art has reached the extension to which it is rapidly approaching, and undergone the improvements of which it is susceptible, the beet sugar will be made as cheap as that from the cane in the *East Indies*, that is for about 2 cents and a *half* or three cents per pound.

To conclude, no doubt can possibly remain on a thorough and candid investigation of the subject, that the introduction of the beet culture and its manufacture into sugar is destined to create a memorable epoch in the prosperity of our Republic, not inferior probably, to the cotton culture, and having over that some preeminent advantages, therefore, to consider it only, as a means of replacing a foreign product, by one of our own growth would be to take a very narrow and inadequate view of the subject.

Since the above Notice was prepared for the press a work on the same subject, and drawn partly from the same sources, has appeared in Boston, I hesitated in consequence whether I should give publicity to mine, but seeing that there is some difference in the view taken of the subject in this little tract, and that both may tend to promote the same desirable object, I have determined to persevere in my original intention.



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