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THE SUGAR INDUSTRY OF HAWAII.

By C. F. Eckart.

The year 1876, when the reciprocity treaty between the Kingdom of Hawaii and the United States of America was entered into, marked the advance of the sugar industry of the Hawaiian Islands; labor was plentiful and comparatively cheap, the prices of sugar were high and the conditions favored a rapid increase in the sugar industry of the islands.

In late years, however, the prices of labor have risen and the prices of sugar have decreased, and periods of industrial depression have at times very much affected the sugar industry. The planters have had their prosperous years, and have also suffered from lack of labor, droughts, low prices of sugar, and other conditions, during which times they have manufactured their sugar at such expense that there has been no profit. The unfavorable conditions, however, have been met with the progressive spirit of American farmers and business men, and improved methods of cultivation and manufacture have been adopted.

Twenty years ago the average yield of commercial sugar was about 10 pounds per 100 pounds of cane and the average yield of cane per acre was about 25 tons. At the present time the average yield of commercial sugar is about 12 pounds per 100 pounds of cane and the average yield of cane per acre is about 40 tons.

There are now being operated 52 sugar plantations, with outputs varying from 350 short tons of sugar per annum to 35,000 tons. The great majority of these plantations are operated under their separate management, while a few sell their cane to neighboring mills and plantations. These 52 plantations are all represented in Honolulu by agents.

Most of the plantations are joint stock companies. There are a few, however, which are owned by individuals. Forty-three of the plantations which are incorporated have 6,366 stockholders.

The sugar is shipped to San Francisco, Cal., and around Cape Horn by steamer and sailing vessel. From California it goes overland to the East.

Under the United States navigation laws it is necessary that all sugar sent from here be shipped in American bottoms. The planters have been unable to obtain suitable American tonnage sufficient to carry all their sugar to the East around Cape Horn, and at least one-fourth of the crop of 400,000 tons produced last year had to go to San Francisco, Cal., and

from thence overland at a rate very much greater than by all water.

The time taken in getting sugar to the market is from two to five months, owing to the great distance which it has to be transported.

In some instances the sugar is shipped direct from the port of a plantation, but in most cases it comes to Honolulu or Hilo, Island of Hawaii, or Kahului, Maui, and from there is shipped to the States. The shipment from the various island ports to Honolulu is accomplished through the two inter-island steam navigation companies, which control about 19 vessels, representing an American tonnage of 6,018.

The Island of Hawaii produces more sugar than any of the other islands, the Island of Oahu coming next, followed by Maui and Kauai. The annual output of the islands since 1894 has been as follows:

[2,000 pounds to the ton.]

	1894. Tons.	1895. Tons.	1896. Tons.	1897. Tons.	1898. Tons.
Hawaii	72,199	61,643	109,299	126,736	91,606
Maui	33,689	27,735	29,097	41,047	45,033
Oahu	18,843	17,433	35,782	28,929	34,181
Kauai	41,701	42,816	51,650	54,414	58,594
Total	166,432	149,627	225,828	251,126	229,414

	1899. Tons.	1900. Tons.	1901. Tons.	1902. Tons.	1903. Tons.
Hawaii	117,239	115,224	134,618	121,295	170,665
Maui	54,389	57,347	58,349	56,726	84,776
Oahu	45,820	53,625	99,534	107,870	121,066
Kauai	65,359	63,348	67,537	69,720	61,484
Total	282,807	289,544	360,038	355,611	437,991

At the present time the sugar industry is depressed and is feeling the effects of the low price of sugar which prevailed during the past three years and the lack of sufficient competent field labor. The damage done to the cane fields by the leaf hopper, cane borer, and fungus diseases has also been very great.

In the year 1902 the total tonnage produced in the islands was 355,611 short tons. The capitalization of the incorporated plantations was $63,940,650, and the amount of dividends paid was $1,757,520, or at the rate of 2.75 per cent.

In 1903 the total tonnage produced was 437,991 short tons. The capitalization of the plantations was $64,878,931.63, and the total amount of dividends paid was $1,555,652.68.

YIELDS, FERTILIZATION, AND CULTIVATION.

The yield of sugar for the Hawaiian Islands for the crop of 1903 was 438,054 short tons, which quantity was harvested from an area of 93,350 acres. The following statements of yields show the relative production on irrigated and unirrigated plantations, and for the islands as a whole:

Yields of sugar for 1903.

	Acres.	Total sugar. Tons.	Yield per acre. Pounds.
Hawaiian Islands	93,350	438,054	9,385
Irrigated plantations	42,097	260,525	12,377
Unirrigated plantations	51,253	177,529	6,927

While the average yield of 4.69 tons of sugar per acre appears high when compared with that of other sugar-growing countries, it is in a measure misleading, for the fact that the Hawaiian cane crop takes as a rule from eighteen to twenty-two months to mature (thirty months are required on certain fields on the uplands of Hawaii) necessitates a considerable reduction in this stated yield before it can be brought into comparison with annual crops of other countries.

Reliable statistics have been recorded since 1895 showing the yields of sugar and acreage of all plantations in the group, and the increased production per acre between 1895 and 1903 may be seen from the following figures:

	1895.	1903.
Under cane ..... acres	47,399.5	93,350
Total yield of sugar ..... tons	157,419.5	438,054
Yield of sugar per acre ..... pounds	6,472	9,385

This increased yield per acre during a period of nine years may be attributed to several causes, which may be briefly stated as follows:

THE EXPANSION OF THE SUGAR INDUSTRY THROUGH THE TAKING OVER OF NEW LAND.

A certain gain per acre has without doubt followed the planting of new lands. The total area of cane harvested in 1895 was 47,399.5 acres. Of these sugar lands 23,945 acres, or practically 50.6 per cent., were dependent upon rainfall for their water supply, and 23,454.5 acres, or 49.4 per cent., were irrigated. In 1903 the area of cane harvested was 93,350 acres, of which

51,253 acres, or 54.8 per cent., were dependent upon rainfall, and 42,097 acres, or 45.2 per cent., received irrigation. These figures show that the unirrigated area has increased over the irrigated lands by 9,156 acres since 1895. Unless we stop to consider the nature of the lands added to the sugar area in each instance we would expect to find a decrease in the acre yield for 1903 rather than an increase, other influences being omitted from consideration.

New lands taken over by the unirrigated plantations have been largely on the higher levels, where the soil is thinner and poorer as a rule, and the sugar yields, although at first good, are soon reduced after harvesting one or two crops and become less than those obtained from the lower-lying areas. On the irrigated plantations the new lands which have been added to the cultivated area have usually been richer than those under cultivation for some time, and such expansion has followed the opening of new sources of water supply with the advantages of improved irrigation facilities. The production per acre on the unirrigated plantations was 30.4 per cent. higher in 1903 than in 1895, and on the irrigated plantations a gain of 61.3 per cent. was obtained during the same period. The gain in the former instance must be attributed almost entirely to improved methods of cultivation and fertilization and to the introduction of more thrifty varieties of cane, while in the latter case a greater production due to new lands can not be omitted as an important factor along with the gain from progressive methods of cane farming. A considerable part of this gain on the irrigated plantations was due to the yields of three plantations situated in a favorable locality bordering on Pearl Harbor. The acreage of cane harvested from these plantations in 1903 was 10,419 and the sugar yields 88,768 tons. Omitting these plantations from the list of irrigated estates would reduce the average yield per acre of irrigated plantations for 1903 from 12,377 pounds to 10,844 pounds, and of the islands as a whole from 9,385 to 8,423 pounds. Two of these plantations, representing 49,993 tons of the 1903 crop, came into existence later than 1895, and the other has largely extended its area since that year. Increased technical skill in the mill and sugar house, with a resulting decrease in losses of manufacture, has also added to the output per acre.

While the foregoing comparison shows a remarkable increase between the years 1895 and 1903, it must be borne in mind that the high-water mark in the production of these islands has been reached; the crop for 1904 will not reach more than 380,000 tons, while that of the following year is not estimated to amount even to that figure.

The profits accruing from the increased yields on the irrigated plantations have not always been commensurate with the increased production, owing to the large cost of waterway

construction and of pumping. The cost of irrigation includes the installation of pumps, construction of ditches and reservoirs, tunneling, and the labor of applying water to the cane furrows. The expense incurred in the making of Hawaiian irrigation ditches may be conceived when the obstacles encountered in this line of engineering work are considered. The headworks of the Makaweli ditch, for instance, involve 29 tunnels of a continuous length of 5 miles, 7 feet wide and 7 feet high, excavated in the solid rock and built on a grade of 8 feet per mile, which will give a daily capacity of over 60,000,000 gallons when running 4 feet deep (report of M. M. O'Shaughnessy.) As regards the cost of pumping to higher elevation, Mr. O'Shaughnessy stated: "To pump 10,000,000 gallons daily against a head of 300 feet with ordinary pumps and fuel in service will consume 15 tons of coal daily, which at $8 per ton amounts to $120 for daily fuel expenses." Another engineer computes the average cost of lifting 1,000,000 gallons of water 1 foot, with coal as fuel, to be as follows:

Operating expenses	$0.081
Interest 6 per cent	.014
Depreciation 3 per cent	.007
	.102

With fuel oil the average cost is reduced as follows:

Operating expenses	$0.053
Interest 6 per cent	.014
Depreciation 3 per cent	.007
	.074

About 5,000,000 gallons are used per acre in the growing of a crop, and this quantity is pumped to a maximum height of 550 feet.

A careful test conducted at the experiment station of the Hawaiian Sugar Planters' Association in Honolulu showed that without irrigation it was only possible to obtain 1,600 pounds, or less than 1 short ton of sugar per acre. This was with a rainfall of 32.5 inches per year. The largest of the irrigated plantations have a much smaller rainfall than 32.5 inches, and it would not be possible to harvest even the small acre output indicated by the unirrigated cane at the experiment station. A yield of 1,600 pounds of sugar to the acre would not justify the expense of growing, harvesting, and milling the same, and it is safe to say that were the sugar lands of this Territory entirely dependent upon rainfall, the 1903 crop would have yielded little more than 177,529 tons of sugar.

INTRODUCTION OF NEW VARIETIES.

In accordance with the experience of planters in other sugar-growing countries, those of Hawaii have been obliged to maintain the yields in many localities by the substitution of more thrifty and hardier canes than the old standard varieties. The attention given to this subject on many of the plantations has undoubtedly helped to raise the acre output. On Hawaii, the Lahaina cane after having been grown for many years was finally succeeded by the Rose Bamboo, which latter variety is now making way for a more vigorous cane, termed Yellow Caledonia. In districts subject to over-copious rains or to excessive drought, and where Lahaina and Rose bamboo (in less measure) would show an occasional falling off in production, under such adverse influences Yellow Caledonia, through its hardier characteristics, has maintained a favorable yield in less-favored seasons. On lands which had given out for Lahaina to such an extent that the cane made but a meager growth, this variety has yielded a profit to some plantations that would otherwise have taken off their crop at a loss.

The Hawaiian Sugar Planters' Association maintains at considerable expense an experiment station in Honolulu, where new varieties introduced from foreign sources are carefully tested as to their productive value, and then sent to the various plantations for trial under their conditions. With the advent of serous insect pests and fungus diseases in Hawaiian cane fields, it became necessary to carefully watch the growth of these canes to note their relative immunity from disease and their ability to cope with the serious pests of the islands.

FERTILIZATION AND CULTIVATION.

Probably in no other cane-growing country does the subject of fertilization receive so much consideration as in the Hawaiian Islands, and the study which has been given to this question by plantation managers has done much to raise the sugar yield per acre throughout the Territory. Planters here have adopted a policy different from that usually in vogue. They do not wait to fertilize after the soil is depleted and exhausted, but practice the plan of sustaining the food qualities of the land and bettering its condition by the extensive use of fertilizers on the virgin soil. The percentage of the various ingredients, as well as the forms in which they are applied in mixed fertilizers, are carefully considered with regard to climate and soil and, owing to the diversity of Hawaiian conditions, fertilizer formulas show wide variations in the various districts of the group.

The average quantity of mixed fertilizer applied per acre for

the crop of 1903 was 910 pounds, the average formula being 7.1 per cent. phosphoric acid, 10.1 per cent. potash, and 6.1 per cent. nitrogen. The amount of mixed fertilizer applied to the crop of 1903 was approximately 41,000 tons. The amount of nitrogen, phosphoric acid, and potash used was as follows:

	Tons.
Nitrogen in mixed fertilizer	2,501
Phosphoric acid in mixed fertilizer	2,911
Potash in mixed fertilizer	4,141

About 6,000 tons of nitrate of soda containing approximately 900 tons of nitrogen were also used. These large quantities of the various fertilizing ingredients would have values somewhat as follows:

Nitrogen in mixed fertilizer	$750,300	
Phosphoric acid in mixed fertilizer	232,880	
Potash in mixed fertilizer	393,395	
		1,376,575
Nitrogen in nitrate of soda	270,000	
Total		1,646,575

In addition to nitrate of soda, specially bought fertilizers, such as lime, ground coral, fish scrap, muriate of potash, tankage, and a mixture of nitrate of soda and sulphate of ammonia were applied. The value of these latter materials, together with the cost of bagging, mixing of complete fertilizers, and transportation would bring the total amount expended for fertilizers to somewhat over $2,000,000. Besides these fertilizers, which were bought, large quantities of stable manure, furnace ash, molasses, and disintegrated mud press cakes were used, the exact quantity of which is not known.

On one plantation, as a result of careful fertilization, a gain of 100 per cent. in sugar was obtained over unfertilized land. On very fertile soils, which respond less to fertilization, a gain of 20 per cent. has been reached through the use of suitable fertilizing material.

Almost as much attention has been given to cultivation as to fertilization, and owing to the diversity of methods little can be said on the subject in a brief report of this nature. The most approved patterns of agricultural implements are used, and specially constructed plows, harrows, etc., have been adopted in some instances for the thorough preparation and cultivation of the soil. Steam plows are used on many estates, and deep plowing with moderate subsoiling are practiced where the depth of the staple will permit. In the rainy districts the cost of stripping, i. e., removing the dried leaves from the cane

and keeping down weeds, are large items in the expense of cultivation.

During the last several years the cane fields of the Hawaiian Islands have been afflicted with a serious pest, termed the leap hopper (Perkinsiella saccharicida), which on many estates has greatly reduced the yield of the 1904 crop. Since getting a foothold in the Territory it has been noticed on seed cane arriving from Queensland and on Chinese cane imported for eating purposes by the Chinese population. It very probably was received originally from either Queensland or China, where it is not known as a pest, owing to the presence of natural enemies which keep it in check, or limitations exerted on its reproductive capacity through climatic causes. An inspection of all plants entering the islands is now rigidly enforced, and much labor and expense have been incurred in reducing to a minimum the chances of receiving insect and fungous pests from foreign sources. The Hawaiian Sugar Planters' Association has organized an efficient entomological bureau for the control of various cane pests, and it is expected that much will be accomplished in keeping down to a safer limit the hopper, borer, and such pests as have in the past proved highly injurious.

The prevailing low prices of sugar and high cost of labor, together with the serious loss annually incurred from insect and fungous depredations, necessitate the utmost vigilance on the part of plantation managers to determine sources of loss in the mill and fields, and through technical skill in the one instance and progressive methods of farming in the other, to combat the tendency toward reduced profit which has been strongly felt from year to year.

*THE INSPECTION AND DISINFECTION OF CANE CUTTINGS.**

By N. A. Cobb.

INTRODUCTION.

The increased losses caused by diseases of the Sugar Cane will, sooner or later, in all countries where that crop is grown, necessitate special attention being given to the cuttings—attention so directed as to minimize the diseases that gain entrance to the plants through the "seed." This subject is one of immediate importance to the planters in Hawaii, and is treated of in these pages.

If it appears to the experienced planter that in some parts of this bulletin we have gone into unnecessary minutiæ, attention is asked to the fact that what are unnecessary particulars to some are not so to others. It seemed better to consider all the possible readers of the bulletin, at the risk of being to prolix for some.

WHAT PLANTATIONS SHOULD TAKE THE PRECAUTIONS OUTLINED IN THIS BULLETIN.

Of all the precautions that can be taken against the occurrence of disease on cane plantations, it is doubtful if any outrank in importance, care in the selection and preparation of the cuttings or sets. From the first moment in this process to the last, there are numerous precautions, some of which at least, no careful manager should allow to escape attention. From the time it is decided what variety to plant, to the placing of the sets in the ground, each step should be so taken as to guard the future crop against disease, and at every step there are measures that may be profitably taken on most plantations.

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*I wish to specially acknowledge the kindness of several friends much experienced in Hawaiian cane growing who have read this bulletin in MS and have given me the benefit of their criticisms. The bulletin has been materially improved thereby. I refer to Mr. W. W. Goodale, manager of the Waialua Agricultural Company's Plantation, Mr. Andrew Adams, manager of the Kahuku Plantation Company's Plantation, and my colleague, Mr. C. F. Eckart, Director of the Agricultural and Chemical Division of this Station.

It may of course be argued that on some plantations disease does not exist, and that it is therefore unnecessary to take any of these precautions. If we consider only the immediate future there may be something in this contention. If the manager asks why he should go to the expense of taking these precautions when his plantation has always been free from disease, and why he should reduce the profits of the plantation by the expense of these precautions, when there is no reason to suppose he is at present losing money through disease, he puts practical questions, the answer to which must be that *if it is true* that he is at present losing nothing through disease and there is no immediate prospect that he will lose from that cause, it would be foolish to borrow trouble.

But the question of disease on cane plantations is a very complicated one, and recent history in many parts of the world show that even when the planter feels most secure he may be on the verge of a serious outbreak of disease. A number of the fungus diseases of cane are most insidious in their attack, gaining ground in such an obscure and hidden way that almost before he is aware of it the planter finds himself in the grip of an unsuspected enemy.

In its general nature disease in a cane plant is similar to disease in the human body. There is hardly a person who cannot recall the attack of some sickness, the grippe, or some one of a dozen or more of the common infectious diseases to which we are subject. Let him ask himself WHEN that attack began. The answer is that he does not know. The organism causing the disease is so minute and the exact method of its attack is so obscure that it is impossible to fix the moment of its first onset, except within wide limits, and then only with the introduction of numerous "ifs" and "ands."

What applies in such an obvious manner to the human body applies with redoubled force to the cane plant. In the first place we know less of the diseases of the cane plant than we do of the diseases of man, as a matter of course. Danger to human life is what we take the greatest pains to avoid, and any disease that threatens us becomes the subject of the most searching inquiry. The number of investigators and the acuteness of the research reaches its maximum in the case of the diseases of man. These are mere truisms. Now, if after all time and money spent in the investigation of the diseases of man we are obliged to admit that in most cases we cannot tell the precise history of the beginning of an attack in any particular case, how much more true this must be in the case of the cane plant whose diseases are so much less well known. To this we must add the fact, and it is a most important one, that we understand the physiology, not only of cane, but of plants in general, much less perfectly than we do that of animals. We are therefore much more likely to misinterpret the

symptoms of disease in the case of plants than in that of animals.

How then is the planter to know that he is not in danger of an attack on his cane? He certainly cannot be positive about the matter, and if this is the case would it not be wise to borrow an axiom from the Public Health Service—"Take no chances?" The public is justly severe on an officer who submits it to the risk of infection. Human life and health are more valuable than the cash profits of a sugar plantation, still the precautions that are taken to guard the one may often serve as models in guarding the other. There are cynics who say that human life and hard cash are practically synonymous terms. They are surely sufficiently analogous to justify the above course of reasoning which leads us to the conclusion that precautions may be profitable even on plantations where apparently no disease exists, and even where there appears no immediate prospect of an attack.

AIMED AT A NUMBER OF DISEASES.

This bulletin is aimed at fungus diseases of the cane in general, not at any particular one of them—or perhaps it would be better to say that it is aimed at all those fungus diseases of the cane that enter the plant by way of the cutting.

The fact that the planting season is now at hand leads to the publication of the present bulletin at this time. The data thus quickly gathered are sufficient to warrant what is here said, and if the suggestions be promptly acted on they may be of service during the present planting season. At a later date, sometime during the next year it is hoped, sufficient advance will have been made in the examination of the cane diseases of Hawaii to justify going into further particulars. Meanwhile, it appears unwise to delay all publication until that time, so plain is it that certain precautions are manifestly advisable to a large extent regardless of particular diseases.

Accordingly the symptoms of the various diseases are left for the most part undescribed. The general rule to be followed is a very simple one. First, become thoroughly familiar with the appearance of unquestionably healthy cane cuttings of the variety to be planted. Second, reject all cuttings that show any departure from a healthy appearance, no matter how small it may be. In particular, look out for colorations at the ends of the fibres, as such coloration is almost without exception an indication of disease present in the cutting. Healthy fibres are colorless. Such cuttings as contain colored fibres are likely to produce diseased plants. It is probable that some planters may be surprised at the fewness of the joints that are free from such markings, but this is simply an indication of

the considerable extent to which the cane has become infested with disease.

Cane fibres when they first become diseased have a tendency to turn pink or reddish—in some diseases, also yellow. From this light tint they become red, then brown and finally almost black. By the time the fibre first attacked is black, others in its vicinity will have become pink or various shades of red, and so the disease progresses.

These fibres which are colored, though they be no wider than a hair, are the infallible symptoms of disease, and cuttings showing them should not be planted.

The writer is prepared to find that on some parts of some plantations the rigid adoption of this rule will exclude nearly all the cuttings. Under such circumstances, if it is not considered advisable to procure cuttings from elsewhere, it will be best to relax the inspection to such an extent as to make the production of the necessary amount of "seed" a feasible operation, but it must not be forgotten that this relaxation is fraught with danger of still propagating the diseases. Still when one cannot do as he would, he must do as he can. Partial measures are often better than none, and if taken this year may result in the possibility of a rigid selection next year.

SELECTION AMONG THE GROWING CANE.

It is not necessary at the present place to go into the very important matter of the selection of disease-resistent varieties, as that subject will be dealt with elsewhere. Leaving this weighty matter out of account, the first thing that calls for attention in the selection of cuttings is the particular area from which they are to be harvested.

There is, in a general way, no part of the whole operation where a little time can be so profitably spent, and the results are in some cases so satisfactory that all other precautions may be to a large extent dispensed with.

The crop from which the "seed" is to be taken should be the healthiest on the plantation, and should there be no healthy areas on the plantation it is best to go elsewhere for the sets. If it is necessary to do this, the planter should be careful to select another plantation as nearly like his own as possible, except of course in the matter of disease. It is, as a rule, rather risky to bring seed from plantations of a different character as to soil, climate, and so forth. There is not the slightest objection to doing it by way of experiment on a small scale—in fact, such a course is highly advisable. But to bring large quantities of seed from a plantation of a different character is too likely to result in decreased profits. Hence if sets are brought to a plantation from elsewhere and on a large scale,

preference should be given to plantations of a similar general character as to soil, elevation, climate, water supply, drainage, proximity to the sea, and general management. This latter list of particulars will show to the practical man what a range of conditions is included under the term "similar plantation."

A variety may do well on one plantation and not so well on another for any one of the above reasons as well as some others. In particular, mention may be made of the general management, as it is one whose bearings are not particularly obvious. The growth of a crop is to a considerable extent a personal problem. This personal factor is an important one. We sometimes hear it said that Blank's crops are always good. This is one way of expressing the personal factor. The crops are good because they are Blank's, that is to say, his methods of using the same forces that his neighbor uses are such that he gets different results. It is obvious that this personal factor must be allowed for in selecting a plantation from which to secure cuttings for the renewal of crops on a diseased area.

Of course if a plantation is ill-adapted to a certain variety and on that account produces poor "seed," it may be advisable to send to a plantation of a different character for seed. It sometimes happens that a crop can be profitably grown under conditions that are on the whole rather unsuitable, with the result however that the crop becomes so much deteriorated that it is an unfit source for "seed." Then it is of course advisable to send to a plantation of a different character that does produce suitable seed. Such cases are exceptional and do not upset the general rule that it is best to bring seed from plantations of a similar character, if it is to be introduced on a large scale.

Once it is decided from what crop to secure cuttings, an important step has been taken, but it should be followed by others second in rank only to it. Of these the rejection for seed purposes of all suspicious parts of the crop, stands first in importance. It must be remembered that every attention paid to these selections on a large scale means a saving in the later steps of our problem.

In a given plot or field it is seldom that there is not one portion better than another. It must be borne in mind that in a crop propagated from cuttings the best is none too good. In fact it has been seriously argued, at any rate in the case of cane, that any given variety is bound to "run out," as the saying is, in the course of time, no matter what precautions are taken. It seems to the writer that it is at least a little incautious to make such a statement until there is more evidence that the proper precautions have been taken to prevent such "running out." His own observations in many parts of the world and on many kinds of crops would lead him to

think, that, as a rule, comparatively little systematic attention has been paid by planters to keeping up the standard, not only of cane varieties, but of varieties in general. This is not to deny that certain individuals have taken the proper course to that end, but simply to indicate that the general practice, on which the result really depends, has been one of carelessness in this regard. Until such a criticism no longer rests on good grounds, it seems as if those who predict the inevitable "running out" of varieties are prognosticating from an insecure basis. Moreover, there is some ground for believing that an actual improvement can be made in varieties by careful and long continued selection of sets, grafts or cuttings. If this be so, it is entirely against the theory that varieties propagated by cuttings necessarily "run out."

In the present state of our knowledge it would, in any case, seem to be a sound maxim that "*The best is none too good for seed.*"

Select, therefore, those parts of the plantation that are known to be the best, and use seed from these only. If this means a decrease in the current year's yield of sugar, remember that the future yield will more than make up for this loss.

In determining what are the best seed-areas on the plantation, consider not only the present condition but the past history. Any part of the plantation that has been the scene of disease in the immediate past is to be regarded with suspicion no matter how well it may look at present. Having a choice of two parts looking equally well at the present time, unhesitatingly reject that which "has a past."

The most experienced and successful planters of other crops not infrequently make a specialty of the growth of their own seed, and no doubt this is to a certain extent the case in Hawaii. It is a highly commendable plan. The details are somewhat as follows:

Secure from some reliable source, one of the most important of which should be the local Experiment Station, seed of the desired varieties. This seed should be specially selected and prepared by the best scientific methods known. It does not matter that the amount of seed is at first small. That is a necessity of the case. The great point to be aimed at is to get the very best and the very healthiest seed. Having secured this good healthy material, give it the best attention from year to year and increase its amount up to the plantation scale as fast as possible. Thus far this plan is one frequently exemplified. There are fewer instances where this process is practiced each year so that *bringing forward fresh seed is a regular part of the year's operations.* When once such a scheme is in operation its details are not onerous and there can be no doubt whatever that sound business principles underlie such a practice.

HARVESTING SEED CANE.

After the seed area has been definitely decided on, the harvesting, from beginning to end, should be so conducted as to weed out any undesirable plants or patches. If the area is "patchy," discard the poorer patches. No matter how healthy the cane may appear as a whole, it is certain that some individual plants will be diseased. The spores of disease are almost omnipresent and it is as impossible for all the plants of a plot of cane to escape disease as it is for every inhabitant of a city to escape sickness. Human foresight cannot absolutely prevent all sickness. It is beyond the present power of man to absolutely exterminate disease. The most he can do is to reduce the disease to what may be termed bearable limits. In the seed-cane area, therefore, the next step is to so modify the harvest as to bring to light, as fast as possible, all the diseased and suspicious plants, because here, as before, the detection of such patches and plants save trouble in rejecting the individual cuttings. It must be borne in mind that our task is not perfectly performed until we have weeded out every diseased cutting and "pickled" the balance.

To this end it is desirable, therefore, to inspect every row of cane and remove therefrom all diseased and suspicious plants; or at least so mark them as to allow the harvester to avoid them. The most expensive part of the process of securing sound cuttings is that part which employs the greatest amount of highly paid labor. It is a matter of judgment what part this shall be in any given case, but in many instances it is certain to be the inspection of the individual sets. In all such cases expense will be saved by careful attention to the cane before it is cut—in the manner just described.

When the canes have been cut the sticks may with advantage be inspected and suspicious individuals discarded. Here the rule should be to unhesitatingly discard any canes that appear in any way undersized, overgrown, "off color," or otherwise suspicious. The rejection should be made by one thoroughly familiar with the normal appearances of the variety under inspection, and this of course applies also to all the previous stages of weeding out.

It is sometimes recommended that an inspection be made of the standing cane after it has been topped and before it is cut. This course may be advisable in some cases, where the requisite method of harvesting is followed, and may be made to replace the inspection of sticks after the canes are cut and before they are cut up into sets or cuttings.

In examining a crop for suspicious plants, attention should be paid to the appearance of the tops of the cane; and if these show symptoms of disease, the canes should be rejected no

matter how healthy the sticks may seem. In case a stalk looks suspicious, the top may be lopped off and split longitudinally, and later on, after the stalk has been allowed to "bleed," the cut may be examined for any suspicious symptoms. This applies particularly to the disease known as gumming.

The three most common routes through which cane becomes diseased are:

1. *From the soil, through the roots, or through the cuttings.*
2. *Through the leaves.*
3. *Through wounds in the stalk.*

As an instance of the first may be cited those numerous cases where diseased cuttings are unwittingly planted. As a result the disease in the cutting gains access to the new cane plant.

As an example of the second may be mentioned a disease, often erroneously termed Rust, which attacks the leaves, kills them, and the stalk in consequence decays from the top down.

As an example of the third may be mentioned those fungus diseases that destroy cane that has been attacked by borers.

Now in any one of these cases the disease may be in its initial stages at the time the planter appears on the scene in search of his seed cane. The point I wish to make in reference to the *tops* of the cane is this: that the stalk while appearing to be still in good condition may be already in the grip of disease through the medium of the leaves, and this is specially liable to be the case if the tops appear in any way diseased. Diseased leaves, if at all seriously attacked, are a sufficient reason for rejecting a stool for seed purposes.

DEALING WITH THE REJECTED CANE.

The rejected cane will, of course, as a rule, be crushed. If there be any considerable quantity, it should be harvested and milled all at one time and particular attention be given to the destruction of the field refuse which will contain untold millions of dangerous spores.

On some plantations in other parts of the world it is the custom to collect all the pieces of cane that refuse to burn with the trash, and on Saturday afternoon put them through the mill, simply to insure the utter destruction of the spores and insects they may harbor. This is a course that in my opinion is fully justified on a plantation severely smitten with disease. The juice for such a crushing should be sterilized or run into the sea. It should not be allowed to contaminate cane land.

The facts of the case are as follows: the burning of the trash while it destroys some sticks that are riddled and dry, does not destroy the "half dead" truck that still contains considerable

juice. These are more or less roasted on one side but not sufficiently heated to destroy more than a fraction of their contained spores or insects. Unless utterly destroyed, they continue to be a source of infection. To plough them in is simply to plant disease—literally to cultivate it.

Where there is much disease it is highly desirable to get rid of these half dead stalks that will not burn. If it be considered too serious an interference with the milling arrangement to put them through the mill at the end of the week, (the time at which it would cause the least inconvenience and loss) then some other method should be adopted.

If these stalks be collected and placed in a ravine whence the drainage is direct into the sea and not on any part of the plantation, I see no serious objection to such a procedure, so far as fungus diseases are concerned, provided the stalks are not allowed to become dry and a source of dust (which would inevitably contain spores of disease).

PREPARATION OF THE CUTTINGS.

The preparation of the cuttings should be entrusted to expert laborers only. Especially is this the case if it is proposed to dispense with treatment with Bordeaux Mixture, of which something will be said later. The tools for the cutting of the sets should be special tools, and they should be kept specially sharp. I find very little attention paid to this point. If the planter will attentively examine two sets, one produced by a skilful stroke of a sharp cane knife and the other by an unskilful stroke or by a dull knife, he will see various differences between them, and these variations are such that they will originate important differences in the history of the cane-plants destined to spring from the cuttings. The explanation may be a little tedious, but it is necessary, inasmuch as it is highly important to a proper understanding of the subject.

The object of preparing cuttings in the manner here advocated is two-fold: first, it is to enable us to make a successful inspection; second, it is to preserve the future plant as far as possible from infection.

In inspecting cuttings one of the principal objects is to examine the ends and to reject any that look diseased or even suspicious. This inspection is greatly facilitated if the ends are clean and well cut. If they are shattered by bad cutting or a dull knife, it will often be difficult to make sure what the internal state of the cutting really is. It is not a difficult matter to learn the normal appearance of perfectly healthy cuttings. A man of ordinary intelligence should be able to do this with a little practice, guided by a little instruction or reading. Very little observation will serve to convince any-

one that the sets may easily be so poorly cut as to seriously interfere with a proper inspection. If the cut is clean and smooth, every fibre of the cane will be visible, and any discoloration due to internal disease will be quickly seen if it is at all pronounced. If it is not of a pronounced character, the chances of seeing it are in proportion to the smoothness of the cut. Hence the sharpness of the tools and the skill exercised in using them play a most important part in the successful inspection of sets or cuttings.

This, however, is only one part of the matter, for the manner of cutting the sets has a most important bearing on the subsequent history of the plants that spring from them.

It is now well established that a number of the diseases of the cane find their way into the plant by way of the cutting. In regions where cane is grown, the spores of these diseases that gain entrance by way of the "seed" are, as we have before remarked, almost omnipresent. They are to be found in almost every conceivable place—on the tops of houses, all over the foliage of trees, even on the tops of the highest accessible land, in our food and drink, in fact, as said, in almost every conceivable location. It is no wonder, therefore, that they are to be found in any part of the soil to which they could be transported by wind, water, or by animal agencies, and in fact, these are the very places where they are the most numerous. In the soil, also, they find their most congenial abode—if we except the interior of the cane-plant itself. In the soil they find nutriment, and there they can maintain life for—we do not know how long. They are always to be found in enormous numbers, in the soil of cane fields, at any rate in the case of the more common diseases of the cane. A single diseased cane plant will often bear such a number of these spores that, if they were evenly distributed, thousands could be supplied to every square foot on an acre of land. From this statement, which is an extremely moderate one, it will be seen that the chances are greatly in favor of every foot of land on a cane plantation being well infested, particularly if cane has been grown there for a series of years in the ordinary way hitherto practiced. The longer the cane is grown on the same land, the greater becomes the infestation, up to a certain point. As before said, it is absolutely impossible to exterminate these diseases, this prevalence of invisible spores being such as to defeat any measure of extermination that has so far been devised. The spores stand ever at hand ready to enter cane tissue if given a chance.

The cane plant has armed itself against any such invasion by the building of a tough and impenetrable cuticle, and in this measure of defense the plant appears successful, for in most cases, so far as we know at present, the disease is incapable of forcing its way through this cuticle, though there

are important exceptions to this statement. It is far different, however, with the raw end of a cane-cutting placed in the ground. Here the tissues upon which the parasite feeds are fully exposed to attack, and the ubiquitious spore soon enters and grows thriftily. I have on many occasions verified this assertion. So have others. Now, though the disease may enter the end of the cutting, its progress may be slow in comparison with that of the new plant under good weather conditions, and it may be some time before the disease overtakes, as it were, the new plant. It may fail altogether to overtake it and the result be a success from the cane-grower's standpoint. But how will it be if the cutting has shattered ends? Obviously the fungus has a much better chance to get in its deadly work under such circumstances. The smallest crack, it matters not how small, quite invisible it may be, is a broad and open door to the spore or mycelium of one of these diseases. The smallest crack affords it a broad road. Now, befor the disease can very seriously menace the new plant it must penerate to near the joint or node from which the bud springs. This distance in a well prepared cutting is several inches, and constitutes a considerable defense to the new plantlet. But if the cutting is shattered in the way we have described, the fungus may enter almost at the node itself, and on the very border of the new plant tissues. As there is at first no very sharp demarkation between the tissues of the new plant and the old, this is tantamount to an entry into the new plant itself, whose fate is now settled. It will become diseased.

There is a third objection to shattered sets, and it applies when the sets are treated with fungicides. It is now established that treatment of the seed with fungicides is an efficient method of preventing the entry of disease, and in many cases there is assurance that some treatment of this sort is of practical value. In certain cases it has already proved to be so, but further tests on the plantation scale are necessary before the best methods will be fully established. Now the treatment of the shattered sets is a much less satisfactory operation than that of clean cut sets because the fungicide fails to enter these small cracks at the shattered end of the set owing to the presence in them of air, and in consequence the fungus has a door still left more or less open to it.

These are powerful reasons why the preparation of cuttings should receive much greater care than is common.

The tendency to shatter is greatest on the "off" side of the knife, and if he keeps this fact constantly in mind a workman will, by taking advantage of certain circumstances, turn out better work. The last cut is often made merely to remove an objectionable end. By cutting in the proper manner, the ten-

dency to shatter may be transferred wholly to the end to be discarded.

From the disease-resistant point of view the manner of cutting the sets may be good or bad according to the position, as well as the nature, of the stroke. One point to which attention should be paid is its position with reference to the eye which is to originate the new cane plant. This eye should have all the nourishment at its disposal that can be conserved. If a single cut is to sever what are to become two separate cuttings, it is best to make it half way between the joints. This preserves to each new plantlet an equal portion of nourishment.

Often this is not the case, and one of the parts into which the knife severs the stick of cane is to be discarded. In this case the cut should be made near the eye next to that it is intended to leave to grow. This procedure leaves to the eye destined to produce the new plant all the nourishment to be derived from the whole of one internode. A two-eye cutting which has three internodes, or practically so, is a better cutting than one of two eyes that has practically only one internode.

It will be seen that the production of good cuttings is the result of the observance of a score of points any one of which may not be of much importance taken by itself, but such that when all are added together on the right side, they constitute something formidable. In this respect the operation does not differ materially from hundreds of the common trades or operations of everyday life. It is the relative amount of careful attention paid to each step in a process that determines the difference between good workmanship and poor, and often between success and failure.

INSPECTION OF THE CUTTINGS.

In the inspection of cane cuttings it is highly desirable to employ a good pocket lens. Not that it is necessary to employ it on every cutting—far otherwise; but when the eye is once familiarized with the appearance of disease under the lens it is much keener in detecting it without the aid of the lens. The Hastings lenses made by the Bausch & Lomb Optical Company of Rochester, N. Y., are about the best pocket lenses known to me, though they are somewhat expensive. It is best to have a good lens. Of course, this is only one of numerous reasons why a cane planter should carry a good pocket lens.

I do not know of any machine invented for the production of cuttings of cane for planting purposes. In my opinion it would be wise to call the attention of the manufacturers of cane machinery to the matter with a view to enlisting their

inventive faculties in this direction. What is wanted is a machine or tool with a special blade of good quality steel, so formed and driven as to produce cane cuttings having perfectly smooth oblique ends quite free from longitudinal cracks. I am confident such an improved tool can be devised, and if it can be produced at a reasonable cost, its use would, I have no doubt, affect a saving that would justify considerable extra expense.

If cuttings are to be made with ordinary cane knives these latter should be specially prepared and used by a skilful workman. They should be of such a good quality of steel that they will take and retain a good edge. They should be thinner and lighter than the ordinary field knife,* and the edges should be as thin and acute as will stand the necessary strain. They should be constantly re-sharpened as they become in the least dull, and in the process of cutting should not be allowed to become gummed up with the juices of the cane. When put on one side for a few minutes they should be wiped or stood in a vessel of water to prevent this gumming up. If these simple precautions be taken, I have proved by trial that cuttings of a superior quality can be made at a very slight additional cost indeed. Of course the precautions to be observed necessitate the employment of skilful men as cutters, but men can be found on almost any plantation who will, with some practice, turn out a good job.

As to the manner of cutting the sets, there is room for choice, for it will be found that if the cane is given a half turn at each swing of the knife the two slanting ends of the cutting will both face upwards at the same time and this is sometimes a help in inspection. The best angle of cutting will soon be acquired. If the cut is too square the tendency to shatter is greater than when it is more oblique.

As the aforesaid skilled cutter produces the sets they may be packed in racks or other receptacles by a boy who places them as regularly as possible with the oblique faces uppermost. The sets will vary in length and hence it will be best to sort them according to length as they are stacked. This work will fall to the boy. The inspection will be much facilitated by whatever regularity can be introduced into the cutting and stacking. This "racking" of cuttings is more feasible on cane "farms" than on the large plantations.

The appearances that are to be looked for in the inspection, as a basis of rejection, will vary with the particular conditions of the plantation. According as one or another disease is to be expected, so will the inspection vary. Of course the object is to exclude all disease. Commonly, the test will be a purely visual one. Having in mind the healthy appearance of the

*More like a Spanish machete.

particular variety under examination, the inspector will reject any cutting that looks suspicious. In general the diseased tissues will give rise to discoloration at the end of the cutting. This may appear at once or it may appear only after the lapse of some time—in some cases, 24 hours. The ends of the fibres of the cane are to be particularly noticed. If pink, red, brown or black, they are undoubtedly diseased, except that there is a slight tendency to a uniform pinkness normal in some varieties. In general the discoloration due to disease is most plainly to be seen while the cut is still quite fresh, and for this reason one inspection should follow closely on the cutting, especially in dry weather. However in at least one disease, the Gumming of the Cane, the appearances are more evident after several hours, or even the whole of one day, especially if the disease is not of a very pronounced character. In such a case it is best to cover the stacks of sets with some wet covering and allow them to remain 24 hours to "sweat." After this time yellow stains on the ends of the cuttings will appear when on an immediate inspection they might have been passed over.

It should be the duty of the man who cuts the sets to reject any joints that show wounds of any kind, but especially those due to borers. The passage formed by these insects, no matter how small, are a fertile source of diseases of a fungoid nature. This is a matter that should also receive attention at all the earlier stages of the selection of the material for the cuttings. As has been pointed out, the spores of the fungus diseases of the cane are to be found in the most unexpected places in the region of the cane fields. They are so numerous that they are to be found on the bodies of insects, no matter how small, and these insects are the means of spreading disease by taking the spores into their habitations both on and in the cane. Whenever an insect punctures a cane, whether for the purpose of obtaining food or for the purpose of laying its eggs, it is likely to insert into the tissues of the cane plant the spores of some disease, and even if it does not do so, spores in the vicinity of the puncture soon find it out and enter. For this reason it is extremely desirable to avoid as far as possible, as a source of cuttings, all fields where insects are known to have made serious depredations. Too much stress can not be laid on this point, for the reason that the punctures of insects are often so small and inconspicuous that it is difficult to detect them. No matter how small they are, they are almost sure to be sooner or later the source of fungus troubles.

Where the inspection results in the rejection of a large number of cuttings, it may be best to arrange the inspection, if possible, so near the carriers of the mill that the rejected cuttings may be thrown on to the carriers and so at once be put through the mill. In this case it is strongly advisable to load

the cuttings, as soon as they are made, into trucks that can be immediately started to the mill. It is well to keep such cuttings moist if possible. This may be done by covering them with wet sacking. The object should be to keep the air among the cuttings in a moist state that will prevent the ends from drying up too much. The cut ends are to be kept as clean as possible. If they become dirty it will be necessary to trim them before a careful inspection can be made

ANOTHER METHOD OF INSPECTION.

Of course the inspection of cuttings can be carried out in a totally different manner by putting the whole of the precautions into the hands of one man, or series of men, each acting independently. In this case the entire series of operations is carried out on each cutting as soon as it is made. As the cut is made, the discolored tissue is at once examined by the operator and the cutting accepted or rejected as the case may be. The cutter is also the inspector. There are many advantages in this method.

Here also if the number of cuttings to be rejected turns out to be great, it may be best to take the cane sticks to the mill and prepare the cuttings in such a manner that those rejected fall on to the mill carriers.

[To be continued.]

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*INTERNATIONAL SUGAR SITUATION.**

BY FRANK R. RUTTER.

INTRODUCTION.

The international sugar situation to-day offers a striking contrast to that of fifty years ago. During the last half century a marvelous growth of the European beet-sugar industry has taken place. At the middle of the nineteenth century the beet-sugar product was insignificant, amounting to less than 200,000 long tons annually. Since that time the output has increased, until now beet sugar constitutes more than half of the commercial sugar crop of the world. This growth, in the face of competition from the cane-sugar industry, aided by the vast natural advantages of the Tropics, has been made

*Bulletin No. 30, Bureau of Statistics, Dept. of Agriculture.

possible only by close scientific study, by mechanical invention, and by the introduction of many practical economies.

LEGISLATION BEFORE THE BRUSSELS CONVENTION.

The course of development in the beet-sugar industry was influenced largely by legislation. In some directions the expansion of the industry was encouraged; in other directions it was restricted. Legislation affecting the industry, while remarkably varied in character, was strikingly similar in results throughout continental Europe. Its effect was in general to confine the market of each country to domestic sugar, to cause high prices within the country of production, and thus incidentally limit domestic consumption, to provide a large surplus product for exportation, and to lower prices on the world's market to an extent unthought of twenty years ago.

Competition from foreign sugar in the markets of continental Europe was prevented by fixing the rate of duty on imported sugar higher than the excise on the domestic product. The amount of the excise, which was imposed solely for purposes of revenue, determined the minimum limit of domestic prices, while the protective import duty fixed the maximum to which prices might be carried without incurring foreign competition.

The production of beet sugar increased much more rapidly than the domestic consumption, and it became necessary to market the surplus abroad. This was accomplished either by exempting from excise the sugar intended for exportation or by refunding, in the form of a drawback, the excise on all sugar exported. The latter method was first adopted. The drawback was frequently paid on a basis that, intentionally or otherwise, more than compensated for the excise orginally collected, and thus carried a concealed export bounty.

The indefinite amount of the hidden bounty proved unsatisfactory, and the system was changed by all the important countries except Belgium before the Brussels Convention went into effect. In Russia the amount of the drawback was limited to the excise actually paid. France, Germany, Austria-Hungary, and the Netherlands abolished drawbacks and exempted from excise sugar destined for exportation.

In place of the encouragement to exports provided by the drawback, Germany, Austria-Hungary, and the Netherlands granted direct bounties, while Russia and France gave privileges that were equivalent to indirect bounties. France in 1897 also granted a small direct bounty on exported sugar.

BRUSSELS CONVENTION.

Prior to September 1, 1903, when the Brussels Convention went into effect, a prohibitory import duty, a high excise, and governmental encouragement of exportation were thus general throughout continental Europe. The Brussels Convention aimed merely to equalize the competition of sugar on the international market by eliminating all legislative aid granted directly or indirectly to exported sugar; it made no attempt to modify the strictly internal regulation of the sugar trade.[a]

In many cases, however, the ability to sell cheaply on the world's market was due indirectly to privileges granted in the case of domestic sales. The French regulations had the general effect of an indirect bounty on production which affected even more conspicuously the export than the domestic trade. The exportation of Russian sugar conferred a special privilege on the domestic market which had a commercial value.

In order to eliminate all regulations that might have the effect of granting government aid to exported sugar, the Brussels Convention consequently prohibited all bounties on exportation, direct or indirect bounties on production, special exemptions from duty, and excessive drawbacks, and also limited the excess of import duty over the consumption tax to 53 cents per 100 pounds in the case of refined sugar and 48 cents in the case of raw (6 and 5.50 francs, respectively, per quintal[b]). The convention thus abolished all direct aid to the sugar industry and even all discrimination in the domestic market against foreign sugar beyond a fixed limit. The latter provision was not to be enforced against the nonexporting countries—Sweden, Italy, and Spain.

Spain did not ratify the convention. Denmark and Russia did not participate in the conference. The convention consequently included Germany, Austria, Hungary, France, Belgium, the Netherlands, Sweden, Italy, and the United Kingdom. Luxemburg and Peru were subsequently admitted.

As a means of enforcing the provisions of the convention a permanent commission was appointed to ascertain how far the legislation of various countries contravened the provisions of the treaty. Countervailing duties were to be imposed on sugar imported from countries granting direct or indirect bounties.

The convention made no attempt to lower excise duties. But,

[a] The proceedings of the conference and the text of the convention are published by the French Ministry of Foreign Affairs under the title "Primes sucrieres, 1895-1902—Conferences internationales de 1898 et de 1901-1902."

[b] The term "quintal" is used uniformly to denote the metric quintal of 100 kilograms (220.46 pounds.)

on account of the decreased expenses resulting from the abolition of bounties, several of the States reduced their internal taxes. Domestic prices were consequently lowered, while export prices were raised, so that the difference between them was considerably reduced.

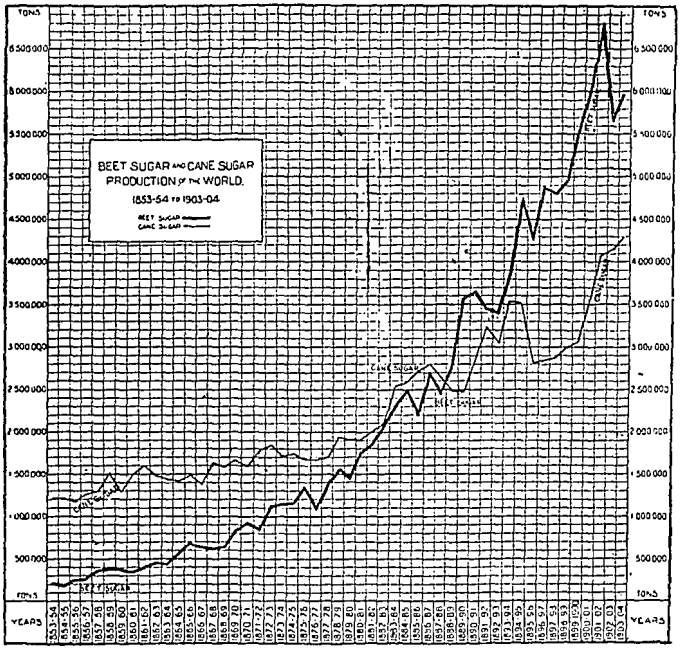
INCREASED PRODUCTION OF BEET SUGAR.

The growth of the beet-sugar industry during the last half century has been remarkable. From 200,000 long tons in 1853-54, the European beet-sugar product steadily and rapidly increased to nearly 6,700,000 long tons in 1901-2. In 1902-3 the production amounted to 5,500,000 long tons, and in 1903-4 to 5,800,000 tons. This falling off, while doubtless traceable in part to the Brussels Convention, was mainly due to industrial and trade conditions.

The production of cane sugar in the past fifty years also shows a large increase. In 1853-54 the total cane sugar output of the world was estimated at only 1,200,000 long tons, while in 1903-4 it reached 4,300,000 tons. Moreover, the statistics for cane sugar are far less complete than those for beet sugar. Much cane sugar is produced in countries of no considerable commercial development, where accurate statistics are not collected. In many cases the statistics available cover only the exports—the quantity placed on the world's market—and exclude sugar consumed within the country of production. The case of India is perhaps most marked. There a large annual production, estimated at about 3,000,000 tons, is almost entirely consumed at home and is omitted from commercial estimates of the world's sugar crop. It must be explained also that the statistics have become progressively more accurate and complete, partly by the gradual inclusion of countries not reported in earlier years; so that the figures given exaggerate the actual increase.

The relative increase in beet-sugar production is even more conspicuous than the actual increase. In 1853-54 cane sugar constituted 86 per cent. of the world's commercial sugar crop; beet sugar only 14 per cent. Half a century later cane sugar contributed 42 per cent., while beet sugar, including the United States crop furnished about 58 per cent.

While these figures include as far as possible the sugar consumed within the country of production, they represent the quantities that enter into commerce rather than the entire production of the world. With the home consumption of sugar in India added to the commercial estimates the total production of cane sugar still exceeds that of beet sugar.



But the sugar product lost to statistics has little or no effect on the world market. The preponderance of beet sugar shown statistically does not exaggerate its actual importance as a factor in determining the world price of sugar or the direction of the world's sugar trade.

Table I shows the commercial production of sugar throughout the world for the last fifty years, together with the relative quantities of cane and beet sugar produced. The increased production of beet sugar is likewise shown graphically in Fig. 1.

TABLE 1.—Commercial sugar production [a] of the world, 1853-54 to 1903-4.

(In tons of 2,240 pounds.)

Years[b].	Total.	Cane.		Beet — Europe.		Beet — U. S.
	Tons.	Tons	P. ct.	Tons.	P.ct	Tons.
1853-54	1,420,558	1,219,558	85.9	201,000	14.1	...
1854-55	1,381,817	1,202,817	87.0	179 000	13.0	...
1855-56	1,413,498	1,176,498	83.2	237,000	16.8	...
1856-57	1,509,214	1,259,214	83.4	250,000	16.6	...
1857-58	1,662,253	1,300,253	78.2	362,000	21.8	...
Average, 1853-54 to 1857-58	1,477,468	1,231,668	83.4	245,800	16.6	...

1858-59	1,893,504	1,510,504	79.8	383,000	20.2	...
1859-60	1,674,316	1,291,316	77.1	383,000	22.9	...
1860-61	1,841,264	1,496,264	81.3	345,000	18.7	...
1861-62	2,006,226	1,601,226	79.8	3,405,000	20.2	...
1862-63	1,944,193	1,486,193	76.4	458,000	23.6	...
Average, 1858-59 to 1862-63	1,871,901	1,477,101	78.9	394,800	21.1	...
1863-64	1,869,664	1,433,664	76.7	436,000	23.3	...
1864-65	1,958,413	1,417,413	72.4	541,000	27.6	...
1865-66	2,168,872	1,488,872	68.6	680,000	31.4	...
1866-67	2,022,407	1,378,407	68.2	644,000	31.8	...
1867-68	2,264,871	1,636,096	72.3	628,775	27.7	...
Average, 1863-64 to 1867-68	2,056,845	1,470,890	71.5	585,955	28.5	...
1868-69	2,233,130	1,585,309	71.0	647,821	29.0	...
1869-70	2,495,285	1,662,239	66.6	833,046	33.4	...
1870-71	2,527,181	1,599,488	63.3	927,693	36.7	...
1871-72	2,650,663	1,791,184	67.6	859,479	32.4	...
1872-73	2,965,329	1,840,986	62.1	1,124,343	37.9	...
Average, 1868-69 to 1872-73	2,574,318	1,695,841	65.9	878,477	34.1	...
1873-74	2,857,612	1,711,763	59.9	1,145,849	40.1	...
1874-75	2,922,017	1,756,681	60.1	1,165,336	39.9	...
1875-76	3,043,749	1,692,828	55.6	1,350,921	44.4	...
1876-77	2,766,270	1,682,531	60.8	1,083,739	39.2	...
1877-78	3,114,273	1,715,900	55.1	1,398,373	44.9	...
Average, 1873-74 to 1877-78	2,940,784	1,711,940	58.2	1,228,844	41.8	...
1878-79	3,515,266	1,965,990	55.9	1,549,276	44.1	...
1879-80	3,334,268	1,903,316	57.1	1,430,952	42.9	...
1880-81	3,648,847	1,902,346	52.1	1,746,501	47.9	...
1881-82	3,847,668	2,016,084	52.4	1,831,584	47.6	...
1882-83	4,217,142	2,104,072	49.9	2,113,070	50.1	...
Average, 1878-79 to 1882-83	3,712,638	1,978,361	53.3	1,734,277	46.7	...
1883-84	4,871,079	2,547,531	52.3	2,323,013	47.7	535
1884-85	5,099,255	2,592,647	50.9	2,505,655	49.1	953
1885-86	4,888,340	2,702,850	55.3	2,184,890	44.7	690
1886-87	5,513,278	2,805,735	50.9	2,706,743	49.1	800
1887-88	5,084,981	2,642,000	52.0	2,442,726	48.0	255
Average, 1883-84 to 187-88	5,091,387	2,658,153	52.2	2,432,605	47.8	629

*The cane sugar production prior to 1888-89 is taken from trade circulars of Messrs. Rueb & Co., as reprinted in British official reports on the sugar trade (Returns No. 325 of 1884 and No. 172 of 1889.) Statistics for 1874-75 to 1880-81 have been increased by adding the export from Hawaii (see Table 50), which are not included in Rueb's estimates prior to 1881-82. Beginning with 1888-89 the statistics for cane sugar are taken from Willet & Gray's Weekly Statistical Sugar Trade Journal, the returns for each of the first three years being increased 200,000 tons to allow for the product of countries not included prior to 1891-92. Beet sugar statistics for Europe since 1865-66 are Licht's figures, taken from Sugar Cane and the International Sugar Journal, and for the years 1853-54 to 1865-66, inclusive, from Jules Helot's Le Sucre de Betterave en France, p. 209. The statistics for the United States beet sugar for 1891-92 to 1894-95 are taken from the annual reports of the Commissioner of Internal Revenue; for 1897-98 from a special report of the Department of Agriculture; for 1899-1900 from the Twelfth Census and for other years from Willet & Gray.

[b] Prior to 1888-89 the statistics for cane sugar refer to calendar years, but are given as if by campaigns, in order to compare with the beet-sugar statistics. In the production of cane sugar the figures for the calendar year in which the beet-sugar campaign ends are taken as the figures for that campaign; for instance, the production of cane sugar for the calendar year 1854 is given for the campaign of 1853-54.

TABLE 13.—Commercial sugar production of the world, 1853-54 to 1903-4.

Years.	Total.	Cane.		Beet. Europe.		Beet. U. S.	
	Tons.	Tons.	P. ct.	Tons.	P. ct.	Tons.	P. ct
1888-89	5,224,379	2,480,700	47.5	2,741,818	52.5	1,861	....
1889-90	6,054,209	2,475,800	40.9	3,576,206	59.1	2,203	....
1890-91	6,524,609	2,868,900	44.0	3,652,250	56.0	3,459	....
1891-92	6,683,497	3,231,561	48.3	3,446,577	51.6	5,359	0.1
1892-93	6,431,609	3,045,186	47.3	3,374,332	52.5	12,091	.2
Average, 1888-89 to 1892-93	6,183,661	2,820,429	45.6	3,358,237	54.3	4,995	.1
1893-94	7,379,862	3,531,621	47.8	3,828,066	51.9	20,175	.3
1894-95	8,247,553	3,510,670	42.6	4,716,791	57.2	20,092	.2
1895-96	7,056,401	2,809,477	39.8	4,217,704	59.8	29,220	.4
1896-97	7,718,279	2,841,857	36.8	4,838,886	62.7	37,536	.5
1897-98	7,660,068	2,864,255	37.4	4,755,415	62.1	40,398	.5
Average, 1893-94 to 1897-98	7,612,433	3,111,576	40.9	4,471,373	58.7	29,484	.4
1898-99	7,931,275	2,995,438	37.8	4,903,366	61.8	32,471	.4
1899-1900	8,560,109	3,056,294	35.7	5,430,843	63.4	72,972	.9
1900-1901	9,618,333	3,646,059	37.9	5,895,415	61.3	76,859	.8
1901-2	10,895,588	4,078,944	37.4	6,653,518	61.1	163,126	1.5
1902-3	9,804,339	4,144,453	42.3	5,464,423	55.7	195,463	2.0
Average, 1898-99 to 1902-3	9,361,929	3,584,238	38.3	5,669,513	60.6	108,178	1.1
1903-4[a]	10,291,000	4,313,000	41.9	5,770,000	16.5	208,000	2.0

[a] Preliminary estimates.

HIGH DOMESTIC PRICES.

A marked characteristic of the beet-sugar industry has been the extremely high range of prices paid in the continental countries as compared with prices in England and the United States. The average wholesale price of refined sugar, excise paid, in Germany, during the sugar year 1902-3 was 6¼ cents per pound; in Belgium, 6½ cents; in Russia and Austria, 7¾ cents; and in France, over 8 cents. In Spain the average price of sugar during 1901-2 was 9 cents per pound, and during 1899-1900, over 10 cents per pound.

In the United States the average price of granulated sugar at New York during the calendar year 1903 was 4.64 cents per pound and during 1902 only 4.46 cents. In 1902-3 the average price of British refined sugar (Tate's cubes No. 1) was 3.87 cents per pound.

The high prices on the Continent have resulted partly from the excise collected on domestic sugar and partly from the combination of sugar producers. The consumption tax on sugar in Germany prior to the Brussels Convention was 2 cents per pound; in Russia, 2½ cents; in Austria-Hungary, 3½ cents; in Belgium, 4 cents; in the Netherlands, 5 cents; and in France, 5¼ cents. In the case of Belgium and France not all of the domestic product was subject to the full rates indicated. The domestic prices were, nevertheless, increased by the total amount of the tax. In Germany and Austria-Hungary, after the formation of the cartels, prices were materially raised with no increase whatever in the excise.

The excise was lowered in several countries when their legislation was modified in accordance with the provisions of the Brussels Convention. In Germany the consumption tax was lessened one-half cent per pound; in France, 3 cents; in Belgium, 2¼ cents. The effect of these changes on domestic prices is marked. For the sugar year 1903-4 the average price of Belgian sugar was only about 4 cents per pound; of German sugar, less than 4¼ cents; of French sugar, about 5 cents; and of Austrian sugar, 6¼ cents.

It will be noticed that the prices for Belgian and French sugar decreased about as much as the tax. In the case of Germany, however, the price fell 2 cents, while only one-half cent was taken off the tax. In Austria, with no change in the excise rate, the price of refined sugar fell 1½ cents. The entire fall in the case of Austria and three-fourths of the fall in Germany were undoubtedly due to the abrogation of the old cartels.

CONSUMPTION OF SUGAR.

In view of the high prices of sugar prevailing on the Continent, it is natural that the average consumption should be much lower than in England and the United States.

During the calendar year 1903 the average consumption of sugar in the United States was 71 pounds per capita and during the calendar year 1902 it was 73 pounds. In the United Kingdom, as estimated by Licht, [a] the average consumption was still higher, reaching 90 pounds per capita during the beet-sugar year 1902-3. In Switzerland, with only one domestic sugar factory, the average consumption for 1902-3 was 63 pounds per capita. In Denmark the per capita consumption was 52 pounds. The larger sugar-producing countries form a marked contrast to those given. In Russia the average consumption per capita was only 11 pounds [b] during 1902-3, less than one-sixth that in the United States. In Austria the per capita consumption was 18 pounds; in Belgium, 22 pounds; in France, 24 pounds; in Germany, 28 pounds, and in the Netherlands, 31 pounds. Spain consumed only 11 pounds and Italy 7 pounds per capita, notwithstanding the rapid growth of sugar production in those countries.

With the lower prices now prevailing, a much enlarged consumption is to be expected, which in time may fully compensate producers for the encouragement withdrawn by the Brussels Convention.

INCREASED EXPORTS.

The production of beet sugar in Europe increased much faster than the demand. For a number of years there was an increasing difficulty in marketing the surplus production, and continually larger quantities were thrown on the world's market. During 1902-3 no less than two-thirds of the total sugar output of Germany and three-fourths of the product of Austria-Hungary was exported.

LOW EXPORT PRICES.

It was, of course, impossible to market these enormous quantities of sugar abroad at prices at all comparable with those obtained in the domestic market. German granulated sugar at Hamburg, free on board, was quoted on the average at only 2 cents per pound during the beet-sugar year 1902-3, while the average price of cut-loaf sugar at Magdeburg for

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[a] Journal des fabricants de sucre, March 30, 1904.

[b] Instead of 18 pounds, as estimated by Licht.

domestic use was over 6 cents per pound. The difference in quality between the two grades represents but a small part of the difference in price. In Austria-Hungary the prices of sugar for domestic consumption and for exportation differed even more widely. At Prague refined sugar was quoted during 1902-3 at 7¾ cents per pound, while at Trieste export sugar was 2 cents per pound.

The difference in price was due principally to the excise on sugar consumed and the bounty on sugar exported. The difference increased after the formation of the cartels. Since the ratification of the Brussels Convention domestic prices have fallen, while export prices have increased.

SUGAR COMBINATIONS.

Strong national combinations of producers have been not infrequent in the continental beet-sugar industry. Of these the cartels of Austria-Hungary and Germany were probably the most conspicuous. The higher profits derived from domestic sales of sugar led to the apportionment of such sales among the various producers by private agreement, in order to increase prices by limiting the supply. In Russia the amount and the apportionment of domestic sales were regulated by the Government.

The sugar combinations aimed to raise domestic prices so as to realize the utmost possible profit. When the Brussels Convention went into effect, the cartels were dissolved, but the Hungarian producers formed a new combination, modified to suit changed conditions.

In Spain, which did not sign the Brussels Convention, and in Italy, which was exempted from the provision limiting the import duty, sugar combinations apportion the output among the various producers.

ACCUMULATION OF SURPLUS STOCKS.

In spite of the enormous quantities of sugar exported, a large stock was accumulated in all of the leading countries of Europe. On September 1, 1903, over 3,000,000,000 pounds, about one-fourth of the total output, was left over from the sugar year 1902-3, while the surplus at the end of the sugar year 1901-2 was even larger.

The large stocks of sugar had the natural effect of restricting materially the acreage devoted to sugar beets. The beet area planted in the eight principal countries of Europe was estimated[a] at 4,653,000 acres in 1901. For 1902 the area was 4,179,000 acres, for 1903 4,041,000 acres, and for 1904 only 3,777,000 acres. The decrease in the three years was nearly 19 per cent. The Brussels Convention probably contributed some-

what to the restriction in acreage. With the possibility that the profits on foreign sales would be materially decreased, it was natural that steps should be taken to lessen the surplus production above domestic requirements.

IMPROVED METHODS.

Legislation has undoubtedly contributed to the growth of the beet-sugar industry in Europe, but its remarkable progress is due primarily to the scientific methods employed in beet raising and in sugar manufacture.

To insure the production of high-grade beets agricultural operations have been closely supervised by the factories. The seed is largely furnished by the factories, and scientific methods of crop rotation, preparation of the soil, fertilization, and cultivation are rigidly enforced.

In the factory all details of manufacture have been closely studied. The equipment of the factories has been greatly improved, their capacity increased, and new economies effected. Twenty years ago diffusion had already been substituted in most cases for mechanical pressure as a means of extracting beet juice. New processes have since been introduced for extracting sugar from molasses. Molasses, formerly a waste product used only for distillation, has become an important raw material for sugar making. In 1902-3 no less than 8 per cent. of the total sugar production of Germany was contributed by factories equipped solely for utilizing molasses.

The effects of improved methods in the beet-sugar industry may be shown statistically in two ways: (1) By ascertaining the average yield of beets per acre in various countries for a series of years, together with the average extraction of sugar from beets; (2) by ascertaining the average number of laborers and the average amount of mechanical power required to produce a given quantity of sugar. These comparisons furnish criteria for measuring the success of the industry in various countries as well as its progress in any one country.

AVERAGE YIELD OF BEETS.

During the last twenty years there has been a striking improvement in the methods of beet culture in the leading countries of Europe. The improvement has resulted not so much in the increased yield of beets per acre as in the larger sugar content of the beets.

In Germany, for instance, the average yield per acre in 1902, as shown in Table 2, was less than 12 short tons of beets. This

[a] According to the International Association for Sugar Statistics, Deutsche Zuckerindustrie, 1902, p. 766, 1903, p. 844, 1904, statistical part, p. 254. The countries included in the estimates are Germany, Austria-Hungary, France, Russia, Belgium, Netherlands, Sweden and Denmark.

TABLE 2.—Averge yield of sugar beets per acre in the principal countries of Europe.—In short tons.

		—Austria-Hungary.—						
Year.[a]	Germany	Total	Austria	Hungary	France	Russia	Belgium	Netherlands
1882.	15.35	9.27	9.27	9.22	15.72	6.53	15.15	10.20
1883	13.32	*	*	9.14	15.49	5.36	15.19	12.66
1884	14.67	8.65	8.79	7.55	13.51	5.65	14.86	12.40
1885.	13.49	7.72	7.61	8.23	12.63	7.52	11.92	11.17
1886	13.39	7.99	8.17	7.19	14.41	7.10	15.19	9.58
1887 .....17.78		7.00	7.11	6.50	11.76	7.55	13.61	10.32
1888	12.57	9.09	9.21	8.53	12.09	7.63	9.11	7.07
1889	14.66	9.75	9.94	8.98	14.08	7.21	17.50	14.63
1890	14.36	9.33	10.06	6.63	12.09	7.23	14.08	11.62
1891	12.57	9.33	9.55	8.52	11.21	6.24	12.13	8.33
1892	12.43	9.29	9.62	8.14	10.77	5.64	13.61	13.61
1893	12.29	8.20	8.17	8.28	10.41	7.54	15.69	11.92
1894	14.67	9.65	10.48	7.09	12.71	7.23	14.44	9.84
1895	13.82	8.69	9.13	7.47	11.98	7.00	12.95	13.09
1896	14.41	10.28	10.70	8.92	14.02	7.22	14.48	17.06
1897	13.98	10.00	10.40	8.85	12.84	6.62	12.84	13.34
1898	12.71	9.75	10.04	8.93	11.22	6.12	12.43	13.01
1899	13.00	11.44	11.96	9.72	11.54	6.73	14.90	15.39
1900	13.21	9.71	9.73	9.67	11.62	5.47	15.31	14.48
1901	14.92	10.99	11.56	9.41	11.87	6.88	15.72	16.49
1902	11.76	10.30	10.69	9.48	11.10	6.53	12.78	12.28
1903	13.63	11.22	11.49	*	12.27	6.24	11.66	10.79

yield, however, was much below the average. For the last five years the average yield per acre was about 13 short tons, while the average yield for the five years 1882-1886 was about 14 tons per acre. By care in the selection of mother beets and in the methods of fertilization and culture, the quality of the beet has been greatly improved, partly at the expense of tonnage. The factories require beets light in weight and rich in sugar. But, while statistics of average yield show little in regard to agricultural improvement within a single country, they constitute a fairly satisfactory standard for comparing the success of the beet crop in different countries.

In tonnage Germany is surpassed only by the Netherlands and Belgium. For 1899-1903 the average yield in the Netherlands was nearly 14 short tons and in Belgium over 14 tons per acre, as compared with 13 tons in Germany. The average yield in France, Austria and Hungary ranges considerably lower. Beet growing in Russia is carried on under unfavorable conditions of climate and cultivation, and exceedingly poor results are obtained. In 1903 the average yield was only 6¼ short tons per acre; in 1901 and 1902, less than 7 short tons; and in 1900, only 5½ short tons.

[a] The beet crops harvested in the years indicated were worked by factories during the ensuing campaign (ending July or August of the following year.)

*Not stated.

AVERAGE SUGAR EXTRACTION.

The increase in the average amount of sugar obtained from a given quantity of beets is shown in Table 3. Both agricultural improvement and improvement in factory methods have contributed to this end; the former has aimed to increase, and the latter to extract more completely, the sugar content of the beet.

TABLE 3.—Average extraction of raw sugar in the principal countries of Europe.—In per cents.

Sugar year	Germany [a]	Austria-Hungary			France	Russia	Belgium	Netherlands	Sweden
		Total	Austria	Hungary					
1882-3	9.51	10.08	(b)	(b)	5.05	8.51	(c)	(c)	(c)
1883-84	10.54	11.23	(b)	(b)	5.65	9.41	(c)	(c)	7.81
1884-85	10.80	11.66	(b)	(b)	6.00	9.45	(c)	(c)	9.11
1885-86	11.43	11.75	(b)	(b)	8.20	9.58	(c)	(c)	9.06
1886-87	12.26	11.83	(b)	(b)	9.55	10.03	(c)	(c)	10.30
1887-88	13.77	12.31	(b)	(b)	9.92	10.12	(c)	(c)	10.98
1888-89	12.55	10.73	10.71	10.98	10.25	11.25	(c)	(c)	10.31
1889-90	12.84	11.69	11.92	9.48	11.08	10.65	(c)	(c)	10.69
1890-91	12.58	11.39	11.51	10.39	9.87	10.48	(c)	(c)	9.45
1891-92	12.63	11.51	11.72	10.02	10.83	12.55	(c)	(c)	10.32
1892-93	12.54	11.10	11.23	10.16	10.04	12.16	(c)	(c)	10.78
1893-94	12.83	12.48	12.74	10.97	10.28	11.38	12.02	11.04	11.54
1894-95	12.59	11.80	12.04	10.13	10.43	10.98	11.00	11.38	11.60
1895-96	14.02	13.36	13.66	12.13	11.54	12.89	12.45	12.24	10.75
1896-97	13.27	11.79	12.13	10.19	10.38	12.16	12.01	12.48	11.86
1897-98	13.46	11.91	11.99	11.59	12.07	11.98	13.03	13.70	12.42
1898-99	14.18	13.27	13.54	12.23	12.81	12.38	13.97	13.35	12.33
1899-1900	14.43	12.85	13.01	12.22	12.42	12.02	13.66	13.68	12.99
1900-1901	14.93	14.26	14.60	13.18	12.62	13.66	12.99	14.54	13.10
1901-2	14.38	14.40	15.10	12.13	11.87	12.98	12.97	13.66	13.87
1902-3	15.87	14.71	15.01	13.96	13.14	13.07	13.88	14.38	14.34
1903-4	15.18	14.85	(c)	(c)	12.33	15.42	12.89	13.20	(c)

The average extraction has varied greatly in different countries, but in all cases a steady improvement is noticeable. Germany shows an increase in the sugar extraction from less than 10 per cent. of the beets worked during the sugar year 1882-83 to over 15 per cent. in 1903-4. In France the average extraction during the same period was more than doubled, increasing from 5 per cent. in 1882-83 to 12 per cent. in 1903-4.

For Germany the average extraction is generally higher than for any other country. The highest extraction recorded

[a] Representing, prior to 1886-87 the average results obtained by beet factories; for subsequent years, the average extraction for the entire sugar industry of the empire.

[b] No official returns of sugar production prior to August 1, 1888.

[c] Not stated.

for Germany was 15.87 per cent. for 1902-3, equal to 317 pounds of sugar per ton of beets. Austria came second, in 1901-2 even surpassing Germany. Preliminary statistics for the year 1903-4 indicate an average sugar extraction for Russia of 15.42 per cent., a rate considerably above that obtained in any other country of Europe.

PRODUCTION OF SUGAR PER ACRE.

The average yield of beets per acre, as shown in Table 2, and the average sugar extraction, shown in Table 3, bring out different aspects of the progress in the beet-sugar industry. A more accurate measure of improvement, both on the farm and in the factory, is the average sugar production per acre, shown in Table 4.

TABLE 4.—Average production of beet sugar per acre.—In pounds.

Sugar year.	Germany	—Austria-Hungary— Total	Austria	Hungary	France	Russia	Belgium	Netherlands
1882-83	2,917	1,873	(a)	(a)	1,588	1,110	(b)	(b)
1883-84	2,811	(b)	(a)	(a)	1,750	1,008	(b)	(b)
1884-85	3,169	2,015	(a)	(a)	1,621	1,068	(b)	(b)
1885-86	3,089	1,814	(a)	(a)	2,071	1,444	(b)	(b)
1886-87	3,281	1,894	(a)	(a)	2,752	1,427	(b)	(b)
1887-88	4,890	1,722	(a)	(a)	2,328	1,525	(b)	(b)
1888-89	3,155	1,954	1,971	1,877	2,478	1,717	(b)	(b)
1889-90	3,768	2,282	2,366	1,706	3,126	1,536	(b)	(b)
1890-91	3,619	2,127	2,314	1,379	2,382	1,518	(b)	(b)
1891-92	3,180	2,146	2,235	1,704	2,433	1,566	(b)	(b)
1892-93	3,120	2,062	2,164	1,652	2,165	1,371	(b)	(b)
1893-94	3,159	2,050	2,083	1,813	2,144	1,719	3,766	2,634
1894-95	3,697	2,277	2,526	1,439	2,656	1,591	3,177	2,244
1895-96	3,870	2,320	2,492	1,815	2,767	1,806	3,225	3,207
1896-97	3,819	2,426	2,600	1,820	2,916	1,754	3,475	4,265
1897-98	3,761	2,380	2,496	2,053	3,094	1,589	3,351	3,655
1898-99	3,610	2,584	2,721	2,188	2,872	1,518	3,468	3,474
1899-1900	3,757	2,940	3,110	2,372	2,862	1,615	4,068	4,217
1900-1901	3,950	2,767	2,841	2,553	2,928	1,493	3,981	4,214
1901-2	4,297	3,165	3,491	2,287	2,813	1,789	4,071	4,502
1902-3	3,728	3,028	3,207	2,635	2,919	1,704	3,553	3,537
1903-4	4,144	3,332	(b)	(b)	3,031	1,922	3,008	2,849

It does not seem fair to give an average obtained by dividing the area cultivated directly into the quantity of sugar produced. In the case of the Netherlands and Belgium, especially, there are considerable shipments of beets across the borders. The same movement also affects France, but to a less extent relative to the total product. Those three countries constitute a single unit as far as the beet crop is concerned, and the

[a] No official returns of sugar production prior to August 1, 1888.
[b] No data available.

roots harvested are frequently worked up in factories across the national boundary from where they are produced. In the case of Germany acreage statistics for the earlier years relate only to a portion of the crop. For these reasons the average yield of sugar per acre, as shown in Table 4, is calculated by multiplying the average yield of beets per acre by the average sugar produced per short ton of beets worked.

During the period covered by the table a remarkable increase in the average sugar production per acre has taken place. In Germany the results for the first five years (1882-83 to 1886-7) show an average of 3,053 pounds of sugar per acre of beets and for the last five years (1899-1900 to 1903-4), 3,975 pounds per acre, an increase of 30 per cent. In Austria-Hungary there was an increase of 60 per cent., from 1,899[a] to 3,046 pounds per acre; in France an increase of 49 per cent., from 1,956 to 2,910 pounds per acre; and in Russia an increase of 41 per cent., from 1,211 to 1,709 pounds per acre.

In most years Germany is surpassed by no other country in the average quantity of sugar produced per acre of beets. The average sugar production was nearly 4,300 pounds for 1901-2. For 1902-3 the average was much lower, amounting to 3,728 pounds of sugar per acre, while in 1903-4 4,144 pounds of sugar per acre were produced.

The Netherlands and Belgium in some years show a larger average production of sugar than Germany. For 1901-2 and the two earlier sugar years the average quantity of sugar produced from a single acre in the Netherlands was greater than in any other country. In four years an average of more than 4,200 pounds of sugar per acre was obtained. The results in Belgium are also extremely good. The high averages shown for these two countries are due principally to their high tonnage of beets per acre.

In Russia the average sugar production per acre of beets is very much lower than in any other important European country. In 1902-3 only 1,725 pounds of sugar per acre were obtained, and in 1903-4 1,922 pounds. These poor results are attributable principally to the low average yield of beets.

The quantity of sugar obtained from an acre of sugar beets in Europe is still far from equal to that obtained from an acre of cane in the Tropics. In Java the highest average is that for 1899, when nearly 8,300 pounds of cane sugar were produced per acre, showing a yield 70 per cent. greater than the highest for Germany. In Hawaii even larger yields are recorded. In 1899 the average production was 9,400 pounds, and in 1901, 9,200 pounds.

[a] Average for the four years 1882-83, 1884-85, 1885-86, and 1886-87.

LABOR AND MECHANICAL POWER.

The results of improved methods on the average beet-sugar production per acre have been discussed. Technical and mechanical improvements in the factory have likewise had the effect of substituting mechanical power for manual labor and even to some extent of economizing the power employed.

There has been a marked decrease during the last twenty years in the average number of laborers required to produce a given quantity of raw sugar. In 1882-83, 52 laborers were employed in the German factories for each million pounds of sugar produced, while in 1902-3 only 13 were required. In France, during 1882-83, 106 laborers were required to produce each million pounds of raw sugar; in 1902-3, only 25. In 1900-1901 40 laborers were required in Austria and 25 in Hungary for each million pounds of output.

Considerable variation has also occurred in the average mechanical power employed in connection with the manufacture of sugar. Two conflicting forces have been in operation. Improved methods have resulted to some extent in the substitution of mechanical power for manual labor. Other improvements have occasioned a decrease in the average power required to produce a given output.

In the German factories, the general introduction of diffusion in place of mechanical pressure occurred between 1871-72 and 1882-83. In the former campaign only 52 out of the 311 beet factories in operation used the diffusion process; in the latter, out of 358 all but 15 used diffusion. With the change of process, a reduction in the power employed from 44 to 22 horsepower per million pounds of output was effected, together with a reduction to one-third in the average number of laborers. Subsequent improvements have resulted in the substitution of steam power for manual labor. The average steam power per million pounds of sugar consequently increased to 28 horsepower in 1901-2 and 38 horsepower in 1902-3.

In the well-equipped factories of Hungary, an average of only 25 horsepower per million pounds was used during 1900-1901. In the Austrian factories, machinery of 39 horsepower, aided by 40 laborers, was required to obtain 1,000,000 pounds. Machinery of equal power and the same number of laborers in Hungary produced 1,600,000 pounds.

TABLE 5.—Average labor and mechanical power required to produce 1,000,000 pounds of raw sugar.

	Number of laborers.					Mechanical powers.[a]				
		Austria-Hungary.					Austria-Hungary.			
Sugar year	Germany	Total	Austria	Hungary	France	Germany	Total	Austria	Hungary	France
1882-83	52	63	(b)	(b)	106	22	21	(b)	(b)	55
1883-84	43	64	(b)	(b)	68	22	25	(b)	(b)	48
1884-85	39	46	(b)	(b)	94	23	19	(b)	(b)	71
1885-86	37	75	(b)	(b)	86	32	33	(b)	(b)	67
1886-87	33	52	(b)	(b)	47	27	23	(b)	(b)	41
1887-88	30	67	(b)	(b)	58	29	32	(b)	(b)	53
1888-89	32	59	60	51	49	29	36	37	22	46
1889-90	29	45	44	55	29	24	27	27	28	27
1890-91	28	45	44	51	35	24	28	28	26	34
1891-92	26	44	44	43	37	29	30	30	27	36
1892-93	24	44	44	42	41	32	31	31	30	43
1893-94	22	42	43	36	42	30	32	33	27	43
1894-95	21	37	35	47	31	24	30	29	33	33
1895-96	18	48	49	41	35	29	42	45	28	40
1896-97	18	42	43	36	32	28	37	38	33	39
1897-98	16	47	50	34	29	30	43	45	32	35
1898-99	16	38	40	28	28	34	35	37	24	38
1899-1900	15	36	38	28	24	34	34	36	25	33
1900-1901	14	37	40	25	20	31	36	39	25	29
1901-2	14	(b)	(b)	25	20	28	(b)	(b)	25	31
1902-3	13	(b)	(b)	(b)	25	38	(b)	(b)	(b)	42

LOCALIZATION OF THE BEET CROP OF EUROPE.

The percentage of the total arable land in Europe devoted to the culture of sugar beets is shown in Plate I. Unfortunately, the statistics available for different countries do not cover exactly the same period. Averages for the latest five years have been used wherever practicable, but in some cases it was necessary to use averages for a shorter period and even statistics for a single census year. It should be noted that the sugar-beet area in Italy has trebled since 1899, the only year for which data by provinces are available.

BEET SUGAR PRODUCTION OF VARIOUS EUROPEAN COUNTRIES.

The earliest production of beet sugar in Europe on a commercial scale took place in France during the Napoleonic wars. At that time the sugar supply of France was drawn mainly from her West Indian colonies. The continental blockade and other commercial restrictions growing out of the war with

[a] In metric horsepower, about 1 per cent. less than the English horsepower.

[b] Not stated.

England suddenly stopped direct colonial trade. The interruption to the supply of colonial sugar gave an enormous impetus to the culture of beets which for some time previous had been recognized as a possible source of sugar.

France was for years the principal and, for part of the time, the sole seat of the sugar industry in Europe. It was not until after the middle of the nineteenth century that Germany took the lead. Since that time the industry has increased at a much slower pace in France than in other countries. The production of France is now surpassed not only by Germany, but by Russia and Austria-Hungary as well.

The rapidity of the increase of sugar production in Russia during the last decade is remarkable. In 1892-93 Russia contributed only 13 per cent. of the total sugar production of Europe, while in 1902-3 its proportion was 23 per cent. During the latter year Russia was surpassed in sugar production only by Germany. It is a source of speculation whether the withdrawal of government aid on the part of countries adhering to the Brussels Convention will tend further to increase the relative importance of the Russian industry.

Fifty years ago Austria-Hungary held third place among the European beet-producing nations; twenty-five years later it surpassed France; in 1902-3 it in turn gave way to Russia.

While Germany entered the field somewhat later than France, its production has steadily increased, and the methods, both of culture and of manufacture, have been constantly improved until it has become more closely identified with the beet-sugar industry than any other country. No other country equals Germany in the average quantity of sugar produced per acre of beets cultivated. During the last five years Germany produced about one-third of the entire sugar output of Europe.

[To be continued.]

THE MOLASCUIT INDUSTRY.

Its Development in British Guiana.

THE RESULTS OF EXPERIENCE.

The utilization of waste and by-products is one of the most remarkable features of modern industrial development. It constitutes at once a striking tribute to the research of the scientist and the energy and enterprise of the manufacturer, and affords at the same time an object-lesson in practical

economy the value of which it would be difficult to over-estimate. It cannot be brought as a charge against cane sugar manufacturers that they have been neglectful of the possibilities of waste products in the past, but the discovery of the properties of molascuit as a cattle-food has enabled them to carry the process of utilization to an almost complete degree in their business. At the present juncture, when this product is making such rapid headway with cattle-owners all over the world, a few facts in connection with its manufacture locally will not be devoid of interest. The details given below, it may be pointed out, possess a special value in that they are not based on vague generalizations or hearsay, but upon actual observation and experience in this colony.

SOME FINANCIAL DETAILS.

There can be no doubt that the manufacture of molascuit is making very satisfactory progress in British Guiana. It is profitable, in the first place, for there is a very ready sale at home; in fact, cattle-breeders and others are clamouring for an increased supply. The average price paid in England during the past six months was £4 per ton. In order to produce one ton of molascuit about 130 gallons of molasses of a density of 44° to 46° Beaumé are required, in addition to the megass meal, which is obtained by sifting the megass as it passes from the rollers which have crushed the canes, to the furnace. The average cost of manufacture, including packages,local freight, lighterage, and other incidental charges, is $4.50 per ton. To this must be added cost of home freight, royalties, commission, etc., which averages about $7 per ton. This leaves net proceeds to the manufacturer of $7.70 per ton, equal to very nearly six cents per gallon for the molasses used. The megass meal used in the process of manufacture is not taken into consideration, as it has little or no practical value as fuel. The present price of molascuit, therefore, may be reckoned as equal to about 1s. per proof gallon in London of rum. There is not, as a matter of fact, any immediate advantage to sugar estates proprietors in making molascuit in preference to rum, but the former acts as a relief to the rum market when prices in the latter are depressed through overstocking, and thus enables the rum industry to be carried on at a reasonable profit. To put the matter in another way, one of the great advantages of the manufacture of molascuit, so far as the estates are concerned, is that the output of rum can be regulated by it. Formerly, if the rum market got swamped, nothing could be done with the molasses; but now it can be utilized with benefit to the manufacturer and to cattle-owners alike. It may be taken for granted, moreover, that as the price of rum increases so will the quotations for molascuit advance.

MANUFACTURE IN THE COLONY.

There are at the present time forty-five estates in this colony making sugar, but only a few of the larger estates are equipped with a plant for the manufacture of molascuit. It is a peculiar feature of this product that it can be made entirely by hand labor without the aid of machinery; but whereas the average cost of hand manufacture is 10s. per ton, with a special plant of machinery the cost can be reduced to 60 cents per ton. Molascuit as made here consists of about 75 per cent. by weight of molasses and about 25 per cent. by weight of megass meal. The mixed product contains from 50 to 55 per cent. of sugar and about 13 per cent. of moisture. One of the chief difficulties experienced in connection with its manufacture here has been the drying of the megass meal. This meal contains more than half its own weight of water, and the bulk of the water must be eliminated, both for the purpose of enabling the meal to absorb the molasses and in order that the molascuit may keep satisfactorily after its manufacture, and not ferment. All these matters are being made the object of careful study on the estates, and the present process of manufacture, which is to a large extent automatic, results in the production of a cattle-food which possesses great nouishment and which will keep in a temperate climate for an indefinite length of time.

A WORLD-WIDE PRODUCT.

Molascuit is being produced now in cane-sugar manufacturing countries all over the world—in Cuba, in Java, and in the Argentine. There is, of course, a great local demand in the last-named country. In British Guiana there is a slight but slowly increasing demand, and no doubt in time owners of stock here will realize the benefits to be derived from the use of such an excellent food-stuff ready to their hands.—Dem. Argosy.

The Dearborn Drug and Chemical Works of Chicago, well known in the islands for their oils and boiler compounds, have recently issued a booklet advertising their Analytical Department and giving prices for all ordinary analyses.