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CULTIVATION OF SUGAR CANE.

IN TWO PARTS.

PART FIRST.

SUGAR CANE:

A TREATISE ON

ITS HISTORY, BOTANY AND AGRICULTURE,

BY

WILLIAM C. STUBBS, A. M., PH. D.

Director of the Sugar Experiment Station, Audubon Park,
New Orleans, Louisiana.

PART SECOND.

SUGAR CANE:

ITS HISTORY IN

GEORGIA, FLORIDA AND SOUTH CAROLINA

1767 TO 1900.

Sugar Content of the Canes of Louisiana, Hawaii and
Cuba Compared with those of Georgia
and Florida.

OUR SUGAR SUPPLY OF THE FUTURE

RECOLLECTIONS OF HOPETON PLANTATION.

Weather Statistics of Georgia, Florida and Louisiana Compared.

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THE MORNING NEWS PRINT,
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INTRODUCTION TO PART FIRST.

It has been so many years since sugar cane was an important crop upon the seacoasts of Georgia and Florida that it will be a surprise to many readers to learn that as early as 1767 extensive plans were perfected in Florida for the planting and manufacture of sugar cane into sugar for export to Europe, twenty-seven years before the industry took shape in Louisiana, and that, in 1829, sugar cane cultivation for the manufacture of sugar, engrossed as much attention in Georgia as either cotton or rice, and promised to outstrip both of these crops in volume and value.

The first attempts in Georgia at the cultivation of sugar cane, for commercial purposes, utilized, chiefly, the alluvial soils, at present exclusively devoted to rice, though, even, then, the pine lands and other uplands showed equal adaptability, and many splendid results are reported from small areas planted upon these, as far North as latitude 33 degrees, confirming the conclusions of to-day.

When Dr. Wm. C. Stubbs, Director of the Louisiana Sugar Experiment Station, visited Georgia and Florida last year, at the invitation of the Savannah Board of Trade, the cane he saw growing, and that which he subsequently analyzed with such splendid results, was planted upon the uplands embraced in the yellow pine belts of Georgia and Florida; such lands as would be selected for corn with a similar cultivation, and it is this character of land of which he speaks in comparison with Louisiana, when he says:

"The numerous samples of sugar cane grown in these sections (Georgia, Florida and South Carolina), and forwarded to me last season, show by analysis to be greatly superior in sugar content to that grown upon the alluvial lands of Louisiana."

At the time of the visit of Dr. Stubbs no alluvial lands were devoted to cane culture in Georgia, as in 1829, when areas of 300 acres, and upward, were common in the seacoast parts of this section.

Upon Dr. Stubbs' return to Louisiana he threw open the Experiment Stations of his state to the cane growers of Georgia, Florida and South Carolina, and now permits this republication of his treatise on the "History, Botany and Agriculture of Sugar Cane," that the farmers of the three states mentioned may have the fullest benefits of prevail-

ing methods of cultivation in Louisiana, the result of his fifteen years of labor and experiment in field and laboratory to bring about the best results in the cultivation of sugar cane for its sugar content, in which he has been so eminently successful.

The alluvial lands, thought most profitable for the growing of cane in Georgia, Florida and South Carolina in 1829, were limited in areas and held at high values. The pine lands and other uplands that to-day, with an equal tonnage per acre, show higher percentages of sucrose, are extensive in area, and among the cheapest lands of this section.

Dr. Stubbs' visit to that section, and his investigations to determine the value of its cane for producing sugar, has done the states of Georgia, Florida and Southeastern South Carolina, an invaluable service, which may result in giving to their agriculture a companion money crop with cotton, of greater value and far more certain in annual results.

Dr. Stubbs, in the preface to the republication of his treatise on "Sugar Cane," speaking from personal observation and experiments in the laboratory, tells how Georgia and Florida can be made profitable sugar producing states "in competition with the world," and a careful perusal and study of this preface is, therefore, earnestly commended to all interested in the prosperity of this section, whether cane growers or not, as Dr. Stubbs is recognized as the highest authority in the United States in all matters appertaining to the cultivation of sugar cane and its manufacture into sugar.

D. G. PURSE.

Savannah, Ga., October, 1900.

SUPPLEMENTARY PREFACE TO GEORGIA-FLORIDA-SOUTH CAROLINA EDITION.

A recent visit to the cane-growing regions of Southern Georgia and Florida has convinced me of the adaptability of these sections to the successful growing of sugar cane and the manufacture of sugar, when the intelligent and progressive practices of the best sugar producing countries are universally adopted.

Both the soil and climate of this section are favorable to the growth of cane, as was evidenced by the splendid patches, sometimes increasing to small fields or plantations, found everywhere throughout this belt.

These numerous object lessons demonstrate, beyond cavil, that if a progressive agriculture be adopted, by which the proper preparation of the soil, fertilization and cultivation of the plant, together with a rotation, including some leguminous crops, at short intervals, be secured, that these sections can successfully make sugar and syrup in competition with the world.

Two other favorable factors, to be specially considered in preparing a solution of this problem are: 1st, the superior saccharine richness of the cane, and 2nd, cheap labor, already available in abundant quantity in every community.

The numerous samples of sugar cane grown in these sections, and forwarded to us last season, show by analyses to be greatly superior in sugar content to that grown upon the alluvial lands in Louisiana.

This increased saccharine content is of vital importance to the manufacturer of sugar, and, as soon as demonstrated by one or two local factories, will cause capitalists from every direction to speedily erect central factories throughout the belt for the purchase of cane and the manufacture of sugar.

One or two factories of the latest type of improvement, well erected, and with ample capacity, would, in my opinion, demonstrate the profits of such an investment, and such a demonstration would at once serve to attract capital to erect factories, in number and capacity, to meet the wants of every community in these sections.

It is useless to speak of the advantages of a large central factory to every community, and of their immense superior-

ity over the small one-horse mills now recklessly throwing away over one-half of the sugar which that cane contains.

A significant fact, which forms the basis of an unanswerable argument in favor of the success of central factories, is given in the present widely extended and presumably profitable cultivation of the cane and its manufacture into syrups by the crudest processes known to the sugar-planting world over 100 years ago.

Small one-horse mills, extracting not over 50 per cent. of the weight of cane, in juice, are everywhere to be found. This juice is crudely cooked in kettles, or shallow pans, without clarification save that produced by the heat of evaporation.

In the process of skimming a loss is incurred of fully 10 to 15 per cent. of the juice obtained, so that the final product in syrup does not really represent one-half of that actually contained in the cane.

Central factories would save the most of this loss, incur the entire expense of manufacture, and divide the gains with planters or farmers.

Growing and delivering the cane would constitute the entire work of the farmer, and, for this, he would receive a larger compensation than he does now for his manufactured product.

The growing of cane would be largely increased and the business created for a community by an up-to-date factory, would in itself justify business men in its erection.

The abundant and efficient field labor found throughout this section would guarantee cheap production of cane, while the factory would supply the expert labor which would require other products of the soil for their support.

With the erection of factories would come the practical and economic handling of the cane from the carts to cars, and from cars to the cane carriers. In fact, a study of the economics of growing sugar cane would become universal, with the inevitable result of increased profits to all growers.

The farmer is not alone interested in the erection of central sugar factories. The community will find them veritable increments to the volume of business transacted. Sales will be increased, real estate will advance, better and larger markets for all farm products will be secured and, of course, public schools and churches, to say nothing of other social interests, will be more liberally fostered.

The railroads will be largely interested. The shipment of cane to the factories, and the transportation of the products to the markets of the world, will constitute an enormous local auxiliary to their business. But when to the above there is added the increased transportation of all

kinds of wares needed by the factory and its dependents and the increased travel which the constantly growing population would indulge in, its local profits would simply be enormous.

Every environment declares for central factories, and if the local growers of cane will promise an ample supply of cane, few business communities can afford to be without them.

It is hoped that the republication of this work will stimulate the planters to grow larger and more profitable areas of cane and convince the business men of every community of the value of a central sugar factory.

WM. C. STUBBS, Director,
Louisiana Sugar Experiment Station.
Audubon Park, New Orleans, La., August, 1900.

PREFACE.

Twelve years ago the sugar planters of Louisiana established and endowed for a term of years, the Louisiana Sugar Experiment Station. They honored me with the Directorship, which position I have held ever since. From chaotic beginnings, I have witnessed the gradual evolution of this station, until to-day it is possessed of ample grounds, filled with canes from every country, well equipped laboratories, presided over by experienced scientists, and a superb sugar-house, fitted with the latest and best machinery for the manufacture of sugar, guided and directed by our own selves. Upon these grounds, within these laboratories, and with this sugar-house, nearly every question pertaining to the sugar industry has been discussed and valuable results obtained, some of which have been periodically published in bulletin form.

On account of the absence of any recent work covering the up-to-date sugar industry of our State, it was deemed an appropriate tribute to the progressive sugar planters, who have so liberally supported this station, as well as a pleasing *devoir* from the writer, to embody in two volumes for general reference and study, all of the available information upon the growing of sugar cane and its manufacture into sugar. This Vol. I, treats only of the agriculture of sugar cane. Vol. II, to be published, it is hoped, within the next year, will treat of its manufacture into sugar. Thanks are especially due to Professor H. A. Morgan for a chapter prepared by him on "Sugar Cane Insects."

THE AUTHOR.

Louisiana Sugar Experiment Station, Audubon Park. New Orleans, La.

June 30, 1897.

CHAPTER I.

HISTORY OF THE SUGAR CANE.

Porter, in his work published in 1843, entitled "The Nature and Properties of Sugar Cane," asserts: "The strongest proofs, carefully collected from the best authorities of ancient and modern times, lead to the conclusion that China was the first country in which the sugar cane was cultivated and its produce manufactured; and it is tolerably well ascertained that the inhabitants of that country enjoyed its use two thousand years before it was known and adopted in Europe." Wray, in "The Practical Sugar Planter," a book published in 1848, says: "The Chinese assert that sugar has been made from the cane in China for upwards of three thousand years; and without disputing with 'the flowery nation' for a few hundred years, more or less, we will at once concede to them their undeniable claim to very great antiquity as sugar manufacturers. But I cannot divest myself of the belief that India—not China—is in reality the country from which the sugar cane first emanated."

De Condolle, in his excellent work, "The Origin of Cultivated Plants," says: "The sugar cane is cultivated to-day in all the warm regions of the earth, but it is demonstrated by a crowd of historical witnesses, that it has been cultivated first in meridional Asia, whence it has spread into Africa and later into America."

Karl Ritter, in several works published in the forties, has given an extensive resume of the evidences bearing on this subject. His first argument was that all the varieties of cane known in a wild state and belonging to the genus "saccharum," grew in India, except one which is in Egypt. "The probability is entirely in favor of the origin in Asia if one can draw a conclusion from botanical geography."

Roxburgh, Wallick, Royle and Aitchison mention the plant as existing only in a cultivated state in India, and the first mentioned author states expressly "where wild, I do not know."

In 1861, Bentham says of the flora of Hong Kong: "We have found no authentic and certain proof of a locality where cane ordinarily grows spontaneously." Some botanists have asserted that since the cane flowers oftener in

Asia than in America or in Africa, that this is proof of its being indigenous there. But it is now known that it flowers and bears true seeds in all tropical countries.

In default of precise information resort is had to linguistic and historical accessories, to establish its Asiatic origin. The Sanskrit for cane, is *Ikshu*, *Ikshura* or *Ikshava*; for sugar, is *Sarkara* or *Sakkara*. All of the names for this substance in the European languages of Aryan origin are clearly derived from the Sanskrit. This is a strong indication of its Asiatic origin and of the antiquity of its products in the meridional regions of Asia, with which the people speaking the old Sanskrit had commercial transactions.

With those races, not of Aryan origin, a singular variety of names exist for sugar—"Kyam" with the Bermans, "Mia" in Cochin China, and "Kan" and "Tche" with the Chinese. In Malay, "Tubu" or "Tabu" for the plant, and "Gula" for the product (sugar). This diversity of names shows a very great antiquity of the culture of sugar cane in Asiatic regions, where already botanical indications have presumed its origin.

The epoch of introduction of the culture in different countries agree with the idea of an origin in India, Cochin China, or in the Indian Archipelago.

Indeed, the Chinese claim that it came to them from the East, since Dr. Bretschneider, with the most complete resources of Chinese literature, says in his work "On the study and value of Chinese Botanical Works:" "I have been able to discover no allusion to sugar cane in the most ancient Chinese works. It appears to have been mentioned for the first time by the authors of the 'II Century Before J. C.'" The first description is found in a work published in the IV century. It says: "The Kan-che (Kan sweet and che bamboo) grows in Cochin China. It is many inches in diameter and resembles the bamboo. The stalk broken into fragments is eatable and very sweet. The juice which is drawn from it is dried in the sun. After some days it becomes sugar——. In the year 286 A. D., the kingdom of Funan, in India, sent sugar as a tribute to China." Pentsao, an emperor who ruled from 627 to 650 A. D., sent a man into the Indian province of Bahar to learn the manner of manufacturing it.

There is, then, no foundation for its origin in China. Indeed, it is asserted, on the contrary, that it came from Cochin China. It is, therefore, most probable that its origin was either in Cochin China, or in Bengal.

The propagation of sugar cane in the west of India was well known. Both Grecian and Roman writers speak of it.

Paulus Egineta first speaks of it as "Indian salt," and likens it to common salt, but with a sweet taste and savor.

Theophrastus mentions it as "another honey which is from bamboos."

Dioscorides, who lived long before Pliny, speaks of a certain *saccharum*, which is a kind of honey concreted in India and Arabia. It is found in bamboos, with a concretion similar to our own salt, and which when subjected to the teeth breaks up after the manner of salt.

Pliny, the ancient, says "Arabia produces sugar, but that of India is more renowned. It is a kind of honey collected from bamboos. It is white as gum, breaks easily under the teeth, and is very useful in medicine."

Varron says: "There grows in India a large reed from which is drawn a sugar so sweet that the best honey does not compare with it."

Seneca observes: "There is found among the Indians a honey contained in the reed; this honey is produced either by the dew of heaven or by the sweet and thick sap of the reed."

While the Greek and Roman writers seem familiar with sugar, the Hebrew works, on the contrary, do not speak of it, from which one would infer that the culture of cane did not exist in the east of India at the time of the captivity of the Jews at Babylon.

India, then, appears to be the cradle of sugar cane, and from there it passed into China, where it has been extensively cultivated from immemorial time. It entered then into Arabia, and from this country was introduced into Nubia, Ethiopia, and Egypt.

After the crusades it was introduced by the Venetians (about 1500 A. D.) into Syria, Cyprus, and Sicily.

Dom Henry, king of Portugal, imported it later into Madeira and the Canary Islands, where for 300 years was manufactured all the sugar which was consumed in Europe.

This culture gave way later to the vine, which was found more remunerative. About the same time it was introduced into southern Spain, where it still grows in limited quantities.

From the Canaries it was carried to Brazil at the beginning of the sixteenth century.

The Portuguese also carried it to the Island of St. Thomas.

After the discovery of the New World, Peter Etienza introduced sugar cane into the island of San Domingo, formerly called Hispaniola. In 1518 there were already twenty-eight *sucreries* in this isle. From this island it spread successively over Mexico (1520), Martinique (1650), Guadeloupe (1644), Cuba, Guianas, and the rest of South America.

Notwithstanding the above historical data, it is now well known that sugar cane was found growing in its utmost luxuriance throughout the islands of the Pacific ocean by our earliest navigators, and that several of our best varieties of cane now cultivated have been domesticated from wild specimens found growing on these islands, and the above facts lead Mr. Wray to suggest that the sugar cane might have been growing on the great continents of America before it was brought there by the Portuguese and Spaniards.

CHAPTER II.

HISTORY OF SUGAR CANE IN LOUISIANA.

Gayarre, in his history of Louisiana, says: "In this year (1751), two ships, which were transporting two hundred regulars to Louisiana, stopped at Hispaniola. The Jesuits of that island obtained permission to put on board of those ships, and to send to the Jesuits of Louisiana some sugar canes, and some negroes who were used to the cultivation of this plant. The canes were put underground according to the directions given on the plantation of the reverend fathers which was immediately above Canal street."*

But it seems that the experiment proved abortive. In another place he says: "The colonists, however, were striving to increase their resources and to ameliorate their condition by engaging with more perseverance, zeal, and skill in agricultural pursuits. Dubreuil, one of the richest men of the colony, whose means enabled him to make experiments, and who owned that tract of land where now is Esplanade street—seeing that the canes introduced by the Jesuits in 1751 had grown to maturity, and had ever since been cultivated with success, as an article of luxury, which was retailed in the New Orleans market, built (1759) a sugar mill and attempted to make sugar. But the attempt proved to be a complete failure."

The next step in the development of the sugar industry is shrouded in uncertainty as to actual results. Gayarre says:

"The manufacture of sugar had been abandoned since 1776 as being unsuited to the climate, and only a few individuals continued to plant canes in the neighborhood of New Orleans to be sold in the market of that town. It is true that two Spaniards, Mendez and Solis, had lately given more extension to the planting of that reed, but they had never succeeded in manufacturing sugar. One of them boiled its juice into syrup, and the other distilled it into a spirituous liquor, of a very indifferent quality, called taffia."

It is certainly true that considerable quantities of cane were used for the manufacture of taffia some years before successful sugar making was accomplished, since on the 7th

* Where the Jesuits' Church on Baronne street, New Orleans, now stands.

of June, 1764, D'Abbadie, in his official report to his government, mentions the immoralities of his people, and says, "the immoderate use of taffia (a kind of rum) has stupefied the whole population."

But the descendants of Mendez in this city deny that he failed to manufacture sugar, and offer in evidence the following from family records: "Don Antonio Mendez, b 1750, d 1829, Procureur de Roi of Spanish Government in Louisiana, married Douna Feliciana Ducrot, and lived in St. Bernard parish. In 1791, he bought out Solis, a refugee from St. Domingo, who had striven in vain to make sugar from sugar cane, and then having secured the services of a sugar maker from Cuba, by name of Morin, made sugar for the first time in Louisiana in 1791, and continued to make it afterwards."

A correspondent, signing himself J. B. A. (J. B. Avequin), writing an account of this history of sugar cane in Louisiana to the "Louisiana Sentinelle de Thibodeaux," says:

"In 1790 a Spaniard named Solis, in Terre aux Bœufs, nine or ten miles below New Orleans, was perhaps the only one who continued cane, but with the purpose of converting the juice into taffia or rum. The numerous experiments in sugar manufacture which had been made in this section had been unsuccessful. The lands owned by Solis are now a part of the Olivier plantation.

"In 1791, Antonio Mendez, of New Orleans, bought from Solis his distilling outfit, the land and the canes, with the firm resolution of devoting himself to sugar manufacture and to conquer all difficulties. For this purpose Mendez employed Morin, who had passed many years in St. Domingo for the purpose of studying cane culture and sugar manufacture. But whether it was that Mendez did not have the means of installing a sugar factory like those of St. Domingo, or whether he still doubted of complete success, he made but a few small barrels of sugar, and it is certain that he experimented also in refining them, for in 1792 Mendez presented to Don Rendon, who was then Intendant of Louisiana for Spain, some small loaves of sugar refined by him. It required one of these little loaves to sweeten two cups of coffee. In a grand dinner he gave that year to the authorities of the city of New Orleans, Intendant Rendon called the attention of his guests to this sugar during dessert, presenting it to them as a Louisiana product made by Antonio Mendez. Up to this time it is thus seen, Mendez and Morin had manufactured but a very small quantity of sugar, since it was still presented as an object of curiosity."

From the above, as well as from other authorities, not necessary to quote, it is certain that Mendez made the first

sugar in Louisiana, as also was the first to refine sugar, but there is no evidence to show that he ever made it in large and paying quantities. The first crop of sugar, large enough to influence the future of Louisiana and profitable enough to justify others to embark in the enterprise, was made by Etienne De Bore, in 1794, '95 or '96, near the present site of the Sugar Experiment Station. Mr. Gayarre, the historian, the grandson of De Bore, thus describes the situation in Louisiana, and the circumstances which drove Mr. De Bore to his bold adventure:

"When the whole agricultural interest of Louisiana was thus prostrated, and looking around for the discovery of some means to escape from annihilation, when the eager and anxious inquiry of every planter was: 'What shall I do to pay my debts and support my family?' The energy of one of the most spirited and respected citizens of Louisiana suddenly saved her from utter ruin and raised her to that state of prosperity which has increased with every successive year." (This was written in 1851. W. C. S.)

That individual was Etienne De Bore, born in (Kaskaskia) the Illinois district of Louisiana in 1740. He married the daughter of Destrehan, the ex-treasurer of Louisiana, and settled on his wife's plantation six miles above New Orleans.

Like the majority of planters, he had given his attention to the cultivation of indigo, and he had also seen his hopes blasted and himself and family threatened with entire ruin. After giving his determination to go into the sugar industry, against the remonstrances of his wife, friends and relatives, he continues: "Purchasing a quantity of canes from Mendez and Solis, he began to plant in 1794 and to make all the other necessary preparations, and in 1795 he made a crop of sugar which sold for twelve thousand dollars—a large sum at the time." To show the excitement prevailing in the community and the intense interest on the part of the planters, the following vivid description is given of the day on which the trial of sugar making was made:

"Bore's attempt had not been without exciting the keenest interest; many had frequently visited him during the year to witness his preparations; gloomy predictions had been set afloat, and on the day when the grinding of the cane was to begin, a large number of the most respectable inhabitants had gathered in and about the sugar house to be present at the failure or success of the experiment. Would the syrup granulate? Would it be converted into sugar? The crowd waited with eager impatience for the moment when the man who watches the coction of the juice of the cane determines when it is ready to granulate.

When that moment arrived, the stillness of death came among them, each one holding his breath and feeling that it was a matter of ruin or prosperity for them all. Suddenly the sugar maker cried out with exultation, 'It granulates!' and the crowd repeated, 'It granulates!' Inside and outside of the building one could have heard the wonderful tidings flowing from mouth to mouth and dying in the distance, as if a hundred glad echoes were telling it to one another. Each one of the bystanders pressed on to ascertain the fact on the evidence of his own senses, and when it could no longer be doubted, there came a shout of joy and all flocked around Etienne De Bore, overwhelming him with congratulations, and almost hugging the man whom they called their saviour—the saviour of Louisiana."

The sugar maker who watched the cooking of the cane juice up to the moment of granulation was Mr. Antoine Morrin, (according to evidence of Mr. Charles LeBreton, a descendant of Bore's, who has recently died in New Orleans), the same one associated with Mendez in his trials. From this time on Mr. Bore redoubled his zeal and increased his wealth which at his death was estimated to be over \$300,000—all made in sugar.

Convinced by this result, a large number of planters followed Mr. Bore's example and erected sugar houses. Among the first were the Piseros, the Cavarets, the Riggios, and the Maccarthys (names no longer on our roll of sugar planters). with each succeeding year names were added to the list of sugar planters and all of them rapidly accumulated wealth.

It may not be inappropriate just here to chronicle the celebration of the centennial of the above event by the Audubon Sugar School by the graduation of its first class in June, 1894. Hon. Theo. S. Wilkinson delivered the centennial address, and Hon. John Dymond the diplomas to the graduates. Full accounts of the meeting, which was largely attended, may be found in the New Orleans dailies, and the Louisiana Planter of that date.

The sugar industry continued to grow and expand until 1820, when an additional impulse was given it by the introduction of our present variety of cane. Previous to this time only two canes were cultivated in Louisiana, the one called Creole, originally from Malabar or Bengal, and the Tahiti, both inferior canes for sugar in this climate. They have been entirely supplanted in general field culture by the purple or red ribbon canes imported by Mr. John J. Coiron about the year given above. The cane from which Mr. De Bore first made sugar was the Creole, since the Tahiti was not introduced from St. Domingo until 1797. The purple and striped varieties, natives of Java, were introduced towards

the middle of the last century to the Island of St. Eustatius, to Curacao and Dutch Guiana by the Dutch. From St. Eustatius a vessel brought some packages of these canes to Savannah, Ga., about 1814, and they were planted by a Mr. King on the Island of St. Simon. They grew well and Mr. King manufactured sugar from them. Mr. Coiron, who had formerly resided in Savannah, but now a planter of Louisiana, induced his friend Mr. King to give him some of these canes. He planted them in his garden at St. Sophie plantation. So pleased with the result of this trial, that later he brought from Savannah a schooner load of them and planted them on his plantation. From this plantation they have spread over the entire State and gave a new ardor to sugar culture. Its ability to withstand greater cold enabled planters to open new plantations farther north, and thus greatly enlarge the area of cane growing in Louisiana. Mr. Coiron, it may be remarked in passing, was the first planter in Louisiana to use the steam engine for the crushing of canes. Mr. Coiron died without knowing the immense benefit he had conferred upon the State of Louisiana, and the planters owe to his memory the erection of some statue or monument to commemorate their grateful appreciation of his invaluable services. The canes introduced by Mr. Coiron, with a few exceptions, occupy the plantations of this State and will doubtless remain unless supplanted by some of the selected seedlings now annually propagated.

CHAPTER III.

BOTANICAL RELATIONS.

Sugar cane is a member of the large family of grasses—graminaceæ—of the tribe Andropogon, and its botanical name is *Saccharum Officinarum*, or *Arundo Saccharifera*.

Although it is now generally conceded by botanists that all the cultivated varieties belong to one species, yet there are strong reasons for believing in the existence of several species. The habits of growth, color of foliage and stalk, content of sugar, and sundry minor properties, would at least justify an opinion in the absence of an opportunity to minutely examine the flowers of each, that the differentiation had extended beyond the "varietal" and into the "specific." The Creole, Japanese, and some of the black varieties from Hawaii, are certainly widely different from each other.

Jacob de Cordemoy has divided all the cultivated varieties into three principal species:

First—The common kind, known as *Saccharum officinarum*.

Second—*Saccharum violaceum*, canes with violet leaves, like the black canes of Hawaii just alluded to. Some varieties of this kind stain the hands and mouths of those who eat it.

They are cultivated rarely.

Third—*Saccharum sinense*, called by Roxburgh, Chinese cane, because cultivated in China from immemorial time. Its chief specific difference is said to reside in the disposition of its panicle, which unlike that of the *Saccharum officinarum*, is oval and ornamental. It is extensively grown in Natal.

However uncertain it may be as to the species of sugar cane, it is well known that all of the canes cultivated for sugar belong to the first class (*saccharum officinarum*). Therefore we shall treat only of this species.

It is a gigantic stalk (see fig. 1), often reaching ten to fifteen feet in height in the tropics, which is straight during early growth, but is bent or reclined either by its own weight or by the winds at maturity. Its roots, like those of all grasses, are fibrous and lateral, stretching in all directions, and usually not penetrating the soil to any depth. Hence its instability in loose or soft soils, and its liability to be blown down by wind.

The root stock is a simple prolongation of the stalk (A to B in fig. 1), terminating in a point of attachment either

to the mother cane (planted) or the mother stalk (stubble). It is around this axis that the true roots ("a" "a") emanate, which run out in every direction.

The stalk is cylindrical, varying in size, according to va-

FIG. 1.

Stalk of sugar cane showing root A-B; stem, B-C; leaves, C-D.

riety, maturity, and conditions of growth. It is composed of nodes and internodes (see fig. 2) sometimes to the number of sixty to eighty, very closely crowded together with canes badly grown, and wide apart—often six inches—with canes grown, vigorously and of a superior quality. Varieties also differ greatly in the length of the internodes, and other things being equal, as will be hereafter shown, that variety is to be preferred which has the longest joints. The epidermis is polished, more or less thick, and densely colored in different varieties (yellow, green, red, brown, black, white, purple, or mixtures of two or more of these colors).

The canes are covered, chiefly on the portions adjoining the nodes, with a whitish pulverulent easily removable powder called "cerosin," which has the chemical formula of $C_{24}H_{48}O$, and represents by its constitution an alcohol of the fatty series. In extracting the juice from the cane by mills, large quantities of this substance are removed and carried forward to the clarifier, where it is precipitated during clarification in the scums and alternately left in the filter cake.

The leaves of the cane are alternate, larger at the base, and about three feet in length. They are green in color, more or less intensified, according to the variety. The midrib is whitish in most varieties, reddish and purplish in others, well developed, and with a channel-like depression on the upper surface. In some varieties the base of the leaves are covered with prickles, which when introduced into the flesh, produce disagreeable and sometimes painful wounds. Cutting such canes, particularly when their upper leaves are immature, is attended by much suffering unless the hands are protected by gloves. The leaves are clasping, receding from the stalk during growth and falling off during maturity. Each joint has its leaf, and through the latter the food for the former is assimilated, and it is believed when the joint casts its leaf, the process of assimilation so far as concerns that joint, is completed—it is mature. Elaboration of the food present afterwards may and does occur, but the growth is completed and only transformations from starches, glucoses, amides, etc., into sucrose and albuminoids thereafter occur. One by one, proceeding from the roots upwards, these joints mature and cast their leaves, until finally a naked stalk with only a few leaves at its upper extremity, announces its fitness for the harvest. Under the base of each leaf, in the node, is a bud (see fig. 2), usually of the size of a pea (round, flat or oval, prominent or inconspicuous, according to variety), covered with a protecting varnish, and with superposed envelopes of a very resisting nature. This is usually denominated the "eye" of the cane. It is usually larger and better

formed as the base of the cane is reached. Towards the top it is whitish, flattened, and often triangular in shape. Those eyes contain the germs of future canes, and are used by planters everywhere for propagation of their plants. Until recently, it was thought that these eyes were the true seed of the cane, but Messrs. Bovell & Harrison, of Barbados, several years ago demonstrated that the panicle of flowers produced in tropical countries where the cane "arrows," was not always composed exclusively of sterile flowers, as was generally believed. They discovered among them true seed, which germinated on planting and gave true cane. Since that time every tropical country has succeeded in raising a few canes from seed (see chapter on seedlings).

Around the stalk, at the eye, are several rows of semi-transparent dots or points (see fig. 2) which produce roots when the cane is exposed to excessive rains, prostrated on a wet soil, or when the stalk is planted in moist earth. Simultaneously the eyes also develop. Certain varieties of cane are subject to this inconvenience, which greatly detracts from their value either for sugar making or for seed.

Just above these rows is a light colored semi-transparent narrow band, which clearly divides the lower from the upper joint.

That portion of the cane stalk which extends below the ground is similar in structure to the stalk above ground. The very much shorter joints have eyes, which develop into plants (suckers, tillers or ratoons), and the circular rows of dots become the true roots of the plant.

In tropical countries, at the epoch of complete maturity the cane flowers, bearing on a long peduncle, a panicle of silken spikes. Each floret has three stamens inserted upon the ovary, which is sessile and glabrous, surmounted by two elongated styles with terminal feathery stigmas. Many seed are infertile, doubtless due to the fact that the cane has been so long propagated by cuttings (boutures) that it has nearly lost its fertility. Cane flowers usually at 12 to 13 months old, but all varieties do not flower. Those varieties which do not flower are usually preferred, since they can be retained a longer time in the field before cutting them.

FIG. 2.
B. Joints of cane.
A. Buds or eyes.
D. Internodes
C. Nodes.
X. Semitransparent dots in rows.

Contrary to the physiology of many plants, the cane is not ripe at the time of flowering. It is only at the end of three months after this phenomenon has taken place that it attains the maximum of sugar. This abnormal procedure is a contradiction to other sugar plants, notably the beet, which consumes during flowering all the sugar stored up in the root.

CHAPTER IV.

ANATOMY AND PHYSIOLOGY OF THE CANE PLANT.

The Stalk.

The stalk is cylindrical, divided into nodes and inter nodes, or, as popularly called, "joints." The upper part of each joint divides into two parts, the inner one forming the rind of the next joint above and the outer one uniting with cells from within, form the leaf. Around the stalk at the eye or bud are several rows of transparent points which produce roots when cane is subjected to certain conditions. Just above these rows is a light colored transparent narrow band which clearly divides the lower from the upper joint. See fig. 2.

The following notes are furnished by Prof. W. R. Dodson, Botanist and Mycologist of the station, based upon his studies of the sugar cane at the Sugar Experiment Station:

"If a very thin section be cut across the stem between the nodes, and prepared, by mounting on a glass slip, for study under the microscope, all the tissues that compose the stem can be viewed by transmitted light. The general matrix is composed of pith cells, which are large and more or less sixsided, as seen in cross section. See fig. 3. These cells constitute the store houses of the plant, and in them is found nearly all the sugar and other products that are laid up for the future use of the plant. In fig. 3 the large cells marked "P" are the pith cells. They make up the greater portion of the inner part of the stem. When the section cut lengthwise with the stem is viewed (see fig. 4), the sugar cells are seen to be somewhat longer than they are thick. Generally these are filled with fluid, but in what is called pithy cane they are partly empty. They seldom contain starch, and it is doubtful if starch and sugar ever occur in the same cell. At the nodes the pith almost entirely disappears and the whole tissue is made up of the bundles and a kind of modified pith that fills between them. The shape and comparative size of the pith cells compared with the cells of the other tissue, is well shown in figures 3 and 4.

FIG 3.

A microphotograph of a thin section across a stalk of cane, magnified about 100 times. The dark areas, with two large and one small circular clear spots within, are the fibrovascular bundles marked "B." The upper side of the picture is the portion of the section near the outside of the stem. The honey-comb appearance is the pith or sugar containing portion, the cells of which increase in size toward the center, see "P" "P," while the number of bundles decreases.

Distributed through the pith are groups of differentiated tissue, which taken together constitute the fibrovascular bundles. In the internodes the bundles run parallel and have no communication with each other, but at the nodes they freely branch and the branches of one run into the branches of another till there is a general communication between them. Fig. 5 shows one of these bundles very much enlarged. Most of the tissues can be made out very easily. The large cells surrounding the bundles are the sugar cells, marked P. The two large and one small circular cavities marked V in the figure are the vessels. It is through these

FIG. 4.

A. Thin section of a portion of a stalk of cane cut longitudinally, magnified about 6 times. Cells marked P show side view of pith or sugar cells.

S. Marks sieve tubes, long cells, which with V vessels, run up the stem and out into the leaves.

vessels that the water travels from the root to the leaf, carrying the food material taken from the soil. Near the vessel is a group of some ten or eleven cells marked "S," which are called sieve tubes. These are long cells, as will be seen from the longitudinal section (see fig. 4), and at intervals in their length are partition walls. The elaborated food material coming from the leaf to be distributed through the plant is conveyed along the sieve tubes. It may be said then in general that the greater portion of the crude food material is conveyed up the stem through the vessels, and when it passes down the stem it goes through the sieve tubes.

FIG. 5.

A microphotograph of a fibrovascular bundle of a stem of sugar cane, magnified about 1000 times. P, pith cells; V, vessels; S, sieve tubes. The thick walled cells around the vessels is the fibrous portion or bast, for strengthening.

The remaining tissues that surround these tubes is mostly of a modified fibre and is for the general purpose of strengthening the stem. In between the sieve tubes are cells which do not come out very plainly in the photograph, which are called the accompanying cells. The function of these has not been very satisfactorily demonstrated. By referring to figure 3, which shows a considerable number of the bundles and the outer portion of the stem, it will be

FIG. 6.

Section of leaf, with one of the large fibrovascular bundles in the middle of the drawing; made under the camera lucida.

VV. Vessels.

B.B. Bast tissue.

A. Air space.

St. Row of starch cells that surround the bundle, in which nearly all the starch is found.

C. Cells filled with small green bodies, which give the green color to the leaf and make the starch found in the starch cells.

St. Large round cells just outside this layer contain intercellular spaces to allow circulation of air to the green cells.

F. Epidermis or skin covering.

F.F. Secondary bundles.

G. Cells that open the new leaf, and cause the leaf to roll up in dry weather.

seen that the bundles are much more abundant and crowded together near the outer portion of the stem. The size of the vessels is somewhat diminished and the amount of strengthening tissue is considerably increased. The pith almost all disappears and the cells become thickened to form the peel or rind of the stem for strength and protection. That portion which is peeled off when the cane is prepared for chewing, has no true pith cells in it.

Leaf.

The bundles of the stem pass into the leaf without losing any of their tissues. There are tissues in the leaf, however, that are not found in the stem. Surrounding the bundle is a layer of short thick cells which may be called the starch cells (see fig 6), as they are filled with starch during the entire day. At night the starch is converted into some other substance and conveyed away to the stem. It may be conveyed during the day also, but there is no known way of proving it directly. In the morning starch appears in these cells very quickly after the sun rises, and is found in very limited quantities elsewhere in the leaf. Immediately on the outside of the starch cells occur other cells that are filled

FIG. 7.

Microphotograph of a single bundle of cane leaf, magnified 1000 times. Tissues not plainly brought out here are shown in the camera lucida drawing, fig. 6. B B, bark tissue for strength; S, starch cells, through which the section was cut longitudinally for fig. 10; C, chlorophyll portion, through which the section was cut longitudinally for fig. 11; E, skin covering the leaf.

with a green coloring matter (see "C," fig 6), and in these cells the starch is manufactured. There is very little green matter in the starch cells.

The green matter of the leaf is made up of what is called chlorophyll bodies, very small, more or less globular, that have the power of making starch out of the water from the

soil and the carbon of the carbon dioxide of the air. It is not known just how this combination is brought about, but the process is probably more complex than would appear from a simple union of the above elements, but starch is the first product formed that can be recognized.

The arrangement of the bundles in the leaf is worth noting. Beginning with one of the large bundles there occurs near it, in the lower portion of the leaf, a small bundle not fully developed (see fig. 6), while in the upper portion it is a loose structure of large cells with two or more wedge-shaped cells extending to the epidermis; then a bundle that extends almost across the thickness of the leaf, then more loose tissue and a small bundle, then another large bundle like the one first noted. This is not exactly the same in all leaves nor in all parts of the same leaf, but in general it is a type.

FIG. 8.

A microphotograph of a section of a cane leaf, showing the arrangement of the bundles in the leaf, and the cells (B) that cause the leaf to roll up when the leaf wilts.

FIG. 9.

Section of the leaf of sugar cane cut longitudinally through the large cells, occupying the intermediate position between the bundles.

The large wedge-shaped cells on the upper side of the leaf (see fig. 6) have the function of unrolling the leaf as it comes out. The leaves are rolled when young, and as these cells become fully expanded they cause the leaf to flatten out. When evaporation is excessive they become less turgid and in shrinking cause the leaf to curl up. Hence the curling of the leaf in dry weather.

The thickened walls of the strengthening cells (B, fig. 6) are arranged in the leaf so as to give strength to a vertical weight. They are grouped so as to form a more or less perfect double girder, shaped like a bridge girder, or as a hollow tube. For transverse and longitudinal sections of cane leaf see figures 6, 7, 8, 9, 10 and 11.

FIG. 10.

Section of a leaf cut longitudinally through the starch-bearing cells, at an angle to secure the greatest number of cells to be obtained in one section, two outer rows being chlorophyll cells.

FIG. 11.

Section of leaf of sugar cane cut longitudinally through the chlorophyll cells See C, figs. 6 and 7.

Expressure of Water from Cane as it Enters the Mill.

It is known to everyone that is a close observer about the sugar mill, that as soon as the cane starts through a roller mill, water, or at least a fluid, will be pressed out at the other end of the cane. It does not matter as to the length of the cane, the water will flow from the end almost immediately after the opposite end enters the rollers. When this fluid is collected it is found to contain little or no sugar. The question arises, "Where does the water come from?"

In early spring or late winter, if a twig of some tree is cut in section, say a foot long, and brought into a warm room, and the stick held vertically, a drop of water will appear at the lower end, and as soon as the stick is reversed the water will disappear from the upper end. Sachs explains this phenomenon by supposing that the water travels in the walls of the cells and the action of gravity is sufficient, in the saturated condition of the stem, to draw enough water from the stem to form the drop on the end of the stick. The water expressed from the cane, however, cannot be thus explained. It is the water from the vessels as will appear from the following: It is the sap on its way to the leaf. Though it traverses very near the tissues rich in sugar, it contains but little organic food material of any kind.

In order to get a proper understanding of the following experiment, it will be necessary to consider for a moment the structure of the cane stem as explained elsewhere and shown in figure 3. The tough strings or threads that traverse the tissues of the stem are called fibro-vascular bundles. These bundles are made up of several tissues, as shown when studied under the microscope, and among these tissues are some large tubes called vessels that traverse the length of the stem and make up an essential part of the bundle. Through these vessels at least a part of the water passes from the root to the leaves, carrying the material taken up from the soil. (It must be remembered that all substances taken up by the roots must pass to the leaves and there undergo certain changes before it can become a part of the plant structure). These bundles are more numerous but of less size near the outer portion of the stem than they are near the center. To a given area, therefore, in a cross section of the stem, there are more bundles and more vessels near the outside than near the center. If the water comes from the bundles, there will be a greater flow near the outside, and least flow near the middle. In order to measure the amount of flow accurately from different portions of the stem, the following process was adopted:

FIG. 12.
Diagram showing the arrangement of tubes in a cane stalk to measure the fluid expressed from different parts of the stem.

A set of brass tubes (see fig 12) was filed sharp so they would cut a clear edge when inserted as a cork borer, and to the other end was inserted and cemented a glass tube that had previously been drawn out to a fine tapering point, that would admit a small flow of water when subjected to pressure, but would hold water by capillarity when not under pressure. The tubes were curved at the ends so that the expressed water would form in drops and fall from the ends as it was forced out. In this way the number of drops will measure fairly accurately the amount of flow, as the drops are pretty constant in weight. The tubes were then filled with water and inserted in the end of the cane so the tube would take a position parallel with the bundles, and the ends of such bundles as would be included in the area of the inside bore of the tubes, would project into them. As the tube is inserted the water is forced out, and the space in the tube is exactly filled by the cane and the water. Now the cane is started through the mill, and any water that flows through the portion of tissue included in the tube and is forced out at the end, will force a like amount of water out of the capillary end of the glass tube. In this way can be measured the amount of flow in the area covered by the inside bore of the brass tube. If now the tubes be inserted so that one will be near the center A, and one near the circumference C, with others intermediate, B, the flow from the one outside will be greatest, and the one near the middle will be least, while the intermediate ones will give a flow greater or less as it is nearer the outside, or the center. If now the tubes be inserted at an angle with the bundles, D, so the tube will cut the same area of tissue, but a smaller number of bundles, the flow will decrease in accordance with the number of bundles cut, and when the tube is inserted at right angles to the bundle E, there will be no flow whatever. Referring to the drawing to illustrate the arrangement of the tubes, the greatest flow will come from the tube marked "C," while the least will come from "A" of the parallel tubes. Less will flow from "D" than from "A." When the tube is inserted at the node at right angles to the axis of the stem, there will be considerable flow, because there are a number of branches of vessels projecting into one end of the tube when in this position. If now the tubes be inserted as represented at "F" and "G," there will be a flow if the tubes are separated from the cut end by a node, and the amount will increase as the angle increases to cut more bundles. The reason for this is that the fluid flows backward from the node above. The pressure goes up to the node in bundles that are not cut by the tube, and at the node it enters the

ones that are cut, and there would be a flow in the direction of the least resistance. Suppose that vessel V1, in figure 13, is cut by tube T, there will be a flow up the vessel V2 when under pressure, through the connecting channels at the node, and down V1 and into tube T. This will be readily understood by a study of the drawing to illustrate the arrangement. (See fig. 13).

When one end of a cane is placed in a tightly fitting rubber tube, and air or water forced into the other end of the tube, the effect on the opposite end of the cane is the same as starting it through the roller mill. Air would not force the water out if it traversed the walls only.

Sometimes air bubbles appear in the tubes. If one

FIG. 13.

Diagram of connecting branches of a fibro-vascular bundle at the nodes in sugar cane.

end of the cane is put in the mill and the other held in a vessel of water, there will be a few bubbles given off, but the amount of air in the stem seems to depend to some extent on the condition of the cane. It is probable that the water fills the tissues almost entirely when the soil is wet enough to afford plenty of moisture.

That the water travels upward through the bundles can be easily shown by a very simple experiment. If the stem be cut and the leaves allowed to remain in position and the cut end be immersed in a diluted red ink or other colored fluid, the fluid will travel up the stem, and the stem will be marked in a few hours by the red lines extending several nodes up. These lines are the stained vessels.

The measurement of the length of these vessels is at most only approximate. They certainly extend through the greater portion of the length of the stem, when their various branches that connect and make a network is considered. As has been noted, the water begins to flow immediately after the application of pressure. One may compare them in a general way to a rubber tube filled with water; when one end of the tube is passed into the compressing rollers, the fluid would be forced out at the other end. If a colored fluid is pumped into the stem, it will traverse the vessels a distance of several nodes in a very short time with a very moderate pressure. It seems, therefore, that there is abundance of evidence that this water is sap water from the vessels.

When dry weather prevails, just previous to and during the grinding season, it is very common to hear a planter say

that he expects a "sweet juice" from his cane, but if the weather is very wet the juice is not so sweet. In fact a good rain will make a difference in the juice of cane cut the day before and the day after the rain.

What has been noted in regard to the water in the vessels is an important factor in accounting for the above phenomenon. When the weather is dry, the water in the vessels is partly used up to supply the needs of the plant, and when a bountiful water supply comes to the roots, the vessels become filled again to their capacity, with water on its way to the leaves, diluting the juice subsequently extracted from the cane.

CHAPTER V.

CLIMATE FOR CANE, WITH WEATHER RECORD OF LOUISIANA.

Coming as it does from India, where it once probably flourished in a natural state, one may at once predict the climatic conditions necessary for its successful growth by an acquaintance with the meteorology of that region.

It is said that the cane should have a warm climate, with a mean temperature between 65 degrees and 86 degrees, F., and for its best development about 77 degrees, F. It should be moderately humid, with intervals of dry heat and sunshine. Most writers assert that it does best near the sea where the sea breezes bring with them particular salts which fertilize the soils. It may more properly be said, that on account of the accessibility of these fertile sea-girted islands and peninsulas and the climatic conditions prevailing thereon, they have been selected for cane growing, in order that the products may be easily and cheaply transported to other countries, and the heavy machinery needed for manufacturing the canes into sugar be easily delivered.

That the cultivation of sugar cane has covered every country which is favorable to its growth, no one will assert. In fact, artificial irrigation, and the construction of railroads have already greatly extended the area occupied by this plant, and if prices of sugar would justify it, the present acreage would be greatly enlarged and many countries would doubtless cultivate it on a large scale, which up to the present have perhaps scarcely experimented with the plant. Mexico, Central and South America, all offer large fields for the development of this industry, and only the prevailing low prices, added to the instability of the local government, prevent an early occupation of these fields. Even in Louisiana, the industry is capable of indefinite expansion, as there are several millions of acres in this State which could be, with but little expense, brought under cultivation with this plant. It will ultimately be done, unless prohibited by the low prices of sugar, due to the expansion of the beet sugar industry in this and other countries. Sugar cane is cultivated in the following countries: the figures in parenthesis attached to each country indicating the latitude: Abyssinia (10 to 15 deg. N.), Argentine Republic (22 deg. to 25 deg. S.), Queensland (10 deg. to 28 deg. S.), New South Wales (22 deg. to 25 deg. S.), Borneo (Equator),

Bourbon and Rennion (21 deg. S.), Brazil (0 deg. to 20 deg. S.), Cape Colony (29 deg. to 35 deg. S.), Cayenne (French Guiana), Surinam (Dutch Guiana) and British Guiana (2 deg. to 8 deg. N.), Central America, Gautemala, Honduras, Nicaragua, Costa Rica and Salvador (8 deg. to 18 deg. N.), Chili (23 deg. to 40 deg. S.), China (10 deg. to 30 deg. N.), Colombia (0 deg. to 10 deg. N.), India (10 deg. to 20 deg. N.), Japan (30 deg. to 35 deg. N.), Java (6 deg. to 8 deg. N.), Louisiana (29 deg. to 31 deg. N.), Madeira (33 deg. N.), Mauritius (20 deg. S.), Mexico (18 deg. to 28 deg. N.), Natal (30 deg. S.), New Zealand (35 deg. to 37 deg. S.), Fiji (15 deg. to 17 deg. S.), Hawaii (19 deg. to 23 deg. N.), Peru (5 deg. to 23 deg. S.), Philippines (5 deg. to 18 deg. N.), Siam (10 deg. to 20 deg. N.), Spain (36 deg. to 37 deg. N.), Straits Settlement (0 deg. to 10 deg. N.), Venezuela (0 deg. to 10 deg. N.), and West Indies, Antigua, Barbados, Cuba, Dominica, Grenada, Guadeloupe, Hayti, Jamaica, Martinique, Porto Rico, St Croix, St. Domingo, St. Kitts, St. Lucia, St. Vincent, Trinidad and Tobago (10 deg. to 23 deg. N.).

It is, therefore, cultivated from Spain, 37 deg. N., to New Zealand, 37 deg. S., on both sides of the Equator. Its range is therefore wide, and doubtless many countries within this range will at some time in the future adopt its cultivation.

Rainfall.

It is generally estimated that an annual rainfall of about sixty inches is most advantageous for the growth of cane. This amount should be well distributed over at least ninety to one hundred days, of which about forty-five inches should fall during the wet or growing season, and about fifteen inches during the dry. However, annual rainfalls of double this amount occur in parts of Rennion and Guiana where they make large crops of cane; but, as remarked elsewhere, such canes are always green and give low sugar contents. On the other hand, cane is grown now most successfully in countries with a very small rainfall, by irrigation. Indeed, it may be said, that when the temperature and soils are suitable, that cane growing by irrigation is the most remunerative. The largest crops, ripened artificially by the withholding of water, are obtained, and the output of sugar per acre in such countries is enormous.

It was once thought that the hygrometric conditions of the air had much to do with successful cane growing, and that the relative humidity of the air ought to attain a mean of at least 70 degrees for best results. It is well known that cane, in common with all cultivated grasses, revels in excesses of moisture, requiring continuously at least 25 per cent. of the weight of the soil for healthy, vigorous growth. This

amount, even in regions of heaviest rainfall, would sometimes be inadequate but for the excessive humidity in the air which prevents excessive evaporation.

The drier the air and the warmer the temperature and more rapid the growth of cane, the greater will be the evaporation of water through the leaves. For every pound of dry matter produced in the cane, there will be required 400 to 500 pounds of water to be evaporated through its foliage. In a crop of cane of forty-five tons there will be 15 tons of tops and leaves.

According to Prof. Ross, the 45 tons of cane will contain about 11 tons of dry matter, and the 15 tons of tops and leaves about 5 tons, making a total of about 16 tons of dry matter per acre. If each ton of dry matter will require 400 tons of water, there would be evaporated through the foliage alone from an acre in cane, 6,400 tons of water, to say nothing of the amount which would be evaporated from the soil.

An inch of rainfall on an acre is equal to 27,154 gallons, or 113 tons. Therefore, to supply 6,400 tons, an amount required during growth of a 45-ton crop of cane, over 56 inches of rainfall must fall, and that, too, distributed through the growing season. Such a fall, with such a distribution, is rarely ever obtained naturally in any country, but this quantity of water can be supplied by irrigation and at such intervals as best suits the wants of the plant. Hence cane growing by irrigation has given yields surpassing the highest records of the best sugar countries. The presence of humidity in the air deemed heretofore necessary to successful cane growing, was but a means to prevent evaporation and to maintain moisture conditions most suitable to the wants of the cane. In irrigated districts, little or no humidity of the air exists.

In the above, no account is taken of the supply of water furnished by capillary action through the soil from below, which is large and of great value to all growing plants. It may, therefore, be asserted most positively that those countries are best suited to the cane which have, 1st, fertile soils; 2d, necessary conditions of temperature, and 3d, an abundant water supply, either naturally or through irrigation, so that it may be supplied in ample quantities only when needed, and withheld when the cane has attained growth, so that the process of maturation may take place.

Weather Record in Louisiana.

From March 1st, 1886, to January 1st, 1897, an accurate condensed weather record is here given, taken from the books of the Sugar Experiment Station:

**Condensed Weather Record of Sugar Experiment Station from
March 1, 1886, to January 1, 1897.**

MONTH.	Average Temperature, Degrees	Maximum Temperature, Degrees	Minimum Temperature, Degrees.	Rainfall, inches.
1886.				
March	63	80	37	9.12
April	69	87	41	7.32
May	76	93	57	3.59
June	83	97	69	11.50
July	83	95	68	3.25
August	84	96	66	4.18
September	80	91	59	5.24
October	73	87	39	1.00
November	66	75	33	5.55
December	65	79	26	2.75
1887.				
January	57	82	22	3.31
February	65.4	80	30	5.23
March	58.2	81	40	3.27
April	71.7	89	57	2.21
May	78	94	59	6.56
June	84	94	62	10.35
July	84	97	68	7.86
August	82.5	95	69	6.70
September	79	92	56	3.30
October	69.5	86	40	6.39
November	60	80	30	.11
December	54.6	77	30	7.14
Average and total	70.3	87	47	62.43
1888.				
January	56.6	77	30	3.77
February	59.8	76	37	9.80
March	59	78	36	5.79
April	73.4	85	54	.91
May	76.7	92	54	11.77
June	79.8	92	65	8.69
July	82	98	71	5.49
August	81.2	95	70	15.80
September	77.3	89	57	3.29
October	70.6	85	53	3.40
November	62.4	84	34	2.50
December	63.6	71	27	4.12
Average and total	70.2	85	49	75.33

MONTH.	Average Temperature, Degrees.	Maximum Temperature, Degrees.	Minimum Temperature, Degrees.	Rainfall, inches.
1889.				
January	54	71	34	8.30
February	55	75	31	3.21
March	63.6	79	40	2.38
April	72	86	47	3.28
May	78.1	91	48	.76
June	82.3	96	57	9.43
July	85.6	92	68	7.15
August	81	90	66	5.74
September	79.1	91	51	5.30
October	68.1	86	51	.
November	58.9	82	30	.
December	63	80	45	.43
Average and total	70.1	85	47	45.98
1890				
January	61.8	80	32	1.00
February	62.8	81	36	3.10
March	60.7	79.5	27	1.98
April	69.7	84.5	42	3.27
May	74.7	87.5	56	10.71
June	87.8	94	68	4.15
July	81.7	95	69	7.30
August	79.8	92.5	67	7.75
September	76.3	90	56.5	4.56
October	67.45	87	38	4.41
November	61.70	82	39	.87
December	55.30	78	33	3.55
Average and total	69.98	86	47	52.65
1891.				
January	52.3	75	32	5.60
February	63.1	78	32	11.25
March	59.3	78	38	3.36
April	66.1	84	37	.80
May	72	90	52	2.37
June	89.2	96	66	5.84
July	79.6	95	65	5.50
August	80.3	98	57	2.05
September	76.7	95	57	9.79
October	67.1	90	57	1.35
November	56.5	70	29	3.95
December	55.9	75	29	4.42
Average and total	68.2	86	45	56.37

MONTH.	Average Temperature, Degrees.	Maximum Temperature, Degrees.	Minimum Temperature, Degrees.	Rainfall, inches.
1892.				
January	48	72	26.5	7.15
February	58	79	40	4.42
March	58	80	28	11.75
April	70	84	48	4.13
May	74	91	54	6.37
June	80	99	63	8.92
July	81	96	70	7.66
August	81	95	71	5.95
September	78	94	59	1.98
October	71	88	42	5.39
November	59	85	38	3.10
December	54	77	21	
Average and total	67.7	87	46.7	66.82
1893.				
January	49.4	73	28	3.07
February	62.4	78	40	4.16
March	60.2	81	30	4.42
April	71.4	89	47	4.00
May	75.8	93	57	2.90
June	80.9	99	67	7.55
July	83.4	94	71	3.67
August	80.8	92	65	2.99
September	77.4	95	58	6.32
October	65.4	85	42	6.57
November	58.6	80	32	7.50
December	54.9	78	29	2.85
Average and total	68.4	86.5	47.2	56.00
1894.				
January	56.63	77	26	1.14
February	53.21	80	29	13.43
March	62.10	83	32	7.66
April	70.50	88	51	4.52
May	74.96	91	49	2.69
June	78.30	98	63	3.34
July	79.70	99	66	12.51
August	80.66	93	69	7.52
September	78.60	92	59.5	1.80
October	69.00	89	46	.85
November	57.83	81	32	1.06
December	55.10	82	19	2.40
Average and total	68.05	87.75	45.12	58.92

MONTH.	Average Temperature, Degrees.	Maximum Temperature, Degrees.	Minimum Temperature, Degrees.	Rainfall, inches
1895.				
January	50.9	77	26	8.58
February	44.1	73	15	4.47
March	61.3	81	34	3.98
April	66.9	86	46	2.53
May	74.5	90	52	12.15
June	81.3	95	68	11.06
July	82.08	98	71	7.62
August	82.50	98	72	6.99
September	80.46	93	52	2.93
October	87.16	86	47	1.45
November	58.90	82	35	1.36
December	51.10	74	25	5.75
Average and total	68.43	86.08	45.25	68.87
1896.				
January	50.16	77	24	2.94
February	54.41	72	32	3.28
March	60.32	52	37	6.10
April	70.36	87	40	2.63
May	78.26	94	61	1.65
June	80.70	97	65	11.04
July	83.13	97	70	4.44
August	82.93	98	69	3.29
September	77.66	93	53	4.70
October	67.17	92	46	7.48
November	63.11	85	34	3.71
December	55.00	79	31	4.57
Average and total	68.76	87.75	46.8	55.83

In the following table is presented the eleven years in a comparative form, and it may be useful in determining some of the factors which go toward solving the problem of good crop years.

The winter of 1886 was very severe, destroying much of the seed and stubble, the spring was late and cold, and good stands of cane were not obtained until May. The subsequent seasons were fair, and where good stands prevailed the crop was medium.

The winter of 1887 was mild and conducive to excellent seed cane, the spring was moderately dry and warm; follow-

ed by a warm and wet summer, grading into a cool, dry autumn; conditions favorable to heavy tonnage.

The winter of 1888 was fairly propitious, but the spring was excessively wet, preventing the proper cultivation of the cane. The wet weather extended to July, causing a serious postponement or abandonment of the regular "lay-by" of cane. These rains were succeeded by a dry, cool fall, giving us light tonnage, but heavy sugar yield, due more to the low glucose content than excess of sugar in cane.

The year 1889 will always be remembered as the year of drouth. The rainfall for the year was only 46 inches, and this fell mostly in the winter and summer, giving us a spring and fall of unexampled dryness—a dryness which was prolonged into the winter of 1890.

The year 1890 will be memorable for the enormous crop produced. It was ushered in amidst a drouth lapsing from 1889, with mild, fair weather in January and February, giving an early germination and growth to both plant and stubble cane—both to be cut down by an unusual freeze early in March; followed by a propitious spring, with an abundant rainfall in May, preceding enough dry weather in June to permit a careful "lay-by" of the crop. Copious showers, at no time excessive, prevailing through July, August, September and October, which together with an abundance of sunshine and continuance of warm weather, all combined to give us the largest tonnage perhaps ever known in our history. The season was favorable throughout for the growth of cane, and hence the large crop was harvested in a very immature condition. Neither the temperature nor rainfall was excessive, but well distributed throughout the season, extending well into the fall.

The year 1891 was characterized by frequent prolonged drouths—particularly during the growing season. From the 13th of March to 21st of June less than four inches, distributed in small showers, occurred. Besides this, less rain fell in the summer than in any year since the organization of this station. Only 13.49 inches, or six inches less than any previous year. Again, in August there was a large deficiency of rain the entire month and extending well into September, giving a little over two inches. Of the 56 inches, nearly one-half fell in winter and nearly two-thirds in winter and fall, leaving a little less than one-third for the growing crops. The mean annual temperature was the lowest for years. Under such conditions, the crops were light in tonnage and rich in sugar.

The year 1892 was a fair even season for cane—the heat and rains having been fairly well distributed. Irrigation was required and practiced only once, in May, upon both

cane and corn. The summer rains were abundant, and the fall an exceptionally good one for harvesting the crops, though the cane continued to grow until December 27th, when a freeze of much severity killed the standing cane. The crop was very fair in both tonnage and sugar content.

The year 1893 was free from extremes. Both the heat and the rains were fairly well distributed—though the aggregate of the latter during the spring and summer months were considerably below the average fall for these months. The rainfall for the fall months was excessive, yet interfered but little with the harvesting of the crop. Irrigation was practiced once (May 30th). The cane was killed December 3rd and 4th by a frost of 29 degrees F., entirely, on untiled lands; partially on tiled lands. Subsequent weather permitted the harvesting of the crop without much loss. The year was fairly favorable for tonnage and sugar content.

The year 1894 gave a good cane crop. The rainfall was nearly up to the average and fairly well distributed. On July 4th a fall of 3.02 inches of rain occurred in 1 hour and 10 minutes. The spring and summer months favorable to crops. Fall very dry, necessitating irrigation. On December 29th thermometer went down to 19 degrees, killing and splitting the cane, rendering it unfit for sugar making. The year was favorable to tonnage, with a fair sugar content.

The year 1895 was ushered in by one of the coldest spells known to this climate, accompanied with snow 11 inches deep, lasting several days, temperature (Feb. 14th) 15 degrees F., killing orange and olive trees and injuring old stubble. Excessive rainfall in May. On 22d, 23d and 24th the precipitation was 6.66 inches. Season too wet in May and June for good cultivation of crop and too little precipitation in July, August and September for maximum yields. Hence crop in some places small. Over the State only a fair tonnage with good sugar content. Fall very dry, and irrigation used to plant cane and alfalfa. Rainfall for the year above the average.

The year 1896 was only fair for the sugar crop. The spring was comparatively dry. There were deficiencies of rainfall in July, August and September. Fall fairly wet, somewhat delaying grinding. The yearly rainfall was light and not well distributed. The crop was rather under a maximum, but sugar content good.

The following is the comparative weather statement for eleven years:

	Average Temperature.	Maximum Temperature.	Minimum Temperature	Rainfall.
	degrees.	degrees.	degrees.	inches.
1887	70.3	97.	22.	62.43
1888	70.2	98.	27.	75.33
1889	70.1	96.	30.	45.98
1890	69.98	95.	27.	52.65
1891	68.2	98.	29.	56.37
1892	67.7	99.	21.	66.82
1893	68.4	99.	28.	56.00
1894	68.05	99.	19.	58.92
1895	68.43	98.	15.	68.87
1896	68.76	98.	24.	55.83
Spring months, 1886	69.3	93.	37.	20.04
Spring months, 1887	69.3	94.	40.	12.04
Spring months, 1888	69.7	92.	36.	18.47
Spring months, 1889	71.2	91.	40.	6.42
Spring months, 1890	68.4	87.5	27.	15.96
Spring months, 1891	65.8	90.	37.	6.53
Spring months, 1892	67.3	91.	28.	20.30
Spring months, 1893	69.1	93.	30.	11.32
Spring months, 1894	69.19	91.	32.	14.87
Spring months, 1895	67.56	90.	34.	18.66
Spring months, 1896	69.65	94.	37.	10.38
Summer months, 1886	83.3	97.	66.	18.93
Summer months, 1887	83.5	97.	62.	24.91
Summer months, 1888	81.0	98.	65.	29.98
Summer months, 1889	82.9	96.	57.	22.32
Summer months, 1890	83.1	95.	67.	19.20
Summer months, 1891	80.0	98.	57.	13.49
Summer months, 1892	80.6	99.	63.	22.95
Summer months, 1893	81.7	99.	57.	14.21
Summer months, 1894	79.55	99.	63.	23.37
Summer months, 1895	81.96	98.	68.	25.67
Summer months, 1896	82.25	98.	65.	18.77
Fall months, 1886	73.0	87.	33.	11.79
Fall months, 1887	60.5	92.	30.	9.80
Fall months, 1888	70.1	89.	35.	9.19
Fall months, 1889	68.7	91.	34.	5.30
Fall months, 1890	74.5	92.5	38.	9.37
Fall months, 1891	66.8	95.	29.	15.09
Fall months, 1892	69.3	84.	38.	13.32
Fall months, 1893	67.1	95.	32.	20.39
Fall months, 1894	68.14	92.	32.	3.71
Fall months, 1895	68.84	93.	35.	5.74
Fall months, 1896	69.98	93.	34.	15.89
Winter months, 1887	59.	82.	22.	15.68
Winter months, 1888	56.6	77.	27.	17.69
Winter months, 1889	57.3	82.	31.	11.94

	Average Temperature.	Maximum Temperature.	Minimum Temperature.	Rainfall.
	degrees.	degrees.	degrees.	inches.
Winter months, 1890	62.5	81.	45.	4.53
Winter months, 1891	57.1	78.	29.	21.36
Winter months, 1892	53.3	79.	21.	10.25
Winter months, 1893	55.6	78.	28.	10.08
Winter months, 1894	52.99	82.	19.	16.97
Winter months, 1895	48.40	77.	15.	18.80
Winter months, 1896	57.91	79.	24.	10.79

Taking the table and the seasons, we find that a dry, warm winter, followed by a moderately dry spring, and this, in turn, followed by a hot, wet summer, are conditions favorable to maximum growth of cane. It seems, too, that a dry, cool autumn, beginning early in September, is necessary to produce a large sugar content.

After the cane is laid by, frequent showers of considerable intensity appear highly beneficial, and if not supplied, the crop will not reach the maximum tonnage.

CHAPTER VI.

DRAINAGE.

Nowhere on earth is drainage more essential than in the alluvial districts of Louisiana, and while many plantations may be considered well drained, the average planter has not yet fully appreciated the necessity for multiplying open ditches to the extent of forcing his soils to their fullest capacity. This is evidenced by a trip over the State and observing the varying distances between ditches which obtain in different plantations.

Only in very dry seasons can badly drained lands be made to yield large crops. Since these unfortunately occur only at long intervals, the average yields on such lands are far below their natural capacity. On badly drained lands neither fertilizer nor cultivation have their full effects, hence the discordant opinions which frequently prevail among our planters, from the use of the same fertilizer or the same method of cultivation. From the experience of this Station it is almost impossible to be "over-drained," provided the work of draining be intelligently performed. It is well for every planter to study his system of drainage, examine his ditches, see if they be deep enough, wide enough and sufficiently abundant to carry off our heaviest rainfalls and retain the "bottom or ground water" at a constant depth below the surface. Excellent results can be obtained with open ditches, provided they are numerous, deep and wide.

In the lower sugar district these ditches should be at least as close as 100 to 125 feet, and deep enough to hold the bottom water at least three feet below the surface.

The expense and attention annually required for the preservation of open ditches and the loss of land incident to them, together with many other disadvantages would force all of our planters sooner or later to adopt

Tile Drainage,

but for the great first cost, and to the absence of fall in the lands, by which the tiles can clean themselves. Tiles laid with great care on the Sugar Experiment Station, are gradu-

ally filling up with silt, and apprehension is felt that at an early day they will have to be abandoned and a return made to open ditches. There is not a great fall in the canal beyond the station into which the tiles empty, and every heavy rainfall backs the water over the mouths of the discharging tiles, checking the flow from the latter. This may account for the filling of our tiles with silt. This is greatly to be regretted, since the superiority of tiles over open ditches is apparent in every operation of the farm, from the flushing of the land to the harvesting of the crop, the great objection to the former being the large outlay of money required in putting the tile down. It is confidently believed, however, that the decreased cost of subsequent cultivation, the increased area of land and the enhanced acre yields of products, to say nothing of the numerous and continuous little expenses and annoyances incident to open ditches will more than pay the interest on the investment and leave yearly a handsome balance for a sinking fund, which in a short time will liquidate the principal required for their construction.

The results have uniformly shown increased tonnage in all those plats where tiles have been used. This increased tonnage has, however, been attended with a decreased sugar content, a result which was to be expected from the known benefits of tiles. Upon tiled lands canes appear earlier in the spring and is the last to be killed in winter by the frost. This has several times been demonstrated on this station on plats with the same exposure and differing in conditions only in drainage.

Great care is needed in putting down tiles, and only experienced engineers should be entrusted with the work, since if proper grades be not given to the fall of the tile more harm than good may be accomplished. Again, the capacity of tiles of various sizes, as well as an acquaintance with our heaviest rainfalls, must be known so that proper calculations may be made for the selection of tiles sufficiently large to take off our heaviest rainfalls in a given time. It must be remembered that in this climate rainfalls of 5 to 7 inches sometimes occur. Owing to the humidity of our local climate a large part of these rainfalls must be drained off. The character of our soils also prevents rapid downward percolation. Tiles are too small when they will not drain off the rainfall in twenty-four hours after its cessation. Water permitted to evaporate above tiles puddles the surface, closes the drain pores of the soils and temporarily obstructs the efficacy of the tiles.

Tables giving the capacity of different sized tiles are given in nearly all the works on drainage. The amount of water

falling upon an acre may be easily calculated in gallons when the inches of rainfall are observed. It is therefore easy to avoid this error by simply learning the heaviest daily rainfall known to this country, calculating the area to be drained and the amount of water to be carried off, and from the tables take the tiles capable of making this discharge in twenty-four hours.

It is even yet uncertain whether tiled drainage will permit of the entire closure of open ditches and quarter-drains on lands having a uniform fall from the banks of the river back to the swamps. The rows are usually run with the slope of the land and in heavy rainfalls the water rapidly runs down the middle of each row and accumulates at the lower end in ponds which will puddle the soil and prevent downward outlet through the tiles. Hence a quarter-drain is needed to let off this accumulated surface water.

Perhaps running the rows at right angles to the slope of the land and as near level as possible, may correct this apparent difficulty.

Too much emphasis cannot be laid upon the importance of drainage to our sugar lands, and when a planter thinks he is well drained he will probably increase his yields and profits by doubling his ditches and quarter-drains.

CHAPTER VII.

IRRIGATION.

The Louisiana sugar planter of to-day is confronted with low prices and unreliable labor, depleted soils and reduced yields, reciprocity treaties and increased imports, monopolistic trusts and monied combinations, prolonged drouths and injurious rainfalls. He must therefore call to his aid every means which will remove the obstacles to maximum crop production. Next to drainage, irrigation is perhaps the most needed factor in the problem of annual large crops. A full crop is rarely obtained oftener than once in five years, and eighty per cent. of the failures are assignable directly to drouths. Irrigation, therefore, eliminates the great element of chance from our planting operations, and together with good drainage make the planter nearly independent of the freaks and idiosyncrasies of the weather.

From accurately kept meteorological records it is learned that maximum crops of sugar are made in Louisiana after a mild, dry winter, succeeded by a spring with moderate rains, well distributed; in their turn supplanted by abundant showers at close intervals during June, July and August, winding up with decreased rainfall in September, with the remainder of the fall dry and clear. We cannot control the dry and warm winters, but we can mitigate the effects of a wet, cold one by proper drainage, and we can give our crops abundant water in the summer months by irrigation. Whenever we realize that water is the most essential chemical ingredient supplied to our plants and is needed for the transportation of all the other ingredients through the plant, then will provision be made to supply it in needful quantities, when rain is withheld. The amount of water needed by cane plants has already been dwelt upon. The contents of the cells must be kept moist. The protoplasm of each active cell must retain its glutinous semi-liquid condition in order that its function may be properly performed. Decrease the moisture and you increase the consistency of the protoplasm and with it diminish the vital activity of the plant.

A plant must be properly charged with moisture in order to grow freely. Hence, in wet seasons, with an abundance of fertilizers, the sugar cane grows very rapidly, and if the moisture and other conditions favorable to growth be maintained till harvest, it comes to the sugar house low in sugar, since the sugar cells are gorged with a surplus of moisture. Interrupt the growth by dry weather and give the cane a period of repose, and its cells lose the excess of moisture, and the cane gives a juice high in sugar.

Irrigation is sometimes needed in Louisiana for other purposes than supplying the growing crop with water. Many a planter has lost his seed cane from dry rot when a slight irrigation of the soil in which it was windrowed would have saved it. Seed cane has frequently refused to germinate when planted in dry, cloddy soils, for its want of proper moisture, when irrigation would have furnished a superb seed-bed. In many a field, in spring, may be seen the plow and cultivator rolling the obdurate clods to and from the young plants in an honest but fruitless effort to pulverize them, when a mere saturation of them with irrigation water would have caused their disintegration.

There is scarcely a year that irrigation cannot be employed profitably on a plantation.

The Sugar Experiment Station established an irrigation plant in 1891, and since that time has used it successfully over twenty times. Crops in all stages of growth have been irrigated. Freshly fallowed lands have been flooded to bring them into a state of pulverization suitable for the planting of alfalfa and clovers.

Cane rows have been opened and irrigation water run down them, to prepare the soil for the reception of cane.

Both surface and sub-irrigation have been tried; the former on our untiled lands, and the latter on tiled plats, using the tiles as pipes to carry the water, after closing with valves, the main connecting each plat. The tiles are four feet deep, and sub-irrigation through them is a great waste of water, and while large and growing plants with extensive root systems are completely watered, small plants in the elevated rows and clods on the surface are but little affected. Hence sub-irrigation is not always as effective as surface irrigation, nor as general in its application.

The results from irrigation of cane have been uniformly successful and satisfactory, sufficiently so to justify the assertion that the profits of irrigation were very large in tonnage and with no sacrifice of the sugar content of the cane.

In establishing irrigation ditches, the reverse of drainage ditches must be observed. In the latter, the line of lowest

level from the levee to the swamp, is found and followed, while in establishing the main irrigation ditch the backbone, or line of highest elevation, is carefully determined and pursued. This ditch transports the water through the plantation. From this ditch on both sides water may be drawn into the lateral or quarter-drains, following still the lines of highest elevation.

From these laterals, water may be drawn into the lowest parts of the field. Our plan in irrigating was to fill the middles of the rows nearly full, permitting the water to remain all night and drawing it off in early morning through the drainage ditches. By accident, however, it was found that cane would stand a complete inundation for forty-eight hours, with the water at a temperature of 72 degrees, while the maximum temperature recorded in the station's weather bureau was 90 degrees F. No fears should be entertained of injuring the cane by too much water, for a reasonable time, say two days, in applying it, provided that when it is drained off, it is well and quickly done; in other words, the land is well drained.

Water can easily be drawn from the adjacent river, or bayou, by nearly every sugar planter in the State. The erection of a boiler, pump and syphon will be needed to lift it over the levees. Nowhere, possibly, can a systematic irrigation plant be established and maintained at a less cost than in Louisiana, and our very variable seasons demand it as an adjunct to every plantation that aims to make maximum crops every year.

CHAPTER VIII.

SOILS BEST ADAPTED TO CANE.

From what has been already said, those soils which contain the largest fertility, and have a large water-holding capacity, are best adapted to large crops of cane. Requiring so much moisture, the cane, like all the grass family, does best upon clayey or heavy loam soils unless artificially aided by irrigation. Even then the soils must be sufficiently retentive to prevent a too rapid downward percolation of supplied water, or else the profits will be exceeded by the costs of too many irrigations and the washing away of the soluble plant food.

Included in "fertility" is a large amount of humus or vegetable matter which is the controlling factor in determining the amount of fine earth and moisture in a soil. Tropical soil, subject to heavy rainfalls, are almost universally adapted to the growth of sugar cane, since the heavy rains induce a luxuriant growth of vegetation upon such soils, and this vegetation, in its transition into humus, furnishes simultaneously organic acids which decompose the soil particles into very fine earth. Hence such soil, in the course of time, become rich in organic matter and very finely divided earth, the latter supplying the mineral and the former the nitrogenous food, and both (but particularly the humus) retaining that excessive moisture so essential for healthy cane growing. Perhaps the heaviest acre crops of sugar in the world are taken from the soils of the Hawaiian Islands. There are four large islands in this group, whereon sugar is grown in large quantities. Hawaii is a wet island, the cane crop depending wholly upon the natural rainfall. The other three use regular irrigation in the growing of cane. Dr. Walter Maxwell, Director of the Experiment Station at Honolulu, in a recent publication, gives a summary table, showing the mean of the results in the examination of the soils of the four islands, which are based upon nearly one hundred analyses, which is here given:

ISLAND.	Lime, per cent.	Potash, per cent.	Phos. Acid, per cent.	Nitrogen, per cent.
Oahu	.380	.342	.207	.176
Kauai	.418	.309	.187	.227
Maui	.396	.357	.270	.388
Hawaii	.185	.346	.513	.540

With such fertile soils, and with perfect control of the supply of water, no wonder that ten tons of sugar have been made per acre.

CHAPTER IX.

SUGAR SOILS OF LOUISIANA.

Nearly all of the land devoted to sugar cane in this State is of alluvial origin. The soils of the Mississippi valley and its outlying bayous are but the agglomerations of the materials brought down by water from over a score of States and deposited upon the blue clays of the Champlain or Port Hudson Group, through which the river has cut its channel. These materials have been assorted and deposited by running water, hence there are found soils varying from fine sandy loams to stiff clays, often in the same field, showing the varying velocities of the current which transported and deposited them. In a rapidly moving current, soil particles of every size are mechanically carried. Check this current and the coarsest materials are deposited. In fact, as the velocity is decreased, particles of soil, decreasing in size, are deposited until finally, when the waters are stilled, the finest silt and clay are gradually released. All sediment-bearing streams flowing through low plains build up banks in flood periods on either side by the deposition of material, due to the retardation of the velocity of water along their edges. With each subsequent overflow the coarse material would increase near the stream, while across the flood plain, extending from river to the swamps in the rear, would be spread particles decreasing in size till the swamps were reached, where, on account of the stagnation prevailing, the finest clay would be deposited. One should expect, then, the sandiest soils near the river and the stiffest in the swamps. Strictly speaking this is true; but the ever-changing banks of the Mississippi, due to caving and the numerous crevasses occurring since man began the system of leveeing, have so changed the relations of the stream to its banks, and so modified surface appearances as to disguise this general fact and render it subordinate to local conditions.

Allusion has been made to the blue clays through which the Mississippi has cut its channel. Underneath these clays

occur a stratum of gravel and coarse sand. In times of flood, the rapidly moving current frequently washes away these deposits, and when the floods subside and the banks are no longer sustained by hydrostatic pressure, caving occurs, and with it a change in the location of the banks and direction of the river. Crevasses greatly modify the surface soil; small ones having only local effects, while large ones, like the Nita or Belmont, superimpose many millions of cubic feet of sediment, and frequently change the tillable character of entire plantations. As a rule, too, the coarsest material will be found high up the stream, with the silt and clays near its mouth. Hence, as we descend the Mississippi river the soils, generally speaking, become more and more clayey, until we reach the clay mud lumps of the delta proper.

Our soils, then, of the sugar belt lying along the Mississippi river and its numerous bayous, may be considered as varying from silty loams to very stiff clays.

There are also the red and brown lands, varying from sandy loams to loamy clays of the Red river and its outlying bayous, the Teche, the Boeuf, the Cocodrie and Robert, which have been formed by a similar process by the Red river, though drawn from a much more restricted area of country.

The prairie lands west of Franklin, varying in character from black stiff clays to silty loams, are our bluff-lands second-hand, which have been removed from the western bank of the Mississippi river and spread out over the marshes of southwest Louisiana. These bluff lands occur in situ on the eastern bank, running continuously from Baton Rouge to Vicksburg, giving us several parishes in which sugar cane is grown. They are usually silty loams and are also of alluvial origin, though antedating the present Mississippi river. The bluff and prairie lands, and the alluvial deposits of the Red and Mississippi rivers and their bayous, give the soils upon which the sugar cane of Louisiana is grown.

Soils are only disintegrated rocks mixed with vegetable debris and more or less charged with micro-organisms, through whose agency the food for plants are rendered available. It is not only necessary that an abundance of plant food exhibited by chemical analysis be present, but it must be in an available form. The more finely divided the rock particles, the larger the quantity of available food, the greater the surface areas of its particles, and therefore a large increase in surface tension which gives an increased capacity for holding moisture. Therefore the mechanical condition of the soil is frequently of more importance than a chemical analysis. Formerly a soil was regarded as being a mass of inert matter whose ingredients were rendered soluble by the

action of air, water and chemicals. This view has given way to a knowledge recently gained by scientific investigations, that all fertile soils are swarming with microscopic organisms which are essential to the proper elaboration of the food materials in a soil for plant use.

Hence a thorough investigation of a soil involves a chemical analysis, a mechanical separation of its particles, a study of its physical properties, and a microscopic research for its bacterial content.

A chemical analysis will give its contents of silica, iron, alumina, lime, magnesia, potash, soda; phosphoric, sulphuric and carbonic acids; chlorine, nitrogen, etc. The total quantities of each of the above soluble in the selected solvent are given, but no definite method has yet been devised by which a knowledge of the immediate availability of these ingredients may be obtained. Chemical analysis has, however, a high value in the hands of a trained chemist.

The particles of soils vary greatly in size as well as in constitution, and a knowledge of the mechanical formation of a soil frequently throws a flood of light upon its relation to heat and moisture, as well as suggestions upon its cultivation. It has been conveniently agreed that all particles in a soil between 1 and 2 mm.* in diameter shall be called fine gravel; between .5 and 1 mm., coarse sand; between .25 and .5 mm., medium sand; between .1 and .25 mm., fine sand; between .05 and .1 mm., very fine sand; between .01 and .05, silt; between .005 and .01 mm., fine silt, and between .0001 and .005 mm., clay. Such an analysis describes the texture of a soil and determines the crop which should be grown thereon, by comparing the water-carrying capacity of the soil with the water requirements of the crop. To illustrate, the more clayey the soil, the greater its carrying capacity, and the nearer the approach to pure sand, the more droughty it becomes. Grasses, in which sugar cane may be placed as a gigantic specimen, require at least 25 per cent. of moisture continually in the soil for best results, a condition found frequently in clayey bottoms; while some vegetables, as melons, do best on soils carrying only 4 per cent. of water, and hence find congenial environments in our climate on very sandy soils.

Other crops grown in this latitude require intermediate quantities between these two extremes.

It may be remarked, on the other hand, that very large quantities of clay or sand are often equally objectionable, giving excesses of moisture or dryness, both being detrimental to the welfare of bacteria, which are necessary to soil fertility.

*NOTE.—Mm., millimetre=0.393 of an inch.

The conditions necessary for bacteriological existence in our soils are the presence of air, and water, a favorable temperature, an absence of light, the presence of proper chemicals, and inoculation with the bacteria desired.

The bacteria best known, and in which we are mostly interested, are those taking part in nitrification, and are of three distinct types or genera: 1. Those which convert nitrogenous matter into ammonia. 2. Those which convert ammonia into nitrous acid. 3. Those which convert nitrous acid into nitric acid. Each are necessary to the complete transformation of the nitrogenous matter in the soil to nitric acid, the form of nitrogen chiefly available as plant food. Since nitrogen is the most costly ingredient of our fertilizers, estimated at present to be worth 15 cents per pound, it is evident that the farmer or planter should endeavor to maintain such conditions in his fields most favorable to these ferments, and thus enhance his harvests by drawing upon his soils, rather than upon purchased fertilizers.

With these preliminary remarks, let us examine several typical soils of each of the sections of the sugar belt. The following are given from hundreds of analyses made in the laboratories of the stations, and are selected because they represent typical soils and have also been subjected to mechanical analyses, which are given further on. These soils represent the alluvial soils of the upper and lower positions of the cane belt of the Mississippi river, the brown loam and whitish soils of the bluff formation, and the sugar lands of the Red river deposits.

They are from Evan Hall plantation, Messrs. McCall Bros., McCall P. O., Ascension parish; from Home Place, of J. H. Meeker & Bro., Rapides parish, and from the State and Sugar Experiment Stations, Baton Rouge and New Orleans.

TABLE No. 1.—Chemical Analyses of Soils.

LOCALITY,	Insoluble Matter.	Potash.	Soda.	Lime.	Magnesia.	Iron Acid.	Phos. Acid.	Sulph. Acid.	Organic Matters.	Nitrogen.
Evan Hall Plant, Cut 9.....	88.720	.062	.158	.394	.087	1.12	.068	.028	2.96	.097
“ “ “ “ 26.....	83.510	.170	.173	.272	.047	6.620	.137	.038	4.45	.118
“ “ “ “ 31.....	80.800	.133	.143	.545	.044	5.041	.103	.038	.....	.....
“ “ “ “ 37.....	83.680	.162	.142	.313	.025	6.33	.126	.046	4.10	.130
“ “ “ “ 44.....	83.710	.125	.184	.182	.036	5.63	.075	.139	3.91	.120
“ “ “ “ 52.....	79.210	.112	.111	.434	.....	6.99	.075	.037	3.51	.117
Home Place, Meeker Bros., soil from 2d front, 4 acres deep, Rapides parish...	86.516	.233	.081	1.494	.039	6.822	.098	.043	1.90	.060
Ditto, 10 acres deep.....	86.420	.206	.122	2.376	.052	5.256	.092	.031	3.33	.084
Sugar Exp. Station, dark soil.....	62.550	.747	.181	.910	1.361	13.444	.146	.....	6.65	.085
“ “ “ “ light soil.....	70.102	.414	.021	.787	.814	11.23	.161	.019	3.16	.112
State Experiment Station, Baton Rouge, bluff soil.....	90.650	.100	.078	.170	.114	4.225	.064	.036	3.15	.096
Subsoil of same.....	89.79	.164	.054	.163	.160	6.510	.128	.025	2.74	.074
Ditto, white soil.....	87.72	.120	.076	.060	.121	6.67	.112	.021	2.82	.080
Subsoil of same.....	83.00	.180	.123	.120	.085	8.80	.106	.016	4.21	.105

An inspection of the above and many other similar soils would lead to the conclusion that the contents of valuable ingredients in the average soils of the sugar belt would be about as follows: Lime .5, potash .4, phosphoric acid .1, and nitrogen .1 per cent. In an acre to the depth of 12 inches, estimated to weigh 5,000,000 pounds, there would be 25,000 pounds lime, 20,000 pounds potash, and 5,000 pounds each of phosphoric acid and nitrogen. An average cane crop of 25 tons, including tops and fodder, will contain about the following: Lime 20 pounds, potash 60 pounds, phosphoric acid 35 pounds, and nitrogen 75 pounds. Hence there is lime enough for 1250 crops of cane, potash for 333, phosphoric acid for 150, and nitrogen for 70.

There is, therefore, no deficiency of plant food in our average sugar soil, and the aim of every planter should be to extract yearly the maximum amounts, which can be obtained only with proper drainage, supply of water (irrigation) in summer, and proper preparation and cultivation of the soil.

Table No. 2 gives the mechanical analyses of the soils whose chemical analyses have been given. Additional soils characteristic of many localities are also given.

TABLE NO. 2.---Mechanical Analyses of Soils.

LOCALITY.		Fine gravel, .2-1 mm.	Coarse sand, .1-5 mm.	Medium sand, .5-25 mm.	Fine sand, .25-1 mm.	Very fine sand, .1-.05 mm.	Silt, .01-1 mm.	Fine silt, .01-.005 mm.	Clay, .005-.0001 mm.	Heated at 110.	Loss on ignition.
Evan Hall, Cut No. 9.		0.00	0.11	0.14	0.64	47.28	25.66	4.88	13.40	4.96	2.96
" " No. 25.		0.00	0.19	0.34	0.76	22.40	39.88	8.30	19.28	4.42	4.45
" " No. 37.		0.00	0.11	0.23	1.39	33.05	23.58	8.14	24.40	5.00	4.10
" " No. 44.		0.00	0.09	0.28	1.00	22.15	25.93	9.12	31.25	6.27	3.91
" " No. 52.		0.00	0.08	0.28	0.58	23.55	37.73	7.51	22.44	4.32	3.51
Audubon Park (dark soil)		0.082	0.064	0.11	0.62	11.49	19.54	14.94	41.29	6.69	6.50
" " (light soil)		0.00	0.055	0.11	0.71	26.22	34.99	6.95	22.28	4.00	4.64
" " plat VI A.		0.00	0.084	0.58	0.36	37.82	28.04	6.83	20.64	3.30	3.49
" " plat VIII D.		0.00	0.070	0.18	0.78	4.72	19.16	12.68	47.00	7.78	5.61
Home Place, Meeker Bros. (front)		0.00	0.06	0.07	0.22	61.43	26.37	2.08	6.65	1.56	1.90
" " " (back)		0.00	0.05	0.06	0.21	36.41	42.78	4.26	9.06	2.34	3.33
Cheneyville, Rapides parish		0.00	0.00	0.05	0.21	27.69	47.16	5.51	11.65	2.85	3.19
Silty Prairie, Calcasieu		0.78	1.30	0.56	1.89	7.73	64.40	9.68	9.74	1.65	2.15
" " Eunice, La.		2.07	2.50	0.80	2.90	24.64	43.48	5.64	12.48	2.61	2.04
Black Prairie, Lafayette.		0.60	1.00	0.61	0.60	11.56	55.49	8.76	16.03	2.38	3.38
State Experiment Station (bluff soil)		0.01	1.08	0.40	0.55	21.65	55.44	9.45	10.90	0.98	1.58
" " (subsoil)		0.05	0.14	0.31	0.37	15.75	47.28	9.33	21.12	2.41	2.17
" " " (white soil)		0.00	0.09	0.50	0.71	19.99	55.52	8.78	9.74	1.38	2.29
" " " (subsoil)		0.31	0.26	0.31	0.43	17.82	48.69	9.50	17.21	2.58	2.62

From table No. 2 it will be seen that very few of these soils can properly be called sandy. They are loamy silts or silty clays. Their water capacity is great, requiring special attention to drainage in order to reduce it to the amount most favorable to soil ferments. The clayey content of several suggests the propriety of breaking at exactly the right time—neither too wet nor too dry—throwing it into ridges to relieve it of excessive moisture and providing for escape of flood waters.

The Red river soils, particularly the front lands, are largely composed of very fine sand, with small portions of clay, while the bluffs and prairie soils are mainly silt.

Numerous experiments have been made at the Sugar Experiment Station during the past two years to determine the rate of nitrification on the different soils and at different depths, and on soils variously treated.

In every instance nitrification was most abundant at a depth of three to four inches, decreasing in depth until at two feet it was practically naught. In lands in good tilth, or manured with stable manure broadcast, or with a good growth of cow peas, nitrification was rapid and copious. It was more abundant on the ridge of the rows than in the middles. Drainage could almost be measured by the rate of nitrification. In badly drained soils it was almost entirely absent, while high dry ridges gave abundant evidence of the activity of the microbes. An immersion of the soil for a few hours, by a heavy downpour of rain, suspended for two days the process of nitrification. It was more abundant in soils lightly stirred than in those cultivated with the plow.

Soils stirred daily gave increased quantities of nitrogen over those stirred weekly, and more in the latter than in those stirred bi-weekly.

In fact, good drainage and frequent surface cultivations were prime factors in rapid nitrification.

Preparation of Soil.

With this knowledge of our soils we can now proceed to apply the well-established principles of preparation of all crops.

Since these soils are so strongly silty and clayey, and being level, are without natural drainage, it is manifest that they should be placed in a condition of artificial drainage, to insure warmth and necessary conditions of bacterial growth. Every operation should look to the maintenance of these conditions. Hence flat culture is unsuccessful. They should be broken as deeply as possible to admit air, to assist in drying out excessive water, and most important, to give

as large an area as possible for the foraging of the roots of the cane, since experiments have shown that in stiff lands but few roots pass beyond the broken soil. They should be broken as early in the fall as possible, thrown into high ridges and the middles, quarter-drains and ditches well cleaned out, for the quick removal of winter rains.

The spring should find each row in the condition of an ash bank, and the planter should endeavor to keep it so by proper cultivation throughout the season.

We break lands to prevent the natural tendency of all soils to return to rocks, evidenced frequently in the hardpan just beyond the plow. We break land to destroy weeds and grasses and relieve the soil of foulness, preparatory to the growth and sustenance of the cultivated crop.

We break land to control moisture, throwing up in high ridges to relieve excessive moisture and flushing or plowing flat to conserve the winter's rainfall for the summer's crop, on dry soils. If the work of preparation has been properly done, in accordance with the nature of the soil and the demands of climate, subsequent planting and cultivation are simple processes.

If, however, our work has been imperfectly performed, then subsequent cultivation must be directed to the acquirement of tilth, which is simply obtaining the best conditions for the growth of crops.

Tilth, however, should always be obtained, if possible, before planting, and then cultivation would simply be a maintenance of tilth. Unfortunately such a happy condition does not always prevail. From haste, overcropping, bad weather, carelessness, and sometimes from ignorance, furrows are hastily thrown together, seed planted in cloddy soil, ditches shallow and foul. The poor stands thus obtained are cultivated more with a view of getting land in good tilth than to benefit the plant. Again, the crop, after it has reached the age when rapid and shallow culture should be practiced, is, from causes given above, left to contest with grasses and weeds the soil designed solely for it; or perhaps unfavorable seasons may keep away the plows until weeds and grass have taken possession of the land. Then comes the turn plows and hoes, and by heroic efforts they are buried or removed. In either event, the results are the same, the crop has not been improved by such treatment.

Plan Pursued by Our Planters.

The plan usually pursued by our best sugar planters is as follows: Corn planted early and laid by early, and at lay-by sown in cow peas, at the rate of one to three bushels per acre. The corn is gathered early and the vines turned un-

der in August or September, with four to eight-mule plows. The lands are thrown into beds or rows from 5 to 7 feet wide, the middles are broken out with double mould-board plows, the quarter-drains are cleaned to a depth of six inches below middles of the rows, the ditches are maintained at the proper depth. The rows are opened, the cane is planted and covered.

If every detail has been properly attended to the soil in the rows will be maintained throughout our winters in a condition favorable to nitrification and growth. No water should at any time cover the rows even for a short while, and the drainage should be such that none should ever accumulate either in the middles or quarter-drains.

The above plan, if rigidly followed, leaves but little room for improvement in the preparation of our soils for cane. If the subsequent cultivation of the crop was as skilfully and scientifically performed, our acre yields would be greater and our money returns more satisfactory. The fundamental principles underlying successful agriculture everywhere may be expressed in the following: A thorough preparation of the soil, proper fertilization and shallow and rapid cultivation.

CHAPTER X.

VARIETIES OF CANE.

Prior to the inauguration of the Sugar Experiment Station in 1885, the Creole, Otaheite, Purple (or Black Java), Purple Striped (or Ribbon), LaPice, Palfrey, Purple Elephant, and Japanese canes, were the only varieties that had been imported and grown in this State. This assertion is based upon an extended investigation by the writer to obtain all available data upon this subject. If any other variety had been introduced prior to this date, the writer is without any information thereto. In 1886, through the courtesy of Hon. Norman J. Coleman, then Secretary of Agriculture for the United States, the Hon. Thos. Bayard, Secretary of State, instructed the United States Consuls in sugar countries to collect and send to the Sugar Experiment Station samples of all varieties of sugar cane obtainable. Accordingly there were received in a few months thereafter samples from the following Consuls: Ramon O. Williams, Havana; W. F. Fuqua, Livingston, Gautemala; ———— Antigua; ———— Jamaica; ———— St. Domingo; ————, Guadeloupe; Moses H. Sawyer, Trinidad; E. W. Thompson, Hayti; and J. H. Putnam, Hawaii. Also a number of samples per steamer Baraconta, of New York, and forwarded through Tyce & Lynch, brokers, of New York, from an unknown source were received. There were fifty-five samples in all. Some of them were in excellent order, and were easily propagated; others in execrable condition—in fact, every eye dead. These samples were received with names frequently purely local or descriptive of color only, giving no indication of origin. A few were intelligently named. Those sent from the experimental gardens of Dr. Alvarez Reynosa, of Cuba, through Hon. R. O. Williams, from Mr. W. G. Irwin, through Hon. J. H. Putnam, were intelligently labeled and described. Dr. Reynosa, whose death was so deeply lamented a few years since by the sugar planters of Cuba, was recognized as a high authority on all matters pertaining to sugar cane. His letter, therefore, relative to the varieties cultivated in Cuba, and the cane suited

to the needs of Louisiana, as well as a description of the canes sent, is inserted here as valuable evidence.

The letter of Mr. Irwin, also inserted, is a valuable description of the varieties sent, particularly of those indigenous to the Hawaiian Islands.

Extracts from the letter of Hon Moses H. Sawyer, of Trinidad, showing varieties cultivated on that island, are also given:

Experimental Field of Dr. Alvarez Reynosa.

1. Variety of canes cultivated in the island of Cuba.

The only canes cultivated on a large scale are those of Otaheite, known as the white and crystalline (*blanca* or *crystallina*).

The white cane is planted in virgin soil, and the crystalline in all other lands.

At first, Creole cane (*cana criollo*) was cultivated in Cuba to make sugar, and its planting was continued afterwards for eating. But for several years past it has not even been preserved for this purpose, and that now sold in the market for eating is the white cane of Otaheite.

The purple and yellow ribbon canes (*cana de cintas morada y amarilla*) were formerly much cultivated here, but were afterwards abandoned, because it was discovered that in dry and not very fertile lands they yielded little juice and were very woody. Nevertheless, these canes when well cultivated are of excellent qualities. Green ribbon cane of the same variety was also cultivated, but it was abandoned on account of being too delicate.

Many varieties of cane have been introduced in Cuba from Porto Rico, Jamaica, Trinidad, and Mauritius, but of these little remain, none of them having been cultivated on a large scale. The elephant cane (*cana elephante*) was somewhat cultivated, but afterwards abandoned because of its brittleness, and not ripening well, being besides too thick to grind it with regularity in the sugar mill. Many persons have uprooted it.

The crystalline cane in its normal state is of green apple color, but gives many varieties according to soil, exposure, methods of cultivation, or atmospheric influences. The most notable variations of this cane are that of acquiring a peculiar yellow color in certain soils, which makes it resemble the white cane of Otaheite; and another variation is that taking a more or less purple color, which makes it resemble other canes of different colors or shades, above all that of the purple ribbon cane (*cana de cinta morada*). Nevertheless, those canes, notwithstanding their variations, recover their genuine original character if planted in proper lands.

The number of different varieties of cane supposed to, do not exist; but their variations are numerous.

2. Cane best adapted for cultivation in Louisiana:

The canes that I consider best for this purpose, owing to their great precocity for ratooning, are those called "Cavengeri," "Portii," "Loucier," "Bambu" and "Black Cane from Java" (Negra de Java). I do not send the latter because I know it exists in great quantity in Louisiana and that it is being experimented upon.

A. The "Cavengerie" comes from Mauritius; it grows rapidly, ratoons, and matures extremely well. In order that this cane may be fully appreciated, I will say that I cut 30 canes, leaving numerous ratoons. From these thirty canes I separated three useless ones, and the other 27 are put up in a package well prepared. It will be noticed that these canes have grown from only one eye (*una sola yema*) which was put in the ground on the 1st of October, 1885. The 27 canes mentioned weigh 186 pounds.

B. Is "Portii" cane from the Mauritius Island; it was highly praised by the manager of the botanical garden when he sent it here. In effect it is an admirable cane. It grows rapidly, ratoons well and its juice weighs more than 12 degrees Baume. One bunch grown from a single root gave me 28 beautiful canes, weighing 233 pounds. This bunch of canes was also produced from one single eye. Of these I send you five canes weighing 59 pounds.

C. Is the "Loucier" cane from Mauritius, and possesses the same excellent qualities. This bunch gave me 34 canes weighing 188 pounds. Of these I send five canes weighing 41 pounds.

D. Is the "Bambu" cane. It came from Mauritius. In my opinion this cane grows and ratoons faster than any other. Nevertheless, I do not dare to give it preference over the others above mentioned, until after it shall have been experimented upon, for the reason that suckers are often developed, forming many upper sprouts which tend to diminish the yield of sugar.

Should you desire further details respecting the cultivation of cane and the manufacture of sugar, I shall take great pleasure in furnishing them.

I have the honor to be your obedient servant,

DR. ALVAREZ REYNOSA.

Havana, April 14, 1887.

Extract from letter of U. S. Consul Moses H. Sawyer, Trinidad, British West Indies:

"There are six varieties, viz.: Otaheite, White Transparent, Green Rose Ribbon, Red Giant Scarlet, Congo and Bourbon,

and one other are generally planted on this island. Of all the many kinds that have been tried none others have done well and only two of these are generally planted. Otaheite is the king cane of this island and Bourbon comes next. Indeed they are much alike.

"Planters generally plough up for Otaheite once in ten or twelve years, but in good soil this extraordinary cane has ratooned here successfully for twenty-three years. The Transparent, Giant Scarlet and Congo, are hardy, and the Rose Ribbon grows straight up, which entice the planter to plant them in some quarters; but the great cane fields of Trinidad are mostly covered with Otaheite and Bourbon. It should be remembered that Trinidad is drenched in profuse rains for two-thirds of the year, making the soil very wet, which is not the case in Louisiana; so that the canes which do so well in Trinidad might not do well in Louisiana, or vice versa."

The following letter to Consul J. H. Putnam, from Mr. W. G. Irwin, of Spreckles Company, who undertook the task of collection, describes the varieties sent:

Honolulu, H. I., August 1, 1887.

SIR: In accordance with your request we have obtained from one of our plantations thirteen varieties of sugar cane. The canes are carefully packed and will go forward per steamship Australia, to-morrow.

The package labeled No. 12 contains four varieties of cane imported by us from Queensland, Australia, viz.:

Altamatie, red, with faint dark stripes; Rose Bamboo, pinkish yellow; Yellow Caledonia, pale yellow; Elephant, purple, with pale green stripes.

These four canes do very well with us, more especially the first mentioned. The canes labeled Manulete, Uwala, Ohia, Akiolo, Honuaula, and Papaa, are indigenous to these islands. These canes, on lands situated at any altitude between 1,550 and 2,000 feet, are, from the fact of their being exceedingly hardy, the favorite varieties of our planters for such lands. The two packages labeled respectively Kanio and Ainakea, came originally from Mauritius, where they are known as the light and dark Bourbon canes. These two canes yield well on our high lands. Lahaina cane, No. 11, was brought here by Capt. Pardon Edwards, from the Marquesas Islands, and was first planted at Lahaina, whence its name. This cane is preferable to all others on lands near the sea level to an altitude of 1,500 feet. Its introduction into this kingdom has increased the yield of sugar at least 50 per cent. In consequence of its heavy stooling, this cane should be planted not less than six feet between the

hills. Kokea, No. 13, does fairly well on side hills and dry lands, but is not a favorite.

We are, sir, yours truly,

WM. G. IRWIN & CO.

In 1889, the station received from the Botanical Gardens of Jamaica, through its courteous director, thirty-five varieties.

In 1890, a box of varieties long delayed en route, was received from Java. It was sent by an enthusiastic planter who was anxious to receive in exchange our varieties to test their value in resisting the "sereh" disease so prevalent in that island. Several single stalks have also at sundry times been received from friends interested in sugar. These importations, together with collections of those varieties imported prior to 1885, make up the "garden of sugar cane varieties," which has been cultivated for several years with the hope that some variety would be found which would be better adapted to our wants than those now cultivated in our State. Up to date our results have not been satisfactory. Cane is a plant which yields slowly to its environments. It requires a long time and considerable patience to acclimate it. The inherited characteristics of tropical tendencies so unsuitable to our short seasons, are but slowly modified by cultivation in our climate. There is, however, a slow but gradual change in nearly every variety with each year's cultivation, and a few promise hope of ultimate benefit to our industry. But the acclimation of old varieties, with the view of obtaining those best suited to our wants, has been entirely superseded by the introduction of

Seedlings.

Mention has been made elsewhere of the discovery by Messrs. Harrison & Bovell, of Barbados, of the fertility of cane seed, hitherto believed to be universally unfertile. In 1890 a package of seed was received from these gentlemen and every effort made to germinate them, without success. Another and larger package was received later from the Fiji Islands and fresh attempts made to germinate them, but again with negative results. In imitation of the manner adopted by the above named gentlemen to obtain true seed, the station planted thirty varieties from all parts of the world in the large horticultural hall, hoping that in the course of time all would flower and that the pollen from some might fertilize the ovaries of the other and produce true seed. They were cultivated, watered, and otherwise cared for, with regularity and intelligence. Some of the varieties attained an immense growth, measuring over 20 feet

in length for the mill, and several inches in diameter, containing over 20 per cent. of sugar. All grew well. At the end of the second year no sign of arrowing was visible. Many of the canes were penetrating the glass roof, others were so heavy as to fall from their own weight, despite all efforts to scaffold them up. Accordingly in the spring of the third year they were cut down and all attempts to grow our own seed abandoned. In 1893, just as we were recovering from sore disappointment in our failure to secure either plants from seed or seed from plants, the station received from the Royal Agricultural Society of British Guiana, twenty-one of the most promising of the new seedlings originating at Barbados.

The seedlings from cane seed vary very greatly in almost every respect, size, color, sugar content, habits of growth, etc. Out of 500 young seedlings, perhaps only a very limited number will prove, upon investigation, worthy of further propagation. This property of variation common to nearly all plants, is excessively great in sugar cane, and hope was entertained that through this property and by careful selection, a cane may be ultimately be obtained which will be rich in sugar and at the same time give a large tonnage—the goal of every sugar planter's ambition. For the first time in the history of our cane culture, such an opportunity is presented through this property of variation in seedlings. Heretofore any marked change in varieties came from accidental bud variation, which occurred at rare intervals and were often lost by virtue of the absence of a trained and intelligent eye to detect and utilize it. By selecting at maturity from a large number of seedlings those plants whose vigor, size, and sugar content, or some other desirable property, were peculiarly marked, and propagating them, over 500 new varieties of cane have thus been introduced. From this large number, further selection is being made annually, and those superior to the rest have been generously distributed throughout the sugar world in order to test them under varying conditions. Should concurrent testimony be obtained from many sources, the cane will be named and largely propagated. At present these seedlings have only been numbered from 1 to 500; a few receiving local names.

The following: *XLI, LXI, LXIX, LXXIV, XCV, *CIII, *CIX, *CXV, *CXVI, CXVII, CXXIV, CXXVIII, *CXXX, *CXXXII, CXXXV, *CCCLXIV, CCCLXXVI, *CCCXCII, *CCCXCVII, and *CCCCII, were received, as remarked above, from the Royal Agricultural Society of Demarara. These have been cultivated to maturity for two years and been tested, both for sugar and tonnage. Over one-half

* Discarded.

of them (12) have been dropped as unworthy of further trial here. Nos. LXXIV and XCV are very rich in sugar, with good sized stalks, and stubble well. They have accordingly been distributed to many planters and have been planted on a large scale so as to secure enough of each kind for sugar house work this year.

Last spring there were received from the Botanical Garden of Jamaica the following varieties, which have succeeded admirably there, viz.: CCCXLV, CCLXIX, CVIII, CII, and XXXXII.

These have not yet reached maturity. The present year enough canes will be secured to give them the necessary preliminary tests.

Of the above seedlings, Nos. LXXIV and XCV have both been found of excellent quality by a number of experiments in different sugar lands.

Canes From Bud Variation.

As an illustration of bud variation, eight years ago some stalks of cane, partly white and partly purple, were selected from the field of Soniat Bros., Tchoupitoulas plantation. They were called by them bastard canes. These stalks were taken and planted as follows: First row, the entire stalk; second row, the white joints of each stalk; third row, the colored joints of each stalk. At the end of the season four distinct canes as far as color could direct us, were obtained. Types of the four new varieties were selected and separately planted, and the next year were found to be nearly pure. Selection and separate plantings have been made each year since. These canes have been named as follows: First, a white cane, No. 29, Soniat, after the owners of the plantation; second, a light striped, No. 59, Nicholls, after the then Governor of our State; third, a light purple cane, No. 64, Bird, after the then Commissioner of Agriculture; fourth, a dark striped, No. 65, Garig, after the other member of the Board of Agriculture. The yield and analyses of these canes have been annually made. They, except the white, are entirely different from any other cane in our collection.

They are now permanent canes in our collection, and with the exception of the striped varieties, which have the tendency of all ribbon canes to vary under cultivation, are fairly permanent in their typical characteristic, viz, color. Their sugar contents are fully equal to those of our home ribbon and purple canes, over which they have as yet no pronounced excellencies. They are cultivated as evidences of bud variation.

Description of Varieties.

The nomenclature of the varieties of cane is execrable. No sooner is a cane received in a country than it is given a local name, either that of the introducer, or the country from which it was directly imported. This is especially true in this State, where we have the Otaheite cane, the Japanese cane, the Palfrey cane, the La Pice cane etc. The canes introduced and thus named are frequently identical with those known in other countries by old and well established names. Frequently importers ignore old names and the countries from which they come and call them by some descriptive property, more frequently color, e. g., green, yellow, yellow striped, red ribbon, etc. Several of the consuls in sending canes to the station, mentioned only local names or color and omitted entirely the history of the canes sent. Ever since the reception of this large number of varieties, the station has been making earnest and persistent efforts to establish the identity of many of its varieties with the prominent ones of old sugar countries, as well as seeking the original home of each one, but so far very little success has been attained. It is difficult to compare canes and eliminate individual differences even when grown on the same soil and under the same conditions. It is therefore almost impossible to decide identities in varieties when grown under such diametrically opposite circumstances as exist in Louisiana and a tropical island, e. g., Cuba. There is, however, a growing demand on the part of those scientifically cultivating cane, to have all this confusion of names eliminated, and a movement is on foot looking to a solution of this perplexing problem. It can only be done by interchanging freely all the known varieties and have them all cultivated under exactly the same environments. Could this be done at all of the botanical gardens and experiment stations within the sugar districts, it would not only afford numerous comparisons of the same varieties under varied conditions, but would throw perhaps a flood of light upon the important question of differentiation under changed environments of the numerous varieties under test.

This station has accordingly, after consultation with those similarly interested in other countries, sent samples of all its varieties to Hawaii, Australia and Demarara, with a view of comparing them with the varieties of those countries and establishing synonymous canes. It will also gladly exchange with any botanical garden or experiment station, the numerous varieties under cultivation here.

By an adoption of the above suggestion, it is believed

that in a few years valuable information to general cane culture would be obtained.

Before describing the numerous varieties under cultivation at this station, it is well to put on record the testimony relative to the introduction of those canes found in Louisiana before 1885.

As has been already stated in the "History of Cane in Louisiana," the Jesuits of Leogane sent from St. Domingo, in 1757, the first cane ever introduced into this State. It was the Malabar or Bengal variety, subsequently known all over the world as Creole cane. It was with this cane that Etienne De Bore made the first crop of sugar in this State.

The Otaheite was introduced from the same island (St. Domingo) about the year 1797. From these varieties all the sugar of Louisiana was made until 1825, when Mr. John J. Coiron, of St. Bernard parish, imported a sloop-load of ribbon canes from Mr. King, of St. Simon Island, near Savannah, Ga., and planted them upon the St. Sophie plantation. A detailed account of this importation is given in the "History of Sugar Cane in Louisiana" from the pen of Mr. J. B. Avequin, long a recognized authority on sugar in this State, and the discoverer of the existence of cerosin on the stalks of the sugar cane. From this importation came both the ribbon and purple canes of this State.

During the administration of Mr. LeDuc as the national Commissioner of Agriculture, he had imported into this State the Japanese or Zwinga variety of cane. This is a very hardy variety, withstanding very low temperatures and great neglect in cultivation. It is a woody, hard cane, deficient in juice, and therefore gives a low extraction with pressure. Its fibre is high and sugar content only fair. The stalks are small but numerous and difficult to prepare properly for the sugar house, on account of its dry fodder adhering closely to the stalk. It ratoons or stubbles well, and for higher latitudes is a most excellent substitute for sorghum in syrup making. Its juice is very easy to work in the sugar house. I have dwelt upon the qualities of this variety since it may be possible to utilize it profitably in North Louisiana, Arkansas, Mississippi, Alabama, and Georgia, where the other varieties of cane would not succeed.

Mr. Duchamp imported the Purple Elephant in 1875, and Mr. Palfrey, of St. Mary, introduced about the same time the cane which bears his name, which is doubtless of the Bourbon type.

The following courteous letter from Mr. Burgundy La Pice explains the origin of the La Pice cane, also called "Panachee," "Beltran" and "LeSassier." It is identical, as

will be seen elsewhere, with the Crystallina and Light Java, Hope and Tibboo Merd, etc., received by this station.

Lauderdale Plantation.

St. James Parish, October 20, 1891.

The cane is called La Pice. My father, P. M. La Pice, in 1872, at the age of 75, went to Java and imported several varieties of cane, among which is the cane that bears his name, called in its own country "Canne Panachee," because it tasseled very soon. When this cane first arrived, it was of a bright yellow color, with a very soft rind. At first it was very delicate and could stand no cold. On account of the beautiful quality of sugar and molasses made from this cane I would not give it up, and I feel that it has now become thoroughly acclimated and stands the cold as well as any cane. I am so much pleased with the results of this cane that I am abandoning the red cane for it. It has changed color considerably and is now greenish yellow; the rind, too, has become much thicker. I always get more yield per ton and better quality of sugar and molasses when I grind a cut of this cane. The fancy sugars and molasses of Westfield and Annalese are made from this cane.

BURGUNDY LA PICE.

The station, by continued cultivation, has been enabled to reduce greatly the number of varieties which came to it from all parts of the world under purely local names, by proving the identity of many of them.

It is curious to watch the changes wrought in a foreign variety by cultivation under new conditions. The station has provisionally divided all varieties into classes and groups.

First Class---White, Green or Yellow Canes.

GROUP I.

- No. 1, Panachee, from Mr. R. Beltran, New Orleans.
- No. 2, La Pice, from Mr. Burgundy La Pice, St. James.
- No. 3, LeSassier, from Mr. Henry LeSassier, New Orleans.
- No. 4, Tibboo Merd, from Manilla Islands.
- No. 5, Bourbon, from Trinidad.
- No. 6, Crystallina, from Dr. Alvarez Reynosa, Cuba.
- No. 7, Green, from Cuba.
- No. 8, Light Java, from Jamaica Botanical Gardens.
- No. 9, Hope, from Jamaica Botanical Gardens.

All of above are identical, and the imported canes have passed through the same metamorphosis described by Mr. La Pice. They are all excellent canes and worthy of extension among planters, especially among those who continue to make choice syrups and open kettle molasses. In

Louisiana they should all be known as the La Pice Cane, in honor of the introducer, though Light Java would better indicate its probable original habitat.

GROUP II.

No. 10, Yellow, from Cuba.

No. 11, Blanca de Otaheite, from Dr. A. Reynosa, Cuba.

No. 12, Loucier or Lousier, from Dr. A. Reynosa, Cuba.

The Otaheite is extensively cultivated in the West Indies, and the Loucier on the islands of Mauritius and Reunion. It is difficult to find a difference between them in our soil. They are fairly good canes, ratoon well, but juices are high in solids not sugar, and objectionable to work in sugar house. The leaves are covered with little prickles which enter the flesh quite easily and sometimes produce painful sores. They all came originally from the Island of Tahiti, or Madagascar, and to indicate their origin they should be called "White Tahiti." They are as yet of little value in this country.

GROUP III.

No. 13, Portier, from Dr. A. Reynosa, Cuba.

No. 14, Lahaina, from Hawaii.

No. 15, Keni-Keni, from Jamaica Botanical Gardens.

It is said that the last got its name from the retail vendors of stalks of the Lahaina cane in the streets of Honolulu, so many stalks for Keni-Keni, which is the Kanaka for ten cents.

The above are unquestionably the same cane. They are the last to come up in the spring, ratoon or stubble very imperfectly, rarely giving even one-fourth of a stand, but grow very rapidly when once up. They are large canes, with very fair sugar content, and may ultimately, by acclimation, do well as plant cane, but promise nothing as stubble, and at present are unworthy of cultivation. They came originally from Marquesas Islands, and were introduced by Capt. Pardon Edwards into the Island Lahaina, of Hawaiian group, whence the name. This cane has added largely to the output of sugar in these islands, where it is now almost exclusively cultivated. See letter of Mr. W. G. Irwin elsewhere.

GROUP IV.

No. 16, China, from Jamaica Botanical Gardens.

No. 17, Green Elephant, from Jamaica Botanical Gardens.

These are closely allied to Group III, but differ essentially in habits of growth and ratooning. They are very large, tapering canes, low in fibre and rich in juice of a low sugar

content and purity; unworthy of cultivation. Their origin is unknown, but is presumed to be Cochin China.

GROUP V.

No. 18, Rose Bamboo, from Hawaii.

No. 19, Salangore, from Jamaica Botanical Gardens.

No. 20, Vulu Vulu, from Jamaica Botanical Gardens.

These canes are not identical. In fact, they are distinctly unlike, but have one common characteristic, viz: parallel narrow cracks, or streaks, of a brownish color, upon the maturer joints of the stalk.

The Rose Bamboo is a fine, large, erect cane, withstanding storms which prostrate completely our home varieties. Eight selected stalks of this cane, taken from a pile at the sugar house of this station, weighed 64 pounds. It is low in sugar, rarely giving as high as 10 per cent. here. At maturity the immense leaves fall off of their own weight, leaving a large erect stalk of a rose color. Salangore and Vulu Vulu are but faintly streaked, and of a dirty greenish color. They are all long jointed, with rather enlarged internodes. They are cultivated extensively in the Straits Settlements, and doubtless originated somewhere in Southern Asia. Wray says the Salangore is the finest variety in the world.

GROUP VI.

No. 21, Pupuha, from Hawaii.

No. 22, Kokea, from Hawaii.

They are both natives of Hawaii, are green in color, with faint and narrow pink stripes upon matured joints. They are devoid of prickles and cerosin, are erect, large, unique canes, rich in sugar and fibre, low in glucose, but quite high in solids not sugar, which continuous cultivation has not yet reduced to a point to justify extensive adoption. They are among the most promising of all varieties. They stubble well and give heavy tonnage.

GROUP VII.

No. 23, Uwala, from Hawaii.

No. 24, Lakoua, from Jamaica Botanical Gardens.

Uwala is a native of Hawaii, and is a beautiful, large green cane, with black spots just above the nodes, turning red at maturity. Its pith is often highly discolored, a property common among all the Hawaiian canes. It is very low in sugar and high in glucose, and solids not sugar. It is of no value whatever, though fine to look upon.

Lakoua is a large, green cane, of better quality than Uwala, but not yet of sufficient merit for commendation.

Its origin is unknown, but it has strong resemblance to the Hawaiian canes.

GROUP VIII.

No. 25, Cuban, from Jamaica Botanical Gardens.

No. 26, Sacuri, from Jamaica Botanical Gardens.

Both are clean, smooth, green canes, of under size, rich in sugar, but low in tonnage. They are both lacking in vigor during growth and size of stalk. They do not stubble well. If vigor of growth and size of stalk could be obtained, they would be very desirable canes, since their sugar content is large.

No knowledge of their original home.

GROUP IX.

No. 27, Yellow Caledonia, from Hawaii.

A stout, clean, short green cane, much larger at the base than summit. Under glass in Horticultural Hall, gave a very large stalk, 20 feet long, with 20 per cent of sugar. In the open field a failure with us. It is a native of New Caledonia.

GROUP X.

No. 28, Creole cane, introduced by Jesuits, 1757.

It is a short, very yellow cane, still cultivated in some gardens for eating. It is of no value for the sugar house. It came originally from Malabar or Bengal.

GROUP XI.

No. 29, Japanese, or Zwinga, from Japan.

Introduced by Commissioner LeDuc. It is "sui generis," and may possibly be a different species of cane. It is extremely hardy, enormously productive under good cultivation, exceedingly woody, difficult to crush, and of a moderate sugar content. Proper cultivation might eliminate some of the objectionable qualities.

Its origin is unknown, as no mention of this variety occurs in any writings on sugar cane, and is perhaps not cultivated elsewhere than in Japan.

GROUP XII.

No. 30, Bamboo, from Dr. A. Reynosa, Cuba.

A peculiar cane with enlarged nodes (hence its name), and prominent eyes, prone to develop into suckers with excessive moisture. It tillers and ratoons splendidly, and has an immense leaf development, but is low in sugar. As yet it is unworthy of cultivation.

It is a native of Bengal, being there called by the natives "Kulloa." It is said to flower, or arrow, very freely.

Second Class---Striped Canes.

GROUP I.

No. 31, Malay, from Jamaica Botanical Gardens.

No. 32, Brisbane, from Jamaica Botanical Gardens.

No. 33, Green Rose Ribbon, from Jamaica Botanical Gardens.

These canes are apparently identical, and of no industrial value. They are beautifully striped with green and rose stripes. In Mauritius they are classed as canes of first merit. They probably originated in Southern Asia.

GROUP II.

No. 34, Red Ribbon, from Jamaica Botanical Gardens.

No. 35, Mexican Striped, from Mexico.

No. 36, Batavian, from Java.

No. 37, Home Ribbon, imported, 1825, by Mr. Coiron.

They are identical. After years of growing them here, one variety can not be told from the other. The Red Ribbon and Batavian Striped are being extensively cultivated, to test whether they will ultimately be an improvement over the Home Ribbon, now cultivated in this climate for nearly seventy-five years.

They came originally from Tahiti, and are usually known as the Otaheite Ribbon cane. They flower very freely. They are purple striped, upon a yellowish background.

GROUP III.

No. 38, Tsimbic, from Jamaica Botanical Gardens.

No. 39, Ysaquia, from Jamaica Botanical Gardens.

No. 40, Vituahaula, from Jamaica Botanical Gardens.

No. 41, Horne, from Jamaica Botanical Gardens.

A very unpromising group, not clearly allied, though possessing the common characteristics of a red stripe, more or less broad, on a yellow background.

Ysaquia has in addition similar streaks possessed by Group V, Class I, and Horne somewhat resembles Group VI, of same class. We have no positive knowledge of their original home, except the Tsimbic, which is a native of New Caledonia.

GROUP IV.

No. 42, Ainakea, from Hawaii.

No. 43, Kainio, from Hawaii.

No. 44, Akilolo Light Striped, from Hawaii.

A peculiar group, with common properties of dark, sometimes variegated, foliage, closely appressed to the stalks; large, straight, soft canes of delicately tinted stripes. Aina-

kea, bright yellow stripe on a deep green background, and the other two red on a similar background.

According to Messrs. Irwin, Kainio and Ainakea are from Mauritius, where they are known as the light and dark Bourbon canes, and it is probable they were introduced there from New Caledonia. Akilolo Light Striped is probably a native of Hawaii.

GROUP V.

No. 44, Akilolo, Dark Striped, Hawaii.

No. 45, Manulete, from Hawaii.

Are both of dark foliage, with a wide purple stripe upon a light purple background. They seem to be identical; are large, soft canes, beautiful to look upon, with dark-green leaves, with mid rib quite red, closely appressed to the stalks. Of little value. They are natives of Hawaii.

GROUP VI.

No. 46, Cavengerie, or Scavengerie, from Dr. A. Reynosa, Cuba.

No. 47, Altamattie, from Hawaii.

No. 48, Po-a-ole, from Jamaica Botanical Gardens.

These are, in appearance, magnificent large red canes, with faint black stripes. Erect, long jointed, soft and vigorous. As much as sixty-four tons per acre has been harvested on this station. They revel in rich soils, with an abundance of rain. Could a fair content of sugar be coaxed into them, this variety (for they are all identical) would be one of the most desirable in our collection. They came from New Caledonia originally.

Third Class---Solid Colors Other Than Class I.

GROUP I.

No. 49, Norman, from Jamaica Botanical Gardens.

No. 50, Grand Savanne, from Jamaica Botanical Gardens.

No. 51, Naga, from Jamaica Botanical Gardens.

Are unlike canes of same type. They are small, vigorous canes, and are said to be valuable for high dry latitudes. They are unsuited to our industry. They more nearly resemble the Japanese variety than any other that we have, yet they fail by a long measure from approaching the peculiar characteristics of this unique variety.

Their origin is unknown, though their peculiarities point to some of the Pacific islands as their habitat.

GROUP H.

No. 52, Black Java, from Java.

Identical with our purple cane, and is so called in contradistinction to White Java. Separate cultivation from our

purple cane has been discontinued. It is undoubtedly a bud variation of the Ribbon cane, and therefore came originally from Tahiti.

GROUP III.

No. 53, Brekeret, from Jamaica Botanical Gardens.

No. 54, Marabal, from Jamaica Botanical Gardens.

Are so nearly identical that doubts are entertained whether the former has not been sent through mistake. They are rich purple canes with enlarged internodes, very large and attractive stalks; very soft, with a yellowish red pith; ratoon well. They are attractive in every way, save sugar content and abundance of prickles on leaf sheaths.

They evidently came from south of Asia.

GROUP IV.

No. 55, Purple Elephant, from Ed. Drouet, New Orleans.

Is unlike any cane in the collection. It was introduced by Mr. Eugene A. Duchamp, of St. Martinsville, in 1875. It is very brittle, breaking at every joint when subjected to mill pressure, making it difficult to grind. It is an enormous cane, very soft, and cultivated only as a curiosity. It is a native of Cochin, China.

GROUP V.

No. 56, Ohia, from Hawaii.

No. 57, Honuaula, from Hawaii.

No. 58, Papaa, from Hawaii.

No. 59, Cuapa, from Jamaica Botanical Gardens.

No. 60, Liguanea, from Jamaica Botanical Gardens.

These are clean, claret-colored or black canes, with peculiar ornamental foliage closely appressed to stalk. The first three seem to be identical and are natives of Hawaii. Cuapa is smaller, of lighter foliage and almost black (without luster) in color. It yields an immense tonnage. It is short-jointed and moderately rich in sugar, but high in non-sugars.

Liguanea is a short, stout, cane of moderate habits; similar in color to Cuapa.

It is probable that both Cuapa and Liguanea are of Polynesian origin.

CHAPTER XI.

COMPARATIVE MERITS OF OUR HOME CANES--- THE STRIPED AND THE PURPLE.

Elsewhere the origin of our red or purple ribbon cane is given. Quoting from Mr. J. B. Avequin, it is pronounced a native of Java and was introduced from Batavia to the West India Islands about the middle of the last century. Mr. King, of Savannah, Ga., brought a schooner load of it from the Island of St. Eustatius and planted it on St. Simon's Island, near the mouth of the Savannah river, in 1814. Mr. John J. Coiron brought a dozen or more stalks from Savannah in 1817 and planted them in his garden at Terre aux Bœufs. He followed this small importation with a sloop load in 1825, and planted them on the St. Sophie plantation below New Orleans. This is the origin of our striped cane.

The violet or purple is asserted to be a degenerate variety of the striped. This assertion, strongly combatted by some, rests upon fairly good testimony. Old planters assert that a plantation started with striped canes will ultimately contain only purple. In the northern confines of the cane sugar district, only purple canes are found. Fields planted only with striped canes, will show in a few years, and sometimes the first year, both purple and white canes, evidencing a lack of permanency in this striped cane—a property common to all striped varieties. The station has studied this transformation with intense interest and has found occasionally white stalks with the purple stripe so faintly delineated as to escape casual observation, and simultaneously purple canes with white stripes almost as faintly portrayed, and both mixed with the pure striped canes, with every proportion of the two colors. This evolution of the striped cane gives two offsprings, the one white, with a much more delicate nature, the other purple, far more hardy.

Indeed, in the differentiation to suit its environments, the striped cane seems to have adopted the purple color as one "fittest to survive." The word color is used because, as will

presently be shown, its superiority in sucrose content, tonnage, etc., can hardly be determined, so nearly equal are the claims. The purple color seems to bestow upon it a thicker rind, a greater capacity to absorb heat, and therefore a harder nature and increased powers of reproduction.

A few years ago, taking advantage of some of the many bud variations, to which all striped canes are subjected, the station originated four new canes, to which the names "Soniat," "Bird," "Nicholls" and "Garig" were given. See elsewhere for detailed statement. These canes have been selected carefully now for eight years, and yet the striped varieties show no permanency of type.

A few years since the Mexican striped was imported from Mexico, the Batavian striped from Java, and the Red Ribbon from Jamaica. They were found, after cultivation, to be identical with our home "striped." The cultivation of the Batavian and Red Ribbon has, however, been continued with every effort to keep them separate and pure. They are fine canes, giving large stalks, and are very attractive to the eye, but transformations, similar to those described above, are already noticeable, and purple stalks are occasionally found, sometimes in the middle of the plat.

To test the comparative merits of our home canes, experiments were begun in 1890 of selecting and planting each separately, and have been since continued.

The results of these experiments have been published annually in bulletin form. These experiments have been made with plant, first and second year stubbles, or ratoons, upon both tiled and untiled lands. They have been made upon rows varying in width from three to eight feet, with and without fertilizers. Both plant and first year stubble have been used to test the efficacy of windrowing versus standing, for the preservation of cane for the mill. The standing cane of both were subdivided into topping and untopping to test the suggestive question whether the prompt removal of the sour bud may not arrest the downward fermentation of the stalk. Duplicate experiments with each cane have been subjected to different methods of cultivation, with and without fertilizers. In all, more than one thousand comparative experiments have been made with these two varieties of cane. In each experiment three rows of equal width and length were used. In planting, the same length of stalks were used, and during the season the canes in every plat were counted three times. 1st, As soon as canes were well up; 2nd, at lay-by, and 3rd, at harvest. Each of these rows were separately harvested; stalks counted, weighed and worked off in the sugar house with great care, the laboratory following the sugar house, with samples from the

canes to the sugar. The results of all these experiments may be summed up as follows: The striped cane has a larger stalk, gives a slightly larger tonnage, with slightly less solids not sugar, and fibre. It therefore contains more juice and is softer and easier to crush in the mill, and resists better what is known as "dry rot." The purple cane is conspicuous for its increased powers of germination and multiplication, and to the latter fact may be ascribed, probably, the generally smaller stalk. It is harder than the striped, containing more fibre and resists "wet rot" better than its competitor. In Brix and sucrose there is a wonderfully close agreement with but slight difference in glucose. There is more coloring matter in the purple, and therefore the striped gives a juice slightly lighter in color. In fact, beyond the reproductive power of the purple and the larger sized of the striped, the two canes may be said to be almost identical. Higher fibre, solids not sugar, and coloring matter, attached to the purple, may modify to some extent its manipulation in mill, vacuum pan and clarifier, otherwise, the two canes are similar.

The average germinative or reproductive power of the purple has exceeded that of the striped by 16 per cent. By actual count it has frequently risen as high as 20 per cent., and sometimes more.

At harvest 6 per cent. more purple stalks existed than striped. These facts suggest the true reason for the final survival of the purple in a field where originally both canes existed. With 16 per cent. more reproductive power, it will be but a short time before it will be master of a field.

Our experiments with mill pressure, and they are up in the thousands, from the hand mill of the laboratory to the 9-roller mill of the sugar house, invariably show a larger extraction from the striped cane. Our sugar makers have frequently noted the greater ease and shorter time in freeing the sugar from the masse cuite of the striped with the centrifugal. These sugar house conclusions emphasize the laboratory results given above. In the field they both show equal facilities to imbibe fertilizers and to appropriate prosperously the waters of irrigation. No difference has been noted in their capacity to withstand droughts, and both have strong tendencies to fall down when nearing maturity, showing shallow root development. The striped cane has a larger leaf and more foliage than the purple, and of rather a lighter green. This would indicate a greater capacity for growth, which is evidenced in the larger size of stalk.

CHAPTER XII.

COMPOSITION OF CANE.

Payen's classical analysis of the sugar cane is as follows:

Water	71.04 per cent.
Sucrose	18.02 per cent.
Fibre	9.56 per cent.
Nitrogenous matter	.55 per cent.
Resinous, fatty and coloring matter	.35 per cent.
Ash	.48 per cent.

100.00

Or juice 90.44 per cent., fibre 9.56 per cent.

If the cane plant be taken in its entirety (stalk and leaves) it will have about the following composition, according to the same chemist:

Water	75.000
Sucrose	15.000
Fibre	9.445
Nitrogen	0.090
Potash	0.086
Phosphoric acid	0.031
Lime	0.041
Magnesia	0.040
Silica, etc.	0.264

These are analyses of matured canes grown in Martinique, a tropical country and only approximately represent Louisiana canes. The canes were selected for the researches to which they were subjected. It will be observed that they contained no glucose—which is an exception—since all canes contain more or less of this substance, especially those worked in our sugar mills. Cane has a very variable composition, depending upon the variety cultivated, the country in which it is grown, and even the soil in which it is planted. With us it varies also with the quantity grown upon an acre and the time of harvest. An examination of the analyses of the numerous varieties grown upon this station, and published from time to time in our bulletins, will convince any one of the variation of composition due to varieties. A comparison of the analyses of Louisiana canes with any tropical canes will exhibit the variation in composition due to different countries. Every planter knows that the same cane grown upon black lands is sweeter than those grown

upon sandy, and that his yield of sugar per ton of cane varies with the tonnage produced. The average of seven canes, usually planted in the Island of Bourbon, is given by the director from experiments in the Agronomic Station, as follows:

Water	69.35
Fibre.	9.95
Sucrose.	19.01
Glucose.	.34
Organic solids not sugar	.75
Ash	.60
	<hr/>
	100.00

Icery has given the following as the average composition of canes in Mauritius:

Water	69.73
Total sugar.	19.11
Fibre.	10.54

And Vandesmet has given for the average cane of Martinique, the following:

Water	73.25
Fibre.	10.10
Sucrose.	15.43
Glucose	.36
Organic solids not sugar	.57
Ash	.35
	<hr/>
	100.00

Before comparing the above, the following facts should be announced:

In all dry localities cane is smaller, more fibrous and more sugary. In wet climates it is gorged with humidity, less rich in sucrose but more charged with glucose. In such cases the cane is always in vegetation and never properly matures. At harvest it always contains a goodly proportion of glucose. It is recognized in tropical countries, that canes with very large stalks and with large and green leaves, always give undesirable quantities of glucose. Canes grown very rapidly, and which have come too quickly to harvest, sometimes designated as "Cannes folles," also contain considerable glucose.

With the above, we can easily see why the canes of Bourbon, Mauritius or New Caledonia, cultivated under good climatic conditions and situated in regions moderately rainy, are the richest in sugar. The West Indies, on account of excessive rainfalls, give canes inferior to the above. The canes of Demarara and Cochin China, planted almost always in marshy soils and in very wet climates, are not rich in sugar and their juices rarely show a higher density than 90 degrees Baume, with a high content of glucose.

The character of canes grown and the quantity raised per acre, can be approximately estimated by an acquaintance with the rainfall and climatic conditions of a country. Hence the marvelous development of the sugar cane in those countries like Hawaii, where climatic conditions, other than rainfall, are perfect, and the water to grow the canes is supplied by irrigation. Here just enough water is supplied for the needs of the cane and the injury from excessive rainfalls is unknown.

The Composition of Louisiana Cane at Various Stages of Growth.

At the State Experiment Station, Baton Rouge, in 1892, Prof. B. B. Ross determined the composition of the seed cane planted, and of the young cane at various stages of growth up to harvest. The cane used was of the purple variety, first year stubble. It was windrowed November 20th. On February 15th it was taken from the windrow and planted. On that day three average stalks gave a juice which contained Brix 16.00 per cent., sucrose 12.6 per cent., glucose 1.95 per cent., solids not sugar 1.45 per cent., purity coefficient 78.75 per cent., glucose ratio 15.48 per cent. Fourteen average stalks were selected for planting and three reserved for complete proximate analysis. Each of the stalks planted was weighed and numbered, and its relative position in the row carefully noted in order that the individual stalk might be located when samples were taken for analysis at a subsequent period. It was intended at planting to analyze monthly the original stalk (planted) and the canes growing from it, and thus determine positively the composition of the cane at different periods of growth, and approximate the food ingredients supplied by the mother stalk to the growing plants. The canes were slow in germinating, and it was the 1st of June before the development was sufficient to justify analysis.

The following are the results of Prof. Ross. The proximate analysis of the three reserved canes was as follows:

	Original Sample.	Water free Sample.
Water.	78.48	.
Ash.	0.61	2.37
Albuminoids	0.47	1.85
Ether Extract (fats, etc.)	0.64	2.51
Cellulose	4.87	19.09
Nitrogen Free Extract (carbohydrates)	18.93	74.18

The cellulose or crude fibre in above is the residue insoluble in water, dilute acid and alkali, and is not the fibre (sometimes called marc) which represents the complement of juice in the cane.

Analysis of seed cane, with all the young plants and their adherent roots (the last cleaned from adherent dirt) was separately made on June 1st, with the following results:

	Seed Cane.	Young Cane. Stems and Leaves.	Roots of Young Cane.
Water	83.38	83.15	62.60
Ash	0.73	2.52	3.59
Albuminoids	0.31	1.55	1.92
Ether Extract (Fats, etc.)	0.36	0.71	0.99
Cellulose	4.99	4.78	11.62
Nitrogen Free Extract (Carbohydrates)	10.23	7.29	14.28

On July 14th another sample of the above was taken, and analyses gave the following composition:

	Seed Cane.	Young Cane. Stems and Leaves.	Roots of Young Cane.
Water	83.86	81.84	77.57
Ash	0.48	1.57	3.13
Albuminoids	0.51	1.03	0.70
Ether Extract (Fats, etc.)	0.41	0.72	0.73
Cellulose	4.95	5.65	6.54
Nitrogen Free Extract (Carbohydrates)	9.80	9.19	11.33

The next sample was taken Sept. 25th, when the cane had obtained nearly its full growth, though far from maturity. The roots of the cane had now become so extensively ramified that it was impossible to secure anything like all of them; so they were not analyzed. The original seed cane was difficult to find and identify, and it, also, was not analyzed. In the following table the analyses of cane, including tops and leaves, are first given, then of the stalks and leaves separately:

	Cane includ- ing tops and leaves.	Stalks.	Tops and Leaves.
Water	72.18	74.00	68.86
Ash	2.02	1.32	3.29
Albuminoids	1.03	0.62	1.79
Ether Extract (Fats, etc.)	0.64	0.57	0.78
Cellulose	9.63	8.61	11.49
Nitrogen Free Extract (Carbohydrates)	14.50	14.88	13.79

The ash found in above stalks was completely analyzed, with the following results, which are given as crude ash in the first column, and in the second reduced to the original sample of cane planted:

	Crude Ash.	Original Sample.
Volatile matter	2.05	. . .
Insoluble matter	30.85	.187
Soluble Silica	1.60	.009
Ferric and aluminic oxides	1.54	.009
Lime	6.60	.040
Magnesia	6.19	.037
Potash	17.85	.108
Soda	9.92	.060
Phosphoric Acid	12.26	.074
Sulphuric Acid	8.98	.054
Chlorine	1.27	. . .

Another complete analysis was contemplated in October (the time of harvest), but depredators removed the samples. A few small canes were left, and on November 1st they were pressed in a hand mill, and juice analyzed as follows: Brix 19.3 per cent., sucrose 18.7 per cent., glucose 0.46 per cent., solids not sugar .014 per cent. These canes showed an increased elaboration of carbohydrates since last analyses, and it is possible that even larger proportions might have been developed later.

An examination of the above will show that in the first period of growth (June 1st) the mother cane had lost albuminoids, fats, and carbohydrates. The slight increase in ash is doubtless due to the variation of the element in all plants, especially in canes where no two are of exactly the same age. On June 1st the weight of the young canes was

about two-thirds that of the mother cane, therefore only a small part of the essential organic elements of plant food could have been furnished the young plants by the seed cane. At this stage of growth the composition of the cane corresponds closely with that of many forage plants, while in subsequent growth it departs further and further from this resemblance in composition. The composition of seed cane on July 14th shows little variation from the analysis of June 1st, indicating that since the young plants had secured roots for themselves, they had not drawn on mother cane for sustenance. With the cane, as with other plants, the younger the plant the greater the percentages of albuminoids and ash, and less the fibre and carbohydrates (sugars, etc.).

An examination of analyses of samples September 25th and November 1st, will show a marked decrease in water and a considerable increase in fibre and carbohydrates as the plant approaches maturity.

The above analyses show that every ton of cane delivered at the mill would remove from the soil 9.4 pounds albuminoids, or 1.5 pounds nitrogen, and 12.2 pounds of ash. This ash would contain 2.17 pounds potash, 1.48 pounds phosphoric acid, and .8 pound of lime. In Louisiana the proportion of tops and leaves to canes is about one to three. Therefore every three tons of mill canes will give one ton of tops and leaves. One ton of tops and leaves will remove 35.80 pounds of albuminoids, or 5.7 pounds nitrogen, and 65.8 pounds ash. Since every ton of cane has about one-third of a ton of tops and leaves, there will be required for the growth of a ton of cane, exclusive of roots, and including tops and leaves, 21.3 pounds of albuminoids, or 3.4 pounds nitrogen, and 34 pounds ash. When the cane is harvested, the trash (tops and leaves) is left on the ground and usually burnt. In burning, the ash or mineral matter is restored to the soil, but the nitrogen is dissipated into the air. Therefore, to one burning his trash, there is withdrawn from the soil with every ton of cane 3.4 pounds nitrogen, 2.17 pounds potash, 1.48 pounds phosphoric acid, and .8 pound of lime. There is a saving of 1.9 pounds nitrogen, by burying the trash, to each ton of cane made, equal to the nitrogen in 27 pounds of cotton seed meal. From the above, it will be seen that the quantities of elements usually supplied in commercial fertilizers are assimilated and utilized by the cane in relatively small quantities when compared with other staple crops. The excessive weight, however, of a crop of cane grown on a given area causes the total absolute quantities of the ingredients referred to, to more nearly approximate those removed from the soil by other plants.

Forty tons of cane per acre is not unusual. This amount would require 136 pounds of nitrogen if the trash was burnt, or 60 pounds if trash was turned under, 87 pounds potash, and 59 pounds phosphoric acid.

The above quantities of nitrogen would be represented by 1943 and 856 pounds cotton seed meal.

It would require over 700 pounds kainit to supply the potash and nearly 400 pounds of a 15 per cent. acid phosphate to furnish the phosphoric acid, if none were furnished by the soil.

Burning of Cane Trash.

Shall we then burn our trash or shall it be turned over? Chemically there is a loss of nitrogen for each ton of cane harvested, by burning, equivalent to that contained in 27 pounds cotton seed meal. On a field averaging 30, 20 or 10 tons per acre, there will thus be lost an equivalent of nitrogen contained in 710,540 and 270 pounds cotton seed meal—a loss which would be serious in any other agricultural industry. Why, then, do we burn? The following reasons are given: The cane borer, which at times becomes so abundant as to seriously injure the cane, is practically held in check by burning the tops in the trash, which contains the worms, thus destroying thousands annually. If a cessation of planting cane on the part of every planter in the State could be simultaneously practiced for one year, and no cane saved for seed wherein the worms could hibernate, and all the trash everywhere burned, it is believed the borer would be exterminated in Louisiana. Since it is extremely rare that any are found in the stubble left after cutting down the stalks, and if by chance any should be so found, the cold of our average winters and the heat from the burning trash would destroy them.

Again, our stubbles are liable to be killed during our winters. It has been clearly demonstrated that this danger is greatly enhanced by excessive moisture, and the latter is frequently produced during our winters, if the trash is permitted to remain on the ground or turned under with a plow. Burning trash off the stubble immediately after the cane is harvested, leaves the cane rows clear of vegetable matter and enables them to shed freely the water falling upon them, and if proper drainage has been established, the entire field will remain practically dry during our wettest winters and the stubble will rarely be injured even by excessive cold. Experiments in burning the trash off immediately after harvest have so conclusively demonstrated the wisdom of the act, that almost every planter in the State seizes the first dry spell after his cane is cut to fire all his fields. If the trash

be left on the ground it will absorb and retain a large amount of moisture in the spring and thus retard the sprouting of the stubbles. Burnt fields always give earlier stubble stands.

Leaving the trash on the field is also a great obstacle to the proper cultivation of the ensuing stubble crop. A crop of thirty tons of cane will leave ten tons of a light porous trash, which during the winter and spring will absorb large quantities of water, and which, decomposing very slowly, will prevent the successful running of plows and cultivators. It is claimed by observant managers that the increase in the stubble crop, due to a more excellent cultivation rendered possible by burning the trash, will alone more than compensate for the fertilizing ingredients lost in burning. These are the main reasons for burning, and an experience of twelve years enables the writer to pronounce them sound and valid. The loss of vegetable matter by burning, is willingly, knowingly, but rigidly sustained to prevent subsequent losses of a far more serious nature.

Variation in Composition of Different Parts of the Stalk.

Canes vary in composition, not only with age, in different countries and on different soils, and under different climatic conditions on the same soils in the same country, but also among themselves. Individual stalks rarely ever give exactly the same composition. This will be more fully discussed under the chapter on "suckers," when it will be shown that in harvesting a clump of canes, no two will be found of exactly the same age, and therefore variable in composition.

Even individual canes have not the same composition throughout their length. It is well known to every planter that the butt of a cane is the sweetest part of the stalk, and that its sweetness decreases as you ascend, until finally the extreme upper part is almost devoid of sugar.

So apparent is this fact to the taste, that chemical analysis is not needed to convince even the "small boy" who chews the cane. Yet time and again has the chemist verified this fact by analysis. He has shown that the sucrose is most abundant in the lower portion of the cane with a minimum of glucose. That the former decreases and the latter increases as you ascend the stalk, until finally in the upper white joints the glucose absolutely predominates. This suggests the wisdom, when only sugar is desired, of lowering the knives in the field and removing the immature upper joints, which from their composition are bound to be melas-

egenic in the sugar house and perhaps restrain from crystallization otherwise available sugar. The analyses of different parts of the cane stalk have been repeatedly given in our bulletins, and to them the reader is referred. Again the nodes and internodes of a stalk of cane vary in composition even when taken from the same part of the stalk. The following analysis, taken from Bulletin No. 38, of the nodes and internodes of twenty stalks of purple canes with normal eyes, will show the variation:

	Brix.	Sucrose.	Glucose.	Solids not sugar.	Fibre.
Nodes	15.94	12.6	0.13	3.21	16.5
Internodes	17.4	15.5	0.94	.96	8.00

From the same bulletin it is found that the nodes vary from the internodes, not only in the total nitrogen content, but also in the form of nitrogen present. The nodes containing .1829 per cent. of total nitrogen, of which .1778 is albuminoids, and .005 amides; while the internodes have only .0817 per cent. of total nitrogen, of which .0559 are albuminoids, and .0258 amides. It will thus be seen that the nodes carry much larger amounts of solids not sugar—fibre and nitrogenous matters, while the internodes are richer in sucrose and glucose. This explains why the juices from the different mills in our sugar houses vary in composition, and that the juice from the first mill is purer and more easily worked than that from the other mills. The first mill extracts juice mainly from the internodes, which are softer than the nodes. The second and third mills crush the nodes and extract from them the impurities given above, and the more powerful the expression, the more impure the juices obtained. From the description given under the chapter on the Anatomy and Physiology of the Cane Plant, the reasons for the presence of the impurities of the nodes can readily be assigned. Attached to every node is an eye or a bud, destined to become a future plant. Around this eye is stored the food for its future use, and in this respect the nodes resemble the seeds of flowering plants with the sucrose and glucose of the internodes as a further food reserve.

The excess of gums, mucilages, albuminoids and fibre in the node, is therefore intended as food material for the young plant until it shall become large enough to obtain its own food, and these substances are formed in the node

during the process of ripening by the condensation of the simple molecules into more complex and less soluble forms of gums and mucilages, and by the union of amides and glucoses in the presence of sulphur compounds, to form albuminoids. As the bud develops, the albuminoids are converted into soluble amides and glucoses, and the gums, mucilages and fibre, into soluble carbohydrates (glucose or dextrose), which furnish the food for the young plant until it can draw its own sustenance from the soil. In case this storehouse should be exhausted before the plant is capable of self-support, it can draw on the reservoir of sucrose, glucose and nitrogenous matter stored in the internodes, as shown by the experiment of Prof. Ross, given elsewhere. The action of ferments during germination will readily produce the above transformations and may even convert a part of the fibre into soluble carbohydrates, thus rendering a portion of this substance available for plant food. The following, taken from Bulletin No. 38, is the conclusion of a series of investigations made by Dr. J. L. Beeson in the laboratory of this station:

"To recapitulate: It has been found in the course of this investigation that the juice of the nodes of the cane is quite different from that of the internodes, containing markedly less reducing sugars, more 'solids not sugars,' and more albuminoid bodies; that the 'fibre' of the nodes contains more albuminoids, more insoluble carbohydrates not sugars, which readily pass into reducing sugars; that as the cane deteriorates, reducing sugars are formed more rapidly into the nodes than in the internodes. In our opinion these facts can be best explained by the hypothesis previously stated, namely, that the physiological function of the node in the cane is similar to that of the seeds in the case of flowering plants—to store food in the region of the eye for the use of the young plant before it has taken sufficient hold of the earth to draw sustenance from the atmosphere and soil. The hypothesis is further confirmed by the fact that the isolated nodes of the cane when planted will germinate and grow to maturity.

"As already shown, there is a marked difference in the purity co-efficient of the juices from the nodes and internodes. That from the node gives an average of 81 per cent. purity, while that from the internode an average of 89 per cent. approximo. If a machine could be devised by which the nodes could be separated from the internodes so as to work the juices separately, it would doubtless be profitable. Since the nodes in the samples analyzed constituted about 14 to 16 per cent. of the whole weight of the cane, it would be a great loss to throw them away. Since the nodes show

a much lower purity co-efficient, many short joints on the stalk decrease the purity of the juice of the whole cane."

Difference in Composition of Rind and Pith.

There has already been shown a marked difference in the percentage of fibre in the nodes and internodes. By reference to a magnified cross-section of the cane stalk given elsewhere, it will be seen that the pith cells are far more abundant near the center of the stalk and decrease as the circumference is approached, giving way for the fibro-vascular bundles. Since the pith cells contain the sugar, it will be apparent that the central portion of the stalk would be richer in sugar and lower in fibre than the rind.

Chemical analysis (see Bulletin No. 38, page 1354) shows the rind to contain from 25.6 per cent. to 29.5 per cent. of fibre, while the pulp contained from 5.40 to 8.70 per cent. The same bulletin records the following percentages of fibre in the different portions of an internode cut from the center of a stalk, "just within the contiguous nodes;" true rind 39.9 per cent., inside rind 13.33 per cent., next to inside rind 6.79 per cent., next to middle 4.77 per cent., middle of stalk 4.13 per cent. It was found, in conducting the above experiments, that the diffusate from the inside rind was quite yellow, and it is probable that these cells furnish the yellow coloring matter of the cane juice. On account of this unequal distribution of fibre throughout the cane, the problem of properly estimating it (fibre) chemically in the cane is far from being solved. The difficulty consists in getting a sample that will fairly represent the cane. When it is remembered that the percentage of juice in the cane is based upon the determination of fibre, it will be evident that a proper estimation of this substance is essential to a complete chemical control of a sugar house. Yet, on account of its unequal distribution throughout the cane, the accurate method of sampling has not yet been devised.

Difference in Composition Between Plant Cane and Stubble Cane.

Peligot accuses plant cane of being richer in sugar than first year stubbles, and first year stubbles richer than second, etc.

Our experiences in Louisiana have led us to different conclusions. The older the stubble, the more fibre it contains and less juice, but this juice is richer in sucrose than that obtained from younger stubbles or plant canes. Every planter is familiar with this fact. Stubble canes always give a richer juice, but less extraction, than the plant.

This necessarily follows from what has already been explained under the "Anatomy of Sugar Cane," and elsewhere.

In Louisiana, the juice of our stubble canes constitutes about 88 per cent. of the weight of the cane, leaving about 12 per cent. of fibre. Plant canes will average about 8 to 10 per cent. of fibre and 90 to 92 per cent. of juice. In rare instances, the fibre has been found as low as 6 per cent. Increase of fibre always means a decrease of juice, but the latter carries a higher density.

CHAPTER XIII.

MODES OF REPRODUCTION.

As already explained, a stalk of cane is divided into nodes and internodes. At the base of each node is an "eye" or bud, (see fig. 2 and fig. 14), which under proper influences develops into a stalk of cane. Around each bud are the parallel semi-transparent lines or dots, which develop into roots simultaneously with the evolution of the bud. These roots, if developed on the standing or growing cane and are in close proximity to the ground, will penetrate it and form true roots of the cane. If, on the other hand, the stalk be buried, as is commonly done in planting cane, simultaneous with the sprouting of the eye, will occur the development of these roots, which nourish, in part, the young sprout, at least, till the latter has reached a growth to send out from its base its own roots. This has been demonstrated by the following experiments made by the writer: Two stalks of cane of the same variety and of the same number of eyes and of equal lengths were planted in boxes of pure sand and watered. A mixture of nitrate of soda, acid phosphate and kainit, was intimately mixed with the sand of one box, while the other contained only pure sand. At the end of a given time, both stalks had completely germinated. The sprouts in the fertilized sand were twice as high as those in the pure sand. A removal of stalks with sprouts from the boxes was made, and on examination it was found that no roots from the bases of the young sprouts had yet appeared and the difference in growth between the canes grown in fertilized and unfertilized sand was plainly due to the fertilizer absorbed through the roots shooting from the mother cane around each eye.

In another box of sand, fertilized as the one just mentioned, several joints of cane were placed, with the embryo roots around the eyes removed carefully with a knife. At the end of a given time, the sprouts were developed, but were of same size as those sprouted in pure sand, and bore an unhealthy look. In this instance nothing was absorbed from the sand, and the sprouts were simply evolved from

the mother stalk. Frequent transplanting of young sprouts with mother cane attached, has shown that when the operation is so carefully performed as not to injure these roots, the young plants suffer much less than when ruthlessly removed. These roots furnish both water and food to the young sprout. How long they continue to perform this function has not been definitely determined, though it is probable that they cease to exercise the function of roots soon after the young plant sends out its true roots from its base.

It was thought until recently that the above method was the only way of propagating the cane. The assertion made by the celebrated voyager, Robert Bruce, that cane was grown from true seed in Egypt and India, has been vigorously denied by all writers on the sugar cane. It is only a few years since Messrs. Harrison and Bovell announced to the world that the cane bore fertile seed and that they had produced full grown canes from seed collected by them. This discovery has changed the opinion of all botanists relative to the absolute infertility of cane seed; and the assertion of Bruce is not now regarded as such an egregious error. Since this discovery of Messrs. Harrison and Bovell, hundreds of persons have propagated canes from seed. The cane, therefore, is capable of being propagated by seed, but on plantations the old method of propagating from the stalk is still exclusively pursued. The seed are very small and are covered with a thick silky pappus which makes them difficult of germination. Besides, the proportion of fertile seed is very small, and even in these the vitality is of short duration, so short as to be incapable of germination after long transportation, however carefully they may be packed. When the cane is left to itself in a wild state, it naturally, when mature, falls to the earth. Its eyes, coming in contact with humid soil, sprout rapidly and produce new stalks which live at first at the expense of the mother cane until sufficiently developed to draw upon the soil, when they become in the ordinary conditions of other vegetables.

CHAPTER XIV.

SUCKERING OF CANE.

The question of suckers in cane has probably been discussed from every standpoint by planters as much as any question involved in the sugar industry. That suckering is a natural function of the cane plant, that cannot be successfully repressed, was positively proven by the earlier experiments of this station. Like the entire family of grasses, to which it belongs, cane multiplies by a process known in botany and among cereal growers as "tillering." See figure 14.

In foreign countries, as is shown by Mr. Skeete's article, given elsewhere, almost the entire crop is made up of suckers. They plant in holes, six feet square, a piece of cane containing three eyes and frequently gather 50 to 100 stalks of matured cane from each stool. That variety of cane which suckers the most vigorously and gives the largest number of matured stalks to the stool, provided its sugar content and other qualities are good, is preferred. There the length of the season favors the maturing of the large number of suckers which are so abundantly produced. In Louisiana the season conditions forbid the maturation of suckers born after a certain date (about July 1) and the paramount question is how far suckers shall be encouraged, and when and how to repress them when a sufficient quantity has been obtained. Experiments conducted for many years in the best width to give cane rows, pointed out the curious fact, that the number of canes per linear foot harvested, increased directly with the width of the row, and that the individual canes decreased in weight in the same proportion. A five foot row, one acre long, had fewer canes on it than on the six foot, and the six foot a less number than seven, and seven than eight. Simultaneously the individual canes were heaviest on the five foot row, followed in order by six, seven and eight foot rows. These curious results suggested that cultivation, which was performed in all the rows with the same cultivators, had probably checked the process of suckering in one direction, just in proportion to the ap-

FIG. 14.

Showing the stalk of cane planted, the young plant with three suckers starting at the base, and the small roots coming from young plants.

proach of the cultivators to the cane, and this suppression of suckers had given an opportunity to the surviving canes to develop more fully.

The next question suggested was how far apart in the row should the young stalks be in order that subsequent

suckering may give the best results. To determine this question the following experiments were conducted for 1892-1893:

Purple cane was used in the plat. It was bedded, like gardeners bed sweet potatoes. When the bed had sprouted sufficiently, each sprout was removed by cutting the mother cane on either side of it. This sprout, with its attachment of mother cane, was carefully examined, to see that no undeveloped eye was left on the adherent cane. Twenty-one rows, five feet wide and one-half acre long, were thoroughly prepared for the reception of the sprouts. The rows were divided into three equal parts. On the first part the sprouts were transplanted exactly six inches apart; on the second or middle part twelve inches apart, and on the remaining part eighteen inches. These were transplanted on March 24th and 25th and were well watered. They grew off well. These plantings gave us respectively 17,600, 8,840 and 5,865 stalks per acre. Each row was counted again June 26th, and at harvest. During the last week in October they were harvested. There were twenty-one rows of each, giving us sixty-three separate and distinct experiments, which were carefully worked up on a horse mill. The stalks from each experiment were counted, weighed and run separately through the mill, the juice collected in a large tank, thoroughly mixed, and duplicate samples taken and carefully analyzed. The following are the averages of the twenty-one experiments of each:

PLANTS SET.	NO. STALKS TO ACRE.			Average weight, pounds	Tonnage per acre.	Brix.	Sucrose.	Glucose.	Solids not sugar.
	March.	June.	Harvest.						
6 inches apart .	17600	72325	39050	2.17	42.55	13.10	9.1	2.39	1.61
12 inches apart .	8840	51188	32964	2.49	41.60	12.6	8.33	2.64	1.63
18 inches apart .	586	37230	29070	2.60	37.24	13.0	8.99	2.63	1.38

On June 26th there were 4.1, 5.8, 6.35, respectively, more stalks on the 6 inch, 12 inch and 18 inch rows than were planted. In October there were 2.2, 3.73, 5. times more than were planted. To every sprout planted on the 6 inch plat there were 3.1 suckers, on the 12 inch plat 4.8, and on the 18 inch plat 5.35. When harvested, however, there were only 1.1, 2.73, and 4, the rest had perished in the battle for existence. These losses represent 33,275 stalks to the acre (nearly as many as were harvested) on the 6 inch plats;

18,228 perished on the 12 inch plats, while only 8,160 were suffocated on the 18 inch plats. A close examination of the plats at harvest revealed the presence of dead stalks of all sizes, from a few inches to several feet in height. It is well known that the soil contributed to the growth of these dead plants and its available fertility drawn upon just in proportion to the amount of matter contained in them. To this extent, therefore, it may be claimed as wasted soil fertility. But how much vitality has been expended by the living plants in producing these suckers, and what delay in their growth has been occasioned by this wasted vital energy, are yet unsolved problems. The difference in the tonnage and the sugar content of these plats is such as may, probably, be charged to accidental variation of soils, since some of the 18 inch plats gave among the highest results. Not so, however, with the average weight of stalks, which was almost uniformly highest with the 18 inch plats. From these experiments it would appear that suckering depends largely upon room—the greater the distance apart the greater the number of suckers. It further appears that there is no practical end to the process of suckering, provided ample room for such multiplication be given.

In 1894, a further series of experiments were begun looking to a more complete solution of the question of suckers.

Both the purple and striped varieties of cane were used. They were bedded and transplanted as described above.

Five plants of each variety were transplanted at distances apart of 6, 12 and 18 inches, making 30 in all. Labels properly numbered were attached to the stalks when transplanted.

A book was kept in which were recorded the dates of transplanting and births and deaths of suckers. Every morning the row was visited by the chemist in charge, who tagged by numbers every newly born sucker and entered simultaneously the fact in the record. Every sucker that perished was also recorded with date of its death. At the end of the season each clump of plants was overturned with a grubbing hoe with adherent lables and carefully studied. The original stalk was found and its relation to all the others minutely studied. After tracing the relationship of each stalk to the original one planted, they were each separately weighed and analyzed. These experiments have been repeated for two years, and the following is a summary of the results: Of the original canes transplanted in 1894, four died without issue (2 purple 6 inches and 18 inches; and 2 striped 12 inches and 18 inches) and four died in August and September, all striped (2, 6 inches, and 2, 18 inches) leaving suckers. In 1895, only one (purple 12 inch)

of the original stalks transplanted died (June 13) and it left issue, only one of which was harvested.

The following is a summary of the results for two years:

KIND OF CANE.	Distance apart, inches.	Year.	No. originals harvested			Lowest No. of suckers to plant.	Highest No. of suckers to plant.	Lowest No. of suckers to plant harvested.	Highest No. of suckers to plant harvested.	Per cent. of stalks started, harvested.
			No. suckers started.	No. suckers harvested.	No. suckers started.					
Striped	6	1894	3	49	18	3	14	1	8	38.9
"	6	1895	5	31	11	4	7	2	4	44.4
Purple	6	1894	4	25	10	2	11	1	4	46.6
"	6	1895	5	25	9	4	6	0	3	46.6
Striped	12	1894	4	49	13	6	19	0	5	30.0
"	12	1895	5	44	17	6	13	2	6	45.0
Purple	12	1894	5	35	18	2	12	1	7	57.5
"	12	1895	4	34	19	4	10	1	7	55.3
Striped	18	1894	2	56	26	4	22	0	11	45.9
"	18	1895	5	48	29	6	14	2	11	64.2
Purple	18	1894	4	67	26	9	16	0	9	41.7
"	18	1895	5	45	19	5	10	2	6	48.0

An inspection of the above table will show that 58.9 per cent. of the suckers that started, perished during the year 1894, and 53.9 per cent. in the year 1895. Of total canes, plants and suckers, started, 44.8 per cent. in 1894, and 52.8 per cent. in 1895, were harvested, showing that over one-half of the young canes had been killed in the battle for existence.

The table further shows about 63 per cent. of the suckers died in the 6 inch, 58.7 in the 12 inch, and 53.7 per cent. in the 18 inch experiments.

Fewer suckers started from canes 6 inches apart than from 12 inches, and fewer from 12 inches than 18 inches, when the percentage of mature stalks, including plants, is about the same for all. This suggests that distance favors suckering, but that the number of matured stalks at harvest within a given length is probably regulated by soil, cultivation, etc. These experiments further showed that cane, like all grasses, will try to occupy all vacant ground around it. Several of the plants died soon after transplanting. The adjoining plants soon filled the vacancies by extraordinary suckering. In one instance, as many as nineteen were recorded.

Sometimes a plant is discovered with an unusual quantity of suckers and it will be found on examination that

next to it is a plant with few or no suckers. Whether the early and vigorous suckering of the one has caused the dwarfing of the other, or whether the other was lacking in vigor in the beginning, and failing to occupy the space allowed it, had been encroached upon by its more vigorous neighbor, more to fill the vacant space, are yet unsettled points. Perhaps both may occur. It is reasonably certain that in the battle for existence here as elsewhere, the fittest survive. It was found that several mother sprouts after giving birth to a number of suckers were suffocated by them in August and September.

It is curious to trace the development of suckers during the season arising from a single plant, e. g., on a striped cane in the 6 inch experiments, the following is recorded: 5 stalks were harvested with 12 large suckers 2 to 5 feet high. The stalks were the original plant No. 1 and the 1st, 2d, 4th and 5th suckers from it. The twelve immature suckers were located, five on the 4th sucker, one on the original plant, three on the 5th sucker, two on 1st sucker, one on 2d sucker. This with other records show conclusively that the buds, or eyes, on the base of the young sprouts will germinate whenever favorable conditions are presented, and are not regulated by age, size of sprout, or soil. Let in heat, air and moisture, and fresh suckers will at once appear. This is seen, in the increased tendency to sucker of canes at the extremities of rows, or canes blown down by the wind. It is also forcibly illustrated in a field from which the cane is cut early in the fall. The warm weather then prevailing forces to germination the bud on the stubbles and endangers the stand for the ensuing year. Hence canes cut early in the fall rarely give good stands of stubble the next year. An examination of a stubble will show from six to ten gradually lengthening joints below the ground. At each node is an eye, or bud, surrounded by concentric rows of roots. The lower eyes give rise to the first suckers which are irrepressible. If conditions be very favorable all of the subterranean eyes will germinate during the season. Sometimes even the earlier suckers are exhausted during the first season and the stubble crop of the ensuing year has for its dependence only the buds on the younger suckers. See Fig. 15.

This accounts for the presence of apparently so many dead stubbles in some years. Of the limited number of eyes on a stubble, there will always be found some which do not germinate at all. From some cause they are worthless. Others are predisposed to germination and will do so whenever favorable conditions prevail. Therefore, the question of suckers, to a large extent involves also the problem of se-

FIG. 15.
Showing a stubble plant and mode of growth from original cane.

curing stubble crops, and with extraordinary suckering in the fall, comes the risk of a poor stubble stand in the spring. Besides the conditions of air, heat and moisture, the fertility or tilth of the soil and the soundness and vigor of the individual cane has much to do with suckering. It is, therefore, important that our soils be maintained in excellent tilth and supplied with proper fertilizers and that our seed should be well selected from sound, vigorous cane. Vigorous suckering is rather an indication of healthy canes, strong growth, and in tropical countries is greatly desired. In Louisiana this vigor sometimes endangers our stubble crop by the intervention of our winters, and diminishes our plant yields on account of the shortness of our seasons. Therefore, it is well to know how and when to repress too great a tendency to suckering.

Comparison of Analyses of Original Canes and Suckers.

In the following tables are given the analyses of 133 canes harvested in 1894, and 131 harvested in 1895. The original canes are the transplanted sprouts of which 20 in 1894, and 29 in 1895, out of the 30 planted, were harvested. Suckers are numbered just in the order in which they appeared around each stalk:

AVERAGE ANALYSES OF STALKS HARVESTED 1894.

No. of Stalks.		Brix.	Sucrose.	Glucose.	Date of Birth.	Average weight of Stalks.
Originals . . .	20	15.88	13.42	.85	March	2.01 lbs.
Suckers No. 1 .	19	15.20	12.40	.97	May	2.10 "
" 2 .	21	15.00	11.90	1.07	May and June . .	1.90 "
" 3 .	12	15.90	13.10	.86	May and June . .	2.10 "
" 4 .	18	15.30	12.40	.97	May and June . .	1.90 "
" 5 .	10	14.96	12.09	1.03	May and June . .	2.00 "
" 6 .	9	14.80	11.70	1.08	May and June . .	1.80 "
" 7 .	5	16.10	11.50	.92	June	2.30 "
" 8 .	7	15.20	12.50	1.01	June	2.40 "
" 9 .	3	16.00	13.40	.89	June	2.10 "
" 10 .	4	15.70	12.90	.84	June	1.80 "
" 11 .	5	15.00	12.30	.89	June	2.30 "
" 12 .	2	14.00	10.50	1.04	June	2.10 "
" 13 .	1	14.80	11.20	.85	July 9	1.50 "
" 14 .	1	17.00	14.90	.45	July 2	1.70 "
" 15 .	1	16.20	13.90	.58	July 2	2.70 "
" 18 .	1	16.90	14.80	.39	July 2	3.30 "
Average of all .		132	15.2	11.90	96	

AVERAGE ANALYSES OF STALKS HARVESTED 1895.

No. of Stalks of each.		Brix.	Sucrose.	Glucose.	Date of Birth.	Average wt. of Stalks harvested.
Originals. . . .	29	15.13	12.43	1.54	Mar.	2.6 lbs.
Suckers No. 1 . .	21	14.93	11.74	1.78	May 18 to June 25	2.2 "
" 2	19	14.70	11.12	1.91	May 22 to June 25	2.1 "
" 3	15	14.95	11.97	1.75	May 22 to July 1	2.2 "
" 4	16	14.85	11.57	1.75	May 23 to July 16	2.4 "
" 5	9	14.39	11.09	1.92	May 27 to July 16	1.9 "
" 6	8	14.95	11.83	1.72	June 1 to July 7	2.4 "
" 7	5	14.14	10.27	2.23	June 8 to July 16	1.8 "
" 8	5	14.98	11.89	1.57	June 8 to Sept. 1	1.5 "
" 9	2	15.11	11.57	1.59	June 8 to Sept. .	1.0 "
" 10	1	12.92	8.35	2.27	July 9	0.9 "
" 13	1	12.03	6.80	2.12	June 16	2.0 "

Average of all . 131 14.82 11.66 1.83

From the above it will be seen that in both years the original sprouts transplanted gave average stalks richer in sugar than suckers. This is true not only of the average but of almost every individual cane. With few exceptions, there has been a gradual diminution of sugar and weight of stalk from the original plants to the youngest sucker. This fact emphasizes the necessity of getting suckers as early as possible and after that cultivating to repress them. Several notable exceptions to the above occurred in 1894. Three suckers born as late as July have unusually high percentages of sugar, and two of them were very heavy. No known reason can be assigned for this aberration from general results.

From the above, it will be seen that suckers up to July 1st may make canes of fair quality and size. It would seem, also, that in Louisiana a uniform stand of plant cane early in the spring, six inches apart in rows five to six feet apart, would give subsequent suckering most favorable to large tonnage and high sugar content. Close cultivation with disc cultivators so as not to cut the roots, is suggested as a further means of repressing suckering. It may also be stated that plant cane 12 to 18 inches apart in early spring may fill up and make a most excellent crop by fall.

CHAPTER XV.

PREPARATION OF LAND, PLANTING, ETC.

As stated above, once in three years a restorative crop is interjected between the cane crops. The rotation being as follows: First year, plant cane; second year, stubble cane; third year, corn and cow peas. No system of rotation is complete without a leguminous crop, and among the leguminous crops the cow pea occupies the front rank as a rapid soil restorer, frequently accumulating in a few months over 100 pounds nitrogen per acre. An examination of the roots of the cow pea vine during rapid growth will reveal large quantities of wart-like tubercles, which, when crushed and a portion examined under the microscope, will reveal countless thousands of bacteria, peculiar to this plant living in symbiotic union with its host. Nothing can supplant the cow pea in the short rotation adopted by the sugar planter. Cow peas perform many valuable functions. By their deep roots and immense foliage they pump up from great depths and evaporate large quantities of water, and thus placing the soil in a condition relative to moisture most favorable to nitrification. They intensely shade the ground, thus protecting the nitrogen ferments from the destructive influences of direct sunlight, and enabling them to work directly up to the surface. Their tap roots are pumping, along with water, soluble plant food from great depths.

But the chief virtue lies in its extraordinary power of utilizing the free nitrogen of the air. Therefore, it is used once in three years to restore the nitrogen exhausted by two crops of cane.

Sometimes second year stubble is carried, and then the pea crop is every fourth year. A few planters practice a continuous growing of cane, and in doing so plant peas in the old stubble and cut the latter early for seed cane, and bury the pea vine for the coming plant cane.

A crop of corn is planted, and when it reaches the height of a few feet, it is laid by and simultaneously sown with cow peas, using one to three bushels per acre, of the Clay, Unknown or Black varieties. Early in summer the corn is

gathered and sometimes the pea vines made into hay for the stock of the plantation. In either event, the soil, with or without the pea vines, is turned under with a four, six or eight horse plow in August or early in September, and the cane planted in October.

Ordinarily, the root residues of the pea vines give enough nitrogen for the ensuing plant cane, and many planters positively assert on this account that it makes no difference to future crops whether they are removed or turned under, but carefully conducted experiments on this station show that when turned under there was an average increase of 7.42 tons of cane per acre, extending through plant and stubble, over soil treated similarly, with vines removed for hay. Yet where there is stock to be fed, it is wise to utilize the vines as hay and restore the manure from the stables to the soil.

Up to date the work of inverting the corn stalks and pea vines has been performed by large turning plows with steel discs, for cutting the vines, attached in front. These plows are difficult to handle and frequently get choked, making the operation a slow, tedious and expensive one. Recently the disc plows have been placed on the market, and one of them has been successfully used by the station for such work. An illustration is here given in figure 16.

FIG. 16.

An improved disc plow.

It has, on our soil, buried successfully pea vines that were waist high and very thick, plowing to the depth of ten inches and cutting a furrow 15 inches wide. It was drawn by three heavy mules and showed on the

dynamometer a pull of 500 to 550 pounds. It was managed entirely by one hand who rode on the plow. There was no choking and no stopping to clean the plow. Nearly three acres per day can be plowed with this implement. For flushing land it has no equal, and the draught is much lighter than with the four-horse plows usually used, and the work performed more satisfactory, there being no compression of the soil at the bottom of the plow, caused by the shear and landslide of the turn-plow.

After the land is flushed, it should be bedded with two-horse plow into high rows, five to seven feet wide and the middles carefully plowed out. The quarter-drains should also be cleaned. It is thus ready for planting late in September or early in October, the time at which fall planting is done. When ready to plant, the rows are opened with a double mould board plow and two or more running stalks

are deposited in this open furrow and covered by a disc cultivator, plow, or by hoes. Fall planted cane is always covered deeper than that planted in the spring, in order to protect it against the cold of our winters. The open furrow in which the cane is deposited should be above the level of the middles between the rows, and the latter should be at least six inches above the bottoms of the quarter-drains. Thus planted and maintained during the winter, there will be no trouble from either excessive cold or moisture.

Which is the Best Time to Plant, Fall or Spring ?

This is still a disputed question among our planters, for in Louisiana, cane is planted from the middle of September to the first of April. Many planters begin planting in September, plant as much as possible before the harvest begins, and then, when sugar making is over, renew planting until through. On large estates this custom very generally prevails, but there are some planters who persistently refuse to plant in the fall, claiming danger from the cold winters, and plant their entire crop in the spring. An experience of twelve years with both fall and spring planting, has demonstrated that fall planting, if properly performed, is most profitable. The young canes come up earlier, and larger yields are obtained at harvest. A very decided obstacle to fall planting consists in the usual dry weather prevailing in this climate during the fall months, which prevents that pulverization of the soil so essential for a proper seed bed. Cane planted in the fall upon cloddy land, unless covered very deeply and properly rolled with a heavy roller, is liable to what is known as "dry rot," since the cloddy land permits of a too rapid evaporation of moisture from the cane. Many fields have been lost from this cause until now a heavy iron roller, to pulverize the lumps and compress the dirt around the cane, is almost universally run over the cane after covering it. If fall planted cane be covered with fine earth to the depth of three inches, and this earth, if very dry, compressed with a heavy roller, there need be no fear of dry rot. If it be planted in a furrow above the level of the middles and the latter kept 6 inches above the quarter-drains, and the middles, quarter-drains, ditches and canals be kept open so as to permit of thorough drainage, there will be no danger from "wet rot." If attention to these precautions be given to fall planting of cane, it is believed that it would prove, all over the State, more profitable than spring planting. Finishing planting in the fall gives the planter an opportunity of devoting more time in the spring to the early cultivation of his crops.

Windrowing of Cane For Seed.

A strong reason for fall planting is the saving of the expense of windrowing cane for seed and digging it up, and the losses of cane incident thereto. This station has found that two running stalks of good cane planted in the fall has never failed to give an abundant stand. It frequently happens that the seed is more or less damaged in windrow, and in spring, planting from it, three, or even four, running stalks are required. This is a large and expensive loss, and is usually avoided by fall planting. All planters who prefer, or are forced to plant in the spring, must preserve their seed cane through the winter. This is usually done by cutting the cane down with all its foliage, and throwing it in the middles between the rows, in such a manner that the tops, with the leaves, shall completely cover the butts of that previously placed. When the operation is completed, nothing should be seen but the green leaves of the cane extending the entire length of the row. After the cane is placed, two four-horse plows, one turning to the right and the other to the left, are started, throwing the soil from the adjacent rows entirely over the cane, completely burying it. Hoes follow to close any openings left by the plows. The operation of windrowing for seed, just described, is delayed usually as late in the fall as is consistent with known danger from frost, and is usually done when the soil is moist from recent rains. In making windrows similar precautions to those given under fall planting of cane must be observed, viz.: The land must be well drained, the middles into which the canes are deposited should be well above the levels of the quarter-drains. The latter should be cleaned out to the ditches, and these to the canal. All these attended to, there will be no "wet rot" of canes in the windrow. As soon as the row of prostrated cane is completed, the plows should be started at once, and behind the plows should be the hoes, so as to prevent by evaporation any moisture of vegetation and exclude the air as quickly as possible. A non-compliance with the last precautions may lead to "dry rot," especially if canes are placed on a very dry soil and covered with the same. There will be no trouble in keeping canes through our severest winters, if the above be carefully attended to.

Matelas.

A few small planters still preserve their canes in mats, which may be made horizontal or vertical. In either case, the canes are so arranged that the foliage of the top is made to cover the stalks and shield them from cold and evapora-

tion. Sometimes, more particularly with horizontal mats, a covering of dirt several inches thick is placed over the mat of canes, to insure fuller protection. In the vertical matelas free use of the trash of the field is used for additional covering.

How Many Stalks to Plant

is a question upon which planters disagree. The average cane used for seed in Louisiana will measure four or five feet and will have their joints about four to five inches apart, and weigh about 2 to 2½ pounds. The average width of rows is from six to seven feet, which can be somewhat reduced with profit.

To plant one running stalk without a lap, in rows six feet apart, with cane of above description, will require in length 7,260 feet of cane per acre. If the stalks be four feet, there will be required 1,815, and if five feet, 1,452. Assuming the weight of a stalk to be two pounds, the number to plant per acre will weigh 3,630 pounds and 2,904 pounds; at 2½ pounds, the weight will be 4,537 and 3,650 pounds. It will, therefore, not be very far wrong to say that it will require two tons of cane to plant an acre in six-foot rows, using one continuous stalk as seed.

For five-foot rows it will require one-fifth more cane, and for seven-foot rows one-seventh less than six-foot rows.

For two running stalks there will be required about four tons of cane, and for three stalks six tons, for six-foot rows. If the cane be perfectly good and each eye germinates, there will be two or three sprouts per foot from one running stalk planted. From two running stalks, five to six sprouts, and from three running stalks, seven to nine sprouts. In the experiments at this station, it has been shown that one stalk to the foot at germination was a good stand, and two to a foot, an excellent one. Each vigorous stalk will give at least three suckers. Therefore there is a possibility of an ultimate stand of six to nine canes to a foot from planting one running stalk, fifteen to eighteen from two stalks, and twenty-one to twenty-seven from three stalks. Why, then, are not such stands obtained? The reply is, first, a goodly number of eyes on our canes are defective; second, our hasty and often reckless methods of planting, prevent many good eyes from germinating; and thirdly, thousands of suckers in every cane field are annually smothered out between lay-by in June, and harvest. Attention is also called to Prof. Dodson's studies upon "red cane," given elsewhere, as another cause for the failure of stands. It is a very fair crop which will yield at harvest three good canes to the linear foot, an excellent one which gives four to the foot,

and a superb tonnage will be harvested from a field showing five good canes to each linear foot of row.

These facts are given in order to appreciate a heavy loss somewhere in planting, and they suggest the propriety of striving to find out how this loss can be avoided. Possibly a better selection of seed cane, more careful handling, better preparation of land, etc., would enable us to economize largely in the quantity of cane planted per acre. A saving of two to four tons of cane per acre at planting, would be in the aggregate a very large economy for the entire State. If the area planted yearly be reckoned at 150,000 acres, and the cane be valued at \$3 per ton, there would be an annual saving in money values of from \$900,000 to \$1,800,000.

This station has uniformly obtained abundant stands from using two continuous stalks in all its general plantings, and in experiments with one continuous stalk, the results have been satisfactory.

In fall planting, cutting the cane at planting has always been injurious, furnishing increased foci of inoculation of ferments. Therefore the knife should be used only on crooked canes to obtain horizontality in the furrow. I cannot speak so positively of the knife in spring planting, as our experiments have been confined to fall planting. Again, the spring plant has a much shorter time for the action of the ferments before germination ensues.

Width of Rows.

Extensive experiments covering every width from three to eight feet, have been carefully conducted for many years, and the general results may be summed up as follows: In almost every instance the narrower the row the larger the yield of cane without injury to the sugar content or its purity.

But while the increase in the very narrow rows has been quite apparent, the increments have hardly paid for the increased seed used in planting. For it will be remembered that there is required twice as much cane to plant an acre in three-foot rows as six-foot rows. If, therefore, four tons are used on six rows, there will be required eight tons in three-foot rows, and the average yield of the latter over five-foot rows 5.40 tons. Other experiments show conclusively that there is no gain in tonnage or sugar content on the wide rows, and therefore suggested the propriety of narrowing them to a distance that will permit of the best cultivation with improved implements. The station, acting on this suggestion, has for the past four years adopted five-foot rows for all of its experiments, except the permanent

fertilizer plats which were established previously at six feet, and have been since continued. The results are very satisfactory, permitting of cultivation with any of the improved implements, and furnishing soil enough to give the necessary dirt for the stability of the plant cane and the preservation of the future stubble. Under no circumstances should rows be over six feet wide, as no possible advantage can be urged for wider rows.

Narrower rows permit of an earlier lay-by, and in case of moderately cold weather, the canes are better protected by the denser foliage.

What Part of the Cane Shall We Plant?

The Louisiana planters utilize a goodly portion of their crop (estimated at one-fifth to one-sixth) each year for seed. From the quantity planted per acre, the aggregate cost for seed each year is enormous. The station has therefore very thoroughly investigated the question as to what part of the cane to plant. It has planted each joint of a cane separately, and followed the result through plant and stubbles. It has divided the stalks into three parts, tops, middles and butts, and planted each separately for years. It has also planted "tops from tops," "middles from middles" and "butts from butts," for ten years, to see if there be a deterioration in the cane from such practices. Yearly it has studied both yields and chemical analyses, and two years ago, such canes pedigreed for eight years, were made the subject of special scientific study by Dr. J. L. Beeson in our laboratory, and his report upon the same appeared in Bulletin No. 38. The object of all these investigations was to test the matter thoroughly and decide whether our planters could not safely use the upper third of their entire crop for seed, instead of one-fifth of their entire cane, as is now being done. In every sugar growing country, save Louisiana, tops are used for seed. The practice is strongly condemned here by some, upon reasons drawn from known principles of vegetable physiology. The cane, they say, has only a few fertile flowers and consequently depends, for propagation, upon the eyes or buds. In all seed-bearing plants, those seed germinate and fructify best which are permitted to reach perfect maturity. Therefore, in imitation of this natural law, we must seek that part of the stalk which contains the largest and best developed eyes in order to secure seed which will produce the most vigorous plants. It is further claimed that where tops are universally used as seed a degeneracy of the seed will follow, since the latter is always

reproduced with these parts of the cane where the juices are poorest in nourishment (sugar) and the eyes most imperfectly developed. Hence, it is a practice with some of our planters never to plant fall cane until the polariscope shows at least 10 per cent. sugar in the cane.

Per contra, there are others who claim that the planting of the tops is justifiable from purely scientific reasons, besides the economy involved. They regard the cane planted as "cuttings" rather than true seed, and the eyes as buds to be developed under proper conditions. They say that the florist when he wants to root new plants, never uses the old or mature wood, but rather the young and succulent portion. Therefore in planting cane the youngest and most succulent portions will secure the best results.

They further urge that they are seeking a cane which contains not a maximum of sugar and a minimum of other constituents, but a maximum of those constituents which are needed to nourish the young plant, and these are found in the younger and tenderer portions of the stalk. They further say it is an error to compare the cane to seeds having a single germ with a supply of food held in reserve around it, suitable in composition for its wants. Each joint of cane has a germ or bud, but each section has a composition of its own, and the question is which one of these joints has a composition best adapted to aid the development and growth of these eyes or buds. The reply, from a continuous series of experiments practically conducted in the field, and from a series of investigations scientifically conducted in the laboratory, is, the tops of matured canes or the lower parts of young cane, where is found a well balanced relation between the mineral (ash) and organic constituents and an absence of excess of sugars, extremely liable to fermentation. The lower portion of the ripe cane contains its nitrogen, as albuminoids and its carbohydrates mainly as sucrose, while the upper portion has its nitrogen as amides, and its carbohydrates mainly as glucose. It has also an excess of ash. These facts are familiar to all sugar chemists and most planters, who recognize that the juice from the upper part of the stalk is rich in solids not sugar. Glucoses and amides are the constructives of albuminoids, sucrose and other carbohydrates of the cane plant, and with ash are found most abundant in the immature portion of the cane, i. e. the tops. Dr. Beeson in his report says:

"The large quantities of mineral matters observed in the tops of the cane correspond to what has been found true of most other plants. This fact would appear, according to Sachs, to be due to two causes, one physical and the other a physiological one. The mineral parts dissolved in the soil

water, diffuse through the roots to the foliage where it evaporates, or is exhaled, leaving the mineral matter behind. Then it is in the foliage system that assimilation of the carbonic acid of the air takes place, and metabolism begins, which requires the presence of certain mineral matters. The presence of a large amount of nitrogenous and mineral matter in the tops of the cane suggests the superiority of the tops, other things being equal, for planting, since these constituents are required as food for the young plants before it is old enough to win its living from the soil and atmosphere. It may be objected, since the seeds of flowering plants contain less mineral matters than any other portion of the plant, that the presence of the one-third more ash in the top would constitute no real advantage for planting, over the body of the stalk. The small quantity of mineral constituents in the seed of plants is explained by Sachs as follows: "That much soil water, rich in dissolved minerals, is absorbed by seeds during germination. Since the cane eye generates its own moisture (unless dried like a seed) it does not acquire mineral matter from the soil water, and frequently would likely need more mineral stored away in its organism."

It has been clearly shown by Prof. Ross' experiments, already given, that only a small portion of the sugar in the cane is consumed by the sprouts in germination, and it has been further shown that fermentation often sets in in the lower portion of the stalk after planting, checking and frequently preventing germination. All of the above considerations, together with practical experiments in the field, would indicate the superiority of the tops for seed, unless it could be shown that the plants coming from tops would partake of the nature of tops in a low content of sucrose and an excess of solids not sugar, and finally giving a cane of reduced sugar content and purity. To determine this question, for ten years, the station has been planting "tops from tops," "middles from middles" and "butts from butts," with no deterioration apparent either to the tonnage or sugar content. Dr. Beeson made an exhaustive investigation by selecting a number of stalks from each "tops from tops," "middles from middles" and "butts from butts." Each set of stalks were divided into "tops" "middles" and "butts," and each analyzed separately. These were compared, first, single with each other, and second, as a whole.

There were found in "tops from tops" less albuminoids and amides in the cane, and less solids not sugar in the juice, with a larger purity than in either of the other samples. It also had less glucose and more fibre, indications of greater maturity. The results of Dr. Beeson confirm

those previously and subsequently obtained by other station workers, and while they are not sufficiently emphatic in declaring a superiority of cane bred exclusively from "tops," they do declare in unmistakable terms that there has been no deterioration.

With these facts before him, cannot the Louisiana planter devise some practical way of utilizing the upper third of his cane for planting and send the lower two-thirds of his entire crop to the sugar house? By such a course both field and sugar house would be gainers. There would be more sugar and less molasses in the latter and better and earlier stands in the field, with the cost of seed reduced to a minimum. With planters supplying central factories, it would be to the mutual benefit of both to adopt such a plan.

The Best Seed, Plant or Stubble ?

Is a mooted question, and will probably be practically decided by planters in favor of the stubble, for the following reasons outside of the merits of the two kinds of cane, *per se*, viz.: Cutting cane early in the season for planting in September or October invariably injures the stubble stand of the ensuing year, due to the vigorous sprouting of the eyes of the stubbles immediately after harvest, which sprouts are killed by the subsequent cold of winter, leaving a very few eyes on the stubbles for germination in the spring. Therefore those planters who practice fall planting are unwilling to destroy their prospects for a first year stubble crop the next year by using the plant cane for seed.

For spring planting the cane must be windrowed, and this is usually placed between the rows on which it has grown. In covering the cane with large plows, the stubbles are greatly injured and therefore are plowed up for another rotation.

For these reasons, the oldest stubbles are used for seed, and until some practical method can be devised by which planting in the field can be carried on "*pari passu*" with the sugar house work and thus enable the planters to have a choice of seed, it is almost useless to discuss the question before a body of Louisiana planters. Fortunately, continuous experiments made now for twelve years, with plants, first stubble and second stubble as seed, show a slight superiority in favor of first year stubble. There are growing on the experiment station pedigreed experiments covering ten years of selection from plant, first and second stubbles. In other words, the seed used for plant has been selected stalks from a plant cane started at Kenner ten years ago. So, too, with the other kinds. Three plats of each are annually carried, plant, first, and second year stubbles of each

series. The seed for the plant is selected from the plant experiment of the plant plat. The seed for the first stubble experiment of each year is selected from the first stubble experiment of the first stubble plat, and seed for second stubble from second stubble experiment in the second stubble plat. Yearly each experiment of each plat is harvested, weighed, analyzed and recorded, and already there are ten annual records, each one covering the three stages of each, plant, first stubble and second stubble. It is designed to carry on these experiments like those described under "What Part of the Cane to Plant," indefinitely in order to test if there be a slow and gradual change recognizable in the course of years.

By closely studying the history of cane planting, it will be found that in all ages and all countries cane has been propagated by planting the tops of stubble canes. May not this custom have superinduced in the cane a stronger vitality in the tops over the butts and in the stubble over the plant? Has the Darwinian doctrine of "selection" and "inherited habit" had a full opportunity of here asserting itself? If stubble cane be the best for seed, may not the fact be accounted for upon these purely scientific reasons?

Cutting Cane at Planting.

It has been clearly demonstrated by numerous experiments that there is no physiological benefit accruing from cutting the cane at planting. Whatever benefit that apparently may arise from this practice, now almost universal, must be ascribed to care and efficiency of work in planting and covering, and to the decreased risk of unearthing the cane during early cultivation, especially when the latter is crooked. When cane has to remain underground all the winter, it is best not to cut the cane at all if its physical condition will permit such a procedure, since every cut produces a wound which more or less induces fermentation and decay. (See Prof. Dodson's studies given elsewhere). It is the belief of those who practice cutting, that when an eye on an entire stalk starts vigorously into growth it can and may injure the vitality of the other eyes, and hence they recommend cutting the cane to prevent this destruction. The anatomy of the cane given elsewhere, showing the independence of each joint, refutes this opinion. Again, a number of experiments conducted by the station has shown the fallacy of such a conclusion. In planting entire stalks of cane it is difficult to cover each eye to the same depth. Those near the surface germinate first, while those at the greatest depth may never germinate at all, though perfectly sound and healthy, because the conditions necessary to germination at that depth are not secured, and

the earlier sprouts near the surface are cultivated, and with each cultivation more dirt is thrown on them, which covers deeper the sound but ungerminated buds. Frequently in digging deep stubble, after the ancient method with grubbing hoes, these eyes are found sound on the old mother cane which have been germinated after a burial of over twelve months. With a view of throwing positive light on this subject, a series of experiments of two stalks each were planted at increasing angles to the horizon. The first one was placed in a horizontal furrow. The next canes were placed so that the tops were three inches, and butts six inches deep. Then with tops and butts at the following depths: No. 3, three and ten inches; No. 4, three and fourteen inches; No. 5, three and sixteen inches; No. 6, three and seventeen inches; No. 7, three and eighteen inches; No. 8, three and twenty inches; No. 9, three and twenty-one inches; No. 10, three and twenty-two inches; No. 11, three and twenty-four inches. The stalks of cane were then reversed leaving butts near surface and burying the tops as follows: No. 12, tops eighteen and butts three inches; No. 13, tops twenty-two and butts three inches; No. 14, tops twenty-four and butts three inches, and No. 15, canes perpendicular, tops up and butts down. Canes of about four feet in length with apparently sound eyes, were placed in trenches prepared as described above, on March 13th. On November 14th and 15th they were all carefully dug up, growing canes removed and counted, the mother stalks carefully washed, and each eye examined as to germination and soundness. The following abbreviated results are given:

No. 1. All eyes germinated; mother canes rotten.

No. 2. Mother canes rotten; seventeen matured stalks from eighteen eyes; one stool coming from eye deepest buried (six inches).

No. 3. One mother cane rotten; other perfectly sound, with two well preserved sound eyes on it; a stool each from eyes at six inches, eight inches and ten inches (lowest eye).

No. 4. Both mother canes sound; germination excellent; stools on one stalk from eyes at 6, 10 and 14 inches, with one sound eye.

The other stalk had its lowest four eyes started, but not yet to the surface; with stools from eyes at 6 and 10 inches. One eye dead at depth of 8 inches; rest all germinated.

No. 5. Both mother canes rotten; only 12 stalks of cane; lowest eye germinated was at 6 inches.

No. 6. Mother canes rotten; 21 stalks of cane; stools from eyes at 6, 8 and 12 inches.

No. 7. Mother canes rotten; stools from eyes 4 and 12 inches, and a living sucker not yet out of the ground from a dead sprout evidently smothered in the spring.

No. 8. Mother canes rotten; stools from eyes 14 and 15 inches deep.

No. 9. Mother canes rotten; no sprouts.

No. 10. One mother cane rotten and no eyes germinated; other perfectly sound with thirteen stalks and three eyes still good.

No. 11. One mother cane rotten, with only three stalks from second eye (5 inches); other cane perfectly sound with stools from eyes 3 to 12 inches. Five eyes developed on lower part of cane into short sprouts, but had been smothered; two eyes still good.

No. 12. Mother cane sound; one stool from an eye 24 inches deep, running out from mother cane at angle of about 45 degrees, until 17 inches long and then shooting perpendicularly up, forcibly illustrating power of vitality in vigorous canes. Three eyes on the two canes perfectly sound.

No. 13. Mother canes rotten; stools from eyes at 6 and 8 inches.

No. 14. Mother canes rotten; stools from eyes 8 and 10 inches.

No. 15. Cane still sound; every eye from eighteen inches up germinated, growing 21 fully developed canes. After digging up it was a curious sight, resembling an umbrella inverted by the wind, only ribs were placed at regular intervals along the stalk. At 25 inches a perfectly sound eye was found. Below, the stalk was rotten; above perfectly sound.

The sound eyes found were planted in a box in a warm laboratory, and in every instance germination was effected. It is believed that the rotten stalks found were due to defective seed. The best seed had been used for the general crop, and the stalks for these experiments were selected from the refused pile.

However, the experiments are conclusive and fully controvert the opinion that an eye starting early in growth, destroys the vitality of other eyes on same stalk unfavorably situated. The immense power of vitality resident in a good eye, is forcibly shown. The season was a dry one and favorable to the experiments; the seed cane, however, was inferior.

The above strongly emphasizes the selection of good sound canes for seed and suggests that the failure to get enormous stands from thick plantings may be due largely to defective seed.

It is yet uncertain whether cutting, so disastrous to fall planted canes, is equally so to those planted in the spring. No experiments have been made to determine this question.

CHAPTER XVI.

MANURIAL REQUIREMENTS OF SUGAR CANE.

Commercial fertilizers are valued chiefly for one or more of the following ingredients: Nitrogen (ammonia), phosphoric acid, and potash. They should be used whenever crops are grown which do not attain their maximum production on account of a deficiency in the soil of one or more of the above ingredients. But the deficiency of plant food is not always the cause of small returns. Water, as already remarked, so essential to crops and needed sometimes in great abundance, is frequently on our soils, and in this climate productive of great harm. Hence drainage for its speedy removal is absolutely essential. A drought, on the other hand, may call for irrigation. Want of porosity, so common on our black lands, seriously impedes root development.

Some soils bake or cake after every hard rain, and thus, by excluding the air and checking evaporation, work disaster to the plant. A great defect with many of our sugar soils is the impermeability of surface water, forming, unless high ridges with deeply plowed middles prevent, stagnant water at or near the surface, which brings disaster, and sometimes death, to a rapidly developing plant.

Humus, so essential to every soil in this climate, is frequently badly needed.

Climatic conditions of a purely local character may temporarily prevail, such as alternations of temperature—hot, parching winds, as in southwestern Kansas, often destroying a crop in a few days.

It may therefore be asserted that whenever a soil from a physical, chemical or climatic defect, forbids the growth of large crops, even when well supplied with fertilizing ingredients, then the application of commercial fertilizers is a waste. The amelioration of its environments is now more needed by the plant than manures. It is better to seek a remedy in drainage, irrigation, deep plowing, better cultivation, harrowing, hoeing, incorporation of vegetable matter, etc. After these ameliorating conditions are established,

then, and not till then, should a liberal use of fertilizers be practiced. It must be remembered that every improvement in the quality of the soil increases its capacity for absorbing large quantities of manure and its transmutation into maximum crops. Heavy plant growth and excellent soil culture mean an enormous conversion of plant food into crops. Where the largest crops are produced there will be the heaviest demands for manure. Hence rich soil can successfully appropriate heavy applications of fertilizers, while poor soils must be fed with great care. Perfect all the other conditions of heavy plant growth and then there will be a demand for commercial fertilizers, not a demand to appease hunger, but one to fatten. In fattening domestic animals, all of the conditions of digestion are first perfected and then they are given all they will eat, not what they need. The object is to transform a larger amount of plant food into fat and muscles within the animal's frame than is required for its maintenance, and this is accomplished by a carefully compounded ration known to be digestible and palatable. So in farming, whenever practicable, plants of known capacity for absorbing fertilizers should be cultivated, and then these plants should be stimulated to a most intensive assimilation of plant food by the application of suitable manures. While the better class of soils always respond more liberally to fertilizers than poorer ones, still the latter, under favorable conditions, often yield remarkable results. Great care should be exercised to see that the favorable conditions are fully attained, and unless they are, very unsatisfactory results may follow the use of commercial fertilizers. Sometimes the use of fertilizers overcomes the unfavorable surroundings. They cause a larger and deeper root development in early growth and thus enable the plant to withstand a subsequent drouth. They frequently cause an early shading of the ground thus preventing surface hardening and encouraging nitrification, and with the sugar planter, enabling him to give an early "lay by" to his crop.

These brief remarks are made to suggest to some planters the cause of their failures sometimes in the use of commercial fertilizers. They may ascribe the failure to the worthlessness of the fertilizer used when it should be ascribed to some defective quality of the soil, rendering it incapable of appropriating the applied fertilizer.

An examination of the cane plant by Prof. Ross revealed the fact that for each ton of cane removed from our soil, with the tops and leaves left in the field which are subsequently burnt, there are removed 3.4 pounds nitrogen, 1.48 pounds phosphoric acid and 2.17 pounds potash. A

crop of thirty tons will therefore remove about 102 pounds nitrogen, 45 pounds phosphoric acid and 65 pounds potash. How much of these ingredients are supplied by our soils? This question can only be answered by experiments. For twelve years the Sugar Experiment Station has tried to solve this problem by a series of systematic experiments. Three permanent plats have been dedicated to replies to this question known respectively as the nitrogen, phosphoric acid, and potash plats. These plats have been divided into twenty experiments, and the question asked of the

"Nitrogen Plat"

is: "Does this soil need nitrogen to grow cane successfully?" "If so, what forms of nitrogen are best adapted to the wants of cane and soil, and in what quantities shall they be supplied?" The form of nitrogen used were "Nitrate of Soda," Sulphate of Ammonia, "Cotton Seed Meal," Dried Blood, Fish Scrap, and Tankage. These were used in such quantities as to furnish twenty-four and forty-eight pounds nitrogen per acre, former experiments having demonstrated that larger quantities could not be appropriated in our average season. These forms were used alone, and combined with excessive quantities of phosphoric acid and potash in highly available forms. At regular intervals through the plat there were left experiments unfertilized to test the natural fertility of the soil, and with each group of nitrogen experiments was attached one containing only phosphoric acid and potash. These experiments have been conducted on this plat for eight years and will be continued indefinitely in the future. The results up to date show conclusively, that this soil needs nitrogen to grow cane successfully, and while sulphate of ammonia has shown annually slightly better results, the high cost gives no advantage over the lower priced forms. Cotton seed meal comes next to the sulphate of ammonia, followed closely by dried blood and nitrate of soda. Fish scrap and tankage are slightly behind the rest, for reasons assigned below.

It has been found also that but very few of our seasons give us rainfalls in quantity and distribution sufficient to enable the cane plant to appropriate 48 pounds of nitrogen. Hence a larger quantity is excessive, and it may be waste. It is therefore safe to recommend quantities of nitrogen varying between 24 and 48 pounds per acre for our cane crop. Again, different soils and different kinds of cane require varying quantities of nitrogen. Plant cane upon pea vine land, will not require the same amount as upon "succession" land, i. e., upon soils from which a crop of stubble

cane has just been taken and which has been continuously in cane for years without the intervention of a leguminous crop to restore the nitrogen. Indeed such soils are frequently in an execrable physical condition, which not only precludes the possibility of themselves furnishing plant food, but also prevents them from assimilating much of that presented in the form of commercial fertilizers. Hence the unsatisfactory results from manuring succession canes, so often experienced by planters. It is doubtful whether one-half of the plant food applied to succession canes in commercial fertilizers, is recovered in the canes in the average season.

Pea vine lands put in plant cane, on account of their excellent physical conditions, not only yield up readily the nitrogen stored up by the peas, but can also assimilate large quantities of plant food supplied as fertilizers. Hence such canes usually make large crops.

Since nitrogen is the chief ingredient taken from the soil by a crop of cane, it follows that with each successive crop of cane grown on the land, without the intervention of a restorative leguminous crop, there arises an increased demand for nitrogen. Hence stubble canes require larger quantities than plant cane, and the older the stubble, the larger its requirements for this element to make a given tonnage.

EXPLANATION OF THE FORMS OF NITROGEN.

Sulphate of Ammonia, is a by-product in the manufacture of coal gas of cities. It is the recovered nitrogen stored up in the plants, which made the coal, ages ago. It is the most concentrated form of nitrogen found on our markets, containing 21 pounds in every 100 pounds of the salt. It is especially adapted to sugar canes on clayey soils, giving larger returns than any other form. Its high price, however, will always prevent its extensive use. Its present price is from \$60.00 to \$80.00 per ton. It is used, like nitrate of soda, as a top dressing for small and stunted canes, with most excellent results.

Nitrate of Soda, is a partially refined product from the mines of Chili and Peru, and contains 15 to 16 per cent. of nitrogen. The output of the mines is controlled by a syndicate which regulates its price. Hence its values change but little from year to year, its present price being about \$40.00 to \$50.00 per ton. It is the most soluble form of nitrogen and should be used with great care to prevent loss. Small quantities at short intervals applied as a top dressing, are frequently used with excellent results on grass lands. It

is believed to be too soluble, in this climate of heavy rainfall, for the best results.

The above, sulphate of ammonia and nitrate of soda, are mineral forms of nitrogen.

Of the vegetable forms of nitrogen available to our planters, cotton seed meal is by far the most extensively used. Sometimes a ton or two of castor pomace finds its way to Louisiana, but the aggregate quantity used as a fertilizer in this State is so small that a discussion of its merits may be omitted.

Cotton seed meal is a by-product from the cotton seed oil mills. Cotton seed are first hulled, and the kernels, after being steamed, are subjected to hydraulic pressure to remove the oil. This leaves, cotton seed cake, which is largely exported for use as a cattle food in England and continental countries. Nearly three-fourths of the products of our mills are thus disposed of. The remainder is consumed in this country, both as a food stuff and fertilizer. However, for use in this country, the cake is ground into a fine meal and sold on our markets as "Cotton Seed Meal." When fresh and free from hulls, it has a bright yellow color, oily appearance and nutty odor. The presence of comminuted hulls darkens the color and lowers the percentage of nitrogen. Age and ferments also darken the color without lowering the content of nitrogen, and therefore cause little or no injury to it for fertilizing purposes, but seriously destroy its feeding values, converting the nitrogenous matters into poisonous ptomaines.

Cotton seed meal has an average composition of 7 per cent. nitrogen, 3 per cent. phosphoric acid and 2 per cent. potash. Being a southern product, the prices paid by our planters may be regarded as initial value, without charges, insurance and freight necessary to place it on the world's markets in competition with other forms of nitrogen. Therefore, it may be asserted that it is to our planters the cheapest form of nitrogen. Occasionally, with low markets elsewhere for fertilizing material, tankage, fish scrap, etc., may find purchasers in our midst at prices for its nitrogen content slightly below the prevailing rate for nitrogen in cotton seed meal; but as a rule, the cost of nitrogen in cotton seed meal to our home planters is less than in any other form. Experiments in the laboratory upon the different forms of nitrogen have shown that next to the mineral forms (sulphate of ammonia and nitrate of soda) stand the vegetable, in their order of availability as plant food. Cotton seed meal especially was shown to have a high co-efficient of availability, as much as 78 per cent. of its nitrogen having been appropriated directly as plant food the first year.

It is, therefore, extremely gratifying to our planters to know that a home product furnishes them with the cheapest and best form of nitrogen.

The following animal forms of nitrogen are found on our markets: (1). Dried blood; (2). Tankage and (3) Fish scrap.

Dried blood is a by-product of our slaughter-houses and comes into markets under two heads, Red blood and Black blood. The former is dried slowly at a low temperature, and is believed to be slightly more available than black blood which is rapidly dried at high temperatures by steam. Dried blood contains 12 to 16 per cent. of nitrogen, with practically no potash or phosphoric acid. It is the most available of animal forms of nitrogen, ranking in the trials given above, next to cotton seed meal.

Tankage, is a mixture of the refuse of the slaughter-houses and consists of dried blood, pieces of meat, particles of bone, etc., all of which have been "rendered" to remove the oil or fats, and the residue is then dried and ground into fine powder and sold as tankage.

Tankage must be examined from two standpoints to determine its value as a fertilizer, viz., Mechanically and chemically. On account of the bone present as a constant ingredient, a mechanical analysis is always in order, since the availability of bone, slow in its best condition, is believed to be directly as its pulverization. Fragments of bone, or even coarsely ground bones, are very slow in decomposing. "Too slow in this busy age when every hour must chase its sixty minutes to its death." Therefore, it is of first consideration that all tankage be very finely ground.

Chemically, tankage is a mixture of blood and meat, substances rich in nitrogen, and of bone high in phosphoric acid. Therefore, it may vary greatly in composition, between wide extremes; bone with 4 per cent. nitrogen, and 24 per cent. phosphoric acid, and blood with 16 per cent. nitrogen (only). Usually it is sold, as it should be, by chemical analysis only. The higher the nitrogen content, the more valuable the tankage, both in dollars and cents, and in availability in the field, since this high content indicates an excess of dried blood or meat, both highly available forms of nitrogen, over bone, a very slowly available form.

When an analysis of tankage is given, the percentage of bone present may be roughly calculated. Suppose analysis show 9 per cent. of nitrogen and 9 per cent. phosphoric acid, what part of tankage is bone? Bone contains on an average, 4 per cent. nitrogen and 24 per cent. phosphoric acid. Therefore, the nitrogen corresponding to the 9 per cent. of phosphoric acid is 1.5 pounds, calculated by

following proportion: $24 : 9 :: 4 : x = 1.5$ pounds. Since there are 9 pounds of nitrogen present, and 1.5 pounds of this adheres to the bone, then 7.5 pounds, or the remainder, comes from the blood and meat. Since 100 pounds of bone contain 24 pounds phosphoric acid and 4 pounds nitrogen, therefore, it will require 37.5 pounds of bone to furnish the 1.5 pounds nitrogen and 9 pounds phosphoric acid found in the tankage. Therefore, the tankage consists of 37.5 parts of bone and 62.5 parts of blood and meat scrap.

This example is given to illustrate the difference in values between different grades of tankage and to show that its value as a fertilizer largely depends upon the amount of nitrogen furnished by the blood and meat scrap, and not that supplied by the bone. Tankage is a popular fertilizer with our planters just now, and the difference of opinion prevailing as to its value is doubtless largely due to the difference in composition of the various brands offered on our markets. Low grades are universally unsatisfactory in their results, while high grades frequently give most excellent returns.

Fish Scrap, the dried and ground residue from fish after the oil has been extracted, is used more to ammoniate manipulated fertilizers than as a direct fertilizer in the South. Like tankage, its value depends upon the relative proportion of meat to bone in the fish worked. A part of the nitrogen always present, is inherent in the bone and is therefore, not as available as that in the meat. The action then of fish scrap as a fertilizer is necessarily slower than the highly active forms of cotton seed meal and dried blood.

NITRIFICATION.

It must be borne in mind that all of the above fertilizers, save nitrate of soda, must be decomposed and converted into soluble forms before they can be appropriated as plant food. This process of conversion is usually denominated as "nitrification."

Nitrification must go on in every cultivated soil in order that plants may grow therein, and the more rapid this nitrification, "*ceteris paribus*," the greater the growth of the plants in a given time. The process of nitrification is accomplished through the work micro organisms (bacteria) of which there are three different types. 1st. Those which convert nitrogenous matter into ammonia. 2d. Those which convert ammonia into nitrous acid, and 3d. Those which convert nitrous acid into nitric acid. Each of these are necessary to the complete transformation of cotton seed meal, dried blood, tankage, etc., into nitric acid, the form of nitrogen chiefly available as plant food.

It should be the aim of every cultivator to maintain his fields in conditions most favorable to the development of these soil ferments, upon whose activity, not only the plant food already in the soil, but also that applied in the form of fertilizers, depend for their solubility. The conditions for the rapid multiplication of these ferments are given in the chapter on cultivation. It will be apparent, however, from the above, that it is a misuse of fertilizers to apply them to soils that have been badly plowed, imperfectly drained and in bad tilth. Every planter before resorting to the use of fertilizers, should see that the soil upon which they are to be applied should be in a condition to aid in the most rapid nitrification possible. Only by the observance of conditions most favorable to nitrification, can the full effects of the applied fertilizer be obtained.

NITROGEN REQUIRED IN A ROTATION.

From investigations made by this station, a crop of cow peas when turned under at the proper time, will add at least 100 pounds of nitrogen per acre, most, if not all of which, it is believed, is gathered from the air. The average crop of plant cane grown upon pea vine land is not far from thirty tons per acre. The first year stubble following this plant, should give twenty tons per acre, and if kept for the second year stubble, a crop of at least 15 tons per acre should be obtained. The three years cropping would give 65 tons of cane which, together with tops and fodder (which are burned) would remove from the soil 221 pounds nitrogen. Of this amount, 100 pounds would be furnished by the peas, most of which would go to the plant cane, leaving 121 pounds to be supplied by fertilizers in order that the soil may retain the original fertility. It will require over 1,700 pounds of cotton seed meal to supply this quantity of nitrogen, or 970 pounds for first year stubble and 730 pounds for the second year stubble. These quantities are usually in excess of practice, because there is a certain amount of nitrogen furnished by the soil every year, and secondly our crops of peas give frequently larger quantities of nitrogen than given above, and, lastly, such tonnage through three years are rarely obtained. However, this will serve as an illustration of the value of nitrogen to the sugar cane crop.

Phosphoric Acid Plat.

Similar questions as to the requirements of this soil for phosphoric acid, to those given under nitrogen, have been propounded to this plat, viz.: First—Does this soil need phosphoric acid to grow cane? Second—If so, in what form can it best be prescribed? and Third—In what

quantities per acre? The forms of phosphoric acid used were, "Dissolved Bone Black," "Acid Phosphate," "Ground Bones," "Thomas Slag," "Charleston Floats," and Natural Phosphates or Guanos. They were used in such quantities as to furnish thirty-six and seventy-two pounds of phosphoric acid per acre. Larger quantities than seventy-two pounds per acre have proven by experiments to be unprofitable. These forms were used alone, and combined with excessive quantities of nitrogen and potash. The most available and adaptable forms to cane were used, viz: Sulphates of Ammonia and Potash. As in other plats at regular intervals, there were the usual number of unfertilized experiments, and experiments containing only Sulphates of Ammonia and Potash. Like the Nitrogen experiments, these have already extended over eight years, and will be continued indefinitely. The results so far indicate positively the value of phosphoric acid in manures for sugar cane on these soils, but the demand for this ingredient is small in comparison to that for Nitrogen, the smaller quantity given above (thirty-six pounds per acre), proving so far an ample quantity for maximum yields. Results further show that the soluble forms of phosphoric acid are preferred, followed in order by slag meal, and finally ground "floats," etc. Therefore, quantities of phosphoric acid, from thirty to forty pounds per acre, in a soluble form, are to be recommended for sugar cane on our soils. Phosphoric Acid, unlike Nitrogen, can not be drawn from the air by leguminous crops. It is true that the latter, by their deep tap roots, pump it up from the lower strata of the subsoils, and by turning them under as green crops, the phosphoric acid is transferred from the subsoil to the surface soil, and is thus placed within the reach of the roots of the subsequent cane crop. If, however, both soil and subsoil be deficient in this ingredient, recourse must be had to some commercial fertilizer containing it, in order to grow maximum crops. A crop of cow peas can and does supply a soil with nitrogen drawn directly from the air, and in doing so makes a positive addition to the store of fertility in the soil. By its tap roots it may transfer phosphoric acid from subsoil to surface soil, but in doing so it has not increased the stock of plant food on hand, but simply transferred it to a more eligible position for assimilation by cane. Therefore, phosphoric acid is equally needed by both plant and stubble cane.

EXPLANATIONS OF FORMS OF PHOSPHORIC ACID.

Dissolved Bone Black.—Bones are subjected to destructive distillation in the process of "charring," by which the

larger part of their organic matter is driven off, and with it their nitrogen. A part of the carbon existing in bones as organic matter, is now left as charcoal, encrusting each grain of phosphate of lime. When thus prepared it is called "Bone Black," or "Bone Charcoal," which is extensively used in sugar refineries for decolorizing and defecating syrups destined for white sugar. After constant use, the bone black becomes "spent;" i. e., no longer exercises a decolorizing influence upon syrups. It is then sold for fertilizing purposes. Sometimes it is, without further treatment, applied directly to the soil, but without immediate benefits, since the phosphates, being encased in charcoal, are protected from rapid decomposition. To overcome this slow action and render it immediately available, it is treated with sulphuric acid, and the resulting product is "Dissolved Bone Black," a most valuable and available form of phosphoric acid, containing usually about 16 per cent. to 18 per cent. soluble phosphoric acid.

Acid Phosphate.—Formerly Bone Black, Bone Ash, or Ground Bones, were used for treatment with sulphuric acid, but the demand becoming greater than the supply, recourse was had to the newly discovered beds of mineral phosphates, and to-day much the larger quantity of soluble phosphates are manufactured from the mineral phosphates obtained in various parts of the world; South Carolina, Florida and Tennessee each furnishing large quantities annually. These mineral phosphates, after being cleaned from adhering dirt, sand, etc., are ground to a fine powder by the "roller" process, and sold on the market as "floats," or are treated with sulphuric acid and converted into soluble phosphates, which are called "Acid Phosphates," "Superphosphates," or "Dissolved Bones." The amount of soluble phosphoric acid which they carry varies from 10 per cent to 20 per cent., according to the purity of the phosphate from which they were made. If phosphoric acid be used to dissolve the bone black or mineral phosphates, the resulting product will be much higher in soluble phosphoric acid. In this way are made the so-called "Double Superphosphates" which are sometimes found on our markets, and which contain from 40 per cent. to 50 per cent. of soluble phosphoric acid.

In the treatment of either bones, bone black, or mineral phosphates, with sulphuric acid, if enough of the latter be used, all of the phosphoric acid will become soluble in water. The above substances are tricalcic phosphates, containing three molecules of lime to one of phosphoric acid, and are soluble only in acids. They are, therefore, slowly soluble in

soil water, and are not a readily available form for plant food.

Treated with sulphuric acid, they lose two molecules of lime, which are appropriated by the acid, and recover in exchange two molecules of water, leaving one molecule of lime combined with one molecule of phosphoric acid and two molecules of water. The resulting products are now monocalcic phosphates, and are very soluble in water, and therefore readily available to plants.

Should a deficiency of sulphuric acid be used in the manufacture of soluble phosphates, a quantity of the tricalcic phosphate will be left unacted upon by the acid, while another portion will be converted into monocalcic or soluble phosphate.

If this mixture be permitted to remain in bulk any length of time, a chemical reaction takes place, by which a dicalcic phosphate is formed, which is insoluble in water, but soluble in certain salts, notably the citrate of ammonia, and is called "reduced," or "reverted," phosphates. The change is as follows: One part of insoluble phosphate, containing three molecules of lime, and one part of phosphoric acid, reacts upon another part of soluble phosphate containing one molecule of lime and one of phosphoric acid, to form two parts of "reduced," or "reverted," phosphate, which contains two molecules of lime and one of phosphoric acid. These three forms of phosphoric acid are found in every "Acid Phosphate," or fertilizer, containing acid phosphate. They are usually denominated as "soluble," "reverted," and "insoluble," and to the chemist are known as "water soluble," "citrate soluble," and "acid soluble" phosphoric acids. In some States the soluble and reverted are classed together as "available" phosphoric acid, a term which has been adopted by the manufacturer rather than the agriculturist, since the question of availability in the soil is yet an undetermined one and varies greatly with the character of the soil. It is true that the soluble phosphoric acid, when applied to the soil, after a while reverts, from contact with basic principles in the soil, but before doing so it diffuses itself throughout the soil, and by this initial velocity becomes thoroughly incorporated with it, and when precipitated in the reverted form, each particle is so minute as to be readily available to the acid secreting roots of plants. The reverted phosphates being insoluble in water, lack this initial diffusion, and therefore remain in the exact position in which they were placed by the planter. The particles are more segregated and less diffused, and therefore less available.

In buying phosphates, therefore, due regard should be given to obtaining the highest possible content of soluble phosphoric acid.

Slag Meal is a by-product in the manufacture of steel or wrought iron by the "Thomas Gilchrist" process, from pig iron rich in phosphoric acid. The pig iron is melted in converters lined with lime, and when thoroughly melted, the lime unites with the phosphoric acid present, and forms a slag which floats on the surface of the melted iron. This slag is removed, cooled, and ground into a powder, and sold as "phosphatic slag," or "slag meal." Besides phosphate of lime, it usually contains goodly quantities of lime, and therefore cannot be mixed without injury with fertilizers containing either ammonia or soluble phosphates. It usually contains 15 to 20 per cent. of phosphoric acid, and upon some soils, with certain crops, is highly esteemed. It has not proven as valuable under sugar cane as the soluble forms. There is a promise of a large supply of this slag in the near future by the manufacturers who work iron by this process.

NATURAL PHOSPHATES.

Besides the mineral phosphates already described, there are found on the smaller islands of the ocean, immense deposits of phosphates, which require little or no manipulation to prepare them for use. They are believed to be the residues from the deposits of fish-eating birds. In a rainless climate, like Peru, such deposits give us the celebrated Peruvian guano, rich in both ammonia and phosphates. In a rainy climate, such as prevails in the Carribean Sea, the ammonia and other soluble matters have been washed out, leaving only the insoluble phosphates. In such a manner has originated the natural guanos, known as Grand Cayman, Redonda, Orchilla, Carib. etc., all coming from islands in the Carribean Sea. These natural guanos should be used with great care, since they are simply phosphates, and not what their name imports, "guanos."

In selecting phosphates for use, intelligent farmers, both in Europe and America, give preference to "super," or "acid phosphates," a fact evidenced by the ever-increasing demand for these goods.

Potash Plat.

On this plat, the Nitrogen and Phosphoric Acid are the constants, and the form and quantity of potash the variable. Does this soil need potash to grow cane? If so, in what form, and in what quantity, shall it be used? The Nitrogen in this plat has been furnished in the form of Sul-

phate of Ammonia and the Phosphoric Acid in Acid Phosphate. The potash has been supplied in Kainite, Muriate of Potash, Sulphate of Potash, Carbonate of Potash, and Nitrate of Potash. Such quantities of each were used as to furnish 25 to 50 pounds of pure potash per acre. There were also present the usual experiments without fertilizer, and those containing only Nitrogen and Phosphoric Acid. These experiments have extended over eight years, and are being continued.

So far, no results of any character, either in the increased sugar content or tonnage per acre have been visible from the use of any form of potash, upon the alluvial lands of the lower Mississippi. Several forms of potash, notably the carbonate, and ashes of cotton seed hulls, have rather decreased the yield of cane and injured the physical qualities of the soil, by causing it to "run together." That this soil should not require potash in fertilizers adapted to them is to be anticipated from its chemical analysis given elsewhere, which shows an abundance of potash. It is further corroborated by the magnificent growth of white clover, wild alfalfa, and "*melilotus officinalis*," growing luxuriantly over almost every headland, and by the excellent crops of cabbages, red clover, alfalfa (*Medicago sativa*), and cow peas, cultivated more or less extensively throughout this section. All of these plants are known to require large quantities of potash for their best development. Where are they grown better and more successfully than in the alluvial lands of South Louisiana?

In New England and the north of Germany, potassic manures are held in high esteem. The application of potash manure has proven a panacea for "clover sickness" on the soils of Scotland. On soils rich in humus, potassic manures are said to release nitrogen, and thus give excessive growth to plants grown thereon. This is a familiar occurrence to all farmers in the spots where log heaps have been burned. Such spots withstand drouth well, since they are better supplied with moisture by capillarity.

SOURCES OF POTASSIC MANURES.

Formerly ashes and green sand marl (Glauconite) furnished all the potash for commerce and agriculture, but the opening of the Strassfurt and Leopoldshal mines of Saxony have furnished the world with every form of potash. The following are the products:

First—Kainite, a crude product of the mines, containing 12 per cent. of potash, and is a mixture of chlorides and sulphates of potash, soda, and magnesia.

Second—Muriate of Potash, a manufactured article containing 50 per cent. of pure potash.

Third—Sulphate of Potash of varying purity, containing 24 per cent. to 50 per cent. of potash, is also a manufactured article.

From these forms the others, carbonate and nitrate, are manufactured.

How Shall Fertilizers be Applied ?

A rational discussion of the properties of each one of the three ingredients of commercial fertilizers will enable us to intelligently appreciate the proper methods of applying them. Nitrogen, the ingredient most desired by cane plants is the transitory one of commercial fertilizers. It is to-day a gas, forming a part of the atmosphere; to-morrow it is a solid in the plant. It is now an ingredient of soil water, and is either appropriated by plants, fixed by the soil or leached out into springs and rivers, to be finally "in the dark bosom of the ocean buried," there to be abstracted and appropriated by fish, which in time furnishes pabulum for man or manure for plants. The idea of rest or permanence is foreign to the chemistry of this element, as to the atmosphere of which it forms so large a part. Therefore, all nitrogenous manures should be used with care and caution, especially those which contain actual ammonia and soluble nitrates. Therefore, in using Nitrate of Soda, it should be applied as a top dressing only on the growing crop, and at short intervals in small quantities. Sulphate of ammonia is also liable to leaching, but may be lost by excessive use, or application, at an improper time. The organic nitrogenous fertilizers mentioned above must be gradually oxidized and converted into nitrates as explained elsewhere under "Nitrification," before they can become available as plant food. Soil conditions determine largely the rate at which this nitrification takes place, and hence excellent tilth with subsequent frequent and shallow cultivation favor the rapid decomposition of organic nitrogenous fertilizers. Messrs. Lawes and Gilbert have found that cotton seed meal formed, when applied to a soil not too dry, a slow but continuous supply of nitrates. The oil present perhaps cripples the nitric ferment, and prevents too rapid nitrification. As shown elsewhere, nearly all of its nitrogen is available in one season. Dried Blood is a quickly acting manure, requiring only a slight covering in the soil for conversion into available plant food. It may even be used as a top dressing.

Tankage, so far as its content of blood goes, has similar properties. The bone and meat portions, particu-

larly the former, are much slower of action. Fish scrap acts more slowly, and there is no evidence that all its nitrogen ever becomes available. However, in the South, if turned too deeply in a warm mellow soil with moderate humidity, the results are fairly satisfactory. It cannot be profitably used either as a top dressing or when turned too deeply, since in both instances fermentation is prevented; nor will it yield good results in early spring upon cold, damp, soils, but in warm sunshine it may do excellent service upon both corn and cane.

It has been shown elsewhere that soluble phosphates, soon after their application to the soil, revert to insoluble forms. It was also shown that before reversion, its solubility rendered its distribution through the soil more thorough and uniform, thus securing advantages not obtained by other forms of phosphoric acid. In such soils, the roots of crops grow regularly, continuously, and rapidly, and not spasmodically and intermittently, as when they pass through spaces of soils free from phosphates. Again, those micro-organisms, regarded now as essential to soil fertility, and which specially favor fermentations, and which convert inert plant food into assimilable forms, can prosper only when phosphates everywhere abound. Besides, superphosphates are exceedingly beneficial to young crops in hastening them beyond the period when they are most susceptible to the attack of parasitical insects.

Potassic manures are so readily fixed by the double silicates in loams and clays, that it is almost impossible to secure their proper dissemination through a soil. They are, therefore, as a rule, not to be recommended as a top dressing. Properly speaking, they should be applied some time before the crop is planted, so that by repeated plowing and harrowing, they may become well mixed with the soil. However, salts of potash have different diffusive powers in themselves, which are greatly modified by admixture with other manures. Hence, the refinement of fertilization would require that in compounding commercial manures, that form of potash should be used which would be increased in diffusive power by the presence of the forms of nitrogen and phosphoric acid used.

At What Time Should Fertilizers be Applied ?

From what has been said, it is evident that the separate application of each ingredient of commercial fertilizer at such a time and in such quantity as the characteristics of the individual soil and crop would suggest, would be the most scientific course of procedure.

Potassic manures could properly be applied several months before planting a crop. Super or acid phosphates a little before or at the time of planting, while nitrogen should be furnished only to meet the demands of the growing plant, and then only in such quantities as will supply immediate necessities. The above are the suggestions of science, but unfortunately, in our present stage of advancement, they cannot be rigidly followed. The larger part of the supply of our commercial fertilizers are manipulated goods, containing two or more ingredients, and therefore separate applications cannot be followed.

Depth at Which Fertilizers Should be Placed.

As already seen, potassic fertilizers should never be applied on the surface of growing crops, since fixation would occur there and the rootlets of plants never find it. It has been found that the more these fertilizers are diffused through the soil, the better the results obtained. Depths of two to ten inches is the range of cane roots in an average clay soil. Therefore, an application at four to five inches, to be subsequently mixed by the plow and cultivator, will probably be the best depth for all potassic manures. Super, or acid phosphates require a small depth, but a very extended width, covering, if possible, the entire distance to be manured. They should be scattered at a depth of two to three inches over the area to be occupied by the roots of plants.

Nitrates and Salts of Ammonia are always best used as a top dressing—at short intervals, in small quantities.

Dried Blood requires but little depth, provided moisture necessary for conversion into available plant food be present.

Cotton Seed Meal requires a little more depth than Dried Blood, while Tankage, Bones, and Fish Scrap, must be sunk to deeper depths to obtain fermentation necessary to their conversion into soluble plant food.

None of the above should be turned too low, especially in stiff soils, since air, moisture, and heat are the factors needed in decomposition. Here, as elsewhere, in good agriculture the judgment of the planter must decide, after a thorough acquaintance with his soil. Proper depths may vary from two inches in a stiff clay soil to six or eight inches in loose sands.

Conclusions.

Shall our manipulated fertilizers, such as Tankage, Cotton Seed Meal, or complete fertilizers, be applied at the time of planting, or later during growth? Shall they be applied

broadcast, or in drills? Shall they be applied in large, or small quantities? Positive replies to these questions, suitable under all circumstances, cannot be given, and here again the farmer must use his judgment after studying his environment. The following will aid him, however, in deciding: Under

Plant Cane

a small quantity of readily available fertilizer directly under and near the cane is highly beneficial, since the double line of rootlets, which are disposed in concentric rays around the stalk, develop simultaneously with the bud and feed the young shoot. Experiments given elsewhere show the superiority of stalks thus manured over those unfertilized. Especially is this true when the seed is more or less unsound.

Again, the rootlets emerging from the base of the young plant simultaneously with the sucker, finding food at hand, aid greatly in developing a healthy sucker, and thus give the entire plant a vigorous send off in youth. This is especially desirable in Louisiana, where we harvest cane after a growth of a few months, and doubly desirable for that cane destined for the mill in early fall.

In Louisiana, cane is planted from September to April. The planter should decide from the character of his soil, whether the loss from leaching, to his nitrogen, during the winter would be greater than the benefits to his crop, and act accordingly. The simple question is thus presented. Nitrification goes on throughout our entire winters, and if some crop is not present to consume the nitrates formed, they will leach (more or less, depending on character of soil) into the drainage waters, and be lost. Sugar cane grows very little during the winter, and is, therefore, incapable of utilizing much nitrate. Will, therefore, the benefits accruing to the cane be more than counterbalanced by the losses from nitrification and subsequent leaching? Again, it may be said that in fall or winter planting of cane, the good judgment of the planter must be used in determining whether fertilizers shall be simultaneously applied. In spring planting, no doubts exist as to the advisability of placing a small quantity of readily available fertilizer directly under and near the cane, provided two applications can be made—the other in the month of May. If, however, only one application is feasible, let this be made at the time of planting in the spring. It is too necessary to give a vigorous start to a young plant, to withhold manures until you have a stand. Usually the more perfect the incorporation of a manure in a soil, the better the results to be expected,

and therefore in countries where short seasons and flat culture prevail, manures are usually broadcasted and thoroughly mixed with the soil before planting. Such a procedure here would be reckless in the extreme. The character of our lands and the methods of preparation and cultivation, forbid broadcast manuring. The manure must be deposited in an open drill. Into this drill it should be broadcasted, and machines which deposit fertilizers in continuous rolls should be amended by a shaker placed just below each spout, so as to scatter the fertilizer within the open furrow. After scattering, the fertilizer should be well mixed with the soil by a fluke or double mould board plow.

In the spring, after the cane is closely off-barred, the fertilizer, if not applied at planting, should be scattered on both sides of the plant, from the center of row to the off-barred furrow. In reversing the furrow, the manure is covered, and subsequent cultivation will mix the latter with the soil. If the cane has received the first application at planting, the second one should be given in May, on both sides of the row, off-barring lightly with a one-horse plow at a distance on each side of at least one foot from the center of the row of plants.

Stubble Cane

should not be fertilized very long before each sprout has sent out its own rootlets, since prior to this no good could be accomplished, and there would be a waste of manure. The quantity to be used under both plant and stubble cane, has already been discussed.

Upon a pea fallow, plant cane requires but little nitrogen and goodly quantities of phosphoric acid. They should be used in the proportion of at least one of nitrogen to two of phosphoric acid. An acid phosphate containing 14 per cent. of phosphoric acid, mixed with an equal quantity of cotton seed meal, will give a mixture containing these proportions. On "succession" cane, nitrogen should be largely increased for reasons given elsewhere, and may sometimes reach with propriety two of nitrogen to one of phosphoric acid. This is very nearly the proportion that these ingredients occupy in good cotton seed meal, hence the excellent results obtained by some planters on black lands, and with "succession" cane, by the use of this fertilizer alone. Ordinarily, on sandy or medium lands, a mixture of two parts of cotton seed meal and one part of acid phosphate, will be found most desirable. This same mixture will also best serve first year stubble coming from plant cane which succeeds a pea fallow.

In fertilizing cane, due regard should be had for the character of the soil and its ability to furnish the much needed element, nitrogen, and the distance of a crop from a pea fallow.

Knowing these factors, the proportion of nitrogen to phosphoric acid must be varied accordingly, extending from one of nitrogen to two of phosphoric acid, to two of nitrogen to one of phosphoric acid.

Cotton Seed Meal has been used in the above calculations, simply because it is a most excellent source of nitrogen, and a home product. Tankage, or any other form, may be used for the cotton seed meal, by taking enough of the former to replace the nitrogen contained in the latter. Potash is not believed to be necessary in manures for cane on Louisiana soils.

A considerable space has been devoted to a discussion of fertilizers, because there is no element of farm expense so cheap as the rightly compounded manure, especially under cane.

Under this crop, the right manure not only shows itself in the increased tonnage of cane and yield of sugar, but in the increased vitality of the succeeding stubbles.

CHAPTER XVII.

CULTIVATION OF CANE.

In previous chapters, detailed instructions have been given for the preparation of the soil and the planting of the cane. If every operation has been performed carefully, the early spring will find the planter working hard to secure a stand. If his cane has been planted in the fall or winter, the early spring will find the young shoots struggling to penetrate the three or more inches of dirt with which the cane was covered in the fall to protect it against the winter's cold. The earliest work is to remove this excessive dirt, and permit an early and rapid germination of the cane. To this end, two furrows on each side of the row are reversed, and the extra dirt on the top of the cane removed with hoes. In practice, the hoes "find" the embedded cane and leave only a thin layer of dirt, well pulverized, above them. By this treatment, the canes, if good, are soon warmed into a vigorous germination, and continuous stands are soon visible on every row. Some planters "scrape" their canes before off-barring with the plow, preferring to maintain the established winter drainage through high ridges and quarter-drains, until the approach of the usually dry weather of spring. Cane planted in the spring is not so deeply covered, and frequently gives a stand without the aid off-barring and scraping. However, the efforts of the planter are mainly directed in early spring to the securing of a stand of cane, and his judgment, disciplined by experience, will frequently suggest the best methods to be pursued to attain this important end.

Having secured a stand of cane, many planters concentrate their next efforts to the encouragement of suckers, which develop with great rapidity during May and June. Others pay but little attention to the encouragement of suckers, feeling assured that this natural process will go on unaided, and begin at once the work of fertilization and cultivation. If the cane has not been fertilized at planting, the first application should now be made before the furrows are re-

turned to the cane and the middles "burst out." In applying the fertilizer, which is usually placed on both sides of the row in the open furrow made by the two-horse plow, great care should be exercised to see that it is well distributed across the narrow ridge of cane and throughout the open furrows. The proper distribution of fertilizers at this stage of the growth of cane may well be styled "broadcasting in the drills," and the latter should not be too deep, else some of the fertilizer may never become available. At this stage in the cultivation of the crop, many planters use the subsoil plow (see fig. 17) before returning the dirt to the

FIG. 17.—Subsoil plow.

cane. On either side of the narrow ridge on which the young canes stand, in the open furrow made by the two-horse plow, the subsoil plow is drawn by four mules, to the depth of six to ten inches.

The advantages of this subsoiling are not always clearly apparent. Before the invention of good pulverizing turn plows, subsoiling was quite fashionable. To-day it is used in but few localities. Upon our alluvial soils, where drainage is of such prime importance, and in our climate of heavy summer rainfalls, subsoiling must be practiced with judgment and skill, else injury to soil and crops may result. It is safer and perhaps better to precede the cane crop with deep tap-rooted leguminous plants, and let them do the subsoiling. After the fertilizers have been applied and the subsoiling (where practiced) performed, the soil is returned to the cane, and the middles broken out with a large double mould board plow, and quarter-drains opened. Emphasis is laid upon the importance of cleaning quarter-drains immediately after each cultivation, since a heavy rainfall, flooding even temporarily the field at this period

of the growth of the cane, may inflict an injury upon the soil which may last through the season and materially lower the yield of cane. Not only the tilth, for which all the previous operations of plowing, etc., have been conducted for the purpose of establishing, will be destroyed, but the bacteria upon whose activity the plant relies for food, will be literally drowned by the million, and time will be required for their restoration. Many cultivations will also be necessary before the conditions known as "tilth" will be re-established.

Having returned the soil to the cane and split out the middles, the process of cultivation begins. It has not been very long since the two-horse and four-horse plows were the only implements used in cultivating cane in this State. Within the last ten or fifteen years the cultivator has been introduced, and to-day may be found on nearly every plantation. Many varieties are used, covering the double shovel solid, and sectional disc patents. Since the cane rows are usually six to seven feet wide, these cultivators cannot reach more than three to four feet around the cane. Hence, the middles of the rows are worked with the two-horse and four-horse turn plows, or with the double mould board plow. A few planters still prefer the turn plows for all operations of cultivation, and use them continuously for "off-barring and throwing back the dirt," until the cane is laid by. The first plan of combined cultivator and plow, is partly right and partly wrong; the second one wholly wrong.

Experiments in different methods of cultivation conducted at the Sugar Experiment Station through several years, have shown that the exclusive use of cultivators has annually increased the yield of cane over ten tons per acre, and the sugar product 700 pounds. The following is an outline of the method pursued, from the preparation of land to the lay-by of the cane: The land is broken "flush" with a large plow (now use the Disc Plow), pulverized with a harrow, and bedded with two-horse plows. The rows are opened with a double mould board plow, cane planted and covered, and the middles broken out with the double mould board plow. The quarter-drains are opened six inches below the middles of the rows, and ditches cleaned. At the proper time the cane is off-barred with two-horse plows, scraped with hoes, and when large enough, is fertilized by scattering the mixture across the open furrows and narrow ridge of cane. The dirt is returned as soon as fertilizer is applied, the middles broken out deep and clean, and the turn plows sent to the barn to remain until the next season. The disc cultivator (fig. 18), with the three small discs on each side, is used for throwing dirt to the cane at the first

FIG. 18.—Disc cultivator.

working, and the middle, or diamond cultivator (fig. 19) for breaking out the middles. In the second and third cultivations, two middle discs replace the three used in the first, and are set at such an angle as to throw the desired amount

FIG. 19.—Middle cult.

of dirt to the cane, and is followed each time by the middle cultivator, thus completing the work with the two implements. At lay-by, the large, or "lay-by," discs are used, followed by the middle cultivator, with its two front shovels removed. By proper adjustment of the two instruments, ridges of any desired height can be made, and the cane properly laid by.

Some contend that insufficient dirt is thrown to the cane for the preservation of the stubble. In reply, the station would point to a most excellent stand of three-year-old stubble now growing on its grounds, which has been thus treated from planting, four years ago.

The rationale of this method will be apparent by a discussion of the principles underlying general cultivation of crops; and our soils and crops should not be exceptions.

If the work of preparation has been performed as described in a previous chapter, subsequent planting and cultivation are easy processes. If badly done, then subsequent cultivation is not, properly speaking, cultivation at all, but efforts in the direction of securing that tilth which a good preparation would have insured. An excellent preparation always secures tilth, and after cultivation should be simply a maintenance of this tilth.

Some of our readers may desire a definition of tilth. In reply, would say that the word involves two principles, viz.: first, the maintenance of such conditions as will promote the most rapid and beneficial chemical changes in the soil, and second, the conservation of the proper amount of moisture.

The chemical changes in a soil are most complex. Formerly the soil was regarded as dead, inert matter, totally devoid of life, and until recently there was no suspicion of living organisms within it, except the plants that emerged therefrom. But the up-to-date agriculturist now knows that every well cultivated and fertile soil is penetrated with living beings—in fact, a living mass of matter. The mineral part of the soil is to-day regarded as the environment of living organisms, from which the latter may draw a part of its sustenance. While air, water, and mineral matter furnish the materials of plant growth, they must all be digested before they can be assimilated. The mineral matter of every soil must suffer complete disintegration before assimilation, and the only forces so far known capable of accomplishing this work are the secretions of the plants, the vital activity of rootlets, organic acids, and the influence of soil ferments and micro-organisms. It is well known that soil ferments are intimately associated with the rootlets of some plants, and hence the leguminous plants are selected for soil improvement. Hundreds of micro-organ-

isms exist in every fertile soil; some are useful to vegetation, some are noxious. In butter making, it has been found that certain bacteria ripen cream, while others prevent, and the former are now specially prepared on a large scale in the laboratory of the chemist and furnished as bacteria No. 41 to the butter makers of the world. So in the soil it has been discovered that organisms favorable to the preparation of plant food are accompanied by others nearly allied, whose chief function is to destroy the work performed by the former. The object, then, of science, is to discover some process by which the former may be multiplied and the latter destroyed. Accompanying the ferments already mentioned, are sometimes found others of a pathogenic nature. Epidemics among men and animals are frequently due to germs which preserve their vitality in the soil, and passing with plant structure, or into wells or springs, are thus conveyed to animals and men, producing disease. Typhoid fever, lockjaw, charbon, cholera, and, by many, malaria, now better styled "malaqua," are believed to be thus propagated. The recent spread of charbon throughout the alluvial section of Louisiana, emphasized this fact. Every effort should be made to prevent infecting the soil with the germs of any zymotic disease. Cremation of dead carcasses, and the dejecta of living patients, are the best preventives. Health officials in cities have therefore wisely prohibited the use of sewage for agricultural purposes.

The attention of bacteriologists has been devoted almost exclusively to the study of the nitrifying organisms of the soil, and these only in their relation to the collection and preparation of nitrogen as plant food. It is believed, however, by some, that all plant food of every character is the work of micro-organisms within the soil. The relatively high price for nitrogen (or ammonia) in our fertilizers has been the cause of the patient investigation of bacteriologists along the exclusive line of nitrifying and denitrifying germs. Nitrogen is the most costly ingredient of plant food. It is the most fugitive. Our largest supply comes mainly from organic matter, which by a process of oxidation through the work of organisms, is converted into nitric acid. The salts of nitric acids, are extremely soluble, and if not utilized at once by growing plants, are washed out by heavy rains. Hence, a gradual development of nitric acid during the period of growth of plants, and the process by which this oxidation is accomplished, is called "nitrification." This oxidation is going on in every fertile soil, and when stopped, even though the soil be rich in vegetable matter containing nitrogen, the plants thereon must also stop growth.

The nitro-bacteria taking part in complete nitrification are of three distinct types of genera: First—Those which convert nitrogenous matter into ammonia. Second—Those which convert ammonia into nitrous acid. Third—Those which convert nitrous acid into nitric acid. Each are necessary to the complete transformation of nitrogenous matter into nitric acid, the form of nitrogen chiefly available as plant food. A complete demonstration of this transformation can be made in any laboratory by analyses of samples of the same soil, after the lapse of a month, the one sterilized and the other not. The unsterilized soil will always give the largest amount of nitric acid. These ferments work together synchronously, each one waiting on the other.

It is the aim of every cultivator to maintain his field in conditions most favorable to the development of these soil ferments, upon whose activity the abundance of his harvests so intimately depends. What are these conditions?

1. They are the most numerous and active near the surface, diminishing in quantity and vitality as one descends. Hence, surface cultivation required for all crops for maximum results.

2. Aeration—an abundance of air needed. The necessity of deep preparation or breaking of land to insure thorough aeration of soil.

3. A high temperature. The maximum activity is developed between 85 degrees and 100 degrees. We all know how rapidly plants grow when both days and nights are warm, and how they are checked by a fall of temperature.

4. The absence of light. While parts of plants above the ground require sunlight for their functional full activity, these soil ferments diminish in activity to the vanishing points as the sunlight intensifies. Hence shading the ground in any way enables them to work nearer the surface, and warm nights are more favorable to their development than warm days. Hence many plants make phenomenal growth during warm nights.

5. A certain amount of moisture. Excessive moisture must be removed by drainage, since it excludes air needed for nitrification, yet a certain amount is indispensable to these ferments. For the most rapid work, experience has shown that from one-third to one-half of the capacity of the soil is the proper amount.

6. Since the final action of these organisms results in nitric acid, it is necessary that there be present in the soil some base which can neutralize it and prevent its accumulation in the soil; killing the ferments and injuring the growing plants. Some lands will produce neither ferments nor

crops, while limestone lands are everywhere very fertile. Hence, small quantities of lime or some other base, is essential to nitrification.

7. The most essential condition of all, the presence in the soil of some organic matter containing nitrogen. If the soil be deficient in this, it must be artificially supplied in some form—stable manure, cotton seed and meal, dried blood, fish scrap, etc. The use of stable manure and compost as a manure is doubly valuable. They not only supply directly the plant food, but nitrifying organisms of a particularly vigorous character in great numbers, and the latter, when incorporated with the soil, together with their progeny, exercise their activity upon the inert nitrogen of the soil, when the more nitrifiable portions of the manure are exhausted. Hence, stable manure and compost produce fertilizing results beyond what was expected from the quantity of plant food contained therein. Even our poorest soils are found by chemical analyses to contain plant food amply sufficient for remunerative crops, and this addition of “ferments” by the compost renders much of it available. It may be asked here whether much of the infertility of some of our soils may not be due to the absence of these ferments, and, if so, cannot they be supplied? In reply, I say, certainly. Different soils vary greatly in the quantity and vitality of these ferments, and frequently good results have followed the thin sprinkling of a rich garden loam over a poor field. This has been frequently done on reclaimed swamp lands, rich in vegetable matter, sterilized by long inundation. A dose of lime and a small quantity of ferment scattered over them, have quickly converted them into fertile soils.

But science has gone further and prepared the way commercially for another class of fertilizers which are now on the market. Professor Nobbe, Director of the Experiment Station at Tharandt, Saxony, is now preparing for the market “pure cultivation of the bacteria.” The preparations consist of “colonies of the bacteria on agar gelatine enclosed in sealed bottles, each of which contains organisms enough for a half acre of land.” These preparations are diluted in water and sprinkled over the soil, or over the seed to be sown, or diluted in water and then mixed with about fifty pounds of the soil, and the mixture scattered over the land. He has named the preparations from the roots of seventeen different legumes, “Nitrogen,” and they are for sale on the market.

Years ago, Sir Bennett Lawes, in a public lecture to farmers, remarked that “the day was not far distant when a man could carry all the fertilizers needed for an acre of

land in his vest pocket." A wag in the audience replied, "yes, and carry the crop from the acre to the barn in his coat pocket." We are about to realize the truth of Dr. Lawes' remarks, and we await with curious solicitude to see if experiments will verify the predictions of the wag. Be this as it may, it is now certain that we can seed a soil with nitrifying germs.

Besides producing nitric acid from organic matter through nitric ferments, the leguminous plants, particularly our own cow pea and some cryptogams, have, through the colonies of bacteria which infect their roots, the power of converting free nitrogen of the air into plant food, and it is also believed that other organisms which are capable of oxidizing free nitrogen of the air, exist in soils that are devoid of organic nitrogen.

As I have remarked, these beneficial bacteria are accompanied by ferments inimical to agriculture; e. g., a ferment has been discovered which will decompose nitric acid, and has been styled "denitrifying ferment." A study of this ferment has developed the gratifying fact that under favorable circumstances they are not propagated in such numbers as to prove destructive. From the above it can readily be seen how cultivation tends to maintain the conditions for rapid nitrification.

Many beneficial effects of cultivation can now be easily explained. We cultivate shallow because such a process not only prevents destruction of roots of the plants, an evil always to be avoided, but also because nitrification takes place in the upper layers of the soil, and by the act of cultivation the ferment is well scattered. Again, the temperature at which fermentation is most active is about 90 degrees to 100 degrees, and this temperature obtains in the upper layers of the soil. The action of the ferment is suspended at or about 50 degrees on the one hand, and 150 degrees on the other. It is destroyed by high heat and electricity; hence, when lightning strikes a soil, nothing will grow where it struck for some time afterward. The presence in small quantities, of lime, highly favors nitrification. Moisture in excessive quantities excludes the air and suspends the vital activities of the ferment; hence the necessity of drainage. The absence of moisture is equally as objectionable, and here the second object of cultivation promotes the first.

From these considerations it will be seen that frequent cultivations, provided no roots are cut, are favorable to rapid nitrification. Soils cultivated daily produce better than the same soils cultivated weekly, and the latter better than those cultivated less frequently.

Besides the beneficial effects of rapid nitrification, other chemical changes of great practical value are induced by shallow and frequent cultivation. The soil is a great laboratory, and the chemical changes taking place there are complex and continuous, and frequent stirrings accelerate these changes and give increased available plant food. One practice must be emphasized here as both wise and expedient, i. e., of breaking the crust after every rain to let in fresh portions of air and to aid nitrification, but under no circumstances should it be done while soil is wet, since this destroys, rather than aids, the ferment.

The second object in cultivation is to conserve the moisture. On the approach of a drouth, cultivators should be run very shallow and almost continuously. In this way the thin layer of earth removed from the great mass of soil is laid as a mulch on the surface, and the continuous upward movement of the water through the soil into the air, is checked just below the surface, and the roots of the plants can then appropriate it. The continuity of capillary pores are broken, and the water therefore passing into the air is arrested just below the surface, and is conserved for the use of the plant. Hence, cultivate continuously in dry weather. One other point: finely divided soils have the power (varying according to character from 15 to 23 per cent.) of absorbing hygroscopic moisture from the air, a not insignificant property in a prolonged drouth with heavy dews at night. These are the reasons why we cultivate. With these reasons before us, the question may be asked, which best promotes the above changes and conditions, the cultivator which stirs only to limited depths and never inverts? or the plow which runs six to twelve inches deep, completely inverting the soil and frequently burying plant foods and ferments beyond resurrection for the growing crop? The plain and candid reply is, the cultivator. Again, but little stress has been laid upon the damage done the cane by the frequent cutting of its roots, by the turn plows, a damage often fatal to good crops, and recognized in the adage among our older planters, "that cane never grew until it was laid by."

It is almost impossible to estimate correctly the annual damage to the cane crop of this State by the use of turn plows in its cultivation. Happily the custom is fast disappearing, and the presence of the middle cultivator on our market, and its trial by many planters this year, gives promise of an early adoption of cultivators alone, as implements suitable for the cultivation of cane.

The element of cost in the use of plow and cultivator has been left to the last; because scientific and practical reasons

were convincing without it. But in this day of strong competition between the new and rapidly developing beet sugar industry, and the ancient, but seriously imperiled, cane sugar planting and manufacturing, every possible economy will be practiced. Only by the adoption of the most improved and economical methods can the tropical sugar cane be maintained in the race with beets.

A comparison of the cost of cultivating a thousand acres with the plow and with the cultivator, will show an enormous balance in favor of the latter. With two good cultivators and four strong mules, from four to ten acres (depending on width of row) of cane can be completely cultivated in a day, whereas, with plows two or three acres per day are reckoned goodly amounts. Again, hoeing, now such an expensive factor in the growing of a crop of cane, can be greatly reduced, if not entirely eliminated (after scraping the cane) by the proper and rapid use of cultivators.

So strong are all the reasons, scientifically, practically and financially, for the substitution of cultivators for plows in the growing of sugar cane, that the assertion is made that all planters will ultimately use them, "if not to-day, they will to-morrow."

Cultivation of the Stubble.

Of prime necessity for securing a good stand of stubble, is the burning of the trash as early after the cane is harvested as possible. The advantages of burning have been given elsewhere and need not be repeated here. After burning, provided the drainage is good, the cane rows should remain high and dry during the winter and ready for off-barring early in February. This latter operation is usually performed with two or four horse turn plows, the stubbles being left on a narrow ridge. Formerly the stubbles were dug with grubbing hoes down to the mother cane and left shaking in the breeze. Happily this custom has very generally disappeared and is now supplanted by the use of an implement called the stubble digger (fig. 20) which is run several times over the stubbles loosening and pulverizing the earth, admitting air and heat and causing early germination of the buds. The stubble digger, when properly operated, is a most effective and economical implement. The rapidity with which it may be operated, covering ten to fourteen acres per day, coupled with the good work performed, makes the cost of digging stubbles very small compared with the old grubbing hoe method. Improperly handled, especially upon very old stubbles, injury may result from its use. Upon old rattoons on the station, it would occasionally pull up a stubble in spite of our best efforts to

FIG. 20.
Bodley—"Mallon" Stubble Digger.

prevent, thus injuring a future stand. However, the amount so injured, especially upon first year stubble, is small and insignificant beside the great saving of cost in the work performed.

Frequently, before running the stubble digger, the stubbles are shaved with an instrument illustrated in fig. 21. By cutting off the tops of the stubbles, the lower eyes are forced out and the succeeding crop of cane is sufficiently low to permit of "dirting" without extra exertions. To make the stubble shaver a safe and effective implement its knives should be kept very sharp. An implement for the rapid sharpening of these knives is illustrated in fig. 22.

Whether stubble shaving should be universally adopted is yet an unsettled question. That there are seasons when it is profitable and proper to shave, all will admit. These seasons are marked by a cold sufficient to injure the upper eyes without damaging the lower ones. By shaving, the injured eyes are removed and the lower ones are placed

FIG. 21.—Bodley—"Mallon" Stubble Shaver.

nearer the surface and more directly under the influence of heat and air, necessary for germination.

If, on the other hand, the soils be not well drained, it will sometimes occur during the winter that the bottom eyes will be injured by contact with stagnant water, while the upper ones will remain unhurt. To shave such cane would be an egregious error. Therefore, the stubble shaver should be used with great judgment, the condition of the stubble after thorough examination being the only guide. The stubble shaver, besides cutting the stubble, cul-

FIG. 22.—Bodley—"Mallon" Knife Grinder,

tivates and pulverizes the soil and leaves it in excellent condition for the future work of the stubble digger. After a stand of stubble is obtained, its future treatment should be identical with that given plant cane.

CHAPTER XVIII.

HARVESTING CANE.

If cane has been properly nourished and worked, it should be laid by in June, or early in July. After lay by, if the drainage has been well established, the cane grows with wonderful rapidity. One by one the red joints appear and by the end of September the growth has been sufficient to furnish seed for fall planting. It is, however, far from being mature and rarely is it in a condition fit for the sugar house before November. It is true that many of our planters are forced into harvest early in October on account of the size of their crop and apprehension of destructive cold during the grinding season, but their yields during this month are always unsatisfactorily small. It is extremely doubtful whether the annual losses from early grinding are not greater than would occur from destructive colds later in the season. Of the twelve years spent on this station, only one winter, 1894-95, has brought a severity of cold, which utterly destroyed the possibilities of making sugar from standing cane. Several bud-killing frosts have occurred, but by windrowing the cane immediately or removing the injured tops, sugar making was prolonged over a month without serious deduction of yields. (See weather report for details). This experience would justify the risk of delay rather than work annually a month upon immature cane. November 1st would seem from experience to be the best time to begin the harvest.

Whenever begun, the force of hands must be largely increased. This is due to the exceedingly expensive and tedious method of cutting and loading the cane. The cane is cut by hand labor, each stalk receiving the same attention. The cutter seizes the cane near the top, with his left hand, strips it of its foliage with the back of his cane knife, tops it, and then severs the stalk at the ground and throws it to the heap, which is made for the convenience of loading, on every third row. A good cutter in good cane will average

about three tons of cane per day. With inferior cane or cutters, the product will be less.

When the cane is cut and piled on the heap rows, wagons are driven between them and loaded from both sides. Formerly, under a large cane shed all of the loads of cane were dumped and were transferred to the cane carrier by hand

FIG 23 —Loading cane wagon.

labor. This method, which involves a large number of hands to keep the necessary cane on the carrier for the continuous running of the mill, has been almost entirely superseded by some of the excellent devices for transferring canes from wagons to cars and cars to cane carrier. The reduction in the cost of labor by the use of these devices has been very great.

But little or no progress has been made in the economical cutting of the cane and loading the wagons. The old cane knife is still used and the cane harvester (so devoutly wished for by our planters) is still without existence. Notwithstanding the Louisiana Sugar Planters' Association has proffered for several years, a prize of \$1,000 to the inventor of a successful cane harvester, no one has even made an effort to claim it. Several improved harvesters have been tested upon cane on the grounds of this station, but with so little success that the patentees abandoned the idea of trying further to adapt them to cane.

The writer has no knowledge of any one working just now upon a cane harvesting machine, and the prospects for

the early securement of such a desirable implement are apparently as remote as ever. So, too, with loading; "main strength and awkwardness" of our loaders are our only reliance.

Elsewhere has been discussed the difference in composition of the different parts of the cane. It is well known that the upper portion is quite immature and when worked in the sugar house is very melassigenic. To one desiring only sugar, care should be exercised to see that the cutters "lower their knives" in cutting cane. Since the butts are the richest part of the cane, equal attention should be given to have the stalks cut at or into the ground.

CHAPTER XIX.
PRESERVATION OF CANE.
Windrowing.

A subject of prime importance to every grower and manufacturer of sugar cane in Louisiana, is how to preserve the cane from the deleterious effects of freezes, so as to prolong our grinding season beyond the regulation period of sixty to ninety days.

In order to accomplish the task of working up a large crop, without endangering a part of it by late freezes, it is customary to begin work in the sugar house early in October, when the cane is quite green. The losses therefore, in working immature canes become in some seasons very heavy. This loss is voluntarily incurred to avoid the risk of loss from freezes later in the season.

Sometimes, in spite of efforts to avoid them, freezes overtake us before the crop is harvested; it is then a mooted question whether windrowing should be resorted to, in order to best preserve the standing cane. If windrowing is practiced, shall it be done before or immediately after the freeze, is also an unsolved problem. Could some economic method be discovered by which our canes could be protected against freezes and thus continue our sugar campaign through January and February, it would be of incalculable benefit to our sugar interests. On December 14, 1888, the Sugar Experiment Station made the first experiments looking to a solution of this problem. It divided a field of cane into four parts. Part 1 was left standing. Part 2 was put up in matelas. Part 3 was windrowed in the usual way for the mill. Part 4 was carefully ensilaged. Unfortunately for the experiments, but fortunately for the planters, the anticipated freeze did not occur. On December 19th, the thermometer recorded 27 degrees F., but did no further damage than scorching the leaves and killing a few upper eyes of the cane. This standing cane was carefully watched, with weekly analyses of it, until January 13th, when it was cut and worked in the sugar house. Beyond a very slightly acid taste, no injury was perceptible either in the results obtained in the laboratory or from the work in the sugar house.

The matelas cane (part 2) was diffused January 16th. It exhibited no sign of alteration of any kind and chemical analysis showed it to be in excellent condition, which was verified by the ease with which it was worked in the sugar house.

The windrow cane (part 3) was worked January 18th, with satisfactory results, showing little or no deterioration.

Part 4, ensilaged cane, however, was a great disappointment. It had been carefully ensilaged and on opening the silos the cane was white and to the eye perfectly sound, but the nose revealed the odor of the escaping acetic acid, and the tongue the distinctly acid taste and absence of sugar. The sugar in the canes, of which there was about 13 per cent. at time of harvest, had by fermentation been converted into alcohol and acetic acid, the most of which had evaporated.

The above experiments proved one fact conclusively, i. e., that sugar cane cannot be ensilaged for the preservation of its sugar content.

Later Experiments.

Abandoning the ensilaging of cane as being totally destructive of sugar, and substituting the usual windrowing for the mill, for seed, and for the matelas, (the latter being too expensive for mill work) experiments were begun in 1892, and completed in 1895, and results published in Bulletin No. 37.

The field experiments were divided into three rows each. Each experiment was taken as a basis for the trial in preserving the cane. The right-handed row of each experiment was cut, weighed and analyzed, and worked up in the sugar house. The left-handed row was simultaneously windrowed for the mill, i. e., the cane was cut down with its adhering fodder and placed in the middle of the row, and so adjusted that the tops covered the butts so completely that when the work was finished, only the leaves of the cane could be seen. Care was taken to see that the butts of the cane touched the ground.

In this condition the cane remained until it was needed, when it was taken up, stripped of its foliage, topped and sent to the sugar house, where it received the same treatment given the early cut.

The middle rows of each experiment were left standing and not cut down until the windrowed cane was ready to be worked, when they were both treated alike.

Our experiments extending over three years, and including 222 field experiments, were divided in two classes:

- 1st. Windrowing for the mill.

2d. Windrowing for the seed.

In the latter case, the cane was treated as in the former, and immediately after windrowing four-horse plows were used to turn heavy furrows of soil over it. Hoes usually completed the covering. In this way cane is preserved for seed in Louisiana, and it is always windrowed before a frost shall have injured the buds.

Under class 1st, windrowing for the mill, there were five divisions, covering all the conditions which our variable seasons permitted, and are as follows:

1st. Canes windrowed before a freeze and harvested before a freeze.

2nd. Canes windrowed before a freeze and harvested soon after a freeze.

3rd. Canes windrowed immediately before a freeze and harvested after a freeze.

4th. Canes windrowed immediately after a bud-killing freeze.

5th. Canes windrowed after a splitting freeze.

Only one division was made under Class II, since all were windrowed before a freeze.

After three years experimenting along the above lines, covering 222 field experiments, which were carefully worked up in the sugar house and followed closely by chemical analyses at every step, the following conclusions were reached:

Conclusions.

It is a law of nature that as soon as a plant or animal is removed from the influence of vitality, that decomposition sets in, brought about by agents prepared by nature and resident in or on the plant or animal. The decomposition is slow or rapid, just in proportion to the conditions which environ the body. At a high temperature and with an abundance of moisture and a free access of air, it becomes rapid and certain. At a low temperature, or in the absence of moisture or air, in most cases, the decomposing action is retarded, or even for a while suspended. Ferments of varying characteristics are found present almost everywhere, and thrive and multiply just in proportion to the existence of such conditions as are most favorable for their propagation.

Cane is no exception to this rule. When cut down from its roots and removed from vital forces, it begins at once to decompose and resolve its complex compounds into simpler ones. This decomposition will be rapid or slow, just in accordance with its surrounding conditions. If a low temperature be maintained or air be excluded, or both, this

decomposition will be checked, and the cane will remain for some time in a comparatively good condition. If a high temperature, with an abundance of moist air, prevail, it will rapidly become unfit for the sugar house. With these facts before us, it is evident that no improvement can come to the cane by windrowing. Therefore to cut cane and put it in windrow with any other purpose than to protect it against an expected evil, whose approach would injure it more than windrowing, is wholly unscientific, and must bring destruction of sugar and loss of values. Windrowing, an acknowledged evil in itself, should never be resorted to, save upon the principle "of the two evils choose the lesser." When threatened with impending freeze, or having been visited by one, which has destroyed the vitality of the stalk, then windrowing may be of immense value; not in improving the cane, but of delaying the decomposition of its sugars until the sugar house can use it. It is certain that prostrated canes lying in contact with the moist earth, and covered well with its own leaves, are better protected against severe freezes than standing ones. They are also in a condition to resist decomposition after a freeze better than those standing. It may be that clear, cold, weather, prevailing after a freeze, may also retard decomposition in standing cane for several weeks, and thus enable the planter to successfully harvest them without much loss. But should warm, sultry, weather, prevail, the standing cane would ferment rapidly. The windrowed cane would, under such weather conditions, also ferment, but its closely appressed leaves preventing a free access of air and partially protecting against the sun and its contact with the moist earth, must furnish some protection against rapid fermentation. Hence, under favorable conditions, both standing and windrowed canes might be worked without much difference in results, but should unfavorable weather exist, the windrow would certainly proffer greater obstacles to rapid decomposition. These are the conclusions deducible from known laws of nature.

Let us see how far they are confirmed by actual experiments.

IN CLASS I, DIVISION I,

it was found that the canes which were windrowed and harvested before a freeze lost heavily compared with those cut and worked at the same time they were windrowed. It was found also that those left standing and worked up with the windrowed canes had gained both in quantity and quality. Here, then, comes a double loss—one from early harvesting and one from windrowing. It is quite certain with

these facts before us, no one living in a frostless climate would ever think of windrowing.

IN CLASS I, DIVISION II.

Cane windrowed before and after a freeze.

Here the results are largely influenced by the time the cane was in the windrow before the freeze, and the time between the freeze and the harvest of the standing cane.

The standing cane evidently did not suffer before the freeze, while the windrow did. The standing cane may disintegrate rapidly after the freeze, while the windrow may proceed with an even pace. It is, therefore, directly a determination of the greatest quantity, and since the weather as well as the time of approaching frost, are both unknown factors, it is manifestly impossible to decide before hand.

Hence, windrowing, performed without forecasts of an approaching freeze, carries with it certain inevitable losses, which are made as costly premiums upon an insurance against freezes.

The average of twelve seasons of which careful records have been kept, would hardly justify such action earlier than the middle or last of December.

CLASS I, DIVISION III.

Shall cane be windrowed immediately before or after a freeze?

This question has been fully discussed under the experiments. It was there shown that there were slight advantages in favor of windrowing immediately before a freeze. Along with these should be added the freedom from risks of a splitting freeze, which is elsewhere shown to be an evil for which there is no known mitigation. Our weather bureau frequently predicts an approaching cold wave several days in advance of its coming, and cold wave flags are exhibited in many places in this State. Could their predictions reach every planter in the State, doubtless many of them would avail themselves of the information given and windrow much of their cane before the freeze appeared.

CLASS I, DIVISION IV.

Windrowing after a bud-killing freeze is perhaps always advisable.

There are seasons like 1892 when the standing cane keeps for a time as well as the windrowed, but they are at long intervals and very uncertain. As a rule, the windrowed cane will be better preserved.

Topping frequently prevents rapid decomposition, and after a bud-killing frost, should be practiced, provided windrowing is deemed expedient.

CLASS I, DIVISION V.

After a splitting freeze, every effort should be made to work up standing cane as rapidly as possible.

Time lost by windrowing is perhaps not compensated by the small gains of the windrow over the standing cane.

All canes not worked up in a short while after such a freeze must be abandoned or attended with loss and delay in manufacture. Windrowing is always advisable before such a freeze, and should be practiced at any cost, when the weather bureau announces its coming.

CLASS II.

Windrowing for seed, if well done, answers the purpose admirably for preserving the eyes of buds of the cane, but the experiments recited above give little encouragement for its practice in preserving canes for the mill.

These experiments show conclusively that it is only in anticipation of a stalk-splitting freeze that windrowing should be resorted to before the freeze. The cane will be preserved, after a bud-killing freeze, best by windrowing it, but it is time enough to windrow after the freeze.

It was also shown in these experiments that after a freeze which killed the bud, fermentation started at the killed bud and gradually proceeded down the cane. By removing the top this fermentation was arrested; therefore in all cane left standing after a freeze, which has had the bud killed, but the stalk not split, it is advisable in the absence of windrowing to top the cane as a substitute for the preservation of the cane.

Against a splitting freeze there is no relief.

Windrowing does not offer advantages that would justify the expense. In fact, split canes should be worked up as early as possible, as it will be possible to work them only a few days after the freeze.

CHAPTER XX.

SUGAR CANE INSECTS.

BY PROF. H. A. MORGAN.

Sugar cane has many enemies, the greater number belonging to that family of sucking insects, known as "leaf hoppers" (Jassidæ). In extent of damage done the "sugar cane borer" and the "Southern grass worm," belonging to the order lepidoptera, and the "sugar cane beetle," a member of the order coleoptera, are the most serious depredators.

Sugar Cane Borer.

(*Diatraea saccharalis*.)

To the sugar interests of Louisiana there is no natural enemy so important as this "sugar cane borer," sometimes called "tropical borer," "stalk borer," and "the larger corn stalk borer."

The larva, or borer, that condition recognized by the sugar cane grower, is, when full grown, about one and one-quarter inches long, has four violet longitudinal stripes on dorsal portion of body; between these the body is light colored, except for the black, peliferous spots, which appear generally distributed over the surface. There is considerable variation in the coloring of the larvæ, as shown by Dr. Howard—"Insect Life, Vol. IV, page 95."

The following is the description of the moth given by Dr. Fernald in "The Crambridae of North America:—" "Expanse of wings, 28-38 mm., head, palpi, antennæ, thorax, and fore wings pale ochre yellow. the latter with darker venular and inter-venular lines; one discal and seven terminal dots, black. Hind wings white in females, pale yellow in the males. All the fringes are concolorous with the adjacent part of the wings. There is a curved line of more or less distinct brown dots from within the apex across the wing, curving in towards the base of the hind margin, and also a trace of a

second parallel line between this and the end of the cell. These lines occur more or less distinctly in the males, and also in a few females."

FIG. 1 (top)—Larva or borer.
FIG. 4 (bottom)—Moth (male).

The area infected extends from the gulf on the South to the bluff lands at Baton Rouge on the North—and from the East to the West lines of the State. The degree of damage done varies in different localities, for in a few places the injury is so inappreciable that borers are not thought to be present, while in other portions of the infested area the amount of damage exceeds 50 per cent. of the crop.

A single moth will deposit over one hundred eggs, which hatch in from four to six days. The caterpillar or borer life is passed rapidly, not exceeding in Louisiana over twenty days. Before pupating, the larva makes an enlarged place in its burrow near the opening, in which the ten or twelve days of pupal life is spent. In a little over a month the life cycle is completed. As the moths appear early in May, a brood may be expected each month from May until December.

As with other insects, a study of the feeding and developmental habits of the sugar cane borer not only gives a clearer insight into the possible loss sustained by its ravages, but aids in suggesting and operating remedial measures. A single borer does much more injury because of its

FIG. 2 (top)—Pupa. FIG. 3 (bottom)—Moth (female).

habit of making many burrows in a single stalk of cane; the habit, too, of following the young growth, and as the cane matures the borers are found in its tops, is of invaluable assistance in controlling the injury done by the larva.

An important point in connection with the habits of this insect is that it has more than one food plant—a fact that has blighted the prospect of ever exterminating this pest from the State. Two plants—wild sorghum or Guinea corn (*Sorghum vulgare*), and Johnson grass (*Sorghum halepense*)—which have become notorious weeds in Louisiana, have been found infested with borers. Sugar cane, corn, and sorghum, are the only species of domestic plants that have been found affected.

FIG. 5—Sugar cane borer enemy.
a, larva; b, magnified mouth parts of larva;
c, beetle.

To remedy the damage of the sugar cane borer, best results have been obtained by burning the tops, thus destroying most of the hibernating young. All Johnson grass and Guinea corn growing as weeds in the vicinity of cane fields should be destroyed. This, anyway, should be carefully attended to late in the season, and thus destroy all plants upon which the borers might exist during the winter. This is particularly important in the extreme southern part of the State in average winters, and throughout the entire in-

fectured area during open winters. In introducing cane culture into entirely new districts, great pains should be taken in the selection of seed cane free from borers.

Among the natural enemies, a species of beetle belonging to the "fire fly" family (Lampyridæ) is a very important one. It has been technically named *Chauliognathus pennsylvanica*. The larva of this predaceous insect has been found devouring the borers in their burrows. A common observation is that when these beetle larvæ are abundant the damage by borers is greatly reduced.

Ants have been claimed by some to destroy the eggs and young larvæ, but they are attracted chiefly by the excretions from the borer-injured cane.

Southern Grass Worm.

(*Laphrygma frugiperda*.)

Although this insect is widely distributed, occurring in all parts of the State, it is only after "overflows" that it becomes a serious pest to sugar cane. Ordinarily it is kept in check by natural enemies which are drowned out when a crevasse occurs, and thus the grass worm, which develops with extreme rapidity, takes complete control, and great injury results.

The female moth possesses dark grey front wings marked with irregular white spots above. Expanse, a little over one inch. The hind wings are light colored, which give the moth a lighter appearance during flight than when at rest.

The eggs are very difficult to detect, being covered with a wool-like deposit which completely conceals them. They may be deposited upon the leaf of some low growing grass, or even upon the ground. In two or three days the eggs hatch a light colored caterpillar, which soon assumes a greenish tinge, due to the food within the alimentary canal. After the first molt the larva is darker on dorsal surface, due to dark band-like longitudinal markings. In ten to twelve days the larval life is complete, when the insect then repairs to the ground, where, beneath its surface, eight days are spent as a pupa. Thus only a little over three weeks is required by this insect to complete its transformations.

Naturally, ground beetles (Carabids) in both larval and adult stages feed upon grass worms, keeping them in subjection. These beetles spread slowly, and after the overflow water has receded, the moths from the surrounding districts fly in, deposit their eggs, and the caterpillars take complete possession of the crop. The habit of the grass worm to fall to the ground when disturbed has been taken

advantage of and myriads collected in vessels containing coal oil. Some planters attach a piece of light scantling to the plow when working the crop. The scantling strikes the cane and jars the worms to the ground, where they are buried in throwing the dirt up to the crop.

One part of paris green diluted with five parts of air-slaked lime, and this dusted well upon the plants by means of Leggett's paris green gun will be found effective.

Knowing that armies of these caterpillars follow an overflow, it will be well to be prepared to fight them.

Sugar Cane Beetles.

(*Ligyris rugiceps*.)

Nothing is known of the early life and habits of this insect. Its attack upon sugar cane is almost as spasmodic as its ravages upon corn. It burrows into the stalks of cane and corn just above the roots, soon completely concealing itself within the plant. It has been found feeding upon the ears of corn.

No method of cultivation of that particular nature has yet been found that will check the work of this beetle. In the application of poisons, the same difficulty is met with as in the case of the borer; the beetle burrows into the stalk and soon gets beyond the reach of poisons.

The beetles are readily attracted by lights, and great numbers may be captured in coal oil pans in which the lamps are setting.

CULTIVATION OF SUGAR CANE.

PART SECOND.

SUGAR CANE:

ITS HISTORY IN

GEORGIA, FLORIDA AND SOUTH CAROLINA,

1767—1900.

Sugar Content of the Canes of Louisiana, Hawaii
and Cuba Compared with those of
Georgia and Florida.

OUR SUGAR SUPPLY OF THE FUTURE.

RECOLLECTIONS OF HOPETON PLANTATION.

WEATHER STATISTICS OF GEORGIA, FLORIDA AND
LOUISIANA COMPARED.

BY

D. G. PURSE, SAVANNAH, GA.

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PREFACE TO PART SECOND.

The object of the author in Part Second has been to review the history of sugar cane cultivation in the States of Georgia, Florida and South Carolina from its first introduction into each State to the present time, and to direct public attention to the value of the quality of the canes grown in these States for their sugar content, that can be made available by improved sugar machinery such as is now employed in Louisiana.

It has also been sought to show in the following pages that canes grown upon the pine lands of these States, with ordinary cultivation, exceed in sugar content and acre tonnage those grown upon the alluvial lands of Louisiana and compare favorably with average results in Cuba.

By the weather reports it is shown that climatic conditions are as favorable to cane cultivation in Southern Georgia and in Florida as in Louisiana.

The article devoted to "Our Sugar Supply of the Future" shows the enormous growth of the beet sugar industry in Europe and its steady development in this country, and directs attention to the possibilities of Georgia and Florida, as sugar producing States.

Special reference is made to the erection of the sugar plant at Hopeton Plantation, in 1829, to show that 24 years after cane cultivation was commenced in Georgia for commercial purposes, it was considered sufficiently firmly rooted to warrant the erection of one of the largest plants in the then sugar world for its manufacture, though within the decade following cane ceased to hold its place as a leading crop of the State, for reasons fully stated elsewhere.

The author (in connection with his investigations) desires to express his thanks for courtesies and valuable information to the Department of Agriculture, Washington; Hon. O. B. Stevens, Commissioner of Agriculture, Georgia; Mr. H. B. Boyer in charge Savannah Weather Bureau Station for valuable tables; Hon. Wm. Harden, Librarian, Georgia Historical Society, Savannah Ga; Prof. H. E. Stockbridge, Florida Experiment Station; Judge Joseph Tillman, Quitman, Ga.; Capt R. E. Rose, President Florida Agricultural Society; Dr. Wm. Berrien Burroughs, Capt. C. S. Wylly, Hon. J. H. Dillinworth and Capt. R. T. Clark, Brunswick, Ga., and the railways of the State and Southern Express Company.

D. G. PURSE.

Savannah, Ga., October, 1900.

CHAPTER I.

HISTORY OF SUGAR CANE IN GEORGIA.

Georgia was the first of the original thirteen States to introduce the cultivation of Sugar Cane.

Nothing, however, can be found to sustain the tradition that the ruins of two sugar plants in the vicinity of Savannah bear witness to a cultivation of cane in Georgia prior to the Revolutionary War. One of these plants, situated opposite the city, on Hutchinson's Island, an old diary affirms, was used as a place of refuge and safety for the women and children during the siege of Savannah, in 1779, by combined forces of the Colonists and their allies, under Counts D'Estaing and Pulaski. The other plant, the ruins of which are more clearly traced to-day, was located upon Oatland,, another island, adjacent to Savannah, and was undoubtedly erected soon after the Revolution.

There can be no doubt, with all the facts now collected, that these ruins were those of rice mills which, after the introduction of Cane Cultivation around Savannah, along with rice, served a double purpose.

To the date of the appointment of Royal Governor Wright, in 1760, even rice had only been moderately cultivated, against the policy of the mother country, whose unyielding and persistent determination, since the landing of Oglethorpe, had been to make Georgia a silk and indigo producing colony, and consequently frowned down attempts at diversity in agriculture, though the exclusive cultivation of silk and indigo had brought the colony to the verge of starvation.

Under Gov. Wright a broader policy prevailed and he himself led in reclaiming and preparing the alluvial bottoms bordering on the rivers for extending the culture of rice. But in five years after his accession to office, began the troubles with the mother country, that culminated in the separation of the colonies from her, and marked a generation of inactivity in agricultural enterprise.

Mr. Thomas Spalding, a citizen of Glynn County and a prominent planter, wrote the "Southern Agriculturalist,"

in 1828, a letter, which appears in the February number 1829, of that periodical, printed in Charleston, S. C., in which he says, "I have received your letter of the 25th of November and will reply to it, as far as I am able, upon the cultivation of sugar cane and other objects in Georgia.

"In 1805 I began the cultivation of sugar cane with 100 plants; I had long before that been impressed with the opinion it would answer as well in Georgia as Louisiana, for one of my early friends, the late Mr. John McQueen, of Savannah, had spent the winter of '96-'97 in Louisiana and had stated, among other circumstances, that the orange trees were killed to the root, in that winter, and as I know there were growing all around orange trees that had been planted by the soldiers and followers of Gen. Oglethorpe, I concluded, without a doubt upon my mind, that the climate of Georgia and South Carolina was better than the climate of Louisiana, because this test by plants was a more certain one than any test that the thermometer could afford, and this I believe to be the opinion of enlightened agriculturalists in Europe and America."

Mr. Spalding's letter is the first written evidence of interest in cane cultivation in Georgia, though cane had evidently been brought into the State previously and planted in a small way. There is nothing in Mr. Spalding's letter to negative this conclusion and his failure to say from whence he obtained his seed supports it.

It was not, however, until 1806 that Mr. Spalding planted, on Sapelo Island, the first crop of cane to be devoted to the manufacture of sugar for sale.

Mr. Spalding says, that in 1814 "his crop of sugar amounted to \$12,500 from the labor of fifty slaves."

"The War of 1812 entailed heavy losses upon planters; Mr. Spalding further says, in his letter in 1828, "but with the return of peace, in 1815, the planters of Glynn County entered largely into the cultivation of cane for sugar making, and from this source cane plants have spread into the interior of Georgia and every acre of cane grown in Florida has been derived from that source, and I presume I shall not exaggerate it, when I say, to you, that between Darien, on the Altamaha, and Milledgeville, on the Oconee, there were at this moment 100 plantations upon which sugar cane is grown, and where sugar is manufactured in more or less quantity.

"Five years ago I commenced the cultivation of sugar cane on river swamp land opposite to Savannah. The year 1824 was a year of great loss to the country generally and to myself in particular. I had growing on the Savannah River 60 acres of cane, which I am quite satisfied ought to

have given me, in the year 1825, 60,000 weight of sugar. My losses of the previous year prevented my procuring a steam mill to grind it; I put up temporary works, which, while they satisfied myself of the productiveness of the sugar cane, that situation generally satisfied me of the necessity of an extensive establishment, to make the culture of cane profitable on river lands. From that time, therefore, I have kept a few acres in constant cultivation, that I might in the first place be master of my own means, at my own convenience, and again that my plantation near Savannah might furnish plants to all who might desire to go into the cultivation of sugar cane. This it has done and it will not perhaps be exaggeration either, to say, that in the coming year there will be an hundred plantations upon the Savannah River, on which cane will be grown in greater or less degree.

"All doubts as to the importance of the value of sugar cane in Georgia has now passed away; one acre of cane, as plants, has been recently shipped from Savannah to North Carolina where it will no doubt plant ten to fifteen acres."

In another letter, about the same date, Mr. Spalding says, "The ribbon cane, which is so much talked of, Louisiana owes to the late Mr. John McQueen of Savannah. He brought it from Jamaica and distributed it among his friends in Georgia from whence it has been carried, within four years, to Louisiana."

It was seed cane from this importation of Mr. McQueen's, from which Mr. Roswell King, St. Simon's Island, (mouth of the Altamaha, not "Savannah River,") shipped a schooner load, in 1825, to Mr. John J. Coiron of Louisiana, which has ever since been esteemed as the parent of the best seed planted in that State, and which shipment is referred to in Dr. Stubbs' History of Sugar Cane in Louisiana.

At Hopeton plantation, a few miles above Darien on the opposite bank of the Altamaha River, Mr. James Hamilton Couper, in 1829, erected a sugar plant for converting into sugar his crop of several hundred acres of cane, planted in rich alluvial soil, with tidal cultivation, along with rice in adjoining fields.

This was not the first plant erected on the seaboard, but was the finest ever erected in the State, and, at that time, was equal to any sugar plant in the West Indies or Louisiana. Mr. Couper had made its erection a matter of deep study and extensive correspondence in this country, in Europe and the West Indies, and when completed, judging from the plan of it published by Mr. Couper in the "Southern Agriculturalist," in 1831, for the benefit of others desiring to erect plants, it was equal to the best plants stand-

ing in Louisiana until the introduction in recent years of more modern methods for the extraction and treatment of the juice of the cane.

In Chapter VI, "Recollections of Hopeton Plantation," will be found a detailed description of this sugar plant with an excellent view of it as it stands to-day.

In 1824, a violent storm, incidentally referred to in quotations from Mr. Spalding's correspondence, visited the coasts of Georgia and South Carolina. It was particularly destructive to planters around Savannah, and from this time cane cultivation appeared to move southward and become centered about the mouths of the Altamaha, Satilla and St. Mary's Rivers, where are still to be found many ruins that bear testimony to the extent cane was cultivated for the manufacture of sugar in those days.

The alluvial lands on the coast, that comprise our rice fields to-day, were principally employed in the cultivation of cane, though as stated by Mr. Spalding, in letters, cane had come to be cultivated all over Middle and Southern Georgia at that time.

In the winter of 1831-32, the price of sugar was very low and greatly discouraged its producers in Georgia and Florida. About this time the prices of both cotton and rice advanced, and in a few years the fields devoted to cane in the lowlands had been turned into the cultivation of rice and into cotton upon the sea islands, until, in 1845, only a few planters made cane an important crop on the Altamaha and neighboring rivers, and, in 1848, Rev. George White, in his "Statistics of Georgia," referring to Glynn County, says: "Some years ago sugar was made to a great extent; but its culture has been discontinued for sale except on two plantations. The crop of 1848, was 105 barrels of syrup and 1,099 barrels in sugar."

By the same author it is learned that all the counties in Middle and Southern Georgia in 1848 were growing cane for the manufacture of syrup and sugar for home consumption, and sometimes a surplus for sale.

The United States Census of 1850 places the production of sugar in Georgia at 1,970,400 pounds, without giving acreage in cultivation or syrup or molasses produced; in 1860, it is placed at 1,400,400 pounds of sugar and 546,749 gallons of syrup or molasses; in 1870, at 772,800 pounds of sugar and 555,192 gallons of syrup or molasses; in 1880 the acreage is reported as 15,053, yield 721,200 pounds of sugar and 1,565,784 gallons of syrup or molasses; in 1890, acreage 20,238, pounds of sugar 1,307,625, and gallons of syrup or molasses 3,233,194.

There can be no doubt that the Census of 1900 will show more than double the acreage of 1890 with a larger relative yield in both sugar and syrup or molasses.

In 1876, the late Dr. T. P. Janes, first Commissioner of Agriculture appointed in Georgia, in his "Hand-book of Georgia," speaking of a tour through the Southern and Seaboard counties of the State, declares that "Nowhere in Louisiana have I seen sugar cane grow more luxuriantly or yield a greater amount of saccharine juice than in this part of the country."

In 1899, a Bulletin issued by Commissioner of Agriculture, Hon. O. B. Stevens, entitled a "Comparative Analysis of condition of Crops by Counties for Month of May," shows 56 counties engaged in the cultivation of sugar cane in Georgia, "the bulk of which is manufactured into syrup, which has an excellent reputation and is marketed over the country." The Bulletin shows an increased acreage in cane over the previous year, but affords no data for comparison with amount planted in 1890.

Twenty-three years after Commissioner Janes' tour through the Southern and Seaboard Counties of the State, Dr. Stubbs, traversing the same territory, in October 1899, writing to Mr. Paul Dupuy, an old Louisiana Sugar planter, now resident at San Antonio, Fla., (to whom the writer is indebted for use of the letter, dated at New Orleans December 22nd, 1899), says, "I was amazed to find the extent to which Sugar Cane was grown and the quantity of Syrup annually made for the market. I spent several days in the field and weighed quite a number of acres growing in Cane, and to my astonishment found the yields were from 16 to 35 tons of Cane to the acre. I may say further that their Cane is unusually rich. I have just finished analyzing another batch of nineteen varieties, (following one of sixty-nine,) grown all through that section and all show a large superiority in sugar content to those grown upon the alluvial soil of South Louisiana."

The cultivation of sugar cane was made the subject of rigid inquiry before it became one of the important crops of the State, at the beginning of the century.

The valuable correspondence of that period, still preserved, shows that inquiries by letter and personal visits made the promoters of cane cultivation thoroughly acquainted with the conditions in the West Indies and other foreign cane growing countries, and as well as with the conditions at home, in Louisiana, which had then come to be recognized as the leading sugar producing State of the Union.

In 1820 to 1840, the average yield per acre in Georgia is placed at 850 pounds of sugar and 45 gallons of molasses, based on the product of the alluvial lands that are known to-day as less rich in sugar content than cane grown upon the highlands in the yellow pine belt of Georgia and Florida.

In 1830-32, a Congressional Committee placed the average yield of Louisiana, per acre, at 1,000 pounds of sugar and 45 gallons of molasses.

In 1885, when Dr. Stubbs was called to Louisiana to organize and conduct Sugar Experiment Stations, the average yield per acre in the State was around 1,500 pounds of sugar, and to-day it is quite double that amount.

Dr. Stubbs reporting upon the canes from Georgia sent him for analysis, in November 1899, summarizes his conclusions as follows:

"These canes have suffered from inversion in transit. It is fair to presume that had no inversion occurred, the average analysis would have shown at least 16 per cent. sucrose and 1 per cent. glucose. This analysis would indicate 225 pounds C. P. sugar per ton upon a 75 per cent. extraction, and 240 pounds C. P. sugar per ton on an 80 per cent. extraction.

"The best sample indicates a yield of 249.6 pounds C. P. sugar per ton of cane, 75 per cent. extraction, and 266 pounds per ton 80 per cent. extraction.

"In an average yield of our sugar houses 70 per cent. of the total sugar is made into firsts of 98 degrees polarization, 18 per cent. into seconds of 90 degrees, and 12 per cent. into thirds of 80 degrees. Applying these percentages to the 80 per cent. extraction, there would be 283 pounds of commercial sugar, firsts, seconds and thirds per ton of cane upon an 80 per cent. extraction."

With 75 per cent. extraction, 16 per cent. sucrose and 1 per cent. glucose, an acre producing 20 tons would yield 4,500 pounds of C. P. sugar, and 30 tons, 6,750 pounds, or 5,900 pounds more from the uplands to-day than was realized from the alluvial lands planted between 1806 and 1840. Of course, much of this greater yield is due to the better machinery for extracting the juice and for the manufacture of the sugar.

CHAPTER II.

HISTORY OF SUGAR CANE IN FLORIDA.

Fairbanks, in his interesting history of Florida, says that upon the acquisition of East Florida by the British, in 1763, Gen. James Grant was appointed Governor, with St. Augustine as the Capital. Governor Grant at once set about to improve the condition of the people of the province, who, under Spanish rule, had been reduced to great straits in the neglect of agriculture and the decay of commerce under proscriptive trade laws.

Governor Grant exhibited great zeal in disseminating the advantages possessed by the province for emigrants, particularly its healthfulness, as shown by the longevity of its citizens, and in setting forth the productiveness of its soil.

In 1767, Sir William Duncan and Dr. Andrew Turnbull, two Scotchmen, influenced by Governor Grant's representations, organized a colony of 1,500 souls, drawn from Minorca, the Greek Islands, Italy and Smyrna, and landed them at the site of New Smyrna, which was so named at its founding.

The projectors of this scheme had expended \$166,000 upon it at the time of the landing of the colonists, and afterwards, besides more money, "Much labor was expended in buildings, opening canals (in part through solid rock) ditches, and various other improvements, the remains of which still exist."

The colonists came to East Florida under indenture, by which they were to give a certain number of years of labor to the projectors of the colony for bringing them out, a common practice in those days and not entirely in abeyance to-day, though against the letter and spirit of the emigration laws of the country.

The object of the projectors of the New Smyrna Colony was to engage, principally, in the cultivation of indigo and Sugar Cane and the manufacture of their products for shipment to the markets of Europe where they then commanded very high prices, and this marks the first instance of manu-

facturing Sugar from the juice of the Cane, on a commercial basis, within the present bounds of the United States.

Dr. Stubbs, in his history of Sugar Cane in Louisiana, credits Etienne De Bore with first inaugurating the manufacture of Sugar on a large scale in Louisiana, in 1794, the Centennial of which event was appropriately celebrated, in New Orleans, in 1894.

Sugar from Cane had been produced in Louisiana by Antonio Mendez, in a small way, in 1791, twenty-four years after Dr. Turnbull had commenced its manufacture in Florida; but Mendez's operations were upon a small scale, until De Bore entered upon its manufacture to an extent "large enough to influence the future of Louisiana."

Dr. Turnbull's colony seemed born to trouble. It had scarcely been well settled before dissensions arose between master and servant as to the character and term of service to be rendered, culminating, in 1769, in the open revolt of the colonists against the articles of indenture and the harsh treatment of those in authority over them.

The ringleaders in the revolt, as claimed, were carried to St. Augustine and there tried for their lives. Of five sentenced to death, two were pardoned by the Governor and one was offered pardon upon his becoming the executioner of his two remaining fellow convicts. Against this he violently protested while his comrades plead with him to save his life by doing the Governor's command.

In 1776, the whole colony had disappeared from New Smyrna, and this splendid foundation for a great industry, planted under the most flattering auspices, was lost to the people of Florida at a time when it could have done so much for their material and permanent prosperity.

In 1771, historian Fairbanks tells us further that "Mr. Oswald established a plantation on the Halifax, still designated as Mount Oswald, and Mr. Rolle at Rollestown near Palatka. There were settlements also at Beresford and at Spring Garden. The cultivation of cane was begun on the Halifax under the fostering care of the British Government, and would, in a few years, have become a very important industry in Florida." But the disastrous conditions that prevailed at New Smyrna seemed to cast their blight over other efforts to develop into a great industry the manufacture of sugar on the Halifax River, and in the adjacent country, though the soil and climate were so admirably suited to the cultivation of cane.

Sugar cane cultivation in Florida now drops out of written history until in 1825, it comes into prominence again in drawing the ribbon or red cane seed, like Louisiana, from Georgia.

There can be no doubt that during this gap in the records, previously and since drawing seed from Georgia and population to plant and harvest it, sugar cane was and has been more or less extensively cultivated in various parts of Florida and sugar manufactured from it. The presence of sugar houses and discarded machinery all over the State establish this fact.

According to the censuses of the last half century, 1850 to 1890, the following showing is made for Florida:

Decade.	Acres Planted.	Hhds. of Sugar.	Lbs. of Sugar.	Galls. of Molasses	
1850		2,750	3,300,000		In the late decades molasses and syrup need to be treated as synonymous terms.
1860		1,669	2,002,800	436,357	
1870		952	1,142,400	344,339	
1880	7,938	1,273	1,527,600	1,029,868	
1890	9,345		1,692,015	1,441,744	

In recent years the St. Cloud Sugar Factory, Kissimmee, built and controlled by the Disston Syndicate, started out with flattering prospects, but the death of the senior Disston put a check upon the experiment, and the mill has since been sold to other parties.

The leading purpose of the "Disston Syndicate," in its location, was to bring into prominence a large body of flat muck lands bought from the State of Florida, regarded as suited for profitable cane cultivation, and which it is claimed produced 30 tons average per acre. It was an up-to-date sugar plant and it is a source of profound regret that its career, which promised so much for Florida, was so soon cut short by the death of Mr. Disston.

The climate of Florida cannot be excelled for the fullest development of the cane and it has been incontestably shown that her soil is equally adapted to its growth.

Dr. Stubbs in his analysis of Georgia, Florida and South Carolina canes finds them equally rich in sugar content.

In Bulletin No. 44, Florida Experiment Station, 1899, Lake City, Prof. H. E. Stockbridge in charge, giving his own experience in analyzing Florida cane, says:

"Our analyses of Florida cane from eighteen different localities, covering the entire State, the present season, show an average of 15.69 per cent. of sugar, and an average coefficient of purity for the juice of 86.30 per cent. The Louisiana comparison is 12 per cent. of sugar and a coefficient purity of 80.50 per cent; a difference of 3.69 per cent. of sugar and 5.80 per cent. of purity in favor of the Florida product. There is no question of equally heavy crops in our

State; so the superiority of Florida for sugar production can hardly be longer questioned."

Prof. Stockbridge's analyses were made prior to Dr. Stubbs'; but though the former had the opportunity of doing his analytical work more immediately after the cane was cut, Dr. Stubbs summarizes the results from his analyses of Florida cane at 16 per cent. sucrose and 1 per cent. glucose, capable with 75 per cent. extraction of juice of yielding 225 pounds of C. P. sugar to the ton of cane.

A most remarkable set of results obtained by Prof. Stockbridge at his Experiment Station, in 1898, is to be found in a letter addressed to Capt. R. E. Rose, of Kissimmee, Fla., which appeared in the "Savannah Morning News" last fall. In this instance every condition favored a perfect conclusion in the determinations; but they are remarkable even in the face of this fact.

The letter read as follows:

"Replying to your letter of 24th inst., I take pleasure in inclosing the actual record of cane polarizations for the month of November, with both red and green cane. The records are made from two different fields of cane, and, therefore, show practically the average content of our entire crop. The cane in question is seed cane planted the last week in March upon land which, though in close proximity to the small branch running through the station farm, is not really bottom land in the ordinary acceptance of the term, except that it is rather more moist than higher land farther from water would be. The land is characteristic Florida land, rather below than above the average quality, and has been under cultivation for at least twenty years, the natural timber growth of which was mixed pine and hard wood.

"The fertilizer used was a basis of stable manure, plowed under at the time of planting, and one or two subsequent applications of chemicals cultivated in when the ground was worked. The quantity and composition of the applications varied on different rows which were subjected to experimental tests. The average application, however, would not exceed 500 pounds of fertilizer per acre.

"Hoping these suggestions meet your requirements and assuring you that I would gladly furnish any further information possible.

"H. E. STOCKBRIDGE."

SUGAR CONTENT OF STATION CANE.

RED SUGAR CANE.

	P. C.*
Nov. 8, 1898	17.26
Nov. 10, 1898	24.83
Nov. 12, 1898	21.016+
Nov. 15, 1898	25.983
Nov. 17, 1898	21.085
Nov. 19, 1898	24.5
Nov. 22, 1898	25.916+
Nov. 24, 1898	27.10
Nov. 26, 1898	23.416
Average	23.33

GREEN SUGAR CANE.

	P. C.
Nov. 8, 1898	15.816
Nov. 10, 1898	16.153+
Nov. 12, 1898	16.90
Nov. 15, 1898	16.283
Nov. 17, 1898	17.416
Nov. 19, 1898	18.75
Nov. 22, 1898	18.533
Nov. 24, 1898	21.00
Nov. 26, 1898	21.166+
Average	18.00

* P. C. means pure chemically.

CHAPTER III.

HISTORY OF SUGAR CANE IN SOUTH CAROLINA.

The first sugar cane planted in South Carolina, according to the "Southern Agriculturalist," in its May number, 1828, was an experiment patch planted in "Tivoli Garden," in or near Charleston, by Philip Chartrand, in 1827.

Ramsey's History of South Carolina makes no reference to sugar cane, either as one of the garden or field crops of the State, in its chapter devoted to an elaborate review of the agricultural growth of the State from its first settlement to 1808.

Other experiments rapidly followed Chartrand's. Mr. Edward Barnwell, in 1830, reports in the "Southern Agriculturalist" an experiment on one acre that he had planted, in 1829, at the request of the Agricultural Society of South Carolina, which yielded 23,150 average sized stalks of cane, that it would be safe to estimate at 27 to 30 tons for the acre.

In concluding his report to the Society, Mr. Barnwell said:

"I am inclined to think our best soil will be such as is best adapted to the culture of corn, and state further that the cane is as easily cultivated."

According to the United States Census of 1850 South Carolina produced 805,200 pounds of sugar; 1860, 237,600 pounds; 1870, 1,266,000 pounds of sugar and 436,882 gallons of molasses or syrup; in 1880, 274,800 pounds of sugar and 138,944 gallons of molasses or syrup, and in 1890, from 3,305 acres produced 219,980 pounds of sugar and 386,615 gallons of molasses or syrup.

Last year, consequent upon the visit of Dr. Stubbs to Georgia, Capt. John Lawton, a prominent citizen and successful planter of Hampton County, was induced to ascertain his cane yield in tons to the acre, a test of value he had never applied before, and found it to be 21.5 tons. It was a low average yield as his cane had suffered from drought.

Analyses of samples of South Carolina canes made by Dr. Stubbs, in November and December, 1899, show the sugar content to be about equal to the canes of Georgia and Florida.

CHAPTER IV.

Sugar Canes of Louisiana, Hawaii and Cuba Compared with those of Georgia and Florida.

By PROF. R. E. BLOUIN, Acting Director.

Sugar content of Louisiana, Hawaiian and Cuban sugar canes compared with those of Georgia and Florida.

Louisiana canes—	Per cent.
Total solids	10.00 to 19.00
Sucrose	7.00 to 17.00
Glucose	1.00 to 2.50
Hawaiian canes—	
Total solids	17.00 to 21.00
Sucrose	15.00 to 19.00
Glucose	.30 to 1.00
Cuban canes—	
Total solids	17.00 to 19.00
Sucrose	15.00 to 18.00
Glucose	.30 to 1.00

These analyses are averages of data gathered from reports of chemists at the experiment stations and from the plantation chemists in Louisiana and Hawaiian Islands, and from chemists on several plantations in Cuba, and represent the extreme variation from the data collected.

Georgia canes—	
Total solids	18.00 per cent.
Sucrose	16.00 per cent.
Glucose	1.00 per cent.

Florida canes—	
Total solids	18.00 per cent.
Sucrose	16.00 per cent.
Glucose	1.00 per cent.

These are averages of analyses made by the Louisiana Sugar Experiment Station of canes collected from growers in Georgia by Capt. D. G. Purse, and in Florida by Mr. Chas. H. Smith.

In averaging the analyses of these canes, considerable latitude was taken in allowing for evaporation and inversion. The Georgia canes show very little signs of drying

out or evaporation, but in some instances inversion has been quite far advanced, and these analyses were eliminated in making the average.

Considerable difficulty was experienced in selecting average analyses of Florida canes, owing to the bad condition in which they arrived. There are a number of individual analyses of Florida canes that are very high in sucrose or cane sugar, the maximum, 19.00 per cent. of sucrose, being quite high for a semi-tropical country; while the maximum of the Georgia canes is 17.70 per cent, sucrose. This difference is largely due to the time of harvest; the Georgia canes being harvested in November, and Florida canes in December, giving the Florida canes one month advantage in maturing.

The general average of the canes from both states are identical, and this is further impressed by individual variations, except in a few extreme cases, which are quite similar. These averages are of one year's growth and may, as in Louisiana, be subject to considerable variation in sugar content from similar canes at different seasons, in fact, such would be expected, as it is one of the invariable characteristics of sugar canes, though canes of such composition as these should be considered good under the most unfavorable conditions.

The minimum in Louisiana is an exceptional case, it occurring during a season of adverse conditions for cane culture, and is far below any average conditions. The average composition of the canes in Louisiana would be a mean between these extremes of 12 per cent. sucrose. Before commenting on the above analyses, a few conditions regarding the growth of cane should be noted.

Cane requires for vigorous growth and large sugar content, a sufficient supply of water and tropical temperature during its growing season, and a dry season for ripening and increasing the sugar content.

In dry countries the cane is more sugary and fibrous, though of smaller size, than in wet countries, where it is less rich in sugar, and more glucose is present; the water stimulating the growth of the cane and causing it to be gorged with water. In Cuba, on account of excessive rains at certain seasons, the sugar content is inferior to that in the Hawaiian Islands where climatic conditions, other than rainfall, are perfect, and the deficiency in rainfall is supplied by irrigation, thus giving the cane the water it required at the proper time and insuring a good ripening season. Different localities, conditions of soils and rainfall, cause variations in the sugar content of canes on the same

islands, and in Louisiana, in the same locality, the soils alone show a marked variation in sugar content of the canes.

In Louisiana the variation in the sugar content of the canes is considerable in different seasons and marks the extremes. Under very unfavorable conditions for ripening, the minimum content has been found and while more common, though not ordinarily the case, under very favorable conditions the maximum sugar content has been reached there several times.

To summarize the above, the average would be:

Louisiana canes	12 per cent. sugar.
Hawaiian canes	17 per cent. sugar.
Cuban canes	16 per cent. sugar.
Georgia canes	16 per cent. sugar.
Florida canes	16 per cent. sugar.

Louisiana Sugar Experiment Station,

Audubon Park, New Orleans, La., Aug. 18, 1900.

CHAPTER V.

OUR SUGAR SUPPLY OF THE FUTURE.

Georgia and Florida Considered as Possible Important Factors in Contributing to It.

For the year ending June 30th, 1899, the United States paid foreign countries \$94,964,120.00 for sugar for domestic consumption, and exported against this only \$2,953,102.00, in value, of sugar and molasses.

Nearly one seventh of the entire amount paid for imports by the United States is expended for sugar alone.

It required nearly half of the sum received from cotton exported to liquidate the indebtedness incurred in the purchase of foreign sugar to provide the amount consumed by the people of this country in the last fiscal year.

This enormous drain upon the resources of the country for a single food crop, is just cause for alarm, and if this burden should be increased, as seems imminent, the consumption advancing from 1,309,383 tons (each 2,240 pounds,) in 1884, to 2,094,610 tons, in 1899, at the end of another decade our entire exports of cotton may be inadequate to satisfy the claims for sugar purchased of foreign manufacturers.

Notwithstanding the great advance made in the manufacture of cane sugar in Louisiana and the liberal encouragement given to the development of the beet sugar industry in the Northern, Western and Pacific States, domestic manufacturers still only provide 16 per cent. of the sugar consumed in the United States annually.

The United States ranks as the second greatest sugar consuming country of the globe, Great Britain only exceeding her enormous consumption. In England the per capita consumption, in 1898, was placed by Herr Licht, German Statistician, at 91.31 pounds; in the United States 59.30 pounds (others place it higher,) and for all Europe at 25.42 pounds.

Until within the last half century the high price of sugar classed its free use among the luxuries of life. Increased production and lower prices in late years have brought su-

gar into general consumption, and within a decade has excited scientific inquiry to ascertain more conclusively its direct effect upon the human system other than its fascination for the palate.

Experiments conducted at home and abroad to determine the position of sugar in food economy, as far as pursued, have established for it a remarkable capacity for developing and sustaining muscular power, in particular, but generally in giving greater vigor to the human organism in combination with the cereals and meats.

Cane was originally the sole source from which commerce drew its supply of sugar.

Beets as a source of sugar supply first attracted attention in France in the reign of Napoleon Bonaparte, "as one of the results of the exigencies of a state of war and the emancipation of the slaves in the British Colonies."

Cane held its place as the base of the sugar supply, however, until 1850. Meanwhile interest in the cultivation of beets for sugar production, had spread from France to Germany and other continental countries, where home consumption was first met with its product.

Since 1850, interest has grown more rapidly and more extended, as to territory, in the cultivation of the beet for its sugar content, several of our Northern and Western States being classed among the successful producers of beet sugar, and, to-day, we are witnesses to the fact that the beet supplies two-thirds of the world's consumption of sugar, and to the further fact that "the center of the sugar industry has been transferred from the tropics to the temperate zone," proclaiming one of the most marvellous achievements of science "in raising an humble garden vegetable" to be, for the time, at least, a potential factor in the world's sugar supply, statisticians fixing the world's annual production of sugar at 7,500,000 tons, and crediting beet sugar with contributing 4,650,000 tons of this amount.

When beet sugar, in 1881, first began to actively threaten the supremacy of the product of the cane, standard "A" sugar, in New York, commanded 9.84 cents per pound; in 1894-95, it had declined 4 cents and in 1899, averaged about 5.50 cents per pound, while the imported raw sugar, in bond, averaged, in 1881, 4.41 cents per pound; 1894, 2.92 cents and in 1899, 3.125 cents per pound.

To this point the victory of beet over cane sugar has been a victory for chemistry. "The influence," says United States Vice Consul Murphy, writing from Madgeburg, June 13th, 1900, "which chemistry has exerted upon the production of beet sugar has been very great and has rendered possible the victory of the beet over cane sugar. * * * *

No other existing industry is subject to such thorough and scientific control as is the German beet sugar industry."

But chemistry is greatly indebted to climate for the wonderful grasp with which it has been able to impart such an astounding value to the beet, and a writer, in the "North American Review," March 1899, goes so far as to say, that "The beet owes its present success solely to the fact of its being grown in a temperate climate, where the talent and enterprise of an energetic race can be applied to the problem of its improvement."

The beet sugar industry in the United States, in some sections, has not proven the success anticipated, though fostered by state bounties to encourage beet growing.

The Year-Book of the Department of Agriculture, however, takes a very bright view of the situation, and says that while the experiments of the year have added no new information in regard to the beet sugar industry, the Year-Book gives a list of 16 new factories that were completed for the beet crop of 1899 and 5 more that will be ready for the crop of 1900-01.

It is well known, however, that beets, as a crop, are subject to many vicissitudes in cultivation, unknown in the cultivation of cane, and that they have shown these characteristics in this country.

In Europe bounties and other forms of encouragement granted to stimulate the development of the beet sugar industry, have been modified and in the near future may be withdrawn entirely and in our own country State bounties are of doubtful constitutionality and may be withdrawn at any time, possibly resulting in the impairment of the beet sugar industry in this country in its competition with the richer product of the cane. Such an abolition of bounties would be in line with the public sentiment that compelled the repeal of the statute that, in recent years, gave sugar growers in the United States a fixed bounty per pound in lieu of the tariff protection previously and subsequently enjoyed.

In Cuba all field labor was demoralized or destroyed by the war. The slave of yesterday is the freeman of to-day, and the reorganization of labor upon economic lines, under these circumstances, will be the most serious problem with which the Cuban Republic must immediately deal, if the sugar industry, her greatest source of wealth and commercial importance, in the past, is to be restored to its former magnitude. If labor conditions can be restored, even in years, it will be the reversal of history in the experience of other islands in the Carribean Archipelago, which in the emancipation of slaves or in changes from despotic to freer

forms of government have, in every instance, fallen from the place to which the fertility of their soil raised them, in consequence of the resulting disorganization of labor, and the utter impossibility of reorganizing it or of replacing it, short of a revival of the slave trade, or the establishment of that worse form of human servitude, a "contract system," that could not be sanctioned by the United States in any form of laws that may be enacted for Cuba without doing violence to her own prohibitory statutes against such an infamous form of bondage with none of the compensating features of straightout slavery.

The labor conditions in Porto Rico and the Philippines are not likely ever to be any better than those in Cuba, hereafter, and the Hawaiian Islands are already feeling the effect of the statutes of the United States, now in force there, against contract labor, under any disguise, which has heretofore been the recognized system of labor for the Hawaiian cane and rice fields.

It is well to consider here, too, as a vital factor in forecasting the future of all tropical islands, now or that may hereafter come under the control or influence of the United States, as well as in Cuba, that there will be no rush of immigration to them from overcrowded States, which made our Western wilds the world's granary; but which could not have been accomplished by "Yankee" push without being backed by "Yankee" brawn. These islands may expect to receive a plenty of the "push" but they must supply the "brawn" from their own labor elements, whose muscles have been enervated by a tropical sun and a climate that does not excite to voluntary effort, and so it will be to the end of time; and it is, therefore, possible that this generation has seen the greatest agricultural growth to which the insular possessions or allies of the United States will ever be able to attain in the future, unless "the leopard can change his spots."

The minerals these islands possess will continue to attract capital, and minor branches of agriculture, where nature contributes all, save the labor for the harvest, be maintained; but the cane that requires careful cultivation, fertilization and economical harvesting, even in the tropics, with the cheapest labor and the greatest luxuriance of growth, will never be to Cuba, and our insular possessions, again the valuable source of revenue it has been to them in the past.

Over the imported sugar, of beet or cane, home producers have the advantage of transportation to commence with, and in the manufacture foreign countries must be at great disadvantage on account of higher cost of fuel, etc., and the

beet and cane industries of this country could be worked together in shutting out the foreign products and supplying the full consumptive demand at home.

The beneficent effects of such a policy would hasten the desirable end of freeing this country from dependence upon Germany and other foreign states, that cannot be overestimated. Besides in the North and West it would stimulate beet production, and in the South, with a temperate climate and the energy of an active and intelligent race, from cane cultivation and its manufacture into sugar, results might be expected to excel even the marvellous development of the beet in Germany where the greatest study has been devoted to the subject.

The rich quality of the cane found by Dr. Stubbs growing promiscuously in Georgia and Florida, without scientific direction, justifies this expectation.

The writer in the "North American Review," who has already been quoted, in support of this view, discussing the relative value of the beet and the cane in sugar production, says:

"It (the cane) can be grown at less expense under the proper climatic conditions and the sugar content can be obtained at a smaller cost of manufacture; and, while the beet has, probably, almost reached the climax of its development, the margin of possibility in the case of the cane is wide and inviting. By the expenditure upon it of one-tenth of the study and energy which have been devoted to the service of the beet, the cane would soon overtake and outstrip its pudgy rival in the race for supremacy."

And the Year-Book, 1899, Department of Agriculture, to which reference has also been previously made, gives additional confirmation to this view, in saying (page 254:) "By means of chemical studies the sugar beet has been developed from the common garden beet, containing only 5 or 6 per cent of sugar, to its present condition of a root containing from 12 to 16 per cent. This great improvement has been secured solely by the aid of chemical science conjoined with the highest skill in practical agriculture. In the process of manufacture, however, chemical science has been even more successful. Beet juices, on account of their composition, present greater difficulties in manufacture than the juice of sugar cane. Without the aid of chemical science the present status of beet sugar manufacture would have been impossible of attainment."

It will be seen that both the writers in the "Review" and in the "Year-Book" agree that the cane is the better base, unaided, for sugar making. In the "Review" it is declared that "with one-tenth of the study and energy which have

been devoted to the service of the beet, the cane would soon overtake and outstrip its pudgy rival in the race for supremacy." The "Review" further claims that the beet sugar industry has "almost reached the climax of its development."

The "Year-Book" (page 744), "Beet Sugar," after referring to the immense scientific labor devoted to the beet in the last year; says: "While it cannot be said that any new information has been gained by this work, a large number of analyses have been made and the data accumulated are undoubtedly of value."

Heretofore the work of the chemist has been equal to the decline in the value of sugar from the price upon which the beet sugar industry was first built.

How much more shrinkage the industry can bear without destroying all margin to growers, as well as manufacturers, while difficult to determine as to both branches of the industry, the reduced price paid by manufacturers for beets in some States have already had a discouraging effect upon production.

Sugar from cane or beet is now produced in nearly every country in the world, and there can, therefore, be no reasonable hope indulged that prices will be restored or be permanently moved upward again. Therefore, upon the present, or possibly lower, prices the industry must stand or fall in the competition.

Until Dr. Stubbs' visit, the possibility of Georgia and Florida becoming sugar producing States again was never given a thought.

It had long since passed from memory that these States had been sugar States in years gone by.

Dr. Stubbs does not announce his conclusions in platitudes upon the possibilities of Georgia and Florida as sugar producing States. He says he saw land under cultivation yielding 16 to 35 tons to the acre of cane, and the analysis of the cane gave a sugar content of 16 per cent. capable of yielding under 75 per cent. extraction, 225 pounds of C. P. sugar to the ton, and an acre producing 20 tons would therefore yield 4,500 pounds, and 30 tons 6,750 pounds per acre of C. P. sugar.

In Cuba the product of cane to the acre varies from 12 to 40 tons, and, with 16 per cent. sugar content, is no richer than the canes of Georgia and Florida.

Commenting upon Dr. Stubbs' statement that he had found cane, with ordinary cultivation in Georgia, to produce 20 tons to the acre with 16 per cent. sugar content, Capt. R. E. Rose, President of the Florida State Agricultural Society, who has made the cultivation and manufac-

ture of cane a study, in an address before that society, May 3rd, 1900, said:

"With a cane, averaging as the purple cane in Prof. Stubbs' report averaged, (referring to Dr. Stubbs' visit to Georgia and Florida) sugar can be manufactured for 40 cents per 100 pounds. At twenty tons to the acre the cane can be grown, harvested and delivered for \$2 per ton, making the actual cost of sugar (200 pounds per ton of cane) \$1.40 per hundred pounds, or less than 1½ cents per pound."

In a recent issue of the Hawaiian Planters Monthly, compiled by Mr. Paul Doerstling, Superintendent of the beet sugar factory at La Grande, Oregon, appears the following table showing the cost of producing cane and beet sugar in various countries, which becomes interesting in connection with estimate of Capt. Rose of the cost of producing sugar in Georgia and Florida.

Mr. Paul Doerstling figured on a basis of 2,240 pounds to the ton; Capt. Rose, 2,000 pounds to the ton, which would make cost of long ton \$1.58 per 100 pounds against \$1.40 or 1.58 cents per pound for short ton, and 4,000 pounds would be 1.8 long tons of commercial sugar to an acre. in comparison with the following compilation of Mr. Doerstling:—

CANE SUGAR.

Country	Tons cane per acre.	Tons sugar per acre.	Cost of sugar per ton.	Cost of sugar per pound in cents.
Spain	17	0.9	\$55.00	2.45
Japan	15.5	1.3	78.00	3.48
Java	32	3.0	38.00	1.69
Straits Settlements	20	1.6	41.00	1.82
Egypt	19	1.9	45.00	2.08
Reunion Islands	21	1.9	69.00	3.00
Louisiana	22	1.9	75.00	3.34
Cuba	24	1.8	40.00	1.78
East Indies	..	1.0	36.00	1.60
Hawaii	22	2.8	39.00	1.74
Argentina	13	1.0	62.00	2.76
British West Indies,	..	1.7	47.00	2.09
Queensland	..	2.0	28.00	1.25
Porto Rico	20	2.0	28.00	1.25

BEET SUGAR.

Germany	12.5	1.2	\$49.00	2.18
Austria	9.3	1.1	47.00	2.09
France	10.9	1.2	58.00	2.58
Russia	7.2	1.9	60.00	2.67

The lands in Cuba devoted to cane cultivation represent a large money value and the same is true of sugar lands in Hawaii and in Louisiana, in the alluvial sections of the latter state.

Lands in Georgia, now planted in cane, represent a value of \$5.00 to \$10.00 per acre; lands equally as good, in the woods, \$1.00 to \$2.00 per acre and cost of preparation, which is inexpensive. These same facts are applicable to Florida.

The lands in both Georgia and Florida suited to cane cultivation are found along our lines of railroads, in healthy locations and in the midst of an active and intelligent population, with abundant school and church facilities, where every surrounding, under scientific direction, will combine to insure the highest development—in both cultivation and manufacture.

CHAPTER VI.

RECOLLECTIONS OF HOPETON PLANTATION.

Hopeton Plantation, situated on the southern bank of the Altamaha River, in Glynn county, Georgia, fifteen miles from the Atlantic Ocean, five miles, by water, from Darien on the opposite side of the river and sixteen miles from Brunswick, by land, was the plantation home of the late James Hamilton Couper.

Hopeton is invested with a peculiar interest at this time while sugar cane cultivation is engaging public thought, because it was here that Mr. Couper, in 1829, erected and operated the first complete sugar manufacturing plant in Georgia, on a scale in advance then of any similar sugar plant in the West Indies or Louisiana.

On the opposite page is a fine view of the Hopeton Sugar plant as it stands to-day. The connected buildings comprising this plant are 39 feet in width and 240 feet in length and the massive walls of the buildings constructed of tabby, a concrete substance, composed of oyster shells and lime or cement.

The plant was started for the first time in the fall of 1829, and "the performance of every part was satisfactory," says Mr. Couper. Mr. Couper's annual cane crop, grown at Hopeton, exceeded 300 acres and was estimated as yielding 30 tons of cane to the acre.

The machinery of this plant remained in place until a few years ago when its present owners, the "Shaker Colony," in Glynn County, sold it as scrap metal.

Though Mr. Couper was deeply engrossed in the affairs of Hopeton and had made it "a model to all interested in scientific agriculture," to quote further from Capt. C. S. Wylly's very interesting "Annals of Glynn County," Mr. Couper "by methodical use of his time found leisure to cultivate his scientific tastes so much as to cause his correspondence to be solicited by almost all of the learned societies. He was recognized as the best planter in the district, as a most humane and successful manager of slaves, as the leading conchologist of the South and as a microscopist whose

HOPETON SUGAR PLANT,
ERECTED BY JAMES HAMILTON COUPER IN 1829, AS IT APPEARED IN 1899.

researches into the then new field of germ life, attracted attention in the laboratories of all the universities."

In the winter of 1832, Editor J. D. Legare, of the "Southern Agriculturalist," of Charleston, S. C., during a tour of Georgia's sugar district, was a guest of Mr. Couper at Hopeton. The object of his visit was to study the sugar cane situation in Georgia for the benefit of the planters of South Carolina, and he gives an account of his visit in several numbers of the "Agriculturalist," in 1833. We quote from this correspondence, as follows:

"We remained several days at Hopeton enjoying the hospitality of J. Hamilton Couper, Esq., during which time we were busily employed in viewing the plantation and of taking notes of such things as we saw and heard of.

"We hesitate not to say Hopeton is decidedly the best plantation we ever visited, and we doubt whether it can be equalled (certainly not surpassed) in the Southern States, and, perhaps, when we consider the extent of the operations, the variety of crops cultivated and the number of operatives who have to be directed and managed it will not be presumptive to say, that it may fairly challenge comparison with any establishment in the United States, whether we consider the systematic arrangement of the whole, the regularity and precision with which each and all of the operations are conducted or the perfect and daily accountability established in every department.

"All the crops had been harvested except the cane, and we had the pleasure of seeing all the operations connected with this valuable crop, from the commencement of the stripping of the cane to the final preparation for the market.

"The proportion of the various crops were 500 acres in rice, 170 acres in cotton and 330 acres in cane."

On the occasion of his second visit to the United States. Sir Charles Lyell, F. R. S., the distinguished English geologist and scholar, became a guest at Hopeton, January 1st, 1846. Sir Charles had reached Darien the night before and thus describes his first meeting with Mr. Couper, in the first volume of the account of his second visit to the United States:

"The next morning, while we were standing on the river's bank, we were joined by Mr. Hamilton Couper, with whom I had corresponded on geological matters, and whom I have already mentioned as the donor of a splendid collection of fossil remains to the museum at Washington, and, I may add, of other like treasures to that of Philadelphia. He came down the river to meet us in a long canoe, hollowed out of the trunk of a single cypress, and rowed by six ne-

groes, who were singing loudly, and keeping time to the stroke of their oars."

Speaking of Mr. Couper's library, which was then regarded as the most valuable in the state, Sir Charles says :

"I found, in the well-stored library of Mr. Couper, Audubon's Birds, Michaud's Forest Trees, and other costly works on natural history; also Catherwood's Antiquities of Central America, folio edition, in which the superior effect of the larger drawings of the monuments of Indian architecture struck me much, as compared to the reduced ones, given in Stephen's Central America, by the same artist."

Sir Charles, while at Hopeton, gave his time to studying the geology of the region with Mr. Couper. But incidentally, Sir Charles could not fail to be impressed by the happy and contented appearance of the 500 slaves on Hopeton under Mr. Couper's management, and he expresses himself very clearly and forcibly upon the subject, in the account of his travels:

"During a fortnight at Hopeton, we had an opportunity of seeing how the planters live in the South, and the condition and prospects of the negroes on a well-managed estate. The relations of the slaves to their owners resemble nothing in the Northern States. There is an hereditary regard and often attachment on both sides, more like that formerly existing between lords and their retainers in the old feudal times of Europe, than to anything now to be found in America. The slaves identify themselves with the master, and their sense of their own importance rises with his success in life. But the responsibility of the owners is felt to be great, and to manage a plantation with profit is no easy task; so much judgment is required, and such a mixture of firmness, forbearance and kindness. The evils of the system of slavery are said to be exhibited in their worst light when new settlers come from the free states; Northern men, who are full of activity, and who strive to make a rapid fortune, willing to risk their own lives in an unhealthy climate, and who cannot make an allowance for the repugnance to continuous labor of the negro race, or the diminished motive for exertion of the slave. To one who arrives in Georgia direct from Europe, with a vivid impression on his mind of the state of the peasantry there in many populous regions, their ignorance, intemperance, and improvidence, the difficulty of obtaining subsistence, and the small chance they have of bettering their lot, the condition of the black laborers on such a property as Hopeton, will afford but small ground for lamentation or despondency. I had many opportunities, while here, of talking with the slaves alone, or seeing them at work. I may be told this was a favorable specimen of a well-manged estate; if so, I may at

least affirm that mere chance led me to pay this visit, that is to say, scientific objects wholly unconnected with the 'domestic institution' of the South, or the character of the owner in relation to his slaves; and I may say that same in regard to every other locality or proprietor visited by me in the course of this tour. I can but relate what passed under my own eyes, or what I learnt from good authority, concealing nothing."

Miss Fredrika Bremer, the Swedish novelist, whose charming works of fiction have a place in every home, in her "Homes of the New World; Impressions of America," in her first volume of travels, writing from Savannah, Ga., 13th of May, 1851, on the eve of taking a steamer for Florida says:

"On my return I shall visit the plantation of a Mr. Couper, where I am told I shall meet the ideal of plantation life in the slave States."

On her return from Florida, Miss Bremer, on May 27th, writes as follows, from the summer home of Mr. James Hamilton Couper, St. Simon's Island:

"Mr. C. is one of the greatest planters in the South of the United States, and this created in me a desire to become acquainted with him and his plantations. But I did not find him a reformer, merely a disciplinarian, with great practical tact, and also some benevolence in the treatment of negroes."

"In other words I found him to be a true representative of the gentlemen of the Southern States—a very polite man, possessing as much knowledge as an encyclopedia, and interesting to me in a high degree through the wealth and fascination of his conversation. He is distinguished for his knowledge of natural history; has a beautiful collection of the natural productions of America, and the lecture which I heard him read, this morning, in the midst of these, on the geology and rock formation of the world has given me a clearer knowledge of the geological structure of this portion of the world than I ever possessed before."

"In urbanity and grace of conversation Mr. C. reminds me of Ralph Waldo Emerson; but, in a general way, the Southern gentleman has too small development of the organ of ideality even as in the gentleman of the North it is too large."

The winter of 1854-55 brought Hon. Miss Amelia M. Murray to the United States, chiefly, it would seem, to study our industrial system, for she had at home, in England, previously given much time and thought to similar subjects. She came to the United States deeply imbued with English antagonism to slavery as it existed in the Southern States.

Miss Murray, at the time of her visit, was serving as a

maid of honor to Queen Victoria, to which position she had been appointed in 1837, at the age of forty-two.

In the course of her travels she visited Savannah, Ga., and to judge from her account of the visit, was most pleasantly impressed with the city, and agreeably entertained by Mr. and Mrs. H. and Miss T., and had the pleasure, on one of these occasions, of meeting the late Bishop Elliott of the Diocese of Georgia, of whom she writes in loftiest eulogy.

On her way south, Feb. 10th, 1855, stopping at Darien, Miss Murray met, by "accident," Mr. Couper, whose fame as a scientist and a scholar was known to her. Mr. Couper insisted upon her party becoming his guests at Hopeton, where a delightful week was spent.

Miss Murray's letters of travel from the United States were not pleasantly received in England, and her determination to print them made a rupture at Court, which led to her retirement from the service of Queen Victoria as a maid of honor.

The trouble arose from the frankness with which she had expressed herself upon slavery, as she had observed it existing in the Southern States during her travels, which was greatly at variance with the prevailing English anti-slavery sentiment at the time. In diplomatic circles it was said she had violated a court rule forbidding officials to engage in political discussions.

Miss Murray was subsequently recalled, however, to the Queen's service as Assistant Lady of the Bed Chamber, and was the first unmarried lady to serve in that capacity.

News from home conveying to her the effect produced by her letters, while evidently annoying to Miss Murray served to draw out in stronger light a nobility of character, in her consciousness of being right in the convictions to which she had given utterance in her letters, that does great credit both to her heart and head, as she writes from New Orleans, April 6th, 1855:

"Only now am I made aware for the first time, of _____'s resignation of the editorship she volunteered. I don't think I should ever have thought of the publication if she had not proposed it, but I could not write to her what I did not see or think. I am sorry and think she had better have trusted to my endeavor to tell the truth, which, if it is not the truth, can never hurt any cause; but the subject in question is too serious a matter to be blinked for the sake of any individual friendship or individual interest, and at any cost I must sacrifice the opinions and impressions of friends to my own honest convictions."

Mr. Couper died in 1866, after a long and useful career, honored and beloved by the whole country that felt that the world was better that he had lived.

CHAPTER VII.

CLIMATOLOGICAL TABLES,

Comparative and Otherwise, of South Georgia, Florida and South Louisiana, Prepared Expressly for this Work under the Direction of Mr. H. B. Boyer, Local Forecast Official of the U. S. Weather Bureau at the Savannah, Ga., Station.

For a variety of reasons it has been difficult to select Stations in Georgia, Florida and Louisiana for the purpose of this comparison, where the Records were complete. Some of the stations, like Eastman and Waycross, in Georgia, are only in operation during the cotton growing season—April to October inclusive.

This is the first attempt to compare the climatological conditions in these States to determine their equal adaptability for the production of Sugar Cane profitably and difficulty has consequently attended the selection of Stations in Georgia and Florida of such sufficient completeness of data as to fully serve the purpose. Of course, in Louisiana data is easily obtainable from its valuable Experiment Stations as well as from the Weather Bureau records in that State.

The comparison of the tables that follow show that Southern Georgia and Florida have, with Louisiana, all the conditions requisite for the profitable cultivation of Sugar Cane for its Sugar Content.

Monthly and Annual Normal Temperature for Florida---From Seven Selected Stations.

STATIONS.	Elevation, feet.	Length of record years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Jacksonville	43	29	55.2	58.4	61.6	68.9	74.9	80.1	82.1	81.1	78.4	69.7	61.6	55.9	69.0
Tallahassee	193	15	51.5	56.0	66.3	67.4	74.2	78.8	80.4	79.6	76.7	67.4	59.1	53.1	67.5
Lake City	201	13	56.7	57.1	64.5	69.4	76.2	81.2	80.9	81.3	77.5	69.8	62.3	57.5	69.5
Ocala	150	11	57.5	60.5	64.3	69.4	74.2	79.0	80.7	80.7	77.8	71.3	64.1	57.9	69.8
Orlando	98	8	59.5	61.7	67.2	70.6	75.9	79.6	81.5	81.9	78.8	72.7	67.5	60.1	71.4
New Smyrna	20	14	60.2	60.4	65.8	71.3	74.8	79.8	80.7	79.7	78.7	72.3	66.6	60.3	70.9
Myers	. . .	15	63.8	66.0	64.9	73.8	78.0	79.8	82.3	82.8	81.2	76.4	72.5	65.8	71.4
		Means	. . .	. . .	. . .	. .	. . .	. . .	. . .	. .	. . .	. . .	. . .	. .	70.3

Monthly and Annual Normal Temperature for South Louisiana---From Eight Selected Stations.

STATIONS.	Elevation, feet.	Length of record years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Alexandria.	77	11	49.2	51.3	58.4	67.1	72.5	78.6	81.3	80.3	76.0	63.6	56.0	50.2	65.0
Donaldsonville . . .	33	10	53.4	56.4	61.3	68.8	74.2	79.3	81.4	80.9	78.2	68.6	60.6	55.5	68.2
Grand Coteau	93	12	53.0	57.1	61.5	69.2	73.8	78.7	80.5	79.9	76.6	66.8	59.0	55.1	67.6
Franklin	19	8	51.8	54.8	63.9	69.5	75.7	80.7	82.2	81.4	79.0	67.9	59.9	53.9	68.4
Lake Charles	22	12	52.0	54.9	59.3	67.8	73.5	79.7	80.7	80.1	76.8	67.9	58.4	53.6	67.1
New Orleans	8	26	54.1	57.8	62.7	69.0	75.0	80.9	82.4	81.8	78.6	70.4	61.2	55.8	69.0
Rayne	. . .	8	53.0	54.0	62.3	69.4	74.9	79.4	81.9	81.8	77.7	68.4	60.3	54.4	68.1
Schriever	. . .	10	53.5	57.0	63.9	69.1	75.5	80.6	81.9	81.7	78.1	68.1	59.6	53.4	68.7
Means			52.5	55.4	61.7	68.7	74.4	79.7	81.5	81.0	77.6	67.7	59.4	54.0	67.8

Monthly and Annual Normal Precipitation for South Georgia—From Eight Selected Stations.

STATIONS.	Elevation, feet.	Length of record years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Albany	232	18	5.22	5.48	5.32	3.27	3.33	6.41	5.29	5.28	2.72	1.93	1.97	2.64	48.86
Alapaha	. . .	16	3.86	4.34	. . .	2.79	3.22	4.83	5.26	5.82	4.16	2.63	1.86	4.05	. . .
Americus	362	16	4.49	3.76	5.74	3.44	3.16	4.98	5.94	5.51	2.70	1.88	2.66	3.21	47.47
Eastman	361	5	. . .	. . .	. . .	2.27	2.51	3.80	6.11	5.05	3.53	1.79	2.37	. . .	. . .
Fort Gaines	766	16	3.62	5.96	6.55	2.41	2.72	4.57	6.06	5.48	2.50	1.98	2.32	3.45	47.62
Savannah	71	48	3.23	2.93	3.86	2.83	3.90	5.51	6.91	7.98	5.60	2.98	2.04	3.27	51.04
Thomasville	330	20	3.78	3.86	3.68	3.74	4.01	4.88	6.57	6.04	4.44	3.41	2.73	4.69	51.83
Waycross	131	16	. . .	. . .	. . .	2.03	2.76	4.93	5.81	6.40	4.85	2.66	0.97	. . .	. . .
		Means	4.03	4.39	5.03	2.85	3.20	4.99	5.99	5.94	3.81	2.41	2.11	3.55	49.36

Monthly and Annual Normal Precipitation for South Louisiana---From Eight Selected Stations.

STATIONS.	Elevation, feet.	Length of record years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Alexandria . . .	77	12	5.84	5.50	5.85	4.00	3.72	6.15	5.50	4.68	2.10	2.63	5.00	4.44	55.41
Donaldsonville . . .	33	10	4.10	5.38	4.79	4.56	3.82	6.75	4.86	6.76	4.60	2.56	5.03	3.84	55.13
Grand Coteau . . .	93	12	4.71	4.73	4.34	3.20	3.45	6.74	5.69	4.84	2.54	3.32	3.89	3.58	51.03
Franklin	10	8	3.87	6.33	3.34	3.75	3.61	7.27	8.33	7.73	6.36	3.09	5.23	4.32	59.93
Lake Charles	22	11	5.92	4.22	4.46	2.35	2.64	7.75	5.56	6.02	2.90	2.75	5.61	3.19	53.37
New Orleans	8	29	4.83	4.54	5.12	5.17	4.47	6.51	6.39	5.73	4.90	3.17	4.12	4.18	59.47
Rayne	. . .	8	4.64	5.31	5.44	2.41	3.02	7.84	6.63	5.47	4.67	2.99	5.58	3.33	57.33
Schriever	. . .	8	3.47	5.93	4.03	3.55	3.40	8.09	8.29	6.91	4.72	3.29	4.31	3.53	59.52
		Means	4.67	5.24	4.67	3.62	3.52	7.14	6.40	6.02	4.10	2.98	4.84	3.80	56.40

Climatological Data for the Year 1899.
SOUTH GEORGIA.

STATIONS.	Temperature (Degrees Fahrenheit).						Precipitation (Inches).						Sky.				Prevailing direction of wind.	
	Elevation, feet.	Length of record, years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of record, years.	Total for the year.	Greatest monthly.	Month.	Least monthly.	Month.	Total snowfall.	Number rainy days.	Number clear days.		Number partly cloudy days.
Albany.....	232	19	67.3	106	July 17	-2	Feb. 13	19	40.49	7.39	Feb.	0.37	Nov.	.....	83	.....	.....	.....
Alapaha.....		17	.....	200	June 15	.....	.....	17	.....	.....	.....	0.83	Sept.	.....	.....	.....	.....	.....
Americus.....	362	17	65.3	101	June 22	-6	Feb. 13	17	40.89	6.05	Jan.	0.59	Sept.	5.6	95	.....	.....	.....
Eastman.....	361	17	.....	101	Aug. 13	.....	.....	17	.....	.....	.....	0.37	.....	.....	.....	.....	.....	.....
Fort Gaines.....	166	17	.....	10	July 16	.....	.....	17	.....	9.98	Jan.	0.54	Sept.	3.5	.....	.....	.....	.....
Savannah.....	71	50	67.0	100	Aug. 7	8	Feb. 13	50	42.17	9.04	Aug.	1.07	June	2.0	104	140	153	72 SW
Thomasville.....	330	21	68.2	99	June 15	2	Feb. 13	21	40.81	7.74	July	0.46	Nov.	2.0	99	.....	.....	.....
Waycross.....	131	17	.....	101	June 6	4	Feb. 13	17	.....	6.66	Feb.	1.07	Dec.	3.0	.....	.....	.....	.....

Climatological Data for the Year 1899.
FLORIDA.

STATIONS.	Temperature (Deg.)						Precipitation (Inches).						Sky.				Prevailing direction of wind.		
	Elevation feet.	Length of Record Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of record years.	Total for the year.	Greatest Monthly.	Month.	Least monthly.	Month.	Total snowfall.	Number rainy days.				
															Number clear days.	Number partly cloudy days.		Number cloudy days.	
Jacksonville.....	43	28	63.4	90	Aug. 6	10	Feb. 13	28	38.57	6.12	July	0.07	Nov.	1.9	117	117	169	79	NE
Tallahassee ...	193	14	67.4	96	.....	-2	Feb. 13	11	44.96	11.46	Aug.	0.52	Nov.	1.0	74	189	134	42	S
Lake City.....	201	11	69.6	103	June 16	6	Feb. 13	11	30.49	4.18	Jan.	0.21	Nov.	3.0	89	83	197	85	SW
Ocala.....	150	12	70.8	101	Aug. 4	12	Feb. 13	12	47.31	8.68	June	0.22	Nov.	.....	103	160	128	76	NE
Orlando	93	8	72.4	97	.....	20	Feb. 14	8	54.76	9.22	Oct.	0.12	Nov.	.....	126	234	71	60	E
New Smyrna.....	20	10	.....	97	May 23	16	Feb. 13	10	.....	14.86	Oct	T.	Nov.	T	65	154	114	32	SE
Myers.....	.....	12	73.1	93	.....	28	Feb. 14	12	49.24	12.08	July	0.58	Dec.	T	109	241	87	37	E

Climatological Data for the Year 1899. SOUTH LOUISIANA.

STATIONS.	Temperature (Degrees Fahrenheit).					Precipitation (Inches).						Sky.				Prevailing direction of wind.			
	Elevation, feet.	Length of record, years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of record, years.	Total for the year.	Greatest monthly.	Month.	Least monthly	Month.	Total snowfall.	Number rainy days.		Number clear days.	Number partly cloudy days.	Number cloudy days.
Alexandria.....	77	11	66.2	103	Aug. 2	3	Feb. 13	12	32.98	10.85	Jan.	0.01	May	7.0	94	146	63	156	S
Donaldsonville.....	33	10	67.1	96	July 29 Aug. 1	3	Feb. 12	10	39.65	7.95	June	0.05	May	3.0	71	.....	.....	.....	.....
Franklin.....	10	8	67.6	99	Aug. 2	8	Feb. 13	8	48.95	7.21	Dec.	0.02	May	2.0	108	177	61	127	N
Grand Coteau.....	93	12	67.6	103	July 30 July 31	2	Feb. 13	12	34.97	10.42	Jan.	0.72	May	1.8	93	110	164	91	SE
Lake Charles.....	22	12	67.7	100	Aug. 2-3	3	Feb. 12	11	50.67	12.32	Jan.	0.00	May	1.0	83	.....	.....	.....	N
New Orleans.....	8	26	68.8	98	Aug. 1	7	Feb. 13	29	31.07	7.80	June	0.14	May	3.0	110	150	150	85	SE
Rayne.....	.....	8	67.0	101	July 31 Aug. 2	3	Feb. 13	8	59.32	11.23	Jan.	1.31	Sept.	2.0	96	.....	.....	.....	S
Schriever.....	.....	10	67.9	100	Aug. 2	6	Feb. 13	8	43.19	7.73	June	0.19	May	3.0	110	135	130	10	SW

Monthly Maximum Temperatures for the Year 1899.
SOUTH GEORGIA.

STATIONS.	Jan'y.		Feb'y.		March.		April.		May		June.		July.		August.		Sept.		Oct.		Nov.		Dec.	
	Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.	
	Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.	
Albany	77	16	75	*7	81	25	84	30	97	21	*104	10	106	17	100	10	97	*6	89	20	79	23	74	*2
Alapaha .....	....	....	....	....	....	....	88	*28	96	19	100	15	98	*15	100	10	97	11	88	20	....	....	....	....
Americus.....	74	6	80	27	90	28	86	*14	96	18	101	22	101	18	96	7	96	11	86	20	76	*16	71	3
Eastman .....	....	....	....	....	....	....	88	*29	97	19	100	8	100	*15	101	*13	98	*8	88	*19	....	....	....	....
Fort Gaines.....	72	6	79	23	87	27	86	28	96	19	99	10	101	16	96	11	94	11	86	20	78	16	71	2
Savannah.....	76	6	81	5	85	26	86	14	97	18	99	15	98	15	100	7	94	7	86	18	81	23	77	19
Thomasville	75	6	80	23	87	26	89	28	97	19	99	*15	99	*17	99	*10	96	*5	90	20	83	2	7	20
Waycross.....	77	7	85	7	83	4	84	*26	97	19	101	16	100	18	100	*7	97	11	91	20	....	....	75	20

* On other dates also.

Monthly Maximum Temperatures for the Year 1899.

FLORIDA.

STATIONS.	Jan'y.		Feb'y.		March.		April.		May.		June.		July.		August.		Sept.		Oct.		Nov.		Dec.	
	Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.	
	Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.	
Jacksonville.....	78	6	81	5	86	27	85	14	96	18	97	15	96	15	98	6	93	10	87	19	81	23	76	14
Tallahassee.....	74	†	78	†	86	26	90	27	94	†	95	16	96	†	92	†	90	†	84	19	78	23	71	19
Lake City.....	81	5	83	26	83	27	87	15	100	18	103	16	100	15	101	7	97	†	90	19	84	1	78	19
Ocala.....	83	6	86	26	90	3	88	14	99	18	99	5	99	29	101	4	97	10	91	5	87	2	82	19
Orlando.....	81	14	85	27	89	28	85	†	94	†	97	†	95	†	97	†	92	†	87	5	82	†	79	14
New Smyrna.....	80	†	84	†	91	28	87	26	*97	23	92	†	93	†	95	†	.....	.....	*87	5	83	23	78	14
Myers.....	82	14	85	26	86	14	86	†	92	†	93	†	93	†	93	†	89	9	86	†	83	23	82	11

* Record incomplete. † More than one date.

Monthly Maximum Temperatures for the Year 1899.
SOUTH LOUISIANA.

STATIONS.	Jan'y.		Feb'y.		March.		April.		May.		June.		July.		August.		Sept.		Oct.		Nov.		Dec.	
	Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.		Maximum.	
	Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.	
Alexandria	76	5	77	22	83	27	91	29	95	24	97	5	101	31	103	2	101	5	92	20	86	16	79	1
Donaldsonville.....	82	4	80	3	88	25	91	29	94	14	94	16	96	29	96	1	95	4	88	19	84	15	78	9
Franklin.....	76	14	76	3	84	27	88	29	95	21	97	9	97	31	99	22	95	5	85	12	80	13	76	15
Grand Coteau.....	78	13	79	4	87	26	90	28	96	31	97	8	103	30	102	2	97	4	89	19	83	12	76	9
Lake Charles.....	76	17	75	3	80	27	86	29	90	23	96	17	100	31	100	2	98	5	91	21	86	13	78	1
New Orleans.....	75	10	79	3	84	26	86	28	90	19	94	16	93	21	96	1	95	4	86	20	80	11	78	9
Rayne.....	79	5	77	3	86	26	88	28	96	21	98	16	101	31	101	2	99	4	93	20	86	12	78	9
Schriever.....	82	13	81	3	87	27	91	30	94	20	99	17	99	17	100	2	97	4	92	13	87	13	82	10

Monthly Minimum Temperatures for the Year 1899.
SOUTH GEORGIA.

STATIONS.	Jan'y		Feb'y.		March.		April.		May.		June.		July.		August		Sept.		Oct.		Nov.		Dec.	
	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.
Albany	27	8	-2	13	23	8	38	10	54	1	60	19	67	*2	69	30	46	28	50	23	32	6	26	*29
Alapaha									56	*1	55	19	65	4	66	30	48	*27	51	1	...	...	...	...
Americus	26	29	-6	13	18	8	31	10	54	1	58	*18	63	2	68	29	43	27	46	23	32	6	23	30
Eastman									54	25	57	17	63	2	67	30	47	27	44	5	...	...	...	...
Fort Gaines					25	8			54	1	58	19	62	3	64	29	47	22	48	30	32	*5	26	*5
Savannah	30	2	8	13	24	8	38	5	58	24	58	18	65	2	67	28	53	27	51	1	41	4	27	30
Thomasville	30	8	2	13	23	8	35	10	53	1	60	19	66	2	69	29	46	27	53	31	33	4	23	6
Waycross	31	2	4	13	30	9	37	5	58	*1	55	19	61	2	67	31	52	27	43	31	...	...	24	6

*On other dates also.

Monthly Minimum Temperatures for the Year 1899.
FLORIDA.

STATIONS.	Jan'y.		Feb'y.		March.		Aprl.		May.		June.		July.		August.		Sept.		Oct.		Nov.		Dec.	
	Minimum.		Minimum.		Minimum.		Minimum.		Minimum.		Minimum.		Minimum.		Minimum.		Minimum.		Minimum.		Minimum.		Minimum.	
	Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.		Date.	
Jacksonville.....	33	8	10	13	26	8	41	10	61	8	60	20	67	5	69	30	54	27	54	30	45	6	30	30
Tallahassee.....	32	8	-2	13	25	8	38	†	56	1	62	†	68	†	69	29	52	27	55	†	38	4	29	30
Lake City.....	36	29	6	13	24	8	36	10	63	†	55	20	67	10	69	31	51	27	53	31	37	6	28	30
Ocala.....	35	29	12	13	28	8	37	11	60	†	56	20	69	†	69	31	53	27	53	†	40	†	25	30
Orlando.....	42	†	20	14	33	8	44	11	64	†	66	†	66	21	72	31	64	27	58	31	43	30	18	30
New Smyrna.....	39	30	16	13	30	8	39	11	59	17	55	21	68	1	69	29	.....	.....	59	9	42	30	31	30
Myers.....	43	19	28	14	39	8	45	11	61	29	67	†	70	†	72	†	69	27	62	31	50	30	38	†

† More than one date.

THE SUGAR CANE.

Monthly Minimum Temperatures for the Year 1899.
SOUTH LOUISIANA.

STATIONS.	Jan'y.		Feb'y.		March.		April.		May.		June.		July.		August.		Sept.		Oct.		Nov.		Dec.	
	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.	Minimum.	Date.
Alexandria	21	2	3	13	29	6	35	9	60	25	56	18	64	10	63	31	40	27	35	30	21	4	23	6
Donaldsonville.....	26	2	3	12	31	7	39	9	60	1	63	18	68	1	68	31	49	27	45	30	31	4	28	16
Franklin.....	28	1	8	13	34	6	40	8	63	1	62	19	69	1	68	31	47	27	43	31	31	4	32	16
Grand Coteau	25	2	2	13	32	6	40	8	61	26	60	18	66	10	67	30	44	28	42	31	29	4	28	16
Lake Charles	25	1	3	12	34	6	35	7	63	22	53	19	68	11	67	31	47	27	44	31	29	4	30	15
New Orleans	29	1	7	13	38	6	45	8	65	1	68	18	69	4	71	30	57	30	55	20	40	4	32	16
Rayne.....	24	2	3	13	31	7	38	8	61	2	61	18	67	10	67	30	44	27	43	8	28	4	28	16
Schrleiver.....	27	1	6	13	31	7	37	8	57	1	61	19	68	2	65	31	43	27	41	30	30	4	28	16

**Monthly and Annual Precipitation for the Year 1899.
FLORIDA.**

STATIONS.	PRECIPITATION.												
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Jacksonville	3.98	3.38	1.35	3.21	1.86	4.52	6.12	3.90	5.10	2.73	.07	2.35	38.57
Tallahassee	3.54	4.92	3.37	2.01	0.54	6.50	3.21	11.46	2.45	3.85	.52	2.59	44.96
Lake City	4.18	3.42	2.05	1.09	1.37	3.06	4.16	3.66	2.95	2.75	0.21	1.59	30.49
Ocala	5.63	5.20	1.24	3.77	0.62	8.68	6.49	4.61	6.16	3.19	0.22	1.50	47.31
Orlando	5.04	8.71	0.96	3.61	0.96	4.15	7.01	6.28	7.77	9.22	0.12	0.93	54.76
New Smyrna	4.33	9.10	3.01	3.13	*1.00	2.92	8.60	7.02	. . .	14.86	T	3.50	. . .
Myers	5.21	8.77	1.23	1.74	1.15	5.93	12.08	6.72	2.31	2.58	0.94	0.58	49.24

* Record incomplete.

Dates on which First and Last Killing Frosts Occurred, or Minimum Temperature Went to 32°.

SOUTH GEORGIA.

STATIONS.	1899. Last in Spring.	1899. First in Autumn.
Albany	March 9	November 6
Alapaha	March 9	November 4
Americus	March 29	November 4
Eastman	March 28	November 5
Fort Gaines	April 10	December 5
Savannah	March 8	November 4
Thomasville	March 9	November 4
Waycross	March 9	November 4

FLORIDA.

STATIONS.	1899. Last in Spring.	1899. First in Autumn.
Jacksonville	February 19	December 30
Tallahassee	March 8	November 4
Lake City	March 8	December 3
Ocala	March 9	December 5
Orlando	February 14	December 5
New Smyrna	March 8	December 30
Myers	February 14	December 30

SOUTH LOUISIANA.

STATIONS.	1899. Last in Spring.	1899. First in Autumn.
Alexandria	April 9	November 3
Donaldsonville	March 20	November 3
Franklin	February 15	November 4
Grand Coteau	March 7	November 3
Lake Charles	March 29	November 4
New Orleans	February 14	December 16
Rayne	March 29	November 3
Schriever	March 29	November 4

Temperature Summary, Savannah, Ga., for 23 Years.

	Average	Highest	Lowest.
January, 29 years :	51	80	12
February, 28 "	54	84	12
March, " "	59	88	26
April, " "	66	90	33
May, " "	74	101	44
June, " "	80	100	50
July, " "	82	105	63
August, " "	80	100	61
September, " "	76	97	46
October, " "	67	92	37
November, " "	58	83	22
December, " "	52	80	12
Average annual temperature			67

Precipitation Summary, Savannah, Ga., for 23 Years.

MONTH.	PRECIPITATION—INCHES.		
	Average.	Greatest Monthly.	Least Monthly.
January, 29 years	3.15	8.84	0.36
February, 28 "	3.20	9.71	0.56
March, " "	3.70	10.18	0.76
April, " "	3.36	8.82	0.16
May, " "	2.83	5.93	0.35
June, " "	6.40	18.79	0.91
July, " "	5.94	13.18	0.82
August, " "	8.17	22.79	1.89
September, " "	6.17	16.58	1.64
October, " "	3.67	9.45	0.34
November, " "	2.37	6.28	0.29
December, " "	3.27	7.99	Trace
Average annual precipitation			52.23

Weather Summary, Savannah, Ga., for 23 Years.

MONTH.	AVERAGE NUMBER OF DAYS.			
	Clear.	Partly Cloudy.	Cloudy.	Rainy.
January, 29 yrs.	10	11	10	10
February, 28 " "	9	10	9	10
March, " "	12	11	8	8
April, " "	13	10	7	8
May, " "	12	13	6	9
June, " "	8	15	7	12
July, " "	7	17	7	13
August, " "	8	14	9	14
September, " "	10	11	9	11
October, " "	14	10	7	7
November, " "	12	10	8	8
December, " "	12	10	9	9
Average annual	127	142	96	119

Growing Sugar Cane on the line of the Central of Georgia Railway.

THAT section of middle and southern Georgia and south and southeastern Alabama traversed by the CENTRAL OF GEORGIA RAILWAY is unsurpassed for growing sugar cane and for the profitable handling of all sugar cane products. The soil throughout this section is admirably suited to growing sugar cane of a very superior quality. From analyses recently made, it has been shown that sugar cane grown on the hill sides of Georgia and Alabama contains from two to four per cent. of saccharine matter over cane grown in the alluvial lands.

Maple and other chemically prepared syrups, which, in the absence of a pure article, have been so extensively used throughout the country, are now being rapidly replaced by a pure unadulterated syrup made from the juice of sugar cane. The supply is wholly inadequate to the demand, and there is the amplest of fields for the disposal of of this relished product, as the deficiency throughout the Union is principally filled with syrups adulterated with glucose and with syrups made from re-boiled molasses which has undergone partial fermentation and has been bleached by chemical processes.

Rich, productive lands along the CENTRAL OF GEORGIA RAILWAY, suitable for growing sugar cane may be obtained at from \$3.00 to \$10.00 per acre, according to location.

Write for full particulars to

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Land and Industrial Agent,
Central of Georgia Railway Co., Savannah, Ga.

De Soto Hotel,

Savannah, Ga.

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...Savannah, Ga....

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Among the improvements the past summer 60 new bathrooms were added. Tourists will find Savannah a beautiful city and an ideal winter resort; 40 miles asphalted and macadamised roads for wheeling. The privileges of the SAVANNAH GOLF CLUB LINKS extended to the guests of the De Soto.

Write for illustrated descriptive booklet and rates.

Watson & Powers,
Proprietors.

THE SOUTHERN RAILWAY

PRESENTS EXCELLENT ADVANTAGES

FOR GROWING SUGAR CANE ALONG

SOME PORTIONS OF ITS LINES.

THERE ARE RICH SOILS, FAVORABLE

CLIMATE, LOW PRICED LANDS AND

GOOD TRANSPORTATION FACILITIES.

IT is being demonstrated by practical experience that the raising of sugar cane in several sections along the SOUTHERN RAILWAY is a successful branch of agriculture. The sugar made is equal in value, strength and color to that of other places where cane has been grown for years as a staple product, and the syrup is especially desirable when made under the new processes now applied. It is being found that the cultivation of sugar cane in several counties of South Carolina, Georgia, Alabama and Mississippi will yield very large crops, rich in saccharine matter.

During the past season, the farmers around Baxley, Georgia, have raised several hundred acres of cane, and a syrup refinery has been established and is now paying a very liberal price for the cane. Another plant has been in operation at Columbus, Georgia, for some time. There is a ready market for the product, and the indications are that larger crops will be put in next season, not only in the vicinity of these mills, but in other sections.

THERE are attractive advantages for raisers of cane in several localities tributary to the SOUTHERN RAILWAY, where the soils are adapted to the crop and the requisite fertility, warmth and moisture obtain. Land is low in price. Large tracts may be purchased on very favorable terms, many of them having timber resources sufficient to pay the cost price. Labor is low in this section of the South. Good market facilities are afforded. The SOUTHERN RAILWAY reaches not only all the large cities of the South, but with its connections, those of the North and East, and also numerous ports for reaching the foreign trade. Mills on its lines have the advantage of through bills of lading to their markets, as well as being in close proximity to fuel supplies which the SOUTHERN reaches over its own tracks.

For refining the syrup, there are more mills needed along the SOUTHERN RAILWAY. With mills established, the people living around them would furnish a liberal supply of cane, and also help in their organization.

Information about suitable lands for this product in Alabama or Mississippi may be obtained from Mr. W. L. Henderson, Mobile, Alabama. About lands in Georgia, from Mr. I. C. Wade, Equitable Building, Atlanta, Georgia, or Mr. W. J. Hurlbut, Chattanooga, Tennessee. Persons in the North, desiring information, should write Mr. M. A. Hays, 228 Washington street, Boston, Mass., Mr. J. F. Olsen, 225 Dearborn street, Chicago, Ill., agents of the Land and Industrial Department, Southern Railway, or to

M. V. RICHARDS,

LAND & INDUSTRIAL AGT., SOUTHERN RAILWAY,

Washington, D. C.

ARE YOU A

Prospector ? Homeseeker ? Manufacturer ? Investor ?

IF SO, THE PLANT SYSTEM IS PREPARED
TO ASSIST YOU.

**Plant System of Railways in Georgia, Florida, South Carolina
and Alabama.**

THE PLANT SYSTEM OF RAILWAYS has organized an Industrial and Immigration Department which is designed to promote Agriculture, Horticulture, Manufactures, Stock-raising, etc., along its lines in the States above mentioned, and to assist Homeseekers to obtain cheap and desirable homes, while helping them to succeed along the lines mentioned.

The advantages and facilities this department is able to offer you are not to be exceeded from any source.

The territory embraced in this presentation will give you, in the matter of climate and soils, the most favorable conditions that could possibly be presented in the South for colonization purposes or individual settlers.

Now is the time homeseekers can locate to advantage on the lines of this System, with the opportunity of purchasing many farms that have already been improved.

If you are seeking a home, advise me what you want.

If you have land, property, etc., for sale, advise me, giving particulars. I am having numerous inquiries, and may serve you to advantage.

One of the most important productions along the lines of the PLANT SYSTEM, is that of **Sugar Cane**, which can be successfully grown anywhere along the entire lines of the System, but more especially in Southern Georgia and Florida.

The land most suitably adapted to successful sugar cane growing, should have a clay or marl subsoil, of which there are thousands of acres in the above mentioned States.

Professor H. E. Stockbridge, of the Florida Experimental Station, says: "The soil and climate of Florida are better adapted to the successful production of **sugar cane** and its products than any other part of the United States."

Farmers growing "**Cassava**" either as a food for farm animals or for making starch, can produce from \$50.00 to \$75.00 per acre, while the cost of preparation, planting, cultivation and harvesting will not exceed \$16.00 per acre.

Celery is being grown all over Florida, and is yielding enormous returns to growers.

Lettuce and strawberries are also found to be very profitable crops.

Pineapples, while requiring larger investments to obtain first crops, will, at present prices, yield larger net returns than any other product of the territory.

The **grapefruit** and **orange** in South Florida are both certain and profitable.

Desirable land for the culture of **sugar cane** may be had at from \$5.00 to \$15.00 per acre.

Lands suitable for truck farming, though requiring fertilizing, can be purchased at almost any price, from \$2.00 up to \$50.00.

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THE PULASKI is a famous hotel. It has entertained more distinguished people, Americans and Foreigners, than any hotel in Georgia.

It lays claim to a service and accommodation not found elsewhere in this section.

Its reputation is based upon its cuisine.

It is furnished with GAS, ELECTRIC LIGHTS, ELEVATOR, and everything to make it a modern hostelry.

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PULASKI HOUSE
SAVANNAH, GA.
&
HOTEL TYBEE
TYBEE ISLAND, GA.

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HOTEL TYBEE is one of the best appointed hostelries on the Atlantic coast. It is ample for the accommodation of all guests who summer at Tybee. Special attention is devoted to the cuisine.

A five minutes walk from HOTEL TYBEE brings you to Tybee Inlet, where fine fishing may be had, and where boating and sailing may be enjoyed.

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Capital and Labor, Independently or Together, are Effecting Marvelous Changes in the South. Virginia's Fertile Valleys and Gentle Slopes are especially adapted to Grasses, Vegetables, Grain and an endless variety of Farm Products. In North and South Carolina and Georgia, throughout the famous Piedmont Region, the crops of Corn, Cotton, Tobacco, Truck and Fruit, are certain and abundant. This entire country is destined to become the garden of the world. Nature has done her best. Man's genius and industry will do the rest. A tidal wave of prosperity is spreading over the South. Its industrial activities have awakened; its agricultural and manufacturing possibilities are appreciated as never before. Wealth and population are increasing. New towns are springing into life. The skilled mechanic is earning good wages. The man of small means is making money. The family that came South under stress of poverty is prospering.

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From Jacksonville to Tampa is traversed by the Seaboard Air Line Railway. In this semi-tropical land the Orange perfects its most delicious and profitable returns. It is the home of the Lemon, the Fig, the Pine Apple and an infinite variety of other fruits. Fortunes are now being made in Tobacco, whose leaf is found equal to the best Cuba and Sumatra. The avenues to wealth here are beyond computing, and open to all. The soil responds to intelligent care in specialties of production that command the highest market prices everywhere.

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Will find excellent Farm, Fruit or Truck Lands in Seaboard territory that can be had at reasonable figures. Twenty to fifty or a hundred acres well tilled are better than a thousand, poorly or indifferently well cultivated. Locations can be secured where the settler can avail himself of good schools, churches, improving social influences and that law and order which prevails in all well regulated communities. The Capitalist who looks for larger fields of speculation can find abundant chances for paying investments. Letters of inquiry will receive prompt attention when addressed to

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Well adapted to the growing of

Sugar Cane, Sea Island Cotton

and other crops of this section,

In WARE, PIERCE, COFFEE, CLINCH and
APPLING COUNTIES, GEORGIA, on the
lines of the OFFERMAN & WESTERN, the
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RAILWAY and PLANT SYSTEM OF RAIL-
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HIS grant is in a solid body, five miles square and consists of 12,000 acres of pine land and 4,000 acres of rich hammock, prairie and swamp.

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An adjoining tract of 20,000 acres can be treated for with the Rodman Grant, and two-thirds of the frontage of that combined area would be protected by the waters of the St. Johns and Ocklawaha Rivers, and save that much in fencing to enclose the two properties for stock raising.

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5,000 acres of land on Seaboard Air Line Railway, in Liberty and McIntosh Counties, 40 miles from Savannah, between Riceboro and Jones Stations, comprising uplands and lowlands, and admirably adapted to the growing of a large variety of crops, especially **Sugar Cane** and **Rice**.

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Having unsurpassed facilities, we guarantee our prices to be as low as any offered. A large stock always on hand for prompt delivery.

**Castings and General Repair Work at Lowest Possible Prices.
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Very respectfully,

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We guarantee them the best in the market, and if they are not what we represent them to be we will refund the money. Send us a trial order and be convinced that our mills are the best offered on the market. Will warrant them for one year. Our pans are all made from new and improved patterns, cast with bottom down, and the metal so proportioned that there is no chance for breakage—a fault which has heretofore been a great source of trouble and expense to the purchaser.

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