



CHAPTER I

Sugar and the Sugar Cane Plant

The environment required for the growth of the sugar cane plant determines the location of the primary producing part of the industry and of the mills which extract raw sugar from the cane. The plant's characteristics and its methods of producing and storing sugar have a dominating effect on the agricultural methods, on the transport systems from field to mill and on the engineering and chemical processes used in the mills to win the sugar. About 60 per cent of the Australian retail price is represented by growing and milling, the costs of which are closely related to the nature of the cane plant.

Before dealing with the role of the Colonial Sugar Refining Company in the sugar industries of the South Pacific it is desirable to convey some understanding of the basic facts about sugar and the sugar cane plant. This short chapter, written jointly by a group of C.S.R. officers, therefore provides a very general background to the chapters which follow.

September 1955

PREHISTORIC man indulged his appetite for sugar, even if he was seldom able to satisfy it, by eating sweet fruits and honey. In the South Pacific, including Fiji but not the Australian continent, he had a more continuous and reliable source—chewing and sucking sugar cane; for sugar cane is indigenous to the islands of the South Pacific. It is thought to have originated in these islands and probably also in the southern parts of Asia. In slow and halting steps, over long ages, sugar from cane came into prominence, but it did not become known to Europeans until historic times.

Sugar cane was well known in India for perhaps a thousand years before Christ. The soldiers of the great Macedonian conqueror, Alexander, did not know sugar in their Mediterranean homeland but they are believed to have been the first Europeans to see sugar cane. When Alexander's conquests took his armies to India about 327 B.C. they saw cane growing and called it "a reed yielding honey without bees".

Slowly, and in minute quantities, sugar from cane—but not as yet the cane plant itself—travelled towards the Near East, as an article of luxury, via the trade routes, by caravan over deserts and mountains and by primitive coastal sailing dhow.

The main impetus westward came with the great Islamic conquests when, about the seventh century A.D., the Arabs brought the plant, sugar cane, from the Tigris and Euphrates in Persia to the Mediterranean countries. Sugar became known in England only 500 to 600 years ago, being imported from the Mediterranean countries. The Venetians became great sugar refiners and merchants, processing it into conical "loaves" for keeping purposes, transport and sale.

Columbus, on his second voyage, took sugar cane to the Caribbean where it flourished to such an extent that the area came later to be described as the "sugar bowl" of the world.

It is recorded that sugar cane was taken aboard the First Fleet at the Cape of Good Hope, en route to Botany Bay. This cane was presumably taken to Norfolk Island, for in 1788 Lieutenant Philip Gidley King, commandant of the island, reported to Governor Phillip, "The sugar cane thrives very well". It is not known what happened to the canes at Norfolk Island. No cane was apparently grown on the Australian mainland until Thomas Alison Scott introduced it from Tahiti in the Society Islands in 1817.

The chemical name for ordinary household sugar is *sucrose*. It is one of the commonest of the sugars produced by nature and is found in varying quantities in many grasses, some vegetables and a few trees, such as the Canadian sugar maple and some palms.

Honey, made by the bees from the nectar of flowers, consists mainly

SUGAR AND THE SUGAR CANE PLANT

of two un-crystallized sugars known as glucose and fructose; nectar contains these sugars, together with a considerable proportion of sucrose which the bees convert to glucose and fructose.

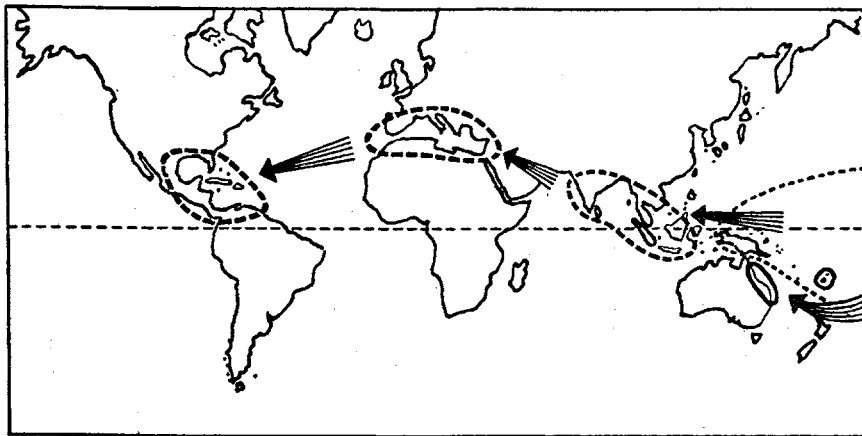
The synthetic sweetener, saccharin, is a derivative of coal tar. It is not a sugar and it has no food value.

Nature's sugar factory is the green leaf; her storehouse is the stalk, root or fruit, where the sugar is held until required for future growth or as sustenance for the next plant generation.

In the green leaf, with the energy from sunlight, sucrose is formed. Thus arises the description "crystallized sunlight". The sun's rays acting on the chlorophyll, or green colouring matter in the leaf, cause carbon dioxide (CO_2) from the air to combine with water (H_2O) to form sucrose, the chemical formula for which is $\text{C}_{12}\text{H}_{22}\text{O}_{11}$. This is the process called "photosynthesis" whose mysteries are still not fully understood.

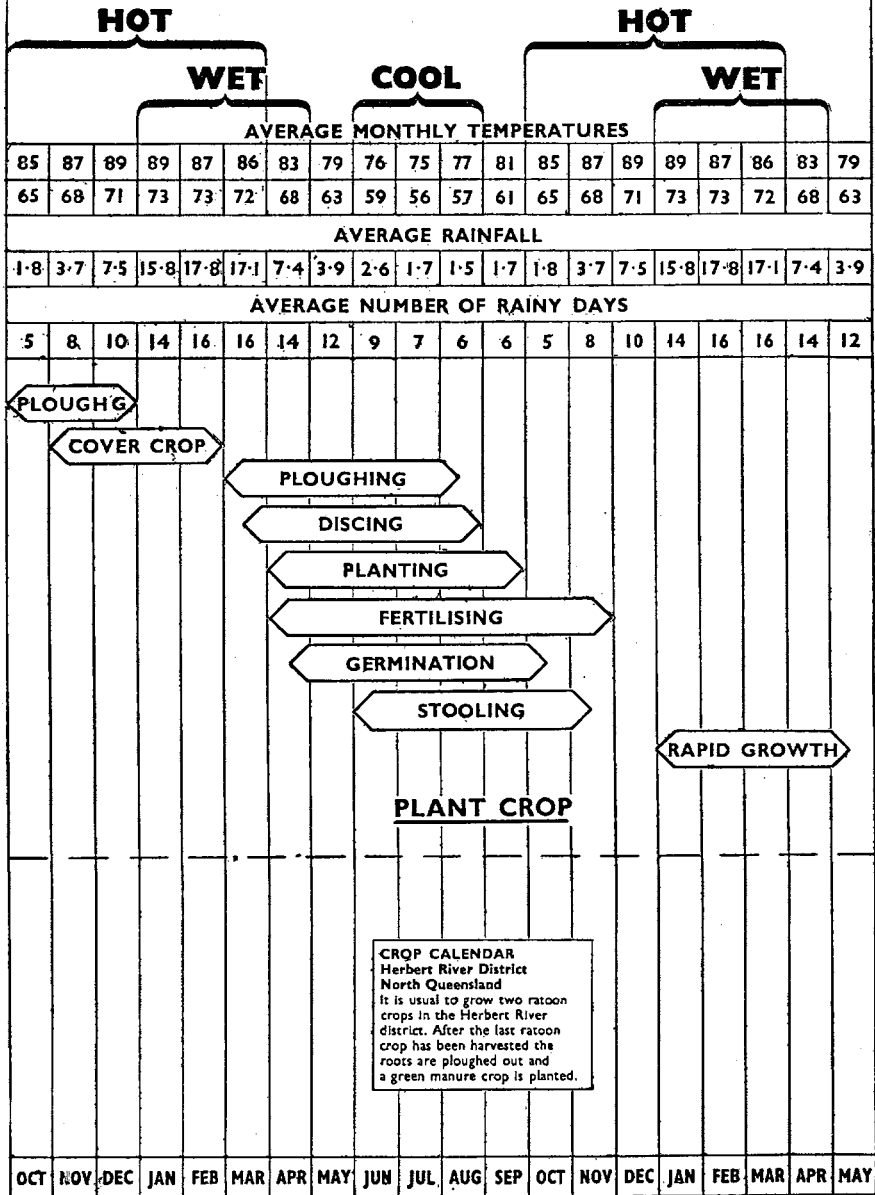
All sugars, and also the starches which are most commonly eaten as bread and potatoes, are called carbohydrates and have similar chemical formulae. They consist of the chemical element *carbon* combined with the elements *hydrogen* and *oxygen*. The last two are always present in the ratio of two atoms of hydrogen to one of oxygen, as in water; hence the name *carbohydrate*. Carbohydrates comprise one of the most important groups of food for man and animals.

Chemists know many sugars besides sucrose, but sucrose is completely dominant as a foodstuff. Its commercial sources are the sugar cane and the sugar beet and, to a very minor extent, the maple tree. World production of sucrose is about 40 million tons, of which 63 per cent is

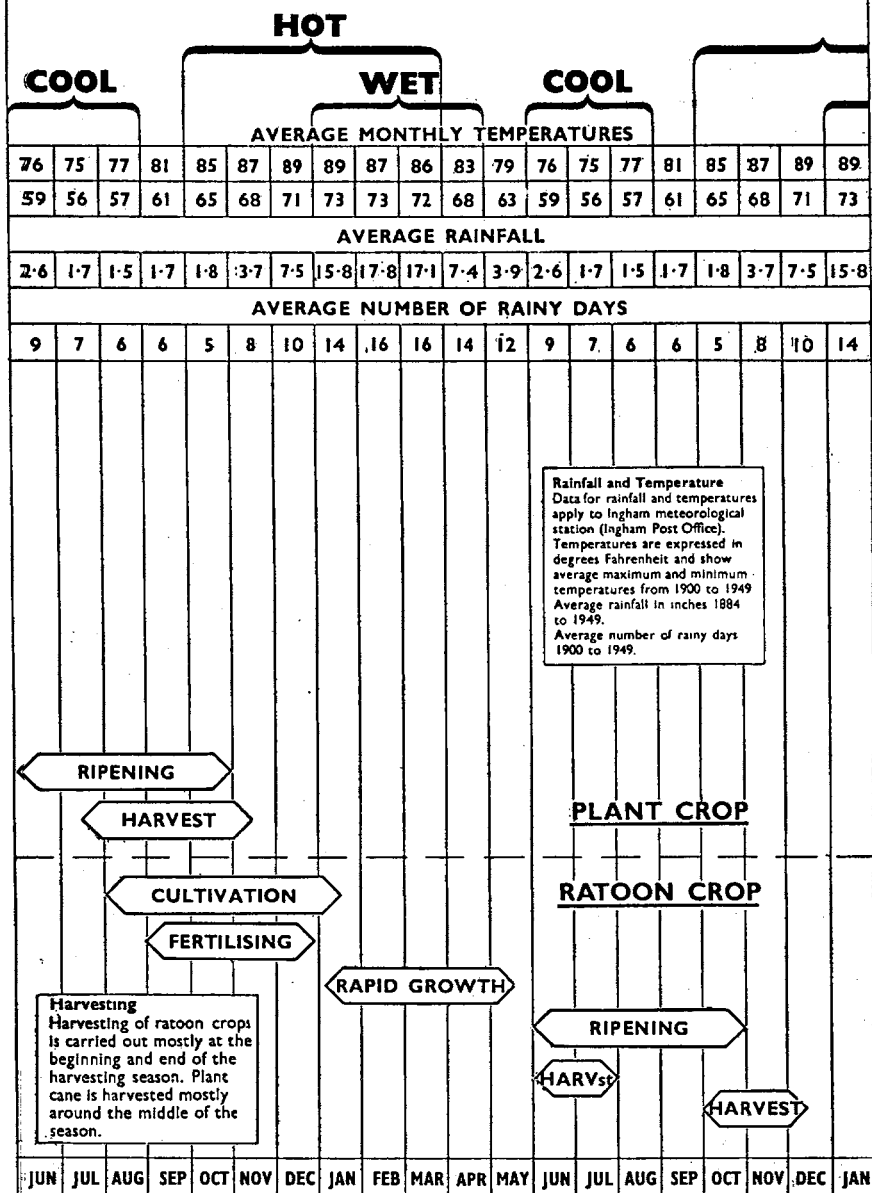


The main path of the movement of sugar cane since prehistoric times. It is believed to have originated in the islands of the South Pacific and probably also in southern Asia—but not in Australia, to which it was probably introduced from Tahiti by T. A. Scott in 1817.

CANE CROP



CALENDAR



cane sugar. The sugar beet grows in cool to cold temperate zones, and is an internal source of sugar important to many countries in Europe and in North America. There used to be a beet sugar factory in Victoria but the industry proved uneconomic and has disappeared.

The largest cane sugar producing country is Cuba which makes about 4,500,000 tons each year. Australia, with about 1,150,000 tons, at present ranks fourth or fifth and Fiji in a normal season makes about 180,000 tons.

The Cane Plant

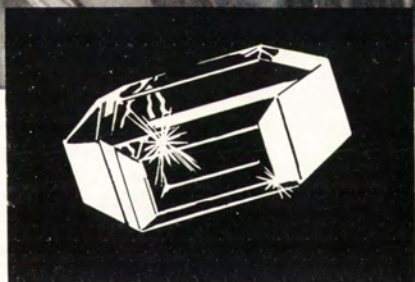
The sugar cane plant is nature's most efficient sucrose factory, producing more sugar to the acre than beet. The sugar is formed in the leaf and stored in the heavy, thick stalk. Commercially grown sugar cane looks something like bamboo, with regularly spaced joints or nodes, but is heavy and solid—not light and hollow like bamboo. It is one of the true grasses, of the genus *Saccharum*. Normally it reaches a height of 10 to 14 feet and grows in a clump. The whole clump forms one cane plant and is called a stool. Thick-stalked commercial varieties, from 1½ to 2 inches in diameter, generally contain five to eight stalks to a stool, but some thinner-stalked types, with a higher proportion of "wild" blood in their breeding, produce up to fifteen stalks. Most of the side leaves die and fall off as the plant grows, but there is always a green top to each stalk, consisting of graceful, waving leaves up to 4 feet long.

The crop usually grows for twelve to eighteen months before it is harvested. From the roots left in the ground after harvesting, a new generation of stalks will grow. This is called a *ratoon* crop. Good ratooning characteristics are most important because a ratoon crop means another harvest without the heavy expense of ploughing out the old stools and roots, cultivating and replanting. However, ratoon crops give successively less vigorous growth and lower yields to the acre, until ploughing out and replanting become necessary to ensure economic operations.

The cane plant has the typical flower of the grass family, on a grand scale. The general appearance is of a grey or purplish-smoky, feathery plume up to 4 feet long and a field in full flower waving and rustling in the breeze is a beautiful and unique scene. In favourable climatic conditions, viable seed is set by many varieties; seed is the essential vehicle for breeding new varieties but is of no direct interest to the cane farmer. He plants his new crop by placing foot-long cuttings of the stalk, known as "setts", flat in a furrow and covering over with two or three inches of soil.



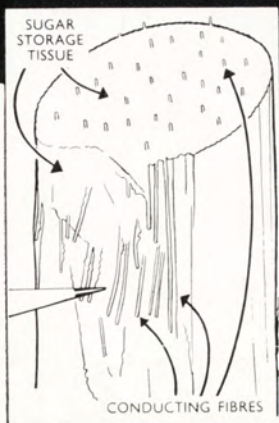
Sugar is made in the green leaves of plants. Through the action of the sun's rays carbon dioxide from the air and water from the soil combine to form sucrose—the chemical name for sugar.



The granulated sugar of the grocery trade and the breakfast table consists of crystals of sucrose—the sugar made by photosynthesis in the leaves of cane and beet plants.



Sugar cane is indigenous to the South Pacific Islands where many islanders grow it as a sweet vegetable which they chew. The cane above was photographed on the northern slopes of the Hydrographers Range, Papua, by a C.S.R. cane collecting expedition in 1914. Native gardeners sometimes grow their cane for 3 or 4 years, supporting it with poles. Sweet New Guinea canes have provided breeding stock for many varieties now grown commercially in Australia and Fiji.



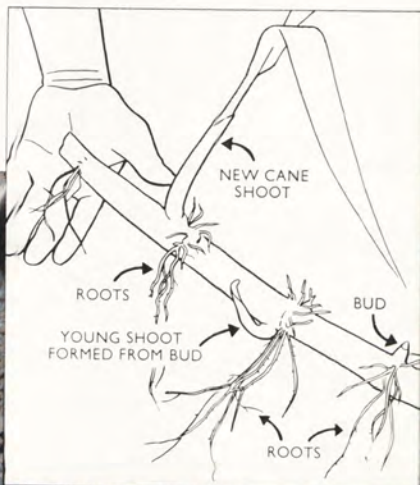
This piece of cane has been cut across the grain to show the long, hard, conducting fibres and the soft storage tissue. The pencil is pointing to several fibres which have been broken off by gouging a piece out of the side of the cane.

The long thin fibres are conducting vessels. Inside each fibre are two channels. One channel takes water from the soil to the leaves of the cane plant, and the other channel brings sugar solution from the leaves, where the sugar is made, to the stalk where it is stored.

Cane is propagated by means of short pieces of "seed" cane, or setts, about a foot long. The eyes, or buds, at the joints, or nodes, will begin to grow when the sett is planted.



Roots and shoots grow out of the cane at the nodes. A number of stalks will grow from one piece of seed cane. The soil in the furrow has been scraped away to show the growth of roots and shoots.



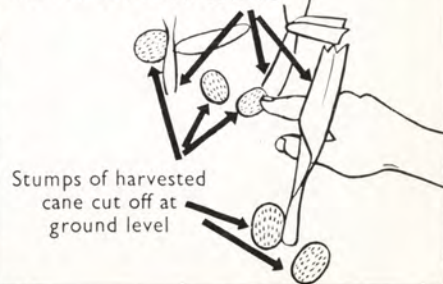


Cane farmer cleaning side leaves off stalks before cutting them up as seed cane. Crop of maturing cane in back ground.



When the mature cane is cut off from the base new shoots grow from the stump left in the ground. The cane is said to "ratoon" and the new crop is called a *ratoon* crop.

NEW SHOOTS GROWING FROM STUMP LEFT AFTER HARVESTING





THE SUGAR CANE PLANT

Sugar cane is a giant member of the grass family. A clump or stool of cane consists of a number of stalks 6 to 10 feet long with leafy tops. Cane is not hollow like bamboo; the sugar is stored as a sweet juice in the pith cells of the stalks.

Leaves and stalks are cut off about here when harvesting. They contain no sugar.

As the cane grows the side leaves die and mostly fall away.

At harvesting the cane stalks are cut off as close as possible to the ground

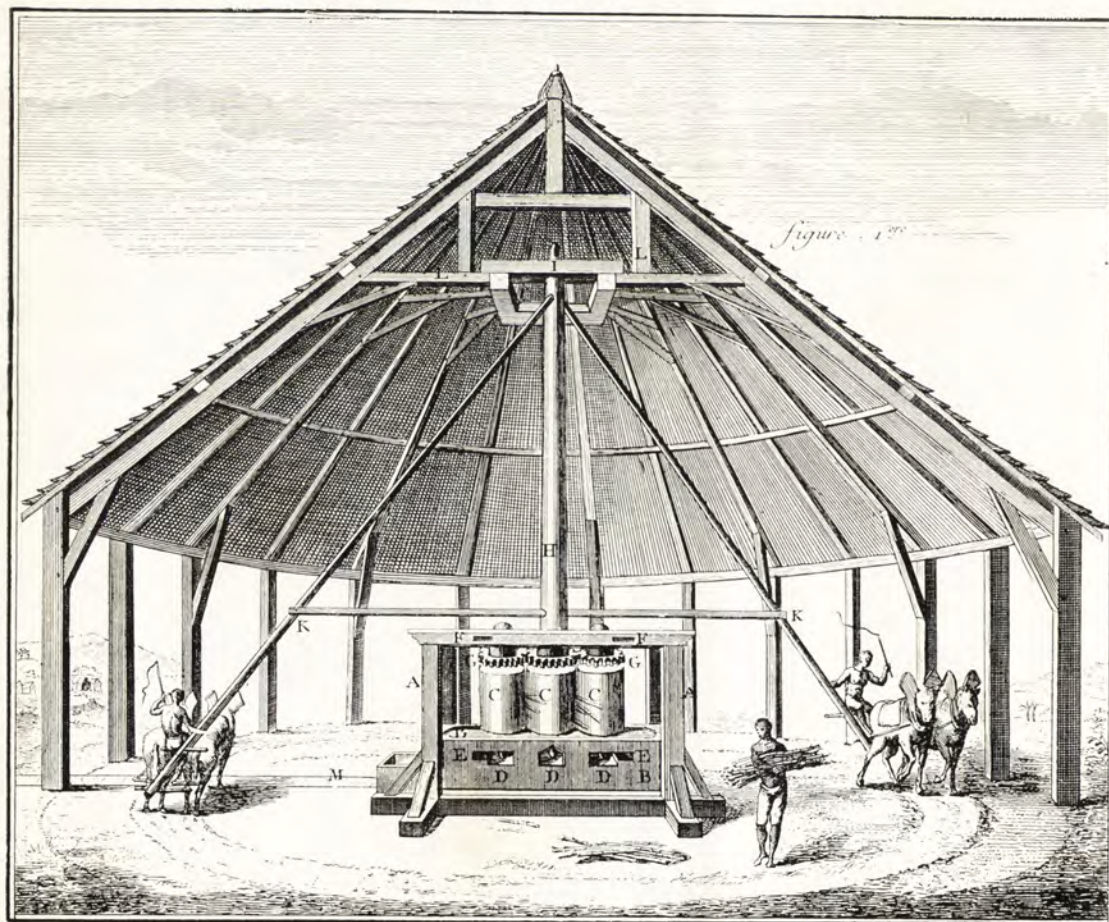
THE SUGAR BEET PLANT

Cane and beet are the two main sugar producing plants. Beet is a temperate zone plant, and is useful for growing in rotation with other crops. It has the advantage that it can be grown close to the main concentrations of consuming population, but it produces less sugar to the acre than the tropical cane plant. Beet was not used as a source of sugar until the nineteenth century when its cultivation was encouraged by Napoleon. There is no beet sugar industry in the South Pacific. The beet sugar industry in Victoria proved uneconomic and disappeared. *Photograph by courtesy of British Sugar Corporation Ltd.*





Above: A plantation in the Antilles Islands in the Caribbean Sea about 1760. Mill and storehouse on the left, canefields in the middle distance, negro quarters on the right. Most of the world's cane is still grown on the plantation system. Below: An eighteenth century plantation mill with metal sheathed vertical wooden rollers. Much of the sugar in the cane was lost in such early mills. From *Agriculture et Économie Rustique*, 1762-1772.



SUGAR AND THE SUGAR CANE PLANT

It is the stalk which is harvested, by cutting it off at ground level and removing all side leaves and the green leafy top. In Australia and Fiji the majority of stalks, as harvested, are 6 to 10 feet long and normally contain between 14 and 17 per cent of sucrose by weight, averaging about 15.5 per cent over a season. The remaining weight consists of some 12 per cent of fibre, 2 per cent of various "impurities" and 71 per cent of water. The sugar content is considerably higher for two or three months but it is not economic to process the whole crop in such a short period. Australia and Fiji, with very sweet canes and high efficiencies of sugar extraction in the mills, obtain more sugar per ton of cane than, as far as we know, any other cane sugar industry in the world. This is a considerable economic advantage because it is sugar that is wanted rather than cane. In Australia and Fiji, 1 ton of sugar is made from about $7\frac{1}{4}$ tons of cane; in many countries it takes 8 tons or more. If in Australia and Fiji it took $8\frac{1}{4}$ tons of cane, the cane cutters, transport system and mills would all have to handle, every season, another 1,400,000 tons of cane (14 per cent more), and this would obviously cause heavy additional expense.

The stalk has a fibrous, wax-coated, hard rind and inside it are more fibres and pith containing the sugar-bearing cells. These are soft and thin-walled and must be broken by pressure and friction in the mill in order to release the sugar-bearing juice.

When Europeans came to the Pacific they found the natives in many islands cultivating gardens of sugar cane, New Guinea being especially noted for this practice. Many of the New Guinea canes are of the species *saccharum officinarum*, a very sweet, thick-barrelled, comparatively soft-rinded species known as "noble" canes. New Guinea blood, which helps to raise the sugar content, is found in most of the successful new Australian-bred hybrid commercial varieties.

The world owes these sweet, thick, heavy canes to the skill of the Polynesians and Melanesians, or their predecessors, who, since time immemorial, have been growing cane for chewing and have naturally concentrated upon a soft rind and the maximum proportion of sweetness and soft pith. If they were not mankind's first cane breeders, they were at any rate the first selectors of the best natural seedling varieties, and only very recently have we been able to improve on their results for our own commercial purposes.

Growing the Cane Commercially

To succeed commercially, cane requires abundant and regular moisture, a lot of sunlight to obtain a high level of photosynthesis,

and the absence of real cold. An astonishing fact, according to one of the world's leading cane botanists, is that it needs about 1,000 tons of water, absorbed from the soil through the roots and mostly exhaled in due course through the leaves into the atmosphere, to produce 1 ton of sugar in the cane. Nearly all this water, having performed its vehicular and other functions for the plant nutrients, is transpired by the plant. Cane also requires fairly good and well-drained soil. In order to become really rich in sugar, it needs a period of comparative coolness and a reduction in soil moisture; this checks the growth, the sugar content increases and, although we are dealing with a stalk and not with a seed or a fruit, it can be said to "ripen". The north-eastern coast of Australia and the coastal regions of the two islands of Fiji provide such conditions.

The soils and climate of the sugar belts of Australia and Fiji are by no means outstanding for commercial cane culture, considered overall. Nevertheless, yields of sugar per acre, especially in Australia, are considered fairly high for cane grown in one year under natural rainfall. Higher yields are obtained in some parts of the world where cane is irrigated or where it is grown for two years before harvesting, but these methods are not used to a great extent in Australia and not at all in Fiji.

In Australia, average yields per acre over good and bad seasons are about 24 tons of cane, giving 3.3 tons of standard quality raw sugar. In Fiji, the figures are 20 tons of cane and 2.8 tons of sugar. These yields are in terms of manufactured sugar, which means that the losses in processing into raw sugar are fully allowed for. In other words, the efficiency of milling, as well as efficiency in agriculture, plays its part in obtaining these yields.

The struggle for more and more efficiency in all phases of the South Pacific sugar industries is a background theme which runs through many of the succeeding chapters. Good farming methods, good varieties of cane, successful control of diseases and pests, are important factors. The part of efficient transport of cane to the mills and efficient mills and refineries will also be described.

The pattern of farming which has been developed here is distinctive—in its effects on sociology and political development as well as on economics. Until recent times in the most advanced countries, cane required a great deal of hand labour—for planting, chipping weeds and harvesting. In the beginning, in both Queensland and Fiji, labour was imported and the plantation system was followed; the cane was grown on large plantations or estates with large numbers of employees. In both countries this system has been superseded by independent

SUGAR AND THE SUGAR CANE PLANT

and generally "small" farmers, selling their crop to a "central" mill. The plantation system still predominates in nearly all other cane-growing countries, with the mill owner often operating the plantation and employing large numbers of field labourers.

The Australian and Fijian "living area" farming system, which is the most distinctive feature of the South Pacific raw sugar industries, creates closer settlement adjacent to mills. The result in Australia is well integrated communities of stable, independent, working farmers of the European race. In Fiji the communities are mainly of Indian tenant farmers with a standard of living and way of life such as few, if any, other rural populations of Asians have achieved. There are profound differences between such communities and those of the traditional plantation system.