

tropical climate and partial shade. Since the plants are gross feeders, they require a rich, loamy soil or heavy fertilization. Ginger is grown from sea level to approximately 3 thousand feet.

Propagation is by divisions of the rhizomes, which are usually planted in rows 12 to 18 inches apart. The plant reaches a height of about 3 feet.

Yields average 1 thousand to 2 thousand pounds an acre. The rhizomes are dug, washed, and dried in the sun.

Peeled ginger is prepared by placing the roots in scalding water and then removing the skin with a knife. Preserved ginger is peeled and boiled in a sugar solution. Ginger is usually exported in the form of dried rhizomes and made into extract or ground into powder in consuming countries.

TODAY SPICES ARE OF comparatively minor importance in world agricultural production and trade, but in the few exporting countries, mainly in the Far East and Africa, spices are a major source of foreign exchange earnings. Cloves, for example, comprise about 80 percent of the total value of Zanzibar's domestic exports, furnishing the government approximately one-third of its revenue from all sources.

Spices are of importance to importing countries because the entire population depends on one spice or another to flavor food. The United States' imports of the eight spices in 1959-1963 had an average value of 31.5 million dollars. That is a small fraction of the value of all our imports but a large factor in the production of millions of dollars' worth of processed products, in which spices are essential ingredients.

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## Cocoa and Chocolate

by ARTHUR G. KEVORKIAN and  
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COCOA is a newcomer among foods and beverages, although Central Americans enjoyed it long before the discovery of the New World. Commercial production of cocoa beans was small until only a half century ago, but has expanded from about 200 million pounds in 1900 to more than 2.2 billion pounds, valued at 500 million dollars, in 1963.

Cocoa beans are seeds of the cacao tree, *Theobroma cacao*. They grow in pods along the trunk and the older branches. The cacao tree, a tropical plant, can be cultivated successfully only in a narrow belt 20° north to 20° south of the Equator.

The cacao tree is native to tropical America. The Indians of Central America and South America grew cacao for many years before the discovery of America. The Aztecs, Toltecs, Mayans, and Incas had various uses for cocoa beans. A favorite was a drink made from the beans, corn, spices, and water. A similar beverage, pinolillo, is still popular in Nicaragua.

Columbus saw cocoa beans but regarded them only as a curiosity.

Cortez, another explorer, found the Aztec Indians of Mexico using them to make a bitter but rather delightful draught. The addition of sugar, vanilla, and cinnamon made this exotic drink more pleasing to the European

tastes, but cocoa was so expensive that only the wealthy could afford it.

Cocoa was consumed only as a beverage until a process of making "eating chocolate" was discovered in the 19th century. A Dutchman, C. T. van Houten, in search of a way to improve the palatability of cocoa, which was rich and somewhat indigestible, devised a way to remove part of the fat—cocoa butter—from the bean. He developed "chocolate powder," which made a more digestible drink, by removing most of the fat contents of the beans. The next step was to mix cocoa butter, cocoa, and sugar to make "eating chocolate."

A Swiss manufacturer, D. Peter, later devised a means of adding milk to cocoa to make the milk chocolate we know. Cocoa then became popular throughout Europe, and production was expanded in tropical areas.

The importance of cocoa in the confectionery industry can be noted in the large variety of candies, cakes, cookies, ice cream, and beverages that contain cocoa and chocolate. Chocolate tastes good and has a high nutritional value.

Cocoa was considered a strategic commodity in wartime because of its nutritional value. Candy bars and the K-rations of the Armed Forces included chocolate to sustain energy when other foods were not available.

Spain guarded its secret of cocoa for many years, but in time the monopoly was broken, and the Dutch, Portuguese, British, French, Belgians, and Germans established plantations in their oversea territories.

Plantings were made in the western African islands of São Tome and Fernando Po in the 17th century.

Cultivation spread into other areas in Africa.

At the beginning of the 20th century, Latin American countries, mainly Ecuador, Brazil, Trinidad and Tobago, and Venezuela, were producing nearly four-fifths of the world output of cocoa beans. But as Africa was relatively free of cacao diseases, mainly witches' broom, and

offered lower production costs, Africa became the major supplier after the First World War.

The expanding industry suffered a setback during the Second World War because of the lack of shipping and the loss of the European market immediately after the war. Production soon gathered momentum, and new plantings were made. During the fifties, cacao acreage was expanded, and more emphasis placed on the control of diseases and pests, especially in western Africa.

MOST OF THE WORLD'S cocoa is produced in a few countries. Ghana accounts for more than one-third of it. Next are Nigeria, Brazil, the Ivory Coast, Cameroon, Ecuador, and the Dominican Republic. These seven countries produced more than four-fifths of the 1962-1963 world harvest. Most of the remainder was grown in Togo, New Guinea, Venezuela, Colombia, Mexico, Costa Rica, the West Indies, and the islands of Fernando Po and São Tome off the coast of Africa.

Of the many varieties of cacao tree, three are commercially important.

The Criollo produces a "fine" or "flavor" cocoa. The Forastero yields a "base" or "ordinary" grade. The Trinitario is a cross between the Criollo and Forastero.

The Criollo has plump, round, white-to-pale violet seeds. The pods are 6 or 8 inches long and about half as wide. The fruit wall is fairly soft and easily split. The surface of the fruit wall has 10 furrows; the ridges between them are rather warty and irregular.

The Forastero is classified on the basis of fruit form into four basic types: Angoleta, Cundeamor, Amelonado, and Calabacillo. The first two have deep ridges and are rather warty. The others have shallow ridges and are less warty. Because the shapes of the fruit vary, another classification divides the Forastero complex of varieties into the Amazonian Forasteros (which represent the four

types we mentioned) and the Trinitarios, a type, originally found in eastern Venezuela, that is said to be hybrids of the South American Criollos and Amazonian Forasteros.

The shifting of the center of production from Latin America to Africa has brought about a sharp reduction in the Criollo flavor cocoas and the predominance of the Forastero variety. The latter variety was preferred for new plantings, as it was hardier and had greater yields than the Criollo. Flavor cocoas now constitute less than 10 percent of world production.

The cacao tree needs temperatures between 65° and 95° F. The tree flourishes best at altitudes of less than a thousand feet, although most plantings in Ceylon are at about 1,500 feet. In the Cauca Valley of Colombia, cacao is grown at elevations of more than 2 thousand feet.

Rainfall may vary from 50 to 80 inches, usually with a distinct rainy and dry season. In regions of long dry seasons, clay soils that retain water well and have ample humus are desirable. The level of the water table also is important. High rainfall and a high water table may be detrimental.

The Criollo types have a somewhat upright growth and can be planted close together. The Forastero types are more spreading and require wider spacing. Plantings can be closer spaced on sandy soils than in rich alluvial soils, where growth is more vigorous.

In many countries, cacao is grown under shade to reduce the amount of direct sunlight. Sometimes windbreaks are needed for protection. When seedlings are transplanted from a nursery, they are usually grown under temporary shade crops, such as bananas, plantains, and cassava, which provide shelter as well as cash returns while the cacao is developing. Permanent shade is provided by planting leguminous trees, whose long taproots will not interfere with the cacao. In some countries, notably in western Africa, few shade trees are utilized, although in

some districts cacao is planted as an intercrop with the Hevea rubber tree.

The cacao tree usually begins to bear in about 3 to 5 years and continues in production for nearly 50 years. A mature tree may reach a height of 12 to 18 feet.

The pods usually contain 30 to 40 beans each.

In the Republic of Ghana, Federal Republic of Nigeria, and Republic of Ivory Coast, cacao usually is grown on small native farms in groves of only a few acres. Spacing is unusually close, and shade trees seldom are used. The older trees, which comprise the major portion of the plantings, were planted 30 or 36 inches apart. Those trees produced only 10 or 12 pods each; plantings with shade and a spacing of 10 to 12 feet yielded 50 to 80 pods in Cameroon and 70 to 85 in Fernando Po.

Cacao is usually grown in Latin America on large plantations. Varieties and hybrids are mixed. The trees are shaded and generally are of the more vigorous type. Normally they are spaced 8 to 15 feet apart.

New plantings in both hemispheres were derived from vegetatively propagated clones or selected seed from trees obtained in the Amazon region of South America.

The late Dr. F. J. Pound, an eminent cacao technologist who worked in the Department of Agriculture in Trinidad, traversed the Amazon area of Brazil, Colombia, and Ecuador in search of disease-resistant cacao. From the clonal nursery that was established on the basis of his collections, healthier, more productive trees were developed through selection and hybridization.

In the western African cacao areas, these Amazonian types have been planted at intervals of 4 feet. Such crowding could result in moisture conditions conducive to serious losses due to pod-rot disease. Officials in Nigeria, for example, have recommended that farmers thin the trees after several years of production when overcrowding is obvious.

CACAO has to be harvested by hand. The mature pods usually are cut from the trees with a machete or with a hook. Pods must be removed carefully from the trees, lest the flower cushions and immature pods are injured. The pods are then gathered into heaps and opened. The extracted seeds or beans are taken to some central place for fermentation.

In the Ivory Coast and other parts of Africa, the first step in fermentation is to put the sticky seeds in containers and cover them with leaves for several days. The beans and their coatings are stirred from time to time until the right degree of fermentation has taken place. Then the beans are placed on platforms and allowed to dry in the sun. Grading and sacking follow, and the cocoa is transported to collecting centers for sale. On the plantations of Fernando Po, fermentation is accomplished under shelter. A mass of beans is shifted from one fermentation box to another every day in order to have a uniform fermented product.

The time of fermentation varies as to the country, climate, and potential market. For example, Spain prefers slightly fermented beans; the plantations of Fernando Po therefore use a 3-day fermenting period. Drying is also accomplished under shelter at the plantations of this island. Large platforms are artificially heated, and automatic stirrers travel back and forth every 5 minutes. Drying usually takes 2 days.

Fermenting boxes and artificial heat are also used in the Western Hemisphere, but a large part of the beans in South and Central America are fermented on raised platforms or on wooden trays and sun dried. The beans are covered at night and before rains.

**MANY DISEASES** and pests may attack the roots, stems, leaves, flowering cushions, and pods of cacao trees, but only a few of them are of economic significance. Without adequate control measures for these, there would be a scarcity of cocoa and its products.

The black or brown pod-rot disease, caused by the fungus *Phytophthora palmivora*, is present in all cacao districts and is worst in wet and humid areas. In 1962-1963, it caused losses of less than 10 percent in the drier areas of Africa but up to 100 percent in parts of Cameroon.

Considerable losses are caused by *Monilia rozeri*, another pod-rot fungus that is related to the brown rot of peaches in the United States. The disease first appeared in Ecuador in the early 1900's and has spread to parts of Colombia, Venezuela, and Panama.

The witches' broom disease of cacao, caused by the fungus *Marasmius perniciosus*, spread from Surinam to Trinidad and Tobago and all the cacao areas of South America, except Brazil. In 1964 it was not known to exist in the other islands of the Caribbean, Central America, Mexico, or the Eastern Hemisphere.

The Imperial College of Agriculture and the Department of Agriculture in the island of Trinidad pioneered in investigations on the disease. Dr. Pound traveled extensively over the Amazon Basin in search of resistant wild cacao trees. In the upper reaches of the Amazon region he found trees that appeared to have some resistance. These were tested, and clonal material with considerable resistance was found. Resistant trees were sent to growers and research workers elsewhere.

Scientists of the United States Department of Agriculture and the Agency for International Development have worked cooperatively with Ecuadorans to perfect strains resistant to witches' broom under Ecuadoran conditions. The resistant strains that were developed have been used for replantings in Ecuador.

The swollen shoot disease has been troublesome in Ghana and nearby countries. It is caused by a virus that has many strains, a number of which can kill a tree. It is transmitted by mealybugs, which can carry it to a healthy tree a few hours after they feed on an infected tree.

Control measures developed by the Ghana Cocoa Research Institute at Tafo consist of cutting out diseased and exposed trees and replanting. Millions of trees have been eliminated in Ghana in attempts to control the disease—a costly operation that caused considerable discontent among growers, even though they received compensation for lost trees and had government assistance in replanting. Amazonian hybrids have given signs of having some tolerance to the swollen shoot disease. Swollen shoot disease is not known to exist in the Western Hemisphere.

Cushion gall disease, which affects the floral cushions of the cacao tree, is prevalent in Central America and is known to occur in most of Africa and South America. Research as to its causal agency, life history, dissemination, and control has been concentrated at the Inter-American Cacao Center at Turrialba, Costa Rica.

The major insect pests of the cacao tree are capsids, which have been especially devastating in western Africa. Their eggs are usually placed in the bark near the feeding punctures and are hard to reach by spraying. The staff of the Ghana Cocoa Research Institute and several teams of specialists have done work on control measures. Their success will affect the size of future crops in Ghana and elsewhere in Africa.

Research on cocoa has been mainly concentrated in three areas. By the turn of the century cocoa production in the Western Hemisphere was threatened by the witches' broom disease. The Imperial College of Agriculture in Trinidad consequently placed its major emphasis on identifying the causal agency, testing chemical sprays to control the malady, and determining the existence of resistance in the various species and varieties available. It is logical that the basic investigation of this disease was conducted in Trinidad, since it only occurs in parts of South America and the island of Trinidad.

Investigations at the Ghana Cocoa Research Institute and the station in Nigeria have been made part of government-sponsored agricultural research activities. The work has centered on swollen shoot disease and the capsid bug, since only these problems are known to exist, and cause serious reduction in cocoa production in western Africa.

The Inter-American Cacao Center was established at Turrialba, Costa Rica, in 1947 as a cooperative venture of United States manufacturers of cocoa and chocolate products and the Inter-American Institute of Agricultural Sciences. Investigations there are concentrated on black or brown podrot and cushion gall diseases.

As COCOA is primarily a cash crop, almost all of it is exported as beans or semiprocessed products—cocoa butter, chocolate, and cocoa powder. In a few countries, such as Peru and Colombia, the entire crop is used at home.

Cocoa exports account for almost two-thirds of export earnings of Ghana and nearly one-quarter of the earnings in Nigeria, Ivory Coast, and Federal Republic of Cameroon.

In most of the producing countries in western Africa, cocoa is marketed through government-controlled marketing boards. In Ghana, for example, the board fixes seasonal prices to be paid to producers, determines purchase arrangements, issues licenses to buyers, and maintains arrangements for purchasing, shipping, and selling.

THE MARKETING boards offer some protection to the growers from the fluctuations in cocoa prices. When world prices remain above a fixed level, the surplus is deposited in the board's reserves; a subsidy is paid when prices fall below a fixed level. The reserves of the boards may be used for research, training farmers in improved practices, and buying new seedlings, spray machines, and insecticides and fertilizers.

Nearly all of the world's production

of cocoa is consumed in Temperate Zone countries. Most of the crop is processed and consumed in the United States and western Europe. The United States usually takes about one-third of the total world imports. The value of United States imports of cocoa beans and semiprocessed cocoa products is about 170 million dollars to 200 million annually. The annual per capita consumption in the United States usually is 3.5 to 4 pounds.

Any appreciable change in world supplies has an immediate effect on prices and sometimes on governments. Manufacturers have been quick to shift to cheaper cocoa-butter substitutes and extenders when prices were exceptionally high. Others have reduced the size of their chocolate bars and thinned the chocolate coatings.

EFFORTS HAVE BEEN made through the Food and Agriculture Organization of the United Nations to develop an international arrangement to provide stability for supplies and prices.

A Cocoa Producers Alliance was formed in 1962 by the five leading cocoa-producing countries, which account for about three-quarters of the world output. Among its activities have been the exchange of statistics and other information, conferences on problems of production and marketing, and efforts to encourage greater consumption.

Tariffs and taxes in many countries make chocolate a luxury. The United States has no duty or quantitative restrictions on the importation of cocoa beans and has small tariffs on imports of semiprocessed products.

The production and consumption of cocoa could be increased if prices were stabilized at a level that would be fair for producers and would allow more consumers to buy it.

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## *Production, Trade, and Use of Tobacco*

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TOBACCO, *Nicotiana tabacum*, from humble beginnings in the Americas has become a crop of economic importance and is grown in nearly every country.

Most producing countries grow more than one type of tobacco and supplement their own production by imports of other types required by the domestic industry. Some countries are nearly self-sufficient in tobacco. Others produce a surplus and export large quantities. A few countries in western Europe grow no tobacco on a commercial scale and purchase from other countries the kinds of leaf they require.

From the grower to the ultimate consumer, because it is such a good producer of revenue, tobacco is under the surveillance of governments around the world.

We can group tobaccos into eight categories—flue-cured, burley, other light air-cured (including Maryland), light sun-cured (excluding oriental and semioriental), oriental and semioriental, dark air-cured (including cigar), dark sun-cured, and fire-cured—on the basis of characteristics due to genetics or breeding, the influence of soil and climate, and the method of curing.

A great increase in cigarette smoking since 1920 raised the demand for the kinds of tobacco suitable for cigarette manufacture, principally flue-cured,