RUBBER

THE HANDMAID OF CIVILIZATION

By EDWARD W. PERRY

REVISED EDITION

NOTE

The chapter given in the following pages is from a work entitled: "TROPICAL AMERICA: ITS PLANTERS AND PLANTATIONS," now in preparation. *Sports Afield* said of the author: "Probably no American is more competent to write of the country life than is this author, who, because of his long-trained habits of observation, careful search for the bottom facts and weighing of details, of deducing therefrom the essentials and presenting them clearly and concisely, has made the best possible use of his time and experience."

A very successful tropical plantation company says of the following treatise on Rubber and its cultivation: "Wishing to furnish our stockholders and friends the most reliable and conservative statement of the *facts* relating to the production of rubber and the progress which has been made in its cultivation, we have secured permission to use the within chapter from 'Tropical America'. It covers the subject in a scholarly and trustworthy manner, up to the year 1900."

CHAPTER IV.

CAUCHO, LONG A MERE PLAYTHING OF THE ANCIENT AMERICAN, NOW THE HANDMAID OF CIVILIZATION, BRINGS WEALTH AND LUXURY TO MODERN LIFE.

Long before Spain's soldiers and priests brought to the New World the gentle teachings of cross and of sword, American aristocrats played ball. They drove through rings of stone, standing out from sculptured walls, globes made from the milk of trees which to this hour bear their ancient Aztec name of hule. Such trees were known in South America, also, and there their gum was named caucho, which is by those to the manor born called "cahoocho;" but by English tongues it is called rubber, for no reason other than that, when first it became known in Britain, almost its only use was the rubbing out of pencil marks.

More than three hundred years passed after Spanish conquistador first saw hule used in America, before the conservative Old World wanted more of it than a few small cubes, and those to correct its errors. As lately as three generations ago Great Britain used only 50,000 pounds in the year, and doubtless thought that a large quantity. Then a devoted Yankee sacrificed himself, his family, and all he could control, to make rubber really useful to mankind. His devotion won success in 1844, and made immortal the name of Goodyear.

He who has curiosity enough about the uses to which rubber is put nowadays, may get some idea of them by looking into shop windows in any town of any size. Or he may call to mind the fact that he may bathe in a tub of rubber, and rub himself down in his bath with a device also made of caucho; then step on a mat, a tile or other floor-covering of the same gum. He may dress his hair with comb and brush, and fasten his clothes with buttons all of rubber, then eat his breakfast with the aid of knife and fork having handles of the same material. The gloves with which the dainty housewife will protect her hands, when she herself washes the china that is too precious to trust to another, are of that elastic substance.

Feet by millions are shod on rainy days with the waterproof caucho; and thousands of other feet in ditch and in mine, in forest and in brook, and in many of the tasks men set themselves to do in mud, and snow, and flood, are saved from wet and resulting ills, by boots made of hule. Gossamer, waterproofed by rubber, drapes tender girls and thicker cloth of rubber protects rugged drivers and their teams, and sturdy sailors and soldiers from rain and sleet and snow. In camp and on trail the rubber blanket and the rubber bed keep men from the dampness of the ground. It cushions the heels on which men tramp, and the wheels on which they glide. It holds the ink with which they make their mark on the scroll of fame, and snugly binds letters and holds bills and other unpleasant things. With rubber the surgeon covers wounds and the dentist dams the mouths of victims. Rubber pads the feet of flying trotters,

and makes springy cushions of the wheels of that juggernaut which threatens soon to override the last claims of the horse to place in the economics of mankind.

Cyclopedias and dictionaries tell the reader that rubber is an elastic, gummy substance, the thickened juice of various plants, mainly of three families, the Apocinaceas, the Euphorbacias, and the Urticaceas; that pure rubber in thin sheets is whitish and half transparent; that it is the most elastic of all known substances; that its elasticity may be removed by stretching and keeping it in cold water, and may be restored by putting it into warm water; that cold makes it hard and stiff, but never brittle; heat makes it supple, and if that heat rises to 248 degrees Fahr., the gum melts, and evaporates if the heat rises to 600 degrees Fahr.; that it dissolves in bisulphide of carbon, naphtha and benzol, in washed ether, chloroform and the oils of cajeput and lavender, of sassafras and turpentine; that when treated with sulphur, as in vulcanizing, india rubber becomes black, horny and brittle, and that since the process of vulcanizing was discovered by Goodyear, pure rubber has been rarely used, the vulcanized being better for nearly every purpose for which rubber is required.

The milky juice of the bark of rubber trees is quite distinct from the sap which circulates through the wood. Each of more than sixty kinds of trees, shrubs and vines give elastic gum useful in the arts and sciences, and having generally the chief characteristics of hule or of the caucho of Para. They are widely distributed over a belt that reaches around the world, and has a width of forty-five degrees of latitude, or

from Madagascar, about twenty-five degrees south of the equator, to Vera Cruz, in Mexico, near the twenty-third degree north—a girdle more than three thousand miles in breadth. Naturally plants of so great a variety, scattered over so wide a range of latitude, differ in habitat, in habits, and in rate of growth, in length of life, in amount and quality of the milk they yield and the age at which they begin giving it in paying quantities. Some of these yield enough of the precious gum to richly reward toilsome search through forests that are often for weeks vast seas of yellow waters of South America's greatest river; through death-dealing swamps of Africa, steaming jungles of India, and moist cool hillsides of Central America and of Mexico.

Pittier says in a series of articles on caucho, that there are no less than fifteen species of *Ficus* the milk of which has not been examined, and an infinite number of vines of the *Apocinaceas* which give milk. "That is, there remains here a vast field open to intelligent investigation, and which may by well conducted experiments give profitable results."

Of the more noteworthy varieties of plants which yield elastic gum, are the *Urceola esculenta*, of Burma; the *Hancornia speciosa* or mangabeira, indigenous to Brazil; *Sapium biglandulosum* of Columbia; *Manihot glaziovii*, or ceara rubber; *Ficus elastica*, of East India; *Tabernaemontana*, *Hevea braziliensis* and *Castilloa elastica*, of America.

Balata comes from Guiana, is inferior to and sells for much less than the price of Brazilian and Central American rubber, which it is used to adulterate. An American consul says of the cultivation of balata:

"That the industry can be made a very profitable one is seen in the price paid for the rubber, which varies, in Paris from three to eight francs (57 cents to $1.54) per kilogram (2.246 pounds), according to quality. It is evident, therefore, that while industrial enterprise is lying under a cloud in South America, it may be to the interest of capitalists to turn these resources to account, the more so as rubber is one of those things which are not likely to suffer depreciation to such an extent as to make the production unremunerative."

The average cost of balata rubber of the Guianas is said to be:

Price paid to the gatherer, per pound	$0 20,	or 50 per cent.
Commissions paid to overseers	02,	or 5 per cent.
General expenses and management	08,	or 20 per cent.
Losses through bad debts	10,	or 25 per cent.
Total cost per pound	$0 40	100 per cent.

In the "bad debts" mentioned are included advances to laborers for outfits and working expenses — "grub-stakes," as they would be termed in mining parlance. Of such losses United States Consul Kennedy, of Para, said that out of a hundred such employees to whom such advances were made, at least seventy-five per cent. die, desert or return to their homes because of illness. Advances made to them are a dead loss.

The *mangabeira* grows on the arid lands of Brazil, especially on the plains west of Sao Paulo. It extends from 46° to 48° west of Greenwich, and 21° to 23° south from the equator. It requires little soil, will not thrive on moist lands, and takes four to five years to reach its full development, when it is about twelve feet in height and has a spread of branches of about eight feet. After

the fifth year the bleedings begin, and the yield of milk is large. It is calculated that the average yield per tree is one kilo ($34\frac{1}{4}$ oz.), but five kilos (11 pounds) each have been obtained from *mangabeira* trees standing on ground especially favorable to their growth. The greyish-black gum exudes a yellow fluid which, if not carefully removed, damages the quality. It is said that losses from that cause are about twenty per cent. of the market value of the gum.

Sapium biglandulosum is indigenous to the Guianas, to Venezuela and to Colombia. It is said that hundreds of thousands of pounds of gum of this species were exported from the neighborhood of Bogota in the years 1880 to 1885. The species is represented in Costa Rica, mainly at altitudes between 1,000 and 2,800 meters (3,281 and 9,180 feet), according to Prof. Pittier. He quotes a statement that *biglandulosum* has been exterminated in Colombia, and asks whether this was necessary to obtain its milk.

In all parts of Central America *Tabernaemontana* exists, usually as shrubs of little height, branching near the ground. Bark, twigs, leaves and fruits give an abundance of white milk. Five species are known to Costa Rica, growing in altitudes of 1,000 to 1,300 meters (3,281 to 4,265 feet).

The deadly swamps of the Dark Continent furnish the rubber of *Kicksia africana*, which grows to a height of fifty to sixty feet, and yields a fair quality of gum. The chief supply of African rubber comes, however, from creepers and vines of the genus *Landolphia*. Africa has roots and tubers, also, which give rubber in paying quantities.

That plant of thick and glossy leaf which stands on northern lawns in summer and adorns our rooms in winter is *Ficus elastica*, a native of Indian jungles. There the parent trunk rises, upheld by thin roots that creep out upon the surface of the ground in devious ways, and look as if they had flowed from the ribbed bole and stiffened in serpentine courses. From the limbs drop thin branches which thicken into new trunks and together hold up one broad, leafy dome, as does its better known cousin, *Ficus indica*, the banyan tree. *Ficus elastica* is of a multitudinous family, and is so slow of growth that fourteen or more years must pass before it can become large enough or strong enough to recover from "tapping" or "bleeding." It has been cultivated in East India, where the government has forests that produce, it is said, an average of about thirteen pounds per tree.

There are in moist and hot regions of America varieties of *Ficus*, better known as matapalo or "kill-tree," which begin life as vines that, starting from some limb of a tall tree, grow downward, until their rootlets, which are bunched at the ends, touch the ground. There they catch hold, sink into the soil and begin drawing food from the earth. In time they enwrap tightly and soon choke to death the tree which gave them their first support. The trunks of the vine in time become a shell which coffins their murdered nurse and foster mother, and hides from sight her ruined body.

The *Heveas* give to the world the best rubber known. They are a purely American branch of the family *Euphorbiaceas*, and have in South America eight

well-known members. The rubber of Para comes from *Hevea braziliensis*, which grows to goodly height and thickness. Its trunk is smooth, branches long, leaves alternate, generally composed of three parts, flowers small and usually of one sex only, in bunches growing at the end of the new branches. The seeds are large, smooth and lengthened. Two or three seeds are found together in a single capsule.

In America the hule of the Aztec, the *Castilloa elastica* of the scientist, is found in all latitudes from 3° south to 20° north. In Colombia it seems to exist west only of the Sierra de Merida, and in Ecuador it appears on the Pacific slopes alone. The altitude at which it thrives varies in different countries. In Costa Rica it grows at a height of 800 meters (2,625 feet), and Pittier is of the opinion that there its middle altitude may be about five hundred meters.

Hule is named *Castilloa elastica* also, and is of kin with that weed common to roadside and pasture of the North, and known to many a thousand boys who have felt mightily stuck up because their fingers pulled apart its pods stuffed with seeds and silk, or broke stem or leaf, and dabbed on things the gummy milk that flowed in thick and creamy drops. Few of those boys, or of their elders for that matter, knew that the juice of the common milkweed is very like that of the latex trees of the tropics which give the rubber that saves us from many a hard rub, and shock of blow and of noise, and in other ways helps to make modern life endurable.

The common hule that gives the rubber of commerce in Costa Rica is not the true *Castilloa elastica*, but is the *Castilloa costaricensis*. Hule macho of Costa

Rica is seemingly identical with the tuno of Honduras, which Hemsley has named *Castilloa tunoi*. In Costa Rica the favorite habitat of hule, or *Castilloa elastica*, is an altitude of 100 to 700 meters (330 to 2,300 feet) above sea-level, the best developed trees being found as high as 300 meters. In the low plains near the coasts, and in altitudes higher than 700 meters, hule becomes scarce. Five hundred meters may be regarded as its higher average level for all Central America and southern Mexico; but hule is not a tree of the lower plains. Its upper limit in Guatemala is said by Sapper to be about 400 meters. It will not thrive where the mercury sinks below 15° centigrade.

That variety called *T. Donell-Smithii*, seen by Dr. Reuss in Salvador, was found by Senor Tonduz in Buenos Ayres in 1892, and by Cooper and Donell-Smith in Santa Clara, Costa Rica, where it is frequently seen in the forests and on the banks of the rivers. The fruits, cut into small pieces, quickly give a large quantity of milk which, when boiled with water, coagulates in a yellowish mass that little by little takes a more decidedly yellowish color. This gum becomes somewhat brittle after two or three months have passed. It has been found that a coating of this gum protected perfectly copper wire immersed in salt water. It is thought, therefore, that it is as valuable as is gutta percha.

From forest trees of those countries comes nearly all the gum elastic required by a multitude of industries, and by the demands of health, comfort and luxury those industries serve; requirements so many, so varied

and often so unobtrusive that one can scarcely count the half without much research.

Although great forests exist in which rubber trees are indigenous, there are no rubber forests, and but few groves of such trees. They are, as a rule, found standing singly. It is, therefore, necessary to give much time to hunting, and labor to gathering their product. Few trees have been planted to take the place of the great number destroyed by the gatherer, although the careful studies of skilled observers have left no doubt that cultivating rubber trees will be most profitable.

Destruction of rubber trees goes on with complete disregard for every interest involved. So far from attempting to save the trees, as a source of future revenue, the native rubber gatherer resents every endeavor to preserve this source of riches, and wantonly destroys the trees which give him his living. He prefers to seek new hunting grounds rather than to use a little care in saving the trees he finds. The more prudent of them usually gashes only one side of a tree, then leaves it for a few months to recover in part. Then he again slashes it on the side opposite that where his first hackings were. This finishes that tree. The two series of cuts will girdle the trunk completely in a dozen or less places, and of course they kill it. In some countries, as Ecuador, the natives simply cut down the rubber tree, and thus at once cut off further supplies from that source.

In Central America many gatherers, when they find an untapped tree, make a ladder of lianas or vines which hang from many of the trees near, and are as tough and strong as whipcord. Across these they lash

short bits of wood, and by their help easily climb to the branches of the hule. Huleros who are clever have such steel "climbers" as aid linemen to ascend telegraph and other poles. With such things fastened to their feet, uleros—the "h" is left out of Spanish speech, and so may be dropped from English print—walk up the smooth, blue-gray trunk of the tree, and begin making cuts from which the milk quickly flows. Many another ulero makes, with rope or flexible vines, a loop around the bole and his own body, presses his bare soles against the bark, swings forward swiftly and as quickly tosses the loop upward, settles his body back against the rope, hitches his feet upward on the trunk, again tosses the loop, and so on until the lower limbs have been reached. The rest is easy.

Once at the lower branches, the ulero cuts with his machete a notch through the bark and into the wood. This notch may be from half an inch to an inch wide, and slopes at a sharp angle which, with a similar notch cut in the other quarter of the trunk, makes a big V. About two feet below this he cuts another V, and then another and another pair of gashes, lower and yet lower until the feet of the wood butcher rest on the ground. As he descends he draws a line, with finger wet in the sap, from the meeting of the first pair of cuts downward to the last, that the milk may follow instead of spreading over the surface of the bark.

In the junction of the lower V he may stick a bit of stiff leaf, or mayhap a piece of that thin-walled bamboo called cariso. Beneath that stands whatever vessel the ulero may have to catch the milk. Some carry

with them tin cups with one side flattened to fit against the tree. Many are well content with less costly and elaborate measures, and cut with a single clip of the machete a length of cariso, which they set up beneath the spout stuck in the side of the tree. In about an hour the milk ceases flowing. Some uleros empty the carisos into such vessels as they have brought to hold the gathering of the day; but many another digs in the soil a little pit, then looks about for that moonplant which scientists have named *Calonyctyon speciosum*. From this he cuts lengths enough, batters them between stones, washes out the juice in a pan and with it wets the sides and bottom of his pit, so that none of the rubber milk shall soak into the earth. He pours his collection into the. pit, and then adds the juice of the vine. The instant the two liquids mingle the milk becomes a spongy, elastic, chalk-colored mass or mat. This he usually stores in some brook.

This method is much quicker and easier than is smoking the gum in thin films over a fire, with eyes smarting well for one's pains, which, it is said, ofttimes causes blindness. There is the further advantage, seldom forgotten by the ulero, and never out of the mind of the buyer, that "mat" made in pits and stored in brooks is well preserved by abundant water, with perchance a little earth from the walls of the pit to lend weight. These make-weights might add to the sum the honest ulero gets from the buyer, if the latter did not know the tricks of the trade.

In some cases the rubber milk is left in pits in the ground until the water filters away in part, and is in part evaporated, leaving the gum. This can be done

in the dry season only. Another way is to mix the sap with a little water, and let it stand for days to coagulate. The mat is squeezed and worked to expel much of the water, and is afterward dried in smoke or in shade. Sometimes alum is used, or salt, or an acid, and the gum is afterward pressed and dried. Or four to eight quarts of water are added to each quart of the milk, and allowed to stand until the rubber rises like cream. This is washed repeatedly and dried slowly, or is smoke-dried. Or the watery parts are permitted to dry away and leave the rubber, shallow vessels being used to hold the milk. All these methods are crude, costly and unsatisfactory.

Better ways have been discovered, and it is more than likely that improvements will be made on these discoveries. The Trinidad Botanical Gardens published in its bulletin of April, 1898, an account of an operation by which a machine on exhibition there separated in two minutes the rubber from the milk of a Castilloa tree or hule. In three hours that gum became sheets or mats of rubber of fine marketable quality. It was free from the usual quantity of proteid and albuminoid matter which is in rubber made by the usual processes. Machines made for this purpose are said to have given satisfaction, after years of experience. In its Circular No. 4 the Royal Botannical Gardens of Ceylon confirms the statement that by a centrifugal machine like that used in making butter, there was prepared, in a few minutes and at little cost, caucho absolutely pure and without odor or risk of decomposition.

Hevea grows rapidly where the temperature never goes much below 75° Farenheit (24° centigrade), and

where the soil is rich and moist. In such situations it will reach a height of thirty feet in two years, and in many cases attains a height of fifty feet and a diameter of twenty-five inches in eight years. Para rubber comes from the vast valley of the Amazon, where *Hevea braziliensis* grows in lowlands which are, during many weeks of each year, a great swirling sea of muddy water. There Indians clad in their native modesty roam, and with little hatchets notch the bark of the *Hevea*, stick against it tiny cups of clay to catch the drip, and when the flow has stopped, collect these cupfuls and carry the milk in an earthen jar slung in a net of twisted bark, to the camp or other place where the curing is to be done. There the Indian makes a fire of the greasy nuts of the uricura palm, and puts over it a funnel or chimney of earthenware, to concentrate the smoke. Then he dips into the pan of rubber milk by the side of the fire a stick or paddle, and turns it over and over in the thick smoke. Again and again he does this, until the mat of gum weighs perhaps twenty-five pounds. This the Indian cuts open and hangs up to dry more thoroughly. Gum thus made is free from twigs and other rubbish, and has all possible elasticity. Possibly because it is so prepared the gum of the Amazon is the most highly prized of all rubber. That from other sources might, perhaps, be as good if as carefully and honestly treated.

The wasteful methods described are commonly followed. They are destroying rapidly the natural sources of supply, while the demand is increasing rapidly. These facts make a strong argument in favor of planting rubber trees to take the place of those in the

forest. For it has long been manifest that reckless ways of treating the rubber supply must soon destroy that source of wealth and comfort.

As no satisfactory success has rewarded experiments of inventors and chemists who have long been searching for a substitute for rubber, great anxiety has been created by the destruction of the trees. This feeling caused the United States Department of State to ask its consuls, in 1890, for such information as they could get relating to the supply of rubber trees, to the treatment given to them, and other points of importance bearing on the subject. The principal questions were:

"Will there be a shortage in the supply of crude rubber?"
"Is the rubber tree susceptible of cultivation?"
"Is rubber-growing profitable?"

The replies to these queries indicate that the supply of india rubber in accessible regions is diminishing, while the demand for it is increasing steadily. The consul-general at Mexico has written that "the Indians, in order to gain as much as possible of the juice at one time, often strip the bark from forest trees yielding the gum, or make such frequent incisions that the trees soon die. In fact, they are constantly destroying those valuable trees which by rational treatment would yield right along." The United States consul at Costa Rica said that "It is certain that the methods used have been so improvident and destructive as to almost extinguish the sources of supply in those regions which formerly produced the greatest quantity of this valuable article of commerce." Dr. Enrique Pittier, Director of the Institute of Physical Geography of Costa Rica, a

painstaking student, says in the Boletin de Agricultura Tropical: "Our forests of hule, ineffectually protected by laws well known to be dead letters, are miserably ruined to such an extent that on all the Pacific slope, from the volcano of Orosi to Punta Burica, a territory in which twenty years ago the beautiful *Castilloas* abounded, it is to-day difficult to find one. Soon we shall be able to say the same of the seemingly inexhaustible forests of the valley of the San Juan and of Talamanca and the other great valleys of the north." A like condition of affairs has long existed in Nicaragua and Honduras. The people of those countries feel that the spontaneous products of nature belong to any one who will take them, and that laws designed to protect the rubber trees are tyrannical.

The India Rubber World says that there are just so many millions of caucho trees in South America, and that it is possible, by cutting down more of these each year, to increase the production of rubber of this kind. But the faster this is done the earlier will come the end. There will be such a decline in production as is shown by the figures which are given in the next paragraph. And not in South America alone do such conditions exist. The rubber yield of Assam has fallen off; almost no Madagascar rubber now comes to market; there is marked decline in the production of Acra, Lagos and Benguela rubbers, and a like condition is predicted for the Congo Free State. In all the regions mentioned the sole mode of obtaining rubber is by destroying completely the trees which supply this gum.

The same authority has published records which show that during the years 1855 to 1875, Colombia ex-

ported 51,332,402 pounds of gum, the average annual increase having been 1,227,061 pounds through the twenty years, and the greatest increase having been during the last five years of that period, when the yearly average increase was 2,331,346 pounds. From that time the falling off was rapid, averaging 898,391 pounds for twenty-five years, during all of which quarter of a century only 43,292,343 pounds were exported by that republic.

Her average annual production of gum for the 45 years mentioned was 2,102,772 pounds, and the average for the last five years was 1,256,825 pounds less than that. If the shrinkage in production should continue at the rate of the last five years, Colombia will export no rubber in and after the year 1907.

In the years 1894 to 1900, both included, the exports of gum from Para and Manaos aggregated 349,347,495 pounds. During that time the volume of exports increased, each year, except in 1897, when 1,269,443 pounds less were shipped than were exported the previous year. The difference between exportations of 1894 and 1900 amounted to 16,038,412 pounds. Of the whole amount 173,102,598 pounds came to the United States, and 176,244,897 pounds went to Europe.

The Revue Coloniale, published by the Ministry of Colonies of France, is quoted as saying that a gang, attracted solely by hopes of immediate gain, destroyed all the *Mangabeira* trees, young as well as old, of a large district in Brazil. The consul-general of the United States, at Guatemala, wrote of the *Castilloas* of that republic: "Owing to the destructive manner which has been employed to obtain their valuable

gum, they are rapidly disappearing. There have been various attempts made by the Guatemalan government to prevent the destruction of these trees, and to encourage the planting of more." And the then consul at Managua reported that "The natural supply of India rubber yearly decreases in Nicaragua. The cause of this is the habit of the natives, until lately, of cutting down the trees, thinking that they could thus secure more milk. The government attempts no supervision of the forests; any one may cut the trees, and great destruction is going on among them, through the young ones being tapped as well as the full-grown ones."

A consul who wrote of the trade in Brazil, said: "If but three gashes per day are made in the bark of the rubber tree, and the hatchet in the hands of the careless native does not penetrate or strike the wood, the tree does not appear to suffer from the treatment, except that the trunk grows thick, and the scarred surface becomes irregular and bumpy. It will continue to grow, however, in good health, and yield milk in abundance for thirty or forty years. If the blow from the hatchet wounds the wood, the tree dies. It will thus be seen how very easily the destruction of almost 'inexhaustible' forests may be completed. For this reason very many of the once 'inexhaustible' rubber swamps of the lower Amazon are already wholly or partially abandoned, and the same fierce onslaughts are being made now upon the virgin swamps of the upper tributaries."

Many quotations might be made, all tending to show that reckless destruction of rubber trees for gener-

ations has been going on in nearly all rubber-producing countries. Several governments have tried to stop, and some have in a small measure checked, the destruction. They have forbidden the slashing of the trunks; but, as uleros work in wilds remote from the ken of the authorities, and as local officials are sometimes under the influence of uleros and traders, it scarcely is astonishing that little has been accomplished. Certain governments have forbidden all exportation of rubber from forest trees, during long periods; but as adjoining states permitted the gathering of forest rubber during the same period, the result has been that uleros and traders smuggled across the boundary lines the gum they had gathered in prohibited districts. Thus a country which has tried to preserve this most valuable source of revenue for its people not only failed in that purpose, but it lost export duties it might have got from rubber taken from its own trees.

While Indians were recklessly cutting off, at the source, supplies which gave them their living, several causes combined to increase the demand for the gum at the other end of the line of trade.

Of all rubber-bearing trees, hule is best known by people of those parts of the New World that lie north of Brazil. Much and thorough study has been given to its habits, requirements and capacity. In this the English seem to have led, and the Germans to have followed closely. From those studies the deductions reached appear to be that the *Castilloa* requires, above all else, good shade on moist, deep and well drained soil. These conditions are best found among tall for-

est trees, on hillsides, or at least on rolling ground. It seems to have been established that trunks and branches of hule exposed to the rays of the sun suffer a change in their bark, and that this adversely affects the flow of milk.

Theodore F. Koschny, of San Carlos, Costa Rica, says that the "*Castilloa elastica* is a shade tree, and any culture other than that which suits this characteristic will prove a failure. It will grow in the open until about the sixth year, when the top begins to dry off, and shoots start from the lower stump to protect the trunk. It is the stem of the tree that needs protection from the sun's rays. Trees not protected will perish from the first attempt to extract rubber. I have lost thousands of trees at the first tapping for this reason."

Koschny planted rubber seeds in the forest after cutting out the larger trees where the shade was densest. Four years later the trees were twenty-five feet in height and five inches in diameter three feet above the ground. He says that while this rubber tree is so delicate in the open field, it is quite the reverse in the forest.

Some have set hule trees among bananas, where they grew luxuriantly while well shaded; but after the tops of the hules passed those of the bananas, the growth was slow and the ultimate result unsatisfactory. Plantations of rubber thus made have been abandoned. Swampy lands and others lacking drainage seem unfit for the cultivation of hule. In such situations the trees may make rapid growth, their foliage

be abundant and fresh, but the life of the tree will be short and the milk poor in gum.

Alberto Fait & Co., owners of an hacienda on the Pacific side of Costa Rica, say: "The experiments we have made in planting hule, and the results obtained thus far, are not in accord with those indicated in the Boletin de Agricultura. Permit us to describe the state of our plantation, without comment nor idea of contradicting persons acquainted with the subject.

"1. We have hule planted among coffee, and this is the best: in two years it has attained a height of two meters (seventy-nine inches), and a circumference of twenty-two cm., (8.6 inches).

"2. We have hule in the sun, but surrounded by the forest; and this also promises well.

"3. That which is in the forest and little accessible to sunshine has lost much.

"From all which it appears that in this place, 600 meters (1970 feet), a little more or less, above the level of the sea, on land formed of volcanic detritus and much vegetable mold, and where it rains with some frequency, air and sunshine are indispensable for hule, which needs shade in its first years only."

The Boletin comments on the foregoing as follows: "We understand that the plants on the Lombardia hacienda are of little age: so we cannot admit the advantage of growing hule and coffee together. Both are plants of surface roots, and require almost the same food elements. Coffee is a mere shrub, but hule becomes a bulky tree. It will greatly damage coffee by exhausting the soil. Neither is its shade on the coffee

without bad effect. With or without reason, hule has the credit of being very exhausting, and the authors who have treated of the subject are unanimous in condemning hule in cafetals, and in plantations of cacao."

Seeds of the hule mature from March to July, according to location. Their power of germination is short lived. They grow to a size rather larger than a cherry pit, or to that of a large pea, and are covered with a mucilaginous substance. Birds and animals eat these seeds with gusto, a fact which tends strongly to keep down the number of wild hule trees. After gathering the seeds they should be kept in water, not longer than four or five days, until planted. Koschny likens the fruit of the hule to a pie three or four inches in diameter, on a green plate. "Its pulp is soft and red, having eight to fifteen seeds. When fresh one thousand seeds weigh a pound; by the end of the third day 1,500 will be required to make a pound."

From some of this evidence it appears that the simplest and safest is also the cheapest way to plant rubber. In that method the planter digs a small spot where the tree is to stand, and there puts a seed two or three centimeters deep. Some argue that quicker results may be got by setting cuttings in places thus prepared. Such cuttings should be taken from the matured branches of the hule. Others assert that trees so obtained do not grow as tall nor of as good shape as those from seed grow. When planted in the forest the trees should be four meters apart, giving 625 per hectare, and should be protected by stakes.

Of many who have given evidence as to the relative merits of various rubber trees for cultivation, the

greater number have decided that *Castilloa* is best. It seems to be suited to a greater range of temperature and altitude than most others, is propagated as easily as any, gives as much and as good gum as any other gives, with the possible exception of *Hevea braziliensis* or Para, and requires no more care in cultivation, harvesting or treatment of its milk than is wanted by any other. For wet lands Para is undoubtedly superior to *Castilloa*, therefore it is thought that *Hevea* will thrive in the low lands of parts at least of Central America, and may give good results as far north as the region of Tehauntepec.

Of hule trees John Crawford, of Nicaragua, says in the U. S. Consular Reports: "Some trees of two or three feet in diameter and thirty-five to fifty feet tall, will give annually twenty to forty pounds of good rubber. In collecting rubber, if the trees have been properly matured, from eight to twelve pounds can be taken biennially; but after the tree is twelve years of age, a sufficient quantity of sap or emulsion could be annually extracted from each tree to yield from ten to fifteen pounds of good, elastic rubber."

The United States Consul in Costa Rica says: "The trees are easily planted, need no cultivation and grow rapidly from the seed. Hitherto most people have been discouraged from planting rubber trees, owing principally to the length of time needed for the tree to become sufficiently large to produce a profitable yield of gum; but the few who have undertaken the investment can now look forward to a time not far distant when their few thousand rubber trees may bring them a fortune little dreamed of."

Another consul says of rubber planting in Nicaragua; "The trees grow very rapidly, and plantations might easily be made which, in the course of ten or twelve years, would become highly remunerative. It is an incontrovertible fact, as far at least as Nicaragua is concerned, that the rubber tree is susceptible of cultivation. This assertion is based upon the success that has accompanied the few experiments that have already been made. In this district are large tracts of land suitable for growing rubber trees. It is the opinion of those here who are interested in rubber production, that it would be very profitable."

John Hinckler Hart, F.L.S., Superintendent of the Botanical Department of Trinidad, who is an authority, says: "The experience personally gathered during twenty-three years of service in the West Indies; what has been gathered from writers on the subject who have detailed their observations from the viewpoint of both travelers and cultivators; and from actual travels and observations personally made in Nicaragua and other parts of Central America, lead to the conclusion that for the present the most valuable rubber for planting in Trinidad is the *Castilloa elastica*. This is the kind from which a crop can be most quickly obtained, and it is the fastest grower. *Castilloa* trees are not found growing in swamps or inundated lands, but on the flat, moist banks of rivers. Of all the different species of rubber-producing trees, the *Castilloa* should prove, under cultivation, the most remunerative. I am of the opinion that, properly and economically conducted, the growing of rubber offers a safe and suitable investment."

Superintendent Hart has continuously and persistently advocated the cultivation in Trinidad of the *Castilloa*, and at the time of writing, in 1898, had orders for 300,000 seeds. He declared that the climate of Trinidad is probably better suited than is that of any other West India island for the successful growth of *Castilloa*, and that it was his belief that it is equal to the climate of Central America.

In Ceylon *Castilloa* trees six years old had a circumference of twenty-six inches three feet from the ground, and grew three and a half inches in girth during the year. Two years later the same trees were forty-three feet in height and thirty-two and a half inches around at three feet from the ground.

Robert Cross, the well-known collector, in his report on gathered seeds of the various rubbers furnished to the Indian government, says: "My own opinion is that, planted in suitable places and properly wrought, *Castilloa* will be found to give a larger return per acre than any other plant or tree cultivated in India."

Mr. Cross further reported to the Madras government "that a tree of *Castilloa* one and one-half to two feet in diameter should give twelve pounds of rubber per annum." Many other sound authorities have given their testimony as to the high value of *Castilloa elastica*, which produces nearly every pound of rubber from Costa Rica and of all the tropical countries north of that republic.

Senor Romero, lately ambassador from Mexico, in his very full and elaborate work, "Coffee and Rubber Culture in Mexico," says of the *Castilloa:* "The large profits of rubber culture are obvious. A plantation

will give, at the end of a few years, six pounds of sap a year for every tree; that sap would lose about one-half by evaporation. Then each tree would yield three pounds net of rubber; the minimum rate of production, which will increase every succeeding year to the extent of being three or four times greater than the first."

In recent years, the better informed, more intelligent and enterprising dwellers in tropic countries have observed with concern the destruction of wild rubber trees, and have asked, with deep interest, whether or not the cultivation of rubber-producing trees will pay. Their interest in this question has been shared by manufacturers, dealers and others. This has caused careful study of the subject by capable inquirers. Perhaps such studies led to the expression credited to the late Collis P. Huntington, who made millions by building and managing railroads. He is said to have remarked: "If I had my life to live over again I would not wear it away in the hard struggle that falls to the lot of the railroad promoter. I would go into the tropics of Mexico and grow rubber. It is better than gold, and it will make more millionaires than oil has made."

Yet he was eminently successful in his field, which required of him wide and accurate knowledge, keen insight and prudent judgment; therefore the words above quoted are deserving of consideration. Others have given evidence of like tenor; as Senor don Matias Romero, formerly minister at Washington for Mexico, who is perhaps the most quoted of all writers on Mexican agriculture. He says: "A well-managed rubber

plantation, after six years, should be able to distribute among its shareholders from one hundred to one thousand per cent. annually on their investment."

Before accepting as a guide opinions which encourage hope of such relatively great profits, prudent people will study well the evidence of many witnesses, that they may know what are the grounds on which such opinions are based; for rubber cultivation is a new industry, almost wholly unknown to millions of intelligent and well-read people of America. Before questions of detail as to management of plantations should come the questions: What are the cost of cultivation, the yield of gum and the probable value of the product? What is the existing, and what will be the future, demand for that product?

Other questions of importance, relating to conditions other than those of soil and climate, will naturally occur to the prudent investor; but, so far as may be learned from the rapidly-growing mass of evidence, there is little if any risk in growing rubber in cleared plantations, and none whatever if planted among forest trees,—a plan which closely follows nature.

All trustworthy evidence obtainable seems to warrant the opinion that a safe guide, for those who think of engaging in tropical agriculture, may be found in the figures gathered into the next page. They present the means of the statistics and the estimates offered by thirty-five authorities, to show the probable quantities of gum from a yearly yield of *Castilloa elastica* trees of various ages and conditions. The values are those of like quantities of gum at the mean New York price for the decade ending with the year 1900:

Countries	AUTHORITIES	Ounces	Values
Bolivia	Conway, Sir Martin	80	$3.00
Brazil	Kennedy, K. K., U. S. Consul	248	9.30
Brazil	Temple, British Vice-Consul	44	1.65
Calcutta	Handbook of Commercial Products	26	.975
Calcutta	Merritt, S., U. S. Consul	128	4.80
Ceylon	Botanic Gardens Report	80	3.00
Colombia	Croft, C. L., Consul	320	12.00
Colombia	Sims, W. E., U. S. Consul	62	1.95
Costa Rica	Koschny, Theodore F.	16	.60
Guatemala	Chama Co	48	1.80
Guatemala	Horta, Jose	16	.60
Guatemala	Record, Philadelphia	80	3.00
Jamaica	Derry, R., British Colonial Forestry Board	43	1.64
Jamaica	Kew Bulletin	26	.975
Jamaica	Jackson, J. R., Kew (*Kicksia africana*)	176	6.60
Mexico	Artiz, Dona Felipa	48	1.80
Mexico	Aztec Co	21	.788
Mexico	Bedford, W. J., manager El Salto	56	2.10
Mexico	British Foreign Office	48	1.80
Mexico	Bryden, superintendent	64	2.40
Mexico	Coate, A. B.	12	.40
Mexico	Dering, Sir Henry, British Minister	44	1.65
Mexico	Ellsworth M. R.	8	.30
Mexico	Fernandez, Don Rejolia	112	4.20
Mexico	Gano, Charles C., C. E.	170	6.35
Mexico	Guenther, Richard, Consul-General	267	10.01
Mexico	Mayangos, Don Lateo	56	2.10
Mexico	Romero, Senor don Matias	93	3.488
Mexico	St. Croix, M.	80	3.99
Mexico	Yorba, Senor	32	1.20
Nicaragua	Armstrong, W. S.	32	1.20
Nicaragua	Crawford, John	169	6.34
Nicaragua	Morris, Dr. Daniel	24	.90
Trinidad	Hart, Superintendent Botanical Garden	64	2.475
General	Bureau American Republics	64	2.40

From the above thirty-five reports it appears that the average of the mean yield reported was 81.6 ounces of crude rubber gum, or 5 pounds 1.6 ounces. The value was calculated at 60 cents a pound net, and averaged $3.06 per tree.

In a series of tests made, evidently with much intelligent care, by A. B. Coate, manager of a plantation on the Isthmus of Tehauntepec, Mexico, it was

found that the milk oozed so slowly from the bark of young trees, and in such small quantity, that it would not leave the cuts. In some cases the milk was allowed to dry into strip in the channels; in other instances it was brushed from the cuts and solidified by modes other than slowly drying in the air.

The first lot of eight trees thus tested by Mr. Coate and mentioned in the following table, stood 5 x 8 feet apart; the second lot of eight were 8 x 10 feet apart. The design is to bleed out enough of these to relieve their fellows, when they shall have become crowded. It appears from the reports that 29 tappings of trees from 5.7 to 7.75 inches in diameter and 30 to 78 months old, averaging 44 months, gave an average of 2.5 ounces per tree, which may be valued at 9.4 cents net.

CONDITIONS	No. Trees	Diam. Inches	Ounces of Gum
Cultivated; 42 months old; all strip	8	5.70	8.00
Retapping above; interval one month	8	5.70	2.70
Cultivated; 30 months old from seed	8	6.25	19.00
Retapping last above; interval one month	3	6.25	2.70
Half wild male	1		8.00
Wild; estimated age 78 months; slight flow	1	7.75	3.00
Total, 29 tappings; averages	29	6.35	1.50

Twelve tappings of uncultivated and larger trees showed results as follows:

CONDITIONS	No. Trees	Diam. Inches	Ounces of Gum
Injured by fire two years before tapping	3	14.2	16.2
Of this gum 8 oz. was strip	1	12.0	24.0
Of this gum 7.3 oz. was strip; bark $\frac{5}{8}$ in	1	11.5	22.0
No strip; bark $\frac{7}{8}$ in. thick	1	18.0	46.0
Retapping last above; interval 3 months	1	18.0	15.0
" " " 1 month	1	18.0	14.0
First tapping; no strip	1	14.0	23.0
Bark $\frac{3}{4}$ in. thick; no strip	1	20.0	55.0
Male, cut down	1	19.0	40.0
Male	1	12.0	4.0
Total tappings, 12; averages	12	13.1	21.6

At 60 cents a pound the average yield above shown would be worth 81 cents. Five of the trees were not far from the same size, but their yield ranged from 15 to 55 ounces.

Reliable data as to some of these points are not easily obtained, because few years have passed since careful study of the subject began, and because few have had conclusive experience in this industry. It is not denied that much knowledge has been gained of the habits of growth, the needs and the yield of various rubber-giving trees, nor can it be doubted that correct deductions from such knowledge will give in time a trustworthy guide to the planter. There may be little risk in planting rubber in the way which requires the least outlay of time, labor and money; and there are practical planters who hold that this way gives the best results yet obtained from rubber culture.

Bearing on the question of yield of rubber trees we have the testimony of a number of witnesses. Many of these were United States consuls who were instructed by the Department of State to inquire into the subject. It is fair to assume that each, as it is certain that some of them, give in their replies evidence obtained from many who had thorough and practical knowledge of the crude rubber industry. A summary of the evidence of these consuls, and of other seemingly trustworthy witnesses, is given in the foregoing table. It has seemed proper to estimate the value at a conservative figure.

Charles C. Gano, C. E., spent nearly ten years in Mexico, during which he studied the subject of culti-

vating rubber. He says that a seven-year-old *Castilloa* should yield at least 1.5 pounds of pure rubber. This yield should increase 8 ounces each of next 17 years of its growth, and after the tree attains the age of 25 years it should give 15 to20 pounds of fine gum annually during the rest of its life.

Such yield from an acre of trees 15 feet apart each way, or 222 trees per acre, would amount to 3,330 pounds. If it should be estimated that the gum will sell for a price equal to the mean of the quotations for 316,807,000 pounds imported in the last nine years, viz., 84 cents, and that 14 cents will be required to pay expenses of gathering and marketing, the planter should have an income of $2,331 per acre.

Mr. Daniel Morris is a botanist of wide reputation who has studied the rubber-yielding species, not only experimentally in botanical gardens, but also in their native forests in Central America. There he became convinced that *Castilloa* trees, planted in suitable localities, will yield an average of one pound sterling, or about five dollars, each at the end of eight or ten years.

Superintendent Hart, of the Botanical Gardens of Trinidad, says there are in that garden *Castilloa* trees which will give from four to six pounds weight per annum. An acre of 200 trees will give a gross return of some ninety pounds sterling, say $450 per annum, while the expense for maintenance is much less than for any other known crop.

In the State of Amazonas, Mr. Temple, British Vice-Consul, found, by examining the books of a number of actually worked rubber estates, that the average yield of Para gum per tree, per season, may safely be

estimated at 2.2 to 3.3 pounds, under favorable conditions, although on some estates the average is not more than 1.1 pounds.

Sir Martin Conway says that in Bolivia he found nobody counting on less than three pounds of rubber per tree annually, and no estimates higher than seven pounds.

In the Ceylon Botanic Gardens one Para rubber tree was tapped, with results as follows:

At 11 years age	27.75 ounces
At 13 years age	42.00 ounces
At 15 years age	45.00 ounces
At 17 years age	51.00 ounces
At 19 years age	48.25 ounces

Evidence has been given showing that 5,000 cultivated *Castillous* gave, in 1899 and 1900, 12,000 pounds of gum. This is equal to two pounds six and one-fifth ounces per tree.

Cost of production is of course an important element in any business, but seems to be comparatively light in the case of rubber cultivation. Even when land is cleared of forest growths, and rubber trees are planted in the open fields, the expense seems to be not heavy. M. H. Lewis, Vera Cruz, Mexico, says that sixty dollars an acre will clear and plant with two hundred such trees. The cost of replanting where trees die, and of cultivating, will be forty dollars per acre the first year, and twenty dollars annually thereafter until the seventh year, making a total of two hundred dollars per acre, or one dollar per tree by the time they are ready to tap.

The same gentleman says that the cost of planting among forest trees, including cost of plants for 150

trees per acre, is thirty-six dollars per acre. Weeding and replacing plants which die will average twelve dollars annually during the next seven years. The trees will then have cost eighty cents each, or one hundred and twenty dollars per acre, and will be ready to tap.

Theodore F. Koschny, of San Carlos, Costa Rica, where *Castilloas elastica* in great numbers thrive, has found by many experiments that the cost of planting 115 to 117 trees per acre, and caring for them until seven years old, would be small in comparison with the large and lasting returns which would be secured from the gum, plus the value of the plantation. He would take sixteen ounces of gum per tree in their eighth year.

Witnesses who have given evidence as to the yield of rubber trees, are quoted as having written as follows:

"A large tree, five feet in diameter, will yield, when first cut, about twenty gallons of milk, each gallon of which will make about two and a half pounds of rubber."—Thomas Belt, F. G. S.

"Trees planted on lands having the soil, climate and elevation adapted to the culture will produce from five to six pounds of juice on the first year that they are tapped, which amount is equivalent to 2.4 pounds of pure rubber. One hundred thousand rubber trees, the first year's harvest, will yield $120,000."— British Foreign Office Report.

"About 44 per cent. of rubber remains from the original amount of milk after the water and other matters have been eliminated by evaporation. Trees planted on lands having the soil, climate and elevation

adapted to their culture, will produce from five to six pounds of juice in the first year that they are tapped, which amount is equivalent to two and two-fifths pounds of pure rubber. This product will be gradually increased every year for the next four or five years, and will sell for fifty cents per pound on the plantation. By the sixth or seventh year rubber trees will be in bearing, and the seventh and thereafter should yield from three to five pounds per tree. Given six hundred pounds as the yield of an acre of 193 trees, and fifty cents per pound as the profit realized over expenses, we have a profit of three hundred dollars gold per acre."—Bulletin of American Republics.

"Trees from one to three and a half feet in diameter yield annually from two and a half to twenty gallons of emulsion, from each gallon of which about two pounds of rubber should be collected."—J. Crawford, botanist.

"On an average about forty pounds of rubber is obtained from each tree of average size."—C. I. Croft, Consul, Cartagena, Colombia.

"Planting is easy and inexpensive and the returns very tempting and good. Trees should yield from $1.50 to $2.00 each per annum. There are two methods of planting—from the seed and from the shoot. The former takes from six months to a year longer than the latter. Statements vary widely as to the period of maturity. Some claim that the tree will yield when four or five years old, and some that it will require a much longer period."—U. S. Consul-General De Leon, at Ecuador.

"Trees planted in land having the desired climate

and elevation for the culture will produce from five to six pounds of juice on the first year that they are tapped (at the expiration of the fifth year from planting), which amount is equivalent to 2.4 pounds of rubber. This product will be gradually increased each year for the next four or five years. Don Juan Aleman, Acayucan, has a grove of several hundred rubber trees of all ages, nine years and down, and irregularly planted, with coffee between, in healthy condition. Last year forty rubber trees were bled, producing 125 pounds of rubber (3⅛ pounds to the tree), or over $480 per acre. Seven hundred and fifty trees will produce 4,500 pounds, worth at the plantation twenty to twenty-two dollars per hundred pounds. Deducting the cost of curing, he will have a net profit of $1,225, besides the profit from corn, bananas and vanilla raised as side crops. The net profit on the investment of 100,000 rubber trees, after deducting the entire cost of land and all expenses up to the first year of harvesting, will be $95,000, and each of the succeeding harvests for twenty-five or thirty years will bring a steady income of over $100,000."—Consul-General Sir Henry Neville Dering to the British Government.

"There is one case authenticated in Soconcusco, where three young forest rubber trees were transplanted which have now yielded for more than thirty-five years. The diameter of trunks of said trees is about seven feet, and the diameter of branches at their greatest expanse is more than eighty feet. Each of these trees yields annually more than fifty pounds of gum."—Richard Guenther, U. S. Consul.

"On the River Aquiry, or Acre, one of the tribu-

taries of the River Purus, two hundred trees yield as much as three tons of rubber per annum."—Consul Kennedy, Para, Brazil.

M. LeCroix, on his plantation on the Tulija River in Chiapas, is said to have secured an average of five pounds of rubber from trees six years old.

Mr. M. H. Lewis, a rubber planter on the Isthmus, says in a letter to the "India Rubber World," July 1, 1899, that at an estimate conservative in the extreme, a plantation of rubber trees will yield the first year's tapping eighty dollars per acre, four hundred dollars per acre four years later and eight hundred dollars per acre when the trees are in full bearing.

"The quantity collected at one cutting seldom exceeds eight to ten pounds."—Samuel Merritt, Consul-General, Calcutta, India.

On September 2, 1891, Mr. Mateo Mijangos wrote to the "Official Journal" a letter about rubber cultivation, in which he says, among other things: "A rubber tree gives, in its first year of bearing, two pounds of product; three pounds in the second year, four in the third, and five in the fourth; together fourteen pounds, which, sold at fifty cents, gives seven dollars, or $1.75 per tree each year."

"A rubber plantation in full bearing, say the eighth year, should yield anywhere from $250 to $350 gold profit per acre. Matured rubber plantations are not for sale."—Philadelphia Museum. W. P. Wilson, Director.

"The greatest number of agriculturists seem to agree that a tree, after attaining its proper proportions, should produce a quantity of rubber weighing not less

than six pounds annually. It must be observed, however, that as the yield of each tree will increase annually, there is every reason to believe that a tree twenty years old will give *fifteen to twenty-five pounds of sap each year.*"—Sr. Don Matias Romero.

"Trees growing in the forest to a height of about forty feet and a diameter of three feet, yield from twenty-five to one hundred pounds of raw rubber per annum, according to the size of the tree."—W. E. Sims, Consul, Colon, Colombia.

Senor Sabatana has a rubber plantation of ninety acres located in Guatemala, across the line from the Department of Palenque, in the State of Chiapas, the trees now being thirty years old. This gentleman claims that his plantation pays him over $1,300 per acre each year.

In "Mexico and United States," published in 1898, Romero says:

"Enough has been written lately on rubber cultivation to show that the profits in Mexico, at least, would be very great; indeed, three hundred per cent. on the capital invested is a possible return, after five years, from cultivating *Castilloa elastica* in that Republic. This is a return which provides plenty of margin for contingencies. Rubber growing is no longer in the experimental stage, as witness the plantation of La Esmeralda, in Oaxaca. According to the same report the total expense for five years' cultivation of a rubber plantation of 100,000 trees will not exceed $25,000 in silver, and the yield of 100,000 trees at the first year's harvest will bring the planter $120,000, besides the product obtained from the corn, vanilla beans, cacao

and bananas raised from side planting. The net profit on the investment, after deducting the entire cost of the land and all expenses up to the first year of harvesting, will be $95,000."

Our consul at Para said: "There is no question whatever as to either the practicability or the immense lucrativeness of rubber growing in this valley. Here it is solely a matter of time. The seeds are abundant and easily obtained. They germinate easily and grow rapidly. The young rubber trees can be found in the forests and transplanted; but it is much less labor to plant the seeds in a garden bed until they are ready to transplant. The great advantage of a compactly planted rubber grove would be the saving of labor in traveling through the swamp. The rest of the work is light and quickly done, except, perhaps, the coagulation of the milk. Then why don't they plant rubber trees? That is the question Brazilians are beginning to ask each other. Every one confesses that it would be a most magnificent investment of capital. The few experiments that have been made abundantly prove that they are right."

Senor don Matias Romero, author of the most complete work in existence on Mexican agriculture, says: "Anyone in a situation to enable him to make a rubber plantation of greater or less extent, may undertake it at once, with the full conviction that it is the safest and most lucrative industry; neither cacao, tea, coffee, sugar nor any other tropical product would give the same profits as rubber; and the returns from each of these industries are in reality equal to those obtained from a rich gold mine."

Eugene Ackerman is said to have carefully studied the rubber interests while at Para, and is credited with the statement that the difficulty of getting laborers in the valley of the Amazon will prevent production keeping up with the increase in consumption.

The India Rubber World, published in New York, is an authority on subjects relating to the rubber business. It says: "The day of scoffing at the idea of cultivating rubber is past. That there will be disappointments and failures in fraudulent and badly managed plantation schemes no one doubts; but that the cultivated rubber tree ten years hence will be a productive and exceedingly profitable part of many large plantations is an undisputed fact."

It said in February, 1901: "As to the future of rubber prices, certain considerations are worthy of attention. In the first place, the great increase in the demand for raw material in recent years has been due both to new uses of rubber and to the introduction of the use of rubber goods into new fields. In not a few cases the recent rate of growth is doubtless meeting a check for the present, whereas the production of rubber seems likely to continue, in which event it would seem that prices should decline. On the other hand, a very marked decline in prices would lead to still further new uses of rubber, which would prevent the cost from sinking to former levels, or at least from staying there very long." That periodical quotes prices of rubber in New York and Liverpool for the years 1892 to 1900, both included, from which the mean prices and rises and declines were found to be as follows, in cents :

Years	New York	Difference	Liverpool	Difference
1892	65.85		67.85	
1893	67.00	— 1.15	73.90	+ 6.05
1894	68.75	+ 1.75	71.85	— 2.05
1895	75.75	+ 7.00	77.20	+ 5.35
1896	78.00	+ 2.25	81.80	+ 4.60
1897	84.25	+ 6.25	87.05	+ 5.25
1898	95.00	+ 10.75	97.70	+ 10.65
1899	100.50	+ 5.50	102.05	+ 4.35
1900	97.25	— 3.25	102.25	+ .20

It is evident that the rise in prices has been almost constant since the year 1893, and amounted to 30.25 cents per pound, or 45.1 per cent. During those years the importation of crude rubber into the United States was 316,807,680 pounds, of the value of $268,946,081, or 84 cents per pound. In 1893 and 1900 there was a decline in New York, and in 1894 in Liverpool.

In the year ending June, 1899, the forests of the tropics sent out some 100,000,000 pounds of rubber. It has been shown that of that vast quantity Para alone furnished about 36,500,000 pounds, Manaos 12,175,000 pounds. Africa ranks next as a producer, but its gum is inferior to that of Brazil; then come in the order of their importance as producers of gum, Ecuador, Nicaragua, Colombia, Mexico, and lastly, Venezuela. Millions of dollars invested in steamships and railroads are employed in carrying to the markets of the civilized world the product of these tropic trees, and in taking back those of factory and of farm to pay for the labor of Indians in the wilderness, and of a host of white men who also serve this great branch of industry, which has the safety, the convenience and the

comfort of humanity for its purpose. The construction of the Congo railway was largely, if not wholly, due to the demands of this great industry.

Money flows from trade centers of Europe and the United States to the rubber traders. Under the stimulus of this traffic cities have been built; perhaps the greatest of these being Para, at the mouth of the Amazon. It has a population of 100,000, and is the rubber market of the world. But 2,000 miles up the Amazon is a lusty young rival, Manaos, with 40,000 inhabitants, to which go vessels direct from ports in distant parts of the world. Para ships daily carry some 100,000 pounds of rubber, and Manaos sends out about one-third as much. There are upon the western coast of Africa two cities of size which almost wholly live upon the rubber trade.

Rubber growing is not a competitive business in the sense in which the term is used customarily; its experimental stage may not be past, and the actual, practical field of operations is in effect quite new. The task is to supply a hundred million pounds of rubber demanded each year. To do this, the product of fifty million trees giving two pounds of gum each would be needed. Manifestly the field is not cramped nor crowded. One who has income enough to support him while waiting for the rubber trees to reach a paying age may invest in planting rubber, assured against early and sharp competition; for comparatively few will have the courage to plant and the patience to wait eight years for an income which, when it does come, should pay amply for all expenditures and waiting.

Only a few years have passed since the first rub-

ber tire was made. To-day a million—or is it perhaps several millions—of tires are rolling over highways and byways in all lands where man may go with more or less safety. Automobiles not only quickly wear out great quantities of rubber, on streets and on roads already well paved and smooth, but they will be the most powerful factor ever known in leading to the making of more good roads, until improved highways will be the rule instead of the rare exception in all the land. And such improvements will bring into service yet more rubber-tired vehicles, which will in their turn work for yet more extensive improvements in roads, and so on, at an accelerating rate.

Rubber may be worked over into new forms, and thus be made to serve a second and perhaps a third time, after having been useful in shapes and for purposes for which great elasticity is required; but that which is worn from a tire is wholly lost. Destruction of the sources of supply on the one hand and more rapid and complete destruction of the manufactured product on the other must result in such scarcity that an advance in prices will follow, unless some effective means shall be adopted for changing such conditions. Planting rubber trees may change all this, but years will probably pass before enough gum will be obtained from plantations to materially reduce the price of rubber. Already the demand for rubber is so great that prices have advanced largely. Changes plainly foreseen are likely to make a demand which all known sources of supply cannot meet. Even if planting of rubber should go on for a generation at a rate many times as great as is now known, there would be no more rubber than

will be required at prices which will give large profits.

Some of the rise in value is doubtless due to the general prosperity which advanced the value of other raw materials; but it seems safe to conclude that the requirements of modern life will scarcely permit prices to fall much, even should a financial and industrial panic come. Economies practicable on a cultivated plantation are enough to give profit, because the trees are on a limited area and therefore within easy reach; there are no losses through advances to laborers who may run away with the rubber; no "dead losses" due to illness or death among laborers; there is saving of time and money and improvement in the quality of the gum through the use of scientific methods in treating the milk; and the owner of the plantation himself may market his crop, without paying profits to many middle-men, as producers of wild rubber now have to pay.

Those who cultivate rubber have advantages which those who till the land of the North do not enjoy. Chief among these is that uniformity of seasons which insures regularity of harvests throughout the decades, thus preventing over-supply and depression of prices. No drought or flood cuts off the crops, nor does frost in a night destroy the products of years of working and of hoping.

Planters who have suitable lands raise bananas, colocasia and cassava with which to feed their laborers, and to sell for the money to pay expenses while waiting for the first crop from their rubber trees. The waiting may seem long and tedious, but each day brings something to help carry the permanent investment toward the harvest; and the planter has the as-

surance that each day adds to the value of his rubber trees, and to the probability that he will in a few years enter on the enjoyment of a sure income for life. No insurance, no pension, no annuity so great as his rubber grove will probably give could be bought for ten times its cost.

Analysis of carefully gathered and trustworthy data shows that the principal eight crops harvested in the United States during the thirty-seven years that ended with 1902, had a general average farm value equal to only $18.98 per acre. Their yield, their values and the amounts by which the ascertained value of banana, and the calculated value of rubber crops *exceed* the value of those eight American crops, is shown by the subjoined table:

CROPS	Yield Per Acre	Value Per Acre	Difference in favor of	
			Rubber	Bananas
Barley, bushels....	22.9	$13 49	$299 37	$106 44
Buckwheat, " ...	15.3	9 47	303 39	110 46
Corn, "	24.8	10 07	302 79	109 86
Oats, "	27.4	8 80	304 06	111 13
Potatoes, "	82.5	48 89	268 97	76 04
Rye, " ...	13.6	7 81	305 05	112 12
Wheat, "	12.5	10 65	302 21	109 47
Hay, tons.....	1.25	10 86	302 00	109 07
Tobacco, pounds.....	797.3	55 81	257 05	64 12
General averages ..		$18 98	$293 88	$100 97

These figures show that the farmer of the United States, in return for all the intelligence and the diligence and energy he puts into his work, for the use of his money and for his exhausting toil, receives from his farm far less than the safest and simplest of all crops

of tropical America gives for little more than the mere harvesting.

If a tract were planted with rubber trees twenty feet apart, and if their annual yield of gum should be worth $3.06 per tree, the net profit would be $312.86 *more* annually than the farm value of those eight crops of the North. In other words, a rubber plantation should give each year a profit equal to the average farm value of those crops for thirty-seven years and nine and a half months.

In the year 1902 a consul of the United States was widely quoted as having written alarming statements about the rubber-planting industry. Articles which were widely published in the United States and Europe, insinuated, if they did not distinctly avow, that "rubber-planting is worse than a lottery," and that those who induced people to join in planting rubber were "digging a hole into which good American dollars may be dropped out of sight forever." Yet the very articles which contained such charges said that on a plantation near Tuxtepec, in the State of Oaxaca, Mexico, 350 rubber trees seven to nine years old gave 800 pounds of gum, for which $312 U. S. gold was received. If correctly reported, the average yield per tree was 2.29 pounds, and the average income per tree was 89 cents. If those trees stood twenty feet apart, the income was $96.27 per acre.

If the cost of clearing, planting and caring for that plantation through the seven to nine years—say eight years—averaged $300 per acre, that first crop paid 3.8 per cent. per annum on that cost. If those figures are correct, those who own that plantation have in it a

property which now pays an amount equal to five per cent. per annum on $1,925.40 per acre. One might be safe in saying land and cultivation which, in a merely experimental stage, pays five per cent. a year on nearly two thousand dollars per acre, may be a safe investment at $300 per acre.

Nevertheless, he who would hurry into the planting of rubber would do well to remember that, rich as the promises of the industry now are, much remains to be learned about the effects which the varying conditions of climate, of soil, of exposure and other matters have on the various kinds of rubber-bearing plants. Without knowledge of such subjects one may find loss where fair gains are promised, even though trustworthy authorities agree that the cultivation of rubber will long be most profitable.

The facts reported seem to show clearly and strongly that rubber growing especially invites co-operation by the many who can invest small sums, and who can scarcely afford, even if they were willing, separately to give their own time and labor to a crop which requires so little attention, during the six or eight years that may elapse, between the planting and the first harvest.